ARHEOMETALURGIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Arheometalurgija
Course title:	Archaeometallurgy
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077532
Koda učne enote na članici/UL Member course code:	678

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15	0	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Knap
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Liabilities are defined in the regulations on examination and evaluation of students at ULNTF. For a positive and successful attendance of their duties students are encourage to regular attendance of lectures, additional domestic more complex work more and appropriate preparing to laboratory work. At least 80% attendance at tutorials is needed.

Vsebina:	Content (Syllabus outline):
/Obravnavana bodo naslednja poglavja: • Postopki proizvodnje kovin in zlitin iz rud. • Zgodovinski pregled sprememb lastnosti kovin in zlitin. • Razvoj bogatenja rud (oksidne, sulfidne, karbonatne) za pridobivanje kovin • Razvoj metalurških reaktorjev (peči) v časovnih obdobjih. • Pomen in sestava žlinder pri pridobivanju kovin in	The following section will be presented: • Technologies for the production of metals and alloys from ore. • Evaluation of changes in the properties of metals and alloys from historical point of view. • Development of processes for ore (oxide, sulfide, carbonate) beneficiation in the production of metal • Development of metallurgical reactors (furnaces) threw time periods.

zlitin. • Pomožni materiali: lesno oglje, glina, steklo in steklasta faza pri nizko taljivih žlindrah. • Razvoj proizvodnih postopkov pridobivanja in predelave kovin skozi stoletja (tisočletja) in njihov pomen za kakovost izdelka. • Mejniki prehoda iz enega v drug proizvodni postopek. • Razlaga starih metalurških izrazov za opis tehnologij in izdelkov. • Razvoj direktnih postopkov proizvodnje, predelave in rafinacije - vpliv na kakovost produktov. • Praktični prikaz starih postopkov pridobivanja kovnega železa, surovega železa, jekla, bakra, brona, svinca itd. Primerjava osnovne ter z legirnimi elementi in toplotno obdelavo spremenjene mikrostrukture. • Zgodovinski pregled energetske učinkovitosti: poraba lesa, lesnega oglja, premoga, vodne sile, pare itd. Pred začetkom predavanj in vaj bo študentom razdeljeno študijsko gradivo.	• Role and composition of slags in metal and alloy production. • Auxiliary materials: wood charcoal, clay, glass and glassy phase slag with low melting point. • Development of technologies for the production and processing of metals through the centuries (millennia) and their importance for the quality of the product. • Milestones in the transition from one to another manufacturing process. • Explanation of the old metallurgical terms which describe the technologies and products. • The development of direct methods of production, processing and refining - impact on the quality of products. • Demonstration of old processes for the production of ductile iron, pig iron, steel, copper, brass, lead, etc. A comparison of the original and with alloying elements and heat treatment modified microstructure. • Historical review of energy efficiency: consumption of wood, charcoal, coal, water and steam power, etc. Before the start of lectures and exercises study material will be presented to students.

Temeljna literatura in viri/Readings:

Andreas Hauptmann: Archaeometallurgy – Materials Science Aspects, Springer, 2020 Jernej Kotar, Tomaž Lazar, Peter Fajfar: Ko zapoje kovina, Narodni muzej Slovenije, 2019

Cilji in kompetence:	**Objectives and competences:**
/Na ozemlju Slovenije je nešteto krajev v katerih so sledovi pridobivanja, proizvodnje in uporabe kovinskih materialov – predvsem železa, njegovih zlitin in tudi neželeznih kovin. Številni kovinski predmeti so bili odkriti z izkopavanjem tudi po drugih arheoloških najdiščih. Cilj tega predmeta je podati pregled postopkov pridobivanja kovin in zlitin v različnih časovnih obdobjih in njihov vpliv na izdelke. S tem znanjem bodo sposobni oceniti pomen dobe z različnih zornih kotov - tehnološkega-razvojnega, kulturno-zgodovinskega in ekonomskega. Spoznali bodo zakaj so nekatere kovine in zlitine že tisočletja nepogrešljivi materiali, ki določajo zgodovinske dobe.	On the territory of Slovenia are countless places where the traces of the gaining, production and usage of metals – particularly iron, iron alloys and non-ferrous metals. Many metal objects were discovered by the excavations at other archaeological locations. The aim of this course is to provide an overview of procedures for metal and alloy production regarding to different time periods and their impact on the products. This knowledge will enable assessment of the importance of historical age from various perspectives - technology-development, cultural-historical and economic. They will learn why are some metals and alloys for millennia indispensable materials that why they define historical periods.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študenti bodo spoznali in razumeli proizvodne postopke s katerimi so ustvarjali metalurgi v davni preteklosti. Spoznali bodo različne materiale in način nastanka čudovitih kovinskih izdelkov. Znanje bodo uporabili pri razlagi in vrednotenju postopka izdelave izdelkov najdenih na različnih mestih izdelave ali uporabe.	Students will prize and understand production processes used by metallurgists in the distant past. They will learn about a variety of materials and origin of beautiful metal products. Knowledge will be used in the interpretation and evaluation of the processes needed creation and usage of products found in various places.

Lahko bodo razumeli veličino mojstrov, ki so v različnih dobah ustvarjali in spoštovali njihove veščine pridobljene na podlagi izkušenj in opazovanja metalurških procesov	They will understand the greatness of the masters who have creating in different historical periods and respect their skills acquired on the basis of experience and observation metallurgical processes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, seminarske in laboratorijske vaje, terenske vaje, samostojno delo	Lectures, seminars, tutorial and laboratory work, fieldwork, individual work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ustni izpit	60,00 %	oral exam
pisni izpit	20,00 %	examination
seminarska naloga in poročilo laboratorijskih vaj	20,00 %	seminar work and the report of the laboratory work

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

LAMUT, Jakob, ŽIVKOVIĆ, Dragana, ŠTRBAC, Nada, DEBELAK, Martin, LAMUT, Barbara, KNAP, Matjaž. Microscopic investigations of slags from Felix Romuliana Gamzigrad. V: STANOJLOVIĆ, Rodoljub (ur.), SOKOLOVIĆ, Jovica (ur.). Proceedings. Bor: Technical Faculty, 2007, str. 449-456, ilustr. [COBISS.SI-ID 733535]

LAMUT, Jakob, LAMUT, Barbara, KNAP, Matjaž. Slag in the production of wrought iron. V: SÁNCHEZ, Mario (ur.), et al. Molten 2009 : proceedings of the VIII international conference on molten slags, fluxes and salts, Santiago, Chile, 18-21 January 2009. Santiago: Gecamin, 2009, str. 993-998. [COBISS.SI-ID 874335]

LAMUT, Jakob, KNAP, Matjaž, DEBELAK, Martin, LAMUT, Barbara. Composition of slags in iron and steel production. V: 9th International symposium on cultural heritage in geosciences, archeology, mining and metallurgy, Québec, 2-7 September 2007. AUGER, Réginald (ur.), TURGEON, Laurier (ur.), HABASHI, Fathi (ur.). Actes du colloque = Proceedings. Québec, Canada: Université Laval, 2007, cop. 2009, str. 225-228. [COBISS.SI-ID 986719]

DIPLOMSKO DELO

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Diplomsko delo
Course title:	Diploma Work
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067605
Koda učne enote na članici/UL Member course code:	660

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
0	0	0	0	150	150	10

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 3. letnik	Entry in 3rd year

Vsebina:	Content (Syllabus outline):
/Vsebino diplomskega dela določi mentor. Študent si mentorja izbere sam glede na temo diplomskega dela.	The content of the diploma work is determined by the mentor. The student selects the mentor himself on base of the topic of the diploma work.

Temeljna literatura in viri/Readings:

/Literaturo iz teme diplomskega dela študent predvidoma poišče sam oz. je usmerjen s strani mentorja.

Cilji in kompetence:	Objectives and competences:
/Cilj diplomskega dela je pokazati sposobnost študenta za reševanje določenega problema iz strokovnega področja. Študent tekom izdelave diplomskega dela dopolnjuje in poglablja temeljna znanja ter razvija sposobnosti in razumevanje za reševanje tehničnih problemov. Kompetence: - Študent reši in predstavi določen problem iz	The aim of the diploma work is to show the student's ability to solve a particular problem from a professional field. During the preparation of the diploma the student completes and deepens the basic knowledge and develops the skills and understanding for solving technical problems. Competencies: - The student solves and presents a certain problem

področja, ki je tema njegovega diplomskega dela, - Izpolnjuje kompetence v ustnem in pisnem izražanju pri reševanju različnih problemov, - Sposobnost uporabe in povezovanja temeljnih in aplikativnih znanj na področju metalurgije ter kritična presoja je teh.	in the field, which is the topic of his thesis, - It upgrades the competencies in oral and written expression in solving various problems, - Ability to use and integrate basic and applied knowledge in the field of metallurgy and its critical evaluation of the results.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Razvijanje sposobnosti lastnega učenja in prilagajanja ter uporaba pridobljenega znanja tekom študija na svojem strokovnem področju. Študent zna kritično vrednotiti tehnične probleme in interpretirati temeljna znanja v povezani z inženirsko prakso. Študent je prav tako sposoben kritično presojati o dobljenih znanstveno raziskovalnih rezultatov.	Developing the capability of own learning and adaptation and the use of acquired knowledge during studies in their field of expertise. The student can critically evaluate technical problems and interpret basic knowledge related to engineering practice. The student is also able to critically evaluate the obtained scientific and research results.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Seminarsko delo, laboratorijsko raziskovalno delo, konzultacije.	Oral presentation of the thesis and the oral defense of the diploma work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

EKONOMIKA OKOLJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Ekonomika okolja
Course title:	Environmental Economics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100790
Koda učne enote na članici/UL Member course code:	553

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	30	15	0	0	90	6

Nosilec predmeta/Lecturer:	Bogomir Kovač
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/- pogoj za vključitev v delo je vpis v letnik študija - pogoji za pristop k pisnemu izpitu: opravljeni seminar (sodelovanje v debati za in proti)	- prerequisite for course enrolment is active enrolment into any year of studies - requirements for writen exam registration: completed seminars (participating in the pro et contra debate)

Vsebina:	**Content (Syllabus outline):**
/1. Okolje in gospodarstvo (vrednotenje naravnih virov). 2. Okolje in družba (trajnostni razvoj). 3. Tržni mehanizem in okoljevarstveni problemi. Omejeni vladni ukrepi in usmerjena okoljska politika. 4. Koristi in stroški alokacije okoljskih virov. Družbena odgovornost in podjetja. 5. Ekonomske oblike nadzora okolja (davki, dovoljenja, standardi). 6. Okoljska ekonomika in okoljsko računovodstvo. Okoljsko vrednotenje investicij. 7. Okoljevarstveni sistemi na podjetniški ravni. Okoljski menedžment. 8. Politika okolja v Sloveniji. EU in problem zaščite	1. Environment and economics (natural resource economics). 2. Environment and society (an approach to sustainable development). 3. Market mechanism and environmental problems. Limitations of government and environmental economic policy. 4. Cost-benefit analysis of environmental changes. Social and corporate responsibility. 5. The economics of pollution control (taxation, transferable emission permits, standards. 6. Ecological economics and environmental accounting. 7. Environmental systems and firms. Environmental

okolja. 9. Novi principi eko-ekonomike.	management. 8. Ecology in Slovenia and EU. 9. New eco-principles of economics.

Temeljna literatura in viri/Readings:

/Turner, K., Pearce, D.: Environmental Economics. London: Prentice Hall, 2000.
Kolk, A.: Economics of Environmental Management. London: Prentice Hall, 2000. X, 205 str.
Nacionalni program varstva okolja.

Cilji in kompetence:	**Objectives and competences:**
/- Razviti znanje o trajnostnem razvoju in ekonomski dimenziji varstva okolja. - Pridobiti razumevanje okoljske ekonomike na področju ekonomskega sistema, gospodarskega razvoja, okoljske politike, okoljskega računovodstva in okoljskega menedžmenta. - Opozoriti na povezanost ekonomskega reševanja okoljevarstvenih problemov na ravni države, regije in podjetja.	- To develop knowledge of sustainable development and economic dimensions of environment protection. - To develop an understanding of the environmental policy in the context of economic systems, economic development, environmental policy, environmental accounting, and environmental management. - Note the relations between economic solutions to the environmental problems at the level of state, region, and enterprise.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/- Študentje bodo sposobni razumeti medsebojno povezavo med okoljem in gospodarstvom, saj vzajemno vplivata drug na drugega. - Študentje bodo razumeli ekonomske vzroke za onesnaževanje okolja, ter obenem pridobili znanje o oblikovanju ustreznih ekonomskih inštrumentov za upočasnitev, prekinitev in spreobrnitev procesov onesnaževanja. - Na osnovi pridobljenega znanja bodo študentje sposobni zajeti, analizirati in kritično oceniti okoljske probleme in izzive v Sloveniji in po svetu. - Študentje bodo skozi študij razvijali sposobnosti za timsko delo ter bolj kakovostno znanstveno raziskovalno delo.	- Students shall learn that environment is not separate entity from the economy, since changes in one affect the other. - Students will be able to understand economic causes of degradation and designing economic incentives to slow down, halt and reverse the degradation process. - Based on the acquired skills and knowledge, the students shall be able to grasp, analyze, and critically evaluate the current environmental issues, challenges and problems in Slovenia and worldwide. - Students shall develop the skills of analytical thinking, independent scientific and research work, and creative teamwork.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja: 2 uri Vaje: 2 ure (vaje: 1 ura, debata za in proti: 1 ura)	Lectures: 2 hours Exercise: 2 hours (exercise: 1 hour, pro et contra debate: 1 hour)

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
pisni izpit - 70%	70,00 %	written exam - 70%
ocene seminarskih nalog (pro et contra) - 20%	20,00 %	seminar paper (pro et contra debate) - 20%
sodelovanje - 10%	10,00 %	participation - 10%

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

KOVAČ, Bogomir. Timsko delo in poslovne spremembe v podjetju. V: MAYER, Janez, BEČAJ, Janez, KNEŽEVIČ, Ana Nuša, KOŠIR, Manca, KOVAČ, Bogomir, PISANI, Lea, PRAPER, Peter, RAJKOVIČ,

Vladislav, TRSTENJAK, Anton, VELIKONJA, Marija. Skrivnost ustvarjalnega tima. 1. izd. Ljubljana: Dedalus - Center za razvoj vodilnih osebnosti in skupin, 2001, str. 72-84. [COBISS.SI-ID 2240978]

KOVAČ, Bogomir. Ekonomska analiza. V: GABRIJELČIČ, Peter, GRUEV, Marta, GAZVODA, Davorin, MARUŠIČ, Janez, JUVANC, Alojzij, KOVAČ, Bogomir. 5. in 10. TEN transportni koridor na območju Slovenije : vpliv prestopnih točk oziroma prometno - logističnih terminalov na regionalni in urbani razvoj : končno poročilo. Ljubljana: Fakulteta za arhitekturo, 1999, str. 67-75. [COBISS.SI-ID 2240466]

KOVAČ, Bogomir. Keynes, keynesianizem in razvojne spremembe sodobne države blaginje - renesansa ali zaton keynesianske teoretske paradigme = Keynes, Keynesianism and the evolution of the contemporary welfare state - a renaissance or fall of the Keynesian paradigm. V: Znanstvena konferenca "Aktualnost misli J. M. Keynesa" oktobra 2006 na Ekonomsko-poslovni fakulteti v Mariboru. Aktualnost misli J. M. Keynesa : znanstvena konferenca, (Naše gospodarstvo, Letn. = Vol. 52, Posebna št. = Special issue, 2006). Maribor: Ekonomsko-poslovna fakulteta, 2006, str. 11-25. [COBISS.SI-ID 8913948]

KOVAČ, Bogomir. Politično ekonomski problemi suverenosti in globalizacije ekonomske politike v okviru pristopa EU. V: Možnosti ekonomske politike v Sloveniji, (Economic and business review, Vol. 5 pos. št.). Ljubljana: Ekonomska fakulteta: Zveza ekonomistov Slovenije, 2003, str. 5-28. [COBISS.SI-ID 14523366]

KOVAČ, Bogomir. Gocpodarske razmere in razvoj malega gospodarstva na področju turizma in gostinstva. V: Slovenska obrt in malo gospodarstvo pred izzivi evropske konkurence. Ljubljana: Društvo ekonomistov, 2002, str. 19-26. [COBISS.SI-ID 2246098]

EKONOMIKA POSLOVANJA V MONTANISTIČNIH PODJETJIH-IZBIRNI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Ekonomika poslovanja v montanističnih podjetjih-izbirni
Course title:	Company Management Leoben Economics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100789
Koda učne enote na članici/UL Member course code:	983

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	15	0	0	60	4

Nosilec predmeta/Lecturer:	Jurij Šporin, Željko Vukelić
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v letnik. Pogoj za pozitivno oceno so uspešno opravljeni kolokviji ter pozitivna ocena s strani študentov pri zagovoru oziroma interpretaciji lastne sodbe o posameznih problemih s področja predmeta.	Enrollment in the year. Condition for positive evaluation are successfully passed preliminary examination and a positive evaluation by the students in defending their own judgment of problems in the field of subject.

Vsebina:	Content (Syllabus outline):
/- osnovni principi in splošni kriteriji načrtovanja in planiranja poslovanja manjših, srednjih in velikih podjetij, - posebnosti poslovanja v tržno problematičnih področjih in možnosti prilagajanja trgu s podobnimi dejavnostmi, - metode planiranja z uporabo sodobnih programskih orodij, - vmesna preverjanja poslovanja in analiza kazalcev poslovanja - načrtovanje in izvajanje projektnega vodenja, - analiziranje uspešnosti in ocenjevanje možnosti razvoja podjetja z vključevanjem drugih gospodarskih	- Basic principles and general criteria for the design and planning of operations of small, medium and large companies - Specifics of business in a market problematic areas and customization options on a market with similar activities - Planning methods using modern software tools - Interim audits and analysis of performance indicators - Planning and implementation of project management, - Analyze and evaluate the potential effectiveness of the company's development with the involvement of

subjektov, - način izdelave scenarijev prestrukturiranja podjetij in možnosti preverjanja realnih pogojev poslovanja v srednje in dolgoročnih časovnih obdobjih.	other operators, - way of making corporate restructuring scenarios and the possibility of checking the realistic operating conditions in the medium and long term periods.

Temeljna literatura in viri/Readings:

/F. BIZJAK, Tea PETRIN, Uspešno vodenje podjetja, Zbirka manager, 1996
M. TEKAVČIČ, Obvladovanje stroškov, Zbirka manager, 1997

Cilji in kompetence:	**Objectives and competences:**
/Študent pridobi znanja o planiranju, vodenju in analiziranju poslovanja podjetij v različnih ekonomskih pogojih z vsem spremljajočimi aktivnostmi, razvije sposobnosti za vodenje montanističnih podjetij in se nauči osnov načrtovanja in poslovanja podjetij ter projektnega vodenja.	Students acquire knowledge of the planning, management and analysis of business enterprises in different economic conditions, with all the attendant activities, develop skills for managing montanistic companies and learn the basics of planning and business operations and project management.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Praktična uporaba teoretičnih analiz pri načrtovanju in spremljanju poslovanja podjetij. Analiziranje ustreznosti uporabljenih metod projektnega vodenja podjetij in preverjanje funkcionalnosti ukrepov pri iskanju optimalne variante poslovanja določenega podjetja.	Knowledge and understanding: Practical application of theoretical analysis in planning and monitoring of business of companies. Analyzing the appropriateness of project management methods. Checking the functionality of the measures in the search for the optimal variant of operations of the company.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Uvodno predavanje o snovi iz posameznega poglavja, individualno delo s študenti, računske vaje iz prakse, navajanje na branje člankov ter uporabo interneta, predstavitev študentovih presoj o posameznih problemih iz prakse, organizirane razprave na v naprej določeno temo, predstavitve praktičnih primerov s področja gospodarjenja s strani strokovnjakov iz prakse.	Introductory lecture on the substance of each chapter, individual work with students, calculations based on practice, getting used to reading articles and Internet usage, presentation of students' assessments of the problem in practice, organized discussions on a specific topic, the presentation of practical examples in management field by the experts.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
seminar	20,00 %	seminar
vaje	40,00 %	Practicals
Izpit	40,00 %	Exam

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. ŠPORIN, Jurij, BALAŠKO, Tilen, MRVAR, Primož, JANC, Blaž, VUKELIČ, Željko. Change of the properties of steel material of the roller cone bit due to the influence of the drilling operational parameters and rock properties. *Energies*. 2020, vol. 13, iss. 22, str. 1-20.

2. ŠPORIN, Jurij. Characterisation of the wear of the roller cone drill bit caused by improperly chosen drilling regime = Karakterizacija obrabe kotalnega dleta povzročene z nepravilno izbiro režima vrtanja. *RMZ - Materials and geoenvironment : periodical for mining, metallurgy and geology*. [Tiskana izd.]. 2020, vol. 67, no. 3, str. 91-102, ilustr.

3. ŠPORIN, Jurij, MRVAR, Primož, PETRIČ, Mitja, VIŽINTIN, Goran, VUKELIČ, Željko. The characterization of wear in roller cone drill bit by rock material - sandstone. *Journal of petroleum science & engineering*. [Print ed.]. 2019, vol. 173, str. 1355-1367.

4. ŠPORIN, Jurij, VUKELIČ, Željko. Structural drilling using the high-frequency (sonic) rotary method = Strukturno vrtanje z uporabo visokofrekvenčne (sonic) rotacijske metode. *RMZ - Materials and geoenvironment : periodical for mining, metallurgy and geology*. [Tiskana izd.]. Jan. 2017, vol. 64, no. 1, str. 1-10, ilustr.

5. VUKELIČ, Željko, DERVARIČ, Evgen, ŠPORIN, Jurij, VIŽINTIN, Goran. The development of dewatering predictions of the Velenje coalmine. *Energies*. 2016, vol. 9, no.9, 9 str.

ELEKTROTEHNIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Elektrotehnika
Course title:	Electrotechnics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077533
Koda učne enote na članici/UL Member course code:	679

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Milan Bizjak
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija. Opravljeno in uspešno predstavljeno projektno delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the third year of study. Completed and successfully presented project work is required before taking the written and oral exam.

Vsebina:	**Content (Syllabus outline):**
/Električno polje. Coulombov zakon električne sile, električna poljska jakost, delo električnega polja, električni potencial, električna napetost, električno odklanjanje, snov v električnem polju, električni pretok, gostota električnega pretoka, kondenzator. Kapacitivnost kondenzatorja, vezave kondenzatorjev. Enosmerna vezja. Tokovno polje. Električna prevodnost in električna upornost. Električna moč, delo in toplota. Elementi enosmernih vezij. Kirchoffova zakona. Enostavna enosmerna vezja. Analiza linearnih električnih vezij. Magnetno polje. Gostota magnetnega pretoka. Amperov zakon. Magnetni pretok. Magnetno	Electrical field. Coulomb's law, electrical field energy, work of electric field, electro potential, electrical voltage, electro deflection, materials in electric field, electric flux, electric flux density, capacitor, capacitance, capacitor installations. Direct current circuits: Electrical field, electrical conductivity, electrical resistance and resistivity. Electrical power, work and heat. Elements of direct current circuits, Kirchoff laws, analysis of electric circuits. Magnetic field: Density of magnetic field, magnetic current, Amper's law, forces on current carrying wire, magnetic deflection, magnetic torque, magnetic flux

odklanjanje. Sile na tokovodnike v magnetnem polju. Navor magnetnih sil. Magnetna poljska jakost. Magnetna napetost. Magnetna vezja. Snov v magnetnem polju Časovno spremenljivo magnetno polje. Inducirana napetost in Faradayev indukcijski zakon. Rotacija zanke v magnetnem polju. Magnetni sklep. Induktivnost. Magnetna energija. Vrtinčni toki. Kožni pojav. Izmenične veličine. Vrste izmeničnih veličin. Harmonske časovne funkcije. Predstavitev harmonskih časovnih funkcij. Srednja in efektivna vrednost izmeničnih veličin. Sinusni tokokrogi z idealnimi elementi in trifazni sistemi. Prehodni pojavi. Električno vezje v prehodnem stanju. Polnjenje in praznjenje kondenzatorja in tuljave. Merjenje električnih veličin. Princip delovanja električnih merilnih inštrumentov. Merjenje napetosti in toka. Merjenje upornosti. Merjenje moči in energije. Merjenje frekvence. Električne inštalacije. Električni krogi. Simboli. Zaščitni ukrepi. Sestavine električne inštalacije. Obremenljivost vodnikov. Elektrokemija. Električni tok v tekočinah. Faradayev zakon elektrolize. Kemijski izvori napetosti: elektrodni potencial, Voltov člen, Leclanchejev člen, svinčev akumulator, alkalni akumulatorji. Elektrotermija Uporovno, induktivno, visokofrekvenčno, obločno, plazemsko, elektronsko in lasersko segrevanje. Ukrepi za zmanjševanje stroškov ogrevanja. Praktični primeri	and its density, voltage, materials in the magnetic field, magnetic circuits. Time varying magnetic field: Faraday's law of electromagnetic induction, inductivity, magnetic energy, voltage, eddy currents, circle phenomena, transformers Alternating current circuits: elements of alternating current circuits, sinusoidal circuits with ideal and real elements, mean and effective values of electrical quantities, three phase electrical systems, harmonic time dependant electrical current Transient phenomena: Electrical circuit in transient state. Charging and discharging of the capacitor and coil. Measurements of electrical quantities: Electrical current, voltage, resistance, power, energy and frequency measurements, working principles of the electric quantities measuring instruments. Electro installations: Electrical circuits, elements of electrical circuits, symbols, protective measures, current carrying cable capacities. Electrochemistry: Electrical current in fluids, Faraday's law of electrolysis, chemical voltage sources, electrode potential, Volta's cell, Leclanche's cell, Lead battery, alkaline batteries… Electrical heating: Resistive, inductive, high frequency, arc, plasma, electro and laser heating. Measures to reduce the heating costs. Study of practical problems.

Temeljna literatura in viri/Readings:

/BIZJAK Milan . Elektrotehnika. Oddelek za materiale in metalurgijo, Naravoslovnotehniška fakulteta, Univerza v Ljubljani, 2008
KERŠIČ Nikolaj. Osnove elektrotehnike I in II. Fakulteta za elektrotehniko, Ljubljana, 1988
BIZJAK Milan. Zbirka nalog iz elektrotehnike za študente VSP metalurške tehnologije. Oddelek za materiale in metalurgijo, Naravoslovnotehniška fakulteta, Univerza v Ljubljani, 2008
BIZJAK, Milan. Elektrodinamika: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2006.
BIZJAK, Milan. Magnetizem: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2006.

Cilji in kompetence:	**Objectives and competences:**
/Študenti se podrobneje seznanijo s fizikalnimi osnovami elektrotehnike in delovne elektrotehnike. Spoznajo osnove električnih meritev, elektrokemije in elektrotermije. Seznanijo se z električnimi inštalacijami, električno zaščito ter tehničnimi in varnostnimi predpisi.	In the course Electrotechnics student familiarize with the basic and operational electrotechnics such as: electrical measurements, electro chemistry electro-thermal principles, electro installations, protection against short circuit, and safety regulations.

Predvideni študijski rezultati:	Intended learning outcomes:
/Znanje in razumevanje: Razumevanja osnovnih pojavov, temeljnih pojmov, količin in fizikalnimi zakonitosti elektromagnetnega polja ter njihovega matematičnega zapisa. Znanje in razumevanje enosmernih in izmeničnih vezij, trifaznih sistemov, električnih meritev, inštalacij, elektrotermije in elektrokemije. Študent v okviru predmeta pridobi spretnosti uporabe strokovne literature in drugih sodobnih virov informacij. Nauči se zbiranja, selekcioniranja in interpretiranja podatkov in rezultatov analiz.	Knowledge and understanding: Within the course Electrotechnics student learns the basic mathematical definitions and principles of electrical and magnetic fields, understand direct and alternating current circuits, three phase systems, measurements of electrical quantities, electrical installations, basic of electrochemistry and electrical heating. Students acquire engineering knowledge to collect, select and interpret the data from professional literature and analysis results.

Metode poučevanja in učenja:	Learning and teaching methods:
/Predavanja, računske vaje, laboratorijske vaje in projektno delo.	Lectures, calculation and laboratory exercises, project work.

Načini ocenjevanja:	Delež/Weight	Assessment:
ocena projektne naloge (10 %)	10,00 %	the mark of project work (10%)
ocena pisnega dela izpita (40 %)	40,00 %	the mark of written examination (40%)
ocena ustnega dela izpita (50 %)	50,00 %	the mark of the oral examination (50%)

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

BIZJAK, Milan. Izbira elektro pločevine za visoko frekvenčne male elektromotorje. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 1998. 15 f. [COBISS.SI-ID 783711]
BIZJAK, Milan. Oksidne plasti na lamelah električnih motorjev. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 1998. 13 f. [COBISS.SI-ID 783455]
BIZJAK, Milan, KOSEC, Ladislav. A continuous electrical resistivity measurement of rapidly solidified aluminium alloys. Metalurgija, ISSN 0543-5846, 2000, vol. 39, br. 3, str. 200. [COBISS.SI-ID 788063]
BIZJAK, Milan. Karakterizacija tankih plasti na kletki komutatorja. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2002. 15 f. [COBISS.SI-ID 785503]
BIZJAK, Milan. Spoji in kontakti stikala za pomik avtomobilskih stekel. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2002. 12 f. [COBISS.SI-ID 784735] BIZJAK, Milan. Elektrostatika. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2005. 24 f., ilustr. [COBISS.SI-ID 738911]
BIZJAK, Milan. Elektrodinamika. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2006. 45 f., ilustr. [COBISS.SI-ID 739423]
BIZJAK, Milan. Magnetizem. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2006. 48 f., ilustr. [COBISS.SI-ID 739167]
BIZJAK, Milan, KOSEC, Ladislav, KOSEC, Borut, ANŽEL, Ivan. The characterization of phase transformations in rapidly solidifield Al-Fe and Cu-Fe alloys through measurements of the electrical resistance and DSC. Metalurgija, ISSN 0543-5846, vol 45, br. 3, str. 230. [COBISS.SI-ID 629087]
BIZJAK, Milan. Elektrotehnika. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2008. 181 str., ilustr. ISBN 978-961-6047-56-2. [COBISS.SI-ID 238275584]
BROVČ, Goran, BIZJAK, Milan. Kontaktna zlitina in metoda za izdelavo zlitine za električne kontakte : patent SI 24365(A), 2014-11-28. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 28.11.2014. 7 str., 2 pril., ilustr. [COBISS.SI-ID 1505631]
BROVČ, Goran, DRAŽIĆ, Goran, KARPE, Blaž, LOJEN, Gorazd, KOSEC, Borut, BIZJAK, Milan.

Precipitation strengthened Cu-Fe-Ni-P alloy for electrical contacts. V: MAMUZIĆ, Ilija (ur.). Materials and metallurgy : summaries of abstract = Materiali i metalurgija : zbornik sažetaka, (Metalurgija, ISSN 0543-5846, vol. 53, no. 3). Šibenik: Croatian Metallurgical Society: = Hrvatsko metalurško društvo, 2014, str. 403. [COBISS.SI-ID 1465183]

ENERGETSKO PREDELOVALNI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Energetsko predelovalni praktikum
Course title:	Practicals in Energy and Workability
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067606
Koda učne enote na članici/UL Member course code:	657

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
15	15	45	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec, Peter Fajfar
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 2. letnik študija. Opravljeno in uspešno predstavljeno projektno delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the second year of study. Completed and successfully presented project work is required before taking the written and oral exam.

Vsebina:	**Content (Syllabus outline):**
/Uvod. 1. Določitev krivulj tečenja za masivni material (natezni test, tlačni test) - testiranje pri sobni temperaturi, - testiranje pri povišanih in visokih temperaturah (vpliv temperature in hitrosti deformacije) - vpliv trenja in oblik preizkušancev na dobljene rezultate 2. Testiranje ploščatih preizkušancev - natezni test (diagrami napetost - deformacija, natezna trdnost, meja plastičnosti, plastična anisotropija (normalna anisotropija, Δr), n vrednost, - ploščati stiskalni preizkus) - določevanje krivulj tečenja (preizkusi na visokih in	Introduction. 1. Determination of the yield curves for the solid material (tensile test, pressure test) - Testing at room temperature, - Testing at elevated and high temperatures (influence of temperature and strain rate) - The effect of friction and feature of test specimens on the results 2. Testing of plate like samples - Tensile test (diagrams stress - strain, tensile strength, yield stress, plastic anisotropy (normal anisotropy, Δr), the value of n, - pressure test - Determination of the yield curve (tests at high and

pri nizkih temperaturah), 3. Določitev mejne plastičnosti - za masivne materiale (natezni tlačni, tlačni) - za ploščate materiale (natezni, upogibni, itd) 4. Lastnosti obdelovanca po plastični deformaciji in/ali toplotni obdelavi -trdota, -natezna trdnost in meja plastičnosti, žilavost -sposobnost nadaljnje predelave z odrezovanjem, varjenjem -dimenzije obdelovanca -lastnosti površine 5. Določitev parametrov natančnosti in relevantnih vzmetnih konstant preoblikovalnih strojev 6. Meritev mehanskih in električnih obremenitev strojev in določitev izkoriščenosti stroja 7. Meritev procesnih parametrov 8. Meritve temperature (v peči, agregatu) 9. Izbira in priprava varovalnih atmosfer, analiza 10. Optimiziranje postopkov toplotne obdelave Energetsko ekološke študije tehnologij in naprav	low temperatures) 3. Determination of the maximum yield stress - For solid materials (tensile pressure, pressure) - For flat materials (tensile, bending, etc.) 4. The properties of the workpiece after plastic deformation and/or heat treatment - Hardness, - Tensile strength and yield strength, toughness - The ability to further processing by shearing, welding - Workpiece dimensions - Properties of the surface 5. Determination of accuracy parameters and relevant spring constants for forming machines 6. Measurement of mechanical and electrical machine loading and determination of machine efficiency 7. Measurement of process parameters 8. Measurements of temperature (in the furnace) 9. Selection and preparation of protective atmospheres, analysis 10. Optimization of heat treatment processes Energy-ecological study of technologies and devices

Temeljna literatura in viri/Readings:

M. Kaviany: Principles of Heat Transfer, John Wiley & Sons, New York, 2002.
ASM Handbook, Vol. 14A: Metalworking: Bulk Forming, 2005
FAJFAR, Peter. Tehnika preoblikovanja. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2010. 126 str.

Cilji in kompetence:	**Objectives and competences:**
/Pridobljena znanja je sposoben uporabiti pri stabilizaciji in optimiziranju proizvodnje v procesu ogrevanja, preoblikovanja in/ali toplotne obdelave materialov. Študent je sposoben sintetizirati pridobljena in jih uporabiti pri reševanju specifičnih kompleksnih problemih. Pridobljeno znanje mu omogoča komuniciranje in sodelovanje na interdisciplinarnih področjih.	Acquired knowledge is able to be used to stabilize and optimize the production process of heating, hot/cold deformation working and heat treatment of materials. The student is able to solve specific complex problems in production technologies. The acquired knowledge allows him to communicate and collaborate on interdisciplinary areas.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent zna izpeljati testiranja za predelavo relevantnih lastnosti materialov ter interpretirati rezultate testiranja, Razume pomen testiranja preoblikovalnosti (plastičnosti in mehanski odziv) materialov za načrtovanje procesa preoblikovanja, Poznavanje ključnih sprememb (struktura, premene) v materialih v širokem temperaturnem območju preoblikovanja, Razume mehanske in električne obremenitve, togostne karakteristike strojnih naprav ter stanje stroja z vidika doseganja zahtevane natančnosti. Zna ocenit varnost na kritičnih mestih delih pogona	Knowledge and understanding: Student is able to carry out testing the relevant properties of materials and interpret test results, Understand the importance of formability testing (plasticity and mechanical response) of materials for the design of the transformation process, Understand key changes (structure, structure changes) in materials over a wide temperature range Understand measured of mechanical and electrical load, stiffness characteristics of mechanical devices and the status of the machine in terms of achieving the required accuracy. He able to evaluate safety of mechanical parts on critical spots

strojev, -zna zmerit tehnološke parametre preoblikovanja, -razume vpliv obremenitev preoblikovanega materiala na deformacije orodij in strojev med preoblikovanjem, -zna izmerit delovno atmosfero v ogrevalnih agregatih in preverit zanesljivost regulacije temperature, -seznani se z vplivom delovne atmosfere v agregatu na procese na površini obdelovancev, -razume vpliv zanesljivega delovanja agregatov na zagotavljanje želenih temperatur obdelovanca (preoblikovanca) in na njegove lastnosti, -razume pomen vpliva zanesljivega delovanje ogrevalnih agregatov na dobljene lastnosti materialov ter vpliv karakteristik (togost, vodenje) strojev na natančnost končnega izdelka, -študent je sposoben sinteze o vzrokih za nestabilno proizvodnjo ter predlagati ukrepe za izboljšanje.	He is able to measure the technological parameters of production technology Understand the impact of load on the machine construction material He is able to measure the atmosphere in furnaces and check the reliability of temperature control, Understand the influence of the working atmosphere on the surface of the workpiece during production, Understand the impact of reliable operation of the production technology, ensuring the desired temperature of the workpiece and its properties, Understand the importance of the reliable operation of heating on the properties of materials and their properties (stiffness, management) on the accuracy of the final product, The student is able to synthesize the causes of the unstable production and to propose measures for its improvement.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje in simulacije, reševanje praktičnih primerov in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Izpolnjen laboratorijski praktikum;	30,00 %	a) presence on laboratory exercises
(b) ustni zagovor;	30,00 %	b) oral examination
(c) ocene: opravil, ni opravil	40,00 %	c) The mark is composed of: to pass / to fail;

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

KRIŽAJ, Ažbe, FAZARINC, Matevž, JENKO, Monika, FAJFAR, Peter. Hot workability of 95MnWCr5 tool steel = Vroča preoblikovalnost orodnega jekla 95MnWCr5. Materiali in tehnologije, 2011, letn. 45, št. 4, str. 351-355.
BOMBAČ, David, TERČELJ, Milan, FAZARINC, Matevž, FAJFAR, Peter. Increasing of hot workability of 1.3302 high speed steel = Poboljšavanje svojstava brzoreznog čelika 1.3302 u vrućem stanju. Metalurgija, 2012, vol. 51, br. 3, str. 313-316.
BRADAŠKJA, Boštjan, PIRNAR, Boštjan, FAZARINC, Matevž, FAJFAR, Peter. Deformation Behaviour and Microstructural Evolution During Hot Compression of AISI 904L. Steel research international, 2011, vol. 82, no. 4, str. 346-351.
;KARPE, Blaž, KOSEC, Borut, NAGODE, Aleš, BIZJAK, Milan. The influence of Si and V on the kinetics of phase transformation and microstructure of rapidly solidified Al-Fe-Zr alloys. Journal of mining and metallurgy. Section B, Metallurgy, 2013, vol. 49 B, no. 1, str. 83-89.
KARPE, Blaž, KOSEC, Borut, KOLENKO, Tomaž, BIZJAK, Milan. Heat transfer analyses of continuous casting by free jet meltspinning device. Metallurgy, 2011, vol. 50, br. 1, str. 13-16.
KOSEC, Borut. Failures of dies for die-casting of aluminium alloys. Metallurgy, 2008, vol 47, no. 1, str. 51-55.

FIZIKA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizika 1
Course title:	Physics 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067582
Koda učne enote na članici/UL Member course code:	328

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Marko Žnidarič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 1. letnik	Enetring the 1st year of program

Vsebina:	Content (Syllabus outline):
- Uvod: jezik fizike, skalarne, vektorske količine, enote, meritve. - Mehanika: kinematika (premo gibanjem enakomerno pospeseno, posevni met, krozenje), dinamika (sila, trenje, lepenje, gravitacijska sila, delo in energija (kineticna in potencialna, ohranitev energije, moc, izkoristek), gibalna kolicina (ohranitev gibalne kolicine, trki, sila curka), sistemi tockastih teles (tezisce, togo telo), deformacije trdnih teles (Hookov zakon, stisljivost, strig, torzija, temperaturno raztezanje), hidrostatika (tlak, vzgon), hidrodinamika (kontinuitetna enacba, Bernoullijeva enacba, viskoznost, upor), nihanje (harmonsko nihanje, matematicno, fizikalno nihalo, resonanca, dusenje), valovanje (hitrost valovanje, interferenca, Dopplerjev pojav).	- Introduction: language of physics, scalar and vector variables, units, measurements. - Mechanics: kinematics (linear motion, acceleration, uniform acceleration, rotation), dynamics (force, friction, gravitational force), work and energy (kinetic and potential energy, energy conservation, power, efficiency), linear momentum (conservation, collisions, jet force), systems of point masses (center of mass), deformations (Hook's law, compressibility, torsion, shear, temperature expansion), hydrostatics (pressure, lift), hydrodynamics (continuity equation, Bernoulli equation, viscosity, drag), Oscillations (harmonic oscillator, mathematical and physical pendulum), wave phenomena (speed, interference, Doppler effect). Electromagnetism: electric charge, electric circuits (current, Ohm's law, power, AC), magnetic field

- Elektromagnetizem: elektricni naboj, elektricna vezja (tok, Ohmov zakon, moc, meritev toka in napetosti, izmenicna napetost), magnetno polje (sila, polje vodnika, tuljava, nabiti delci v polju, indukcija, motor, generator, transformator).	(force, field of a conductor, coil, induction, motor, generator, transformer)

Temeljna literatura in viri/Readings:

1) I. Kuščer, A. Moljk, T. Kranjc, J. Peternelj: Fizika za srednje šole – 1. del. DZS, Ljubljana (1999), 195 str.
2) I. Kuščer, A. Moljk, T. Kranjc, J. Peternelj: Fizika za srednje šole – 2. del. DZS, Ljubljana (2000), 259 str.
3) I. Kuščer, A. Moljk, T. Kranjc, J. Peternelj, M. Rosina, J. Strnad: Fizika za srednje šole – 3. del. DZS, Ljubljana (2002), 399 str.
4) I.D. Olenik, B. Golob, I. Serša: Naloge iz fizike za študente tehniških fakultet (DMFA, 2003), 66 str.

Alternative readings:
1) H.D. Young, R.A. Freedman: Sears and Zemansky's University Physics, Addison-Wesley, ZDA, 2000;

Cilji in kompetence:	**Objectives and competences:**
Cilji: - kratka ponovitev, nadgradnja srednješolske fizike; - seznanitev študentov s temeljnimi poglavji fizike; - poudarek na temah, za katere se pričakuje, da jih bodo študenti srečevali pri kasnejšem študiju in delu (opis vsebine v oklepajih); - podajanje analitičnega reševanja zadanih problemov in upravičene poenostavitve le-teh. Kompetence: - razumevanje fizikalnih zakonitosti, na katerih temeljijo naravni pojavi in merske metode; - sposobnost matematične formulacije problemov; - obvladovanje fizikalnih osnov metod in tehnik, s katerimi se bodo študenti srečevali; - formulacija problemov z izbiro potrebnih podatkov, metodo in interpretacijo meritev, ter upoštevanjem poenostavitev.	Objectives: - short repetition and sophistication of high school physics; - acquainting with the basic laws of physics; - emphasize on the subjects which are expected to be encountered by students during the later studies and work; - analytic problem solving and justified simplification of problems. Competences: - understanding of laws of physics on which natural phenomena and measurement methods are based upon; - ability of mathematical formulation of problems; - mastering basic physics methods to be used by the students at later studies and work; - formulation of problems by selection of necessary data, method and simplifications, measurements interpretation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Osnovne fizikalne zakonitosti, opisno ter v matematični formulaciji; medsebojno povezovanje le-teh. Analitičen pristop k zadanim problemom, dedukcija na osnovne fizikalne zakonitosti, na katerih posamezni pojavi in merske metode temeljijo; nekateri primeri aplikacij na področju, s katerim se bodo študenti srečavali. Razumevanje pojavov v naravi na podlagi preprostejših abstraktnih zakonitosti; utemeljevanje uporabljenih poenostavitev in približkov. Modeliranje problemov z uporabo poenostavitev (zanemaritve nebistvenih lastnosti); izbira potrebnih	Knowledge and understanding: Basic laws of physics, descriptive and in mathematical formulation; interconnection among laws of physics. Analytic approach to problems and their deduction to basic physics mechanisms; examples of applications in the area of the program. Understanding of natural phenomena on the basis of simple (abstract) laws; justification of simplifications and approximations. Modelling of problems using simplifications; choice of necessary data and interpretation of measurements.

podatkov; interpretacija meritev.	

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja z demonstracijskimi poskusi, vodeno in samostojno reševanje računskih vaj in problemov.	Lectures with demonstrations, assisted and individual problem solving

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Written exam
Teoretični del	50,00 %	Theory part

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. ŽNIDARIČ, Marko. Spin transport in a one-dimensional anisotropic Heisenberg model. Physical review letters, ISSN 0031-9007. [Print ed.], 2011, vol. 106, str. 220601-1-220601-4, doi: 10.1103/PhysRevLett.106.220601. [COBISS.SI-ID 2357860], [JCR, SNIP, WoS do 19. 11. 2017: št. citatov (TC): 96, čistih citatov (CI): 87, Scopus do 24. 11. 2017: št. citatov (TC): 89, čistih citatov (CI): 79]
2. ŽNIDARIČ, Marko, SCARDICCHIO, Antonello, VARMA, Vipin Kerala. Diffusive and subdiffusive spin transport in the ergodic phase of a many-body localizable system. Physical review letters, ISSN 0031-9007. [Print ed.], 2016, vol. 117, iss. 4, str. 040601-1-040601-6, graf. prikazi, doi: 10.1103/PhysRevLett.117.040601. [COBISS.SI-ID 3010404], [JCR, SNIP, WoS do 26. 11. 2017: št. citatov (TC): 39, čistih citatov (CI): 36, Scopus do 29. 11. 2017: št. citatov (TC): 34, čistih citatov (CI): 31]
3. ŽNIDARIČ, Marko. Exact solution for a diffusive nenequilibrium steady state of an open quantum chain. Journal of statistical mechanics, ISSN 1742-5468, 2010, vol. 5, 9 str., doi: 10.1088/1742-5468/2010/05/L05002. [COBISS.SI-ID 2251876], [JCR, SNIP, WoS do 19. 11. 2017: št. citatov (TC): 44, čistih citatov (CI): 31, Scopus do 23. 11. 2017: št. citatov (TC): 24, čistih citatov (CI): 15]
4. ŽNIDARIČ, Marko, PROSEN, Tomaž, PRELOVŠEK, Peter. Many-body localization in the Heisenbeg XXZ magnet in a random field. Physical review. B, Condensed matter and materials physics, ISSN 1098-0121, 2008, vol. 77, str. 064426-1-064426-5, doi: 10.1103/PhysRevB.77.064426. [COBISS.SI-ID 2083172], [JCR, SNIP, WoS do 19. 11. 2017: št. citatov (TC): 238, čistih citatov (CI): 223, Scopus do 21. 11. 2017: št. citatov (TC): 228, čistih citatov (CI): 213]
5. GORIN, Thomas, PROSEN, Tomaž, SELIGMAN, Thomas H., ŽNIDARIČ, Marko. Dynamics of Loschmidt echoes and fidelity decay. Physics reports, ISSN 0370-1573. [Print ed.], 2006, 435, nos. 2-5, str.3-156. [COBISS.SI-ID 1972068], [JCR, SNIP, WoS do 12. 11. 2017: št. citatov (TC): 288, čistih citatov (CI): 284, Scopus do 19. 11. 2017: št. citatov (TC): 258, čistih citatov (CI): 255]

FIZIKA 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizika 2
Course title:	Physics 2
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067583
Koda učne enote na članici/UL Member course code:	334

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Paul Kerševan
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 1. letnik	Entering the 1st year of program

Vsebina:	Content (Syllabus outline):
/- Termodinamika: temperatura (vklj.: merjenje temp., temp. raztezanje, bimetal); enačbe stanj (vklj.: plinska enačba, fazni diagrami); termodin. spremembe na plinu (vklj.: delo pri raztezanju, zveza med specifičnima toplotama); energijski zakon (vklj.: fazne spremembe); toplotni stroji (vklj.: izkoristki toplotnih strojev); razširjanje toplote (vklj.: toplotno prevajanje, izolacija). - Optika: valovna optika (vklj.: interferenca, uklon rentgenskih žarkov); geometrijska optika (vklj.: odboj, lom, popolni idboj, optične naprave - mikroskop, teleskop).	- Thermodynamics: temperature (incl.: measurements of T, expansion, bimetal); 1st law of thermodynamics; equation of state (incl.: phase diagram); thermodynamic changes on gas (incl.: expansion work, specific heat relation); heat engines (incl.: efficiencies); heat dissipation, heat isolation) . - Optics: wave optics (incl.: interference, X-ray diffraction); geometric optics (incl.: reflection, refraction, total reflection, microscope, telescope). - Selected topics in Modern Physics: fotoeffect, model of atom, radioactivity

- Izbrane teme iz moderne fizike (vklj.: fotoefekt, model atoma, radioaktivnost)	

Temeljna literatura in viri/Readings:

/1) H.D. Young, R.A. Freedman: Sears and Zemansky's University Physics, Addison-Wesley, ZDA, 2000; poglavja: 15-1, 15-2, 15-3, 15-4, 15-5, 15-7, 15-8, 16-1, 16-2, 16-3, 16-5, 16-7, 17-1, 17-2, 17-3, 17-5, 17-8, 18-4, 18-7, 19, 21-1, 21-2, 21-5, 21-6, 206 str.
34-3, 34-4, 35-1, 35-2, 35-3, 36-3, 36-4, 36-5, 36-6, 37-1, 37-2, 37-3, 38-1, 38-2, 38-3, 38-4, 38-5, 38-7, 40-9, 45-4, 45-5
2) I. Drevenšek Olenik, B. Golob, I. Serša: Naloge iz fizike za študente tehniških fakultet (DMFA, 2003),
Alternativna literatura:
3) I. Kuščer, A. Moljk: Fizika 2. del. DZS, Ljubljana (1984),
poglavja 13, 14, 19, 20, 21
4) I. Kuščer, A. Moljk: Fizika 3. del. DZS, Ljubljana (1987),
poglavja 28, 31
5) D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics (J. Wiley & Sons, več izdaj).

Cilji in kompetence:	**Objectives and competences:**
/Cilji: - kratka ponovitev, nadgradnja srednješolske fizike; - seznanitev študentov s temeljnimi poglavji fizike; - poudarek na temah, za katere se pričakuje, da jih bodo študenti srečevali pri kasnejšem študiju in delu (opis vsebine v oklepajih); - podajanje analitičnega reševanja zadanih problemov in upravičene poenostavitve le-teh. Kompetence: - razumevanje fizikalnih zakonitosti, na katerih temeljijo naravni pojavi in merske metode; - sposobnost matematične formulacije problemov; - obvladovanje fizikalnih osnov metod in tehnik, s katerimi se bodo študenti srečevali; - formulacija problemov z izbiro potrebnih podatkov, metodo in interpretacijo meritev, ter upoštevanjem poenostavitev.	Objectives: - short repetition and sophistication of high school physics; - acquainting with the basic laws of physics; - emphasize on the subjects which are expected to be encountered by students during the later studies and work; - analytic problem solving and justified simplification of problems. Competences: - understanding of laws of physics on which natural phenomena and measurement methods are based upon; - ability of mathematical formulation of problems; - mastering basic physics methods to be used by the students at later studies and work; - formulation of problems by selection of necessary data, method and simplifications, measurements interpretation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Osnovne fizikalne zakonitosti, opisno ter v matematični formulaciji; medsebojno povezovanje le-teh. Analitičen pristop k zadanim problemom, dedukcija na osnovne fizikalne zakonitosti, na katerih posamezni pojavi in merske metode temeljijo; nekateri primeri aplikacij na področju, s katerim se bodo študenti srečavali. Razumevanje pojavov v naravi na podlagi preprostejših abstraktnih zakonitosti; utemeljevanje uporabljenih poenostavitev in približkov. Modeliranje problemov z uporabo poenostavitev (zanemaritve nebistvenih lastnosti); izbira potrebnih podatkov; interpretacija meritev.	Knowledge and understanding: Basic laws of physics, descriptive and in mathematical formulation; interconnection among laws of physics. Analytic approach to problems and their deduction to basic physics mechanisms; examples of applications in the area of the program. Understanding of natural phenomena on the basis of simple (abstract) laws; justification of simplifications and approximations. Modelling of problems using simplifications; choice of necessary data and interpretation of measurements.

Metode poučevanja in učenja:	Learning and teaching methods:
/Predavanja z demonstracijskimi poskusi, vodeno in samostojno reševanje računskih vaj in problemov.	Lectures with demonstrations, assisted and individual problem solving

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit	50,00 %	Written exam
teoretični del	50,00 %	Theory part

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

1) AAD, G., CINDRO, Vladimir, DELIYERGIYEV, Maksym, DOLENC, Irena, FILIPČIČ, Andrej, FRATINA, Saša, GORIŠEK, Andrej, KERŠEVAN, Borut Paul, KRAMBERGER, Gregor, MAČEK, Boštjan, MANDIĆ, Igor, MIJOVIĆ, Liza, MIKUŽ, Marko, TYKHONOV, Andrii, et al., ATLAS Collaboration. A particle consistent with the Higgs boson observed with the ATLAS detector at the large hadron collider. Science, ISSN 0036-8075, 2012, vol. 338, no. 6114, str. 1576-1582, doi: 10.1126/science.1232005. [COBISS.SI-ID 26464551], [JCR, SNIP, WoS do 25. 6. 2017: št. citatov (TC): 45, čistih citatov (CI): 45, Scopus do 26. 8. 2017: št. citatov (TC): 56, čistih citatov (CI): 56]
2) AAD, G., CINDRO, Vladimir, DELIYERGIYEV, Maksym, DOLENC, Irena, FILIPČIČ, Andrej, FRATINA, Saša, GORIŠEK, Andrej, KERŠEVAN, Borut Paul, KRAMBERGER, Gregor, MAČEK, Boštjan, MANDIĆ, Igor, MIJOVIĆ, Liza, MIKUŽ, Marko, TYKHONOV, Andrii, et al., ATLAS Collaboration. Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC. Physics letters. Section B, ISSN 0370-2693. [Print ed.], 2012, vol. 716, no. 1, str. 1-29, doi: 10.1016/j.physletb.2012.08.020. [COBISS.SI-ID 26060071], [JCR, SNIP, WoS do 27. 8. 2017: št. citatov (TC): 4232, čistih citatov (CI): 4117, Scopus do 26. 8. 2017: št. citatov (TC): 3647, čistih citatov (CI): 3587]
3) AAD, G., CINDRO, Vladimir, FILIPČIČ, Andrej, GORIŠEK, Andrej, KERŠEVAN, Borut Paul, KRAMBERGER, Gregor, MANDIĆ, Igor, MIJOVIĆ, Liza, MIKUŽ, Marko, ŠFILIGOJ, Tina, VALENČIČ, Nika, et al., ATLAS Collaboration. Combined measurement of the Higgs boson mass in pppp collisions at √s=7 and 8 TeV with the ATLAS and CMS experiment. Physical review letters, ISSN 0031-9007. [Print ed.], 2015, vol. 114, no. 19, str. 191803-1-191803-33, doi: 10.1103/PhysRevLett.114.191803. [COBISS.SI-ID 28811815], [JCR, SNIP, WoS do 27. 8. 2017: št. citatov (TC): 216, čistih citatov (CI): 216, Scopus do 31. 8. 2017: št. citatov (TC): 245, čistih citatov (CI): 244]
4) 5. AAD, G., CINDRO, Vladimir, DELIYERGIYEV, Maksym, DOLENC, Irena, FILIPČIČ, Andrej, FRATINA, Saša, GORIŠEK, Andrej, KERŠEVAN, Borut Paul, KRAMBERGER, Gregor, MAČEK, Boštjan, MANDIĆ, Igor, MIJOVIĆ, Liza, MIKUŽ, Marko, TYKHONOV, Andrii, et al., ATLAS Collaboration. Observation of associated near-side and away-side long-range correlations in √sNN=5.02sNN=5.02 TeV proton-lead collisions with the ATLAS detector. Physical review letters, ISSN 0031-9007. [Print ed.], 2013, vol. 110, no. 18, str. 182302-1-182302-18, doi: 10.1103/PhysRevLett.110.182302. [COBISS.SI-ID 26742311], [JCR, SNIP, WoS do 27. 8. 2017: št. citatov (TC): 228, čistih citatov (CI): 223, Scopus do 26. 8. 2017: št. citatov (TC): 184, čistih citatov (CI): 184]
5) AD, G., CINDRO, Vladimir, DOLENC, Irena, FILIPČIČ, Andrej, FRATINA, Saša, GORIŠEK, Andrej, KERŠEVAN, Borut Paul, KRAMBERGER, Gregor, MAČEK, Boštjan, MANDIĆ, Igor (pisar), MIJOVIĆ, Liza, MIKUŽ, Marko, TYKHONOV, Andrii, et al., ATLAS Collaboration. Search for the Standard Model Higgs boson in the diphoton decay channel with 4.9fb−14.9fb−1 of pppp collision data at √s=7s=7 TeV with ATLAS. Physical review letters, ISSN 0031-9007. [Print ed.], 2012, vol. 108, no. 11, str. 111803-1-111803-19, doi: 10.1103/PhysRevLett.108.111803. [COBISS.SI-ID 25702695], [JCR, SNIP, WoSdo 22. 1. 2017: št. citatov (TC): 161, čistih citatov (CI): 157, Scopus do 25. 6. 2017: št. citatov (TC): 119, čistih citatov (CI): 118]

FIZIKALNA METALURGIJA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizikalna metalurgija 1
Course title:	Physical Metallurgy 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067594
Koda učne enote na članici/UL Member course code:	977

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
60	0	30	0	0	90	6

Nosilec predmeta/Lecturer:	Boštjan Markoli
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/-Obvezna prisotnost na laboratorijskih vajah -50% prisotnost na predavanjih -Opravljen izpit iz predmeta Struktura materialov	-Obligatory attendance at laboratory work -50% attendance at lectures -Successful completion of the course Structure of materials

Vsebina:	Content (Syllabus outline):
/Konstitucija kovinskih in nekovinskih materialov. Mešanje kemijskih elementov. Gibbsovo fazno pravilo. Zlitinski sistem, heterogeno ravnotežje in diagram stanja. Vzvodno pravilo. Diagrami stanja in kristalizacija iz taline. Ravnotežno in neravnotežno strjevanje. Razmešanje zlitinskih elementov in porazdelitveni koeficient. Konstitucijska podhladitev. Izcejanje. Konstitucija binarnih zlitinskih in nekovinskih sistemov. Binarni sistem z dvofaznim ravnotežjem. Mikrostruktura, fizikalne in mehanske lastnosti v izomorfnem sistemu. Binarni sistem s trofaznim ravnotežjem. Evtektični sistem. Mikrostrukture evtektičnih, pod- in nadevtektičnih zlitin. Procesi izločanja na črti solvus. Mejne oblike evtektičnih	Constitution of metallic and non-metallic materials. Mixing of chemical elements. Gibbs phase rule. Alloy system, phase equilibrium and phase diagram. Lever rule. Phase diagram and crystallization from a melt. Equilibrium and non-equilibrium solidification. Segregation of alloying elements and the partitioning coefficient. Constitutional supercooling. Coring. The constitution of binary alloys and non-metallic systems. Two-phase equilibrium in binary system. Microstructure, physical and mechanical properties in binary isomorphous systems. Three-phase equilibrium in binary system. Eutectic system. Microstructure of hypoeutectic, eutectic and hipereutectic alloys. Precipitation process on solvus line. Eutectic system. Peritectic system.

sistemov. Peritektični sistem. Zlitinski sistem Al-Si, zlitinska sistema Cu-Sn in Cu-Zn. Zlitinski sistem Fe-Fe3C in razvoj mikrostrukture, premena avstenita v bainitni stopnji, premana avstenita v martenzitni stopnji, sistem Fe-C. Ternarni izomorfni in evtektski sistem ter obravnava kvazibinarnega reza v realnem ternarnem sistemu Al-Si-Mg. Mehanizmi plastičnega preoblikovanja kristalov čistih kovin, dislokacijski mehanizmi plastične deformacije kristalov kovin, deformacija z dvojčenjem, deformacija polikristalnih agregatov in teksture. Poprava in rekristalizacija, lezenje in mehanizmi lezenja kovinskih materialov, razdelitev lomov kovinskih materialov, Griffithova teorija krhkega loma, mehanizmi nastanka mikrorazpok, prehod iz žilavega v krhki lom, utrujanje materiala, trajna nihajna trdnost. Električna prevodnost kovin in zlitin. Magnetne lastnosti materialov.	Al-Si alloy system, Cu-Sn and Cu-Zn alloy systems. Fe-Fe3C system and development of microstructure, transformation of austenite to bainite, transformation of austenite to martensite, Fe-C system. Ternary isomorphous and eutectic system and study of quasibinary eutectic in commercial Al-Si-Mg system. Mechanisms of plastic deformation of pure metal crystals, dislocation mechanism of plastic deformation of metallic crystals, deformation by twinning, deformation of polycrystalline aggregates and textures. Recovery and recrystallization, creep and creep mechanisms in metallic materials, Types of fracture of metallic materials, Griffith theory of brittle fracture, mechanisms of micro-crack formation, ductile-to-brittle fracture transition, fatigue, Fatigue limit. Electrical conductivity of metals and alloys. Magnetic properties of materials.

Temeljna literatura in viri/Readings:

S. SPAIĆ: Fizikalna metalurgija: binarni sistemi, metalografija zlitin, Ljubljana 2000
B. Markoli: Ternarni in kvaterni zlitinski sistemi, Ljubljana 2009
B. MARKOLI: Osnove fizikalne metalurgije, Ljubljana 2008
V. MARINKOVIČ: Fizikalna metalurgija II, skripta, Ljubljana 1999
PORTER, EASTERLING: Phase Transformations in Metals and Alloys, Chapman – Hall 1992
VERHOEVEN: Fundamentals of Physical Metallurgy, John Wiley, New York
C.KITTEL, Introduction to solid state physics, John Wiley & Sons 2005
A.PRINCE: Alloy phase equilibria, Elsevier publishing company, Amsterdam-London-New York 1966
R.J.D.TILLEY: Understanding Solids, Wiley&Sons, Chichester 2004

Cilji in kompetence:	**Objectives and competences:**
Predmet obravnava problematiko, ki je osnova za razumevanje procesov toplotne obdelave, plastične predelave in mehanizmov utrjevanja materialov. Poznavanje kristalnih lastnosti, difuzije defektov v strukturi kovinskih materialov, teorijo utrjevanja in faznih transformacij omogoča spoznanje s katerimi fizikalnometalurškimi faktorji se lahko vpliva na mikrostrukturo in lastnosti kovinskih in tudi drugih materialov s kristalno zgradbo.	The course deals with the topic, which is the basis for understanding the processes of heat treatment, plastic deformation processing and mechanisms of hardening materials with crystal structures. Knowledge of crystal properties, diffusion of defects in the structure of metallic materials, theory of strengthening and phase transformation enables to understand factors which may have an influence on the microstructure and properties of metal and other materials with crystalline structure.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Za razumevanje vsebine predmeta so potrebna predhodna znanja s področja matematike, fizike in strukture materialov. Namen predmeta je, da se študenti seznanijo s teorijo fizikalne metalurgije kovinskih materialov. Teoretične osnove so potrebne za nadaljnji študij ter razumevanje postopkov in procesov pri izdelavi, predelavi in toplotni obdelavi kovinskih polizdelkov in izdelkov.	Knowledge and understanding: To understand the topic of this course it is required prior knowledge of mathematics, physics and structure of materials. The purpose of this course is students to get familiar with the theory of physical metallurgy of metallic materials. Theoretical foundations are needed for further study and understanding the procedures and processes in the manufacture, processing and heat treatment of metal materials and products.

Metode poučevanja in učenja: **Learning and teaching methods:**

Predmet se poučuje v obliki predavanj in vaj.	The course is taught through lectures and tutorials.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Poročilo o opravljenih vajah, ki doprinese h končni oceni 20 %,	20,00 %	(a) The report on lab work, which contributes to the final grade of 20%,
(b) pisni izpit, ki doprinese h končni oceni 40 %,	40,00 %	(b) examination, which contributes to the final grade 40%
(c) ustni izpit, ki doprinese h končni oceni 40 %.	40,00 %	(c) oral examination, which contributes to the final grade of 40%.

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

ZUPANIČ, Franc, MARKOLI, Boštjan, NAGLIČ, Iztok, BONČINA, Tonica. The experimental investigation of phase equilibria in the Al-rich corner within the ternary Al-Mn-Be system. J. alloys compd.. [Print ed.], 5. sep. 2013, vol. 570, str. 125-132

MARKOLI, Boštjan, BONČINA, Tonica, ZUPANIČ, Franc. Behaviour of a quasicrystalline strengthened Al-alloy during compression testing = Verhalten einer quasikristallinen Aluminiumlegierung im Druckversuch. Mater.wiss. Werkst.tech., Apr. 2012, vol. 43, no. 4, str. 340-344

MARKOLI, Boštjan, BONČINA, Tonica, ZUPANIČ, Franc. The solidification path of the complex metallic Al-Mn-Be alloy. Croat. chem. acta, Apr. 2010, vol. 83, no. 1, str. 49-54

MARKOLI, Boštjan, SPAIĆ, Savo. Effect of tempering on the microstructure and hardness of ledeburitic chromium steel X155CrVMo12.1. Z. Met.kd., 2007, vol. 98, no. 2, str. 150-154

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The intermetallic phases containing transition elements in common Al-Si cast alloy. Aluminium (Dusseld.), 2004, let. 80, št. 1/2, str. 84-88

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The constitution of alloys in the Al-rich corner of the Al-Si-Sm ternary system. Z. Met.kd., 2001, vol. 92, no. 9, str. 1098-1102.

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. Contribution to the Si-Sm phase diagram. Metall (Berl. West), Nov. 1999, jhrg. 53, 11, str. 604-606

FIZIKALNA METALURGIJA JEKLA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizikalna metalurgija jekla
Course title:	Physical Metallurgy of Steel
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067617
Koda učne enote na članici/UL Member course code:	666

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija. Študijske obveznosti lahko opravljajo tudi ponavljavci.	Prerequisites are defined in the Regulations on verification and assessment of students at UL NTF. For the positive and successfully prerequisites and inclusion in the study work is recommended to regularly attend lectures, solving additional and more challenging tasks at home and corresponding preparation prior to laboratory work, to demonstrate the activity and at least 80 % of attendance at exercises. The condition for inclusion in the study work is the enrollment into the third year of study. Study obligations may perform repeaters as well.

Vsebina:	**Content (Syllabus outline):**
/Mehanizmi utrjevanja: Deformacijsko, substitucijske trdne raztopine, kristalno zrno, disperzijsko utrjevanje, inženirske aplikacije. Ravnotežni binarni fazni diagram Fe-C: austenitizacija,transformacije austenita ($\gamma \rightarrow \alpha$, γ	The mechanisms of strengthening: Strain hardening, solid solution strengthening, grain boundary strengthening, dispersion hardening, engineering applications, Equilibrium binary phase diagram Fe-C:

→Fe3C, γ → α + Fe3C); perlit, jekla z mikrostrukturo iz ferita in perlita. Legirni elementi v železovih zlitinah: fazni diagrami Fe-C-legirni element; razdelitev legirnihelementov v zlitinah; vpliv legirnih elementov na transformacijo. Martenzit: transformacija austenita v martenzit; kristalna struktura martenzita in kristalografija transformacije; morfologija martenzita v železovih zlitinah; karakterizacija spremembe pri transformaciji austenita v martenzit in lastnosti martenzita. Bainit: transformacija austenita v bainit; kinetika transformacije; morfologija bainita; vpliv legirnih elementov; jekla z bainitno mikrostrukturo. Acikularni ferit: mikrostruktura in mehanizem transformacije. Kinetika faznih transformacij v železovih zlitinah: TTT (IT) in CCT diagrami. Prekaljivost jekel: vpliv kemične sestave, mikrostrukture zlitin in hladilnega medija na prekaljivost; preizkušanje prekaljivosti; kalilne napetosti; martempering. Popuščanje: popuščanje ogljikovih in legiranih jekel; popuščanje martenizta in bainita; maraging jekla. Toplotne obdelave: naprave za toplotne obdelave; krmiljenje in kontrola procesov toplotne obdelave; napake pri toplotni obdelavi. Patentiranje. Krhkost in porušitev jekel. Površinsko utrjevanje železovih zlitin: kemotermične obdelave; površinsko kaljenje; deformacijsko utrjevanje Sistematika jekel.	Austenitisation, transformations of austenite (γ → α, γ →Fe3C, γ → α + Fe3C); pearlite, steels with microstructure of ferrite and pearlite. Alloying elements in iron alloys: phase diagrams Fe-C-alloying elements, distribution of alloying elements in alloys, the effect of alloying elements on transformations of austenite Martensite: Transformations of martensite; crystal structure of martensite and crystallography, morphology of martensite, the characterisation of changes during transformations of austenite in martensite and properties of martensite Bainite: transformation of austenite in bainite; kinetics of transformation, morfology of bainite; the effect of alloying elements on steels with bainitic microstructure. Acikular ferrite: microstructure and mechanism of the transformation Kinetics of phase transformations in iron alloys: TTT (IT) and CCT diagrams. Hardenability of steels: the influence of chemical compositions, microstructure of alloys and quenching media on hardenability; testing of hardenability; quenching stresses; martempering Tempering: tempering of plain carbon steel and alloyed steels; tempering of martensite and bainite; maraging steels. Heat treatment: equipment for heat treatment procedures; monitoring and controlling of the processes of heat treatment, mistakes at heat treatment process Patenting Embrittlement and failures of steels Surface hardening of iron alloys: chemical heat treatment; surface quenching; work hardening, Systematisation of steels

Temeljna literatura in viri/Readings:

H.K.D.H. BHADESHIA, R.W.K. HONEYCOMBE, Steels: Microstructure and Properties, 4th edition, 2017
GEORGE E. TOTTEN, Steel Heat Treatment: Metallurgy and Technologies, 2nd, CRC Press, 2014
JOSÉ IGNACIO VERDEJA GONZÁLEZ, DANIEL FERNÁNDEZ-GONZÁLEZ, LUIS FELIPE VERDEJA GONZÁLE, Physical Metallurgy and Heat Treatment of Steel Springer Cham, 2023
JOCIĆ, B. Jekla in železove zlitine. Ravne na Koroškem: BIO-TOP, 2008
WILLIAM C. LESLIE, Physical Metallurgy of Steels Reprint Edition, Techbooks, 1991

Cilji in kompetence:	**Objectives and competences:**
/Predmet obsega fizikalno kemijske lastnosti železa, kristalno strukturo, pojav alotropije, meritve temperatur faznih prehodov, difuzijo, zlitinske sisteme železa z ogljikom in drugimi elementi, potek faznih	The course includes study of physical and chemical properties of iron, crystal structure, allotropy, determination of temperatures of phase transformations, diffusion, phase diagrams of iron with other alloying elements, phase transformations

transformacij v sistemu Fe-C, vpliv legirnih elementov na konstitucijo faznih diagramov in potek transformacij, osnove toplotnih obdelav, termomehanske obdelave in površinsko utrjevanje.	in Fe-C phase diagram, the effect of alloying elements on constitution of phase diagrams and on heat treatment processes; thermomechanical processing and surface hardening.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Za razumevanje vsebine predmeta so potrebna predhodna znanja s področja materialografije, fizikalne metalurgije, termodinamike materialov in jeklarstva. V okvirju predmeta bodo študentje osvojili znanja, ki so potrebna za izbiro, obdelavo in uporabo jekel, za njihovo načrtovanje in razvoj, za raziskave na področju fizikalne metalurgije jekla in vzpobuda k samostojnemu delu.	For the understanding the content of the course is necessary to have the knowledge from Materialography, Physical metallurgy, Thermodynamics of materials and steel processing. The purpose of the course is getting the knowledge which are necessary for selection, treatment and application of steels, for designing and development, for investigations on the field of physical metallurgy and for motivation to independent work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, laboratorijske vaje	Lectures, laboratory work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena laboratorijskih vaj (30 %)	30,00 %	the mark of laboratory work (30 %)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30 %)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40 %)

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

BURJA, Jaka, ŠULER, Blaž, ČEŠNJAJ, Marko, NAGODE, Aleš. Effect of Intercritical Annealing on the Microstructure and Mechanical Properties of 0.1C-13Cr-3Ni Martensitic Stainless Steel. Metals. 2021, iss. 3, vol. 11, str. 1-16

ULE, Boris, NAGODE, Aleš. The improved power-law, stress-dependent, energy-barrier model of 9Cr-1Mo-0.2V steel using short-term creep data. Scripta materialia, ISSN 1359-6462, 2007, vol. 57, no. 5, str. 405-408

NAGODE, Aleš, KOSEC, Ladislav, ULE, Boris. Uni-axial and multi-axial creep behavior of P91-type steel under constant load. Engineering failure analysis, ISSN 1350-6307. [Print ed.], 2011, vol. 18, no. 1, str. 61-67

KLANČNIK, Grega, MEDVED, Jože, NAGODE, Aleš, NOVAK, Gašper, STEINER PETROVIČ, Darja. Influence of Mn on the solidification of Fe-Si-Al alloy for non-oriented electrical steel. Journal of thermal analysis and calorimetry, ISSN 1388-6150, 2014, vol. 116, no. 1, str. 295-302.

ZORC, Borut, NAGODE, Aleš, KOSEC, Borut, KOSEC, Ladislav. Analysis of weld cracking in shotblasting chambers made of Hadfield steel. Engineering failure analysis, ISSN 1350-6307. [Print ed.], Oct. 2013, vol. 33, str. 48-54

FIZIKALNA METALURGIJA NEŽELEZNIH KOVIN

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizikalna metalurgija neželeznih kovin
Course title:	Physical Metallurgy of Non-ferrous Metals
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067618
Koda učne enote na članici/UL Member course code:	667

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 3. letnik študija.	Matriculation into the 3rd year of the study programme.

Vsebina:	Content (Syllabus outline):
/Uvod: opis specifične problematike neželeznih kovin in zlitin. Taljenje, polkontinuirno ulivanje in strjevanje gnetnih kovin in zlitin: čiščenje taline; modifikacija; izceje notranje napetosti; napake pri strjevanju in ulivanju. Homogenizacijsko žarjenje: difuzijski procesi pri homogenizacijskem žarjenju; vpliv žarjenja na mikrostrukturo; heterogenizacija mikrostrukture; vpliv žarjenja na lastnosti polizdelkov in izdelkov; vpliv parametrov homogenizacijskega žarjenja na lastnosti kovin in zlitin; tehnika homogenizacijskega žarjenja. Hladna deformacija gnetnih kovin in zlitin: mikrostruktura; tekstura; mehanizmi deformacijskega utrjevanja; lastnosti in značilnosti kovin in zlitin v deformiranem stanju. Mikrostrukturne spremembe med vročim	Introduction: description of the specifics of non-ferrous metals and alloys Melting, DC casting and solidification of wrought metals and alloys: purification and modification of melt; segregation; internal stresses; failures at casting and solidification. Homogenisation annealing: diffusion processes; the effect of annealing on the properties of semi-products and products; the effect of homogenisation´s parameters on the properties of metals and alloys; technique of homogenisation. Cold working of wrought metals and alloys: the microstructure; texture; mechanisms of strain hardening; the properties and characteristics of metals and alloys in deformed condition. Microstructural changes during the hot working of metals and alloys: dynamic recovery; dinamic

preoblikovanjem kovin in zlitin: dinamična poprava;dinamična rekristalizacija; metadinamična rekristalizacija; Mikrostrukturne spremembe med žarjenjem hladno deformiranih kovin in zlitin: statična poprava; statična rekristalizacija; rast zrn; nukleacija, hitrost nukleacije, rast zrn in kinetika rekristalizacije za primer aluminija in zlitin; pomen poprave in rekristalizacije za lastnosti polizdelkov in izdelkov; eksperimentalna tehnika za določevanje kinetike rekristalizacije. Toplotna obdelava - izločevalno utrjevanje - za zlitinske sisteme na osnovi aluminija, bakra in magnezija: prenasičena trdna raztopina, gašenje, naravno in umetno staranje, mehanizem izločevalnega utrjevanja, vpliv zlitinskih elementov in nečistoč, kinetika staranja, prestaranje, končna FTMT in vmesna IMTI termomehanska obdelava, tehnika izločevalnega utrjevanja, vpliv izločevalnega utrjevanja na lastnosti zlitin; toplotna obdelava titanovih zlitin. Lastnosti zlitin neželeznih kovin za posebne namene: temperaturno odporne zlitine, superplastične zlitine, mehansko legirane zlitine, zlitine s spominom. Lastnosti komercialnih gnetnih zlitin: zlitinski sistemi, lastnosti in posebnosti zlitin, oznaka zlitin. Perspektive in razvoj neželeznih kovin in zlitin.	recrystalisation; metadynamic recrystalisation. Microstructural changes during the annealing of cold worked metals and alloys: static recovery, static recrystalisation; grain growth; secondary recrystalisation; nucleation; nucleation rate; grain growth and the kinetics of recrystalisation of aluminium and its alloys; the effect of recovery and recrystalisation on properties of semi-products and products; experimental determination of the kinetics of recrystalisation. Heat treatment – precipitation hardening of alloys based on aluminium, copper and magnesium: Supersaturated solid solution, quenching, ageing, the mechanism of precipitation hardening, the effect of alloying elements and impurities, kinetics of ageing, overaging, final FMT and intermediate IMTI thermomechanical processing, technique of precipitation hardening, the effect of precipitation hardening on properties of alloys; heat treatment of titanium alloys. The properties of non-ferrous metals on special purposes: heat resistant alloys, alloys with superplastical properties, mechanical alloyed alloys, shape-memory alloys. The properties of commercial wrought alloys: properties and characteristics of alloys, alloy designation. Perspective and development of non-ferrous metals and alloys.

Temeljna literatura in viri/Readings:

/POLMEAR I. J:: Light Alloys, Arnold, London MARTIN J. W., DOHERTY R. D in B. CANTOR B.: Stability of microstructure in metallic systems, Cambridge University Press, Cambridge, (DIES K.: Kupfer und Kupferlegierungen in der Technik, Springer Verlag, Berlin)

Cilji in kompetence:	**Objectives and competences:**
/Vsebina predmeta je nadaljevanje predmeta Fizikalna metalurgija. S fizikalno metalurškega stališča so obravnavani specifični problemi in procesi v pomembnejših kovinah in zlitinah neželeznih kovin. Smoter predmeta je tudi uporaba in prenos teoretičnih predznanj na konkretne primere v praksi.	The content of the course is a continuation of the course ˝Physical metallurgy˝. From physical and metallurgical point of view this course deals with specific problems and processes of most important non-ferrous metals and alloys. The aim of the course is an application of theoretical knowledge in concrete examples in professional work.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Za razumevanje vsebine predmeta so potrebna predhodna znanja s področja Fizikalne metalurgije. Namen predmeta je, da se študenti seznanijo z teoretičnimi in praktičnimi problemi barvnih kovin in njihovih zlitin.	Knowledge and understanding: For the understanding of the content of the course the previous knowledge of >Physical metallurgy is needed. The purpose of the course is to meet the students with theoretical and practical problems of non-ferrous metals and their alloys. The content of

Vsebina obsega za posamezne kovine teoretične osnove in specifične posebnosti posameznih kovin in zlitin od njihove izdelave s taljenjem in ulivanjem do končne izdelave polizdelkov in izdelkov . Teoretično znanje je dopolnjeno s praktičnimi vajami.	the course includes theoretical basis and specific characterisations of some metals and alloys. That includes the processes from melting and casting till final treatment of semi-products and products. Theoretical knowledge will be combined with practical exercises.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja in laboratorijske vaje	Lectures and laboratory work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Ocene poročila o opravljenih vajah, (20 %)	20,00 %	(a) Report from laboratory work (20 %)
(b) ocene pisnega izpita (40 %) in	40,00 %	(b) written examination (40 %) and
(c) ocene ustnega izpita (40 %)	40,00 %	(c) Oral examination (40 %)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

SMOLEJ, Anton, KLOBČAR, Damjan, SKAZA, Branko, NAGODE, Aleš, SLAČEK, Edvard, DRAGOJEVIČ, Vukašin, SMOLEJ, Samo. Superplasticity of the rolled and friction stir processed Al-4.5 Mg-0.35Sc-0.15Zr alloy. Materials Science & Engineering. A, Structural materials: Properties, Microstructure and Processing, ISSN 0921-5093. [Print ed.], Jan. 2014, vol. 590, str. 239-245

KARPE, Blaž, KOSEC, Borut, NAGODE, Aleš, BIZJAK, Milan. The influence of Si and V on the kinetics of phase transformation and microstructure of rapidly solidified Al-Fe-Zr alloys. Journal of mining and metallurgy. Section B, Metallurgy, ISSN 1450-5339, 2013, vol. 49 B, no. 1, str. 83-89.

SKUMAVC, Andrej, TUŠEK, Janez, NAGODE, Aleš, KOSEC, Ladislav. Tungsten heavy alloy as a filler metal for repair welding of dies for high pressure die casting. International journal of materials research, ISSN 1862-5282, Nov. 2013, vol. 104, no. 11, 1143-1150,

FIZIKALNO KEMIJSKE OSNOVE SPAJANJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Fizikalno kemijske osnove spajanja
Course title:	Physico-Chemical Basics of Soldering
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077534
Koda učne enote na članici/UL Member course code:	676

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Zorc, Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Vpis v 3. letnik. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Matriculation into the 3rd year of the study programme. For a positive and successfully prerequisites and inclusion in the study programme regularly attending lectures, solving additional more demanding homework, appropriate pretreatment prior to implementation of laboratory work, demonstrating the activity and at least 80 % attendance at exercises is recommended.

Vsebina:	**Content (Syllabus outline):**
/Vsebina predmeta je razdeljena na pet (5) poglavij: V UVODU je podana kratka zgodovina varjenja in varjenju sorodnih tehnik spajanja ter prikazan pomen, perspektive in mesto, ki ga obravnavane tehnike spajanja materialov zavzemajo med proizvodnimi tehnologijami v industriji. V PREGLEDU POSTOPKOV SPAJANJA so sistematično prikazani postopki varjenja s taljenjem (plamensko, ročno obločno, TIG, MIG/MAG, EPP in EPŽ-varjenje), varjenja s pritiskom (eksplozijsko,	The content of the course is divided in 5 chapters: In the INTRODUCTION a short history of welding and other techniques of joining similar to welding is presented. Also the impotrtance and the position of the joining techniques among other production technologies in industry are demonstrated. In the chapter˝OVERVIEW OF METHODS OF JOINING˝ the following welding procedures are explained: welding with melting (using flame, hand arc welding, TIG, MIG/MAG, EPP and XXX),

kovaško, torno, difuzijsko, uporovno, obžigalno in visokofrekvenčno varjenje), posebni postopki spajanja (plazma, elektronski snop, LASER ter spajkanje in lepljenje) ter postopki oplemenitenja površin (nabrizgavanje in navarjanje). V poglavju KEMIJSKO METALURŠKI PROCESI, ki je osrednje in tudi najobširnejše, je obdelano odtaljevanje dodajnega materiala (plamensko in oblačna varjenja), kemijski procesi na raztaljenem delu dodajnega materiala, odtaljeni kapljici in talini na osnovnem materialu. To poglavje vsebuje tudi metalurgijo spajanja, to je strukturne spremembe, ki jih povzroči segrevanje osnovnega materiala zaradi vnosa toplote, taljenje in kristalizacijo ter strukturne spremembe pri ohlajanju spojev. S posebno pozornostjo so predstavljene napake spojev, ki večinoma nastajajo pri kristalizaciji vara in ohlajanju zvara. Posledice ugotavljamo z metalografijo spojev, ki je opisana tudi v tem poglavju. Zaključujemo pa ga z opisom vzrokov za nastanek napetosti, ki lahko povzročijo deformacije spoja. V poglavju VARIVOST je obdelano ugotavljanje primernosti različnih materialov za varjenje (preizkušanje varivosti). Podani pa so tudi problemi in napotki za spajanje jekel, litega železa, neželeznih kovin in njihovih zlitin, umetnih snovi in keramike. Peto poglavje ZAŠČITA IN ZAGOTAVLJANJE VARNOSTI …, ki obravnava nevarnosti zaradi plinov, ki jih uporabljamo ali pa nastajajo med spajanjem, zaradi dimov ter zaradi sevanja in dela z električnim tokom, pa zaključuje vsebino predmeta »Fizikalno kemijske osnove spajanja«.	pressure welding (explosion welding, forgin welding, ... In the chapter ˝CHEMICAL AND METALLURGICAL PROCESSES˝ is the largest and most important part of the lectures. It discusses the melting of filler material (flame and arc welding), the chemical processes in melted filler material, droplet and metled base material. This chapter also discusses the metallurgy of welding which includes structural changes due to heating of the material, melting and crystalisation as well as structural changes during the cooling of the joints. Also the failures of the joints which can occur during cristalisation of the weld will be described. The metallography of joints is also included in explanation of failures. The chapter ends with the presentation of the causes for stresses which can lead to deformation of joints. In the chapter ˝WELDABILITY˝ the determination of suitability of joining of different materials is explained. The problems and advices of welding of steels, cast irons, non-ferrous metals and their alloys, polymers and ceramic are presented. In the fifth Chapter PREVENTION AND SAFETY ASSURANCE discusses the danger due to gasses which are used or which occur during welding and the fume which occurs due to radiation and electric current.

Temeljna literatura in viri/Readings:

B. Zorc.: Varjenje, skripta za predavanja. Univerza v Ljubljani, NTF, Ljubljana, 2020
Gojić M.: Tehnike spajanja i razdvajanja materiala. Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2008
Tušek J.: Varjenje in sorodne tehnike spajanja materialov v neločljivo zvezo. Univerza v Ljubljani, Fakulteta za strojništvo, Ljubljana, 2014Kou S.: Welding Metallurgy, third edition. John Wiley & Sons, Inc., Hoboken, 2021
ASM Handbook, Vol. 6A: Welding Fundamentals and Processes. ASM International, Materials Park, 2011

Cilji in kompetence:	**Objectives and competences:**
/Namen predmeta je seznanjanje slušateljev s spajanjem materialov po postopkih varjenja in varjenju sorodnih tehnikah, ki bodo predstavljene glede na njihov pomen v industriji. Pri obravnavi različnih tehnik spajanja bo poudarek na razumevanju fizikalno kemijskih in metalurških procesov, ki med spajanjem potekajo na dodajnem materialu, odtaljeni kapljici in talini spoja. Slušatelji morajo dojeti pomen sestave dodajnega materiala ter izbire pomožnih materialov (zaščitnega plina, varilnega praška…) in parametrov spajanja za kakovost spoja.	The purpose of the course is meet the students with the joining of materials with the welding and similar methods which they will be presented according to their meaning in the industry. The emphasis will be given to physical-chemical and metallurgical processes which operate during the welding in filler materials, droplet and in melted joint. The student should understand the importance of composition of filler materials and selection of auxiliary materials (shielding gas, xxxxxxxxxxx) and parameters of welding for the quality of joint.

Predvideni študijski rezultati:	**Intended learning outcomes:**

/Znanje in razumevanje: Namen predmeta je, da se študenti univerzitetnega študija seznanijo s postopki spajanja materialov z varjenjem in sorodnimi tehnikami spajanja materialov. Poudarek pa je na razumevanju poteka fizikalno kemičnih in metalurških procesov med spajanjem, kar jim bo v pomoč pri izbiri postopkov ter dodajnih in pomožnih materialov za določanje najustreznejše tehnologije spajanja izbranih materialov.	Knowledge and understanding: The purpose of the course is to introduce the students to joining materials with the welding and similar techniques. The emphasises is put on understanding of physical-chemical and metallurgical processes during the welding. This knowledge will help the student for the selection of proper welding techniques and filler and auxiliary materials and the most adequate welding technology for the selected materials.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, laboratorijske vaje, samostojno delo.	Lectures, laboratory work, independent work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Timsko poročilo o laboratorijskih vajah, ki doprinese 10 % h končni oceni;	10,00 %	(a) Team report of laboratory work which contributes 10 % to the final mark
(b) samostojna študija, ki doprinese 10 % h končni oceni,	10,00 %	(b) independent study which contributes 10 % to the final mark
(c) pisni izpit, ki doprinese 40 % h končni oceni,	40,00 %	(c) written exam which contributes 40 % to the final mark and
(d) ustni izpit. ki doprinese 40 % h končni oceni	40,00 %	(d) oral exam which contributes 40 % to final mark.

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

ZORC, Borut. Automatic TIG welding of austenitic stainless steels in nitrogen and nitrogen-based gas mixtures. Revista de metalurgia, ISSN 0034-8570, 2011, vol. 47, no. 1, str. 29-37

ZORC, Borut, KOSEC, Ladislav. A new approach to improving the properties of brazed joints. Welding journal, ISSN 0043-2296, 2000, vol. 79, no. 1, str. 24s-31s

ZORC, Borut. TIG varjenje nerjavnih avstenitnih jekel v zaščitni atmosferi dušika. Varilna tehnika, ISSN 0505-0278, 2006, letn. 55, št. 1, str. 3-8
MRVAR, Primož, MEDVED, Jože, KASTELIC, Sebastjan. Welding sequence definition using numerical calculation. Welding journal, ISSN 0043-2296, 2011, vol. 90, str. 148-151

INDUSTRIJSKE PEČI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Industrijske peči
Course title:	Industrial Furnaces
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077535
Koda učne enote na članici/UL Member course code:	683

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	45	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija. Opravljeno in uspešno predstavljeno projektno delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the third year of study. Completed and successfully presented project work is required before taking the written and oral exam.

Vsebina:	**Content (Syllabus outline):**
/Uvod: Razdelitev industrijskih peči. Po vrsti, namenu, načinu kurjenja, atmosferi, … Temeljni procesi dela industrijskih peči Gorenje, aerodinamika, prenos toplote. Mehanizmi prenosa toplote v industrijskih pečeh. Parametri, ki vplivajo na prenos toplote v peči. Prenos toplote na vložek v peči. Delovne temperature industrijskih peči. Temperaturna območja delovanja industrijskih peči. Temperaturne tolerance industrijskih peči. Zgorevanje in atmosfera v peči. Goriva in njihove lastnosti. Zgorevalne toplote in kurilnosti. Vžigne meje. Koraki pri gorenju.	Introduction: Classification of industrial furnaces by type, purpose, method of heating, the type of atmosphere ... The basic processes of industrial furnaces: Combustion, furnace aerodynamics, heat transfer. The mechanisms of heat transfer in industrial furnaces: Parameters that affect the heat transfer in the furnace. Heat transfer to the charge. Working temperature in the furnaces: Temperature operating range of industrial furnaces. Temperature tolerance of industrial furnaces. The combustion and the atmosphere in the furnace: Fuels and their properties. Combustion heat, calorific

Gorilniki. Naloge gorilnika: mešanje goriva in oksidanta, vžig goriva, stabilizacija plamena, vzdrževanje plamena z določenimi lastnostmi. Razdelitev gorilnikov. Dimenzioniranje. Varovalne atmosfere. Delovne atmosfere. Atmosfere inertnih plinov. Ogrevanje peči z varovalno atmosfero. Določitev sestave varovalne atmosfere. Določitev ravnotežja reakcije vodnega plina. Varovalne atmosfere pri toplotni obdelavi jekla. Reakcije med plini in jeklom. Priprava varovalnih atmosfer. Dimniki. Statični vlek dimnika. Višina in presek ustja dimnika. Dimenzioniranje. Cevovodi. Elementi cevovodov. Upori in izgube v cevovodih. Dimenzioniranje cevovodov. Elektro ogrevanje: Uporovno ogrevanje, Induktivno ogrevanje. Principi. Prednosti in slabosti. Ognjevzdržna gradiva in obzidava industrijskih peči. Razdelitev ognjevzdržnih gradiv. Lastnosti ognjevzdržnih gradiv. Kriteriji izbire / selekcije ognjevzdržnih gradiv. Obzidava peči. Osnove dimenzioniranja, projektiranja in izdelave industrijskih peči. Vodenje in nadzor procesov v industrijskih pečeh. Oprema za optimalno vodenje in nadzor procesov. Poraba energije in toplotne izgube pri različnih tipih industrijskih peči. Toplotni izkoristek peči. Sankeyev diagram. Efektivnost peči. Toplotne izgube skozi stene, strop in dno peči. Toplotne izgube med odprtjem peči. Stroški ogrevanja. Sestava stroškov ogrevanja. Ukrepi za zmanjševanje. Toplotna in masna bilanca industrijske peči. Postopki in pristopi. Možnosti in načini izkoriščanja odpadne toplota. Prenosniki in izmenjevalci toplote. Dimenzioniranje. Študij praktičnih problemov.	value and ignition limits of different type of fuels. Combustion mechanism. Burners and burner's tasks: Mixing of fuel and oxidizer, fuel ignition, flame stabilization, flame maintenance with certain properties. Classification of the burners. Dimensioning. The atmosphere in the furnace: Atmosphere of inert gas. Heating furnace with protective atmosphere. Determination of the protective atmosphere composition. Determination of the water-gas equilibrium reactions. Protective atmosphere for heat treatment of steel. Reactions between gases and steel. Preparation of protective atmospheres. Chimneys: Static chimney draft. Height and cross section of the mouth of the chimney. Dimensioning. Pipelines: Elements of pipelines. Resistors and pipeline losses. Dimensioning pipelines. Electrical heating: Resistive heating, inductive heating. Principles, advantages and disadvantages. Refractory materials and insulation of industrial furnaces: Classification of refractory materials. Properties of refractory materials. Selection criteria / selection of refractory materials. Furnace insulation. The basics of dimensioning, design and manufacture of industrial furnaces: Command and control processes in industrial furnaces. Equipment for optimal management and control processes. Power consumption and heat dissipation in various types of industrial furnaces: Heat efficiency of the furnace. Sankey diagrams. Efficiency of the furnace. Heat loss through the walls, ceiling and floor of the furnaces. Heat losses during the opening of the furnace. Heating costs: Composition of heating costs. Measures to reduce the heating costs. The heat and mass balance of industrial furnaces: Procedures and approaches. Possibilities and ways of exploiting waste heat: Heat exchangers and recuperators. Dimensioning. Study of practical problems.

Temeljna literatura in viri/Readings:

/WARD, J. in COLLIN, R. Short Course on Industrial Furnace Technology, Vol.1, Vol. 2. Rio Tinto: CENERTEC, 2002.

GWYTHER, D.N. Worked Examples: Heat Transfer, Fuels Refractories, Fluid Flow and Furnace Technology, The Institution of Metallurgists, Monograph No. 12. London: The Chameleon Press, 1985.

HEILIGENSTEADT, W. Waermetechnische Rechnungen fuer Industrieoefen. Duesseldorf: Stahleisen Verlag, 1969.

DESHMUKH, Y.V. Industrial Heating – Principles, Techniques, Materials, Applications and Design. London: Taylor Francis, 2005.

POPOVIĆ, Z. in RAIĆ, K. Peći i projektovanje u metalurgiji. Beograd: Naučna knjiga 1988.

BRUNKLAUS, H.J. Industrieöfen- Bau und Betrieb. Essen: Vulkan Verlag, 1986.

TRINKS, W., MAWHINNEY, M.H., SHANNON, R.A., REED, R.J. in GARVEY, J.R. Industrial Furnaces. New Jersey: John Wiley Sons, 2004.

Cilji in kompetence:	Objectives and competences:
/V okviru predmeta Industrijske peči se študent seznani s pomenom industrijskih peči za posamezne tehnološke postopke in tehnologije. Seznani se z elementi peči, osnovami dimenzioniranja in izbire peči ter spozna njihov ustroj ter pomen spremljajočih naprav in opreme za optimalno vodenje. Študent se navaja na samostojno, timsko ter projektno delo, uporabo strokovne literature in sodobnih virov informacij.	The lecture course Industrial furnaces familiarize students with the importance of industrial furnaces for individual production processes and technology. Students are acquainted with the elements of the furnace, basic dimensioning and selection of furnaces as well as with their structure and the importance of supporting facilities and the equipment for optimal control. The students get accustomed to individual and team, project and research work, and application of expert literature and modern information sources.

Predvideni študijski rezultati:	Intended learning outcomes:
/Znanje in razumevanje: V okviru vsebine predmeta Industrijske peči študent spozna pomen peči za posamezne tehnološke postopke pri izdelavi, predelavi in toplotni obdelavi. Spozna mehanizme prenosa toplote, zgorevanje in aerodinamiko peči. Pozna elemente peči. Razume principe delovanja peči in obvlada vodenje in nadzor procesov. Nauči se osnov dimenzioniranja, projektiranja in izdelave industrijskih peči. Spozna pomen spremljajočih naprav in opreme za optimalno vodenje tehnoloških procesov. Študent pridobi inženirska znanja s področja dimenzioniranja, projektiranja, izdelave, oziroma izbire industrijskih peči. Obvlada izdelavo toplotnih in energetskih bilanc; izračune stroškov ogrevanja ter ukrepe za njihovo optimiranje. Pozna in je sposoben vodenja in nadzora procesov v industrijskih pečeh. Študent pridobi znanja za samostojno oziroma timsko delo pri načrtovanju, izdelavi in izbiri industrijskih peči, spremljajočih naprav in opreme. Sposoben je vodenja in nadzora procesov. Nauči se zbiranja, selekcioniranja in interpretiranja podatkov in rezultatov analiz. V okviru predmeta pridobi spretnosti uporabe strokovne literature in drugih sodobnih virov informacij.	Knowledge and understanding: Within the course Industrial furnaces student learns the importance of furnaces for individual technological processes in the production and heat treatment. Learns about the mechanisms of heat transfer, combustion and aerodynamics in the furnace. Becomes familiar with the elements of the furnace. Understand the principles of the operation and control of the furnace. Learns the basics of furnace dimensioning, design and manufacture of industrial furnaces. Realizes the importance of supporting facilities and equipment for optimal control of technological processes. Students acquire engineering knowledge for dimensioning, design, manufacture or selection of industrial furnaces. Masters the production of heat and energy balances, calculations of the costs of heating and measures to optimize them. Knows and is able to command and control processes in industrial furnaces. Student acquires skills for independent and team work in the design, manufacture and selection of industrial furnaces, ancillary facilities and equipment. He is able to command and control processes. Learns to collect, select and interpret the data from professional literature.

Metode poučevanja in učenja:	Learning and teaching methods:
/Predavanja, računske vaje in simulacije, laboratorijske vaje in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	Delež/Weight	Assessment:
ocena projektne naloge (30 %)	30,00 %	the mark of project work (30%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40%)

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

BRUNČKO, Mihael, RUDOLF, Rebeka, KOSEC, Borut, ANŽEL, Ivan. Vacuum carburizing of steels. TTEM. Tech. technol. educ. manag., 2012, vol. 7, no. 4, str. 1516-1521

KOSEC, Borut, KARPE, Blaž, BUDAK, Igor, LIČEN, Metod, ĐORĐEVIĆ, Miroslav, NAGODE, Aleš, KOSEC, Gorazd. Efficiency and quality of inductive heating and quenching of planetary shafts. Metallurgy, 2012, vol. 51, br. 1, str. 71-74.

GOJIĆ, Mirko, NAGODE, Aleš, KOSEC, Borut, KOŽUH, Stjepan, ŠAVLI, Štefan, HOLJEVAC-GRGURIĆ, Tamara, KOSEC, Ladislav. Failure of steel pipes for hot air supply. Eng fail. anal.. [Print ed.], 2011, vol. 18, no. 6, str. 2330-2335.

KEMIJA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Kemija 1
Course title:	Chemistry 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067584
Koda učne enote na članici/UL Member course code:	906

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
60	0	15	0	0	75	5

Nosilec predmeta/Lecturer:	Urška Lavrenčič Štangar
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Ne	None

Vsebina:	Content (Syllabus outline):
/Metode, definicije in osnovni pojmi v kemiji. Atomi, molekule, ioni in spojine. Kemijske reakcije splošno in reakcije v vodnih raztopinah. Termokemija. Elektronska zgradba atoma, periodičnost, kemijska vez in zgradba molekul Plini, tekočine in trdne snovi in medmolekulske sile. Raztopine. Osnove kemijske kinetike. Kemijsko ravnotežje. Kisline in baze. Spontanost kemijskih reakcij. Elektrokemija. Atomsko jedro in jedrska kemija. Osnove kemijskega računanja (množina snovi, elementna analiza, računanje množinskega razmerja	Methods, definitions and fundamental concepts in chemistry. Atoms, molecules, ions and compounds. Chemical reactions in general and reactions in aqueous solutions. Thermochemistry. Electronic structure of atom, periodicity, chemical bond and structure of molecules. Gases, liquids, solids and intermolecular forces. Solutions. Fundamentals of chemical kinetics. Chemical equilibrium. Acids and bases. Spontaneity of chemical reactions. Electrochemistry. Atomic nucleus and nuclear chemistry. The fundamental of stoichiometry (amount of substance, elemental analysis, calculation of amount

pri reakcijah v plinskih zmeseh in raztopinah).	ratio in chemical reactions taking place in gases or solutions).

Temeljna literatura in viri/Readings:

/B. Čeh: Splošna in anorganska kemija. Zbirka pojmov in nalog z odgovori in rešitvami, Univ. založba, Ljubljana, 2005, 240 str.;
B. Čeh: Kemijsko računanje in osnove kemijskega ravnotežja. Univ. založba, Ljubljana, 2006, 198 str.;
F. Lazarini, J. Brenčič: Splošna in anorganska kemija, DZS, Ljubljana, 2005, 557 str.
Dodatna literatura:
R.H. Petrucci, F.G. Herring, J.D. Madura, C. Bissonnette, General Chemistry, Principles and modern applications, deseta izdaja, Pearson, Toronto, 2011, 1303 str.

Cilji in kompetence:	**Objectives and competences:**
/Pri predmetu se študentje naučijo temeljnih prijemov in konceptov, ki so potrebni za razumevanje lastnosti in obnašanja anorganskih in organskih snovi.	The students learn the basic concepts of chemistry and stoichimetry with the aim of understanding of the properties and behavior of the inorganic and organic substances.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Razvijanje sposobnosti lastnega učenja osnovnih predmetov in nato prilagajanje ter uporaba znanja na svojem strokovnem področju.	Knowledge and understanding: The abilities of acquiring and sharing of fundamental chemical knowledge and concepts and linking them with other (related) topics.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja Pisanje na tablo PowerPoint predstavitev Prikazovanje kemijskih eksperimentov	Oral lectures Blackboard writing skills Power-Point presentation Demonstration of chemical experiments

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
vaje	30,00 %	exercises
pisni izpit	70,00 %	writing exam

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. PLIEKHOV, Oleksii, PLIEKHOVA, Olena, OSMAN DONAR, Yusuf, SINAG, Ali, NOVAK TUŠAR, Nataša, LAVRENČIČ ŠTANGAR, Urška. Enhanced photocatalytic activity of carbon and zirconium modified TiO [sub] 2. Catalysis today, vol. 284, str. 215-220 (2017).

2. VODIŠEK, Nives, RAMANUJACHARY, Kandalam, BREZOVÁ, Vlasta, LAVRENČIČ ŠTANGAR, Urška. Transparent titania-ziconia-silica thin films for self-cleaning and photoctalytic applications. Catalysis today, vol. 287, str. 142-147 (2017).

KEMIJA 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Kemija 2
Course title:	Chemistry 2
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067585
Koda učne enote na članici/UL Member course code:	910

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Iztok Turel
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Ne	None

Vsebina:	Content (Syllabus outline):
Kemija elementov glavnih skupin (1. in 2. ter skupine od 13 do 18) in osnove kemije elementov prehodnih kovin (zgradba, barva in magnetizem). Teorija valenčne vezi in teorija molekulskih orbital. Kovinska vez, teorija pasov, prevodniki in polprevodniki. Kemijsko računanje (nadgradnja iz Kemije 1) in osnove kemijskega ravnotežja (plini, raztopine močnih in šibkih kisline in baz, topnostni produkt)	Chemistry of s and p block elements (groups 1, 2, 13 to 18) and fundamental of d block elements an compounds (structure, colour and magnetism). Valence bond theory and molecular orbital theory. Metallic bonding, band theory, conductors and semiconductors. Stoichiometry (more advanced) and fundamental chemical equilibrium calculations (gases, strong and weak bases and acids, solubility product).

Temeljna literatura in viri/Readings:

/B. Čeh: Splošna in anorganska kemija. Zbirka pojmov in nalog z odgovori in rešitvami, Univ. založba, Ljubljana, 2005, 240 str.;
B. Čeh: Kemijsko računanje in osnove kemijskega ravnotežja. Univ. založba, Ljubljana, 2006, 198 str.;
F. Lazarini, J. Brenčič: Splošna in anorganska kemija, DZS, Ljubljana, 2005, 557 str.;
P. W. Atkins, M. J. Clugston, M. J. Frazer, R. A. Y. Jones: Kemija, zakonitost in upora, Tehniška založba

Slovenije, Ljubljana, 1998, 318 str. (prevod);

Cilji in kompetence:	**Objectives and competences:**
Pri spoznavanju in razumevanju kemizma spojin elementov glavnih in stranskih skupin študentje uporabijo koncepte in znanje, pridobljeno pri predavanjih pri Kemiji 1.	The concepts and knowledge, recognized at Chemistry 1, are used to learn and to understand the chemistry of main group, and partially, d-block elements.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razvijanje sposobnosti lastnega učenja osnovnih predmetov in nato prilagajanje ter uporaba znanja na svojem strokovnem področju.	Knowledge and understanding: The abilities of acquiring and sharing of fundamental chemical knowledge and concepts and linking them with other (related) topics.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja Pisanje na tablo PowerPoint predstavitev Prikazovanje kemijskih eksperimentov	Oral lectures Blackboard writing skills Power-Point presentation Demonstration of chemical experiments

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni in ustni izpit	70,00 %	Oral and written exam
računski kolokvij 30	30,00 %	exercises

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. K. Traven, N. Eleftheriadis, S. Seršen, J. Kljun, J. Bezenšek, B. Stanovnik, I. Turel, F. J. Dekker, Ruthenium Complexes as Inhibitors of 15-lipoxygenase-1, Polyhedron, 101, 306-313(2015).

2. J. Kljun, A. J. Scott, T. Lanisnik Rizner, J. Keiser, I. Turel, Synthesis and biological evaluation of organoruthenium complexes with azole antifungal agents. First crystal structure of a tioconazole metal complex, Organometallics, 33, 1594−1601 (2014).

3. P. Živec, F. Perdih, I. Turel, G. Giester, G. Psomas, Different types of copper complexes with the quinolone antimicrobial drugs ofloxacin and norfloxacin: Structure, DNA- and albumin-binding, J. Inorg. Biochem., 117, 35–47 (2012).

4. R. Hudej, J. Kljun, W. Kandioller, U. Repnik, B. Turk, C. G. Hartinger, B. K. Keppler, D. Miklavčič, I. Turel, Synthesis and Biological Evaluation of the Thionated Antibacterial Agent Nalidixic Acid and its Organoruthenium(II) Complex, Organometallics, 31, 5867−5874 (2012).

5. I. Turel, J. Kljun, Interactions of metal ions with DNA, its constituents and derivatives, which may be relevant for anticancer research, Current Topics in Medicinal Chemistry, 11, No. 21, 2661-2687 (2011).

KERAMIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Keramika
Course title:	Ceramics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067619
Koda učne enote na članici/UL Member course code:	670

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Andraž Kocjan, Tadej Rojac
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/- Razumevanje slovenskega in angleškega jezika (del študijskega gradiva je v angleščini). - Pisalo in kalkulator. - Dostop do računalnika, okolja Microsoft Office in interneta (zagotovljen na lokaciji, kjer se izvaja predmet).	- Comprehensive understanding of Slovenian and English languages (part of the study material is in English). - Pen and calculator. - Access to a computer with installed Microsoft Office and access to Internet (which is available on the course location).

Vsebina:	Content (Syllabus outline):
Predmet zajema osnove in aplikacije keramičnih materialov, pretežno elektronske in inženirske keramike. Razdeljen je na dva sklopa. V prvem sklopu študentje spoznajo osnove o keramiki, keramičnem procesiranju ter o lastnostih keramike s poudarkom na razlikah s kovinskimi materiali. Podrobneje se spoznajo s sintezo keramike v trdnem stanju, strukturo keramičnih materialov in defekti, obdelovanjem keramičnih prahov, sintranjem in mehanskimi lastnostmi keramike. V drugem sklopu predmeta je poudarek na bolj specifičnih lastnostih in uporabnosti nekaterih keramik. Študentje spoznajo	The course encompasses basics and applications of ceramic materials with the emphasis on electronic and engineering ceramics. It is composed of two parts. In the first part, students learn about basics of ceramics, ceramic processing and properties of ceramics with the emphasis on the property differences between ceramics and metals. Students get familiar with solid state synthesis of ceramics, its structure and defects, processing of ceramic powders, sintering and mechanical properties. In the second part of the course, the emphasis is on specific properties and applications of ceramic related materials. Students

karakteristike cirkonijevega oksida, ki je dopiran z itrijevim oksidom, osnovne zakonitosti elektronske keramike (di-, piezo-, fero-elektriki, elektrokaloriki, varistorji) ter nanos tankih in debeloplastnih struktur.	learn about yttrium-doped zirconia and basics about electroceramics (di-, piezo-, ferro-electrics, electrocalorics and varistors). This part also includes a background on deposition techniques for thin- and thick-film structures.

Temeljna literatura in viri/Readings:

// Kolar, D., Tehnična Keramika 1 in 2. Kingery, W. D., Introduction to Ceramics. Reed, J. S., Principles of Ceramics Processing (2nd edit). Chiang, Y-M, Birnie, P. B., Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering

Cilji in kompetence:	**Objectives and competences:**
/CILJ Cilj predmeta je, da poslušalec razvije razumevanje osnov o keramiki, keramičnem procesiranju ter o lastnostih keramik, v čem in zakaj prihaja do razlik s kovinskimi materiali. Poleg osnov, je cilj predmeta, da se študentje seznanijo s trenutnim stanjem na področju sinteze in uporabe keramičnih materialov. KOMPETENCE Doc.dr. Andraž Kocjan, doc.dr. Tadej Rojac že vrsto let delujeta na Odsekih za nanostrukturne materiale (K7) in elektronsko keramiko (K5), kjer sta vpletena v raziskave in razvoj tako procesov izdelave keramičnih materialov kot tudi naprednih tehnik karakterizacije njihovih lastnosti.	OBJECTIVES The objective of the course is to deliver to students a comprehensive understanding about basics of ceramics, ceramic processing and properties of ceramics. Emphasis is given on the comparison between ceramics and metal properties. The objective is that students learn about state-of-the-art ceramics synthesis and applications of ceramic materials. COMPETENCES Asst. Prof. Andraž Kocjan and Asst. Prof. Tadej Rojac have permanent positions at the Department for Nanostructured Materials and at the Electronic Ceramics Department, respectively. For several years now, they are active in research and development of processes for fabrication of ceramic materials as well as advanced methods for structural, microstructural and functional property characterization of ceramics.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Rezultat študija na predmetu »Keramika« je poznavanje osnov keramike (od kristalografije, defektov do sinteze) s širokim naborom različnih primerov iz področja elektronske in inženirske keramike. Poleg širine, je namen predmeta, da študent pridobi bolj poglobljeno znanje iz specifičnih področij, ki vključujejo piezoelektrično keramiko, keramiko za uporabo v zobni protetiki ter miniaturizacijo keramičnih elementov v obliki tankih in debelih plasti integriranih na podlage.	Intended learning outcomes on the "Ceramics" course is obtaining knowledge about fundamentals of ceramics (from crystallography, defects to synthesis) coupled with plethora of different real-time cases from the field of electronic and engineering ceramics. Besides acquired general broad-mindedness on the field of ceramics, the intended outcome is that the student also acquires deep understanding from more specific fields of ceramics involving piezoelectric ceramics, dental ceramics and downsizing of ceramic elements in the form of integrated surfaces comprised of thin and thick films.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predmet poteka v obliki tedenskih, 3-urnih predavanj, kjer je snov študentom podana preko PPT prezentacij. Študentje prejmejo kopije prosojnic za lažje sledenje. Vsakemu predavanju sledijo vaje, kjer študentje vsaj del podane snovi praktično izvedejo v laboratorijih odsekov elektronske keramike in nanostrukturnih materialov, Instituta Jožef Stefan. Študentje so razdeljeni v skupine. Najkasneje do prihodnje vaje morajo napisati in oddati poročilo iz prejšnje vaje. Pred vsakim kolokvijem je namenjen čas za ponovitev in utrditev snovi.	The course takes place in the form of weekly, 3-hour lectures, where the subject matter is forwarded to students via power point presentations. Students receive printed copies of slides before each course session to easily follow the course. Each lecture is followed by practical courses, where students conduct simple practical experiments that comply with the theoretical part of the course (lectures) and with at least part of the subjects currently investigated by of the Department for Nanostructured Materials and the Electronic Ceramics Department, at Jožef Stefan

	Institute. During practical courses, students are divided in groups. Prior to the next practical course, students need to provide a written report on the previous practical course. Theoretical and practical courses are thematically interconnected; on the given topic students thus attain both theoretical and practical basics. Prior to each colloquium sufficient time is devoted to revise and fortify knowledge attained.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
kolokvija	67,00 %	two written midterm
ustni izpit	33,00 %	oral examination

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

- ROJAC, Tadej, BENČAN, Andreja, DRAŽIĆ, Goran, SAKAMOTO, Naonori, URŠIČ, Hana, JANČAR, Boštjan, TAVČAR, Gašper, MAKAROVIČ, Maja, WALKER, Julian, MALIČ, Barbara, DAMJANOVIĆ, Dragan. Domain-wall conduction in ferroelectric BiFeO3 controlled by accumulation of charged defects. Nature materials, 2017, vol. 16, no. 3, str. 322-327
- ROJAC, Tadej, URŠIČ, Hana, BENČAN, Andreja, MALIČ, Barbara, DAMJANOVIĆ, Dragan. Mobile domain walls as a bridge between nanoscale conductivity and macroscopic electromechanical response. Advanced functional materials, 2015, vol. 25, no. 14, str. 2099-2108
- PAVLIČ, Jernej, MALIČ, Barbara, ROJAC, Tadej. Microstructural, structural, dielectric and piezoelectric properties of potassium sodium niobate thick films. Journal of the European ceramic society, 2014, vol. 34, issue 2, str. 285-295
- ROJAC, Tadej, KOSEC, Marija, BUDIČ, Bojan, SETTER, Nava, DAMJANOVIĆ, Dragan. Strong ferroelectric domain-wall pinning in BiFeO3 ceramics. Journal of applied physics, 2010, vol. 108, no. 7, str. 074107-1-074107-8
- ROJAC, Tadej, BENČAN, Andreja, KOSEC, Marija. Mechanism and role of mechanochemical activation in the synthesis of (K,Na,Li)(Nb,Ta)O3 ceramics. Journal of the American Ceramic Society, 2010, issue 6, vol. 93, str. 1619-1625
- ROJAC, Tadej, KOSEC, Marija, MALIČ, Barbara, HOLC, Janez. The application of a milling map in the mechanochemical synthesis of ceramic oxides. Journal of the European ceramic society, 2006, vol. 26, str. 3711-3716.

KOMPOZITI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Kompoziti
Course title:	Composites
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067620
Koda učne enote na članici/UL Member course code:	671

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	30	15	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku opreverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija. Študijske obveznosti lahko opravljajo tudi ponavljalci.	Prerequisites are defined in the Regulations on verification and assessment of students at UL NTF. For the positive and successfully prerequisites and inclusion in the study work is recommended to regularly attend lectures, solving additional and more challenging tasks at home and corresponding preparation prior to laboratory work, to demonstrate the activity and at least 80 % of attendance at exercises. The condition for inclusion in the study work is the enrollment into the third year of study. Study obligations may perform repeaters as well.

Vsebina:	**Content (Syllabus outline):**
/Karakteristike kompozitov. Sestavine kompozitov. Matice: kovinske, keramične, polimerne, ogljikove. Lastnosti matice. Materiali za elemente utrjevanja. Lastnosti. Kovine, keramike, polimeri, ogljikova vlakna. Vlakna. Lastnosti vlaken. Sinteza vlaken. Viskersi. Sinteza viskersov. Mejne površine v kompozitih. Pogoji kompatibilnosti sestavin kompozitov. Mehanika kompozitov. Analiza in	Composites characteristics. Constituents of composites. Matrix materials: metal, ceramics, polymer, carbon. Matrix properties. Reinforced materials. Properties. Metals, ceramics, polymers, carbon fibers. Fibers properties. Fibers synthesis. Whiskers. Whiskers synthesis and properties. Interfaces in composites. Compatibility of composite materials. Mechanics of composites. Analysis and

načrtovanje. Minimalni in kritični volumski deleži vlaken. Prenos obremenitve z matice na vlakna. Kritična dolžina vlaken. Porušitev kompozitov. Puljenje vlaken. Mehanizmi povečevanja žilavosti kompozitov. Utrujenost kompozitov. Računalniško podprto načrtovanje. Mehanika loma kompozitov s kovinsko in keramično matico. Druge aditivne lastnosti kompozitov. Izdelava kompozitov. Obdelovalni postopki za kompozite. Spajanje kompozitov. Preizkušanje kompozitov. Preiskave poškodb. Problemi recikliranja. Primeri uporabe kompozitov.	design of composites. Minimal and critical volume part of fibers. Mechanics of load transfer from matrix to fibers. Fiber critical length. Composite fracture. De-bonding. Fibers pullout. Mechanisms of enhancing the toughness. Fatigue of composites. Composite designing using computer. Fracture mechanics of metal and ceramics matrix composites. Heat properties of composites. Superconducting composites, Composite density. Fabrication of composites. Machining procedures. Composite joining. Composite testing. Nondestructive testing. Failure analysis. Recycling of composite materials. Application and experience.

Temeljna literatura in viri/Readings:

CHAWLA KRISHAN K.: Composite Materials, Science and Engineering,Springer; 4th ed., 2019
BHAGWAN D. AGARWAL, LAWRENCE J. BROUTMAN, K. CHANDRASHEKHARA: Analysis and Performance of Fiber Composites, 4th Edition, Wiley, 2017
CLYNE T. W., HULL D.: An introduction to composite materials, University of Cambridge Press, 2019
MALLICK P.K.: Fiber-Reinforced Composites: Materials, Manufacturing, and Design, 3rd Edition, CRC Press, 2007
GERMAN R.M. Sintering: From Empirical Observation to Scientific Principles, Elsevier Inc., 2014
ASHBY, M., SHERCLIFF, H., CEBON, D. Materials – Engineering, Science, Processing and Design. Amsterdam: Elsevier, 2007.

Cilji in kompetence:	**Objectives and competences:**
/Vsebina predmeta Kompoziti obsega metodiko načrtovanja,selekcijo, sintezo in lastnosti sestavin kompozitov in načrtovanje in napoved mehanskih lastnosti, posebej trdnosti in žilavosti, oblikovanje, spajanje in inženirske aplikacije. Študent se vpelje v svet materialov, ki so po svojem konceptu, zgradbi, sintezi in lastnostih bistveno različni od klasičnih.	The teaching course Composites scales methodology design, selection, synthesis and properties of composites and its components, design and prediction of mechanical properties (particularly strength and toughness), forming, bonding and engineering applications. The student is introduced to the world of materials which are in their concept, structure, synthesis and properties substantially different from the classical materials.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Razumevanje in napredek pri tem predmetu zahteva znanje osnovnih strokovnih predmetov, mehanike, osnove inženirstva in širše poznavanje področja materialov. Napredovanje omogoča prepletajoče se znanje več predmetov predhodnih semestrov, predmet zahteva od študenta interdisciplinarno znanje in organiziranost. Je neke vrste diplomski predmet pred diplomo.	The basis for understanding the content of this subject requires knowledge of basic technical courses, mechanics, and fundamentals of engineering and general knowledge of the materials science. The course requires from the student interdisciplinary knowledge and organization and is a kind of graduation exam before graduation, which involves knowledge of several subjects from previous semesters.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske in laboratorijske vaje, seminarsko delo.	Lectures, calculatios, laboratory work, seminar

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena raziskovalnega seminarja (25 %)	25,00 %	the mark of project work (25 %)
ocena laboratorijskih vaj (20 %)	20,00 %	the mark of laboratory work (20 %)
ocena pisnega dela izpita (25 %)	25,00 %	the mark of written examination (25 %)

ocena ustnega dela izpita (30 %)	30,00 %	the mark of the oral examination (30 %)

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

NAGODE, Aleš, KLANČNIK, Grega, BIZJAK, Milan, KOVAČEVIĆ, Dušan, KOSEC, Borut, DERVARIČ, Evgen, ZORC, Borut, KOSEC, Ladislav. Structural and thermodynamic analysis of whiskers on the surface of grey cast iron. Metalurgija, ISSN 0543-5846, 2013, vol. 52, br. 1, str. 11-14

NAGODE, Aleš, ZUPANČIČ, Katja, ZORC, Matija, ŽUŽEK, Borut, KARPE, Blaž, ŠETINA, Barbara, ZORC, Borut, KOSEC, Borut, BIZJAK, Milan, PAVLIČ, Alenka. Investigating the properties of dental composites = Preiskava lastnosti kompozita za zobne zalivke. Materiali in tehnologije

ZORC, Borut, ZORC, Matija, KOSEC, Borut, NAGODE, Aleš. Effect of the shape of styrene-acrylonitrile water-filter housings on the destructive pressure, crack-initiation, propagation conditions and fracture toughness of styrene-acrylonitrile. Polymers. 2020, vol. 12, iss. 2, str. 1-22.

GODEC, Matjaž, ŠETINA, Barbara, MANDRINO, Djordje, NAGODE, Aleš, LESKOVŠEK, Vojteh, ŠKAPIN, Srečo D., JENKO, Monika. Characterization of the carbides and the martensite phase in powder-metallurgy high-speed steel. Materials characterization, ISSN 1044-5803. [Print ed.], April 2010, vol. 61, no. 4, str. 452-458

RAVNIKAR, Dunja, TRDAN, Uroš, NAGODE, Aleš, ŠTURM, Roman. Energy density effect of laser alloyed TiB2/TiC/Al composite coatings on LMZ/HAZ, mechanical and corrosion properties. Metals. 2020, iss. 3, vol. 10, str. 1-19

KOROZIJA IN ZAŠČITA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Korozija in zaščita
Course title:	Corrosion and Corrosion Protection
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067630
Koda učne enote na članici/UL Member course code:	677

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode, Jožef Medved
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija.	The condition to attend in the teaching course and to perform study obligations is an entry in the third year of study.

Vsebina:	Content (Syllabus outline):
Elektrokemjska korozija kovin: termodinamika in kinetika elektrokemijskih reakcij, osnovna korozijska celica, polarizacija, pasivacija kovin. Vrste korozije: lokalna, špranjska, jamičasta, metalurško vplivana, interkristalna, transkristalna korozija ter korozija po kristalnih mejah, selektivno raztapljanje, mehansko podprta degradacija, erozivna, udarno delovanje korodiranega medija, torna kavitacija, korozijsko utrujanje, napetostna korozija, vodikova krhkost. Korozijske lastnosti nekaterih kovinskih materialov: atmosferska korozija ogljikovih jekel, nerjavna jekla, železove litine, aluminij in njegove zlitine, baker in njegove zlitine, titan, nikelj in zlitine. Korozija pri visokih temperaturah: reakcije s plini in s staljenimi kovinami in solmi, kovinski oksidi, rast	Electrochemical corrosion of metals: thermodynamics and kinetics of electrochemical reactions, basic oxygen corrosion cell, polarization, passivation of metals. Types of corrosion: local and crevice corrosion, pitting, metallurgicaly influenced, intergranular, transcrystalline and grain boundary attack corrosion, selective dissolution, erosive, fretting, and stress corrosion, impingement attack, corrosion fatigue, hydrogen-evolution type of corrosion. Corrosion properties of various metallic materials: atmospheric corrosion of plain steels, stainless steels, cast irons, aluminium and its alloys, copper and its alloys, titanium and its alloys, nickel and its alloys. Corrosion at elevated temperatures: reactions with gases, salts, molten metals, metallic oxides, growth of

oksidnega filma, oksidacija zlitin. Principi in metodika zaščite proti koroziji. Katodna in anodna zaščita. Praktični problemi in računski primeri.	oxide film, oxidation of alloys. Principles and methodology of corrosion protection Cathodic and anodic corrosion protection. Practical case studies and calculations.

Temeljna literatura in viri/Readings:

SMITH, W.F. Foundations of Materials Science and Engineering. Singapure: McGraw - Hill, 1993.
VEHOVAR, L. Korozija kovin. Ljubljana: IMT, 1991.
AHMAD Z. Principles of Corrosion Engineering and Corrosion Control, Elsevier Inc, 2006
David J. Young. High Temperature Oxidation and Corrosion of Metals, Elsevier, 2016

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je seznaniti študente s teoretičnimi osnovami, vzroki, mehanizmi in načini propadanja materialov in naprav zaradi vpliva okolja. Študenti se spoznajo z načini preprečevanja korozije, ki povzroča enormno gospodarsko škodo ter ogroža varnost ljudi in integriteto produktov.	The aim of this course is to familiarize students with the theoretical basics, causes, mechanisms and various modes of decay of materials and devices due to the influence of the environment. Students learn how to prevent corrosion, which causes enormous economic damage and endangering the safety of people and integrity of the products.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Korozija materialov in zaščita je eden izmed zaključnih predmetov študija. Področje znanja izhaja iz termodinamike materialov, metalografije, fizikalne metalurgije, preiskav materialov ter predmetov procesne tehnike.	Knowledge and understanding: Corrosion and corrosion protection is one of the final courses of study. The scope of activities include knowledge of metallography, thermodynamics of materials, physical metallurgy, and materials testing.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, laboratorijske in računske vaje, seminarsko delo.	Lectures, laboratory and computational exercises, seminars.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
poročilo laboratorijskih (20%)	20,00 %	Laboratory exercises report (20%)
ocena pisnega dela izpita (25 %)	25,00 %	the mark of written examination (25%)
ocena ustnega dela izpita (30 %)	30,00 %	the mark of the oral examination (30%)
seminar (25%)	25,00 %	seminar (25%)

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

BAJT LEBAN, Mirjam, VONČINA, Maja, KOSEC, Tadeja, TISU, Robert, BARBORIČ, Matevž, **MEDVED, Jože**. Comparison of cycling high temperature corrosion at 650°C in the presence of NaCl of various austenitic stainless steels. Oxidation of metals. 2022, str. 1-15. [COBISS.SI-ID 128327683],
VONČINA, Maja, TISU, Robert, **MEDVED, Jože**. Oxidation stability of various Ti-alloys. Journal of thermal analysis and calorimetry, ISSN 1588-2926. [Online ed.], 2017, vol. 129, iss. 1, str. 117-122, [COBISS.SI-ID 1666399]
BALAŠKO, Tilen, VONČINA, Maja, BURJA, Jaka, ŠETINA, Barbara, **MEDVED, Jože**. High-temperature oxidation behaviour of AISI H11 tool steel. Metals. 2021, vol. 11, no. 5, str. 1-27. [COBISS.SI-ID 62092547].
NAGODE, Aleš, JERINA, Kaja, JERMAN, Ivan, VELLA, Daniel, BIZJAK, Milan, KOSEC, Borut,

KARPE, Blaž, ZORC, Borut. The effect of sol-gel boehmite coatings on the corrosion and decarburization of C45 steel. Journal of sol-gel science and technology. 2018, vol. 86, iss. 3, str. 568-579. ISSN 0928-0707. DOI: 10.1007/s10971-018-4664-4. [COBISS.SI-ID 1720927],
GUDIĆ, Senka, VRSALOVIĆ, Ladislav, MATOŠIN, Ante, KROLO, Jure, OGUZIE, Emeka Emanuel, **NAGODE, Aleš**. Corrosion behavior of stainless steel in seawater in the presence of sulfide. Applied sciences. 2023, vol. 13, iss. 7, str. 1-24. ISSN 2076-3417. DOI: 10.3390/app13074366.
VRSALOVIĆ, Ladislav, GUDIĆ, Senka, PERČIĆ, Nika, GOJIĆ, Mirko, IVANIĆ, Ivana, KOŽUH, Stjepan, **NAGODE, Aleš**, KOSEC, Borut. Electrochemical behaviour of CuAlMn alloy in the presence of chloride and sulphate ions. Applied surface science advances. 2023, vol. 13, str. 1-12. ISSN 2666-5239. DOI: 10.1016/j.apsadv.2023.100380.

LIVARSTVO

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Livarstvo
Course title:	Foundry
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067612
Koda učne enote na članici/UL Member course code:	663

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Mitja Petrič, Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Vpis v letnik in predhodno ali vzporedno obiskovanje predavanj in vaj iz matematike, fizike, kemije, računalništva, metalografije, strojništva, toplotne tehnike, termodinamike	Prerequisites defined in the Regulations on checking and assessing students at UL NTF. For a positive and successful Prerequisites and involvement in academic work is recommended to regularly attend lectures deal with additional increasingly complex homework and corresponding pre-treatment before carrying out laboratory work and demonstrated activity and at least 80 % attendance at tutorials. Requirement for involvement into the work is enrolment into current academic year or parallel course of study of lectures, tutorials of Math, Physics, Chemistry, Computer science, Metallography, Mechanical engineering, Thermal technique, Thermodynamics.

Vsebina:	**Content (Syllabus outline):**
/Uvod: zgodovinski razvoj livarstva, pomen livarstva za gospodarstvo, trendi Ulivanje kot tehnika izdelave delov: prednosti litja: konstrukcijske, tehnološke, gospodarnostne in	Introduction: historical development of casting technology, importance of foundry industry for the economy, trends Casting as a technique of making parts: the

ekološke Konstruiranje ulitih delov: sodobni trendi, konstruiranje s funkcionalnim in livarsko-tehničnim optimiranjem, lahke konstrukcije, računalniško generiranje geometrije ulitka na osnovi trdnostnih zahtev in geometrijskih omejitev Procesi litja: ulivanje v formo, livarski modeli in jedrovniki, izdelava form in jeder, napajalniki in ulivni sistemi, tehnološka dokumentacija Polnjenje forme s talino, tok taline po ulivnem sistemu in livni votlini, livnost zlitin, zakonitosti toka taline, laminarno in turbulentno gibanje taline, površinska turbulenca, nastanek filmov na površini taline, simulacijski izračuni polnjenja forme Strjevanje ulitka v formi, prehod toplote v ulitku in formi, strjevanje in krčenje, napajanje, usmerjeno strjevanje, kriteriji, samostojna strjevalna področja, simulacijski izračuni toplotnih centrov Nastanek napetosti v ulitku in orodju, krivljenje, vpliv forme in jeder, trajne forme, aktivno hlajenje in ogrevanje, razvoj napetosti, simulacijski izračuni napetosti v ulitku in orodju Načrtovanje tehnoloških procesov s simulacijskimi izračuni: simulacijski paketi, konstruiranje ulitkov z istočasnim optimiranjem litja, virtualna livarna Pregled načinov litja: litje v peščene forme, serijsko in posamično litje, postopki izdelave form in jeder, precizno litje, litje v trajne forme, tlačno in nizkotlačno litje, kokilno, centrifugalno litje, kontinuirno litje, precizno litje, plastno litje, litje s trdo oblo Pregled in značilnosti livnih zlitin: siva litina z različno matrico, bela litina, aluminijeve, magnezijeve, bakrove in cinkove zlitine, titanove zlitine	advantages of casting: design, technological, economic and ecological advantages Construction of cast parts: the contemporary trends, design by a functional and casting-technical optimization, lightweight construction, computer-generated geometry of the casting based on strength requirements and geometric constraints The processes of casting: casting in the mold, foundry models and core boxes, production of molds and cores, feeders and gating systems, technological documentation Filling the mold with the melt, a melt stream through a gating system and the mold cavity, castability of alloys legality of melt flow, laminar and turbulent movement of the melt, surface turbulence, the formation of films on the surface of the melt, the simulation calculations of the filling of mold cavities Solidification of the casting in a mold, heat transfer and shape of casting, solidifiation and contraction, feeding, directional solidification, criteria, independent solidification areas, simulation calculations of thermal centers The emergence of stresses in casting and tool, deformations, influence of molds and cores, permanent molds, an active cooling and heating, the development of stresses, simulation calculations and stress in the casting tool Design of technological processes with simulation calculations: the simulation packages, design of castings with simultaneous optimization of casting, virtual foundry Overview of casting technologies: casting in sand molds, serial and individual casting, manufacturing processes of molds and cores, investment casting, permanent mold casting, high pressure die casting and low-pressure die casting, centrifugal casting, continuous casting, layer casting, casting with a rigid layer Overview and characteristics of casting alloys: cast iron with different matrix, white cast iron, aluminum, magnesium, copper and zinc alloys, titanium alloys

Temeljna literatura in viri/Readings:

TRBIŽAN, M.: Livarstvo, skripta, Naravoslovnotehniška fakulteta, 2000.
MRVAR, P.: Livarski izračuni, skripta, Naravoslovnotehniška fakulteta 2024.
MRVAR, P.: Preiskave peščenih mešanic, skripta, Naravoslovnotehniška fakulteta 2024.
CAMBELL, J.: Castings, OBE, Feng, Butterworth Heinemann Ltd, 1993
PETRIČ, M.: Livarstvo – zbirka rečenih nalog, Naravoslovnotehniška fakulteta 2023

Cilji in kompetence:	**Objectives and competences:**
/Razumevanje livarstva in njegovega gospodarskega pomena, spozna in razume procese litja v enkratne in trajne forme gravitacijsko in pod tlakom, zakonitosti strujanja po elementih ulivnega in napajalnega sistema pri polnjenju livne votline, strjevanje in nastanek notranjih napetosti v ulitku ter odnos s krivljenjem, načrtovanje in računalniške rešitve livarsko	Understanding the foundry and its economic importance, student realizes and understands the processes of casting in unique and permanent molds, gravity and pressurized casing, melt flow in gating and feeding systems during the mold cavity filling, solidification and the formation of internal stresses in the casting and the relationship with deformations,

tehnoloških problemov, se nauči osnovne livne zlitine;	design and computer solutions of foundry technological problems, learning of basic casting alloys;

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent mora razumeti definicije livarstva in osnovnih pojmov, specifične prednosti litja pred ostalimi izdelovalnimi tehnikami (konstrukcijske, tehnološke, gospodarnostne in ekološke), Spozna osnove konstruiranja livarsko tehnološko ustreznih ulitkov in se seznani s programskim paketom SolidWorks, spozna in razume procese litja v enkratne in trajne forme gravitacijsko in pod tlakom, se nauči zakonitosti strujanja po elementih ulivnega in napajalnega sistema pri polnjenju livne votline in jih izračuna, strjevanje in nastanek notranjih napetosti v ulitku ter odnos s krivljenjem obvladuje za izbrano zlitino s pomočjo ustreznega faznega diagrama, ohlajevalne in dilatometrijske krivulje, nauči se praktične izdelave ulitkov s tehniko gravitacijskega litja v trajne in enkratne forme, spozna in eksperimentira z osnovnimi livarskimi kontrolnimi metodami, Analizira elemente mikro in makrostrukture na ulitkih . Znanje je uporabno pri načrtovanju in izdelavi ulitkov z različnimi postopki litja. Študent mora znati povezati različne teoretične in eksperimentalne pristope pri reševanju tehnoloških livarskih problemov začenši pri ustreznem naboru postopka, izbiro livne zlitine in materiala forme. Obvladovati mora sekvence na relaciji litje, polnjenje livne votline, strjevanje, ohlajanju in transformacija v trdnem, lita mikrostruktura z osnovnimi fizikalnimi in kemijskimi zakonitostmi. Študent se pri laboratorijskih vajah iz livarstva seznani s potrebnim metodičnim in natančnim pristopom pri delu z merilnimi napravami, računalniki, mikroskopi in pisanjem poročil o svojem delu v skupini.	Knowledge and understanding: Student must understand the definition of foundry and basic concepts, specific advantages of casting over other fabrication techniques (structural, technological, economic and ecological), learns about the basics of design of foundry technologic castings, becomes acquainted with the software package SolidWorks, learns about and understands the processes of casting in a single and permanent molds by gravity and by pressure, learns about melt flow through the gating and feeding system during the filling of the mold cavity and calculation, solidification and the formation of internal stresses in the casting and the relationship with deformations, manages the selected alloy using the corresponding phase diagram, cooling and dilatometric curves, learns the practical manufacture of castings technique by gravity casting in permanent and unique molds, learns and experiments with basic casting control methods, analyzes the elements of micro and macrostructure on castings. Knowledge is useful in the design and manufacture of castings with different casting methods. The student must be able to connect to different theoretical and experimental approaches in solving technological casting problems starting with the appropriate set of proceedings, the choice of the cast alloy material and mold. Student must handle sequences between casting, mold cavity filling, solidification and cooling transformation in the solid, alloy microstructure basic, physical and chemical laws. A student is acquainted with the necessary methodical approach in in working with instrumentation, computers, microscopes and writing reports on their work to the group.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/predavanja, računske vaje, laboratorijske vaje, programiranje in modeliranje z računalnikom s programsko opremo SolidWorks, ProCast in QuickCast.	Lectures, calculation exercises, laboratory exercises, programming, and computer modeling by SolidWorks, ProCast and QuickCast software

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) povprečje iz ocen kolokvijev oziroma ocene pisnega izpita in ocene poročila predstavlja oceno vaj, ki doprinese k skupni oceni	50,00 %	the average of the estimates of colloquia and evaluation of the written examination and assessment of the report presents an assessment exercises and contribute to the overall assessment

(b) ocena iz ustnega izpita predstavlja oceno predavanj in doprinese k skupni oceni	50,00 %	an assessment of the oral examination represents an assessment of lectures and contributes to the overall assessment

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

MRVAR, Primož, MITROVIĆ, Danijel, MEDVED, Jože, KRIŽMAN, Alojz, PETRIČ, Mitja. Tehnologija izdelave in karakterizacija gradientnega ulitka = Manufacturing technology and characterization of gradient casting. *Livarski vestnik*, ISSN 0024-5135, 2015, vol. 62, no. 1, str. 33-42. [COBISS.SI-ID 1520735]

MAHMUTOVIĆ, Almir, POTOČNIK, Janez, PETROVIĆ, Vladimir, MRVAR, Primož. Izračun numerične simulacije postopka nizkotlačnega litja s programom ProCAST = Numerical calculation simulation of low pressure die casting process by use of ProCAST programme. V: 54th International Foundry Conference Portorož 2014, 17.-19. september 2014. KRIŽMAN, Alojz (ur.), et al. *Zbornik referatov [sic] 54. mednarodnega livarskega posvetovanja, Portorož 2014 = Conference proceedings*. Ljubljana: Društvo livarjev Slovenije, 2014, str. 79-80. [COBISS.SI-ID 1480287]

MEGUŠAR, Andrej, DEBELJAK, Milan, MRVAR, Primož, MAHMUTOVIĆ, Almir. Uporaba "jet cooling" sistema za lokalno usmerjeno strjevanje ulitkov iz Al-zlitine = Application of jet-cooling system for local directional solidification of aluminium-alloy castings. *Livarski vestnik*, ISSN 0024-5135, 2013, letn. 60, št. 3, str. 141-151, ilustr. [COBISS.SI-ID 1314399]

PETRIČ, Mitja, MEDVED, Jože, KASTELIC, Sebastjan, MRVAR, Primož. Meritve dimenzijskih sprememb med strjevanjem Al-Si zlitin = Measurement of dimensional changes of AlSi alloys during solidification. *Livarski vestnik : glasilo Društva livarjev Slovenije*. 2016, letn. 63, št. 3, str. 154-159, ilustr. ISSN 0024-5135. [COBISS.SI-ID 1643359]

MATEMATIKA 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Matematika 1
Course title:	Mathematics 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067586
Koda učne enote na članici/UL Member course code:	905

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
60	0	30	0	0	90	6

Nosilec predmeta/Lecturer:	Janko Bračič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 1. letnik	Entering first year class

Vsebina:	Content (Syllabus outline):
/• Števila (realna števila; kompleksna števila). • Osnove funkcij ene spremenljivke (osnovni pojmi, računanje s funkcijami, inverz bijektivne funkcije, pregled elementarnih funkcij; zveznost, limite). • Odvod (definicija odvoda in odvodi elementarnih funkcij, pravila za odvajanje; geometrijski pomen odvoda, naraščanje/padanje funkcij, konveksnost/konkavnost, stacionarne točke in njihova klasifikacija; uporaba odvoda, diferencial funkcije). • Integral (tabela nedoločenih integralov, tehnike integriranja: uvedba nove spremenljivke, metoda per-partes; integrali nekaterih racionalnih funkcij; definicija določenega integrala, uporaba določenega integrala pri računanju ploščin krivočrtnih likov in prostornin/površin rotacijskih teles, posplošeni integral).	• Numbers (real numbers; complex numbers). • Basics of real functions (basic notions, operations between functions, inverse, outline of elementary functions, continuity, limits). • Derivative (definition of the derivative and derivatives of elementary functions, derivative rules , geometrical meaning of the derivative, increasing/decreasing of functions, convexity/concavity, stationary points and their classification; application of the derivative, diferential of a function). • Integrals (table of indefinite integrals, different integration technics: new variable, per-partes; integration of rational functions; definition of definite integral, applications: area, volume, length, improper integral).

Temeljna literatura in viri/Readings:

1. Janko Bračič, *Matematika 1-2: števila, funkcije, linearna algebra*, Oddelek za materiale in metalurgijo NTF UL, 2021, 224 str.
2. Janko Bračič, Priprave na izpit iz matematike, Naravoslovnotehniška fakulteta 2022, 179 str.
3. Mizori-Oblak, Pavlina, Matematika za študente tehnike in naravoslovja. Del 1, Ljubljana : Fakulteta za strojništvo, 2001.

Spletni strani
http://sl.wikipedia.org/wiki/Kategorija:Matematika
http://mathworld.wolfram.com/

Cilji in kompetence:	**Objectives and competences:**
/Predmet obravnava osnove funkcij ene spremenljivke. Slušatelj se seznani z ustrezno teorijo in njeno uporabo. Večina izrekov je podanih brez dokazov. Poudarek je na učenju standardnih metod za reševanje problemov. Namen vaj je utrditev predavane snovi in pridobitev računske prakse, predmet pa je kot temeljni podlaga tako za strokovne kakor za druge osnovne predmete (Fizika, Statika, Kemija, Geometrija v inženirstvu).	Basic theory of function of one variable is presented. A student becomes familiar with some notions from the theory and get skilled in its use. The emphasis is on standard methods for solving problems in calculus. The aim of tutorial is in practising. The subject is a basis for many other subjects.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Razvijanje sposobnosti učenja osnovnih predmetov in prilagajanje ter uporaba znanja na svojem strokovnem področju.	Knowledge and understanding: Developing the ability of understanding of all basic subjects and adapting and using the knowledge in the own professional area.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja in vaje s praktičnimi računskimi primeri.	Lectures and tutorials with concrete numerical examples.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	70,00 %	Writing exam
Teoretični izpit	30,00 %	Theoretical test

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

Janko Bračič, *Reflexivity of finite-dimensional sets of operators,* Banach J. Math. Anal. (2023) 17:72.
Janko Bračič, Marko Kandić, *Hyperinvariant subspaces for sets of polynomially compact operators,* Annals of Functional Analysis 13, Article number: 71 (2022).
Janko Bračič, Marko Kandić, *On the normalizer of the reflexive cover of a unital algebra of linear transformations,* Linear Algebra and its Applications 653 (2022), 207-230.
Janko Bračič, *Local commutants and ultrainvariant subspaces*, Journal of Mathematical Analysis and Applications 506 (2022), Issue 2.
Janko Bračič, *Arens regularity and weakly compact operators*, Filomat, 32:14 (2018), 4993-5002.

MATEMATIKA 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Matematika 2
Course title:	Mathematics 2
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067587
Koda učne enote na članici/UL Member course code:	909

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
60	0	30	0	0	90	6

Nosilec predmeta/Lecturer:	Janko Bračič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 1. letnik	Entering first year class

Vsebina:	Content (Syllabus outline):
/• Matrike in vektorji (računanje z matrikami, determinante, obrnljive matrike; sistemi linearnih enačb, Cramerjeva metoda, Gaussova metoda; vektorji v ravnini in prostoru, skalarni, vektorski in mešani produkt; premice in ravnine v prostoru). • Linearne transformacije (predstavitev linearne transformacije z matriko, lastne vrednosti, lastni vektorji). • Tenzorji (definicija, zgledi, operacije med tenzorji, uporaba). • Krivulje in ploskve (krivulje v ravnini in prostoru, polarne koordinate, parameterizacija, ploskve).	• Matrices and vectors (opeartions with matrices, determinants, inverse of a matrix; linear systems of equations, Cramer's method, Gauss' method; vectors in plane and space, inner product, vector product and mixed product; lines and planes in three dimensional space). • Linear transformations (representation by a matrix, eigenvalues, eigenvectors). • Tensors (definition, examples, operations with thensors, applications). • Curves and surfaces (curves in plane and in three dimensional space, polar coordinates, parameterisation, surfaces).

Temeljna literatura in viri/Readings:

Janko Bračič, *Matematika 1-2: števila, funkcije, linearna algebra*, Oddelek za materiale in metalurgijo NTF UL, 2021, 224 str.
Janko Bračič, Priprave na izpit iz matematike, Naravoslovnotehniška fakulteta 2022, 179 str.

Mizori-Oblak, Pavlina, Matematika za študente tehnike in naravoslovja. Del 1, Ljubljana : Fakulteta za strojništvo, 2001. Spletni strani http://sl.wikipedia.org/wiki/Kategorija:Matematika http://mathworld.wolfram.com/

Cilji in kompetence:	**Objectives and competences:**
/Predmet obravnava osnove linearne algebre. Slušatelj se seznani z ustrezno teorijo in njeno uporabo. Večina izrekov je podanih brez dokazov. Poudarek je na učenju standardnih metod za reševanje problemov. Namen vaj je utrditev predavane snovi in pridobitev računske prakse, predmet pa je kot temeljni podlaga tako za strokovne kakor za druge osnovne predmete (Fizika, Statika, Kemija, Geometrija v inženirstvu).	Basic linear algebra is presented. A student becomes familiar with some notions from the theory and get skilled in its use. The emphasis is on standard methods for solving problems related to linear algebra. The aim of tutorial is in practising. The subject is a basis for many other subjects.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Razvijanje sposobnosti učenja osnovnih predmetov in prilagajanje ter uporaba znanja na svojem strokovnem področju.	Knowledge and understanding: Developing the ability of understanding of all basic subjects and adapting and using the knowledge in the own professional area.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja in vaje s praktičnimi računskimi primeri.	Lectures and tutorials with concrete numerical examples.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	70,00 %	Writing exam
Teoretični izpit.	30,00 %	Theoretical test

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

Janko Bračič, *Reflexivity of finite-dimensional sets of operators,* Banach J. Math. Anal. (2023) 17:72.
Janko Bračič, Marko Kandić, *Hyperinvariant subspaces for sets of polynomially compact operators,* Annals of Functional Analysis 13, Article number: 71 (2022).
Janko Bračič, Marko Kandić, *On the normalizer of the reflexive cover of a unital algebra of linear transformations,* Linear Algebra and its Applications 653 (2022), 207-230.
Janko Bračič, *Local commutants and ultrainvariant subspaces*, Journal of Mathematical Analysis and Applications 506 (2022), Issue 2.
Janko Bračič, *Arens regularity and weakly compact operators*, Filomat, 32:14 (2018), 4993-5002.

MATEMATIKA 3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Matematika 3
Course title:	Mathematics 3
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067595
Koda učne enote na članici/UL Member course code:	978

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Janko Bračič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 2. letnik	Entering second year class

Vsebina:	Content (Syllabus outline):
/• Navadne diferencialne enačbe (linearne diferencialne enačbe 1. in 2. reda). • Osnove funkcij več spremenljivk (graf, zveznost, limite). • Parcialni odvodi (definicija in geometrijski pomen; tangentna ravnina na graf, stacionarne točke in njihova klasifikacija; gradient, odvod v dani smeri). • Dvojni in trojni integrali (primeri, uvedba novih spremenljivk: polarne, valjne in krogelne koordinate; uporaba).	• Ordinary differential equations (linear differential equations of order 1 and 2). • Basics from the theory of functions of several variables (graph, continuity, limits). • Partial derivatives (definition and geometrical meaning; tangent plane, stationary points and their classification; gradient, derivative in a given direction). • Double and triple integrals (examples, new coordinates: polar, cilindric and spherical coordiantes; applications).

Temeljna literatura in viri/Readings:

Vidav: Višja Matematika I DMFA-založništvo, Ljubljana, 1994.
Vidav: Višja Matematika II, DZS, Ljubljana, 1979.
F. Križanič: Navadne diferencialne enačbe; Parcialne diferencialne enačbe; Variacijski račun, DMFA-založništvo, Ljubljana, 1991.

P. Mizori-Oblak: Matematika za študente tehnike in naravoslovj. Del 2. Ljubljana, Fakulteta za strojništvo, 1997.
Janko Bračič, Priprave na izpit iz matematike, Naravoslovnotehniška fakulteta 2022, 179 str.

Spletni strani
http://sl.wikipedia.org/wiki/Kategorija:Matematika
http://mathworld.wolfram.com/

Cilji in kompetence:	**Objectives and competences:**
/Študent spozna osnovne pojme iz analize funkcij več spremenljivk in navadnih diferencialnih enačb.	A student becomes familiar with basic notions from theory of functions of two or more variables and with the ordinary differential equations.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Razvijanje sposobnosti učenja osnovnih predmetov in prilagajanje ter uporaba znanja na svojem strokovnem področju.	Knowledge and understanding: Developing the ability of understanding of all basic subjects and adapting and using the knowledge in the own professional area.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja in vaje s praktičnimi računskimi primeri.	Lectures and tutorials with concrete numerical examples.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	70,00 %	Writing exam
Teoretični del	30,00 %	Theory part

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

Janko Bračič, *Reflexivity of finite-dimensional sets of operators,* Banach J. Math. Anal. (2023) 17:72.
Janko Bračič, Marko Kandić, *Hyperinvariant subspaces for sets of polynomially compact operators,* Annals of Functional Analysis 13, Article number: 71 (2022).
Janko Bračič, Marko Kandić, *On the normalizer of the reflexive cover of a unital algebra of linear transformations,* Linear Algebra and its Applications 653 (2022), 207-230.
Janko Bračič, *Local commutants and ultrainvariant subspaces*, Journal of Mathematical Analysis and Applications 506 (2022), Issue 2.
Janko Bračič, *Arens regularity and weakly compact operators*, Filomat, 32:14 (2018), 4993-5002.

MATERIALI IN LASTNOSTI (UN-IM-BO)

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Materiali in lastnosti (UN-IM-BO)
Course title:	Materials and Their Properties
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067588
Koda učne enote na članici/UL Member course code:	990

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Mitja Petrič, Primož Mrvar
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v 1. letnik.	Entering first year class.

Vsebina:	Content (Syllabus outline):
/Razdelitev materialov na kovine in zlitine, keramične materiale, polimere, stekla in kompozite s predstavitvijo tipičnih predstavnikov. Splošna opredelitev kristalne, amorfne in kvazikristalne zgradbe. Razdelitev funkcionalnih materialov na prevodnike, polprevodniki, superprevodnike, magnetne materiale, dielektrike (izolatorje) in elektrooptične materiale. Za vsako osnovno skupino materialov so kratko predstavljene značilne metalurške tehnologije zaradi razumevanja vpliva izdelovalne tehnologije na lastnosti materiala. V okviru kovinskih materialov so osnovno obravnavane lastnosti Mg, Al, Ti, Zr, Fe, Co, Ni, Cu, Pb, in njihove zlitine kot tudi žlahtne kovine s svojimi zlitinami. Obravnavane so tudi ognjevarne zlitine. Lastnosti keramičnih materialov so predstavljene na primerih tradicionalnih keramik in cementov, silikatnih keramikah, ognjeodpornih keramikah,	Dividing materials on metals and alloys, ceramic materials, polymers, glasses and composites with presentation of typical representatives. General presentation of crystal, amorphous and quasi-crystalline structures. Dividing functional materials on conductors, semiconductors, superconductors, magnetic materials, dielectrics (isolators) and electro-optic materials. For each basic group of materials some characteristic metallurgical technologies are presented in order to understand the influence of production technology on properties of materials. Within the metallic materials the properties of Mg, Al, Ti, Zr, Fe, Co, Ni, Cu, Pb, noble metals and theirs alloys are presented. Also some heat resistant alloys are presented. Properties of ceramic materials are presented on cases of traditional engineering ceramics and cements, silicate ceramics, fire-resistant ceramics, oxide and

oksidnih in neoksidnih keramikah. Značilne lastnosti polimerov so kratko podane skozi opredelitev tipičnih predstavnikov polimerov. Stekla in njihove lastnosti so predstavljene skozi navadna stekla za masovno potrošnjo (okenska stekla in embalaža), posebna stekla in optična stekla.	non-oxide ceramics. Characteristic properties of some typical representatives are discussed. In order to present glasses and their properties the ordinary glasses for mass production (windows), special glasses and optic glasses are presented.

Temeljna literatura in viri/Readings:

/W. Martienssen, H. Warlimont: Handbook of Condensed Matter and Materials Data, Springer, Berlin-Heidelberg-New York, 2005
R.J.D. Tilley: Understanding solids, John Wiley & Sons Ltd. 2004
HOSFORD F. William: Materials Science, An intermediate text (2006)

Cilji in kompetence:	**Objectives and competences:**
/Cilji: srečanje z razdelitvijo materialov glede na splošne značilnosti in izgled, njihovo notranjo zgradbo, transportne pojave v materialih, mehanske lastnosti, posebne lastnosti. Spoznati povezavo med strukturo materialov in njihovimi lastnostmi na splošno. Pridobiti pregled nad postopki in izdelovalnimi tehnologijami za doseganje določenih ciljanih lastnosti materialov na strukturnem nivoju ter vplivi nekaterih dejavnikov na te lastnosti. Spoznati osnovne skupine materialov in tehnologij za njihovo izdelavo in predelavo. Pri tem gre za pregled kovinskih, nekovinskih, polimernih in kompozitnih materialov. Spoznati prve osnovne pojme, ki se nanašajo na uporabnost, mehanske in tehnološke lastnosti, sposobnost izdelave in predelave z različnimi tehnologijami. Razdelitev materialov po kemični sestavi, namenih uporabe, kriterijih izbire in uporabe, kompatibilnosti, pojemih standardizacije materialov. Kompetence: strokovno vključevanje v razvojne trende inženirskih materialov za glavne industrijske panoge, kot so avtomobilska in letalska industrija, gradbeništvo... Študent se usposobi za strokovno uporabo in izbiro ter razvoj različnih kovinskih in nekovinskih materialov na sodobnih področjih uporabe.	Objectives: to learn how materials are divided by their basic characteristics and appearance, their structure, transport phenomena in material, mechanical properties and special properties. To learn to link the structure of material with his properties. To learn the overview of processes and production technologies and some influencing factors in order to achieve aimed properties of materials. To learn the basic groups of metals non-metals and polymer materials and their production technologies. To learn basic concepts concerning utility, mechanical and technological properties, and ability of materials to process them with different technologies. To divide materials according to chemical composition, criterion of choice and purpose of use, compatibility, concept of standardization of materials. Competences: professional integration into development trends of materials for industry such as automotive, aeronautics, construction industry,… Student is able to professionally and in accordance with modern technologies use, choose and develop different metallic and non-metallic materials

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Deklarativno poznavanje in razumevanje osnovnih gradnikov in njihove razporeditve v kristalih, kvazikristalih, amorfnih, keramičnih, polimernih snoveh in kompozitnih materialih ter s tem povezane lastnosti. Študent se nauči in dobi prvi strokovni vpogled v materiale, metalurgijo, predelavo in njihovo selekcijo za izbrano aplikacijo. Nauči se razumevanja osnovnih pojmov, ki so v zvezi z mehanskimi lastnostmi, mikro- in makrostrukturo, tehnološkimi lastnostmi. Nauči se razlikovati izdelke in povezati izdelek z	Knowledge and understanding: Declarative knowledge and understanding of basic constituents and their structure in crystals, quasi-crystals, amorphous, ceramic, polymer materials, composites and their properties. Student has knowledge of professional understanding of materials, metallurgy, processing and selection for chosen application. He understands basic concepts which re connected to mechanical properties, micro and macro-structure and technological properties. He knows how to visulay distinguish materials and to distinguish products according to production process.

izdelovalno tehniko, nauči se na makro nivoju - vizualno ločevati različne materiale med seboj.	

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, raziskovalni seminarji, laboratorijske vaje, simulacije, nastopi. Predavanja v multimedijski učilnici, pregled laboratorijev.	Lectures, seminars, laboratory exercises, simulations, presentations. Lectures in multi-media classrooms, an overview of laboratories.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Test v semestru, ki prinese k skupni oceni 30%	30,00 %	(a) Exam (30 %)
(b) Ustni izpit, ki prinese k skupni oceni 60%,	60,00 %	(b) Oral exam (60 %)
(c) seminar, ki prinese k skupni oceni 10%	10,00 %	(c) Seminar (10 %)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. **MRVAR**, Primož, TRBIŽAN, Milan, MEDVED, Jože. Dilatation analysis of the eutectoid transformation of the as-cast spheroidal graphite cast iron. *Scand. j. metall.*, 2002, str. 393-400. [COBISS.SI-ID 415327] , IF = 0,337 A2;
2. **MRVAR**, Primož, MEDVED, Jože, KRIŽMAN, Alojz. Control of microstructure during the eutectoid transformation in the As-cast spheroidal graphite cast iron with ˝in-situ˝ dilatation analysis and quenching experiments. *Steel research international*, 2006, vol. 77, no. 5, 353-361 str. [COBISS.SI-ID 617055] , IF = 0,478 A2;
3. **MRVAR**, Primož, MEDVED, Jože, KASTELIC, Sebastjan. Welding sequence definition using numerical calculation. *Weld. j.*, 2011, vol. 90, str. 148-151. [COBISS.SI-ID 1141087], IF = 0,887 A2;
4. **MRVAR**, Primož, MEDVED, Jože, PETRIČ, Mitja. New complete "in situ" thermal and chemical analysis for quality control of Al-alloys. V: *World technical forum : Brno, Czech Republic, 1st - 3rd June 2009 : lectures/presentations*. Brno: Czech Foundrymen Society, 2009, 21 str. [COBISS.SI-ID 921183];

doc. dr. Mitja Petrič

5. KOZINA, Franjo, ZOVKO BRODARAC, Zdenka, BRAJČINOVIĆ, Sandra, PETRIČ, Mitja. Determination of Al-2.18Mg-1.92Li alloy's microstructure degradation in corrosive environment. *Crystals*. 2021, vol. 11, iss. 4, str. 1-13. ISSN 2073-4352. DOI: 10.3390/cryst11040338. [COBISS.SI-ID 80274947]

6. TONKOVIČ-PRIJANOVIČ, Marica, MRVAR, Primož, VONČINA, Maja, DONIK, Črtomir, GODEC, Matjaž, PETRIČ, Mitja. Analysis and thermodynamic stability of nuclei in spheroidal graphite in Fe-C-Si alloys = Analiza in termodinamska stabilnost kali v kroglastem grafitu pri Fe-C-Si zlitinah. *Materiali in tehnologije*. [Tiskana izd.]. jul.-avg. 2021, letn. 55, št. 4, str. 533-539, ilustr. ISSN 1580-2949. https://mater-tehnol.si/index.php/MatTech/article/view/62/76, DOI: 10.17222/mit.2021.063. [COBISS.SI-ID 72304643]

MATERIALOGRAFSKI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Materialografski praktikum
Course title:	Materialographic Practicum
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067589
Koda učne enote na članici/UL Member course code:	911

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
20	0	40	0	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Markoli
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Obvezna prisotnost na seminarskih in laboratorijskih vajah. Obvezna 50 % prisotnost na predavanjih. Nujno predznanje o pripravi poročil in predstavitev rezultatov z vaj.	Obligatory attendance at seminars and laboratory work. The mandatory 50% attendance at lectures. Necessary background knowledge on the preparation of reports and presentation of results gained during the exercises.

Vsebina:	Content (Syllabus outline):
/Svetlobna mikroskopija. Preparacija vzorcev in odkrivanje mikrostrukture. Kemijski in fizikalni postopki odkrivanja mikrostrukture in kontrastiranje raziskovane površine. Postopki priprave interferenčnih plasti na vzorcih in njihova uporaba v materialografiji. Ambulantna metalografija. Optični postopki kontrastiranja. Naprave in postopki za upodobitev. Interakcija svetloba-snov. Konstrukcija svetlobnega mikroskopa za opazovanje v odbiti svetlobi. Kvantitativna materialografija in stereologija; elementi in definicije za kvantitativni opis mikrostrukture, osnovni parametri, možnost zajemanja podatkov, priprava vzorcev, postopki vrednotenja.	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 and methods for representation. Light-matter interaction. Construction of a light microscope to observe the reflected light. Quantitative materiallography and stereology; elements and definitions for quantitative description of the microstructure, basic parameters, the possibility of data collection, sample preparation, evaluation procedures.

Elektronska mikroskopija in mikroanaliza. Priprava vzorcev: potenciostatična metoda, ionsko tanjšanje, izdelava prerezov (cross-sectioning), uporaba fokusiranega ionskega curka (FIB), mehanska priprava (tripod). Interakcija elektronov s snovjo: neelastično in elastično sipanje elektronov, emisija rentgenske svetlobe. Spektrometri in detektorji. Konstrukcija in karakteristike analiznih inštrumentov: presevni (TEM in HREM) in vrstični (SEM) elektronski mikroskop, elektronski mikroanalizator (EDXS), tunelski mikroskop. Osnove delovanja sinhrotrona in možnosti raziskav materialov. Rentgenske kristalografske naprave. Priprava vzorcev. Interpretacija analiznih podatkov RTG. Interpretacija elektronskih in rentgenskih uklonskih podatkov. Osnove teorije uklonskega kontrasta: analiza in interpretacija presevnih elektronsko mikroskopskih slik. Mikroanalize in spektroskopije energijskih izgub elektronov. Primerjava ločljivosti in občutljivosti metod in tipični primeri uporabe. Metode za analizo površine. Preiskave topografije in fizikalnih lastnosti površin z mikroskopom na atomsko silo (AFM). Fizikalno-kemijske osnove metod za analizo površin: AES, XPS, SIMS, ISS. Interakcija elektronskega in ionskega curka s trdno snovjo. Primerjava metod za analizo površin z elektronsko mikroanalizo. Analizirana debelina, lateralna in globinska ločljivost. Vrste preiskav: točkovna, linijska in profilna analiza ter slike površin napravljene z Augerjevimi elektroni. Profilna analiza z metodami za analizo površin v kombinaciji z ionskim jedkanjem. Optimizacija parametrov ionskega jedkanja. Kvalitativna in kvantitativna analiza AES, XPS in SIMS: faktor občutljivosti, metoda standardov, priročnik standardnih spektrov. Uporaba metod za analizo površin pri oksidaciji, površinski difuziji, segregaciji, reakcijah na faznih mejah in večplastnih strukturah. Konstitucija in fizikalno-metalurške osnove izbranih zlitinskih sistemov in kovinskih materialov. Železove, bakrove, aluminijeve in posebne zlitine. Fizikalno-metalurški pojavi v zlitinah in raziskovalni praktikum. Opazovanje strukture nekovinskih materialov predvsem keramičnih in materialov s posebnimi lastnostmi, kot magnetni, polprevodni, itd.	Electron microscopy and microanalysis. Sample preparation: potentiostatic method, ion depletion, production cross-sections (cross-sectioning), the use of focused ion beam (FIB), a mechanical device (tripod). The interaction of electrons with the substance: inelastic and elastic scattering of electrons, the emission of X-rays. Spectrometers and detectors. The design and characteristics of analytical instruments: resolution transmission (TEM and HREM) and scanning (SEM) electron microscope, electronic microanalyzer (EDXS) tunneling microscope. Basics of synchrotron and the possibilities of research materials. X-ray crystallographic devices. Preparation of the samples. Interpretation of analytical data RTG. Interpretation of electronic and X-ray diffraction data. Fundamentals of the theory of diffraction contrast: analysis and interpretation of resolution transmission electron micrograph images. Microanalysis and spectroscopic energy losses of electrons. Comparison of resolution and sensitivity of the methods and typical examples. Methods for the analysis of the surface. Investigation of topography and physical properties of surfaces with atomic force microscope (AFM). Physico-chemical basis of methods for the analysis of surfaces: AES, XPS, SIMS, ISS. The interaction of electron and ion beam with the solid. Comparison of methods for surface analysis by electron probe microanalysis. The analyzed thickness, lateral and depth resolution. Types of tests: point, line and profile analysis, and image surfaces at your Best AES. Profile analysis using the methods of surface analysis, in combination with ion etching. Optimizing the parameters of ion etching. Qualitative and quantitative analysis of AES, XPS and SIMS: sensitivity factor method, standard, manual standard spectra. Using methods for the analysis of surfaces by oxidation, surface diffusion, segregation reaction, phase boundaries and multilayer structures. The constitution and physical-metallurgical base selected alloy systems and metal materials. Iron, copper, aluminum and special alloys. Physico-metallurgical phenomena in alloys and research practicum. Observing the structure of metallic and ceramic materials, in particular materials with special properties, such as magnetic, semiconductor, etc.

Temeljna literatura in viri/Readings:

/S. Spaić: Metalografska analiza, FNT, Ljubljana 1993
S. Spaić: Fizikalna metalurgija-Binarni sistemi-Metalografija zlitin, Oddelek za materiale in metalurgijo, Naravoslovnotehniška fakulteta, Univerza v Ljubljani, 2000
B. Markoli: Fizikalna metalurgija I, Praktikum I. in II. del, NTF, Ljubljana, 2008
B. Markoli: Analiza strukture in sestave, NTF, Ljubljana, 2008
B. Markoli: Struktura in lastnosti materialov : električna in toplotna prevodnost, izolatorji, magneti, polprevodniki : interna skripta. NTF, Ljubljana 2008

Cilji in kompetence:	Objectives and competences:
/Cilji: nadgradnja znanja o strukturi ter njenem vplivu na lastnosti kovin in zlitin ter drugih materialov. Spoznanje z osnovnimi pojmi konstitucije zlitin in zakonitosti nastanka določenih zlitinskih sistemov tudi za nekovinske materiale in srečanje z osnovnimi postopki priprave vzorcev. Pridobiti znanje in razumevanje tipičnih metod s področja karakterizacije materialov na splošno. Kompetence: usposobljenost za branje faznih diagramov, kar omogoča razumevanje in interpretacijo opazovane mikrostrukture oz. konstitucije materialov na splošno. Strokovno poznavanje fizikalnega ozadja uporabljenih raziskovalnih metod. Pri računskih in laboratorijskih vajah se razvije sposobnost kritičnega presojanja obravnavnih pojavov v kovinah in zlitinah, kot tudi drugih materialih, ter samostojno izvajanje laboratorijskega dela. Pridobi se sposobnost izbire primerne preiskovalne metode.	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.

Predvideni študijski rezultati:	Intended learning outcomes:
/Znanje in razumevanje: Deklarativno: poznavanje in razumevanje zakonitosti mešanja kovin in nastanek zlitinskega sistema v povezavi s procesom strjevanja kovinskih materialov. Poznavanje osnovnih mikrostrukturnih značilnosti tipičnih predstavnikov tehničnih zlitin, kar je prenosljivo tudi na značilnosti drugih nekovinskih materialov.	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.

Metode poučevanja in učenja:	Learning and teaching methods:
/Predavanja, seminarji, raziskovalni seminarji, laboratorijske vaje, simulacije, nastopi.	Lectures, seminars, research seminars, laboratory exercises, simulations, occurs.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ustni/pisni izpit	50,00 %	Seminar
seminar	20,00 %	seminar
laboratorijsko delo	30,00 %	laboratory work
Možno je tudi kreditno ovrednotenje posameznih (preverljivih) študijskih dosežkov. Predmet se zaključi z izpitom.		Credit evaluation is also possible of individual (verifiable) study achievements. The course ends with an exam.

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

B. MARKOLI, I. NAGLIČ, M. PROSENC, V. KUHAR: Assessment of some methods for grain size measurement-Beurteilung einiger Verfahren zur Korngrößenmessung, Practical Metallography, accepted for publication

ZUPANIČ, Franc, MARKOLI, Boštjan, NAGLIČ, Iztok, BONČINA, Tonica. The experimental investigation of phase equilibria in the Al-rich corner within the ternary Al-Mn-Be system. J. alloys compd..

[Print ed.], 5. sep. 2013, vol. 570, str. 125-132

MARKOLI, Boštjan, BONČINA, Tonica, ZUPANIČ, Franc. The solidification path of the complex metallic Al-Mn-Be alloy. Croat. chem. acta, Apr. 2010, vol. 83, no. 1, str. 49-54

MARKOLI, Boštjan, SPAIĆ, Savo. Effect of tempering on the microstructure and hardness of ledeburitic chromium steel X155CrVMo12.1. Z. Met.kd., 2007, vol. 98, no. 2, str. 150-154

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The intermetallic phases containing transition elements in common Al-Si cast alloy. Aluminium (Dusseld.), 2004, let. 80, št. 1/2, str. 84-88

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The constitution of alloys in the Al-rich corner of the Al-Si-Sm ternary system. Z. Met.kd., 2001, vol. 92, no. 9, str. 1098-1102.

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. Contribution to the Si-Sm phase diagram. Metall (Berl. West), Nov. 1999, jhrg. 53, 11, str. 604-606

MEHANIKA MATERIALOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Mehanika materialov
Course title:	Mechanics of Materials
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067596
Koda učne enote na članici/UL Member course code:	372

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Tomaž Rodič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v letnik	Entry in the academic year

Vsebina:	Content (Syllabus outline):
/Teorija deformacij: Lagrangeov in Eulerjev opis gibanja deformabilnih teles, gradient vektorja pomikov, tenzor malih specifičnih deformacij, kompatibilnostne enačbe, volumetrične in deviatorične deformacije. Teorija napetosti: napetostni vektor, napetostni tenzor, ravnovesne enačbe, glavne napetosti, invariante napetostnega tenzorja, krogelni tenzor, deviator napetosti. Elastomehanika: Hookeove enačbe, vpliv temperature, volumsko in preobrazno delo, pregled reševanje statičnih in kvazistatičnih problemov ter osnovne vrste robnih pogojev. Plastomehanika: Heigh-Westergaardov napetostni prostor, pogoji tečenja (von Mises, Tresca, Mohr-Coulomb, Druker-Prager), zakon tečenja in napetostni potenciali, izotropni in kinematični modeli utrjevanja, ciklična plastičnost in modeliranje	Strain theory: Lagrangian and Eulerian description of motion of deformable bodies, gradient of displacements, small strain tensor, compatibility equations, the volumetric and deviatoric deformations. Stress theory: stress vector, stress tensor, equilibrium equations, principal stresses, invariants of stress tensor, spherical and deviatoric parts of stress tensor. Elasticity: Hooke´s equation, the effect of temperature, volumetric and deviatoric work, overview of solution methods for static and quasi-static problems and the basic types of boundary conditions. Plasticity: heigh-Westergaardov stress space, yielding criteria (von Mises, hard, Mohr-Coulomb, Druker-Prager), flow rule and stress potential, isotropic and kinematic hardening models, cyclic plasticity and damage modeling of porous materials and powders,

poškodb, modeliranje poroznih snovi in prahov, modeliranje kompozitnih materialov. Reologija: temeljna aksioma, osnovne reološke lastnosti, elastičnost, plastičnost in viskoznost, vezave reoloških modelov, Hookeov, St. Venantov, Newtonov, Maxwellov in Kelvin-Voigtov reološki model. Mehanika poškodb Konstitutivni modeli materialov za: kovine, steklo, keramiko, polimere.	modeling composite materials. Rheology: the fundamental axioms of rheology, basic rheological properties, elasticity, plasticity and viscosity, rheological models Hooke, St. Venant, Newton, Maxwell and Kelvin-Voigt Damage mechanics Constitutive models of materials for metals, glass, ceramics, polymers.

Temeljna literatura in viri/Readings:

/Rodič, T. Nelinearna mehanika materialov, Naravoslovnotehniška fakulteta, 2010
Lubliner, J. Plasticity Theory, New York, Macmillian Publishing Co., 1990
Hosford W.F., Mechanical Behaviour of Materials, Cambridge University Press, 2005

Cilji in kompetence:	**Objectives and competences:**
/Poudarek pri tem predmetu je na tistih poglavjih mehanike kontinuuma, ki obravnavajo zveze med napetostmi in deformacijami v odvisnosti od snovnih lastnostih materialov.	The emphasis in this course is on those topics of continuum mechanics, dealing with relationship between stress and strain, depending on the material properties of materials.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študentje se naučijo iz polja pomikov izračunati tenzor deformacij in nato določiti tenzor napetosti v odvisnosti od elastičnih, plastičnih in viskoznih lastnosti materialov. Za napetostne in deformacijske tenzorje znajo določiti invariante, glavne in primerjalne vrednosti, ter krogelni in deviatorični del. V okviru predmeta spoznajo osnovne kriterije plastičnosti ter fenomenološke modele za napovedovanje razvoja poškod in porušitev materiala. Teorijo znajo uporabiti za analize osnovnih obremenitvenih stanj, kot so nateg, tlak, strig in upogib ter njihove kombinacije, ki se najpogosteje pojavljajo v strojnih elementih in konstrukcijah.	Students learn how to evaluate deformation tensor from the displacement field, how to determine the stress tensor as a function of elastic, plastic and viscous properties of materials. For stress and strain tensors are able to determine the invariants, principal and effective values of stress, as well its spherical and deviatoric parts. They learn basic criteria of plasticity and phenomenological models to predict the development of damage and fracture of materials. Theory they can be used for analysis of basic stress states, such as tension, compression, shear and bending as well as their combinations, which occur most frequently in machine parts and structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, vaje v učilnici in računalniškem laboratoriju, seminarji	Lectures and exercises in the classroom and computer laboratory, seminars

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
- Pisni izpit	50,00 %	- Written exam
- Ustni izpit	50,00 %	- Oral exam

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

RODIČ, Tomaž, ŠUŠTAR, Tomaž, ŠUŠTARIČ, Primož, KORELC, Jože. Efficient numerical implementation of pressure, time and temperature superposition for elasto-visco-plastic material model by using a symbolic approach. International journal for numerical methods in engineering, ISSN 0029-5981, okt. 2010, letn. 84, št. 4, str. 470-484,
STUPKIEWICZ, Stanislaw, KORELC, Jože, DUTKO, Martin, RODIČ, Tomaž. Shape sensitivity analysis of

large deformation frictional contact problems. Computer Methods in Applied Mechanics and Engineering, ISSN 0045-7825. [Print ed.], 2002, vol. 191, issue 33, str. 3555-3581
ŠUŠTARIČ, Primož, SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., RODIČ, Tomaž. Sensitivity analysis based crack propagation criterion for compressible and (near) incompressible hyperelastic materials. Finite elements in analysis and design, ISSN 0168-874X. [Print ed.], May 2014, vol. 82, str. 1-15
SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., ŠUŠTARIČ, Primož, RODIČ, Tomaž. Damage driven crack initiation and propagation in ductile metals using XFEM. Computational mechanics, ISSN 0178-7675, 2012, vol. 52, no. 1, str. 161-179.
GRM, Aleksander, GRÖNLAND, Tor-Arne, RODIČ, Tomaž. Numerical analysis of miniaturised cold gas thruster for micro- and nano-satellites. Engineering computations, ISSN 0264-4401, 2011, vol. 28, no. 2, str.184-195.

MENEDŽMENT KAKOVOSTI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Menedžment kakovosti
Course title:	Quality Management
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077591
Koda učne enote na članici/UL Member course code:	559

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	45	0	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec, Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Prisotnost pri predavanjih in vajah v skladu s pravili UL. Pogoj za opravljanje pisnega dela izpita je izdelano in uspešno predstavljeno projektno delo. K ustnemu izpitu lahko pristopijo študenti s pozitivno opravljenima kolokvijema ali s pozitivno oceno pisnega izpita.	Attendance at lectures and tutorials in accordance with the rules of UL. Condition to attend a written examination is prepared and successfully presented project work. The oral examination may accede students with positive midterm tests, or a positive assessment of the written examination.

Vsebina:	Content (Syllabus outline):
Osnove kakovosti. Definicija kakovosti. Zgodovina zagotavljanja kakovosti. Zagotavljanje kakovosti. Pregled strategij vodenja kakovosti sodobni koncept vodenja kakovosti. Politika kakovosti podjetja. Stroški kakovosti. Spodbujanje kakovosti. Razvoj standardnih sistemov vodenja kakovosti. Sistemi zagotavljanja kakovosti. Serija standardov ISO 9000: sistem kakovosti, odgovornost vodstva, obvladovanje načrtovanja in razvoja, nabava, proizvodi, ki jih dobiva kupec, prepoznavanje proizvodov in sledljivost, obvladovanje procesa,	Basics of quality. Defintion of quality, History of quality assurance. Assurance of quality. Overview of quality management strategies, modern concept of quality management. The company's quality policy. Quality costs. Promoting quality. Development of standard quality management systems. Quality assurance systems. ISO 9000 series of standards: quality system management responsibility, management of planning and development, purchasing, products that meet customer, identification and product traceability, process of acontrol, inspection and testing, inspection,

kontrola in preskušanje, kontrola, merilna in preizkusna oprema, status kontroliranja in preskušanja, obvladovanje neskladnih proizvodov, korektivni ukrepi, ravnanje, skladiščenje, pakiranje in oprema, zapisi o kakovosti, interne presoje kakovosti, vodenje interne presoje, usposabljanje, servisiranje, certificiranje sistema kakovosti. Statistična kontrola kakovosti. Elementarne statistične metode in njihova uporaba v praksi. Statistični nadzor procesa. Sedem orodij za izboljšanje kakovosti (shema vodenja, Pareto diagram, posnetek stanja, kontrolna karta, histogram, korelacija odklonov, vzročno-posledični (Ishikawa) diagram). Razdelitev in vrsta kontrolnih kart. Metodologija izdelave x- in R- kart. Delo s programskimi paketi za statistični nadzor procesov. Analiza sposobnosti procesov. Definicija indeksov sposobnosti (zmogljivosti) procesov, strojev in merilne opreme (cp, cpk, cm, cq). Povezava med indeksi sposobnosti (zmogljivosti). Stroški kakovosti. Sodoben pristop pri analizi stroškov menedžmenta kakovosti. Izračun stroškov kakovosti za konkretne primere.	measuring and test equipment, status of control and testing, control of non-conforming products , corrective actions, handling, storage, packaging and equipment, quality records, internal quality audits, conduct internal audits, training, servicing, quality system certification. Statistical quality control. Elementary statistical methods and their application in practice. Statistical process control. Seven tools for quality improvement (Scheme Management, Pareto diagram, control chart, histogram, correlation of deviations, cause-effect (Ishikawa) diagram). Distribution and types of control charts. The methodology of x-and R-charts. Working with software packages for statistical process control. Process capability analysis. Definition of indexes of processes ability (capacity), machines and measuring equipment (cp, cpk, cm, cq). Relationship between indexes of ability (capacity). Quality costs. A modern approach to the analysis of the costs of quality management. Calculating the cost of quality of concrete examples.

Temeljna literatura in viri/Readings:

Juran S.M.: Quality Control Handbook, 3rd Edition, McGraw-Hill, New York, 1979.
Marolt J., Gomišček B.: Menedžment kakovosti, Založba Moderna organizacija, Kranj, 2005.
Standardi ISO 9000: 2000 – Sistemi vodenja kakovosti, USM Republike Slovenije, Ljubljana (zadnja izdaja).
Revija Kakovost (letniki 1992 – 2008)
Lazić M.: Alati, metode i tehnike unapređenja kvaliteta, Univerzitet u Kragujevcu, Centar za kvalitet, Kragujevac, 2006.
Ishikawa, K.: Kako celovito obvladati kakovost, Tehniška založba, Ljubljana 1987

Cilji in kompetence:	**Objectives and competences:**
V okviru predmeta Menedžment kakovosti se študent: • seznani z osnovami pojma kakovosti in kontrole kakovosti, • seznani z razvojno potjo menedžmenta kakovosti, • spozna standardne modele sistemov menedžmenta kakovosti, • nauči osnovnih statističnih metod in orodij pri zagotavljanju kakovosti, • nauči interpretirati rezultate meritev pri statističnem nadzoru procesov, • usposobi za kompleksno analizo pojavov, ter usposobi za analizo in vrednotenje stroškov menedžmenta kakovosti.	In the course Quality Management, the student: • gets familiar with the basic concept of quality and quality control • is informedwith the development path of quality management, • meets the standard models of quality management, • learns basic statistical methods and tools for quality assurance • learns to interpret the results of measurements in the statistical control of processes • is able to analyze complex phenomena and trained to analyze and evaluate the cost of quality management.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent v okviru predmeta pridobi znanje in razumevanje menedžmenta kakovosti in statističnih metod. Študent teoretično znanje in strokovni vpogled v področje kakovosti lahko uporabi v podjetjih in drugih organizacijah.	Knowledge and understanding: The student in this course will acquire knowledge and understanding of quality management and statistical methods. The student can use theoretical knowledge and professional insight into the quality in companies and other organizations.

Študent pridobi teoretična in praktična znanja menedžmenta kakovosti. Sposoben je vodenja, uvajanja in organizacije procesov menedžmenta kakovosti. Študent je sposoben samostojnega obvladovanja in organizacije procesov zagotavljanja kakovosti. Nauči se veščin dela v skupini. Spozna osnovne pojme menedžmenta kakovosti. Dvigne nivo spretnosti in fleksibilnosti za samostojno in timsko delo ter uporabe sodobnih virov informacij.	Students acquire theoretical and practical knowledge of quality management. He is able to control, introduce and organize quality management processes. The student is capable of self-management and organization of quality assurance processes. He gets skills to work in groups. he gets the basic concepts of quality management. Raises the level of skills and flexibility for independent and team work and the use of modern information sources.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje v računalniški učilnici z osebnimi računalniki in programskimi paketi za statistično vrednotenje rezultatov meritev parametrov kakovosti. Projektna naloga.	Lectures and exercises in the computer lab with PCs and software packages for statistical evaluation of data quality parameters. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena projektne naloge (20 %)	20,00 %	- assessment of the project work (20%)
ocena pisnega dela izpita (kolokvijev) (40 %)	40,00 %	- score of the written examination (midterm tests) (40%)
ocena ustnega dela izpita (40 %)	40,00 %	- oral part of the exam (40%)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. MEDVED, Jože, GODICELJ, Tomaž, KORES, Stanislav, MRVAR, Primož, VONČINA, Maja. Contribution of Mn content on the pressure dose properties = Prispevek vpliva deleža Mn na lastnosti tlačnih doz. RMZ-mater. geoenviron., jul. 2012, letn. 59, št. 1, str. 41-54. [COBISS.SI-ID 991070]
2. BRODARAC, Z. Zovko, MRVAR, Primož, MEDVED, Jože, FAJFAR, Peter. Local squeezing casting influence on the compactness of AlSi[sub]10Mg alloy casting = Utjecaj postupka lokalnog tiskanja na kompaktnost odljevka od AlSi[spodaj]10Mg legure. Metalurgija (Sisak), 2007, let. 46, zv. 1, 29-35 str. [COBISS.SI-ID 666719]
3. MEDVED, Jože, MRVAR, Primož, VONČINA, Maja, ZDOVC, Miro, BRATUŠ, Vitoslav, KOSMAČ, Ivan, MARTINČIČ, Tomaž. Reciklaža zlitine AlSi9Cu3(Fe) : kratko poročilo za Razvojni center za materiale in tehnologijo d.o.o.. Ljubljana: Naravoslovnotehniška fakulteta, OMM, oktober 2006. 16 str., graf. prikazi. [COBISS.SI-ID 661855];
;1. KOSEC, Borut, KOVAČEVIĆ, Dušan, KOSEC, Ladislav, KOSEL, Franc. Macroscopic modelling and fea of tensile deformed two-phase metal-matrix materials. Journal of production engineering, 2011, vol. 14, no. 1, str. 27-30. [COBISS.SI-ID 1137759]
2. KOSEC, Borut, KARPE, Blaž, LIČEN, Metod, KOSEC, Gorazd. Inductive heating and quenching of planetary shafts. J. Achiev. Mater. Manuf. Eng., April 2010, vol. 39, issue 2, str. 190-196. [COBISS.SI-ID 1041503]
3. JEVREMOVIĆ, Danimir, PUŠKAR, Tatjana, KOSEC, Borut, VUKELIĆ, Djordje, BUDAK, Igor, ALEKSANDROVIĆ, Srbislav, EGBEER, David, WILLIAMS, Robert. The analysis of the mechanical properties of F75 Co-Cr alloy for use in selective laser melting (SLM) manufacturing of removable partial dentures (RPD). Metalurgija (Sisak), travanj/lipanj 2012, vol. 51, br. 2, str. 171-174. [COBISS.SI-ID 1173599]

MERITVE IN REGULACIJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Meritve in regulacije
Course title:	Measurements and Regulations
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077537
Koda učne enote na članici/UL Member course code:	673

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	45	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec, Peter Fajfar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija tehnike. Minimalno 80 % prisotnost na laboratorijskih vajah ter opravljeno in uspešno predstavljeno seminarsko delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the first year of study. Minimal 80 % presentation at laboratory work, and completed and successfully presented seminar work is required before taking the written and oral exam.

Vsebina:	Content (Syllabus outline):
/Uvod. Prikažemo pomen merilne tehnike v tehnoloških procesih in razvoj regulacijske tehnike iz merilne tehnike. Merilnotehnične osnove. Merilna veličina, merilna vrednost, enota, analogno in digitalno prikazovanje, merilne napake, merilna točnost in občutljivost, mednarodni sistem merskih enot, mednarodna	Introduction. Review of importance of measuring technics in technological processes, and development of regulation technics from measuring technics. Measuringtechnics - basis. Measuring quantity, Measuring value, Unit, Analogue and digital displaying, Errors of measurements, Accuracy of measurement and sensitivity, International System of

praktična temperaturna skala. Merilna negotovost in statistika. Sistemski in naključni pogrešek, Statistična obdelava izmerjenih vrednosti, Merilna negotovost, Podajanje merilnih rezultatov. Električne naprave, obdelava signalov in zajemanje podatkov. Analogne naprave, Digitalne naprave, Obdelava signalov, Zajemanje podatkov. Merjenje tehničnih veličin. Merjenje časa, vrtilne hitrosti in frekvence, Merjenje giba, Merjenje debeline, Merjenje elastičnih deformacij, Merjenje mase, Merjenje sil, Merjenje vrtilnih momentov, Merjenje električnih veličin. Meritve temperatur. Senzorji za temperaturo, posebne izvedbe termoelementov kontaktni, aspiracijski, oplaščeni; naprave za umerjanje termoelementov. Optični pirometri, termovizijska kamera. Meritve tlakov. Tlak izražen v mm H2O in v mm Hg; barometrski tlak, nadtlak, podtlak; U-cevni manometer; Elastične merilne naprave z Bourdonovo cevjo, z membrano, s komoro; Bartonova celica; Kapacitivni in piezoelektrični tlačni senzorji. Meritve pretokov. Bernoullijeva enačba; Normirana Venturijeva cev; Normirana zaslonka; Tlačne izgube; Reynoldsovo število; Merilniki diferenčnega tlaka in umerjanje; Korekcija odbirka na skali; Dimenzioniranje merilnih zaslonk; Induktivno merjenje pretoka. Vlaga. Odvisnost tlaka nasičenosti z vlago od temperature; Različne enote za izražanje vsebnosti vlage; Absolutna vlažnost, relativna vlažnost, rosišče; Merilniki vlage aspiracijski psihrometer, higrometer s čutilom iz litijevega klorida. Načrtovanje in izvedba meritev. Laboratorijske meritve, Tehnološke meritve. Regulacijska tehnika. Regulacijski krog in osnovne regulacijskotehnične veličine; Regulacija nivoja kapljevine; Regulacija temperature; Regulator. Princip delovanja samodejnih regulatorjev. Bločna shema regulacijskega kroga. Prikaz elementov regulacijskega kroga s simboli regulator, regulirna linija, vhodne in izhodne veličine, primerjalna in dejanska vrednost, regulirana, nastavna in motilna veličina, nastavno območje, referenčna vrednost. Karakteristike členov regulacijske proge. Ravnotežno obnašanje regulacijske zanke; Karakteristike reguliranega sistema; Karakteristika regulatorja; Faktor ojačenja, proporcionalni in integralni regulator. Prehodna funkcija reguliranega objekta. Člen prvega reda, Členi višjih redov, Neznan red člena. Osnovne zakonitosti regulatorjev. Dvopoložajni način regulacije. Proporcionalni regulator. Integralni regulator, PI regulator, Diferencialno delovanje regulatorja, PD in PID regulator. Praktično določanje parametrov regulatorjev.	measuring Units, International practical temperature scale. Uncertaincy of measurements and statistics. Sistematic and random error, Statististic data processing of measured values, Uncertaincy of measurements, Presentation of measuring results. Electrical devices, signal processing and datacollection. Analogue devices. Digital devices, Signal processing. Data collection. Measurments of technical values. Measurement of time, rotational frequency and speed, Displacement measuring, Thickness measuring, Measurement of elastic deformation, Mass measuring, Force measuring, Measuring of torque, Electrical valeues measuring. Temperature measurement. Temperature sensors, special types of thermocouples: contact, aspiratic, covered; devices for termocouple calibration. Optical pyrometers, thermovision camera. Pressure measurement. Pressure expresses in mm H2O and in mm Hg; barometric pressure, low pressure, high pressure; U-bent manometer; Elastical measuring device with Bourdon tube, with membrane, with chamber; Barton cell; Capacitive and piezoelectric pressure sensors. Flow measurement. Bernoulli equation; Normalised Venturi tube; Normalised restrictor; Pressure losses; Reynolds number; Measuring instruments for measurement differential pressure and callibration; Correction of pick on the scale; Dimesioning of measuring restrictors; Inductive measuring of flow. Humidity. Dependence of pressure of saturation with humidity from temperature; Different units for humidity content expression; Absolute humidity, relative humidity, dew point; Measuring instruments for humidity measuring: aspiratic psyhrometer, higrometer with sensor from lithium chloride. Planning and relization if measurements. Laboratory measurements, Tehnological measurements. Regulation technics. Regulation circle and fundamental regulation technics quantities; Regulation of the fluid level; Temperature regulation; Regulator. Principle of work of automatic regulators. Block scheme of regulation circle. Presntation of elements of regulation circle with the symbols: regulator, regulation line, input and output ; Quantities, comparative and real value; Regulative, adjustive and spurious values; adjustive range, reference value. Characteristics of segments of regulation track. Balance behaviour of regulation loop; Characteristics of regulated system; Charcteristic of regulator; Factor of amplification, proportional and integral regulator. Transition function of regulated object. First order, higher order, unknown order. Fundamental lawnesses of regulators. Dvopoložajni način regulacije. Proportional regulator.

	Integral regulator, PI regulator, Diferenctial work of regulator, PD and PID regulator. Praktical determination of regulators parameters.

Temeljna literatura in viri/Readings:

/Kolenko, T. Osnove regulacijskih sistemov, Univerza v Ljubljani, 2006
Roling, E. Regeltechnik, Einführung…Anwendung, Hartman & Braun, Frakfurt/Main, 1960
Zupančič, B. Zvezni regulacijski sistemi - I. del, Založba FE in FRI,1996
Miklavc, M. Reguliranje toplotnih objektov, Elektrotehniško društvo,Ravne na Koroškem, 1977
Seborg, E.D., Edgar, T.F., Mellichamp, D.A. Process Dynamics and Control, John Wiley & Sons, New York, 1989
Smith, C.A., Corripio, B.A. Principles and Practice of Automatic Process Control, John Wiley & Sons, New York, 1997
Voland, G. Control System Modeling and Analysis, Prentice-Hall, New Jersey, 1986 Johnson, C.D. Process Control Instrumentation Technology, Prentice-Hall International, New Jersey, 1997
Fajfar, P. Meritve zapiski predavanj / Peter Fajfar. - Ljubljana
Univerza v Ljubljani, Naravoslovnotehniška fakulteta, 2000.
Figliola R. S, Beasley D. E. Theory and design for mechanicalmeasurements / Richard S. Figliola, Donald E. Beasley. - New York [etc.] John Wiley & Sons, 1991
Dobovišek Ž. Tehniške meritve v strojništvu skripta / Želimir Dobovišek. - 6. Popravljena in dopolnjena izd. - Maribor Založništvo Fakultete za strojništvo, 1996
Bergelj, F. Osnove meritev / Franc Bergelj. - 5. dopolnjena izd. -Ljubljana , Fakulteta za elektrotehniko, 2000.
Schöne, A. Meßtechnik / Armin Schöne. - 2., überarbeitete Aufl. -Berlin [etc.] Springer, 1997.
The MEASUREMENT, instrumentation, and sensors handbook /editorin-chief John G. Webster. - Boca Raton CRC Press; Heidelberg Springer ; [New York] IEEE Press, 1999

Cilji in kompetence:	**Objectives and competences:**
/Študent spozna pomen merilne tehnike za nadzor, analizo in obvladovanje tehnoloških procesov. Študent se seznani z osnovnimi pojmi merilne tehnike, z merilnimi metodami in z lastnostmi merilnih sistemov. Študent se seznani z osnovnimi pojmi regulacijske tehnike. Študent se navaja tako na samostojno kot na skupinsko strokovno ter projektno delo, uporabo ažurne strokovne literature in sodobnih virov informacij.	Student is acquainted importance of measuring technics for inspection, analysis and control of technological processes. Student is familiarized with the basic conceptions of measuring techniques, measuring systems and their properties. Student is familiarized with the basic conceptions of regulation techniques. The student states both independently and in team expert and project work, the use of up to date literature and contemporary sources of information.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent je sposoben izbrati potrebne meritve za izdelavo toplotne bilance in obvlada namestitev senzorjev in kontrolo merilnikov; razume pomen termičnega izkoristka in specifične porabe toplote ogrevalnega procesa. Študent razume prednosti proporcionalne regulacije pred regulacijo vklop/izklop in izboljšave, ki jih doda integralna regulacija; razume tudi intenzivnost poseganja diferencialnega načina regulacije. Razume nastavitvene parametre regulatorjev in njihovo povezavo s procesnimi parametri. Študent se navaja na samostojno sprejemanje odločitev, povezuje in vrednoti analitične, eksperimentalno in numerično dobljene rezultate.	Študent je sposoben izbrati potrebne meritve za izdelavo toplotne bilance in obvlada namestitev senzorjev in kontrolo merilnikov; razume pomen termičnega izkoristka in specifične porabe toplote procesa. Študent razume prednosti proporcionalne regulacije pred regulacijo vklop/izklop in izboljšave, ki jih doda integralna regulacija; razume tudi intenzivnost poseganja diferencialnega načina regulacije. Razume nastavitvene parametre regulatorjev in njihovo povezavo s procesnimi parametri. Student will get accustomed to reach decision individually and link and asses analytical, experimental and numerical acquired results. Students get used to

Navaja se na samostojno in skupinsko delo, na projektno in raziskovalno delo, uporabo strokovne literature in sodobnih virov informacij.	individual and team, project and research work, and expert literature and modern information source applications.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje, programiranje in modeliranje z uporabo računalnika, laboratorijske vaje, seminarsko delo.	Lectures. Exercises solving. Programming and computer modeling. Laboratory work. Seminar work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena seminarske naloge (10 %)	10,00 %	the mark of seminar work (10%)
ocena kolokvijev (20 %)	20,00 %	the mark of colloquiums (20 %)
ocena pisnega dela izpita (20 %)	20,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (50 %)	50,00 %	the mark of the oral examination (40%)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. ZORC, Borut, KOSEC, Borut, KOSEC, Ladislav, NAGODE, Aleš. Analysis of hot water pipeline system leakage. Eng fail. anal.. vol. 28, no. 3, 78-81, 2013.
2. KOSEC, Borut, KARPE, Blaž, BUDAK, Igor, LIČEN, Metod, ĐORĐEVIĆ, Miroslav, NAGODE, Aleš, KOSEC, Gorazd. Efficiency and quality of inductive heating and quenching of planetary shafts. Metallurgy, vol. 51, no. 1, 71-74, 2012.
3. BRUNČKO, Mihael, RUDOLF, Rebeka, KOSEC, Borut, ANŽEL, Ivan. Vacuum carburizing of steels. TTEM. Tech. technol. educ. manag., vol. 7, no. 4, 1516-1521, 2012.
1. TERČELJ, Milan, TURK, Radomir, KUGLER, Goran, FAJFAR, Peter, CVAHTE, Peter. Measured temperatures on die bearing surface in aluminium hot extrusion. RMZ-mater. geoenviron., 2006, vol. 53, no. 2, str.: 163-173.
2. FAJFAR, Peter, TURK, Radomir. Meritve in kontrola tehnoloških parametrov valjanja = Measurements and control of technological rolling parameters. Kovine zlit. tehnol., 1999, letn. 33, št. 5, str. 299-301
3. TERČELJ, Milan, KUGLER, Goran, TURK, Radomir, CVAHTE, Peter, FAJFAR, Peter. Measurement of temperature on the bearing surface of an industrial die and assessment of the heat transfer coefficient in hot extrusion of aluminium: a case study. Int. j. veh. des., 2005, vol. 39, nos. 1/2, str. 93-109

METALURGIJA PRAHOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Metalurgija prahov
Course title:	Powder Metallurgy
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077538
Koda učne enote na članici/UL Member course code:	681

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija.	The performing of study obligations are defined in the Regulations of the assessment of students at UL NTF. For a positive and successful fulfillment of study obligations and involvement in academic work is recommended to regularly attend lectures, solving the additional exercises and more demanding tasks, self preparation prior to laboratory work and at least 80 % attendance at exercises. The condition for the enrollment in the 3rd year of study is fulfillment of the requirements.

Vsebina:	Content (Syllabus outline):
Postopki izdelave prahov. Karakterizacija prahov. Priprava prahov za oblikovanje in konsolidacijo. Oblikovanje in stiskanje prahov v togih matricah. Drugi postopki oblikovanja. Sintranje; dogodki v posameznih stopnjah; aktivacijsko sintranje, sintranje s talino; sintranje pod tlakom; reaktivno in reakcijsko sintranje, supersolid sintranje, razvoj mikrostrukture.	Production technology of metal powders. Characterization of powders. The preparation of powders for forming. Design and powder compaction in rigid matrices. Other methods of design. Sintering: phenomena during sintering at different stages; activation sintering, liquid phase sintering; sintering under the pressure, reactive and reaction

Hitro strjevanje Dodajalne tehnologije (osnove) Sekundarne operacije. Primeri izdelave materialov in izdelkov po postopkih metalurgije prahov. Povezava metalurgije prahov z drugimi procesnimi tehnikami.	sintering supersolid sintering, microstructure development. Rapid solidification Additive technologies (basics) Secondary operations. Examples of materials and products of powder metallurgy. Connections of powder metallurgy process with other production processes.

Temeljna literatura in viri/Readings:

ANGEOLO P.C., SUBRAMANIAN R.: Powder metallurgy: Science, technology and application, PHI Learning Private Limited, New Delhi, 2008
ANISH UPADHYAYA, G. S. UPADHYAYA, KEN-ICHI TAKAGI: Powder Metallurgy: Science, Technology and Materials,CRC Press Inc; Illustrated edition, 2011
B. K. DATTA: Powder Metallurgy: An Advanced Technique of Processing, PHI Learning; 2nd Revised edition, 2014
IAN GIBSON , DAVID ROSEN , BRENT STUCKER , MAHYAR KHORASANI: Additive Manufacturing Technologies,Springer; 3rd ed. 2021
GERMAN R.M. Sintering: From Empirical Observation to Scientific Principles, Elsevier Inc., 2014

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je spoznati študente s teoretičnimi osnovami, načrtovanjem, postopki izdelave izhodnih surovin, sinteze materialov in izdelkov, karakterizacije materialov in izdelovalnimi tehnologijami metalurgije prahov.	The aim of the course is to give the students the knowledge about theoretical fundamentals, designing, manufacturing processes, raw materials, materials synthesis and product made by PM route, the characterization of materials, and production technologies of powders.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Metalurgija prahov je eden izmed zaključnih predmetov študija. Razvoj znanja izhaja iz termodinamike materialov, materialografije, fizikalne metalurgije, preiskav materialov ter predmetov procesne tehnike. Vsebina predmeta je ena od metalurških tehnologij sinteze in obdelave materialov, katerih večine po drugih tehnologijah ni moč izdelati. Največ t.i. sodobnih materialov se izdela po tej tehnologiji. Vsebina predmeta sloni na osnovnih strokovnih in nekaterih inženirskih predmetih. Prenosljive spretnosti izvirajo iz eksperimentalne metodike večih predhodnih predmetov za sintezo in karakterizacijo materialov in omogočajo pestro razvojno raziskovalno dejavnost študentom.	Knowledge and understanding: Powder metallurgy is one of the final courses of study. The knowledge is derived from thermodynamics of materials, materialography, physical metallurgy, materials investigations and process engineering objects. The content of the course is dealing with one of the metallurgical technology of synthesis and processing of materials which cannot be made by other technologies. Most so-called modern materials can be produced by this technology. Course content is based on some basic professional and engineering courses. Transferable skills come from the experimental methodology of some other courses which handling the synthesis and characterization of materials and allow diverse research and development activity for students.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske in eksperimentalne vaje, seminarsko delo.	Lectures, computational and experimental work, project work.

Načini ocenjevanja: **Delež/Weight** **Assessment:**

ocena eksperimentalnih vaj in seminarja (35 %)	35,00 %	the mark of project work (35%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (35 %)	35,00 %	the mark of the oral examination (35%)

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

KARPE, Blaž, KOSEC, Borut, NAGODE, Aleš, BIZJAK, Milan. The influence of Si and V on the kinetics of phase transformation and microstructure of rapidly solidified Al-Fe-Zr alloys. Journal of mining and metallurgy. Section B, Metallurgy. 2013, vol. 49 b, no. 1, str. 83-89. ISSN 1450-5339.

GODEC, Matjaž, ŠETINA, Barbara, MANDRINO, Djordje, NAGODE, Aleš, LESKOVŠEK, Vojteh, ŠKAPIN, Srečo D., JENKO, Monika. Characterization of the carbides and the martensite phase in powder-metallurgy high-speed steel. Materials characterization. [Print ed.]. April 2010, vol. 61, no. 4, str. 452-458. ISSN 1044-5803. DOI: 10.1016/j.matchar.2010.02.003.

NAGODE, Aleš, ZUPANČIČ, Katja, ZORC, Matija, ŽUŽEK, Borut, KARPE, Blaž, ŠETINA, Barbara, ZORC, Borut, KOSEC, Borut, BIZJAK, Milan, PAVLIČ, Alenka. Investigating the properties of dental composites = Preiskava lastnosti kompozita za zobne zalivke. Materiali in tehnologije. [Tiskana izd.]. 2020, letn. 54, št. 4, str. 433-437, ilustr. ISSN 1580-2949. http://mit.imt.si/izvodi/mit204/nagode.pdf, DOI: 10.17222/mit.2019.128.

KARPE, Blaž, NAGODE, Aleš, KOSEC, Borut, STOIĆ, Antun, DOLENEC, Matej, BIZJAK, Milan. Microstructure evolution and thermal stability of rapidly solidified Al-Ni-Co-Re alloy. Metalurgija. 2013, vol. 52, br. 3, str. 305-308. ISSN 0543-5846.

RAVNIKAR, Dunja, TRDAN, Uroš, NAGODE, Aleš, ŠTURM, Roman. Energy density effect of laser alloyed TiB2/TiC/Al composite coatings on LMZ/HAZ, mechanical and corrosion properties. Metals. 2020, iss. 3, vol. 10, str. 1-19, ilustr. ISSN 2075-4701. https://www.mdpi.com/2075-4701/10/3/411/htm, DOI: 10.3390/met10030411.

MODELSKI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Modelski praktikum
Course title:	Modelling Practicum
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067607
Koda učne enote na članici/UL Member course code:	659

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
15	0	60	0	0	75	5

Nosilec predmeta/Lecturer:	Goran Kugler
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za delo je vpis v letnik študija ter poznavanje osnov programiranja.	Enrollment in the year of study and basics knowledge of computer programming.

Vsebina:	Content (Syllabus outline):
/Študent opravi s pomočjo navodil za vaje in na računalnike nameščenih programov za simulacije različnih fizikalno-metalurških procesov 10 vaj, ki obsegajo metode na atomistični, mezoskopski in makroskopski skali, pri čemer se najprej seznani z računalniško kodo in jo po potrebi modificira, rezultate simulacij pa ustrezno obdela. Na podlagi obdelanih in analiziranih podatkov izdela poročilo. Seznam vaj: • statična rekristalizacija • normalna in pretirana rast zrn • fazni prehod pri segrevanju ferit v avstenit • nanos tanke plasti • kinetika izločanja delcev druge faze v binarni zlitini • difuzija v binarni zlitini • natezni preizkus	Using the instructions for exercises and preinstalled source codes for computer simulations of various physical-metallurgical processes, students conduct 10 exercises that include methods on atomistic, mesoscopic and macroscopic spatial scale. For each work assignment students begins, with getting familiar with computer code and if required they modify it. They appropriately analyze the results of simulations and prepare the reports. List of exercises: • static recrystallization • normal and abnormal grain growth • phase transformation ferrite to austenite during heating • deposition of thin coating • kinetic of precipitation in binary alloy • diffusion in binary alloy • tensile test

• fazna sestava žlindre • gravitacijsko litje • model izmenjevalnika toplote Poleg vaj, pripravijo študentje, ki se v ta namen razdelijo v skupine, tudi eno projektno nalogo. Projektna naloga zajema: načrtovanje simulacij (definicija problema, izbira primernih orodij), pisanje računalniške kode (ali modifikacija oz. nadgradnja računalniške kode za katero od vaj), izvajanje simulacij in analiza rezultatov, priprava poročila ter kratka predstavitev projekte naloge pred ostalimi skupinami (mini simpozij). Temo za projektno nalogo lahko predlagajo študentje sami, ali pa jo izberejo med naborom razpisanih nalog.	• phase composition of slag • gravity casting • model of the heat exchanger In addition to the exercises, students divide themselves into groups and get one project assignment. Project work includes: planning and designing the simulation (Definition of the problem, the selection of appropriate tools), writing computer code (or modification and/or. upgrading of computer codes from any of the exercises), conducting simulations and analysis of the results, preparation of reports and a brief presentation of the project tasks in front of other groups (mini-symposium). The theme for the project work can be initiated by students themselves, or can be chosen from the set of assignments prepared by the lecturers.

Temeljna literatura in viri/Readings:

/1. Navodila za vaje za praktikum
2. Specialna literatura ob posameznih vajah
3. D. Raabe: Computational Materials Science: The Simulation of Materials Microstructures and Properties, Wiley-VCH, Weinheim, 1998
4. D. Raabe, F. Roters, F. Barlat, L-Q. Chen, Continuum Scale Simulation of Engineering Materials: Fundamentals - Microstructures - Process Applications Wiley-VCH, Weinheim, 2004
5. Z. H. Barber: Introduction to Materials Modelling, Maney, London, 2005.
6. Günter Gottstein, Integral Materials Modeling: Towards Physics-Based Through-Process Models, Wiley-VCH, Weinheim, 2007

Cilji in kompetence:	**Objectives and competences:**
/Študent spozna najpomembnejše računalniške modele materialov in se jih nauči uporabljati ter vrednotiti rezultate simulacij. Predmetno specifične kompetence: pridobitev praktičnega znanja pri uporabi računalniških modelov in računalniških eksperimentov v znanosti o materialih in metalurgiji. Pridobitev znanja opazovanja poteka računalniških eksperimentov, kritične ocene rezultatov in njihove natančnosti, organizacije rezultatov in njihove predstavitve.	Students learn about the most important computational models of materials and learn how to use them and to evaluate the results of simulations. Subject-specific competencies: obtaining the practical knowledge and skills for using the computer models and computer experiments within the fields of materials science and metallurgy. Obtaining knowledge of observation of computer experiments, critical evaluation of the results and their accuracy, organization of results and their presentation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Pridobitev praktičnega znanja na področju uporabe modernega računalniškega eksperimentiranja v znanosti o materialih in metalurgiji. Seznanitev z najpomembnejšimi modeli in simulacijskimi metodami, ki se uporabljajo v metalurgiji in znanosti o materialih. Uporaba: Uporaba znanja pridobljenega pri ostalih predmetih na širšem področju metalurgije in materialov na primeru računalniških poskusov. Razumevanje kritičnih parametrov pri računalniških poskusih in sposobnost izbire in načrtovanja	Knowledge and understanding: Obtaining practical knowledge within the field of conducting of modern computer experiments in materials science and metallurgy. Familiarization with some important modelling and simulation methods that are used in materials science and metallurgy. Applications: Use of knowledge obtained at other courses in materials science and metallurgy fields for conducting computer simulations. Understanding of critical parameters of computer experiments and ability of selection and design of computer simulations. The principles of processing and analysis

računalniških simulacij. Postopek obdelave in analize rezultatov je uporaben tudi pri obdelavi rezultatov dobljenih s pomočjo realnih eksperimentov. Refleksija: Kritično ovrednotenje rezultatov računalniških eksperimentov in njihove natančnosti. Obdelava rezultatov računalniških eksperimentov z različnimi matematičnimi orodji. Prenosljive spretnosti (niso vezane le na en predmet): Sposobnost dela s kompleksnimi simulacijskimi orodji, obdelava dobljenih podatkov in njihova analiza. Sposobnost določanja njihove natančnosti. Sposobnost ovrednotenja uporabnosti modelov na podlagi rezultatov.	of the results is also useful for processing of the results obtained with real experiments in laboratory or in industry. Reflection: Critical evaluation of the results of computer experiments and their accuracy. Processing of the results of computer experiments employing various mathematical tools. Transferable skills (not linked to only one course): Ability to work with complex simulation tools, processing of obtained data and their analysis. Ability of determining their accuracy. Ability of evaluation of the usefulness of models from obtained results.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, izvedba praktikumskih vaj, priprava poročil, izvedba seminarske naloge in konzultacije.	Lectures, conducting practicum exercises, preparation of reports, conducting seminar and consultations.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) zagovori vaj in seminarja, ki prinesejo h končni oceni	30,00 %	(a) defense of tutorial and seminar
(b) ustni izpit, ki prinese h končni oceni	70,00 %	(b) oral examination

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. PERUŠ, Iztok, TERČELJ, Milan, KUGLER, Goran. Determination of scrap/supply probability curves for the mechanical properties of aluminium alloys in hot extrusion using: a neural network-like approach. Expert systems with applications, 2012, vol. 39, no. 5, str. 5634-5640.
2. PERUŠ, Iztok, FAZARINC, Matevž, KUGLER, Goran, FAJFAR, Peter. On the influence of human factor on mechanical properties in aluminium hot extrusion process, Metalurgija, 2010, vol. 49, 2, str. 87-90
3. KUGLER, Goran, TERČELJ, Milan, FAZARINC, Matevž, FAJFAR, Peter, BOMBAČ, David, RODIČ, Tomaž, TURK, Radomir, PERUŠ, Iztok, VEČKO PIRTOVŠEK, Tatjana, KRUŠIČ, Uroš, AŽMAN, Marko, BUHVALD, Alojz. Uvajanje virtualnih tehnologij v proizvodni proces Metal Ravne. V: Recesija - priložnost povezovanja industrije in akademske sfere ,Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2009

NANOTEHNOLOGIJE IN NANOMATERIALI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	NANOTEHNOLOGIJE IN NANOMATERIALI
Course title:	NANOTECHNOLOGIES AND NANOMATERIALS
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0553524
Koda učne enote na članici/UL Member course code:	Nov predmet

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
35	10	30			75	5

Nosilec predmeta/Lecturer:	Boštjan Markoli
Vrsta predmeta/Course type:	Strokovni izbirni/Professional elective subject

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
-Obvezna prisotnost na laboratorijskih vajah -50% prisotnost na predavanjih -Opravljen izpit iz predmeta Struktura materialov	-Obligatory attendance at laboratory work -50% attendance at lectures -Successful completion of the course Structure of materials

Vsebina:	Content (Syllabus outline):
Spektroskopija, mikroskopija na atomsko silo (AFM), tunelska elektronska mikroskopija (STM), mikroskopija na magnetno silo (MFM) in druge metode. Osnove spektroskopije, elektrokemije in elektronske mikroskopije. Nanotehnologije, litografija na nanonivoju, nanolitografija s pomakanjem konice (DPN) elektronska litografija, litografija nanosfer (NSL), molekularna in sinteza in sinteza na nanonivoju, samourejevanje, rast kristalov na nanonivoju, polimerizacija, nanogradniki. Nanomateriali in njihova uporaba. Pametni materiali, senzorji, biostrukture na nanonivoju, hranjenje in zajemanje, optika, magneti, energije, podatkov, elektronika, izdelovalne tehnike, modeliranje.	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.

Temeljna literatura in viri/Readings:

Nanomaterials and Nanochemistry - C. Brechignac, et al., (Springer, 2007) Nanophysics and Nanotechnology - An Intro to Modern Concepts in Nanoscience 2nd ed - E. Wolf (Wiley-VCH, 2006) Nanotechnology - An Introduction to Nanostructuring Techniques 2nd ed - M. Kohler, W. Fritzsche (Wiley-VCH, 2007) Ratner - Nanotechnology - A Gentle Introduction to the Next Big Idea Williams - Nanotechnology Demystified

Cilji in kompetence:	**Objectives and competences:**
Predmet obravnava problematiko, ki je osnova za razumevanje nanotehnologij in nanomaterialov. Predhodno poznavanje struktur in kemijskih vezi skupaj s poznavanjem sodobnih preiskovalnih metod, ki se obenem uporabljajo za izdelavo nanomaterialov in manipulacijo osnovnih gradnikov. Področja uporabe nanomaterialov in razvoj v prihodnosti.	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

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Za razumevanje vsebine predmeta so potrebna predhodna znanja s področja kemije, matematike, fizike in strukture materialov. Namen predmeta je, da se študenti seznanijo z osnovami nanomaterialov in nanotehnologij. Teoretične osnove so potrebne za nadaljnji študij ter razumevanje postopkov in procesov pri izdelavi, predelavi in uporabi nanomaterialov.	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.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predmet se poučuje v obliki predavanj in vaj.	The course is taught through lectures and tutorials

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

LESKOVAR, Blaž, ŠTURM, Sašo, SAMARDŽIJA, Zoran, AMBROŽIČ, Bojan, MARKOLI, Boštjan, NAGLIČ, Iztok. Epitaxial growth of a metastable icosahedral quasicrystal on a stable icosahedral quasicrystal substrate. *Scripta materialia*, ISSN 1359-6462, 2018, vol. 150, str. 92-95.

PEČKO, Darja, ŽUŽEK ROŽMAN, Kristina, KOSTEVŠEK, Nina, ARSHAD, Muhammad Shahid, MARKOLI, Boštjan, SAMARDŽIJA, Zoran, KOBE, Spomenka. Electrodeposited hard-magnetic Fe[sub](50)Pd[sub](50) nanowires from an ammonium-citrate-based bath. *Journal of alloys and compounds*, ISSN 0925-8388. [Print ed.], 2014, vol. 605, str. 71-79.

ŠTURM, Sašo, ŽUŽEK ROŽMAN, Kristina, MARKOLI, Boštjan, SPYROPOULOS ANTONAKAKIS, Nikolaos, SARANTOPOULOU, Evangelia, KOLLIA, Zoe, CEFALAS, Alciviadis-Constantinos, KOBE, Spomenka. Pulsed-laser fabrication of gas-filled hollow CoPt nanospheres. *Acta materialia*, ISSN 1359-6454. [Print ed.], 2013, vol. 61, no. 61, str. 7924-7930.

ZUPANIČ, Franc, MARKOLI, Boštjan, NAGLIČ, Iztok, WEINGÄRTNER, Tobias, MEDEN, Anton, BONČINA, Tonica. Phases in the Al-corner of the Al-Mn-Be system. *Microscopy and microanalysis*, ISSN 1431-9276. [Print ed.], Oct. 2013, vol. 19, iss. 5, str. 1308-1316.

NUMERIČNO MODELIRANJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Numerično modeliranje
Course title:	Numerical Modelling
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067597
Koda učne enote na članici/UL Member course code:	376

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec, Tomaž Rodič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v letnik	Entry in the academic year

Vsebina:	Content (Syllabus outline):
/Numerično modeliranje: - pregled najpogosteje uporabljenih numeričnih metod: metoda končnih elementov, metoda končnih razlik, metoda končnih volumnov, metoda robnih elementov - numerična diskretizacija v prostoru in času, modeliranje začetnih in robnih pogojev, konstitutivno modeliranje materialov, kontaktni problemi, izvori in ocenjevanje numeričnih napak - numerično modeliranje napetostno-deformacijskih, temperaturnih in elektromagnetnih polj; - nelinearne metode in modeliranje medsebojnih vplivov med različnimi fizikalnimi polji ter sklopljene mikro-makro analize - modeliranje poškodb in strukturnih sprememb v materialu - parametrične študije, občutljivostne analize in	Numerical modeling: - An overview of the most commonly used numerical methods: finite element method, finite differences, finite volume method, boundary element method; - Numerical discretization in space and time, modeling of initial and boundary conditions, constitutive modeling of materials, contact problems, sources and assessment of numerical errors; - Numerical modeling of stress-strain, temperature and electromagnetic fields; - Non-linear methods and modeling the interactions between various physical fields and coupled micro-macro analyses; - Modeling of damage and structural changes in materials - Parametric studies, sensitivity analyses and inverse models; - Optimization of processes, formulations of

inverzni modeli - optimiranje procesov, formulacije namenskih funkcij in omejitev - izbira numeričnih algoritmov, analize napak in zanesljivosti podatkov Reševanje praktičnih problemov s poudarkom na analizi odzivov materialov v aplikacijah iz strojništva, gradbeništva, geomehanike, kemijskega inženirstva, biomehanike, letalske in vesoljske tehnike.	objective functions and constraints; - The choice of numerical algorithms, error analysis and data reliability; Solutions of practical problems with an emphasis on analysis of the responses of materials for applications in mechanical engineering, civil engineering, geomechanics, chemical engineering, biomechanics, aerospace technology.

Temeljna literatura in viri/Readings:

/O.C. ZIENKIEWICZ and R.L. TAYLOR, (2000)
The Finite Element Method, Vol. 1: The Basis, Butterworth and Heneimann, 5th Edition, 689 pp
O.C. ZIENKIEWICZ and R.L. TAYLOR, (2000)
The Finite Element Method, Vol. 2: Solid Mechanics, Butterworth and Heneimann, 5th Edition, 459 pp
J.N. Reddy, D.K. Garting:
The Finite Element Method in Heat Transfer and Fluid Dynamics (3th ed.) CRC Press Taylor Francis, Boca Raton, London, New York, 2010

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je študente naučiti uporabljati računalniške modele za numerične analize materialov, izdelkov in procesov po metodi končnih elementov (MKE). Kompetence: Študentje spoznajo teoretične osnove MKE metode ter se naučijo določati geometrijo definicijskih območij, izvesti prostorsko in časovno diskretizacijo problema, predpisati mehanske in termalne robne pogoje, izbrati ustrezne snovne modele in določiti snovne podatke ter nastaviti parametre za linearne in nelinearne analize, katerih rezultate so sposobni kritično ovrednotiti. V okviru predmeta študentje opravijo praktične vaje na računalniku iz vseh naštetih veščin numeričnega modeliranja.	The main objective of the course is to teach students how to use computer models for numerical analysis of materials, products and processes by the finite element method (FEM). Competencies: theoretical background of the FEM method, determination of geometrical domains, spatial and temporal discretization of problems, formulatuion of mechanical and thermal boundary conditions, choice of the appropriate material models, determination of the material data and parameters for linear and non-linear analyses, critical assessment of numerical results. During the course students perform practical exercises to gain computational skills in all above listed aspects of numerical modeling.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Po končanem predmetu bodo študentje sposobni izdelati MKE modele za 2D in 3D analize v mehaniki kontinuuma in prenosu toplote.	After completion of the course, students will be able to setup FEM models for 2D and 3D analyses of continuum mechanics and heat transfer problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje in simulacije, reševanje praktičnih primerov in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena projektne naloge (30 %)	30,00 %	the mark of project work (30%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40%)

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

KOVAČEVIĆ, Dušan, BUDAK, Igor, ANTIĆ, Aco, NAGODE, Aleš, KOSEC, Borut. FEM modeling and analysis in prevention of the waterway dredgers crane serviceability failure. Engineering failure analysis, ISSN 1350-6307. [Print ed.], Mar. 2013, vol. 28, str. 328-339.

KARPE, Blaž, KOSEC, Borut, KOLENKO, Tomaž, BIZJAK, Milan. Heat transfer analyses of continuous casting by free jet meltspinning device. Metalurgija, ISSN 0543-5846, 2011, vol. 50, br. 1, str. 13-16.

KOSEC, Borut, KOSEC, Ladislav, KOSEL, Franc, BIZJAK, Milan. Macroscopic simulation of two-phase copper matrix materials subjected to tensile deformation. Metall, 2000, jg. 54, nr. 4, str. 186-188.

;RODIČ, Tomaž, ŠUŠTAR, Tomaž, ŠUŠTARIČ, Primož, KORELC, Jože. Efficient numerical implementation of pressure, time and temperature superposition for elasto-visco-plastic material model by using a symbolic approach. International journal for numerical methods in engineering, ISSN 0029-5981, okt. 2010, letn. 84, št. 4, str. 470-484,

STUPKIEWICZ, Stanislaw, KORELC, Jože, DUTKO, Martin, RODIČ, Tomaž. Shape sensitivity analysis of large deformation frictional contact problems. Computer Methods in Applied Mechanics and Engineering, ISSN 0045-7825. [Print ed.], 2002, vol. 191, issue 33, str. 3555-3581

ŠUŠTARIČ, Primož, SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., RODIČ, Tomaž. Sensitivity analysis based crack propagation criterion for compressible and (near) incompressible hyperelastic materials. Finite elements in analysis and design, ISSN 0168-874X. [Print ed.], May 2014, vol. 82, str. 1-15

SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., ŠUŠTARIČ, Primož, RODIČ, Tomaž. Damage driven crack initiation and propagation in ductile metals using XFEM. Computational mechanics, ISSN 0178-7675, 2012, vol. 52, no. 1, str. 161-179.

GRM, Aleksander, GRÖNLAND, Tor-Arne, RODIČ, Tomaž. Numerical analysis of miniaturised cold gas thruster for micro- and nano-satellites. Engineering computations, ISSN 0264-4401, 2011, vol. 28, no. 2, str.184-195.

OGNJEVZDRŽNA GRADIVA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Ognjevzdržna gradiva
Course title:	Refractory Materials
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077539
Koda učne enote na članici/UL Member course code:	680

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Knap, Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Liabilities are defined in the regulations on examination and evaluation of students at ULNTF. For a positive and successful attendance of their duties students are encourage to regular attendance of lectures, additional domestic more complex work more and appropriate preparing to laboratory work. At least 80% attendance at tutorials is needed.

Vsebina:	**Content (Syllabus outline):**
/Obravnavana bodo naslednja poglavja: • Ognjevzdržna gradiva v procesni tehniki kovin in materialov • Struktura in lastnosti oksidnih in neoksidnih keramičnih materialov • Reaktorji in agregati za proizvodnjo ognjevzdržnih gradiv • Uporaba ognjevzdržnih gradiv • Surovinska osnova naravnih in sintetičnih materialov za izdelavo ognjevzdržnih gradiv	The following section will be presented: • Refractory materials for the engineering of metals and materials • Structure and properties of oxide and non-oxide ceramic materials • Furnaces and aggregates for the production of refractory materials • The use of refractory materials • The natural and synthetic raw materials in the production of refractory materials

• Kakovost in preiskovalne metode surovinske osnove • Postopki priprave in izdelave tehnične keramike • Ravnotežni sistemi oksidne keramike • Silikatna in alumosilikata ognjevzdržna gradiva • Oksidna tehnična ognjevzdržna gradiva • Fazna sestava pri žganju in sintranju • Tvorba steklaste faze in njen vpliv na kakovost ognjevzdržnih gradiv • Izolacijski materiali • Veziva • Reakcije na fazni meji med talino, žlindro in plinom in ognjevzdržnimi materiali Pred začetkom predavanj in vaj bo študentom razdeljeno študijsko gradivo.	• Quality and testing of basic raw materials • Preparation and production of technical ceramics • Equilibrium systems in oxide ceramics • The silicate and aluminosilicate refractory materials • Oxide refractories for application in technology • The phase composition changes during the calcination and sintering • The formation of a vitreous phase and its impact on the quality of refractory materials • Insulating materials • Bindings • Reactions at the interface between the molten slag and gas and refractory materials Before the start of lectures and exercises study material will be presented to students.

Temeljna literatura in viri/Readings:

Subir Biswas, Debasish Sarkar: Introduction to Refractories for Iron- and Steelmaking, Springer, 2020 Thomas Vert: Refractory material selection for steelmaking, John Wiley & Sons, 2016

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je naučiti kandidata o ognjevzdržnih gradivih, ki jih uporabljamo pri različnih tehnoloških postopkih proizvodnje in predelave kovinskih in nekovinskih materialov, kot so železo, jeklo, ferozlitine, aluminij in aluminijeve zlitine, baker in njegove zlitine, posebne zlitine, cementna in keramična industrija... Kandidat bo znal kompetentno odločiti, katera vrsta ognjevzdržnega gradiva je za določen tehnološki postopek najbolj primerna glede na vzdržnost in obstojnost pri povišanih ali visokih temperaturah ter v stiku z različnimi atmosferami, kovinskimi in nekovinskimi talinami. Prav tako bo znal kompetentno odločati o izbiri primernega ognjevzdržnega gradiva glede na izolacijsko učinkovitost zaradi porabe energije, možnosti nastanka neželenih odpadkov in njihovo sanacijo zaradi zaščite okolja. Neizrabljena gradiva pa bo znal uporabiti kot sekundarno surovino. Znanje pridobljeno pri tem predmetu bo uporabil pri vseh drugih strokovnih predmetih iz tega študijskega programa. Prav tako bo znanje pridobljeno pri drugih predmetih koristilo pri uporabi teh materialov (ognjevzdržnih gradiv) in razvoju novih postopkov	The aim of this course is that students get knowledge of refractory materials that are used in different technological processes of production and processing of metallic and non-metallic materials such as iron, steel, ferroalloys, aluminium, aluminium alloys, copper and its alloys, special alloys, cement and ceramics industry… The candidate will be able to competently decide what type of refractory material is for each technology most appropriate regard to the sustainability and stability at elevated or high temperatures and in contact with different atmospheres, metallic and non-metallic melt. They will also be able to competently decide what refractory material is most suitable in relation to the insulating efficiency due to energy consumption, the possibility of unwanted waste and their recovery in order to protect the environment. They will deal with unused material as a secondary raw material. Knowledge gained in this course will be used for all other professional subjects during further study. Also, the knowledge obtained before will be helpful when using these materials (refractory materials) and in the development of new processes.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študenti bodo razumeli, da primerna izbira materiala, t.j. ognjevzdržnega gradiva, vodi k uspehu in učinkovitosti proizvodnega postopka. K učinkovitosti spada nemoten potek procesa, ki daje kakovosten proizvod pri najmanjši možni meri uporabe osnovnega in pomožnih materialov ter energije. Znali bodo ocene emisij na okolje, njihovo	Students will understand that appropriate choice of material, i.e. refractory material, leads to the success and efficiency of the manufacturing process. As the efficiency is meant a smooth process flow which is giving quality product at the lowest possible price, use of primary and secondary raw materials and energy. They will be able to estimates the amount of

preprečevanje in zniževanje. Znali bodo analizirati enostavne tehnološke postopke pri proizvodnji teh gradiv ali pri njihovi uporabi. Zna načrtovati učinkovite proizvodne procese. Znanje bo uporabno pri uporabi ognjevzdržnih gradiv za industrijske namene, v proizvodnji kovinskih in nekovinskih materialov, pri toplotnih obdelavah kovinskih in nekovinskih materialov, pri izdelavi izolacijskih materialov v gradbeništvu ...	emissions to the environment and prevent or reduce them. The knowledge will enable them to analyse a simple technological production processes and usage of these materials. Design of efficient production processes. Knowledge will be useful in the use of refractory materials in industry, in the production of metallic and non-metallic materials, during the heat treatment of metals and non-metallic materials, in the manufacture of insulating materials, in construction ...

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, seminarske in laboratorijske vaje, terenske vaje, samostojno delo	Lectures, seminars, tutorial and laboratory work, fieldwork, individual work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ustni izpit	60,00 %	oral exam
pisni izpit	20,00 %	examination
seminarska naloga in poročilo laboratorijskih vaj	20,00 %	seminar work and the report of the laboratory work

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

LAMUT, Jakob, ROZMAN, Alojz, KNAP, Matjaž, DEBELAK, Martin, LAMUT, Barbara. By-products of steel production. V: 7. simpozijum "Reciklažne tehnologije i održivi razvoj" sa međunarodnim učešćem, Soko Banja, 5.-7. septembar 2012. godine = 7th Symposium "Recycling Technologies and Sustainable Development" with International Participation. BOGDANOVIĆ, Grozdanka D. (ur.), TRUMIĆ, Milan (ur.). Zbornik radova = Proceedings. Bor: Tehnički fakultet: = Technical Faculty, 2012, str. 319-325. [COBISS.SI-ID 1245791]

LAMUT, Jakob, FALKUS, Jan, JURJEVEC, Beno, KNAP, Matjaž. Influence of inclusions modification on nozzle clogging = Wpływ modyfikacji wtrąceń niemetalicznych na zarastanie wylewów zanurzeniowych. Archives of metallurgy and materials, ISSN 1733-3490, 2012, vol. 57, no. 1, str. 319-324. [COBISS.SI-ID 1211231]

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ORGANIZACIJA IN MENEDŽMENT PODJETJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Organizacija in menedžment podjetja
Course title:	Company Organization and Management
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067608
Koda učne enote na članici/UL Member course code:	658

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15	0	0	75	5

Nosilec predmeta/Lecturer:	Goran Kugler
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za v delo je vpis v letnik študija.	Enrollment in the year of study.

Vsebina:	Content (Syllabus outline):
1. Opredelitev, pojmi in definicije, zgodovinski pregled: 2. Elementi proizvodnega procesa 3. Oblikovanje in struktura delovnega sistema 4. Študij dela 5. Celostno obvladovanje kakovosti 6. Vzdrževanje in organizacija 7. Ekonomsko tehnični kazalci uspeha 8. Izdelek in proces vodenja 9. Modeli operativnega vodenja 10. Organizacija in vodenje projekta 11. Organizacija proizvodnih obratov	1. Definitions, concepts and definitions, historical overview 2. The elements of the production process 3. Design and structure of the production system 4. Study of Work 5. Total Quality Management 6. Maintenance and Organization 7. Economic and technical indicators of success 8. Processes of management and product 9. Models of operational management 10. Project management 11. Organization of production plants

Temeljna literatura in viri/Readings:

Skripta predlagatelja programa
Duhovnik,J. in Tavčar,J.:Elektronsko poslovanje in tehnični informacijski sistemi: LECAD. Ljubljana: FS, 2000

Nicholas van Dam, Jos Marcus: Handbook organisation and management: a practical approach: Routledge, Noordhoff Uitgevers Groningen / Utrecht, 2019

Cilji in kompetence:	**Objectives and competences:**
/V industrijskem podjetju se inženir vsakodnevno srečuje z organizacijskimi vprašanji in odločitvami ter vodenjem. Zato je študent najprej poučen o tem, kaj pojmujemo pod izrazom organizacija v industrijskem podjetju, dobil bo odgovore o znanstvenem pristopu opazovanja pravil in zakonitosti organizacije, preučeval organizacijske principe za dosego zadanega cilja in pomen sistemske analize za kompleksno opazovanje delovanja organizacije in proizvodnega procesa. ter na praktičnih primerih razpoznaval elemente podjetja, njihove organizacijske lastnosti ter refleksijo teh na okolje, v katerem podjetje deluje. Obravnavani so realni primeri uspešnih in neuspešnih podjetij. Sledijo spoznavanje pojmov s področja gospodarjenja, osnovni pojmi monetarne in makro ekonomije ter se učna snov zaključi z osvajanjem znanj o planiranju, vodenju in analiziranju poslovanja podjetja v različnih ekonomskih okoljih z vsemi spremljajočimi aktivnostmi. Seminarski del povezuje teoretska znanja s primeri organiziranja in delovanja proizvodnih industrijskih obratov v praksi.	In the industrial enterprise engineer is daily subjected to organizational issues, decision making and management. Therefore, the student is firstly informed on what we understand by the term organization in the industrial company. Students will be taught about scientific approach to organization of systems and organizational structures and how to define and to achieve goals. They will be further taught on the importance of systems analysis of complex systems and on operational research of the production process. Based on practical situations, i.e. case studies, they will learn how to recognize the elements of the business, its organizational characteristics and its reflection of the environment in which the enterprise operates. Real examples of successful and unsuccessful businesses will be discussed. This will be followed by learning the basics concepts of management, monetary and macro-economic policies. Course will ends with obtaining of knowledge on planning, managing and analyzing of enterprises in different economic environments considering all accompanying activities. Seminar part will connect theoretical knowledge with examples of organization and functioning of the production sites in practice.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študenti spoznajo temeljne koncepte s področja organizacije in menedžmenta skozi planiranje, organiziranje, vodenje in kontroliranje ter analize primerov domače in tuje prakse. Primeri se nanašajo na procesno tehnološka podjetja. Uporaba: Oblikovanje in samostojno sprejemanje odločitev organizacijske in menedžmentske narave. Zaznava vodenja in svetovanja na osnovi znanja in teoretskih in izkustvenih znanj. Refleksija: Sistemski pristop in analiza procesov, prenosljiva tudi na druge oblike organiziranosti Dojemanje informacij za razvijanje samostojnega mišljenja, odločanja in prenosa v prakso. Prenosljive spretnosti (niso vezane le na en predmet): Sposobnost samostojnega in kritičnega mišljenja. Sposobnost celovitega pogleda na vloge in kompetence menedžmenta in organizacije. Sposobnost sistematičnega pristopa k reševanju organizacijskih in vodstveni nalog.	Knowledge and understanding: Students learn basic concepts in the field of organization and management through planning, organizing, leading and controlling and through analysis of case studies from domestic and foreign practice. Examples will be related to technological companies. Application: Design and independent decision-making of organizational and management nature. The perception of leadership and consulting based on theoretical and experiential knowledge. Reflection: Systemic approach and analysis of processes that is transferable to other forms of organization. Perception of information for development of independent thinking, decision-making and transfer into practice. Transferable skills (not linked to only one course): Ability of independent and critical thinking. Ability comprehensive view on the roles and competencies of management and organization. The ability of systematic approach to organizational and managerial tasks solving.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje, seminarji.	Lectures, exercises and practice, seminar work.

Načini ocenjevanja:	Delež/Weight	Assessment:
(a) zagovori vaj in seminarja, ki prinesejo h končni oceni 30 %,	30,00 %	(a) defense of tutorial and seminar (30% contribution to final score)l,
(b) ustni izpit, ki prinese h končni oceni 70 %.	70,00 %	(b) oral examination (70% contribution to final score).

Ocenjevalna lestvica:	Grading system:
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

1. PERUŠ, Iztok, TERČELJ, Milan, KUGLER, Goran. Determination of scrap/supply probability curves for the mechanical properties of aluminium alloys in hot extrusion using: a neural network-like approach. Expert systems with applications, 2012, vol. 39, no. 5, str. 5634-5640.
2. PERUŠ, Iztok, FAZARINC, Matevž, KUGLER, Goran, FAJFAR, Peter. On the influence of human factor on mechanical properties in aluminium hot extrusion process, Metalurgija, 2010, vol. 49, 2, str. 87-90
3. KUGLER, Goran, TERČELJ, Milan, FAZARINC, Matevž, FAJFAR, Peter, BOMBAČ, David, RODIČ, Tomaž, TURK, Radomir, PERUŠ, Iztok, VEČKO PIRTOVŠEK, Tatjana, KRUŠIČ, Uroš, AŽMAN, Marko, BUHVALD, Alojz. Uvajanje virtualnih tehnologij v proizvodni proces Metal Ravne. V: Recesija - priložnost povezovanja industrije in akademske sfere ,Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2009

OSNOVE EKONOMSKE ANALIZE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Osnove ekonomske analize
Course title:	Introduction to Economic Analysis
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100785
Koda učne enote na članici/UL Member course code:	549

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	45	0	0	90	6

Nosilec predmeta/Lecturer:	Polona Domadenik
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo je vpis v prvi letnik študija	The prerequisite is the enrollment in the first year of study.

Vsebina:	Content (Syllabus outline):
/1. Razmišljati kot ekonomist 2. Osnove povpraševanja in ponudbe 3. Obnašanje potrošnikov 4. Posameznikovo in tržno povpraševanje 5. Proizvodnja 6. Proizvodni stroški 7. Cene in optimalna proizvodnja v popolni konkurenci 8. Neoklasično podjetje, cilji in vrste podjetij v tržnem gospodarstvu 9. Monopol 10. Monopolistična konkurenca, oligopol in kartel. 11. Trg proizvodnih dejavnikov 12. Trg kapitala in trg zemlje	1. Introduction 2. Theory of demand and supply 3. The theory of individual behavior. 4. Individual and market demand. 5. Production. 6. Costs. 7. Perfect competition. 8. The firm in the economic theory. 9. Monopoly 10. Monopolistically competitive markets, oligopoly and cartel. 11. Labor markets. 12. Capital markets and land markets.

Temeljna literatura in viri/Readings:

/Prašnikar, J., Domadenik, P., Koman, M.: Mikroekonomija. Ljubljana: Gospodarski vestnik, 2008. Domadenik, P., Feldin, A., Gregorič, A., Koman, M.: Mikroekonomija: Zbirka rešenih nalog. Ljubljana: Gospodarski vestnik, 2007. ---------- Pindyck, r., Rubinfeld, D.: Microeconomics. Prentice Hall, 2012.

Cilji in kompetence:	**Objectives and competences:**
/Predmet seznanja študenta z osnovnimi ekonomskimi problemi in načini njihovega reševanja. Podrobno predstavi teorijo produkcije in stroškov, delovanje tržnega mehanizma in teorijo razdelitve. Študentu daje osnovni analitični in kategorialni aparat, potreben pri tem in kasnejših ekonomskih predmetih. Predmet podaja tudi institucionalni okvir in predstavi organizacijske in lastninske oblike podjetij ter okolje, v katerem podjetja delujejo in ki ga sooblikuje državna regulacija.	The course acquaints students with basic economic problems and ways of solving them. The course presents in detail the theory of demand, production and costs, the operation of the market mechanism and the theory of distribution. The course gives the student a basic analytic and categorical apparatus needed for this and subsequent economic subjects. The course provides also the institutional framework and presents organizational and ownership forms of enterprises and the environment in which businesses operate and is influenced by state regulation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent se bo pri predmetu seznanil s temeljnimi mikroekonomskimi zakonitostmi, spoznal instrumentarij ponudbe in povpraševanja, osnovne zakonitosti obnašanja potrošnika ter teorijo proizvodnje in stroškov. Na tej podlagi bo študent spoznal delovanje različnih tržnih struktur (trg prozivodov in proizvodnih dejavnikov) ter njihovo medsebojno prepletanje.Pridobljeno znanje bo študent uporabil pri nadaljnjem študiju ekonomije in poslovnih ved. Praktični primeri, ki predstavljajo pomemben del predmeta, študentu ponazarjajo možnosti dejanske implementacije teoretičnih primerov v poslovni praksi. Na osnovi pridobljenih znanj bo študent sposoben razumeti in analizirati tekoča dogajanja v gospodarstvu ter ukrepe ekonomske politike. Predviden način dela pri predmetu študenta navaja na uporabo matematičnih orodij pri reševanju ekonomskih problemov. Študent bo razvil spretnosti in veščine zbiranja, interpretiranja ter grafične ponazoritve podatkov. Ob izpolnjevanju zastavljenih nalog in obveznosti študent razvija sposobnosti analitičnega razmišljanja ter kreativnega skupinskega dela.	Students will get equipped with the basic microeconomic laws. They will be able to apply supply and demand mechanisms to study real word problems. They will gain understanding in the laws of consumer behavior and the theory of production and costs. On this basis, the student will be able to understand the behavior of firms and individuals in different market structures (output and factors markets) and how these markets are interconnected. Acquired knowledge will be used by the students in further economics and business subjects. Practical examples constitute an important part of the course. They will allow students to implement theoretical concepts in real world applications. Based on acquired knowledge the student will be able to understand and analyze the current developments in the economy and analyze the economic policy measures. Students will be able to analyze economic problems with the help of basic mathematical skills. Students will develop the skills and competences of collecting, interpreting, and graphical representations of data. In the fulfillment of the set tasks and obligations of the student develops the skills of analytic thinking and creative team work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predmet obsega tri ure predavanj in dve uri vaj tedensko. Poleg tega bodo imeli študenti tudi 2 kolokvija in 5 preverjanj znanja. PREDAVANJA: Študentje so razporejeni v dve skupini. Predavanja so zasnovana na učbeniku Mikroekonomija. Prehajanje med skupinami predavanj ni dovoljeno. Na določenih predavanjih bodo študentje reševali domače naloge	The course consists of three hours of lectures a week and two hours of exercises. In addition, students will also have two midterms and up to five homework's. ---------- LECTURES: Students are divided into two groups. Lectures are based on the textbook Microeconomics. Transitions between groups

VAJE: Študenti so razporejeni v več skupin. Na vajah se ob uporabi računskih primerov iz zbirke vaj utrjuje celotna snov. Vaje so obvezne za redne študente, ki so se na EF prvič vpisali v šolskem letu 2014/2015. Odsotnost iz vaj je upravičena le v primeru zdravstvenih razlogov. Prehajanje med skupinami vaj ni dovoljeno.

BONUS TOČKE: Študentje bodo imeli do 5 domačih nalog. Domače naloge bodo študenti reševali na predavanjih. Točke iz domačih nalog predstavljajo bonus v višini največ 10 točk. Upoštevajo se le, če so študentje uspešno opravili izpit. Domače naloge se upoštevajo le na prvem izpitnem roku(januar).

KOLOKVIJI: Študentje bodo imeli dve pisni preizkušnji in sicer kolokvij 1 (K1) in kolokvij 2 (K2)

Vsak kolokvij predstavlja največ 33 točk. V primeru, da študent katerikoli kolokvij piše pozitivno (doseže več kot polovico možnih točk), lahko na prvem izpitnem roku opravlja le preizkus znanja iz preostalih poglavij ter poglavij, ki pokrivajo snov kolokvija, katerega študent ni uspešno opravil . Tisti študenti, ki bodo na obeh kolokvijih neuspešni, bodo morali izpit opraviti v celoti. Dodatnih kolokvijev ne bo.

Kolikvija se upoštevata le na prvem izpitnem roku.

IZPIT: Celtoni izpit je pisni in traja 120 minut.

Izpit predstavlja 100 točk za tiste študente, ki so bili na kolokvijih neuspešni oziroma se kolokvijev niso udeležili.

Na prvem izpitnem roku lahko študentje, ki so opravili enega ali oba kolokvija opravlja delni izpit iz preostale snovi oziroma snovi, katere kolokvij niso opravili. Pisni izpit iz preostale snovi v tem primeru predstavlja največ 34 točk oz 67 točk.

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of lectures is not permitted. In certain lectures, students will solve homework's.

EXERCISES: Students are divided into several groups. In exercise sessions we will be solving problems from exercise book. This will allow students to strengthen their knowledge. Attendance at Exercise sessions is mandatory for full-time students who are enrolled at Faculty of Economics for the first time in the school year 2014/2015. Transitions between groups of exercises is not allowed.

BONUS POINTS: Students will have up to 5 homework's. Homework's will be solved at lectures. Points from homework's represent a bonus of at most 10 points. Bonus points will be awarded only if the student passes the exam. Bonus points will be given only in first exam period (January)

MIDTERMS: Students will have two written midterm tests, midterm 1 (M1) and midterm 2(M2).

Each midterm accounts for at most 33 points. In the event that a student writes any of the midterm positive (reaches more than half of the possible midterm points), students is allowed to answer in the first exam period only question on the remaining chapters and chapters which cover the midterm that the student did not pass. Those students who are unsuccessful at both midterms will need to take the whole exam. Additional midterms will not available.

Points from midterms are valid account only the first exam period (January.

---EXAM: The exam is written and lasts 120 minutes.

Exam represents 100 points for those students who did not pass midterms or did not attend them.

In the first exam period (January), students, who have passed one or both of the midterms, can write the partial exam, which includes the remaining material which was not covered by midterms and of material of the midterm, which they did not pass. The exam of the remaining material in this case represents no more than 34 points or 67 points.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
kolokviji - 66%	66,00 %	midterm exam - 66%

končni izpit - 34%	34,00 %	final exam - 34%
bonus (le na prvem izpitnem roku) - 10%	0,00 %	bonus (only on first exam period) - 10%

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

DOMADENIK, Polona, PRAŠNIKAR, Janez, SVEJNAR, Jan. Restructuring of firms in transition : ownership, institutions and openness to trade. Journal of international business studies, ISSN 0047-2506, 2008, vol. 39, no. 4, str. 725-746.

DOMADENIK, Polona, PRAŠNIKAR, Janez, SVEJNAR, Jan. How to increase R&D in transition economies? : evidence from Slovenia. Review of development economics, ISSN 1363-6669, 2008, vol. 12, no. 1, str. 193-208.

KNEŽEVIĆ CVELBAR, Ljubica, DOMADENIK, Polona, PRAŠNIKAR, Janez. Performance, ownership, and management turnover in privatized Slovenian companies. Eastern European economics, ISSN 0012-8775, Jul./Aug. 2008, vol. 46, no. 4, str. 77-93.

OSNOVE INŽENIRSTVA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Osnove inženirstva
Course title:	Fundamentals of Engineering
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067590
Koda učne enote na članici/UL Member course code:	331

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Milan Terčelj, Tomaž Rodič
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Vpis v letnik	Entry in the academic year

Vsebina:	Content (Syllabus outline):
- zgodovinski pregled uporabe in razvoja materialov in produkcije. - osnovne obremenitve (mehanske, termične, tribološke, kemične) materialov (strojnih delov). - osnove obnašanja materialov med obremenitvami (statične in dinamične), pri različnih temperaturah (nizki, sobni in pri povišanih temperaturah), σ-digram, Woehlerjeva krivulja, Smithov diagram, itd. -osnovni vzroki za porušitev materiala pri statičnih in dinamičnih obremenitvah, vplivi zarez in napak v materialu na porušitev, itd, -izbira varnostnega faktorja pri statičnih in dinamičnih obremenitvah, - vzroki za koncentracije napetosti v materialu ter rast razpok. - definicija varnostnega faktorja ter vzroki za odpoved materialov z vidika nihanja lastnosti materialov ter obremenitev.	-historical overview of use and developing of materials and production. -basic of loads (mechanical, thermal, tribological, chemical) of materials (components). - The basics of material behavior during loading (static and dynamic), at different temperatures (low, ambient and elevated temperatures), σ- diagram, Woehler´s curve Smith´s chart, etc. -Basic causes of the collapse of materials under static and dynamic loads, impact of notches and defects in materials on breakage, etc., -choice of safety factor for static and dynamic loads, - causes of stress concentration in material and crack growth - Definition of safety factor and causes for material failure from the point of view of variation of materials properties and load. -Basic mechanical parts in the process chain for

-osnovni strojni deli naprav v procesni verigi izdelave kovinskih materialov (razstavljivi in nerazstavljivi spoji, gredi, osi, zveze med pestom in gredjo, zobniki, jermeni, verige, sklopke, zavore, vrvi, itd), - osnove risanja in dimenzioniranje strojnih elementov ter pogonskih elementov strojev za izdelavo materialov, -osnove izbire materialov za strojne dele, osnovno poznavanje vzrokov za razlike v mehanskih lastnostih med uporabljenimi materiali, -izračun dopustnih napetosti glede na vrsto obremenitve in način obremenjevanja, osnovne karakteristike materiala in obliko strojnega dela, -osnovna risanja in branja načrtov, -osnove uporabe CAD sistemov, -tolerance strojnih delov pri njihovi izdelavi, -pogoni strojnih naprav za izdelavo materialov, njihove mehanske in termične obremenitve, kritična mesta za zlom, -vrste in velikost obremenitev pogonskih delov strojev glede na čas in napetosti v preseku -poškodbe na pogonskih delih, rast razpok, -osnove značilnosti pogonov in konstrukcije strojev v procesni verigi izdelave materiala -osnovni pogonski agregati, njihove karakteristike in dopustne obremenitve, -vzdrževanje strojev in naprav, -vplivi strojev na okolje in ljudi in zmanjšanje negativnih učinkov na okolje.	manufacturing of metallic materials (detachable and non-detachable joints, shafts, axles, interfaces between the hub and the shaft, gears, belts, chains, clutches, brakes, cables, etc.) - The basics of drawing and dimensioning of machine elements and drive elements of machines for the production of materials, -basic choices of materials for machine parts, a basic knowledge of the causes of the differences in mechanical properties between the materials used, - calculation of critical and permissible loads depending on the type of load and mode of loading, the basic characteristics of the material and shape of machine parts, -Basic drawing and reading plans -basic use of CAD systems, -tolerances of mechanical parts and their manufacturing, -drives of machinery for the production of materials, their mechanical and thermal loads, the critical zones of fracture, -types and magnitudes of loads on the drive section with respect to time and stress in the cross-section -damages on drive elements, growth of cracks, -basic characteristics of drives and construction machines in the process chain of manufacturing material -Basic power agregates, their characteristics and permissible loads, -maintenance of machinery and equipment, -impact of machines on people and their environment, minimisation of the negative effects on the environment.

Temeljna literatura in viri/Readings:

/Zoran Ren in Srečko Glodež, Strojni elementi I, 2001 Rolof/Matek Maschinenelemente, 2004, Peter R.N. Childs, Mechanical Design, 1998, A. Hirsch Werkzeugmaschinen Grundlagen, Lehr und Ubungsbuch, 2000.

Cilji in kompetence:	**Objectives and competences:**
/Študentom podati osnovno znanje o tehniški dokumentaciji, elementih strojev in naprav, njihovih tipičnih obremenitvah med delovanjem ter vplivih na okolje	To provide students the basic knowledge of technical documentation, elements of machines and devices, their typical loads during operation as well as their interactions with environment

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študenti pridobijo osnovno znanje o materialih, vrstah obremenitev (mehanske, termične, tribološke, kemične), produkciji, tehniški dokumentaciji, elementih strojev, s poudarkom o pogonih in konstrukciji naprav (strojev), dimenzioniranju osnovnih strojnih elementov in sklopov, s poudarkom pomembnosti pri pogonih strojev za izdelavo materialov, osnovno znanje o obremenitvah pogonskih in drugih delov strojev, o osnovnih	Students acquire basic knowledge of the materials, type of loads (mechanical, thermal, tribological, chemical), production methods, technical documentation, machine elements, with emphasis on drives and construction equipment (machines), sizing of basic machine elements and assemblies, with the emphasis the importance of drives of machines for the production of materials, basic knowledge about loads propulsion and other machinery, of basic

karakteristikah in dopustnem obremenjevanju pogonskih agregatov strojev, sposobnost za določitev kritičnih mest za poškodbe in zlome pogonskih delov ter ugotavljanje o vzrokih za poškodbe strojnih delov in naprav, vzdrževanju in varnosti glede na čas obratovanja in preobremenitve, uporabi materialov za posamezne strojne elemente in njihovimi mehanskimi lastnostmi pri nizkih, sobnih in povišanih temperaturah in možnostmi izboljšanja delovanja strojev z razvojem materialov z boljšimi mehanskimi lastnostmi, nadalje o osnovah za izračun dopustnih napetosti glede na material, strojne del in način obremenjevanja. To mu omogoča komunikacijo tako s proizvajalci materialov kot tudi z izdelovalci proizvodnih naprav. Študent pridobi tudi osnovno znanje o vplivih teh naprav na okolje in ljudi ter ukrepih za zmanjšanje negativnih učinkov.	characteristics and the permissible loading of engines listings, the ability to determine the critical points for injuries and fractures on the drive and determination of the causes of damage to machinery and equipment, maintenance and security, regardless of the time of operation and overloading, use of materials for the individual hardware components and their mechanical properties at low, ambient and elevated temperatures and the possibility of improving the operation of machinery, the development of materials with improved mechanical properties, further the basis for calculation of allowable stress of the material, the hardware part of the way and pollution. This allows communication both with the material manufacturers as well as manufacturers of production equipment. The student will acquire the basic knowledge about the effects of these devices on the environment and human health and measures to mitigate adverse effects.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje in simulacije, reševanje praktičnih primerov in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena projektne naloge (30 %)	30,00 %	the mark of project work (30%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40%)
od 6-10 (pozitivno) oz. 1-5 (negativno) oz. opravil / ni opravil; ob upoštevanju Statuta UL in fakultetnih pravil.	0,00 %	

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

RODIČ, Tomaž, ŠUŠTAR, Tomaž, ŠUŠTARIČ, Primož, KORELC, Jože. Efficient numerical implementation of pressure, time and temperature superposition for elasto-visco-plastic material model by using a symbolic approach. International journal for numerical methods in engineering, ISSN 0029-5981, okt. 2010, letn. 84, št. 4, str. 470-484,

STUPKIEWICZ, Stanislaw, KORELC, Jože, DUTKO, Martin, RODIČ, Tomaž. Shape sensitivity analysis of large deformation frictional contact problems. Computer Methods in Applied Mechanics and Engineering, ISSN 0045-7825. [Print ed.], 2002, vol. 191, issue 33, str. 3555-3581

ŠUŠTARIČ, Primož, SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., RODIČ, Tomaž. Sensitivity analysis based crack propagation criterion for compressible and (near) incompressible hyperelastic materials. Finite elements in analysis and design, ISSN 0168-874X. [Print ed.], May 2014, vol. 82, str. 1-15

SEABRA, Mariana R. R., CESAR DE SA, Jose M. A., ŠUŠTARIČ, Primož, RODIČ, Tomaž. Damage driven crack initiation and propagation in ductile metals using XFEM. Computational mechanics, ISSN 0178-7675, 2012, vol. 52, no. 1, str. 161-179.

GRM, Aleksander, GRÖNLAND, Tor-Arne, RODIČ, Tomaž. Numerical analysis of miniaturised cold gas thruster for micro- and nano-satellites. Engineering computations, ISSN 0264-4401, 2011, vol. 28, no. 2, str.184-195.

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Prof.dr. Milan Terčelj, redni profesor za področje inženirskih materialov
full professor of engineering materials

- DROBNE, Matej, KLANČNIK, Urška, FAJFAR, Peter, TERČELJ, Milan. Role of oxidation and microstructure constituents on high chromium steel work roll surface degradation. Journal of Materials Research and Technology. 2021, vol. 12, str. 186192. ISSN 2238-7854. DOI: 10.1016/j.jmrt.2021.02.067. [COBISS.SI-ID 55144963].
- BOMBAČ, David, GINTALAS, Marius, KUGLER, Goran, TERČELJ, Milan. Thermal fatigue behaviour of Fe1.7C-11.3Cr-1.9Ni-1.2Mo roller steel in temperature range 500 - 700 °C. *International journal of fatigue*. 2019, vol. 121, str. 98111. ISSN 0142-1123. DOI: 10.1016/j.ijfatigue.2018.12.007. [COBISS.SIID 1773919].
- PERUŠ, Iztok, PALKOWSKI, Heinz, KUGLER, Goran, TERČELJ, Milan. Quantifying complex influences of chemical composition and soaking conditions for increasing the hot workability of M2 highspeed steel by using the alternative approach. Journal of Materials Research and Technology. 2020, vol. 9, iss. 6, str. 13301-13311. ISSN 2238-7854. DOI: 10.1016/j.jmrt.2020.09.029. [COBISS.SI-ID 30450435].
- BOMBAČ, David, GINTALAS, Marius, KUGLER, Goran, TERČELJ, Milan. Mechanisms of oxidation degradation of Cr12 roller steel during thermal fatigue tests. Metals. 2020, vol. 10, iss. 4, str. 1-25. ISSN 2075-4701. DOI: 10.3390/met10040450. [COBISS.SI-ID 1859423].

OSNOVE MEHANIKE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Osnove mehanike
Course title:	Foundations of Mechanics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067591
Koda učne enote na članici/UL Member course code:	907

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Pino Koc
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/(a) Vpis v letnik (b) Pogoj za pristop k izpitu: pravilno izdelane vse domače naloge.	(a) Inscription (b) Necessary condition to accession to the exam: all coursework should be finished.

Vsebina:	Content (Syllabus outline):
/Sile s skupnim prijemališčem: sestavljanje, razstavljanje, ravnotežje. Sile brez skupnega prijemališča: sestavljanje, dvojica sil – moment. Redukcija sile: sistema sil v točko, projekcija momenta na poljubno os. Nosilni konstrukcijski elementi: razdelitev, razvrščanje obremenitev, podpore, vezi, prostostne stopnje. Notranje sile in momenti v nosilcih. Paličja. Dotikalno trenje. Napetostni vektor, napetostni tenzor. Glavne napetosti. Ravninsko in enoosno napetostno stanje. Mohrova krožnica. Deformacije, definicija. Navedba eksperimentalnih postopkov merjenja deformacij. Deformacijski	Forces on a particle: addition, decomposition and equilibrium. Forces on a body: addition, couple – moment. Simplification of the force and couple system, moment about a specified axis. Load carrying structures: classification, loading reduction, supports, joints, degrees of freedom. Internal forces in beams. Trusses. Dry friction. Stress vector, stress tensor. Principal stresses. Uniaxial stress state. Plane stress. Mohr's circle. Theory of strain and deformation. Strain tensor. Stress—strain relation. Basic facts from experimental measurements. Plane deformation.

tenzor, ravninsko deformacijsko stanje. Natezni preizkus. Hooke-ov zakon. Vpliv temperature. Geometrijske lastnosti prerezov. Simetrični in nesimetrični upogib. Ekcentrični upogib. Strižne napetosti. Porazdelitev strižnih napetosti v simetričnih prečnih prerezih. Neovirana torzija. Torzija krožnega prereza. Torzija odprtih in zaprtih tankostenskih prerezov. Sestavljene obremenitve.	Tensile test. Hooke's law. Temperature effects. Geometric properties of cross sections. Symmetric and asymmetric bending. Bending with axial force. Eccentric bending. Shear stress. Shear stress distribution in symmetric cross sections. Torsion. Torsion of circular shaft. The torsion formula. Torsion of open and closed thin-walled sections. Combined loading.

Temeljna literatura in viri/Readings:

/M. Muršič: Osnove tehniške mehanike I, Statika, Slovensko društvo za mehaniko, Ljubljana, 1993, 325 str.;
M. Stanek, G. Turk: Statika I, FGG, Ljubljana, 2005, 329 str.;
M. Škerlj: Mehanika, Trdnost, FS, 1988, 191 str.;
M. Stanek, G. Turk: Osnove mehanike trdnih teles, FGG, 1998, 254 str.;
M. Halilovič, J. Urevc, B. Starman: Osnove statike in trdnosti s preprostimi in nazornimi poskusi, FS, Ljubljana 2011;
D.J. MacGill, W.W. King: Engineering mechanics: Statics, PWS Publishing, Boston, 1995, 663 pages.
J. Case, A.H. Chilver, C.T.F. Ross: Strength of Materials and Structures, Arnold Publisher, London, 1999, 719 pages;
V.D. da Silva: Mechanics and Strength of Materials, Springer - Verlag, Berlin, 2006, 531 pages.

Cilji in kompetence:	**Objectives and competences:**
/Pridobitev osnovnega znanja za izpeljavo mehanske analize preprostih linijskih konstrukcij (nosilci), v kateri je zaobjeto: postavitev analitičnega-mehanskega modela iz poznane tehnične rešitve konstrukcije (podprtje, vezi, obremenitev), sestavljanje in razrešitev ustreznih ravnotežnih enačb, interpretacija rezultatov.	Obtaining the basic knowledge of mechanical analysis of simple structures (beams) which includes: setting-up the analytical-mechanical model based on known structural design (supports, joints, loadings), setting-up and solving of equilibrium equations, interpretation of results.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: 1) Reševanje preprostih mehanskih sistemov, 2) Razumevanje, ne pa tudi reševanje zahtevnejših sistemov.	Knowledge and understanding: 1) Solving of simple problems of mechanics, 2) Understanding of basic principles of complex structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje; Predavanja: obrazložitev izhodišč in izpeljava problemov. Komentar k dobljenim rešitvam. Kabinetne vaje: reševanje praktičnih nalog po predhodni razčlenitvi problema in napotkih o postopku reševanja, interpretacija rezultatov. Naloge so prirejene potrebam geotehnološke stroke. Vaje doma: izdelava štirih do šestih domačih nalog, ki vsebujejo obširneje zastavljene probleme.	Lectures, exercises. Lectures: explanation of principles and derivation of solutions. Commentary on solutions. Exercises in a classroom: solving of various problems of statics, which are chosen such to represent typical geotechnical tasks. Typical exercise procedure: identification and analysis of the problem, setting up the equations, solving them, interpretation of results. Individual exercises at home: four to six course works, which includes more demanding (usually mathematically) problems.

Načini ocenjevanja:	Delež/Weight	Assessment:
vaje	50,00 %	exercises
izpit	50,00 %	exam

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

1. UREVC, Janez, KOC, Pino, ŠTOK, Boris. Characterization of material parameters used in the mathematical modelling of arc welding and heat treatment processes. Trans. FAMENA, 2011, vol. 35, no. 4, str. 1-14, ilustr.
2. UREVC, Janez, KOC, Pino, ŠTOK, Boris. Numerical simulation of stress relieving of an austenite stainless steel = Numerično simuliranje žarjenja za odpravo zaostalih napetosti avstenitnega nerjavnega jekla. Stroj. vestn., 2009, vol. 55, no. 10, str. 590-598, ilustr.
3. KOC, Pino, ŠTOK, Boris. Usage of the yield curve in numerical simulations. Stroj. vestn., 2008, letn. 54, št. 12, str. 821-829.
4. ČELIK, Anže, KOC, Pino, ŠTOK, Boris. Analiza mehanskega odziva ohišja jedra elektromagneta. Ventil (Ljubl.), 2008, letn. 14, št. 5, str. 446-455.

OSNOVE POSLOVNIH FINANC

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Osnove poslovnih financ
Course title:	Fundamentals OF Business Finance
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100788
Koda učne enote na članici/UL Member course code:	552

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	45	0	0	90	6

Nosilec predmeta/Lecturer:	Dušan Mramor
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo je vpis v letnik študija.	Entry in the year.

Vsebina:	Content (Syllabus outline):
/Poslovne finance in finančni management. Finančna analiza. Časovna vrednost denarja. Vrednotenje naložb. Ocenjevanje tveganja in zahtevane donosnosti naložb. Ocenjevanje stroškov kapitala podjetja. Investicijske odločitve: kriteriji za presojo upravičenosti investicij, ocenjevanje denarnih tokov in tveganja projektov. Finančne odločitve: pridobivanje virov financiranja, struktura kapitala in dividendna politika. Upravljanje z obratnim kapitalom.	Content (Syllabus outline): The role of corporate finance, the goal of the firm, stakeholders.Time value of money. Valuation of stocks and bonds. Risk and return, the CAPM. Capital budgeting: cash flow estimation, cost of capital, risk. Financial decisions: capital structure, leverage, payout policy. Long-term financing decisions: common stock, long-term debt, lease and preferred stock financing.Working capital: working capital policy and financing, cash cycle, cash and marketable securities, inventory, accounts receivable, accounts payable, short-term financing.

Temeljna literatura in viri/Readings:

/Študijska in izpitna literatura:

Prosojnice predavanj in vaj (dostopno med gradivi te domače strani).

Hillier, D., I. Clacher, S. Ross, R. Westerfield, and B. Jordan. Fundamentals of Corporate Finance, Second European Edition, 2014.

Berk, A., I. Lončarki, in P. Zajc. Poslovne finance: Vodnik po predmetu. 2007.

Drugi materiali posredovani študentom v okviru predavanj in vaj.

Dodatna:
Mramor, D.: Poglavja iz poslovnih financ. Ljubljana: Ekonomska fakulteta, 2000. 125 str. (dostopno med gradivi te domače strani
Mramor, D.: Dodatna poglavja iz poslovnih financ.
(dostopno med gradivi te domače strani)

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je študente seznaniti z osnovnimi teorijami in temeljnimi orodji ter praktičnimi rešitvami, ki se uporabljajo v poslovnih financah. Namen predmeta pripraviti študente za sprejemanje investicijskih in finančnih odločitev ter odločitev v zvezi z upravljanjem obratnega kapitala v podjetju.	

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Navedemo tisto znanje, kjer zadošča, da študentpozna / navede določene podatke / avtorje, postopke ipd. – t.i. deklarativno znanje. Razumevanje pojmov, zakonitosti, teorij, pojavov, struktur, procesov, relacij, postopkovipd.Principov oz. zakonitosti oz. modelov na posameznih primerih, iskanje povezav s prakso, utemeljevanje in evalvacija ipd.Lastnega razumevanja teorije in izkušenj v praksi, kritično ovrednotenje skladnosti medteoretičnimi načeli in praktičnim ravnanjem ipd.Spretnosti uporabe domače in tuje literature indrugih virov, zbiranja in interpretiranja podatkov, uporaba IKT in drugih didaktičnihpripomočkov, uporaba različnih postopkov, poročanje (ustno in pisno), identifikacija in reševanje problemov, kritična analiza, sinteza, pisanje člankov, refleksij na prebrano literaturo, delo v timih, socialne spretnosti ipd.	

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Študenti morajo redno obiskovati predavanja in vaje, ki potekajo ločeno. Na predavanjih se študentje seznanijo s teoretičnimi osnovami poslovnih financ ter možnosti njihove uporabe v praksi. Vaje so namenjene poglabljanju snovi in reševanju praktičnih računskih primerov.	

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
/kolokvij - 17%	17,00 %	
izpit - 83%	83,00 %	

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

GARROD, Neil, MRAMOR, Dušan. On accounting flows and systematic risk. Southern African business review, May 2004, vol. 8, no. 1, str. 1-6. (Objavljeni članki) ŠUŠTERŠIČ, Maja, MRAMOR, Dušan, ZUPAN, Jure. Consumer credit scoring models with limited data. Expert syst. appl.. [Print ed.], Apr. 2009, vol. 36, no. 3, str. 4736-4744. (Objavljeni članki)

ČRNIGOJ, Matjaž, MRAMOR, Dušan. Determinants of capital structure in emerging European economies : evidence from Slovenian firms. Emerg. mark. financ. trade, jan./feb. 2009, vol. 45, no. 1, str. 72-89. (Objavljeni članki)

BOLE, Velimir, MRAMOR, Dušan, VALENTINČIČ, Aljoša, JERE, Žiga, ČERTALIČ, Maša. Pomen pristaniške dejavnosti za nacionalno in regionalno gospodarstvo Slovenije. 1. natis. V Ljubljani: Ekonomska fakulteta, 2007. 86 str., graf. prikazi, tabele. ISBN 978-961-240-107-8.

Bhattacharya, Utpal, Peter Groznik and Bruce Haslem, 2007. Is CEO Certification of Earnings Numbers Value-relevant? Journal of Empirical Finance

PIROMETALURGIJA ŽELEZA IN ZLITIN

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Pirometalurgija železa in zlitin
Course title:	Pyrometallurgy Of Iron And Iron Alloys
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067598
Koda učne enote na članici/UL Member course code:	982

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Knap
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Liabilities are defined in the regulations on examination and evaluation of students at ULNTF. For a positive and successful attendance of their duties students are encourage to regular attendance of lectures, additional domestic more complex work more and appropriate preparing to laboratory work. At least 80% attendance at tutorials is needed.

Vsebina:	Content (Syllabus outline):
/Pomen grodlja, starega železa, metaliziranih peletov in ferozlitin za izdelavo jekla. Redukcija in metalizacija železovih in drugih oksidov pri proizvodnji grodlja. Procesno tehnološke posebnosti reakcij v trdnem, tekočem in mejnih plasteh. Agregati v proizvodnji surovega železa: plavž, elektroredukcijske naprave, itd. Izbira ognjevzdržnih materialov v metalurških reaktorjih. Žlindrotvorni dodatki, talila in goriva v proizvodnji grodlja: apnenec, dolomit, boksit, premog in koks, plinasta goriva.	The significance of pig iron, scrap, metallized pellets and ferro-alloys in steel making. Reduction and metallization of iron- and other oxides in the production of pig iron. Process technology specific reactions in the solid and liquid phase and in boundary layers. Aggregates in the production of pig iron: blast furnace, devices for electro-reduction, etc. Selection of refractory materials for the metallurgical reactors. Slag-making additions, fluxes and fuels for the production of pig iron: limestone, dolomite, bauxite,

Gospodarsko tehnološki vidiki izdelave jekla. Osnove procesne tehnike potrebne za proizvodnjo jekla in železovih zlitin Sistematika ferozlitin. Oligoelementi in njihov vpliv na proizvodnjo. Metalurški reaktorji za izdelavo jekla: elektroobločna peč, indukcijske peči, kupolna peč za pripravo tekočega vložka za elektropeči. Keramični materiali potrebni pri vlivanju jekla. Procesi odtaljevanja in taljenja v lastni talini. Metalurgija izdelave jekla izven talilnega agregata. Rafinacijski in dezoksidacijski postopki. Žlindre in njihov pomen za izdelavo jekla ter njihova uporabnost kot sekundarne surovine. Vlivanje jeklenih talin. Postopki in procesi pri vlivanju v kokile in pri kontinuirnem vlivanju. Strjevanje v različnih vrstah kokil in pri kontilivu. Energetska bilanca delnih procesov in celotnega procesa izdelave jekla. Posebni postopki izdelave jekla in pretaljevanja glede na uporabne lastnosti izdelka; npr. glede na čistost jekla.	coal and coke, gaseous fuels. Economic and technological conditions of steel-making. Basic of engineering process needed in the production of steel and ferro-alloys Systematics of ferro-alloys. Trace elements and their impact on production. Metallurgical reactors in the steel making practice: electric arc furnace, induction furnace, cupola furnace - preparation of the liquid charge for electric furnaces. Ceramic materials needed for steel casting. The processes of fusing and melting in own melt. Metallurgy steel production outside of the fuse unit. Processes of refining and deoxidation. Slag and their significance in the production of steel. Slag as secondary raw material. Casting of steel melts. Procedures and processes for casting in ingots and at continuous casting. Solidification in molds and the continuous casting. Energy balance of partial processes, and the summary process of making steel. Special steelmaking and remelting processes with regard to applicability: e.g. steel cleanliness.

Temeljna literatura in viri/Readings:

Seshadri Seetharaman, Roderick Guthrie, Alexander McLean, Sridhar Seetharaman, H. Y. Sohn: Treatise on Process Metallurgy, Volume 3: Industrial Processes, Elsevier, 2024
KNAP, Matjaž. Ekstraktivna metalurgija jekla : računske vaje za študente prve in druge stopnje : univerzitetni učbenik. 1. izd. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2022. XII, 208 str., ilustr. ISBN 978-961-6047-98-2. [COBISS.SI-ID 127883267].
Seshadri Seetharaman, Roderick Guthrie, Alexander McLean, Sridhar Seetharaman, H. Y. Sohn: Treatise on Process Metallurgy, Volume 2: Process Phenomena, Elsevier, 2024
Miroslaw Karbowniczek: Electric Arc Furnace Steelmaking, CRC Press Book, 2021

Cilji in kompetence:	**Objectives and competences:**
/Cilj tega predmeta je, da študenti dobijo zanje o pomenu surovin in procesov za izdelavo različnih materialov, ki so nepogrešljivi v vsakodnevnem življenju. Med take materiale spada železo in železove zlitine, to je grodelj (surovo železo), različne vrste jekla in ferozlitine. Glede na globalizacijo proizvodnje in surovinske baze morajo študenti znati ovrednotiti smiselnost proizvodnje materialov iz različnih surovin v končne izdelke. Pri tem predmetu se študenti prvič srečajo z nizom med seboj povezanih procesov, ki zagotavljajo dober in uporaben končni izdelek. V proizvodnji železovih zlitin (jekla) se delni procesi povezujejo v celoto – v proizvodnjo jekla, npr. termična priprava železovih rud kot oksidnega sistema – pomemben študij sintranja z ali brez tekoče faze. Drugi pomemben cilj pa je, kako za namen	The aim of this course is that students become aver of the importance of raw materials and processes which are needed for the production of a variety of materials that are indispensable in everyday life. Examples of such materials are iron and iron alloys, i.e. pig iron, various grades of steel and ferro-alloys. Globalization of the production and raw materials force students to be able to evaluate the reasonableness of the production of materials from a variety of raw materials into finished products. In this course, the students first encounter with a series of interrelated processes that provide a good and useful end product. In the iron- and steel-making practice a number of partial processes are linked into the integral process – the production of steel. An example is thermal preparation of iron ores as an oxide system – study of sintering with or without a liquid phase is needed.

proizvodnje različnih jekel izkoristiti raznorazne sekundarne surovine – recikliran material. Znanje, ki ga bodo dobili pri tem predmetu je osnova za nadaljnji, v procese izdelave jekla orientiran študij. Poleg tega pa bodo študenti na osnovi realnih oz. praktičnih primerov utrdili in nadgradili znanje pridobljeno pri naravoslovnih in strokovnih predmetih.	Another important goal in the production of different steel grades is to take advantages of all kinds of secondary raw materials – recycled material. Knowledge which will students get in this course is the basis for further, in the process of steel-making oriented studies. On the bases of real or practical examples they will consolidate and upgrade the knowledge learned in the natural science courses and engineering courses.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študenti bodo dobili pregled nad različnimi pirometalurškimi procesi, ki jih uporabljamo pri izdelavi kovinskih in nekovinskih materialov. Spoznali bodo agregate v katerih pirometalurški postopki potekajo. Po opravljenem izpitu bodo študenti razumeli osnove pirometalurških reakcij, fizikalnih in mehanskih lastnosti taljenja, reakcij v talini ter osnove strjevanja.	Knowledge and understanding: Students will get an overview of various pyrometallurgical processes used in the production of metallic and non-metallic materials. They will learn about aggregates in which pyro-metallurgical processes take place. Upon passing the exam, students will understand the basics of pyrometallurgical reactions, of physical and mechanical properties during melting, of reactions in the melt and basis of solidification.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, seminarske in laboratorijske vaje, terenske vaje, samostojno delo	Lectures, seminars, tutorial and laboratory work, fieldwork, individual work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ustni izpit	60,00 %	oral exam
pisni izpit	20,00 %	examination
seminarska naloga in poročilo laboratorijskih vaj	20,00 %	seminar work and the report of the laboratory work

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

KNAP, Matjaž, BRADAŠKJA, Boštjan. Determination of the influence of steelmaking parameters on surface defects in quarto plates. Metals. 2023, vol. 13, iss. 3, str. 1-14. ISSN 2075-4701. DOI: 10.3390/met13030536. [COBISS.SI-ID 184934659]
BURJA, Jaka, TEHOVNIK, Franc, LAMUT, Jakob, KNAP, Matjaž. Alumothermic reduction of ilmenite in a steel melt = Alumotermična redukcija ilmenita v jekleni talini. Mater. tehnol., 2013, letn. 47, št. 2, str. 217-222. [COBISS.SI-ID 976298]

LAMUT, Jakob, FALKUS, Jan, JURJEVEC, Beno, KNAP, Matjaž. Influence of inclusions modification on nozzle clogging = Wpływ modyfikacji wtrąceń niemetalicznych na zarastanie wylewów zanurzeniowych. Archives of metallurgy and materials, 2012, vol. 57, no. 1, str. 319-324. [COBISS.SI-ID 1211231]

LAMUT, J., KNAP, M., TOLAR, M., ROZMAN, A.. Slag composition in making alloyed steel. V: MARKOVIĆ, Zoran S. (ur.). Proceedings. Bor: Technical Faculty, 2004, 2004, str. 618-626 [COBISS.SI-ID 528735]

POLIMERI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Polimeri
Course title:	Polymers
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077525
Koda učne enote na članici/UL Member course code:	669

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15	0	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Krajnc
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Student oz. Kandidat mora imeti predmet opredeljen kot študijsko obveznost. Opravljen izpit iz predmeta Polimerne kemija ni pogoj.	The course has to be assigned to the student/candidate. Passed exam from Poymer chemisty is not a prerequisit.

Vsebina:	Content (Syllabus outline):
/- Uvod v polimere; - Porazdelitev molekulskih mas in povprečja molekulskih mas; - Stopenjska polimerizacija: mehanizem, izračun molekulskih mas in porazdelitve molekulskih mas za linearne polimere, kinetika stopenjske polimerizacije v homogenih in difuzijsko nekontroliranih sistemih (katalitska reakcija z uporabo zunanjega katalizatorja, avtokatalitska reakcija), tvorba razvejenih in zamreženih polimerov, računski primeri, stopenjski polimeri; - Verižna polimerizacija s prostimi radikali: mehanizem, kinetika, kinetična dolžina verige in stopnja polimerizacije, vpliv reakcij prenosa na povprečno stopnjo polimerizacije, kopolimerizacija, računski primeri, primeri polimerov, verižni polimeri;	- Introduction to polymers; - Molecular weight distribution and averages; - Step polymerization: mechanism, calculation of average molecular weights and distribution for liner polymers, kinetics in homogeneous and diffusion uncontrolled systems (catalytic reaction with external catalyst, autocatalytic reaction), formation of branched and cross-linked polymers, problems, case studies of polymers produced by step polymerization; - Free radical chain polymerization: mechanism, kinetics, kinetic chain length, degree of polymerization, effect of chain transfer reactions on average degree of polymerization, copolymerization, problems, case studies of polymers produced by chain-growth polymerization; - Emulsion polymerization: principles of emulsion

- Emulzijska polimerizacija: osnove emulzijske polimerizacije, Harkinsov mehanizem, kinetika, povprečno število radikalov na delec, računski primeri, polimerne emulzije. - Laboratorijske vaje: Kinetika šaržne polimerizacije vinil acetata v raztopini; Knetika kontinuirne polimerizacije 2-etilheksil akrilata v masi; Kinetika suspenzijske polimerizacije vinil acetata v šaržnem reaktorju; Kinetika emulzijslke polimerizacije vinil acetata v šaržnem reaktorju.	polymerization, Harkins mechanism, kinetics, average number of radicals per particle, problems, case studies of polymer emulsions. -Laboratory practice: Kinetics of vinyl acetate polymerization in solution in a batch reactor; Kinetics of continuous bulk polymerization of 2-ethylhexsyl acrylate; Kinetics of suspension polymerization of vinyl acetate in a batch reactor; Kinetics of batch emulsion polymerization of vinyl acetate.

Temeljna literatura in viri/Readings:

/• A. Kumar in R. K. Gupta, Fundamentals of Polymers, The McGraw-Hill Companies, Inc., New York, 1998, 543 str., (20 %).
• R. O. Ebewele, Polymer Science and Technology, CRC Press, Boca Raton, 2000, 463 str., (10 %).
• U. Šebenik, Osnove polimernega inženirstva: Zbirka nalog, UL FKKT, Ljubljana, 2012, 41 str., (100 %).
Dopolnilna literatura:
• Rudin, The Elements of Polymer Science and Engineering, 2nd Ed., Academic Press, London, 1999, 483 str.
• P. Rempp, E. W. Merrill, Polymer synthesis, 2nd Ed., Huthig & Wepf Verlag, Basel, 1991, 336 str.

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je, da študentje osvojijo osnovna znanja s področja polimerov in polimernega inženirstva. Študentje pri predmetu pridobijo naslednje specifične kompetence: poznavanje načinov napovedovanja distribucije molekulskih mas;- poznavanje toplotnih prehodov, specifičnih za polimerne molekule; poznavanje fizikalnih stanj polimerov in vpliva procesnih parametrov na fizikalna stanja; poznavanje in kvantitativno ovrednotenje polimerizacijskih procesov; razumevanje vpliva načina polimerizacije na lastnosti polimernega produkta.	Acquisition of basic knowledge about polymers and polymer engineering. Acquisition of knowledge about molecular weight and molecular weight distribution and methods for molecular weight distribution prediction; knowledge about thermal transitions in polymers and the ability to distinguish between different polymer physical states; Acquisition of knowledge about polymerization processes and their quantitative description; Understanding the effect of the type of polymerization and of polymerization process parameters on product properties.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Razumevanje osnov polimerov in polimernega inženirstva. Študent zna kvantitativno obravnavati osnovne polimerizacijske procese in napovedovati ključne lastnosti produkta glede na vrsto in način polimerizacijskega procesa. Razume zvezo med procesnimi parametri in sintetiziranim polimerizacijskim produktom.	Understanding basic principles of polymer and polymer engineering science; Ability of quantitative description of basic polymerization processes and resulting polymers; Understanding relationship between process parameters and polymer properties.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, laboratorijske vaje	Lectures, laboratory practice

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Poročila in zagovor laboratorijskih vaj.	30,00 %	Written reports and oral laboratory practice defence.
Pisni izpit.	70,00 %	Written exam.

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

• ŠTIRN, Žiga, RUČIGAJ, Aleš, KRAJNC, Matjaž. Innovative approach using aminomaleimide for unlocking phenolic diversity in high-performance maleimidobenzoxazine resins. Polymer, 2017, vol. 120, str. 129-140.
• KAJTNA, Jernej, ŠEBENIK, Urška, KRAJNC, Matjaž. Synthesis and dynamic mechanical analysis of nanocomposite UV crosslinkable 100% solid acrylic pressure sensitive adhesives. International journal of adhesion and adhesives, 2014, vol. 49, no. 1, str. 18-25.
• AMBROŽIČ, Rok, ŠEBENIK, Urška, KRAJNC, Matjaž. Synthesis, curing kinetics, thermal and mechanical behavior of novel cardanol-based benzoxazines. Polymer, ISSN 0032-3861. [Print ed.], 2015, vol. 76, no. 1, str. 203-212.

POLIMERNA KEMIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Polimerna kemija
Course title:	Polymer Chemistry
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077526
Koda učne enote na članici/UL Member course code:	668

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15	0	0	75	5

Nosilec predmeta/Lecturer:	Urška Šebenik
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v letnik študija. Minimalno 80 % prisotnost na laboratorijskih vajah ter opravljeno in uspešno predstavljeno seminarsko delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the year of study. Minimal 80 % presentation at laboratory work, and completed and successfully presented seminar work is required before taking the written and oral exam.

Vsebina:	**Content (Syllabus outline):**
/- vrste polimernih materialov in njihove lastnosti ter uporabnost (Naravni, modificirani in sintetični polimeri, plastomeri, duromeri, elastomeri, polimeri za široko proizvodnjo in inženirski polimeri, polimeri s posebnimi lastnostmi);. - struktura polimerov (morfologija): stereokemija, molekularne interakcije, polimerni kristali, amorfno stanje, povezava med strukturo polimerov in lastnostmi, - definicija in določanje molekulske mase polimerov; - stopenjska polimerizacija in polimeri kot produkti stopenjske polimerizacije;	- types of polymer materials and their properties and application (natural, modified natural, synthetic polymers, plastomers, elastomers, duromers, polymers for general use, engineering polymers, polymers with functional properties); - polymer structure (morphology); stereochemistry, molecular interactions, polymeric crystals, amorfic state, relations between polymer structure and their performance; - definition and determination of polymer molecular weight; - step growth polymerization and polymers;

- verižna polimerizacija in polimeri kot produkti verižne polimerizacije; - vrste polimerizacij glede na reakcijski medij; - polnila in dodatki; - polimerni kompoziti in nanokompoziti; - recikliranje in razgradnja polimerov;	- chani polymerization and polymers; - polymerization medium; - fillers and additives for polymers; - polymer composites and nanocomposites; - polymer degradation and recycling

Temeljna literatura in viri/Readings:

/- C. E. Carraher, Jr., Polymer Chemistry: An Introduction, 4th Ed., Marcel Dekker, Inc., New York, 1996, 541 str., (60 %),
- R. O. Ebewele, Polymer Science and Technology, CRC Press, Boca Raton, 2000, 471 str., (20 %).

Dopolnilna literatura/Additional literature:
- C. A. Harper, Handbook of Plastics Technologies, McGraw-Hill, New York, 2006, (loč. pag.).,
- A. Kumar in R. K. Gupta, Fundamentals of Polymers, The McGraw-Hill Companies, Inc., New York, 1998, 543 str.
- A. Rudin, The Elements of Polymer Science and Engineering, 2nd Ed., Academic Press, London, 1999, 483 str.

Cilji in kompetence:	**Objectives and competences:**
/Cilj predmeta je, da študentje osvojijo osnovna znanja o polimernih materialih in njihovih ključnih lastnostih. Študentje pri predmetu pridobijo naslednje specifične kompetence: poznavanje fizikalnih stanj in načina urejanja polimernih verig v polimernih materialih ter razumevanje vpliva na lastnosti polimernih materialov; poznavanje osnovnih vrst polimernih materialov, njihovih specifičnosti in uporabe; razlikovanje med osnovnimi sintetičnimi polimernimi materiali; razlikovanje med polimernimi materiali za široko potrošnjo in inženirskimi polimernimi materiali; poznavanje polimernih materialov s specifičnimi lastnostmi; razumevanje pomena in prednosti polimernih zmesi, polimernih kompozitov in polimernih nanokompozitov; poznavanje osnovnih biopolimerov; poznavanje možnosti ter načinov recikliranja in razgradnje polimerov.	Acquisition of basic knowledge about polymer materials and their properties; Acquisition of knowledge on polymer morphology and polymer structure-property relationships, knowledge about basic polymer materials, key properties and use of basic polymer materials, distinction between basic synthetic polymer materials for common use and engineering polymer materials, polymer materials with specific properties, polymer blends and composites, polymer nanocomposites, biopolymers, polymer recycling and degradation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent pozna osnovne in specifične, znane polimerne materiale in njihove lastnosti ter uporabnost. Lastnosti polimernih materialov zna povezati z njihovo strukturo in fizikalnim stanjem. Razume pomen in prednosti polimernih zmesi, polimernih kompozitov in polimernih nanokompozitov. Pozna osnovne načine recikliranja polimernih materialov.	Knowledge and understanding: Understanding the basic principles of composition and structure of polymer materials and polymer composites, and understanding the basic principles of the relationship between polymer material properties and their composition and structure.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminatska naloga, laboratorijske vaje	Lectures, project (seminar) work, laboratory practice

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Poročila in zagovor laboratorijskih vaj.	30,00 %	Written reports and oral laboratory practice defence.
Pisni izpit.	70,00 %	Written exam.

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

• KAJTNA, Jernej, ŠEBENIK, Urška, KRAJNC, Matjaž. Synthesis and dynamic mechanical analysis of nanocomposite UV crosslinkable 100% solid acrylic pressure sensitive adhesives. International journal of adhesion and adhesives, ISSN 0143-7496. [Print ed.], 2014, vol. 49, no. 1, str. 18-25. [COBISS.SI-ID 1663791]
• KRAJNC, Matjaž, KARGER-KOCSIS, József, ŠEBENIK, Urška. Grafting of maleic anhydride onto an ethylene-propylene-diene terpolymer and concurrent organoclay nanocomposite preparation in solution and melt. Journal of applied polymer science, ISSN 0021-8995, 2013, vol. 127, no. 2, str. 950-958. [COBISS.SI-ID 35973125]
• MOHORIČ, Ines, ŠEBENIK, Urška. Anionic ring-opening polymerization of octamethylcyclotetrasiloxane in emulsion above critical micelle concentration. Polymer, ISSN 0032-3861. [Print ed.], 2011, vol. 52, no. 5, str. 1234-1240. [COBISS.SI-ID 34739717]

POSEBNE TEHNIKE LITJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Posebne tehnike litja
Course title:	Special Casting Techniques
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077540
Koda učne enote na članici/UL Member course code:	675

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Vpis v letnik in predhodno ali vzporedno obiskovanje predavanj in vaj iz matematike, fizike, kemije, računalništva, metalografije, strojništva, toplotne tehnike, termodinamike.	Prerequisites defined in the Regulations on checking and assessing students at UL NTF. For a positive and successful Prerequisites and involvement in academic work is recommended to regularly attend lectures deal with additional increasingly complex homework and corresponding pre-treatment before carrying out laboratory work and demonstrated activity and at least 80 % attendance at tutorials. Requirement for involvement into the work is enrolment into current academic year or parallel course of study of lectures, tutorials of Math, Physics, Chemistry, Computer science, Metallography, Mechanical engineering, Thermal technique, Thermodynamics.

Vsebina:	**Content (Syllabus outline):**
/Tlačno litje (izbrana poglavja): - procesna tehnika tlačnega litja, livna celica, računalniško vodenje in nadzor procesa, senzorji, - zgradba trajne forme, materiali,	High presure die-casting (selected chapters): - Processing technique of presure die-casting, casting cell, computer management and process control, sensors,

- aluminijeve, cinkove in magnezijeve livne zlitine za tlačno litje, - taljenje, obdelava taline, razplinjevanje, oksidacija, cepljenje in kontrola taline, TA aluminijevih zlitin, vključki, - simulacijski izračun s primeri. Nizko tlačno litje: Prednosti litja, geometrija in vrste ulitkov, naprave, prednosti in slabosti. Precizno litje: postopek, izdelava modelov, školjk in litje, materiali, postopek Show, prednosti Litje v testastem stanju: metalurške značilnosti, vrste litja, postopki in naprave, trendi Na značilnih primerih spozna: Ohlajevalna krivuljo ulitka v odvisnosti od debeline stene, modificiranje, zajemanje plinov v ulitku, dilatometrija strjevanja, projekt simulacijskih izračunov tlačnega litja	- structure of permanent mold, materials, - Aluminum, zinc and magnesium casting alloys for die casting, - Smelting, melt processing, degassing, oxidation, inoculation and control of the melt, Thermal analysis of aluminum alloys, inclusions, - Simulated examples. Low-pressure die-casting: Benefits geometry and type of castings, appliances, advantages and disadvantages Investment casting: process, production of models, shells and casting materials, Show process, benefits Rheo-casting and Thixo-casting: metallurgical characteristics, procedures and systems, trends In typical cases, they realize: Cooling curve of the casting depending on the wall thickness, modification, capture of gases in the casting, dilatometry of solidifying casting, project of simulations of die-casting proces

Temeljna literatura in viri/Readings:

TRBIŽAN, M.: Livarstvo, skripta Naravoslovnotehniška fakulteta, 2000.
MRVAR, P.: Livarski izračuni, skripta, Naravoslovnotehniška fakulteta, 2024.
CAMBELL, J.: Castings, OBE, Feng, Butterworth Heinemann Ltd, 1993
VINARCIK E. J.: High integrity die casting processes, John Wiley and sons, 2003
BEELEY P. R., SMART R. F.: Investment Casting, Taylor & Francis Group, (CRC Press) 1995

Cilji in kompetence:	**Objectives and competences:**
/Razumevanje določenih livarskih tehnik: tlačno litje s hladno in toplo komornim strojem, nizkotlačno litje, precizijsko litje in litje v testastem stanju. Spozna in razume zakonitosti strujanja po elementih ulivnega in napajalnega sistema pri polnjenju livne votline s tlakom, se nauči osnovne livne zlitine za navedene tehnike;	Understanding the specific casting techniques: High pressure die casting with hot and cold chamber machine, low pressure die casting, investment casting and Rheocasting and Thixocasting. They learn and understand the legality of the melt flow through elements of gating and feeder system for the filling of the mold cavity by pressure to learn the basic of casting alloys for these techniques;

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent mora razumeti in spoznati posebne tehnike litja. Spozna osnove konstruiranja livarsko tehnološko ustreznih trajnih form za tlačno litje in se seznani z programskim paketom ProCast, spozna in razume procese litja v školjke - enkratne forme (precizijsko litje) in trajne forme – (litje pod tlakom), se nauči zakonitosti strujanja po elementih ulivnega in napajalnega sistema pri polnjenju livne votline, strjevanje in nastanek notranjih napetosti v ulitku za izbrane posebne tehnike litja. Znanje je uporabno pri načrtovanju in izdelavi ulitkov s posebnimi postopki litja. Študent mora znati povezati različne teoretične in	Knowledge and understanding: Students must understand and learn about special techniques of casting. They learn basics of design offoundry technology appropriate permanent mold for die-casting and get acquainted with the software package ProCast, learns and understands the processes of casting in shells - molds (investment casting) and permanent mold - (casting under pressure), learn the elements of the legality of the melt flow gating and feeder system for the filling of the molding cavity, solidification and formation of internal stresses in the casting for selected special casting techniques. Knowledge is useful in the design and manufacture of

eksperimentalne pristope pri reševanju tehnoloških livarskih problemov pri vseh posebnih tehnikah litja. Obvladovati mora sekvence na relaciji litje, polnjenje livne votline, strjevanje, ohlajanje in transformacija v trdnem, lita mikrostruktura z osnovnimi fizikalnimi in kemijskimi zakonitostmi. Študent se pri laboratorijskih vajah seznani s potrebnim metodičnim pristopom pri delu z livarsko opremo, merilnimi napravami, računalniki, mikroskopi.	castings with special casting methods. The student must be able to connect to different theoretical and experimental approaches in solving technological problems in all specific techniques of casting. Student has to handle the sequences between casting, mold cavity filling, solidification and cooling, transformation in the solid, as cast microstructure with basic physical and chemical laws. A student is acquainted with the necessary methodical approach in working with a casting equipment, instrumentation, computers, microscopes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/predavanja, računske vaje, laboratorijske vaje, programiranje in modeliranje z računalnikom s programsko opremo SolidWorks, ProCast in QuickCast	Lectures, calculation exercises, laboratory exercises, programming, and computer modeling by SolidWorks, ProCast and QuickCast software

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Sestava ocene:	0,00 %	Final evaluation of the course consists of oral and written exam, two colloquia, reports on laboratory exercises.
(a) povprečje iz ocen kolokvijev oziroma ocene pisnega izpita in ocene poročila predstavlja oceno vaj in doprinese k skupni oceni 50 %	50,00 %	(a) the average of the estimates of colloquia and evaluation of the written examination and assessment of the report presents an assessment exercises and contribute to the overall assessment 50 %
(b) ocena iz ustnega izpita predstavlja oceno predavanj in doprinese k skupni oceni 50 %	50,00 %	(b) an assessment of the oral examination represents an assessment of lectures and contributes to the overall assessment 50 %

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

MEGUŠAR, Andrej, DEBELJAK, Milan, MRVAR, Primož, MAHMUTOVIĆ, Almir. Uporaba "jet cooling" sistema za lokalno usmerjeno strjevanje ulitkov iz Al-zlitine = Application of jet-cooling system for local directional solidification of aluminium-alloy castings. Livarski vestnik, ISSN 0024-5135, 2013, letn. 60, št. 3, str. 141-151, ilustr. [COBISS.SI-ID 1314399]
MEDVED, Jože, PIRNAT, Miran, MRVAR, Primož. Fazna ravnotežja v aluminijevih livarskih zlitinah v odvisnosti od vsebnosti Si in Fe = Phase equilibrium in aluminium cast alloys depending on Si and Fe content. V: KRIŽMAN, Alojz (ur.), et al. Zbornik referatov 54. mednarodnega livarskega posvetovanja, Portorož 2014 = Conference proceedings. Ljubljana: Društvo livarjev Slovenije [etc.], 2014, [8] str., graf. prikazi. [COBISS.SI-ID 1479775]
MRVAR, Primož, TALJAT, Boštjan, MEDVED, Jože, MAHMUTOVIĆ, Almir. Passive and active chambers for die casting with cold and hot chamber machines. V: First Metallurgical & Materials Engineering Congress of South-East Europe (MME SEE 2013), May 23-25, 2013, Belgrade, Serbia. ROMHANJI, Endre (ur.), JOVANOVIĆ, Milan T. (ur.), RADOVIĆ, Nenad (ur.). Proceedings and book of abstracts. Belgrade: Association of Metallurgical Engineers of Serbia (AMES): = AMES, 2013, str. 63-81. [COBISS.SI-ID 1279071]
TORKAR, Matjaž, MRVAR, Primož, MEDVED, Jože, PETRIČ, Mitja, TALJAT, Boštjan, GODEC, Matjaž.

Die casting and new rheocasting. V: NUSHED, Mohammed (ur.). Recent researches in metallurgical engineering : from extraction to forming. Rijeka: InTech, 2012, str. 143-160, ilustr. [COBISS.SI-ID 1200991]

POSEBNE TEHNIKE PREOBLIKOVANJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Posebne tehnike preoblikovanja
Course title:	Special Forming Techniques
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067631
Koda učne enote na članici/UL Member course code:	674

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	David Bombač, Peter Fajfar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za pristop k izpitu so: • opravljene vaje, • seminarsko delo, njegova predstavitev • in pismeni izpit.	Enforcement of obligations related to process of study is specified in regulations for verification and evaluation students' knowledge on UL NTF. For positive and successfully enforcement of obligations related to process of study as well as integration of students in mentioned study process following is recommended: active presence at lectures and laboratory exercises, solving of special demanded problems related to metal forming and adequate preparation (study) before laboratory exercises, lowest value regarding to presence at laboratory exercises should be above 80%. Conditions for the exam are as follows: • 80% attendance at tutorials. • tutorials, • seminar work, its presentation and written exam

Vsebina: **Content (Syllabus outline):**

/1. Primerjava prednosti in slabosti pri uporabi konvencionalnih in posebnih (in specialnih) preoblikovalnih postopkov, prednosti v primerjavi z drugimi postopki izdelave (odrezavanjem). 2. Področja uporabe posebnih preoblikovalnih postopkov, okvirna razmejitev s klasičnimi glede oblike, dimenzij, mehanskih lastnosti, procesnih parametrov, kvalitete izdelkov, itd. 3. Trendi razvoja specialnih in posebnih preoblikovalnih postopkov. 4. Posebni preoblikovalni postopki: 4.1. Preoblikovanje žice: - Krivljenje (upogibanje) žice - Hladno valjanje tanke žice - Vroče valjanje kompleksnih profilov iz žice v enem prevleku 4.2 Specialno masivno preoblikovanje in preoblikovanje pločevine: - Oblikovanje cevi, - Preoblikovanje s kapljevinskim mazanjem, - Preoblikovanje z ultrazvokom, - Vtiskovanje, - Luknjanje, - Prečno valjanje, - Razširjanje, - Stiskanje prahov, - Elektrohidravlično in - Elektromagnetno preoblikovanje. - Preoblikovanje z visokohitrostnimi kladivi - Oblikovanje z veliko gostoto energije (vroče in hladno preoblikovanje) z uporabo ekspanzije medijev, eksplozivi, elektrohidravlični proces, elektromagnetni proces in visokohitrostna kladiva, - Preoblikovanje s hidrostatičnim pritiskom, - Preoblikovanje z vsiljenim hidrostatičnim napetostnim stanjem, - Preoblikovanje z vsiljenimi vibracijami, - Preoblikovanje s platenjem, - Hladno varjenje, - Valjanje folij, - Mikro preoblikovanje, - Preoblikovanje v testastem stanju materiala. 5. Preoblikovanje z izkoriščanjem posebnih lastnosti (superplastičnost faznih premen, valjanje v dvofaznih področjih, itd,) materiala. 6. Materiali za posebne preoblikovane postopke. 7. Procesni parametri preoblikovanja (temperatura, napetostna stanja, deformacije, hitrosti deformacije, trenjska stanja, mazalna sredstva, obremenitve orodij in naprav, energija preoblikovanja). 8. Dimenzijska območja izdelkov, oblikovna kompleksnost, natančnost in mehanske lastnosti. 9. Strojna oprema in orodja ter materiali orodij in njihove mehanske	1. Comparison between advantages and weaknesses at applying of conventional and special forming procedures (methods), advantages and weaknesses in comparison to other production methods (cutting, welding, casting, etc). 2. Domain of applying of special metal forming procedures, approximately delineation between classical and special metalforming procedures regarding to dimensions, shapes, mechanical properties, process parameters, quality of products, etc. 3. Tendency of future development of special metalforming procedure. 4. List of special metalforming procedures: 4.1 Forming and shaping of wire - bending of wire - cold rolling of thin wire - hot rolling of complex profiles in deformation step 4.2 Special massive metalforming and special sheet metal forming - forming and shaping of pipe - ultrasonic forming - coining - blanking - cross rolling - expansion process - sintering - electro hydraulic and electromagnetic forming - forming with high speed hammer - metal forming with high energy rate (hot and cold forging) with using expansion of mediums, explosives, high strain rates hammers, etc - hydrostatic forming - forming with imposed hydrostatic stress state - forming with imposed vibrations, - forming by exploiting of special material properties, - cladding - cold welding - cold sheet metal forming - upsetting - superplastic forming - swaging - spinning - rolling of foil - microforming - thixoforming 5. Metalforming with utilizing of special characteristics of metals (superplasticity, phase transformation, forming in two-phase regions, etc). 6. Materials used in special metalforming 7. Process parameters and other production characteristics of special metalforming characteristics (temperature, stress states, strains, strain rates, friction and applied lubricants, loads on tools and equipments, energy, etc). 8. Achieved range of product dimensions, accuracy, surface quality, shape complexity and mechanical

lastnosti. 10. Industrijska aplikacija posebnih in specialnih postopkov in gospodarnost.	properties. 9. Applied dies and equipments, die materials and their properties. 10. Industrial applications of special metalforming procedures and their economy.

Temeljna literatura in viri/Readings:

R. Turk, G. Kugler, M. Terčelj, D. Bombač: Preoblikovanje kovinskih materialov, UL-NTF, OMM, 2008 (elektronska in tiskana verzija)
Hydroforming for Advanced Manufacturing, 1st Edition - April 25, 2008, Editor: M Koç
Sheet Metal Forming PROCESSES AND APPLICATIONS, Edited by Taylan Altan and A. Erman Tekkaya, ASM International® Materials Park, Ohio, 2012

Cilji in kompetence:	**Objectives and competences:**
/Študent spozna osnove posebnih in specialnih preoblikovalnih postopkov, področje uporabe in odločanja za te postopke ter načrtovanje njihove tehnologije. Študent pridobi osnovno znanje o vrstah posebnih in specialnih preoblikovalnih postopkov in principih njihovega delovanja, potrebno znanje za odločitev za izbiro specialnih postopkov namesto konvencionalnih, o prednostih in slabostih v primerjavi s konvencionalnimi postopki z vidika dobljenih mehanskih lastnosti, porabljeni energiji in gospodarnosti teh postopkov, o načrtovanju teh postopkov, nadalje pridobi osnovno znanje o strojni opremi in orodjih ter materialih za orodja, o mazanju in trenju, o okvirnih procesnih parametrih in nastopajočih napetostnih stanjih, njihovi industrijski uporabi, primernih materialih za specialne postopke in njihovih zahtevanih lastnostih ter izkoriščanju teh lastnosti pri teh postopkih, posebnih testiranjih lastnosti teh materialov, mehanskih lastnostih dobljenih produktov, področjih njihove dosedanje uporabe ter potencialnih smereh njihovega razvoja za njihovo bodočo uporabe z razvojem tehnike. Razumljeno kompleksnost pri teh postopkih lahko transferira na širjenje mej uporabe in razvoja postopkov preoblikovanja materialov za izdelavo produktov.	Student managed basic of special metal forming procedures (methods), domain of their application and making of decision for selection and planning of their technology. Student acquires basic knowledge about kind of special metalforming procedures and basic of their performing, needed knowledge for making decision of selection of special metalforming procedures instead of classical procedures, about advantages and weaknesses in comparison to classical procedures from point of view of obtained mechanical properties, shapes and dimensions of products, consumed energy and economy of these procedures, about planning of these procedures, further student acquires basic knowledge about applied equipments and tools, tool materials used, about lubrications and friction, frame values of process parameters and prevailing stress states, industrial application of mentioned metalforming procedures, appropriate materials and their required properties as well as utilizing of these properties in these procedures, special tests for testing of these properties, mechanical properties of products, domains of their applications so far as well as potentials for their future applications and development. Understand complexity at these metalforming procedures can student transfer on extension of application limit and development of these procedures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent pridobi osnovna znanja o posebnih tehnikah preoblikovanja, uporabi preoblikovanih materialov za preoblikovanje izdelkov posebnih oblik, dimenzij, mehanskimi lastnostmi in načrtovanju tehnoloških poti izdelave idejno zasnovanih predmetov. Razširi se mu razumevanje glede možnosti uporabe postopkov preoblikovanja in pomen interakcije med posameznimi parametri preoblikovanja za širitev postopkov preoblikovanja kot ekonomičnega	Knowledge and understanding: Student acquired basic knowledge about special metalforming processes, applying of materials for special forming processes and products with special shapes, dimensions, mechanical properties and planning of technological routes for production of designed products. His understandings related to possibility of using of special metalforming procedures as well as importance of particular process parameters for increasing of application of mentioned procedures is extended. Economy of applied special

tehnološkega postopka v proizvodnji.	metalforming procedures is also considered at selection and planning of metalforming procedures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/• predavanja, • seminarske vaje, • laboratorijske vaje • projektno delo v seminarjih	• lecture, • tutorial • laboratory practice • project (seminar) work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) poročilo o opravljenih vajah	20,00 %	(a) report of laboratory work
(b) seminar	20,00 %	(b) seminar work
(c) pisni izpit	60,00 %	(c) examination

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

FAJFAR, Peter, KOSEC, Ladislav. Vortices at the interface of explosion welded metals. Metall (Berl. West), 2000, jg. 54, nr. 4, str. 201-204

BRODARAC, Z. Zovko, MRVAR, Primož, MEDVED, Jože, FAJFAR, Peter. Local squeezing casting influence on the compactness of AlSi[sub]10Mg alloy casting = Utjecaj postupka lokalnog tiskanja na kompaktnost odljevka od AlSi[spodaj]10Mg legure. Metalurgija (Sisak), 2007, let. 46, zv. 1, 29-35 str.

FAJFAR, Peter. Tehnika preoblikovanja. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2010. 126 str.

PRAKSA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Praksa
Course title:	Practice
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code: 0642785

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
0	0	75	0	0	75	5

Nosilec predmeta/Lecturer: David Bombač

Vrsta predmeta/Course type: Strokovni izbirni /Profesional optional course

Jeziki/Languages:		
	Predavanja/Lectures:	
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik	Entry in the academic year.

Vsebina:	**Content (Syllabus outline):**
V okviru praktičnega usposabljanja se študent seznani z organizacijo podjetja, varnostnimi ukrepi in spozna tehnološki proces. Vsebine prakse so prilagojene konkretnemu mestu, kjer se opravlja. Področja opravljanja prakse so: - uvajanje v delo magistra metalurgije in materialov, - zasledovanje tehnoloških procesov, - zasledovanje toka materiala, - nadzor proizvodnega procesa, - karakterizacija materialov, - osvojitev pravil varnosti pri delu, - varstvo okolja, - vzdrževanje strojev in naprav	During the practice qualification the student is acquainted with the organisation of the industry, security measurements and gets to know with the technological process. The practical work is adapted to the industry where the practice work is executed. The fields of practice are: - work responsibilities of master of metallurgy and materials, - following the technological processes, - following of the flow material, - supervision of the fabrication processes, - characterization of the materials, - safety regulations, - maintenance of the production equipment and devices

Temeljna literatura in viri/Readings:

Literatura je odvisna od strokovnega področja in vsebine prakse. / Literature depends on the field of the research and content of the practice.

Cilji in kompetence:	Objectives and competences:
Cilj praktičnega usposabljanja je narediti most med teoretičnim delom izobraževanja in konkretnim delovnim okoljem, kjer študent pridobi praktična znanja in izkušnje.	The main goal of practice is to bridge the theoretical part of the education and real production environment, where the student gains the practical knowledge and experiences.

Predvideni študijski rezultati:	Intended learning outcomes:
Študent zna povezati teoretična znanja in realno delovno okolje. Seznani se z reševanjem različnih problemov s področja metalurgije in materialov. Nauči se strokovnega sporazumevanja in delovanja v timu.	The student learns how to connect the theoretical knowledge and real production environment. He is acquainted with the solving of various problems from the field of metallurgy and materials. He gains the professional communication skills and how to work as a member of a team.

Metode poučevanja in učenja:	Learning and teaching methods:
Študent v okviru prakse izdela poročilo o opravljeni praksi. Potrdita ga mentor v podjetju in mentor na fakulteti.	The student is obligated to in the frame of practice writes a report about the performed practice. This must be confirmed by both, mentor in the industry and at the faculty.

Načini ocenjevanja:	Delež/Weight	Assessment:
Opravil / Ni opravil		Passed / Failed

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

1. FAJFAR, Peter. *Tehnika preoblikovanja*. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2010. 126 str.
2. DROBNE, Matej, KLANČNIK, Urška, FAJFAR, Peter, TERČELJ, Milan. Role of oxidation and microstructure constituents on high chromium steel work roll surface degradation. *Journal of Materials Research and Technology*. 2021, vol. 12, str. 186-192.
3. ŠALEJ LAH, Alenka, MEDVED, Jože, FAJFAR, Peter, PAULIN, Irena, VOLŠAK, Darja, VONČINA, Maja. The influence of chemical composition and heat treatment on the mechanical properties and workability of the aluminium alloy EN AW 5454 = Vpliv kemijske sestave in toplotne obdelave na mehanske lastnosti in preoblikovalnost aluminijeve zlitine EN AW 5454. *Materiali in tehnologije*. sep.-okt. 2021, letn. 55, št. 5, str. 709-716.
4. KRANER, Jakob, FAJFAR, Peter, PALKOWSKI, Heinz, KUGLER, Goran, GODEC, Matjaž, PAULIN, Irena. Microstructure and texture evolution with relation to mechanical properties of compared symmetrically and asymmetrically cold rolled aluminum alloy. *Metals*. 2020, iss. 2, vol. 10, str. 10020156-1 - 10020156-14

PREDELAVA MATERIALOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Predelava materialov
Course title:	Materials Processing
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067613
Koda učne enote na članici/UL Member course code:	664

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Peter Fajfar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Enforcement of obligations related to process of study is specified in regulations for verification and evaluation students' knowledge on UL NTF. For positive and successfully enforcement of obligations related to process of study as well as integration of students in mentioned study process following is recommended: active presence at lectures and laboratory exercises, solving of special demanded problems related to metal forming and adequate preparation (study) before laboratory exercises, lowest value regarding too presence at laboratory exercises should be above 80%.

Vsebina:	Content (Syllabus outline):
/1. Pregled preoblikovalnih postopkov 2. Elastični in plastično obnašanje materiala 3. Fizikalni in metalurški procesi pri preoblikovanju 4. Vplivni parametri pri toplem in hladnem preoblikovanju 5. Utrjevalni - mehčalni mehanizmi	1. Presentation of metalformingprocedures. 2. Elastic – plastic beahaviour of materials. 3. Physical and metallurgical processes during metal forming. 4. Influential parameters at hot and cold metal forming.

6. Preoblikovalnost; krivulje tečenja, mape plastičnosti 7. Kriterij in pogoj tečenja 8. Matematični zapis preoblikovalnosti 9. Parametri preoblikovanja stacionarnih in nestacionarnih postopkov 10. Analitična obravnava izbranih postopkov 11. Uvod v elementarno teorijo plastičnosti 12. Osnove valjanja, kovanja, iztiskovanja, vlečenja in preoblikovanja pločevine	5. Hardening and softening mechanisms 6. Workability; flow curves, processing maps of plasticity. 7. Criterium and conditions of material flow. 8. Mathematical description of workability. 9. Parameters related to stationary and nonstationary metalforming procedures. 10. Analitical consideration of selected metalforming procedures. 11. Introduction in elementary theory of plasticity. 12. Basic of rolling, forging, extrusion, drawing and sheet metal forming.

Temeljna literatura in viri/Readings:

Fajfar, P., Tehnika Preoblikovanja, Univerza v Ljubljani, NTF-OMM, 2010
ASM Handbook, Vol. 14A: Metalworking: Bulk Forming, 2005
ASM Handbook, Vol. 14B: Metalworking: Sheet Forming, 2006

Cilji in kompetence:	**Objectives and competences:**
/Študenti dobijo vpogled v osnovne tehnologije preoblikovanja, osvojijo tehniko določevanja preoblikovalnih lastnosti in računsko podlago za obravnavo termomehanskih obremenitvenih stanj v plastični coni ter to uporabijo za izbrane postopke preoblikovanja.	Students managed so basic of metalforming technologies as well as main procedures for determination of metalforming characteristics and mathematical tools for consideration of thermomechanical load states in plastic zone of individual selected metalforming procedure.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: • Poznavanje področja, pojmov in definicij, • Uporaba analitskih orodij za opis procesov, Razumevanje osnovnih tehnoloških procesov, • Njihovo načrtovanje in trend razvoja	Knowledge and understanding: - Understanding of domain of metalforming, as well as concepts and definitions used, - Using of analytical tools for description of metalforming procedures, understanding of basic of metalforming procedures. - Planning of metalforming procedures and tendency of their development.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja ob pomoči medijev: PowerPoint, filmi; demonstracija s primeri (realni in virtualni); laboratorijske vaje z aktivnim delom.	Lectures with the use of power point, movies, real and virtual demonstration, laboratory work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Poročilo o opravljenih vajah	20,00 %	(a) The report on lab work
(b) pisni izpit	40,00 %	(b) examination
(c) ustni izpit	40,00 %	(c) oral examination

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

BRADAŠKJA, Boštjan, PIRNAR, Boštjan, FAZARINC, Matevž, FAJFAR, Peter. Deformation Behaviour and Microstructural Evolution During Hot Compression of AISI 904L. Steel research international, 2011, vol. 82, no. 4, str. 346-351

BOMBAČ, David, TERČELJ, Milan, FAZARINC, Matevž, FAJFAR, Peter. Increasing of hot workability of 1.3302 high speed steel = Poboljšavanje svojstava brzoreznog čelika 1.3302 u vrućem stanju. Metalurgija (Sisak), 2012, vol. 51, br. 3, str. 313-316

FAJFAR, Peter, FAZARINC, Matevž, ŽUŽEK, Borut, TERČELJ, Milan. Implementation of newly developed tests with heated and internally cooled tool steel samples for different applications = Primjena novo razvijenih testova sa grijanjem i unutarnjim hlađenjem uzoraka od alatnog čelika za različite primjene. Metalurgija (Sisak), 2012, vol. 51, br. 4, str. 453-456. [COBISS.SI-ID 1217375]

PREISKAVA MATERIALOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Preiskava materialov
Course title:	Materials Testing
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067599
Koda učne enote na članici/UL Member course code:	375

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleš Nagode, Milan Bizjak
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 2. letnik študija. Opravljeno in uspešno predstavljeno poročilo laboratorijskih vaj je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the second year of study. Completed and successfully presented laboratory exercises report is required before taking the written exam.

Vsebina:	Content (Syllabus outline):
/Osnove statistične analize za vrednotenje rezultatov. Poglavje seznani študente z uporabo statistike pri vrednotenju rezultatov meritev. Natezni preizkus. Določevanje napetosti tečenja ter natezne trdnosti. Krivulje napetost-deformacija. Pravokotna anizotropija. Natezni preizkus pri nižjih in višjih temperaturah. Preizkušanci. Natezni stroji. Računalniški programi za natezni preizkus. Tlačni preizkus. Tlačni preizkus pri višjih temperaturah. Osno simetrični cilindrični tlačni preizkus. Ploski tlačni preizkus. Strižni preizkus. Namen preizkusa in izvedba. Veličine strižnega preizkusa. Trajni mirujoči preizkusi. Osnove procesa lezenja	Basics of statistical analysis for data evaluation. The chapter familiarize students with basic statistical methods for measurement data evaluation. The tension test. Yield and ultimate tensile strength, anisotropy of mechanical properties, stress-strain curves, tension testing at low temperatures, standard test samples, tension test machines, computer software for tension test. The compression test. Uniaxial compression testing at low temperatures, Stress-strain behaviour, Plate sample testing The shear test. Test intention and execution of test, sear test quantities Permanent stationary tests. Basic of creep testing

(prehodno lezenje, stacionarno lezenje, terciarno lezenje). Odvisnost raztezek čas lezenja. Metode za napovedovanje odpornosti proti lezenju (Larton Millerjev parameter). Meritve trdot. Brinell, Rockwell (HRC, HRB, HRA, HRF), Knoop, Vickers, Shore, Poldi, mikrotrdota. Namen preizkusov, izvedbe in poteki preizkusov, Veličine preizkusov trdot. Primerjave trdot za različne preiskovalne metode. Empirična odvisnost trdote in natezne trdosti. Trajni nihajni preizkusi. Matematični opis trajnih nihajnih preizkusov. Statistična ocena rezultatov preizkusov. Parametri, ki vplivajo na rezultate preizkusa. Diagrami trajnih nihajnih trdosti (Smithov diagram), Gerber-Goodmanov model. Utrujenostni prelom. Udarni zarezni preizkus. Določevanje prehodne temperature. Morfologija prelomov. Udarni natezni preizkus. Namen preizkusa. Izvedba in potek preizkusa. Določanje lomne žilavosti. Definicija lomne žilavosti. Namen in izvedba preizkusa. COD test. Tehnološki preizkusi preoblikovalnosti. Namen, opisi in izvedbe upogibnega, pregibnega in izmeničnega pregibnega preizkusa. Preizkus globokega vleka po Erichenu in preizkus vlečenja čašic. Opis pojava ušesenja. Preizkusi cevi, žic in žičnih vrvi, verig, zakovic, vijakov, matic in vzmeti. Za vsak element je podan namen in izvedba preizkusa. Preizkusi obrabe. Faktorji, ki vplivajo na odpornost materiala proti obrabi. Načini obrabe in trenja (kotalno trenje, drsno trenje, menjajoča obremenitev, pretok obrabnega sredstva). Stroji za določanje obrabe (stroji za kotalno trenje z ali brez drsnega trenja, stroji za drsno trenje). Izvedbe in potek preizkusov. Preiskave z ultrazvokom. Primeri za odkrivanje različnih napak. Preiskave zvarov. AVG diagrami. Radiografske preiskovalne metode. Fizikalne osnove X in γ žarkov. Izvori X in γ žarkov. Karakteristične krivulje filma. Ekspozicijski diagrami. Indikatorji kvalitete radiogramov. Preiskava zvarov. Preiskava napak v ulitkih. Električne preiskovalne metode. Električna potencialna sonda, Metoda s štirimi konicami, merjenje električne prevodnosti. Magnetne preiskovalne metode. Fizikalne osnove. Način določevanja napak. Krožno magnetno polje. Vzdolžno magnetno polje. Penetranti. Namen in izvedba preizkusa. Praktični primeri pri uporabi neporušnih preiskovalnih metod	(transient creep, steady state creep, tertiary creep). Time-elongation dependency. Methods for creep resistance evaluation (Larton Miller parameter) Hardness measurement. Brinell, Rockwell (HRC, HRB, HRA, HRF), Knoop, Vickers, Shore, Poldi, microhardness measurement. Test intention and execution of various testing methods. Comparison of methods. Empirical connectivity between hardness and ultimate strength. Fatigue testing. Mathematical description of fatigue testing. Statistical evaluation of measurement data. Parameters, which influence on measurements. Fatigue strength charts (Smith chart), Geber-Goodman model, Fatigue rapture. Impact notch toughness testing. Determination of transition temperature, fracture morphology Impact-tension test. Test intention and execution. Determination of fracture toughness. Definitions, test intention and execution, COD test. Technological ductility tests. Intention, description and execution of various types of bend test and alternating bend test. Erichsen test for deep drawing capability evaluation. Description of ear formation phenomena Testing of tubes, wires, wire ropes, chains, rivets, screws, nuts, and springs. Test description and execution for each mechanical element. Wear testing. Factors, which influence on material wear resistance. Types of wear and friction (rolling friction, sliding friction, cyclic loads, flux of particles). Machines for wear testing (for rolling and sliding friction). Practical execution of tests. Ultrasound tests. Practical cases for detection of various material defects with ultrasound. Weld ultrasound testing. AWG charts. Radiographic testing methods. Physical basics of X and γ rays. Sources of X and γ rays. Characteristic curves. Expositional charts. Indicators of radiograph chart quality. Weld testing. Castings testing. Electrical testing methods. Electric potential probe, method with four pins, measurement of electrical resistivity Magnetic testing methods. Physical basics. Modes of defect determination. Circle magnetic field, longitudinal magnetic field. Penetrants. Test intention and execution. Non-destructive testing methods practical case studies

Temeljna literatura in viri/Readings:

Milan Bizjak, Gradivo za predmet Preiskava materialov, UL NTF, 2021
Y. Leng: Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Wiley, 2008

A. Otsuki et al: Non-Destructive Material Characterization Methods, 1st Edition, Elsevier, 2023 E. Gdoutos, M.K. Gdoutos: Mechanical Testing of Materials, Springer, 2024 Fractography, ASM Handbook, Vol.12, 9th Edition, ASM International, 1987

Cilji in kompetence:	**Objectives and competences:**
/Študent se seznani z najpomembnejšimi mehanskimi, tehnološkimi in neporušitvenimi preiskovalnimi metodami, ki se uporabljajo za preiskavo materialov v laboratorijski in industrijski praksi. Cilj predmeta je, da se študent spozna teoretične osnove posameznih preiskovalnih metod ter se na osnovi praktičnega dela usposobi za samostojno izvajanje in vrednotenje preizkusov.	The course Material testing familiarize student with the most important mechanical, technological and non-destructive methods for material testing in laboratory and industrial practice. The aim of the course is that students understand the theoretical bases of individual testing methods and is trained to independently conduct investigational tests and evaluate results.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Razumevanje in obvladanje vsebine predmeta mora zadoščati za samostojen pristop k mehanskih in tehnoloških preiskav materialov.	Knowledge and understanding: Understanding and mastery of subject matter must be sufficient for an independent approach to the mechanical and technological material testing.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja in laboratorijske vaje.	Lectures and laboratory exercises.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
poročilo laboratorijskih vaj (20 %)	20,00 %	laboratory exercises report (20%)
pisni izpit (40 %)	40,00 %	the mark of written exam (40%)
ustni izpit (40%)	40,00 %	the mark of oral exam (40%)

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

BIZJAK, Milan. Oksidne plasti na lamelah električnih motorjev. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 1998. 13 f. [COBISS.SI-ID 783455]
BIZJAK, Milan, KOSEC, Ladislav. A continuous electrical resistivity measurement of rapidly solidified aluminium alloys. Metalurgija, ISSN 0543-5846, 2000, vol. 39, br. 3, str. 200. [COBISS.SI-ID 788063]
BIZJAK, Milan. Karakterizacija tankih plasti na kletki komutatorja. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2002. 15 f. [COBISS.SI-ID 785503]
BIZJAK, Milan, KOSEC, Ladislav, KOSEC, Borut, ANŽEL, Ivan. The characterization of phase transformations in rapidly solidifield Al-Fe and Cu-Fe alloys through measurements of the electrical resistance and DSC. Metalurgija, ISSN 0543-5846, vol 45, br. 3, str. 230. [COBISS.SI-ID 629087]

KLOBČAR, Damjan, TUŠEK, Janez, BIZJAK, Milan, LEŠER, Vladka. Micro friction stir welding of copper electrical contacts. Metalurgija, ISSN 0543-5846, 2014, vol. 53, no. 4, str. 509-512, ilustr. [COBISS.SI-ID 13473819]

BIZJAK, Milan, KOSEC, Borut, KARPE, Blaž, BROVČ, Goran, NAGODE, Aleš, KOSEC, Ladislav. Development of device for detecting microstructure changes. V: MAMUZIĆ, Ilija (ur.). Materials and metallurgy : summaries of abstract = Materiali i metalurgija : zbornik sažetaka, (Metalurgija, ISSN 0543-5846, vol. 53, no. 3). Šibenik: Croatian Metallurgical Society: = Hrvatsko metalurško društvo, 2014, str. 402. [COBISS.SI-ID 1463647]

ČESNIK, Damir, ROZMAN, Janez, KARPE, Blaž, BIZJAK, Milan. Fine-blanking tool temperature deviation and its influence on dimensions of final parts. V: MAMUZIĆ, Ilija (ur.). Materials and metallurgy : summaries of abstract = Materiali i metalurgija : zbornik sažetaka, (Metalurgija, ISSN 0543-5846, vol. 53, no. 3). Šibenik: Croatian Metallurgical Society: = Hrvatsko metalurško društvo, 2014, str. 425. [COBISS.SI-ID 1468255]

BROVČ, Goran, DRAŽIĆ, Goran, KARPE, Blaž, LOJEN, Gorazd, KOSEC, Borut, BIZJAK, Milan. Synthesis and characterization of hardened Cu-Fe-Ni-P alloy. V: MAMUZIĆ, Ilija (ur.). Materials and metallurgy : summaries of abstract = Materiali i metalurgija : zbornik sažetaka, (Metalurgija, ISSN 0543-5846, vol. 53, no. 3). Šibenik: Croatian Metallurgical Society: = Hrvatsko metalurško društvo, 2014, str. 407. [COBISS.SI-ID 1466207]

NAGODE, Aleš, KLANČNIK, Grega, SCHWARCZOVA, Heidy, KOSEC, Borut, GOJIĆ, Mirko, KOSEC, Ladislav. Analyses of defects on the surface of hot plates for an electric stove. Engineering failure analysis. 2012, vol. 23, str. 82-89. ISSN 1350-6307. http://dx.doi.org/10.1016/j.engfailanal.2012.03.001, DOI: 10.1016/j.engfailanal.2012.03.001.

ZORC, Borut, ZORC, Matija, KOSEC, Borut, NAGODE, Aleš. Effect of the shape of styrene-acrylonitrile water-filter housings on the destructive pressure, crack-initiation, propagation conditions and fracture toughness of styrene-acrylonitrile. Polymers. 2020, vol. 12, iss. 2, str. 1-22. ISSN 2073-4360. DOI: 10.3390/polym12020280.

NAGODE, Aleš, JERINA, Kaja, JERMAN, Ivan, VELLA, Daniel, BIZJAK, Milan, KOSEC, Borut, KARPE, Blaž, ZORC, Borut. The effect of sol-gel boehmite coatings on the corrosion and decarburization of C45 steel. Journal of sol-gel science and technology. 2018, vol. 86, iss. 3, str. 568-579. ISSN 0928-0707. DOI: 10.1007/s10971-018-4664-4.

SEDLAČEK, Marko, ZUPANČIČ, Katja, ŠETINA, Barbara, KOSEC, Borut, ZORC, Matija, NAGODE, Aleš. Influence of precipitation hardening on the mechanical properties of Co-Cr-Mo and Co-Cr-W-Mo dental alloys. Metals. 2023, vol. 13, iss. 3, str. 1-13, ilustr. ISSN 2075-4701. https://www.mdpi.com/2075-4701/13/3/637, DOI: 10.3390/met13030637.

ZORC, Borut, ZORC, Matija, NAGODE, Aleš. Analysis of the mixing of filler and base materials in arc-welded single-bead surface welds using an EDXS method. Materials. 2022, vol. 15, iss. 1, str. 1-11. ISSN 1996-1944. DOI: 10.3390/ma15010217.

PRENOS TOPLOTE IN SNOVI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Prenos toplote in snovi
Course title:	Heat and Mass Transfer
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067600
Koda učne enote na članici/UL Member course code:	368

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 2. letnik študija. Opravljeno in uspešno predstavljeno projektno delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the second year of study. Completed and successfully presented project work is required before taking the written and oral exam.

Vsebina:	Content (Syllabus outline):
/Uvod. Mednarodni standardi ISO 31 (Veličine in enote). Toplotne lastnosti snovi. Toplotna prevodnost. Toplotna prevodnost kot funkcija temperature. Specifična toplota. Gostota. Temperaturna prevodnost. Pojem temperaturnega polja. Mehanizmi prenosa toplote. Prevod, prestop, sevanje. Prevod toplote. Osnovni zakon prevajanja toplote in njegova uporaba. Formulacija splošne parcialne diferencialne enačbe prevoda toplote brez in z izvori toplote. Eno in večdimenzionalni prevod toplote. Prevajanje toplote v osnovnih geometrijskih oblikah teles. Prevajanje toplote v kompleksnih in sestavljenih	Introduction. International standards ISO 31 (Quantities and units). Thermal properties of materials: Thermal conductivity. Thermal conductivity as a function of temperature. Specific heat. Density. Temperature diffusivity. The concept of temperature field. Mechanisms of heat transfer. Conduction, convection and radiation. Heat conduction. The basic law of heat conduction and its use. Formulation of general partial differential equations of heat conduction with and without heat sources. Single and multi-dimensional heat conduction.

telesih. Faktor ukrivljenja. Prestop toplote. Formulacija splošne parcialne diferencialne enačbe prestopa topote. Pojem toplotne prestopnosti. Kinematika fluida. Hidravlični radij. Formulacija gibalne in kontinuitetne enačbe. Teorija podobnosti. Geometrijska, termična in hidrodinamična podobnost. Podobnostna števila. Kriterijske enačbe; za omejen in neomejen prostor ter gibanje fluidov v ceveh. Toplotno sevanje. Fizikalne osnove toplotnega sevanja. Stefan-Boltzmanov zakon. Stefan-Boltzmanova konstanta. Koeficient emisivnosti. Analiza vpliva toplotne prevodnosti in prestopnosti na prehodnost toplote. Prenos snovi. Osnovni mehanizmi prenosa snovi. Difuzija. Fickovi zakoni. Difuzija v plinih. Difuzija v tekočinah in trdnih snoveh. Analogija med procesi prenosa toplote in prenosa snovi. Procesi v bližini fazne meje. Model Reynoldsovega toka snovi in definicija v njem nastopajočih veličin. Uporaba spoznanj prestopa toplote v modelu Reynoldsovega toka v praksi. Sočasni prenos toplote in snovi. Študija primerov.	Conduction of heat in basic geometric bodies. Heat transfer in complex and composed objects. Convection heat transfer. Formulation of general partial differential equations of convection heat transfer. The concept of heat transfer coefficient. Motion of the fluid. Hydraulic radius. Formulation of momentum and continuity equation. Theory of similarity. Geometric, thermal and hydrodynamic similarity. Similarity dimensionless numbers. Criterion equation; for limited and unlimited space. Internal fluid flows and heat transfer. Thermal radiation. Physical fundamentals of radiation heat transfer. Stefan-Boltzman law. Stefan-Boltzman constant. The coefficient of emissivity. Analysis of thermal conductivity influence on heat transfer coefficient and convection heat transfer. Mass Transfer. Basic mechanisms of mass transfer. Diffusion. Fick's laws. Diffusion in gases. Diffusion in liquids and solids. Analogy between the processes of heat transfer and mass transfer. The processes in the vicinity of the phase boundary. Reynolds flow model and definition of variables occurring in it. Convection heat transfer in Reynolds flow model Simultaneous heat and mass transfer. Case studies.

Temeljna literatura in viri/Readings:

/HERR, H. Nauka o toploti. Ljubljana: Tehniška založba Slovenije, 1997.
INCROPERA, F.P. in DeWITT, D.P. Fundamentals of Heat and Mass Transfer. New York: John Wiley & Sons, 1990.
LINDON, C.T. Heat Transfer. New Jersey: Prentice-Hall, 1992.
HOLMAN, J.P. Heat Transfer. New York: McGraw-Hill, 1986.
KAVIANY, M. Principles of Heat Transfer. New York: John Wiley & Sons, 2002.
KAMINSKI, D.A. in JENSEN, M.K. Introduction to Thermal and Fluid Engineering. New York: Wiley International Edition, 2005.
PITTIS, D.T. in SISSOM, L.E. 1000 Solved Problems in Heat Transfer. New York: McGraw-Hill, 1991.
MASSOUD, M. Engineering Thermofluids: Thermodynamics, Fluid Mechanics and Heat Transfers. Berlin / Heidelberg: Springer Verlag, 2005.
TURNS, R.S. Thermal – Fluid Sciences. New York: Cambridge University Press, 2006.

Cilji in kompetence:	**Objectives and competences:**
/Osnovni cilj predmeta je spoznati študente z mehanizmi prenosa toplote in snovi v naravi in tehniki. Študent se v okviru predmeta usposobi za kompleksno analizo pojavov s področja prenosa toplote in snovi. Študent se navaja na samostojno, timsko ter projektno delo, uporabo strokovne literature in sodobnih virov informacij.	The primary objective of Heat and Mass Transfer course is to familiarized students with the mechanisms of heat and mass transfer in nature and processing technology. Students are trained to analyze complex phenomena in the field of heat and mass transfer. The student gets accustomed to individual and team, project and research work, and application of expert literature and modern information sources.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Pri predmetu Prenos toplote in snovi se študent spozna s pojmi s tega področja, s toplotnimi	Knowledge and understanding: In the course, Heat and Mass Transfer, the student learns about basic conception in this field and

lastnostmi snovi. Nauči se mehanizmov prenosa toplote, njihovih matematičnih formulacij, povezave med njimi ter njihove uporabe v inženirstvu. Seznani se s teorijo podobnosti, in njeno uporabnostjo, mehanizmi prenosa snovi, analogijo med procesi prenosa toplote in prenosa snovi. Pridobljena znanja je sposoben aplicirati na konkretnih inženirskih problemih s področja procesne tehnike ter inženirstva materialov in metalurgije. Študent mora znati povezati in uporabiti pridobljena znanja s področja prenosa toplote in snovi pri reševanju inženirskih problemov s področja prenosa toplote in snovi v procesni tehniki ter inženirstvu materialov in metalurgiji. Študent se v okviru predmeta usposobi za kompleksno analizo procesov s področja prenosa toplote in snovi s poudarkom na njihovi industrijski aplikaciji. Navaja se na samostojno in timsko raziskovalno in projektno delo ter uporabo strokovne literature in drugih - sodobnih virov informacij.	thermal properties of substances. He learns about the heat transfer mechanisms, their mathematical formulations, links between them, and their use in engineering. Learns about the theory of similarity, and its usefulness, mechanisms of mass transfer, and the analogy between the processes of heat transfer and mass transfer. The student must be able to connect and to use this knowledge in the field of thermal and fluid engineering, solving engineering problems in the field of heat and mass transfer, materials and process engineering, and metallurgy. Student acquires knowledge for the analysis of complex processes in the field of heat and mass transfer with emphasis on their industrial application. Student acquires skills for independent and team work, project work and application of professional literature and other - modern sources of information

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje in simulacije, reševanje praktičnih primerov in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ocena projektne naloge (30 %)	30,00 %	the mark of project work (30%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40%)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

KARPE, Blaž, KOSEC, Borut, NAGODE, Aleš, BIZJAK, Milan. The influence of Si and V on the kinetics of phase transformation and microstructure of rapidly solidified Al-Fe-Zr alloys. Journal of mining and metallurgy. Section B, Metallurgy, 2013, vol. 49 B, no. 1, str. 83-89.
KARPE, Blaž, KOSEC, Borut, KOLENKO, Tomaž, BIZJAK, Milan. Heat transfer analyses of continuous casting by free jet meltspinning device. Metallurgy, 2011, vol. 50, br. 1, str. 13-16.
KOSEC, Borut. Failures of dies for die-casting of aluminium alloys. Metallurgy, 2008, vol 47, no. 1, str. 51-55.

PROCESNA JEKLARSKA TEHNIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Procesna jeklarska tehnika
Course title:	Process Engineering in Steelmaking
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067614
Koda učne enote na članici/UL Member course code:	661

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	20	0	10	75	5

Nosilec predmeta/Lecturer:	Matjaž Knap
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Liabilities are defined in the regulations on examination and evaluation of students at ULNTF. For a positive and successful attendance of their duties students are encourage to regular attendance of lectures, additional domestic more complex work more and appropriate preparing to laboratory work. At least 80% attendance at tutorials is needed.

Vsebina:	Content (Syllabus outline):
/Surovine za izdelavo jekla: grodelj, staro železo, metalizirani peleti, ferozlitine, klasifikacija starega železa Grodelj: Pridobivanje in priprava grodlja kot čiste predzlitine za pridobivanje jekla. Redukcija železovih oksidov v protitočnem reaktorju. Fazne spremembe v coni segrevanja in mehčanja. Taljenje kovinskih in nekovinskih materialov. Reakcije v trdnem in tekočem. Mejne plasti. Večkomponentni sistemi: CaO-SiO2, CaO-Al2O3, Al2O3- SiO2, MgO-SiO2, CaO-MgO-SiO2- Al2O3, CaO-FeO-SiO2, CaO-	Raw materials for steel making: pig iron, scrap iron, metallized pellets, ferroalloys, scrap classification. Pig iron: Extraction and preparation of pig iron as pure master alloy for steelmaking. Reduction of the iron oxides in the countercurrent reactor. Phase changes in zone heating and softening. The melting of metallic and non-metallic materials. Reactions in solid and liquid. The boundary layer. Multi-component systems: CaO-SiO2, CaO-Al2O3, Al2O3-SiO2, MgO-SiO2, CaO-MgO-SiO2- Al2O3, CaO-FeO-SiO2, CaO-CaF2, CaO-Al2O3-CaF2, SiO2-

CaF2, CaO-Al2O3-CaF2, SiO2-Na2O, SiO2-Al2O3-K2O (Na2O) Goriva: Trdna, tekoča in plinasta goriva za pridobivanje grodlja, jekla, ferozlitin. Pomožna sredstva; Žlindrotvorni dodatki. Ognjevzdržni materiali, izolacije, eksotermna sredstva. Izdelava jekla: Vrste jekel, legirni elementi. lastnosti surovin in priprava. Reaktorji za izdelavo jekel. Metalurška in procesna tehnika izdelave jekla: Ravnotežja: železo-kisik, železo- ¬kisik-silicij, železo-kisik-mangan, železo-kisik-fosfor, železo-kisik-žveplo, železo-kisik-krom, železo-kisik-titan, železo-kisik-volfram, ogljik-krom. Termodinamične in kinetične osnove. Obločna peč: Konstrukcija. Priprava peči, vložek in zakladanje, taljenje, oksidacija, redukcija, razžveplanje, dezoksidacija, legiranje. Obzidava peči in obraba ognjevzdržnega gradiva, reakcije med žlindro, talino in obzidavo. Kakovost izdelanega jekla, merjenje kisika in izračun dezoksidantov. Tehnologija taljenja s starim železom in grodljem. Staro železo in ogljik, metalizirani peleti, briketi. Električna oprem, regulacija, elektrode. Sestava žlindre pri izdelavi jekla, Zaščita okolja. Ekonomski kazalci proizvodnje. Dezoksidacija: Reakcija med kisikom v talinah in dezoksidanti, produkt dezoksidacije. Dezoksidanti in legirni elementi. Sestava, načini legiranja in dezoksidacija. Metalurgija izdelave jekla izven talilnega agregata: Postopki izdelave jekla v loncu. Vakuum v metalurgiji. Argon za mešanje talin. Tehnika izdelave jekla v kombinaciji obločna peč – izven pečna obdelava talin. Reakcije med talino in žlindro v odvisnosti od sestave taline, metalurške možnosti postopkov, primeri izdelave raznih vrst jekel. Čistost jekla, ogrevanje taline, termodinamične, kinetične in procesno metalurške in tehnološke zakonitosti. Priprava taline za nadaljnjo obdelavo in izdelavo želene vrste jekla v loncu. Redukcija žlinder. Konvertor: Rafinacijski konvertor (MRP). Žilavenje s kisikom in mešanico inertni plin - kisik. Energija mešanja, metalurgija procesa, kinetika reakcij. Indukcijske peči: Indukcijsko ogrevanje, sestava vložka, pretaljevanje, reakcija med žlindro in talino, žlindro in steno peči, legiranje, dezoksidacija, oksidacija elementov, razžveplanje. Izdelava raznih vrst jekla, izračun vložka in dodatkov. Žlindre: Nastajanje žlinder, vpliv MgO, MnO, Al2O3 na sistem CaO-SiO2-FeO. Sintetične žlindre, raztapljanje apna obraba ognjevzdržnega materiala, Žlindre pri izdelavi raznih vrst jekel v obločnih pečeh, žlindre in oksidacija elementov, redukcija žlinder . Nekovinski vključki v talinah: Nastajanje vključkov. Rast, velikost, sestava med izdelavo jekla in med vlivanjem. Izločanje vključkov, nekovinski vključki v sistemu FeO-MnO-SiO2, CaO-Al2O3, Al2O3, oksisulfidi, MnS, CaS, FeO.Cr2O3, MgO. Velikost vključkov v jeklu, razdelitev. Izdelava čistega jekla.	Na2O, SiO2-Al2O3-K2O (Na2O). Fuel: Solid, liquid and gaseous fuels for the production of pig iron, steel, ferroalloys. Auxiliaries; Slag making additions. Refractories, insulation, exothermic agent. Steelmaking: Steel grades, alloying elements. Properties of raw materials and their preparation. Reactors for steelmaking. Metallurgical and process engineering steelmaking: Balances: iron-oxygen, iron-oxygen-silicon, iron-oxygen-manganese, iron-oxygen-phosphorus, iron-oxygen-sulphur, oxygen-iron-chromium, iron-oxygen-titanium, iron-oxygen-tungsten and carbon-chrome. Basics of reactions thermodynamic and kinetic. Arc furnace: Construction. Furnace preparation, charge and charging, melting, oxidation, reduction, desulphurization, deoxidation, alloying. Furnace linings and wear of refractory material, the reaction between the slag, melt and lining. The quality of produced steel, oxygen measurement and calculation of deoxidizers. Melting of scrap iron and pig iron. Scrap and carbon, metallized pellets, briquettes. Electrical equipment, control systems, electrodes. Slag composition in steelmaking. Protection of the environment. Economic indicators of production. Deoxidation: The reaction between the oxygen in melts and products of deoxidation. Deoxidizers and alloying elements. Structure, methods of alloying and deoxidation. Metallurgy of steelmaking outside the melting aggregate: Methods of producing steel in a ladle. The vacuum in metallurgy. Mixing of melts with argon. The technique of producing steel in combination arc furnace - ladle processes. The reactions between the melt and slag and influence of the composition of the melt, the possibility of metallurgical processes, examples of producing various steel grades. Steel cleanness, melt heating, thermodynamic, kinetic and process-metallurgical and technological basis. The preparation of the melt for further processing and manufacture of the steel grade in the ladle. Reduction of slags. Converter: Refining converter (MRK). Refining with oxygen and mixture of inert gas-oxygen. Mixing energy, metallurgy processes, kinetics of reactions. Induction furnace: Induction heating, the composition of the charge. Remelting, reactions between slag, melt and furnace wall, alloying, deoxidation, oxidation of elements, desulphurisation. Production of various steel grades, calculation of charge and alloys. Slags: Formation of slags, the influence of MgO, MnO, Al2O3 on the system CaO-SiO2-FeO. Synthetic slag, the dissolution of lime wear refractory material, slag in the manufacture of various steel grades in arc furnaces, slag and oxidation elements, reduction of slags. Non-metallic inclusions in melts: Formation of

Elektropretaljevanje pod žlindro. Vlivanje jekla: Pomožna sredstva pri vlivanju jekla: Ulivni sistemi, livne ponovce (lonci), vmesne ponovce, izlivki in izlivne šobe, drsna zapirala. Reakcije med ognjevzdržnim materialom pri vlivnih sistemih in talino, zaščita curka taline. Vlivanje v kokile: Hitrost in tehnika vlivanja, kristalizacija v ingotu in brami. Izceje. Livni prahovi in izolacijska sredstva. Pred začetkom predavanj in vaj bo študentom razdeljeno študijsko gradivo.	inclusions. Growth, size and composition during the steelmaking and during the casting process. Elimination of inclusions, non-metallic inclusions in the system FeO-MnO-SiO2, CaO-Al2O3, Al2O3, oxysulfide, MnS, CaS, FeO.Cr2O3, MgO. The size of the inclusions in the steel. Production of clean steel. Electro-slag remelting (ESR) Steel casting: Auxiliaries for casting steel: gating systems, the casting ladle, tundish and nozzle, sliding shutters. Reactions between the refractory material and the melt, the protection of the melt jet. Casting in moulds: Casting speed and technique, the crystallization ingot and slab. Segregations. The casting powders and insulating agent. Before the start of lectures and exercises students will be divided into study materials.

Temeljna literatura in viri/Readings:

Seshadri Seetharaman, Roderick Guthrie, Alexander McLean, Sridhar Seetharaman, H. Y. Sohn: Treatise on Process Metallurgy, Volume 1: Process Fundamentals, Elsevier, 2024 Seshadri Seetharaman, Roderick Guthrie, Alexander McLean, Sridhar Seetharaman, H. Y. Sohn: Treatise on Process Metallurgy, Volume 2: Process Phenomena, Elsevier, 2024 Pasquale Cavaliere: Hydrogen Assisted Direct Reduction of Iron Oxides , Springer, 2022 Seshadri Seetharaman, Roderick Guthrie, Alexander McLean, Sridhar Seetharaman, H. Y. Sohn: Treatise on Process Metallurgy, Volume 4: Industrial Production, Elsevier, 2024

Cilji in kompetence:	**Objectives and competences:**
/Jeklo, kot na nek način masovni material, z izrednimi mehanskimi in drugimi uporabnimi lastnostmi, uporabnikom omogoča široko področje uporabe. Osnovni cilj tega predmeta je študentom najprej prikazati pomen jekla kot nenadomestljivega materiala v razvoju družbe, povezane z vsemi okoljskimi problemi. Pri predmetu se bodo študenti naučili postopke izdelave jekla in ferozlitine. Predmet daje znanje o kemični sestavi in lastnostih jekla ter njihovo uporabnost. Študenti bodo dobili vpogled v pomen surovin kot so grodelj, staro železo in metalizirani peleti ter pomožna sredstva, ki jih rabimo za izdelavo kakovostnih vrst jekla. Teoretične osnove dobljene pri osnovnih predmetih, o posameznih delnih procesih, bodo povezali v tehnološki proces, s ciljem izdelati jeklo. Dobili bodo pravilen odnos do materiala in surovin, ter varčevanje z energijo in zaščito okolja. Učili se bodo izdelati razne vrste jekel, od nelegiranih do visoko legiranih in jih vliti po različnih postopkih ali pa kontinuirano in blizu končnih dimenzij. Študenti bodo dobili znanje o vodenju procesov in načrtovanju proizvodnje. Nadaljnji cilj je, da študenti pri tem predmetu nadgradijo znanje, ki so ga dobili pri predmetu Pirometalurgija železa in zlitin. Pridobljeno znanje in veščine bodo študentom omogočili, da bodo razumeli procese pri izdelavi jekla, da bodo sposobni inovativnega mišljenja in bo	Steel, as a mass material with exceptional mechanical and other functional characteristics, allows users a wide range of applications. The primary objective of this course is first to demonstrate the importance of steel as irreplaceable material in the development of society associated with any environmental problems. In this course students will also learn the process of steel- and ferroalloys making. It provides the knowledge about the chemical composition and properties of steel and their usefulness. Students will gain an insight into the importance of raw materials such as pig iron, scrap metal, metallized pellets and auxiliaries needed in production of high-quality steel grades. Theoretical basis gained in basic subjects and in the individual, partial processes will be interconnected to the technological process steelmaking process. The correct attitude to materials, raw materials will be gained with respect to the energy saving and environmental protection. Production of various steel grades, from non-alloy and high alloy which are casted by various methods in continuous casting machine and close to the final dimensions in moulds. Students will gain knowledge of process control and production planning. Another objective is that students build on the knowledge they obtained during the previous courses, i.e. Pyrometallurgy of iron and alloys. Learned knowledge and skills will enable students to

služilo kot osnova za nadaljnje, poglobljeno izobraževanje. Študenti bodo sposobni presojati procese tudi s stališča energetske učinkovitosti in s tem z zornega kota varstva okolja.	understand the processes of the steelmaking and to be able to innovative thinking. It will serve as a basis for further, in-depth working out. Students will be able to judge processes in terms of energy efficiency and the environmental protection.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študenti bodo nadgradili znanje, ki so ga dobili pri predmetu Pirometalurgija železa in zlitin. Razumeli bodo kako termodinamične in metalurške zakonitosti reakcij, ki nastopajo v postopku izdelave jekla. Študenti bodo dobili osnove, ki so potrebne za izdelavo kvalitetnih vrst jekla. Spoznali bodo osnovne agregate v katerih se izdeluje jeklo, dobili pregled nad postopki, ki se uporabljajo v jeklarski industriji. Znanje, ki ga bo pridobil pri tem predmetu je osnova za poglobljen študij posameznih faz v procesu izdelave jekla, kot so npr. izdelava jekla v elektroobločni peči, redukcijski in rafinacijski postopki, vakuumska metalurgija itd. Prav tako bodo razumeli osnovne termodinamične in metalurške reakcije, ki nastopajo v postopku izdelave jekla. Pridobljeno znanje bo študent lahko uporabil: pri inženirskem delu v proizvodnji, pri razvojnem in raziskovalnem delu, pri nadaljnjem samoizobraževanju itd. Na podlagi znanj pridobljenih pri tem predmetu bo študent sposoben nadgraditi znanje s pomočjo ustrezne literature. Glede na reaktorje, ki jih bo imel na razpolago in surovine, ki so na voljo, bo znal študent izbrati primerno tehnologijo za izdelavo jekla.	Students will build upon the knowledge they have obtained on the subject Pyrometallurgy of iron and alloys. They will understand thermodynamic and metallurgical sense of reactions that occur in the steel production process. Students will get the basics that are necessary for the production of quality steels. They will learn about basic aggregates used for steelmaking and get an overview of the procedures used in the steel industry. The knowledge gained in this course is the basis for in-depth studies of individual phases in the steel making process, such as production of steel in electric arc furnace, reduction and refining processes, vacuum metallurgy, etc. The acquired knowledge will use in the steel production, development and research work, for further self-education, etc. Based on the knowledge gained in this course the student will be able to upgrade skills through the relevant literature. According to the set of available reactors and raw materials the student will be able to choose the appropriate technology for steel making.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, seminarske in laboratorijske vaje, terenske vaje, samostojno delo	Lectures, seminars, tutorial and laboratory work, fieldwork, individual work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ustni izpit	60,00 %	oral exam
pisni izpit	20,00 %	examination
seminarska naloga in poročilo laboratorijskih vaj	20,00 %	seminar work and the report of the laboratory work

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

KNAP, Matjaž, BRADAŠKJA, Boštjan. Determination of the influence of steelmaking parameters on surface defects in quarto plates. Metals. 2023, vol. 13, iss. 3, str. 1-14. ISSN 2075-4701. DOI: 10.3390/met13030536. [COBISS.SI-ID 184934659]

BURJA, Jaka, TEHOVNIK, Franc, LAMUT, Jakob, KNAP, Matjaž. Alumothermic reduction of ilmenite in a steel melt = Alumotermična redukcija ilmenita v jekleni talini. Mater. tehnol., 2013, letn. 47, št. 2, str. 217-

222. [COBISS.SI-ID 976298]
LAMUT, Jakob, FALKUS, Jan, JURJEVEC, Beno, KNAP, Matjaž. Influence of inclusions modification on nozzle clogging = Wpływ modyfikacji wtrąceń niemetalicznych na zarastanie wylewów zanurzeniowych. Archives of metallurgy and materials, 2012, vol. 57, no. 1, str. 319-324. [COBISS.SI-ID 1211231]
LAMUT, J., KNAP, M., TOLAR, M., ROZMAN, A.. Slag composition in making alloyed steel. V: MARKOVIĆ, Zoran S. (ur.). Proceedings. Bor: Technical Faculty, 2004, 2004, str. 618-626 [COBISS.SI-ID 528735]

PROCESNA METALURGIJA NEŽELEZNIH KOVIN

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Procesna metalurgija neželeznih kovin
Course title:	Process Metallurgy of Non-ferrous Metals
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067615
Koda učne enote na članici/UL Member course code:	662

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	20	0	10	75	5

Nosilec predmeta/Lecturer:	Jožef Medved
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v letnik	Entry in the academic year

Vsebina:	Content (Syllabus outline):
Kratek zgodovinski pregled metalurgije neželeznih kovin. Razdelitve neželeznih kovin in njihova uporabnost. Pregled postopkov pridobivanja neželeznih kovin iz primarnih in sekundarnih surovin, osnove fizikalno-kemičnih zakonitosti metalurških postopkov pridobivanja neželeznih kovin, ekonomika procesov. Osnove reciklaže sekundarnih surovin. Vplivi pridobivanja neželeznih kovin in zlitin na okolje. Eksplozivnost kovinskih prahov. Postopki pridobivanja posameznih kovin: aluminij, magnezij, titan, baker, svinec, cink, nikelj in plemenite kovine. Pri pridobivanju posameznih kovin se obravnavajo osnovne fizikalno-kemične lastnosti, obstoječe tehnologije pridobivanja od surovin, praženja, postopkov redukcij, rafinacij, obdelave	A brief historical overview of non-ferrous metal metallurgy. Distributions of non-ferrous metals and their applicability. Review of non-ferrous metal extraction processes from primary and secondary raw materials, basics of physico-chemical laws of metallurgical non-ferrous metal extraction processes, process economics. Basics of recycling of secondary raw materials. Environmental impacts of non-ferrous metals and alloys extraction. Explosiveness of metal powders. Processing of individual metals: aluminium, magnesium, titanium, copper, lead, zinc, nickel and precious metals. In the extraction of individual metals, the basic physico-chemical properties, existing technologies of extraction from raw materials, roasting, reduction processes, refining, melt

taline, postopkov ulivanja polproizvodov in uporabnosti. Pridobivanje kovinskih prahov. Vsa teoretična znanja pridobljena na predavanjih bodo podprta s seminarjem (študentje izdelajo seminar iz področja pridobivanja posebnih kovin), računskimi in laboratorijskimi vajami ter terenskim delom (opravi se ternsko delo v proizvodnji sekundarne metalurgije svinca in izdelave akumulatorjev ter proizvodnje aluminija in aluminijevih zlitin.	processing, semi-finished product casting processes and usability are considered. Extraction of metal powders. All theoretical knowledge acquired in lectures will be supported by a seminar (students make a seminar in the field of extraction of special metals), computational and laboratory exercises and field work (field work is performed in the production of secondary lead metallurgy and batteries and aluminium and aluminium alloys).

Temeljna literatura in viri/Readings:

MEDVED, Jože. Procesna metalurgija neželeznih kovin: z računskimi primeri in praktikumom. Ljubljana: Oddelek za materiale in metalurgijo, Naravoslovnotehniška fakulteta, 2014.
VONČINA, Maja. Procesna metalurgija neželeznih kovin: računski primeri z rešitvami. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2018.
G.E. Totten, D.S. MacKenzie. Handbook of Aluminum, Marcel Dekker, Inc.,2003.
F. Habashi, Fathi. Principles of Extractive Metallurgy, Taylor &Francis Grup, London, 2017.
Handbook of Extractive Metallurgy, Edited by Fathi Habashi, Volume I., II., III., VCH Verlagsgesellschaft mbH – A Wiley company, 1997.
J. Medved, Procesna metalurgija neželeznih kovin, Laboratorijski praktikum, NTF, 2021.

Cilji in kompetence:	**Objectives and competences:**
Cilji: študente naučiti fizikalno-kemične osnove in tehnologije pridobivanja neželeznih kovin od surovin do končnih polproizvodov ter njihove uporabnosti. Kompetence: študentje bodo spoznali procese pri pridobivanju aluminija, magnezija, titana, bakra, svinca in cinka. Predavanja se dopolnjujejo z računskimi in laboratorijskimi vajami ter terenskim delom, ki omogočajo boljše razumevanje in predstavo metalurških procesov.	Objectives: To teach students the physical-chemical bases and technology of obtaining non-ferrous metals from raw materials to finished and semi-finished their usefulness. Competences: Students will learn about the processes for obtaining aluminium, magnesium, titanium, copper, lead and zinc. The lectures are complemented with computational and laboratory exercises and field work, which allow a better understanding and performance metallurgical processes.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent spozna zgodovino razvoja kovin, glavne surovine za pridobivanje kovin, načine in postopke pridobivanja kovin iz rud, seznani se z napravami s katerimi se v procesu pridobivanja srečuje. Študent se tudi seznani z pravili o varstvu okolja ter ekonomiki procesov.	Knowledge and understanding: Students learn about the history of the development of metal, the main raw material for the production of metals, methods, and procedures for obtaining metals from ores, recognize the devices which are in the process. Students are also acquainted with the rules on the protection of the environment and the economics of processes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarske vaje, laboratorijske vaje in terensko delo	Lectures, tutorials , laboratory work and field work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) Oddan laboratorijski praktikum in opravljeno terensko delo	30,00 %	(a) Submitted laboratory practicum and fieldwork done
(b) pisni izpit, ki ga lahko študent opravi z 2 kolokvijema in prinese h končni oceni	30,00 %	(b) examination, which can be done by a student 2 colloquia and bring the final grade

(c) ustni izpit, ki prinese h končni oceni	40,00 %	(c) an oral exam , which brings the final grade

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

MEDVED, Jože, VONČINA, Maja, KLANČNIK, Grega, MRVAR, Primož. Thermodynamic modeling as a support for optimization of aluminium materials and technologies. V: Mednarodno 52. livarsko posvetovanje = International 52nd Foundry conference, 12.-14. September 2012, Portorož, Slovenia. Zbornik referatov 52. mednarodnega livarskega posvetovanja, Portorož 2012 = Conference proceedings 52nd International Foundry Conference Portorož 2012, 12.-14. September 2012. Ljubljana: Društvo livarjev Slovenije, 2012, 17 str.
SALIHAGIĆ HRENKO, Haris, **MEDVED, Jože**. Managing in the electrolysis process by integrating in situ measurment of the bath's properties. JOM : The journal of minerals, metals and materials society, 2018, vol. 70, no. 9, str. 1883-1886.
VONČINA, Maja, PAULIN, Irena, **MEDVED, Jože**, PETRIČ, Mitja. Predicting the quality of grain refiners from electrical resistance measurements of aluminum. Metals. 2023, vol. 13, iss. 4, str. 1-12. ISSN 2075-4701. [COBISS.SI-ID 147990019]
VONČINA, Maja, KRESNIK, Kristijan, VOLŠAK, Darja, PETRIČ, Mitja, **MEDVED, Jože**. Enthalpy balance of process path of the sheet production from EN AW 5182 aluminium alloy. Journal of thermal analysis and calorimetry. 2023, 148, 1241-1249.
MEDVED, Jože, KORES, Stanislav, BALAŠKO, Tilen, VONČINA, Maja. Vpliv manjšega dodatka legiranih elementov na aluminijeve livarske zlitine = influence of minor alloying element addition on aluminium casting alloys. *Livarski vestnik : glasilo Društva livarjev Slovenije*. 2019, letn. 66, št. 3, str. 191-202, [COBISS.SI-ID 1839199]

PROCESNI IN LIVARSKI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Procesni in livarski praktikum
Course title:	Process and Foundry Practicum
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067601
Koda učne enote na članici/UL Member course code:	378

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
15	0	60	0	0	75	5

Nosilec predmeta/Lecturer:	Mitja Petrič, Primož Mrvar, Tilen Balaško
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za vključitev v delo je vpis v tekoči letnik in predhodno ali vzporedno obiskovanje predavanj in vaj iz matematike, fizike, kemije, računalništva, metalografije, strojništva, toplotne tehnike, termodinamike	Prerequisites defined in the Regulations on checking and assessing students at UL NTF. For a positive and successful Prerequisites and involvement in academic work is recommended to regularly attend lectures deal with additional increasingly complex homework and corresponding pre-treatment before carrying out laboratory work and demonstrated activity and at least 80 % attendance at tutorials. Requirement for involvement into the work is enrolment into current academic year or parallel course of study of lectures, tutorials of Math, Physics, Chemistry, Computer science, Metallography, Mechanical engineering, Thermal technique, Thermodynamics.

Vsebina:	**Content (Syllabus outline):**
/Praktično delo v specializiranem livarskem laboratoriju. Praktikum obsega vse sekvence v procesno-livarski tehnološki verigi: priprave peščene mešanice, izbira modelne naprave z	Practical work in a specialised foundry laboratory. Practical course comprises all of the sequences from process-foundry technological chain: preparations of sand mixtures, choice of pattern with gating and

elementi ulivnega in napajalnega sistema, formanje, namestitev in inštrumentacija livne votline s termočleni, priprave taline z ustreznim udrobnjevanjem in modificiranjem evtektika, litjem, podiranjem enkratne forme, peskanjem, odstranitvijo elementov ulivnega in napajalnega sistema, analizo ohlajevalne krivulje, in primerjanje z izračunano s simulacijskim programom, jemanje vzorcev za analizo mikro in makro strukture, ročna preparacija vzorcev, opazovanje in analiza pod stereo in metalografskim mikroskopom. Sledi sinteza rezultatov na relaciji spremljanje strjevanja z enostavno termično analizo v ulitku kot funkcija lokalne ohlajevalne hitrosti (posamezna debelina stene ulitka), mikro, makro struktura ter livarske napake, ustrezen fazni diagram. Študent izdelani ulitek odnese domov kot lasten izdelek.	feeding system, moulding, instrumentation of casting cavity with thermo-couples, preparation of melt wit additions of grain refining and modifying agents, casting, mould dismantle, sand blasting of a casting, cutting off the gating and feeding system, analysis of cooling curves and comparison with calculated results, sampling for analyses of micro and macro structure, manual preparation of metallographic samples and optic microscopy. Followed by synthesis of results of thermal analysis of a casting as a function of local cooling rate (wall thickness), micro and macro structure, and casting defects in correlation with phase diagram. Student produces his own product as a result of his work.

Temeljna literatura in viri/Readings:

MRVAR, P.: Preiskave peščenih mešanic, skripta, Naravoslovnotehniška fakulteta 2024.
KNAP, Matjaž. *Ekstraktivna metalurgija jekla : računske vaje za študente prve in druge stopnje : univerzitetni učbenik*. 1. izd. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2022. XII, 208 str., ilustr. ISBN 978-961-6047-98-2. [COBISS.SI-ID 127883267].

Cilji in kompetence:	**Objectives and competences:**
/Laboratorijski praktikum omogoča osvojitev kompleksnih kombinacij procesnih in livarskih veščin in tehničnih znanj s področja livarstva. Praktikum obsega vse sekvence na relaciji priprave peščene mešanice, formanje, namestitev in inštrumentacija livne votline s termočleni, priprave taline z ustreznim udrobnjevanjem in modificiranjem evtektika, litjem, podiranjem enkratne forme, peskanjem, odstranitvijo elementov ulivnega in napajalnega sistema, analizo ohlajevalne krivulje, in primerjanje z izračunano s simulacijskim programom, jemanje vzorcev za analizo mikro in makro strukture, ročna preparacija vzorcev, opazovanje in analiza pod stereo in metalografskim mikroskopom. Sinteza rezultatov na relaciji spremljanje strjevanja z enostavno termično analizo kot funkcija lokalne ohlajevalne hitrosti (posamezna debelina stene ulitka), mikro, makro struktura ter livarske napake, ustrezen fazni diagram. Študent izdelani ulitek odnese domov kot lasten izdelek. Praktikum dopolnjuje teoretično pridobljena znanja pri predmetih Procesi v tekočem, Livarstvo ter Materiali in lastnosti.	Laboratory practicum enables to conquer the complex process and foundry techniques and technical knowledge from the field of casting. Practicum comprises all of the sequences from process-foundry technological chain: preparations of sand mixtures, choice of pattern with gating and feeding system, moulding, instrumentation of casting cavity with thermo-couples, preparation of melt wit additions of grain refining and modifying agents, casting, mould dismantle, sand blasting of a casting, cutting off the gating and feeding system, analysis of cooling curves and comparison with calculated results, sampling for analyses of micro and macro structure, manual preparation of metallographic samples and optic microscopy. Followed by synthesis of results of thermal analysis of a casting as a function of local cooling rate (wall thickness), micro and macro structure, and casting defects in correlation with phase diagram. Student produces his own product as a result of his work. Practicum supplements the theoretical knowledge from the courses such as Processes in Liquid state, Casting and Materials and properties.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent zna v celoti v skladu z znanstveno in tehnološko prakso ročnega formanja izdelati kakovostno formo, litino, ki jo oplemeniti in ulitek s potrebno mehansko finalizacijo. Osvoji ključne	Knowledge and understanding: Student is able to produce the mould, to prepare the melt, to cast and finish the casting in the theoretical and scientific way. Student conquers basic casting

livarske napake, pri čemer poveže, posname in okarakterizira njihov nastanek z eksperimentalnimi metodami in ga izčrpno opredeliti v obliki tehničnega poročila. Metode so opredeljene v vsebini. Znanje je uporabno pri načrtovanju in izdelavi ulitkov s tehnologijo gravitacijskega litja v enkratne forme, izdelava litine, kontrolne metode. Študent mora znati samostojno izdelati formo, optimalno udrobnjevati in modificirati evtektik, gravitacijsko ročno uliti in finalizirati ulitek. Študent se pri laboratorijskih vajah iz livarstva seznani s potrebnim metodičnim in natančnim pristopom pri delu z merilnimi napravami, računalniki, mikroskopi in pisanjem poročil o svojem delu.	defects and characterizes the way they are formed by experimental methods and at the end writes the technical report. Methods are presented in Content. Knowledge is usable at planning and production of castings by gravity casting in sand moulds, preparation of the melt, control methods. Student is able to individually manufacture the mould, add optimal amount of modifier and grain refiner into the melt, gravity cast the casting and finalize the casting. Student learns about methodical and precise work with measuring devices, computers, microscopes and writing reports about his work in laboratory courses.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Laboratorijske vaje	Laboratory courses

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Sprotno poročilo o izvedenih laboratorijskih vajah istega dne, ko so bile le te izvedene in opisane v izčrpnem tehničnem poročilu.	100,00 %	Formative writing of a report on the laboratory courses of the same day when they were made and only those described in the comprehensive technical report.

Ocenjevalna lestvica:	**Grading system:**
opravil z odliko/opravil/ni opravil	passed with distinction/passed/failed

Reference nosilca/Lecturer's references:

MRVAR, Primož, PETRIČ, Mitja, MEDVED, Jože. Influence of cooling rate and alloying elements on kinetics of eutectoid transformantion in spheroidal graphite cast iron. V: NOFAL, Adel (ur.), WALY, Mohamed Attia (ur.). *Science and processing of cast iron IX : selected, peer reviewed papers from the Ninth international symposium on science and processing of cast iron, Luxor, Egypt, November 10-13, 2010*, (Key engineering materials, ISSN 1013-9826, vol. 457, 2011). Zürich: Trans tech publications, 2011, str. 163-168. [COBISS.SI-ID 1086559]

PETRIČ, Mitja, MEDVED, Jože, MRVAR, Primož. Effect of modification on shrinkage of Al alloys. Part 2 = Vpliv modificiranja na krčenje Al zlitin. Del 2. V: *Zbornik referatov 50. mednarodnega livarskega posvetovanja, Portorož 2010 = Conference proceedings*. Ljubljana: Društvo livarjev Slovenije, 2010, str. 82-83. [COBISS.SI-ID 1064031]

PETRIČ, Mitja, MRVAR, Primož, MEDVED, Jože. Vpliv modificiranja na krčenje Al zlitin = Effect of modification on shrinkage of Al-alloys. V: Mednarodno 49. livarsko posvetovanje = International 49th Foundry conference, 9.-11. september 2009, Portorož, Slovenia. *Zbornik referatov mednarodnega 49. livarskega posvetovanja, Portorož 2009 = Conference proceedings*. Ljubljana: Društvo livarjev Slovenije, 2009, 8 str. [COBISS.SI-ID 959583]

BURJA, Jaka, TEHOVNIK, Franc, LAMUT, Jakob, KNAP, Matjaž. Alumothermic reduction of ilmenite in a steel melt = Alumotermična redukcija ilmenita v jekleni talini. Mater. tehnol., 2013, letn. 47, št. 2, str. 217-222. [COBISS.SI-ID 976298]

LAMUT, Jakob, FALKUS, Jan, JURJEVEC, Beno, KNAP, Matjaž. Influence of inclusions modification on nozzle clogging = Wpływ modyfikacji wtrąceń niemetalicznych na zarastanie wylewów zanurzeniowych. Archives of metallurgy and materials, 2012, vol. 57, no. 1, str. 319-324. [COBISS.SI-ID 1211231]

LAMUT, J., KNAP, M., TOLAR, M., ROZMAN, A.. Slag composition in making alloyed steel. V: MARKOVIĆ, Zoran S. (ur.). Proceedings. Bor: Technical Faculty, 2004, 2004, str. 618-626 [COBISS.SI-ID 528735]

ZEKA, Bastri, MARKOLI, Boštjan, MRVAR, Primož, MEDVED, Jože, PETRIČ, Mitja. Suitability of moulding materials for Al-Li alloy casting = Primetnost formarskih materialov za litje Al-Li zlitin. *Materiali in tehnologije*. [Tiskana izd.]. mar.-apr. 2021, letn. 55, št. 2, str. 311-316, ilustr. ISSN 1580-2949. https://mater-tehnol.si/index.php/MatTech/article/view/134/48, DOI: 10.17222/mit.2020.208.

PROIZVODNI SISTEMI V TRDNEM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Proizvodni sistemi v trdnem
Course title:	Production Systems in Solid State
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067602
Koda učne enote na članici/UL Member course code:	981

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
60	0	30	0	0	90	6

Nosilec predmeta/Lecturer:	Goran Kugler, Milan Terčelj
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za v delo je vpis v letnik študija.	Enrollment in the year of study.

Vsebina:	Content (Syllabus outline):
/Obravnavali bodo naslednji sklopi za hladna, topla in vroča stanja materialov ter različna začetna mikrostrukturna stanja: -splošna teorija preoblikovalnosti in aplikacija na masivno preoblikovanje (problemi preoblikovalnosti, osnove načrtovanja procesov preoblikovanja) -krivulje tečenja in njihov opis z matematičnimi modeli in sklepanje na procese v materialu iz oblik krivulj tečenja , -osnovni vplivi temperature, deformacije in hitrosti deformacije na preoblikovalno trdnost in izoblikovano mikrostrukturo, -osnovni vpliv kemične sestave in procesnih parametrov na procese utrjevanja, poprave, rekristalizacije in fazne premene, -osnove dinamične poprave, dinamične rekristalizacije, metadinamične rekristalizacije in statične rekristalizacije,	Next chapters referring to cold, warm and hot state of metallic materials as well as for different initial microstructural states will be presented: - general theory of workability and application on massive forming processes (problems of workability, basic of planning of massive forming processes), - Flow curves and their description by mathematical models and suggestions (deductions) on relevant processes from shape of flow curves, - General influences of temperature, strain and strain rate on flow stresses and on obtained microstructure, - General influences of chemical composition and process parameters on processes related to hardening, recovery, dynamic as well as metadynamic and static recrystallization, - Empirical model for describing of

-empirični modeli za razvoj mikrostrukture med preoblikovanjem in po preoblikovanju, -fizikalni modeli za razvoj mikrostrukture -tribologija pri preoblikovanju (prestop toplote), -procesne mape in uporaba različnih kriterijev določitev področij koeficientov učinkovitosti porazdelitve energije, stabilnega oz. nestabilnega toka materiala v preoblikovancu ter določitev okna varnega preoblikovanja ter optimalnega področja preoblikovanja, -eksperimentalne metode za določevanja preoblikovalnosti in njeno kvantitativno ovrednotenje -vrste in karakteristike preoblikovalnih strojev, njihove delovne zmogljivost, doseganja ter možnosti variiranja (izbire) procesnih parametrov, - orodja za preoblikovanje, oblikovanje, materiali, obremenitve, življenska doba -osnovni vplivi preoblikovalnih strojev na dimenzije in oblike preoblikovancev, -analiza poteka procesnih (preoblikovalnih) parametrov na realnem preoblikovalnem postopku, t.j. deformacij, hitrosti deformacij, temperature na relevantnih mestih preoblikovanca, -laboratorijska simulacija analiziranih procesnih parametrov --izbira relevantnih preoblikovalnih strojev (karakteristike) za preoblikovanje, koraki za uspešen prenos laboratorijskih rezultatov o preoblikovalnosti v prakso (kovanje, valjanje, vlečenje, iztiskanje) in načrtovanje procesov za jekla, Al zlitine, Mg zlitine ter Cu zlitine, -termomehansko procesiranje kovinskih materialov s kontroliranim valjanjem, -Pomen obravnavanja izdelave materialov in produktov na osnovi pristopa s procesnimi verigami za doseganje končnih lastnosti, ter oblik in dimenzij produktov.	microstructure development during forming and after forming, - Physical models for describing of microstructure development, - Tribology during metal forming processes (heat transfer), - Processing maps and using of different criterions for determination of regions of values for coefficient of efficiency of energy dissipation, stable and unstable regions of material flow, determination of windows of safe hot working and region of optimal hot working, - Experimental methods for determination of workability and their quantitative estimation, - Type and characteristics of forming equipments, their capabilities, possibility of variation (selection) of appropriate process parameters, - Forming dies, shaping of dies, materials, loads, service time, - General influences of forming equipments on dimensions and shape of product, - Analysis of course of process (deformation) parameters on real deformation process, i.e. strains, strain rates and temperature on relevant areas of workpiece, - Laboratory simulation of analyzed deformation parameters, - Selection of relevant and appropriate forming equipment (characteristics) for deformation process, - Steps for successful transfer of laboratory results about workability in practice (forging, rolling, drawing, extrusion) and planning of these deformation processes, - Thermo-mechanical processing of metallic materials with controlled rolling, - Relevance of considering of material processing and manufacturing of products on base of process chain approach for achieving of final properties, shape and dimensions of products.

Temeljna literatura in viri/Readings:

/R. Turk, G. Kugler, M. Terčelj, D. Bombač: Preoblikovanje kovinskih materialov, UL-NTF, OMM, 2008 (elektronska in tiskana verzija),
J.G. Lenard, M. Pietrzyk, L.Cser, Mathematical and Physical Simulation of the Properties of Hot Rolled Products; 1999,
E.Doege, B.A. Behrens, Handbuch Umformtehnik; 2007,
K.F. Karhausen, Intergrierte Process- und Gefuegesimulation bei der Warmumformung; 1994,
F.J. Humpreys, M. Hathertly, Recrystallization and related annealing phenomena, 2004,
G.E. Totten, K.Funatani, L. Xie, Handbook of Metallurgical process design; 2004,
B. Verlinden, J. Driver, I. Samajdar, R. D. Doherty, Thermomechanical Processing of Metallic Materials; 2007.

Cilji in kompetence:	**Objectives and competences:**
/Študentje osvojijo metodološki pristop za načrtovanje tehnologije metalurških izdelkov z vnaprej predpisanimi lastnostmi ob upoštevanju	Students manage methodological approach for planning of technology of metallurgical products with prescribed properties considering properties of

lastnosti materiala, proizvodnimi karakteristikami strojev in naprav ter načina vodenja materiala skozi tak proces. Študent tako pridobi kompleksno znanje za načrtovanje celotne tehnologije. t.j. osvoji potrebno znanje za integriranje posameznih členov procesne verige v celoto s ciljem, zagotoviti izdelku njegove zahtevane lastnosti ne le geometrijske, dimenzijske in površinske pač pa tudi tiste, ki jih zagotavlja končna plastično predelana mikrostruktura. Vsebina predmeta zajema: znanje o procesih v materialu med ogrevanjem materiala ter zadrževanjem materiala na določeni temperaturi in sicer tako lite kot tudi za predelane mikrostrukture z upoštevanjem kinetike procesov, nadalje vrsti procesov v materialu ter njihovi kinetiki med/po vroči, topli in hladni predelavi materiala, izkoriščanju procesov v materialu za dosego načrtovanih končnih lastnosti materiala. Nadalje pridobijo znanje o vplivu karakteristik proizvodnih naprav (stroji in orodja) na kinetiko notranjih procesov v materialu ter oblike in dimenzije izdelka ter tako na določitev tehnoloških procesnih parametrov izdelave materiala v posameznih členih procesne verige ter vpliv karakteristik proizvodnih sredstev na dosego zahtevanih oblik in dimenzij na končne proizvode oz. pol-proizvode. Študent tako zna določiti osnovne parametre preoblikovanja, izbirati posamezna proizvodna sredstva oz. dajati predloge za izboljšanje procesa.	processed materials, characteristics of production equipments, as well as guiding of material during its processing. Student gain complex knowledge needed for planning of entire technology of production, i.e. gain the knowledge needed for integration of individual step of process chain in whole with aim to ensure demanded properties of product (not only geometrical, dimensional and surface finish but also final properties of plastic deformed microstructure). The content of the subject covers: knowledge of processes during heating of material and holding on prescribed temperature for wrought as well as as-cast states of material considering processes and their kinetic in materials, knowledge of processes during hot, warm and cold deformation and after deformation of material for wrought as well as as-cast states of material considering processes and their kinetic in materials, utilizing of processes taking place in material for achieving of desired final properties of material. Furthermore students gain required knowledge about influence of characteristics of production equipments (machines and dies) on kinetic of processes in material as well as shape, dimensions and surface finish of final product and thus also knowledge for determination of technological parameters of material production for each individual step of process chain. Furthermore, knowledge influence of characteristics of production equipments in entire process chain for achieving of desired shape and dimensions, surface finish and material properties of final semi- product will be gained. Thus student can determine basic parameters referring to deformation; he can select appropriate production equipment and can give suggestions for improvements of process.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent zna združevati karakteristike preoblikovalnih strojev in procese, ki potekajo v materialu med preoblikovanjem in ogrevanjem v celoto za dosego želenih končnih lastnosti, oblik in dimenzij izdelka. Razume pomen procesov v materialu jih kvantitativno ovrednoti z enostavnimi modeli	Knowledge and understanding: Student can combine characteristics of forming equipments and processes taking place in materials during deformation and heating in whole in order to achieve desired final properties related to microstructure, shape, dimensions and surface finish of product. Students understands relevance of processes in materials and can by simple models quantitative assess extend of these processes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, vaje, laboratorijske vaje, seminarji	Lectures, tutorial, laboratory practice, seminar work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) zagovori vaj in seminarja, ki prinesejo h končni oceni 30 %,	30,00 %	(a) defense of tutorial and seminar (30% contribution to final score)l,

(b) ustni izpit, ki prinese h končni oceni 70 %.	70,00 %	(b) oral examination (70% contribution to final score).

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. PERUŠ, Iztok, TERČELJ, Milan, KUGLER, Goran. Determination of scrap/supply probability curves for the mechanical properties of aluminium alloys in hot extrusion using a neural network-like approach. Expert syst. appl.. 2012, vol. 39, no. 5, str. 5634-5640
2. FAZARINC, Matevž, TERČELJ, Milan, BOMBAČ, David, KUGLER, Goran. Transformation and precipitation kinetics in 30Cr10Ni duplex stailess steel. Metall. mater. trans., A Phys. metall. mater. sci., 2010, vol. 41A, september, str. 2197-2207
3. KUGLER, Goran, TURK, Radomir. Modeling the dynamic recrystallization under multi-stage hot deformation. Acta mater., 2004, vol. 52, no. 15, 4659-4668 str

;1. TERČELJ, Milan, FAZARINC, Matevž, KUGLER, Goran, PERUŠ, Iztok. Influence of the chemical composition and process parameters on the mechanical properties of an extruded aluminium alloy for highly loaded structural parts. Constr. build. mater. 2013, vol. 44, str. 781-791
2. VEČKO PIRTOVŠEK, Tatjana, KUGLER, Goran, GODEC, Matjaž, TERČELJ, Milan. Three important points that relate to improving the hot workability of ledeburitic tool steels. Metall. mater. trans., A Phys. metall. mater. sci., 2012, vol 43, no 10, pp 3797-3808
3. TERČELJ, Milan, SMOLEJ, Anton, FAJFAR, Peter, TURK, Radomir. Laboratory assessment of wear on nitrided surface of dies hot extrusion of aluminium. Tribol. int., 2007, vol. 40, iss. 2, str. 374-384

PROJEKTNI MANEDŽMENT

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Projektni manedžment
Course title:	Project Management
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100786
Koda učne enote na članici/UL Member course code:	550

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	15	15	0	0	60	4

Nosilec predmeta/Lecturer:	ALJAŽ STARE
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo je vpis v letnik študija; pogoj za opravljanje izpita je izdelana seminarska naloga.	The condition for the examination is a prepared corsework.

Vsebina:	Content (Syllabus outline):
/1 UVOD V MANAGEMENT PROJEKTOV - opredelitev projektov (vrste, značilnosti, življenjski cikel),namen, obseg in cilji projekta, udeleženci projektov in njihove vloge, opredelitev in področja managementa projektov, osebnostne lastnosti in veščine managerjev projektov 2 ZAČETEK/SNOVANJE PROJEKTA - proces snovanja in naročilo projekta,povezanost strategij in projektov 3 PRIPRAVA PROJEKTA - planiranje aktivnosti, rokov, stroškov, ljudi in drugih virov(klasično in s podporo MSP), plan obvladovanja projektnih tveganj, mesto projekta v organizaciji združbe, organigram deležnikov projekta, matrika pristojnosti in odgovornosti 4 VODENJE PROJEKTNEGA TIMA - stili	1 INTRODUCTION TO PROJECT MANAGEMENT - project definition (types, characteristics, life cycle), the goal, scope and objectives of the project, project stakeholders and their roles, project management definition and areas, personal characteristics and skills of project managers 2 PROJECT START/INITIATION – initiation process and project charter, strategies and projects 3 PROJECT PLANNING - planning the activities, schedule, costs, human and other resources (using MS project), project risk management, project organization, resource breakdown structure, responsibilities and competence matrix 4 TEAM LEADERSHIP - leadership styles, teamwork, motivation, communication, conflict resolution

vodenja, timsko delo, motiviranje, komuniciranje v timu, reševanje konfliktov 5 KONTROLIRANJE PROJEKTA - proces in področja kontroliranja, spremljanje poteka projekta, kontroliranje rokov, stroškov, kakovosti in tveganj, informacijski sistem za podporo kontroli 6 ZAKLJUČEVANJE PROJEKTA - zaključevanje del, dokumentiranje, administrativni zaključek, razpustitev tima	5 PROJECT CONTROL - control process and areas, project tracking, time, cost, quality and risk control, project information system support 6 PROJECT CLOSURE – completion of works, documentation, administrative closure and team disbanding

Temeljna literatura in viri/Readings:

/Obvezna literatura
Rozman, R., Stare, A., 2008. Projektni management ali ravnateljevanje projekta (učbenik). * Prosojnice predavanj

Izbirna literatura
Stare, A., 2011. Projektni management: teorija in praksa. * Andersen, E.S., et.all, 2009, Goal directed project management. * Burke, R., 2010, Fundamentals of PM. * Coupin, G., et. all, 2006, ICB International Competence Baseline. * Harrison, F., Lock, D., 2004, Advanced project management. * Kerzner, H., 2009, Project management: a systems approach. * Lewis, J.P., 2006, Fundamentals of project management. * Lock, D., 2007, Project management. * Meredith, J.R., Mantel, S.J., 2009, Project management: a managerial approach. * Milošević, D., 2003, Project management toolbox. * Pinto, J.K., 2009, Project management. * PMI, 2008, A guide to the project management body of knowledge. * Turner, J.R., 2009, The Handbook of Project-based Management. * Verzuh, E., 2008, The fast forward MBA in project management. * Wysocki, R.K., 2009, Effective project management. * Young, T.L., 2007, The handbook of project management.

Revije: ZPM - Projektna mreža Slovenije, IPMA - International journal of project management
Internet: www.projektni-management.si

Cilji in kompetence:	**Objectives and competences:**
/Naučiti in usposobiti študente za management enostavnih projektov. Študentje bodo: - spoznali vrste projektov in zahtevnost management le-teh - spoznali ozadje raznih vrst projektov, razloge za izvedbo in dejavnike izbire - razumeli in znali izvajati korake managementa projektov: planiranje, uveljavljanje in kontroliranje - spoznali orodja, metode in tehnike managementa projektov - seznanjeni z zaključevanjem projekta	Teach and train students for management of less complex projects. Students will - recognize types of projects and the complexity of the management of these - become aware about the background of various types of projects, the reasons for the implementation and selection factors - understand and be trained to implement steps of project management: planning, implementation and control - learn about tools, methods and techniques of project management - be familiar with the project closure

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Razumevanje pojmov, zakonitosti, pojavov, značilnosti projektov in z njimi povezanega projektnega managementa. Uporaba spoznanj projektnega managementa v konkretnih projektih z različnimi značilnostmi. Pripravljenost na ustrezna odstopanja prakse od teorije projektnega managementa. Sposobnost razmišljanja vnaprej; ločevanje celote in bistva od posameznih delov; povezovanje delov v celoto; spretnost sodelovanja v in s timom.	Understanding of concepts, lawfulness, phenomena, characteristics of projects and related project management. Using knowledge of project management in concrete projects with different characteristics. Preparedness for deviations from the practice and project management theory. Ability to think ahead, and to separate of whole essence of the individual parts, integration of parts into a whole. Ability to participate in the team and with the team.

Metode poučevanja in učenja:	Learning and teaching methods:
/Predavanja in razprava, poglabljanje snovi s primeri; usposabljanje za delo s programskim orodjem za planiranje projektov. Izdelava primera seminarske naloge - plana projekta. Obisk podjetij in seznanjanje s projekti v praksi.	Lectures and discussion, presentation of examples and cases studies, MS project (project planning SW)training. The preparation of the sample of a project plan (coursework).

Načini ocenjevanja:	Delež/Weight	Assessment:
/Pisni izpit - 60%	60,00 %	Examination - 60%
Projekt - 40%	40,00 %	Project - 40%

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

Preko 20 let dela na projektih v praksi, 15 let kot manager projektov, mednarodno certificiran projektni manager (IPMA Certified Senior Project Manager).

Predsednik Slovenskega združenja za projektni management med leti 2006 in 2010, urednik znanstvene revije (2008-2009), programski vodja osrednje letne konference s področja projektnega managementa "ZPM forum" v letih 2004, 2005, 2009.

11 objavljenih prispevkov v revijah, 27 prispevkov na konferencah. Mentor pri 44 diplomskih nalogah.
Pomembnejši prispevki:
1. STARE, Aljaž. The impact of a project organisational culture and team rewarding on project performance. Journal for East European Management Studies. 2012. Vol 17, iss. 1. ISSN 0949-6181.
2. STARE, Aljaž. Comprehensive management of project changes. Econ. bus. rev, 2010, vol. 12, no. 3, str. 195-210. ISSN: 1580-0466.
3. STARE, Aljaž. Reducing negative impact of project changes with risk and change management. Mibes trans. (Online), spring 2011, vol. 5, iss. 1, str. 151-165. ISSN 1790-9899.
4. STARE, Aljaž. The impact of the organisational structure and project organisational culture on project performance in Slovenian enterprises. Management, Journal of Contemporary Management Issues. 2011. Vol. 16, No. 2. ISSN 1846-3363

Monografija: Projektni management: teorija in praksa, 2011.
Osnove managementa projektov: www.projektni-management.si

RAČUNALNIŠKI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Računalniški praktikum
Course title:	Programming Practicum
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067592
Koda učne enote na članici/UL Member course code:	908

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	10	20	0	0	60	4

Nosilec predmeta/Lecturer:	Goran Kugler
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za v delo je vpis v letnik študija. Zaželeno je osnovno poznavanje uporabe računalnikov	Enrollment in the year of study. Basic computer skills are desirable.

Vsebina:	Content (Syllabus outline):
/Osnove programskega jezika C: - spremenljivke in konstante - formatirano branje in izpis - operatorji in izrazi - stavki - tabele in nizi - strukture - funkcije - kazalci - dinamična alokacija spomina - vhodno-izhodne funkcije - delo z datotekami Osnove objektno orientiranih jezikov - osnove programskega jezika C++	Basics of the C programming language: - Variables and constants - Formatted input/output - Operators and expressions - Statements - Arrays and strings - Structures - Functions - Pointers - Dynamic memory allocation - Input-output functions - Working with files Basics of object-oriented languages - The basics of the programming language C + +

Temeljna literatura in viri/Readings:

/• Navodila za vaje za praktikum • Priročniki in učbeniki za programske jezike

Cilji in kompetence:	**Objectives and competences:**
/Študentje pridobijo osnovno znanje o uporabi računalnikov in spoznajo osnovne tehnike programiranja ter se usposobijo za samostojno reševanje enostavnih problemov s pomočjo računalnika. Kompetence: pridobitev praktičnega znanja pri uporabi OS Linux in Windows. Predmet študenta vpelje v osnove programiranja v programskem jeziku C ter na primeru programskega jezika C++ predstavi osnove objektno-orientiranih jezikov. Pridobitev znanja algoritmičnega reševanja problemov. Sposobnost dela z računalnikom in pridobljene programerske spretnosti lahko študent uporabi pri predmetih, ki zahtevajo zahtevnejše računske postopke in računalniške simulacije procesov, ki jih študent spozna pri drugih predmetih.	Students acquire basic knowledge of using of computers; learn basic programming techniques and are trained for solving of simple problems using the computer. Competencies: obtaining practical skills in the use of Linux and Windows OS. The course introduces students to the basics of programming in C programming language and to the basics of object-oriented approach through programming language C + +. They obtain the knowledge of algorithmic problem solving. Both the ability to work with a computer and acquired programming skills can be used by students in courses that require knowledge of complex computational procedures and computer simulations of processes that are learned within the framework of other courses.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Pridobitev praktičnega znanja na področju uporabe računalnika. Osnovno programersko znanje in razumevanje algoritmičnega reševanja problemov. Uporaba znanja pridobljenega pri ostalih predmetih na širšem področju metalurgije in materialov in tudi na drugih področjih s pomočjo računalnika. Osnovna programerska pismenost je nepogrešljiva za uspešen študij. Brez osnovne računalniške pismenosti je moderen študij materialov in metalurgije nemogoč. Sposobnost programiranja omogoča uporabniku reševanje problemov, ki jih z drugimi aplikacijami ni mogoče rešiti.	Knowledge and understanding: Gaining practical knowledge and experience of employing computer in their work and research. Basic programming skills and understanding of algorithms and data structures which are required to solve a variety of programming problems. Knowledge how to use the algorithms in concrete programs: students will be able to implement the algorithms in programming language C and C++. Identifying the algorithms best suited for solving particular problems. Modern study of materials and metallurgy is impossible without basic computer literacy.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, izvedba praktikumskih vaj, priprava poročil, izvedba seminarske naloge in konzultacije.	Lectures, conducting practicum exercises, preparation of reports, conducting seminar and consultations.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Oddane in potrjene laboratorijske vaje. Oddan seminar in njegov zagovor. At least 80% attendance at exercises.	100,00 %	Submitted and approved laboratory exercises. Seminar defense. At least 80% attendance at exercises.

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

1. TURK, Radomir, KNAP, Matjaž, KUGLER, Goran. HFS-hot forging simulator. RMZ-mater. geoenviron., 2002, vol. 49, no. 1, str. 1-8.
2. KUGLER, Goran. Hot working activation energy calculator : HWAEC 1.0 : verzija 1.0. Ljubljana: Naravoslovnotehniška fakulteta, OMM, januar 2007. 1 optični disk (programska oprema)
3. TURK, Radomir, KUGLER, Goran, TERČELJ, Milan. Hot forming simulator : HFS 2.0. Ljubljana: Naravoslovnotehniška fakulteta, OMM, 2006 (programska oprema)
4. KUGLER, Goran, TURK, Radomir. Study of the influence of inital microstructure topology on the kinetics of static recrystallization using a cellular automata model. Comput. mater. sci., 2006, vol. 37, no. 3, str. 284-291

RECIKLAŽA MATERIALOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Reciklaža materialov
Course title:	Materials Recycling
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077542
Koda učne enote na članici/UL Member course code:	672

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
35	15	15	0	10	75	5

Nosilec predmeta/Lecturer:	Jožef Medved, Matjaž Knap
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj, reševanje dodatnih domačih bolj zahtevnih nalog in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah.	Liabilities are defined in the regulations on examination and evaluation of students at ULNTF. For a positive and successful attendance of their duties students are encourage to regular attendance of lectures, additional domestic more complex work more and appropriate preparing to laboratory work. At least 80% attendance at tutorials is needed.

Vsebina:	Content (Syllabus outline):
/• Ekološko in ekonomsko vrednotenje procesov recikliranja • Predpisi o varovanju okolja • Industrijsko recikliranje kovinskih materialov • Zmanjšanje porabe primarnih surovin pri proizvodnji in predelavi • Odpadki in emisije • Reciklaža žlinder • Aglomeriranje in reciklaža kovinskih in nekovinskih prahov • Procesi z manj odpadki	• Ecological and economic evaluation of recycling processes • Regulations on environmental protection • Industrial recycling metallic materials • Reduction of consumption of raw materials in production and processing • Waste materials and emissions • Slag recycling • Agglomerating and recycling of ferrous and non ferrous powders • Low waste processes

• Ekobilanca • Recikliranje v livarnah: kovinski in nekovinski materiali • Recikliranje jeklarskih proizvodov • Reciklaža krožnega materiala • Recikliranje v proizvodnji in predelavi barvnih kovin • Recikliranje bele pločevine • Recikliranje kovinske in druge embalaže • Recikliranje vozil • Recikliranje kovinskih/nekovinskih materialov, kjer je površina zaščitena s kovinsko ali nekovinsko prevleko • Recikliranje elektronskih materialov Pred začetkom predavanj in vaj bo študentom razdeljeno študijsko gradivo.	• Eco-balances • Recycling in foundries: metallic and non-metallic materials • Recycling of steel products • Recycling circular material • Recycling in the production and processing of ferrous metals • Recycling of tin plates • Recycling of metal and other packaging • Recycling of vehicles • Recycling of metallic / non-metallic materials, wherein the surface is protected by a metal or non-metal coating • Recycling of electronic materials Before the start of lectures and exercises study material will be presented to students.

Temeljna literatura in viri/Readings:

Sehliselo Ndlovu, Geoffrey S. Simate, Elias Matinde: Waste Production and Utilization in the Metal Extraction Industry, CRC Press, 2017 Thorvald Abel Engh, Principles of Metal Refining and Recycling, Oxford University Press 2022. Mark E. Schlesinger, Aluminum Recycling, 2nd Edition, CRC Press, 2017. Sehliselo Ndlovu, Geoffrey S. Simate, Elias Matinde: Waste Production and Utilization in the Metal Extraction Industry, CRC Press, 2017

Cilji in kompetence:	**Objectives and competences:**
/Osnovni smotri predmeta so seznaniti študente z zahtevami recikliranja sedanjih in novih odpadnih materialov iz ekonomskih in ekoloških vidikov.	The rudimentary aims of the course is to familiarize students with the requirements of the recycling of current and new waste materials from the economic and ecological point of view.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent mora razumeti osnovne pojme o recikliranju materialov, ter njihov pomen. Znanje je uporabno pri načrtovanju sodobnih procesov recikliranja in pogojev v katerih se le to izvaja. Študent mora znati povezati različne teoretične in eksperimentalne pristope pri reševanju problemov in se seznaniti z osnovnimi principi recikliranja. Osnovni pojmi o recikliranju materialov so povezani z ekonomskimi in ekološkimi vidiki sedanjih in materialov prihodnosti.	Students must understand the basic concepts of recycling materials, and their significance. Knowledge is useful in the design of modern recycling processes and the conditions in which it being performed. The student must be able to connect to a variety of theoretical and experimental approaches for problem solving and become acquainted with the basic principles of recycling. Basic concepts of recycling materials are related to economic and ecological aspects of current and future materials.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, terenske vaje, samostojno delo	Lectures, seminars and laboratory work, fieldwork, individual work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
ustni izpit	60,00 %	oral exam
seminarska naloga in poročilo laboratorijskih vaj	40,00 %	seminar work and the report of the laboratory work

Ocenjevalna lestvica:	Grading system:
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

VONČINA, Maja, JERINA, Lina, MRVAR, Primož, **MEDVED, Jože**. Optimizacija razvrščanja sekundarnih surovin na osnovi aluminija = Sorting optimization of secondary aluminium. V: KRIŽMAN, Alojz (ur.), et al. Zbornik referatov 53. mednarodnega livarskega posvetovanja, Portorož 2013 = Conference proceedings. Ljubljana: Društvo livarjev Slovenije, 2013, [16] str. [COBISS.SI-ID 1303903]
KORES, Stanislav, TURK, Jože, **MEDVED, Jože**, VONČINA, Maja. Development of aluminium alloys for aerosol cans = Razvoj aluminijevih zlitin za aerosol doze. Materiali in tehnologije, ISSN 1580-2949. [Tiskana izd.], 2016, vol. 50, no. 4, str. 601-605, ilustr. http://mit.imt.si/Revija/izvodi/mit164/kores.pdf, doi: 10.17222/mit.2015.330. [COBISS.SI-ID 1621599] ;
VONČINA, Maja, BALAŠKO, Tilen, RUDOLF, Karlo, **MEDVED, Jože**. Vpliv specifične površine in deleža recikliranega aluminija na kakovost zlitine AlSi10Mg(Fe) = influence of specific surface and recycling aluminium content on quality of AlSi10Mg(Fe) alloy. Livarski vestnik : glasilo Društva livarjev Slovenije. 2023, letn. 70, št. 2, str. 93-107. [COBISS.SI-ID 158324739]
MEDVED, Jože, KORES, Stanislav, BALAŠKO, Tilen, VONČINA, Maja. Vpliv manjšega dodatka legiranih elementov na aluminijeve livarske zlitine = influence of minor alloying element addition on aluminium casting alloys. *Livarski vestnik : glasilo Društva livarjev Slovenije*. 2019, letn. 66, št. 3, str. 191-202, [COBISS.SI-ID 1839199]
BANOVŠEK, Jure. Model optimizacije uporabe bele žlindre pri nizkoogljičnih jeklih : magistrsko delo = model for optimizing white slag usage in low-carbon steel : master's thesis. Ljubljana, 2020. [COBISS.SI-ID 41524483] **KNAP, Matjaž** - mentor pri magistrskem delu
STARE, Grega. Optimizacija AOD procesa z uporabo sekundarne žlindre pri nerjavnem jeklu 1.4307 : diplomsko delo = optimization of AOD process by implementing secondary slag in stainless steel 1.4307 : diploma work. Ljubljana, 2021. [COBISS.SI-ID 86647299] **KNAP, Matjaž** - mentor pri diplomskem delu

SPLOŠNI IZBIRNI PREDMET 01

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Splošni izbirni predmet 01
Course title:	General optional course 01
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111925
Koda učne enote na članici/UL Member course code:	920

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	
Jeziki/Languages:	Predavanja/Lectures:
	Vaje/Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:

Vsebina:	Content (Syllabus outline):

Temeljna literatura in viri/Readings:

Cilji in kompetence:	Objectives and competences:

Predvideni študijski rezultati:	Intended learning outcomes:

Metode poučevanja in učenja:	Learning and teaching methods:

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

SPLOŠNI IZBIRNI PREDMET 02

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Splošni izbirni predmet 02
Course title:	General optional course 02
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111932
Koda učne enote na članici/UL Member course code:	810

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	
Jeziki/Languages:	Predavanja/Lectures:
	Vaje/Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:

Vsebina:	Content (Syllabus outline):

Temeljna literatura in viri/Readings:

Cilji in kompetence:	Objectives and competences:

Predvideni študijski rezultati:	Intended learning outcomes:

Metode poučevanja in učenja:	Learning and teaching methods:

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNA ANGLEŠČINA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovna angleščina
Course title:	Technical English
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0077543
Koda učne enote na članici/UL Member course code:	684

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Barbara Luštek Preskar, prof. angl. in nem.
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Vpis v letnik.	Enrolment in study year

Vsebina:	Content (Syllabus outline):
/- branje in strategije branja, uvajanje v diskurz strokovnih in tehničnih tekstov; - uporaba slovarjev in drugih informacijskih virov; - pisanje sestavkov in poročil - predstavitve projektov v angleščini - opisovanje grafov - poslovna komunikacija (telefoniranje, pisanje pisem) - sodelovanje v razpravah	- reading, reading strategies, discourse of technical texts - use of dictionaries and other information sources - writing paragraphs and reports - project presentations - describing graphs - professional communication (writing letters, telephoning) - taking part in discussions

Temeljna literatura in viri/Readings:

Vukadinović Beslić N.: Mining & tunnelling : English for geotechnology and mining : visokošolski učbenik jezika
stroke, Naravoslovnotehniška fakulteta, Oddelek za geotehnologijo in rudarstvo, Ljubljana, 2011, 95 str.;
Didaktiziran material, ki ga pripravi predavatelj sam.
Materiali, dostopni na spletnih straneh na temo stroke.
Spletni slovarji in glosarji, splošni ter terminološki.
Literatura je dosegljiva v knjižnici Oddelka za geotehnologijo, rudarstvo in okolje ter Oddelka za materiale in

metalurgijo, NTF. Literature is available in the library at the Faculty of Natural Sciences and Engineering, Department of Geotechnology, Mining and Environment, and Department of Material and Metallurgy.

Cilji in kompetence:	**Objectives and competences:**
/-dograjevanje splošnega znanja angleščine na višjo stopnjo z uvajanjem strokovnih tekstov; - izpopolnjevanje kompetenc v ustnem in pisnem izražanju; - širjenje besednega zaklada in gradnja strokovnega besedišča; - razvijanje bralnih spretnosti.	- upgrading general knowledge of English by introducing professional/technical texts - acquiring competences for written and oral communication - acquiring technical vocabulary - acquiring reading skills in English

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: -poglobljeno znanje posameznih slovničnih struktur - povzemanje, parafraziranje - pisanje sestavkov in poročil - predstavite v angleščini - poslovna komunikacija	Knowledge and understanding: - expanded knowledge about grammatical structures - paraphrasing, making abstracts - writing paragraphs and reports - oral presentations in English - professional communication

Metode poučevanja in učenja:	**Learning and teaching methods:**
/- predavanja - vaje - delo v parih/skupinah	- lectures - exercises - pair work/group work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
pisni del	50,00 %	written test
projektno delo	50,00 %	project work

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

1. LUŠTEK PRESKAR, Barbara. English for specific purposes : graphic arts. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo, 2009. II, 108 str., ilustr. [COBISS.SI-ID 2272368]
2. LUŠTEK PRESKAR, Barbara. English for specific purposes : textile engineering. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo, 2009. III, 107 str., ilustr. [COBISS.SI-ID 2272112]
3. LUŠTEK PRESKAR, Barbara. English for specific purposes : graphic arts. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo, 2011. 129 str., ilustr. ISBN 978-961-6045-87-2. [COBISS.SI-ID 254528000]
4. LUŠTEK PRESKAR, Barbara. English for specific purposes, Textile engineering. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za tekstilstvo, 2011. 128 str., ilustr. ISBN 978-961-6045-95-7. [COBISS.SI-ID 257973760]

STROKOVNI IZBIRNI 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 1
Course title:	Optional professional course 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111927
Koda učne enote na članici/UL Member course code:	805

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	

Jeziki/Languages:	Predavanja/Lectures:	
	Vaje/Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**

Temeljna literatura in viri/Readings:

Cilji in kompetence:	**Objectives and competences:**

Predvideni študijski rezultati:	**Intended learning outcomes:**

Metode poučevanja in učenja:	**Learning and teaching methods:**

Načini ocenjevanja: **Delež/Weight Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNI IZBIRNI 2

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 2
Course title:	Optional professional course 2
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111928
Koda učne enote na članici/UL Member course code:	806

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	

Jeziki/Languages:	Predavanja/Lectures:	
	Vaje/Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**

Temeljna literatura in viri/Readings:

Cilji in kompetence:	**Objectives and competences:**

Predvideni študijski rezultati:	**Intended learning outcomes:**

Metode poučevanja in učenja:	**Learning and teaching methods:**

Načini ocenjevanja: **Delež/Weight Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNI IZBIRNI 3

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 3
Course title:	Optional professional course 3
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111929
Koda učne enote na članici/UL Member course code:	807

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	
Jeziki/Languages:	Predavanja/Lectures:
	Vaje/Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:

Vsebina:	Content (Syllabus outline):

Temeljna literatura in viri/Readings:

Cilji in kompetence:	Objectives and competences:

Predvideni študijski rezultati:	Intended learning outcomes:

Metode poučevanja in učenja:	Learning and teaching methods:

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNI IZBIRNI 4

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 4
Course title:	Optional professional course 4
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111930
Koda učne enote na članici/UL Member course code:	808

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	
Jeziki/Languages:	Predavanja/Lectures:
	Vaje/Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:

Vsebina:	Content (Syllabus outline):

Temeljna literatura in viri/Readings:

Cilji in kompetence:	Objectives and competences:

Predvideni študijski rezultati:	Intended learning outcomes:

Metode poučevanja in učenja:	Learning and teaching methods:

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNI IZBIRNI 5

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 5
Course title:	Optional professional course 5
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111931
Koda učne enote na članici/UL Member course code:	809

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	

Jeziki/Languages:	Predavanja/Lectures:	
	Vaje/Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**

Temeljna literatura in viri/Readings:

Cilji in kompetence:	**Objectives and competences:**

Predvideni študijski rezultati:	**Intended learning outcomes:**

Metode poučevanja in učenja:	**Learning and teaching methods:**

Načini ocenjevanja: **Delež/Weight Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STROKOVNI IZBIRNI 6

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Strokovni izbirni 6
Course title:	Optional professional course 6
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0111933
Koda učne enote na članici/UL Member course code:	811

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	

Jeziki/Languages:	Predavanja/Lectures:	
	Vaje/Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**

Temeljna literatura in viri/Readings:

Cilji in kompetence:	**Objectives and competences:**

Predvideni študijski rezultati:	**Intended learning outcomes:**

Metode poučevanja in učenja:	**Learning and teaching methods:**

Načini ocenjevanja: **Delež/Weight Assessment:**

Ocenjevalna lestvica: **Grading system:**

Reference nosilca/Lecturer's references:

STRUKTURA MATERIALOV

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Struktura materialov
Course title:	Structure of Materials
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067593
Koda učne enote na članici/UL Member course code:	336

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Boštjan Markoli
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Obvezna prisotnost pri laboratorijskih vajah. Prisotnost pri predavanjih in seminarskih vajah v skladu s pravili UL. Do frekvence so upravičeni vsi ki glede prisotnosti izpolnjujejo predpise UL. K ustnemu izpitu lahko pristopijo tisti s pozitivno opravljenima testoma ali s pozitivno oceno pisnega izpita.	Obligatory attendance at seminars and laboratory work. The mandatory 50% attendance at lectures and laboratory work in accordance with the University rules. Only students that have passed tests or written exam can attend the oral exam.

Vsebina:	Content (Syllabus outline):
Fizikalne osnove materialov in osnove kristalografije. Osnovni strukturni tipi kovin. Kristalna zgradba kovinskih materialov. Kristalne strukture. Zapolnitev in prazni prostor. Geometrija osnovne celice. Alotropija in polimorfizem. Realna zgradba kovinskih materialov in pojem mikrostrukture, zgradba kvazikristalnih materialov, amorfnih snovi in polimerov. Napake v kristalni mreži: točkaste, linijske in ploskovne. Napake v kvazikristalnih, amorfnih in polimernih snoveh. Velikokotne in malokotne meje, skladnost mej, dvojčične meje, antifazne meje, domene. Velikost, oblika in orientiranost kristalnih	Physical fundamentals of materials and basics of crystallography. The basic structural types of metals. Crystal structure of metallic materials. Crystal structure. Occupancy and interstitials. The geometry of the unit cell. Allotropy and polymorphism. Real structure of metallic materials and the concept of microstructure, structure of quasicrystalline materials, amorphous materials and polymers. Defects in the crystal lattice: point, line and two dimensional. Defects in quasicrystalline, amorphous and polymeric materials. Hihg- and low-angle boundaries, coherency of boundaries, twin boundaries, antiphase boundaries

zrn in ureditev konstituentov v kvazikristalih, amorfnih snoveh in polimerih. Izomorfni in evtektski sistem ter značilnosti ravnotežnega in neravnotežnega strjevanja z aplikacijo vzvodnega pravila. Osnovne značilnosti mikrostruktur in mikroskopiranje.	of the domain. The size, shape and orientation of the crystal grains and regulation of constituents in quasicrystals, amorphous materials and polymers. Isomorphic and eutectic system and characteristics of equilibrium and nonequilibrium solidification by application of the lever rule. Basic characteristics of microstructures and microscopy.

Temeljna literatura in viri/Readings:

B. Markoli: Struktura in lastnosti materialov: interna skripta, NTF, Ljubljana 2005
R.J.D. Tilley: Understanding solids, John Wiley & Sons Ltd. 2004
P. Atkins, J. de Paula: Physical Chemistry, 7th ed., OXFORD University Press 2002
S. Spaić: Fizikalna metalurgija: binarni sistemi, metalografija zlitin, Ljubljana 2000

Cilji in kompetence:	**Objectives and competences:**
/Cilji: pridobiti osnovno znanje o strukturi ali zgradbi materialov. Spoznati kristalno, kvazikristalno in amorfno stanje snovi, napake v zgradbi ter osnovne značilnosti tipičnih predstavnikov kovinskih, kvazikristalnih, keramičnih in polimernih materialov. Kompetence: študent je sposoben na osnovi osvojenih znanj se samostojno in strokovno neodvisno vključevati v raziskovalno in razvojno delo na širšem področju materialov. Spozna in razume ter loči značilnosti posameznih stanj materije in se usposobi za interpretacijo lastnosti materialov glede na specifičnost njihove zgradbe. Prav tako razume vpliv posameznih napak zgradbe na lastnosti materialov ter kako vplivati na njihovo koncentracijo, ureditev in porazdelitev.	Objectives: To acquire basic knowledge about the structure or building materials. Recognize crystal, quasicrystalline and amorphous material defects in the structure and basic characteristics of typical representatives of metal, quasicrystalline, ceramic and polymeric materials. Competencies: the student is able on the basis of their knowledge and expertise to independently engage in independent research and development work in the wider field of materials. They learn to understand and distinguish the characteristics of individual states of matter, and is trained to interpret the properties of materials depending on the specificity of their buildings. We also understand the impact of the individual errors buildings on the properties of materials and how they affect their concentration, organization and distribution.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Deklarativno znanje: Osnove zgradbe materialov. Sposobnost ločevanja in razumevanje kristalnega, amorfnega in kvazikristalnega ter polimernega stanja. Razumevanje značilnosti napak ali defektov v zgradbi materialov in vplivu le-teh na lastnosti. Pri študiju značilnosti zgradbe materialov, kar predstavlja osnove pri izboljšavi obstoječih in načrtovanju novih posebnih lastnosti materialov. Prenosljivost osvojenih znanj na praktično vse vrste materialov. Spoznavanje s tujo literaturo in načini iskanja le-te. Izdelava pisnih poročil in javna predstavitev. Sinteza osvojenega znanja pri praktičnih aplikacijah materialov in njihovi izdelavi.	Declarative knowledge: Basics of building materials. The ability to distinguish and understand crystalline, amorphous and quasicrystalline and a polymer state of matter. Understanding the characteristics of errors or defects in the structure of materials and the impact thereof on the properties. In studying the characteristics of building materials, which form the basis for the improvement of existing and designed new special properties of materials. Transferability of acquired knowledge in virtually all types of materials. Getting to know the foreign literature and ways to find it. Production of written reports and public presentations. Synthesis of the acquired knowledge in practical applications of materials and their manufacture.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, seminarji, raziskovalni seminarji, laboratorijske vaje, simulacije, nastopi.	Lectures, seminars, research seminars, laboratory exercises, simulations, presentations.

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit	60,00 %	Written exam
Teoretični del	40,00 %	Theory part

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

MARKOLI, Boštjan, SPAIĆ, Savo. Effect of tempering on the microstructure and hardness of ledeburitic chromium steel X155CrVMo12.1. Zeitschrift für Metallkunde, ISSN 0044-3093, 2007, vol. 98, no. 2, str. 150-154.

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The constitution of alloys in the Al-rich corner of the Al-Si-Sm ternary system. Zeitschrift für Metallkunde, ISSN 0044-3093, 2001, vol. 92, no. 9, str. 1098-1102.

MARKOLI, Boštjan, BONČINA, Tonica, ZUPANIČ, Franc. Behaviour of a quasicrystalline strengthened Al-alloy during compression testing = Verhalten einer quasikristallinen Aluminiumlegierung im Druckversuch. V: Euro ECAA 2011, European Conference on Aluminium Alloys, 5-7 October 2011, Bremen, Germany. HEHL, Axel von (ur.). Aluminium based compounds, composites and novel materials (ECAA 2011), (Materialwissenschaft und Werkstofftechnik, ISSN 0933-5137, Vol. 43, iss. 4, April 2012). [S. l.]: Wiley, 2012, vol. 43, no. 4, str. 340-344.

MARKOLI, Boštjan, BONČINA, Tonica, ZUPANIČ, Franc. The solidification path of the complex metallic Al-Mn-Be alloy. V: SMONTARA, Ana (ur.), BABIĆ, Emil (ur.), VIKIĆ-TOPIĆ, Dražen (ur.). Frontiers in complex metallic alloys : proceedings of the CMA-Zagreb'08, Workshop of the European Networks of Excellence Complex Metallic Alloys, Zagreb, Croatia, October 1-4, 2008 : Institute of Physics, Zagreb, October 1-4, 2008 : dedicated to Professor Boran Leontić on the occasion of his 80th birthday : special issue, (Croatica chemica acta, ISSN 0011-1643, Vol. 83, no. 1, 2010). Zagreb: Hrvatsko kemijsko društvo, 2010, vol. 83, no. 1, str. 49-54, ilustr.

MARKOLI, Boštjan, SPAIĆ, Savo, ZUPANIČ, Franc. The intermetallic phases containing transition elements in common Al-Si cast alloy. Aluminium, ISSN 0002-6689, 2004, let. 80, št. 1/2, str. 84-88, ilustr., graf. prikazi.

SKOBIR BALANTIČ, Danijela Anica, VODOPIVEC, Franc, JENKO, Monika, SPAIĆ, Savo, MARKOLI, Boštjan. Vpliv popuščanja na fazno sestavo karbidnih izločkov v jeklu X20CrMoV121 = Influence of tempering on the phase composition of the carbide precipitates in X20CrMoV121 steel. Materiali in tehnologije, ISSN 1580-2949. [Tiskana izd.], 2003, letn. 37, št. 6, 353-358 str.

ZUPANIČ, Franc, BONČINA, Tonica, ROZMAN, Niko, ANŽEL, Ivan, GROGGER, Werner, GSPAN, Christian, HOFER, Ferdinand, MARKOLI, Boštjan. Development of an Al-Mn-Be-Cu alloy with improved quasicrystalline forming ability. V: 10th International Conference on Quasicrystals, July 6-11, 2008, Zurich, Switzerland. ICQ10 Proceedings. Part 1, (Zeitschrift für Kristallographie, ISSN 0044-2968, Vol. 223, iss. 11/12, 2008). Zürich: Oldenburg, 2008, str. 735-738.

BONČINA, Tonica, MARKOLI, Boštjan, ANŽEL, Ivan, ZUPANIČ, Franc. Metallographic techniques for the characterization of quasicrystalline phases in aluminium alloys. V: 10th International Conference on Quasicrystals, July 6-11, 2008, Zurich, Switzerland. ICQ10 Proceedings. Part 1, (Zeitschrift für Kristallographie, ISSN 0044-2968, Vol. 223, iss. 11/12, 2008). Zürich: Oldenburg, 2008, str. 747-750.

TEMELJI TRŽENJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Temelji trženja
Course title:	Principles of Marketing
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100787
Koda učne enote na članici/UL Member course code:	551

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	30	0	0	0	60	4

Nosilec predmeta/Lecturer:	Tomaž Kolar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/pogoj za vključitev v delo je vpis v letnik študija	enrollment in the semester

Vsebina:	Content (Syllabus outline):
/1. Opredelitev trženja in temeljnih trženjskih konceptov 2. Vrednost, zadovoljstvo, zvestoba porabnikov 3. Strateški trženjski proces in načrt 4. Izzivi in prilagajanje trženja v 21. Stoletju 5. Trženjsko okolje 6. Trženjske raziskave 7. Napovedovanje in merjenje povpraševanja 8. Nakupno vedenje porabnikov 9. Ciljno trženje – segmentiranje, ciljanje in pozicioniranje 10. Izdelek, storitev in ostale trženjske entitete 11. Življenjski cikel izdelka/druge entitete in razvoj novih izdelkov/drugih entitet 12. Blagovne Znamke 13. Cena 14. Tržne poti 15. Trženjsko komuniciranje – oglaševanje,	1. Marketing in the modern firm and main marketing concepts 2. Customer value, satisfaction and loyalty 3. Strategic marketing process and plan 4. Challenges and adaptations of marketing in the 21st century 5. The marketing environment 6. The marketing research 7. Forecasting and measuring demand 8. Consumer behavior 9. Target marketing - segmentation, targeting and positioning 10. Product, service and other entities 11. Product/entity life cycle and development of new products/entities 12. Brands 13. Price 14. Marketing channels

pospeševanje prodaje, odnosi z javnostmi 16. Trženjsko komuniciranje – osebna prodaja, neposredno trženje, trženje od ust do ust, interaktivno trženje	15. Marketing communications - advertising, sales promotion, public relations 16. Marketing communications - personal selling, direct marketing, word of mouth marketing, interactive marketing

Temeljna literatura in viri/Readings:

/Konečnik Ruzzier, M. (2011): Temelji trženja: Pristop k trženjskemu načinu razmišljanja v 21. stoletju. Ljubljana: Meritum. 253 str. (for course in Slovenian language)

Kotler, P. & Armstrong, G. (2012). Principles of Marketing- Global Edition. 14th Ed. London, UK: Pearson Prentice Hall (for Course in English language).

Cilji in kompetence:	**Objectives and competences:**
/- Razviti temeljna znanja o trženju kot poslovnem konceptu in kot dejavnosti v podjetju. - Privzgojiti študentom občutek za to, kaj je tržno naravnano podjetje, ki stremi k izpolnjevanju pričakovanj porabnikov bolje od konkurentov. - Razviti sposobnosti za povezovanje posameznih sestavin trženja v harmonično celoto. - Privzgojiti študentom potrebo po budnem spremljanju dogajanja v konkurenčnem okolju podjetja in lastno pozitivno naravnanost do sprememb. - Navaditi študente na skupinsko delo in na uporabo pridobljenega znanja pri reševanju konkretnih problemov.	- To develop basic knowledge about marketing as a business concept and as an activity in the company. - To impart the feeling what is a market-oriented company which aims to fulfil customer expectations better than the competitors. - To develop competences for integration of marketing elements into a harmonious integrity. - To impart to students the need for careful monitoring of competitive business environment and for own positive attitude toward changes. - To accustom students to a team work and to the application of the acquired knowledge for concrete problem solving.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent pridobi temeljna znanja o trženju kot poslovnem konceptu in kot dejavnosti v podjetju, tako da jih zna temeljito razumeti, povezovati, vrednotiti in praktično uporabiti.Uporaba znanja pridobljenega na temelju teorije in študija praktičnih primerov za opredelitev in analizo kritičnih pojavov na področju trženja v podjetju. Študent bo na osnovi pridobljenega znanja sposoben povezati posamezne sestavine trženja v harmonično celoto.Znanje, ki mu ga da študij predmeta, omogoča študentu ne zgolj razumevanje ključnih razsežnosti in celovitih vprašanj v zvezi z razvojem in načrtovanjem trženja v podjetju, ampak tudi kritično ocenjevanje teoretičnih prispevkov in prakse trženja doma in na tujem.Študent bo razvil spretnosti za analitično razmišljanje ter za identifikacijo in reševanje problemov na temelju študija primerov; navadil se bo poročati (ustno in pisno) o svojih ugotovitvah in odločitvah; razvil bo sposobnosti za učinkovito delo v skupinah.	A student acquires basic knowledge about marketing as a business concept and as an activity in the company so that she/he can thoroughly understand, integrate, evaluate, and use them in practice. The application of knowledge acquired based on theory and practical examples for a definition and analysis of critical phenomena in the field of marketing in the company. Based on the acquired knowledge, a student will be able to integrate marketing elements into a harmonious integrity. The knowledge, acquired with the course study, enables the student not only to understand the key extensiveness and questions regarding the development and planning of marketing in the company, but also to critically assess theoretical contributions and practice of marketing in Slovenia and abroad. A student will develop skills for analytical thinking and for problem identification and solving based on case studies, she/he will become familiar (oral and written) about her/his findings and decisions; she/he will develop capabilities for an efficient team work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja: 2 uri tedensko, s pomočjo katerih študetje pridobijo osnovna teoretična spoznanja o trženjskih konceptih ter njihovem prenosu na	Lectures: 2 hours per week, with the aim to introduce students with major theoretical marketing concepts and their application to real Slovenian and worldwide

konkretne slovenske in tuje praktične primere. Vaje in seminarji: 2 uri tedensko, ki omogočajo poglabljanje in nadgradnjo teoretičnih vsebin s pomočjo proučevanja aktualnih praktičnih primerov. Na vajah in seminarjih študentje samostojno v okviru skupin rešujejo praktične trženjske probleme, ki jih kasneje med skupinami in vodjo vaj tudi podrobneje analizirajo ter se pogovorijo o primernih in ustreznih pristopih k njihovemu reševanju.	practical cases. Tutorial and seminars: 2 hours per week, which contribute to deeper understanding of theoretical marketing concepts with the examination of case studies. Students actively and in groups analyze real marketing problems and propose possible solutions, which are further discussed.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
pisni izpit	80,00 %	written final exam
pisna preizkušnja	10,00 %	midterm exam
aktivno sodelovanje na predavanjih, vajah in seminarjih (dodatne točke)	10,00 %	active participation at tutorials and seminars (additional points)
projekt	10,00 %	research project

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

Kolar, T., Toporišič, A. (2007). Marketing as warfare, revisited. Mark. intell. plann., 25(3), str. 203-216.

Kolar, T. (2008). Perceived survey quality and respondent participation. Druš. istraž. (Zagreb), stu./pros. 2008, 17(6), str. 1203-1217.

Kolar, T., Kolar, I. (2008). What respondents really expect from researchers. Eval. rev., 32(4), str. 363-391.

TERMODINAMIKA MATERIALOV 1

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Termodinamika materialov 1
Course title:	Thermodynamics of Materials 1
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067603
Koda učne enote na članici/UL Member course code:	979

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Jožef Medved, Maja Vončina
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo je vpis v tekoči letnik.	Condition for inclusion is enrollment in the current year.

Vsebina:	Content (Syllabus outline):
• Termodinamika plinov. • Prvi zakon termodinamike: popolni in nepopolni diferencial, reverzibilni procesi, Joule-ov poskus, toplotna kapaciteta, entalpija, reakcijska toplota, Kirchoffov zakon. • Drugi zakon termodinamike: učinek toplotnega stroja, Carnotev krog, entropija, sprememba entropije izoliranih sistemov, statistični pomen entropije, skupna trditev prvega in drugega zakona termodinamike. • Pomožne funkcije: Helmholtzova in Gibbsova prosta energija, termodinamični potenciali, kriterij spontanosti, Gibbs-Helmholtzova enačba. • Tretji zakon termodinamike. • Raztopine: kemijski potencial, fugativnost, aktivnost, integralne količine, Van't Hoffova	• Thermodynamics of gases. • First law of thermodynamics: complete and incomplete differential, reversible processes, Joule experiment, heat capacity, enthalpy, reaction heat, Kirchoff's law. • Second law of thermodynamics: heat engine effect, Carnot circle, entropy, change of entropy of isolated systems, statistical significance of entropy, joint statement of the first and second law of thermodynamics. • Auxiliary functions: Helmholtz and Gibbs free energy, thermodynamic potentials, spontaneity criterion, Gibbs-Helmholtz equation. • The third law of thermodynamics. • Solutions: chemical potential, fugativity, activity, integral quantities, Van’t Hoff equations, Gibbs-

enačb, Gibbs-Duhemova enačba, Henryjevo standardno stanje, Raoultov zakon, regularne raztopine, aktivnosti v večkomponentnih raztopinah, presežne funkcije. • Richardson-Ellinghamovi diagrami. • Termodinamika faznih diagramov: uporaba termodinamičnih baz podatkov, Gibbsovo fazno pravilo, fazne spremembe v enokomponentnih in večkomponentnih sistemih, Clausius-Clapeyronova enačba, diagrami popolne topnosti v tekočem in trdnem, enostavni evtektski sistemi. • Osnove reakcijske kinetike: hitrost reakcije, red reakcije, aktivacijska energija. • Osnove elektrokemije: prevodnost, transport ionov, potenciali, elektrokemija raztopin, ireverzibilnost, procesi v staljenih soleh, račun termodinamičnih parametrov iz elektromotorske sile, elektrokemične meritve; gorilne celice. • Osnove termodinamike metalurških procesov: topnost plinov v staljenih kovinah, oksidacija, redukcija, žilavenje, vakuumska obdelava.	Duhem equation, Henry's standard state, Raoult's law, regular solutions, activities in multicomponent solutions, excess functions. • Richardson-Ellingham diagrams. • Thermodynamics of phase diagrams: use of thermodynamic databases, Gibbs phase rule, phase changes in one-component and multi-component systems, Clausius-Clapeyron equation, Diagrams of complete solubility in liquid and solid, simple eutectic systems. • Basics of reaction kinetics: reaction rate, reaction order, activation energy. • Basics of electrochemistry: conductivity, ion transport, potentials, electrochemistry of solutions, irreversibility, processes in molten salts, calculation of thermodynamic parameters from electromotive force, electrochemical measurements; fuel cells. • Basics of thermodynamics of metallurgical processes: solubility of gases in molten metals, oxidation, reduction, toughness, vacuum treatment.

Temeljna literatura in viri/Readings:

V. Gontarev. Termodinamika, učbenik, Univerza v Ljubljani, NTF, Ljubljana, 2005.
D. R. Gaskell, D. E. Laughlin. Introduction to the Thermodynamics of Materials, Taylor & Francis Group, 2018.
M. Vončina. Termodinamika materialov: računski primeri z rešitvami. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2020.
R. DeHoff. Thermodynamics in Materials Science, Second Edition, CRC Press, Taylor & Francis Group, 2006.
S. R. Turns. Thermodynamics, Cambrige University Press, Cambridge, 2006.

Cilji in kompetence:	**Objectives and competences:**
Cilji: Osnovni cilji predmeta so naučiti študente termodinamične zakonitosti in lastnosti, ki so inženirju metalurgije in materialov potrebne za razumevanje fizikalno-kemijskih procesov v materialih in tehnologijah izdelave le-teh. Kompetence: Študentje osvojijo termodinamične zakone, osnove termodinamike v tekočih in trdnih raztopinah, kemijska in fazna ravnotežja v materialih, osnove kinetike in elektrokemije. Vse razlage so združene z veliko računskih primerov, ki omogočajo boljše razumevanje procesov v materialih.	Objectives: 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.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent mora razumeti osnovne pojme ter zakonitosti termodinamike. Spozna osnove zakonitosti obnašanja plinov in par, zakone termodinamike, pomožne funkcije teorije raztopin, pozna na čem temeljijo fazna ravnotežja, računa ravnotežja, spozna osnove	Knowledge and understanding: Students must understand the basic concepts and laws of thermodynamics. Learn the basics legality of the behavior of gases and fumes, laws of thermodynamics, auxiliary functions theory of solutions, knowledge on what the phase equilibria, account balance, learn the basics of

statistične termodinamike, spozna termodinamiko Binarnih faznih diagramov Študent spozna na čem temelji kinetika procesov v raztopinah, difuzija ter spozna principe in pomen elektrokemije.	statistical thermodynamics, thermodynamics realizes binary phase diagrams Familiarity is based on what the kinetics of processes in solution, diffusion, and learn the principles and importance of electrochemistry.

Metode poučevanja in učenja:	**Learning and teaching methods:**
predavanja, računske vaje	lectures, tutorial

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) aktivno sodelovanje pri predavanjih in vajah 20%	20,00 %	(a) active participation in class discussions 20%
(b) pisni izpit, ki ga lahko študent opravi z 2 kolokvija, če opravi pozitivno vse kolokvije in doprinese k skupni oceni 40%;	40,00 %	(b) examination, which the student can perform the 2 tests, if done positively all three colloquia and contributes to the overall assessment of 40%;
(c) ustni izpit, ki doprinese k skupni oceni 40%;	40,00 %	(c) oral examination, which contributes to the overall assessment of 40%;

Ocenjevalna lestvica:	**Grading system:**
5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

MEDVED, Jože, VONČINA, Maja, KLANČNIK, Grega, MRVAR, Primož. Termodinamično modeliranje kot pomoč pri optimiranju aluminijevih materialov in tehnologij = Thermodynamic modeling as a support for optimization of aluminium materials and technologies. *Livar. vestn.*, 2013, vol. 60, no. 1, str. 31-51. [COBISS.SI-ID 1269343]

VONČINA, Maja, KRESNIK, Kristijan, VOLŠAK, Darja, MEDVED, Jože. Effects of homogenization conditions on the microstructure evolution of aluminium alloy EN AW 8006. Metals, 2020, vol. 10, iss. 3, str. 1-12. [COBISS.SI-ID 1859167]

VONČINA, Maja, MEDVED, Jože, KORES, Stanislav, XIE, Pan, SCHUMACHER, Peter, LI, Jiehua. Precipitation microstructure in Al-Si-Mg-Mn alloy with Zr additions. Materials characterization, ISSN 1044-5803. [Print ed.], 2019, vol. 155, str. 1-8, doi: 10.1016/j.matchar.2019.109820. [COBISS.SI-ID 1816671]

VONČINA, Maja, MEDVED, Jože, JERINA, Lina, PAULIN, Irena, CVAHTE, Peter, STEINACHER, Matej. The impact of Al-Ti-B grain-refiners from different manufacturers on wrought Al-alloy. Archives of metallurgy and materials, 2019, vol. 64, no. 2, str. 739-746. [COBISS.SI-ID 1807711]

TERMODINAMSKI PRAKTIKUM

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Termodinamski praktikum
Course title:	Practicals in Thermodynamics
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0067604
Koda učne enote na članici/UL Member course code:	980

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
15	0	60	0	0	75	5

Nosilec predmeta/Lecturer:	Jožef Medved, Maja Vončina
Vrsta predmeta/Course type:	Obvezni / Compulsory

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Pogoj za vključitev v delo je vpis v tekoči letnik.	Condition for inclusion is enrollment in the current year.

Vsebina:	Content (Syllabus outline):
/V prvem delu praktikuma se študente uvede v eksperimentalno delo ter se mu pojasni pomen praktikuma ter teoretične osnove posameznih preiskovalnih tehnik. Preiskovalne tehnike in vrednotenje rezultatov spadajo v področja: potrditve osnovnih zakonov termodinamike, termičnih analiz, elektrokemičnih metod in določanja parnih tlakov, za kovinske, keramične in polimerne materiale. Analizne metode in preiskave, ki jih študent opravlja so: Efuzija – Grahamsov zakon, določevanje specifične toplotne kapacitete, določevanje talilne (latentne) toplote, konstrukcija faznega diagrama s termičnimi analizami, termodinamično modeliranje faznih diagramov, specifična električna prevodnost elektrolitov, diferenčna termična analiza, diferenčna vrstična kalorimetrija, določevanje aktivnosti v	In the first part of the practical course is to introduce students in the experimental work, and explains the importance of practicum and the theoretical basis of particular investigative techniques. Investigative techniques and evaluation of the results fall within the areas: validation of basic laws of thermodynamics, thermal analysis, electrochemical methods and the determination of vapor pressures of metal, ceramic and plastic materials. Methods of analysis and investigation by the student performs are: effusion - Grahamsov law, the determination of the specific heat capacity, determination of melting (latent) heat, construction of phase diagram by thermal analysis, thermodynamic modeling of phase diagrams, specific electrical conductivity of the electrolyte, differential thermal analysis, differential scanning calorimetry, the

binarnih in večkomponentnih sistemih z določanjem parnih tlakov in po elektrokemični metodi, specifična električna prevodnost staljenih keramičnih materialov, viskoznost, površinska napetost, določevanje koeficienta difuzivnosti. Termodinamične osnove pridobivanja neželeznih kovin. Seminar iz področja procesne tehnike neželeznih kovin. Praktično pridobivanje kovin po pirometalurški in hidrometalurški poti.	determination of activity in binary and ternary systems, by determining the vapor pressure and the electrochemical method, the specific electric conductivity of the molten ceramic materials, viscosity, surface tension, the determination of the coefficient of diffusivity. Basic thermodynamics of production of non-ferrous metals. Seminar in the field of process engineering, non-ferrous metals. Practical extraction of metals by pyrometallurgical and hydrometallurgical route.

Temeljna literatura in viri/Readings:

J. Medved, M. Vončina: Termodinamski praktikum, Laboratorijski praktikum, NTF, 2017

Cilji in kompetence:	**Objectives and competences:**
/Cilj: Termodinamični praktikum je nadgradnja premeta Termodinamika materialov. Študent osvoji eksperimentalne tehnike in vrednotenje rezultatov osnovnih termodinamičnih preiskovalnih metod ter procesne tehnike neželeznih kovin. Kompetence: Študentje v okviru praktikuma osvojijo najpomembnejše laboratorijske in »in-situ« preiskovalne metode termodinamike in kinetike materialov ter vrednotenja rezultatov. Študentje se naučijo osnov procesne tehnike neželeznih kovin.	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.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Laboratorijski praktikum naj bi doprinesel k boljšemu razumevanju in večji uporabi preiskovalnih metod s področja termodinamike in kinetike tako v raziskovalni dejavnosti kot tudi v industriji.	Knowledge and understanding: Laboratory practicum should bring a better understanding and greater use of investigative techniques in the field of thermodynamics and kinetics in both, research and industry.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, praktično delo, seminarsko delo, predstavitev seminarja in rezultatov	Lectures, practical work, seminar, seminar presentation and results.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Oddane in potrjene laboratorijske vaje ter opravljen seminar.	100,00 %	Submitted and approved lab and conducted a seminar.

Ocenjevalna lestvica:	**Grading system:**
opravil z odliko/opravil/ni opravil	passed with distinction/passed/failed

Reference nosilca/Lecturer's references:

VONČINA, Maja, NAGODE, Aleš, **MEDVED, Jože**, BALAŠKO, Tilen. Interaction kinetics between molten aluminium alloy Al99.7 and H11 tool steel with and without an AlCrN protective coating. Applied surface science advances. 2023, vol. 18, str. 1-7. [COBISS.SI-ID 168865795]

VONČINA, Maja, KRESNIK, Kristijan, VOLŠAK, Darja, PETRIČ, Mitja, **MEDVED, Jože**. Enthalpy balance of process path of the sheet production from EN AW 5182 aluminium alloy. Journal of thermal analysis and calorimetry. 2023, vol. 148, str. 1241-1249. [COBISS.SI-ID 126860035]

VONČINA, Maja, PAULIN, Irena, **MEDVED, Jože**, PETRIČ, Mitja. Predicting the quality of grain refiners from electrical resistance measurements of aluminum. Metals. 2023, vol. 13, iss. 4, str. 1-12. [COBISS.SI-ID 147990019].

BALAŠKO, Tilen, **VONČINA, Maja**, **MEDVED, Jože**. Simultaneous thermal analysis of the high-temperature oxidation behaviour of three hot-work tool steels. Journal of thermal analysis and calorimetry. [Print ed.]. 2023, vol. 148, str. 1251-1264. [COBISS.SI-ID 124047875]

ARBEITER, Jože, **VONČINA, Maja**, ŠETINA, Barbara, **MEDVED, Jože**. Transformation of the metastable Al6Fe intermetallic phase during homogenization of a binary Al-Fe alloy. Materials. 2021, vol. 14, iss. 23, str. 1-9. [COBISS.SI-ID 86912003]

TOPLOTNA TEHNIKA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Toplotna tehnika
Course title:	Thermal Engineering
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	1. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067616
Koda učne enote na članici/UL Member course code:	665

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	45	0	0	75	5

Nosilec predmeta/Lecturer:	Borut Kosec
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
/Pogoj za vključitev v delo oziroma za opravljanje študijskih obveznosti je vpis v 3. letnik študija. Predhodno ali vzporedno obiskovanje predavanj in vaj iz višje matematike, fizike, kemije, prenosa toplote in snovi, računalništva. Opravljeno in uspešno predstavljeno projektno delo je pogoj za pristop k pisnemu in ustnemu izpitu.	The condition to attend in the teaching course and to perform study obligations is an entry in the third year of study. Prior or parallel attending to lectures and exercises from higher mathematics, physics, chemistry, heat and mass transfer, computer science. Completed and successfully presented project work is required before taking the written and oral exam.

Vsebina:	**Content (Syllabus outline):**
/Uvod. Pomen toplotne tehnike za optimalen potek procesov v tehnoloških sistemih ob racionalni uporabi energije in varovanju čistega okolja; Področje toplotnotehničnih problemov temelji na poznavanju fizikalno-kemijskih osnov, doslednem upoštevanju sistema merskih enot, meritvah temperature, tlaka in pretoka ter teoriji prenosa toplote in snovi; Trdna, tekoča in plinasta goriva, Vlažnost plinov, Meritve vlažnosti plinov, Idealno in realno obnašanje plinov;	Introduction. The importance of thermal engineering for optimized processes flow in technological systems on rational use of energy and environment protection; Solving problems in thermal technique is based on knowledge of physics and chemistry, acquaintance of systems of units, measurement of temperature, pressure and flow and the theory of heat and mass transfer; Solid, liquid and gaseous fuels, gas humidity, humidity measurements of gases, ideal and real gas behaviour;

Snovne lastnosti plinov; Stehiometrija zgorevanja, Ostwaldov trikotnik zgorevanja, Adiabatna temperatura plamena, vpliv kemijskih ravnotežnih reakcij in računanje ravnotežnih sestav produktov zgorevanja; Analiza kurilnih in zgorevnih plinov, Merjenje temperature, tlakov in pretokov; Toplotnotehnični izračuni pri ogrevanju in ohlajanju: Naprave za zgorevanje trdnih, tekočih in plinastih goriv, Zamenljivost plinov in Wobbe indeks; Prenos toplote v ceveh, prečno na snope cevi, na stene in v nasipanih materialih; Prenos toplote med ploskvami različnih orientacij; Prenos toplote s sevanjem plinov; Celokupni prenos toplote v prostoru peči; Toplotne izgube skozi ravne stene, vogale in robove v stacionarnem in nestacionarnem temperaturnem stanju; Proces ogrevanja tanko in debelostenega vložka, Različni ogrevalni režimi.	Material properties of gases; Stoichiometry of combustion Ostwaldov triangle of combustion, Adiabatic flame temperature, influence of chemical equilibrium equations and calculating the equilibrium configurations of combustion products; Analysis of combustion and flue gas measurement of temperature, pressure and flow; Thermal output calculations in heating and cooling: Devices for the combustion of solid, liquid and gaseous fuels, gas interchangeability and Wobbe index; Heat transfer in the tubes, Heat transfer transversely and perpendicularly to the bundles of tubes, heat transfer in the furnace wall and in dispersed materials; The heat transfer between the surfaces of different orientations; Heat transfer by radiation of gases; The overall heat transfer in the furnace; Heat losses through the straight walls, corners and edges in stationary and non-stationary temperature conditions; The process of batch and continuous heating; various heating regimes.

Temeljna literatura in viri/Readings:

/HERR, H. Nauka o toploti. Ljubljana: Tehniška založba Slovenije, 1997.
INCROPERA, F.P. in DeWITT, D.P. Fundamentals of Heat and Mass Transfer. New York: John Wiley Sons, 1990.
LINDON, C.T. Heat Transfer. New Jersey: Prentice-Hall, 1992.
KAVIANY, M. Principles of Heat Transfer. New York: John Wiley Sons, 2002.
KAMINSKI, D.A. in JENSEN, M.K. Introduction to Thermal and Fluid Engineering. New York: Wiley International Edition, 2005.
PITTIS, D.T. in SISSOM, L.E. 1000 Solved Problems in Heat Transfer. New York: McGraw-Hill, 1991.
MASSOUD, M. Engineering Thermofluids: Thermodynamics, Fluid Mechanics and Heat Transfers. Berlin / Heidelberg: Springer Verlag, 2005.
TURNS, R.S. Thermal – Fluid Sciences. New York: Cambridge University Press, 2006.

Cilji in kompetence:	**Objectives and competences:**
/Termično načrtovanje in računalniške rešitve toplotnotehničnih problemov; Meritve kurilnosti trdnih, tekočih in plinastih goriv, plamenišča, vnetišča, viskoznosti in gostote tekočih goriv; Meritve pretokov, tlakov in temperature; Zajemanje signalov merilnih pretvornikov in hkratna računalniška obdelava merilnih podatkov; Fizikalne in kemijske metode za analizo kurilnih in zgorevnih plinov; Povezava osnovnih zakonitosti prenosa toplote in snovi, dinamike tekočin in koncepta termodinamičnih energijskih bilanc z različnimi merilnimi tehnikami in regulacijami za analizo visokotemperaturnih procesov.	Thermal designs and computer solutions in thermal engineering problems; Measurements of the net calorific value of solid, liquid and gaseous fuels, flash point, viscosity and density of liquid fuels; Measurements of flow, pressure and temperature; data acquisition from transducers and simultaneous computer processing of measurement data; Physical and chemical methods for the analysis of combustion and flue gas; Link of basic laws of heat and mass transfer, fluid dynamics and thermodynamic concept of energy balance with different measuring techniques and control systems for the analysis of high-temperature processes.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Znanje in razumevanje: Študent mora znati povezati toplotnotehnične pristope pri reševanju problemov v plinski, zgorevalni	Knowledge and understanding: The student must be able to connect thermal engineering principles for solving problems in the

in ogrevalni tehniki z osnovnimi fizikalnimi in kemijskimi zakonitostmi. Znanje je uporabno pri izdelavi toplotnih bilanc za določitev specifične porabe toplote, termičnega izkoristka in oceno racionalne rabe energije ter kvalitete ogrevanja. Študent mora razumeti stehiometrijo zgorevanja, vpliv vlage zraka in plina na rezultate izračunov količine dimnih plinov in na gostoto ter meritev volumna in pretoka plina in zraka. Razumeti mora iteracijski izračun teoretične temperature gorenja in toplotnih izgub skozi stene peči. Ločiti mora med postopki izračuna ogrevanja tankostenega in debelostenega vložka in razumeti režim ogrevanja mirujočega in gibajočega se vložka. Pri meritvah mora osvojiti meritve neelektričnih veličin s pretvorniki in avtomatsko zajemanje meritev ter računalniško obdelavo podatkov v realnem času.	heating technology with basic physical and chemical laws. Knowledge is useful in the manufacture of heat balances, to determine the specific heat consumption, thermal efficiency and evaluation of rational use of energy and quality of heating. Student must understand the stoichiometry of combustion and moisture effects of air and gas to the results of calculations, calculate the amount of flue gas and its composition, density and maximum temperature, measurements of gas and air flow and their temperature. Understand the iterative calculation of the theoretical combustion temperature and heat loss through the walls of the furnace. He must be able to calculate temperature inside the workpeace during batch or continuous heating regime. He must be able to perform measurements with various measuring sensors and data acquisition in real time.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/Predavanja, računske vaje in simulacije, reševanje praktičnih primerov in projektno delo.	Lectures. Exercises solving and simulations. Solving case studies. Project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
/Način (pisni izpit, ustno izpraševanje, naloge, projekt)	0,00 %	Type (examination, oral, coursework, project):
ocena projektne naloge (30 %)	30,00 %	the mark of project work (30%)
ocena pisnega dela izpita (30 %)	30,00 %	the mark of written examination (30%)
ocena ustnega dela izpita (40 %)	40,00 %	the mark of the oral examination (40%)

Ocenjevalna lestvica:	**Grading system:**

Reference nosilca/Lecturer's references:

KARPE, Blaž, KOSEC, Borut, NAGODE, Aleš, BIZJAK, Milan. The influence of Si and V on the kinetics of phase transformation and microstructure of rapidly solidified Al-Fe-Zr alloys. Journal of mining and metallurgy. Section B, Metallurgy, 2013, vol. 49 B, no. 1, str. 83-89.

ŠKRABA, Polona, KOSEC, Ladislav, BIZJAK, Milan, RUDOLF, Rebeka, ROMČEVIĆ, Nebojša, KOSEC, Gorazd, KOSEC, Borut, LAZAREVIĆ, Zorica, ROTH, Jože, ANŽEL, Ivan. Internal oxidation of Ag-VC composites. Corrosion science, ISSN 0010-938X. [Print ed.], Jan. 2011, vol. 53, iss. 1, str. 127-134

KOSEC, Borut. Failures of dies for die-casting of aluminium alloys. Metallurgy, 2008, vol 47, no. 1, str. 51-55.

UMETNOSTNO OBLIKOVANJE KOVIN

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Umetnostno oblikovanje kovin
Course title:	Artistic Forming of Metal
Članica nosilka/UL Member:	UL NTF

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Inženirstvo materialov, prva stopnja, univerzitetni	Ni členitve (študijski program)	3. letnik	2. semester	izbirni

Univerzitetna koda predmeta/University course code:	0067632
Koda učne enote na članici/UL Member course code:	682

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	0	45	0	0	75	5

Nosilec predmeta/Lecturer:	David Bombač, Mitja Petrič, Peter Fajfar, Primož Mrvar
Vrsta predmeta/Course type:	Izbirni / Elective

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/Opravljanje študijskih obveznosti je opredeljeno v pravilniku o preverjanju in ocenjevanju študentov na UL NTF. Za pozitivno in uspešno opravljanje študijskih obveznosti ter vključevanje v študijsko delo se priporoča redno obiskovanje predavanj in ustrezna predpriprava pred izvajanjem laboratorijskih vaj ter izkazana aktivnost in vsaj 80 % prisotnost na vajah. Pogoj za pristop k izpitu so: opravljene vaje, seminarsko delo, njegova predstavitev v obliki razstave in pismeni izpit.	Enforcement of obligations related to process of study is specified in regulations for verification and evaluation students' knowledge on UL NTF. For positive and successfully enforcement of obligations related to process of study as well as integration of students in mentioned study process following is recommended: active presence at lectures and laboratory exercises, and adequate preparation (study) before laboratory exercises, lowest value regarding to the presence at laboratory exercises should be above 80%. Conditions for the exam are as follows: • tutorials, • seminar work, its presentation at the exhibition and • and written exam

Vsebina:	Content (Syllabus outline):
/ Zgodovinski pregled umetnostnega oblikovanja kovin Kovinski materiali za umetnostno oblikovanje Tehnike umetnostnega ulivanje	• Historical review of the artistic forming of metals, • Metal materials for artistic forming • Techniques art casting • Techniques of art forging

Tehnike umetnostnega kovanja Tehnike umetnostnega varjenja Zaščita in dekoracija površin Uporaba v arhitekturi	• Techniques of welding • Protection and decoration of surfaces • The use in architecture

Temeljna literatura in viri/Readings:

Campbell, J., Casting practice, Elsevier Butterworth-Heinemann, 2004
McRaven, C. The Blacksmith's Craft: A Primer of Tools & Methods, McRaven, C.,2005
Ruth, K., Artisan Welding Projects, Creative PublishingInternational, 2006
Zahner, L. W., Architectural Metals: A Guide to Selection,Specification, and Performance, John Wiley & Sons,Inc., 1995
R. Rome, H. Young: Fine art casting: An illustrated guide in mold making and lost wax process, Robert hale, London, 2003

Cilji in kompetence:	**Objectives and competences:**
/Študent pozna osnovne tehnike umetnostnega oblikovanja kovin: kovanje, litje, varjenje, površinska obdelavo in zaščito. Sposoben je načrtovanja in vodenja postopka oblikovanj izdelka iz kovine od ideje do izdelka. Pozna materiale in tehnologije ki se uporabljajo pri umetnostnem oblikovanju. Pozna različne oblikovne zmožnosti in jih uskladi glede na določene tehnološke lastnosti kot so livnost, preoblikovalnost materiala in razpoložljive tehnologije. Oblikuje unikatne in umetniške izdelke (umetniško kovanje, umetniško varjenje, umetniško litje, …). Spozna pomembne zgodovinske skulpture v svetu in na slovenskem. Nadaljuje tehnično in kulturno dediščino oblikovanja kovin na slovenskem.	Student manages basic techniques of artistic forming of metal metals: forging, casting, welding and surface treatment. He is able to plan and to manage the forming process from the idea to finished product. Student acquired basic knowledge about materials and technologies which are used the artistic forming of material. Student get knowledge of different material forming abilities and he adjust them according to the technological properties such as castability, workability and disposable technologies. He designed unique artistic objects (artistic forging, casting and welding). He realizes the momentous historical sculptures in the world and in Slovenia. He continues the technical and cultural heritage of metals in Slovenia.

Predvideni študijski rezultati:	**Intended learning outcomes:**
/Študent pridobi osnovna znanja o uporabi materialov pri umetnostnem oblikovanju in danih tehnoloških zmožnostih izdelave idejno zasnovanih predmetov. Znanje uporabi pri izdelavi umetnostih skulptur s tehnikami litja, kovanja in varjenja. Zna povezati teoretična znanja iz oblikovanja kovin ter jih prenesti v prakso. Sposobnost umetniškega izražanja.	Student acquires basic knowledge about the use of the materials in the art design and the technological capabilities of the conceptual-based objects. He uses the acquired knowledge in the manufacture of arts sculpture with the techniques of casting, forging and welding. He has ability to apply the theoretical knowledges of metals, and to translate them into practice. The ability of artistic expression.

Metode poučevanja in učenja:	**Learning and teaching methods:**
/ predavanja, laboratorijske vaje projektno delo v seminarjih	• lecture, • laboratory practice • project (seminar) work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
(a) opravljenih vaj	10,00 %	(a) laboratory work
(b) seminarskega dela	40,00 %	(b) project (seminar) work
(c) pisnega izpita	50,00 %	(c) examination

Ocenjevalna lestvica: **Grading system:**

5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

FAJFAR, Peter. Tehnika preoblikovanja. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2010. 126 str
FAJFAR, Peter. Vliti ali kovati. Umetnostno oblikovanje kovin : [kovanje, varjenje in ulivanje] Ljubljana: Društvo za varilno tehniko, 2011, str. 17-21.
TRBIŽAN, Milan, MRVAR, Primož. Objava J. V. Valvasorja o litju tankostenskih kipov. *Glasnik Slovenske matice*, ISSN 0351-0298, 2005/2007, let. 29/31, št. 1/3, str. 35-42.
PETRIČ, Mitja, MRVAR, Primož, MARTINČIČ, Tomaž. Umetniško litje. *Umetnostno oblikovanje kovin : [varjenje, vlivanje in kovanje] :* Ljubljana: Društvo za varilno tehniko, 2009, str. 28-30
PETRIČ, Mitja, MRVAR, Primož, KASTELIC, Sebastjan. Zgodovinski razvoj livarstva v Sloveniji in svetu. V: POLAJNAR, Ivan (ur.), FAJFAR, Peter (ur.), KRAJNC, Antonija (ur.). *Umetnostno oblikovanje kovin : [kovanje, varjenje in ulivanje] : delavnica 2011, Župeča vas, 6.-8. maj 2011*. Ljubljana: Društvo za varilno tehniko, 2011. Str. 10-13. ISBN 978-961-92843-1-5. [COBISS.SI-ID 1121887]
PETRIČ, Mitja, MRVAR, Primož, KASTELIC, Sebastjan. Litje zvonov. V: POLAJNAR, Ivan (ur.), FAJFAR, Peter (ur.). *Umetnostno oblikovanje kovin : [kovanje, varjenje in ulivanje] : delavnica 2010, Župeča vas, 16.-18. april 2010.* Ljubljana: Društvo za varilno tehniko, 2010. Str. 34-36. ISBN 978-961-92843-0-8. [COBISS.SI-ID 1025119]
BOMBAČ, David. Preoblikovanje s kovanjem od tehnologije do umetnosti. V: POLAJNAR, Ivan (ur.), FAJFAR, Peter (ur.), KRAJNC, Antonija (ur.). Umetnostno oblikovanje kovin : [varjenje, vlivanje in kovanje] : delavnica 2009, Župeča vas, 22.-24. maja 2009. Ljubljana: Društvo za varilno tehniko, 2009. Str. 18-21.
BOMBAČ, David. Izdelava viteških oklepov v srednjem veku. V: POLAJNAR, Ivan (ur.), FAJFAR, Peter (ur.). Umetnostno oblikovanje kovin : [kovanje, varjenje in ulivanje] : delavnica 2010, Župeča vas, 16.-18. april 2010. Ljubljana: Društvo za varilno tehniko, 2010. Str. 20-24.
TURK, Radomir, KUGLER, Goran, TERČELJ, Milan, BOMBAČ, David. Preoblikovanje kovinskih materialov. Ljubljana: Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, 2008. 181 str.