UČNI NAČRT PREDMETA/COURSE SYLLABUS	
Predmet	Sodobni materiali
Course title	Modern Materials

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Tehnologije in sistemi v strojništvu/ 2. stopnja	Ni smeri študija	1. letnik	1.
Technologies and systems in mechanical engineering/ 2nd Cycle	No study field	1st year	1st

Vrsta predmeta/Course type	obvezni/core
Univerzitetna koda predmeta/University course code	**TSS 1 UN 3**

Predavanja **Lectures**	**Seminar** **Seminar**	**Sem. vaje** **Tutorial**	**Lab. vaje** **Laboratory work**	**Teren. vaje** **Field work**	**Samost. delo** **Individ. work**	**ECTS**
30			30		120	6

Nosilec predmeta/Lecturer:	doc. dr. Gorazd Hlebanja

Jeziki/ **Languages:**	**Predavanja/Lectures:**	slovenski/Slovenian
	Vaje/Tutorial:	slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
• Vpis v prvi letnik študijskega programa. • Študent mora pred izpitom pripraviti in predstaviti ter zagovarjati projektno seminarsko nalogo in opraviti laboratorijske vaje.	• A prerequisite for inclusion is enrolment in the first year of study. • Student has to prepare, present and defend a project seminar and completed laboratory exercises before the exam.

Vsebina:	**Content (Syllabus outline):**
• *Uvod* Splošni pregled vsebine predavanja. • *Zgradba trdnih snovi* Zgradba atoma, Primarne atomske vezi, Sekundarne atomske vezi, Kristalna zgradba, Amorfna zgradba, Napake v kristalni zgradbi. • *Gibanje atomov in ionov v trdnih snoveh*	• *Introduction* General overview of the lecture´s content • *Structure of solids.* Atomic structure, Primary interatomic bonds, Secondary bonding, Crystal structure, Amorphous structure, Imperfections in crystal structure.

Difuzija, Mehanizmi difuzije, Difuzijske poti, Aktivacijska energija, 1. Fickov zakon, 2. Fickov zakon. • *Strjevanje* Homogena in heterogena nukleacija, Rast faz, Ohlajevalne krivulje, Lita struktura, Krčilna in plinska poroznost, Strjevanje amorfnih materialov. • *Trdne raztopine in fazno ravnotežje* Popolna in delna topnost, Faze in fazni diagrani, Binarni izomorfni, binarni evtektski, binarni peritektski fazni diagrami, Reakcije v trdnem, Binarni evtektoidni in binarni peritektoidni fazni diagrami, Vzvodno pravilo. • *Mehanizmi utrjevanja materialov* Utrjevanje trdne raztopine, Izločevalno utrjevanje, Disperzijsko utrjevanje, Utrjevanje z zmanjšanjem velikosti kristalnih zrn, Transformacijsko utrjevanje, Deformacijsko utrjevanje. • *Jekla* Fazne transformacije avstenita v perlit, ferit, bainit in martenzit, TTT diagrami, Ogljikova jekla, Legirana jekla, Visokotrdna malolegirana (HSLA) jekla, Jekla z dualno mikrostrukturo, Jekla TWIP, Jekla TRIP, Maraging jekla, Orodna, jelka, Nerjavna jekla • *Superzlitine.* Superzlitine na osnovi niklja in kobalta, Disperzijsko utrjene superzlitine • *Titanove zlitine* Fazne transformacije, α-titanove zlitine, (α+β) titanove zlitne, β-titanove zlitine. • *Magnezijeve zlitine* Livarske in gnetne magnezijeve zlitine. • *Aluminijeve zlitine* Toplotno utrjevalne aluminijeve zlitine, toplotno neutrjevalne alumjinijeve zlitine. • *Bakrove zlitine* Baker, Medi, Broni, Alpaka. • *Masivna kovinska stekla* Sestava, Mehansko vedenje, Deformacija, Uporaba	• *Atom and ion movements in solids* Diffusion, Mechanisms for Diffusion, Diffusion paths, Activation energy, Fick´s first law, Fick´s second law. • *Solidification* Homogeneous and heterogeneous nucleation, Growth, Cast structure, Shrinkage and gas porosity, Solidification of amorphous materials. • *Solid solutions and phase diagrams* Unlimited and limited solubility, Phases and phase diagrams, Binary isomorphus, binary eutectic and binary peritectic phase diagrams, Reactions in solid, Binary eutectoid and binary peritectoid phase diagrams, Lever rule. • *Material strengthening mechanisms* Solid solution strengthening, Precipitation hardening, Dispersion Strengthening, Grain boundary strengthening, Transformation strengthening, Work hardening. • *Steels* Phase transformations of austenite into pearlite, bainite, martensite, TTT diagrams, Plain carbon steels, Alloy steels, High strength low ally (HSLA) steels, Dual phase (DP) steels, TWIP steels, TRIP steels, Maraging steels, Tool steels, Stainless steels • *Superalloys* Superalloys base on nickel and cobalt, Dispersion hardened superalloys. • *Titanium alloys* Phase transformations, α-titanium alloys (α+β)-titanium alloys, β-titanium alloys. • *Magnesium alloys* Cast and wrought magnesium alloys. • *Aluminium alloys* Heat treatable aluminium alloys, Non-heat treatable aluminium alloys. • *Copper alloys* Coppers, brass, bronze, alpaca. • *Bulk metallic glass* Composition, mechanical behavior, Deformation, Application.

• *Keramični materiali in materiali iz kovinskih prahov* Sintranje, Oksidna keramika, karbidna keramika, nitridna keramika, steklokeramika. • *Polimeri* Zgradba, Kristaliničnost, Plastomeri, Duromeri. • *Kompoziti* Zgradba, Kompoziti utrjeni z delci, Kompoziti utrjeni z vlakni, MMC, CMC, PMC, CCC, Pravilo zmesi. • *Funkcionalni in pametni materiali* • Zlitins s spominom oblike, Piroelektrični materiali, Piezoelektrični materiali, Biorazgradljivi materiali.	• *Ceramic materials and materials from metallic powders* Sintering, Oxide ceramics, Carbide ceramics Nitride ceramics. • *Polymers* Structure, Crystalinity, Thermosets, Thermoplastics. • *Composites* Structure, Particle-reinforced composites, Fiber-reinforced composites, MMC, CMC; PMC, CCC, Rule of mixture. • *Functional and smart materials* • Shape-memory alloys, Pyroelectric materials, Piezoelectric materials, Biodegradable materials.

Temeljna literatura in viri/Readings:

Temeljna literatura/Basic literature

- CALLISTER, William D. in David G. RETHWISCH. *Materials Science and Engineering, An introduction, 9th Edition*. Hoboken, New Jersey, ZDA: John Wiley & Sons, Inc., 2011. ISBN: 978-1-118-47770-0.

Priporočljiva literatura/Recommended literature

- KOLAR, Drago. *Tehnična keramika*. Ljubljana: Zavod Republike Slovenije za šolstvo in šport, 1993. ISBN 8677591613, 9788677591618.
- GROOVER, Mikell P. *Fundamentals of modern manufacturing: Materials, Processes, and Systems, 6th Edition*. Hoboken, New Jersey, ZDA: John Wiley & Sons, Inc., 2016. ISBN 978-1-119-12869-4.
- ASKELAND, Donald R, Pradeep P. FULAY, D.K. BHATTACHARYA. *Essentials of Materials Science and Engineering Second Edition, SI*. Stamford, CT, ZDA: Cengage Learning 2010. ISBN-13: 978-0-495-43850-2.
- SMALLMAN, R.G. in A.H.W. NGAN. *Physical Metallurgy and Advanced Materials*,*7th Edition*. Oxford, ZK: Elsevier Ltd., 2007. ISBN: 978 0 7506 6906 1.
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Cilji in kompetence:	**Objectives and competences:**
Učna enota prispeva predvsem k razvoju naslednjih splošnih in specifičnih kompetenc: • sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju strojništva, • sposobnost samostojnega spremljanja in kritične presoje najnovejših dosežkov s področja strojništva in širše,	*The learning unit mainly contributes to the development of the following general and specific competences:* • ability of independent and creative research and development work in the field of mechanical engineering, • ability to independently perceive and critically assess the latest achievements

• sposobnost aktivnega pisnega in ustnega sporazumevanja na visoki strokovni kot tudi na poljudni ravni, odvisno od ciljnega občinstva, • sposobnost timskega dela s strokovnjaki z različnih področij, • sposobnost delovanja v sozvočju s poklicno, okoljsko, socialno in etično odgovornostjo • razumevanje osnov fizikalne kemije, • poznavanje zgradbe in lastnosti sodobnih kovinskih, keramičnih, polimernih, kompozitnih in pametnih materialov, • sposobnost branja in razumevanja faznih diagramov, • razumevanje procesov razvoja mikro- in makrostrukture ter mehanizmov utrjevanja materialov, • sposobnost izbire in načrtovanja materialov za določeno uporabo.	in the field of mechanical engineering and beyond, • ability to actively communicate in writing and orally at a high professional as well as at a popular level, depending on the target audience, • ability to work in teams with experts from different fields, • ability to work according to professional, environmental, social and ethical responsibility • understanding the basics of physical chemistry, • knowledge of the structure and properties of modern metals, ceramics, polymer, composites and smart materials, • ability of reading an understanding of phase diagrams, • understanding the processes of micro and macro structure development and strengthening mechanisms of the materials, • ability to select and design the material for a specific application.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Namen predmeta pridobiti znanje o načrtovanju, sintezi in selekciji materialov. ***Študent/študentka:*** • pozna strukture in lastnosti materialov, • razume in prepozna procese v materialih na mikro in makro nivoju, • povezuje lastnosti in strukturo materialov, • razvije sposobnosti razumevanja in praktične uporabe faznih diagramov, • razvije sposobnosti načrtovanje in selekcije materialov, • razvije sposobnost svetovanja in načrtovanja toplotne obdelave materialov, • se usposobi za predvidevanje vedenja materialov v različnih pogojih delovanja.	The purpose of the course is to acquire knowledge about the design, synthesis and selection of materials. ***Student:*** • knows the structures and properties of materials, • understands and recognize the processes in materials on the micro and macro level, • connects the properties and structure of materials, • develops the skills of understanding and practical application of phase diagrams, • develops material design and material selection skills, • develops the ability to consult and plan material heat treatment, • is able to predict the behavior of materials in different operating conditions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov), • *avditorne vaje:* reševanje problemov, študije primerov, kritično presojanje, diskusija, refleksija izkušenj, vrednotenje, projektno delo, timsko delo, • *laboratorijske vaje:* praktično reševanje več tipičnih problemov v laboratoriju, • *seminar:* priprava, predstavitev in uspešen zagovor projektne/raziskovalne naloge, (reševanje problemov, študije primera, kritično presojanje, diskusija, refleksija izkušenj, vrednotenje, projektno delo, timsko delo).	• *lectures* with active student participation (explanation, discussion, questions, examples, problem solving), • *tutorial:* problem solving, case studies, methods of critical thinking, discussion, reflection of experience, evaluation, project work, team work, • *laboratory work:* practical solving of several typical problems in laboratory, • *seminar tutorial:* presentation and defence of project/research work (problem solving, studies, critical thinking, discussion, reflection of experience, evaluation, project work, team work).

Načini ocenjevanja:	Delež (v %) Weight (in %)	**Assessment:**
Načini: • pisni izpit • ustni izpit • projektno seminarsko delo Ocenjevalna lestvica: ECTS.	 40 % 40 % 20 %	Types: • written exam • oral examination • project seminar Grading scheme: ECTS.