UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	MATERIALI ZA INŽENIRJE
Course Title:	MATERIALS FOR ENGINEERS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**4.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**4th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN121

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
45	**15**	**15 LV**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Marjan Marinšek / Dr. Marjan Marinšek, Associate Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	Content (Syllabus outline):
• Uvod: Razdelitev in pregled osnovnih skupin materialov: kovine, polimeri, keramika, kompoziti, polprevodniški materiali, biomateriali. Opis vede o materialih in inženirstva materialov. • Struktura atomov in kemijske vezi: Bohrov model atoma, Kvantno-mehanski model atoma, Nastanek kemijske vezi med elementi, Primerne vezi, Sekundarne vezi, Vpliv kemijskih vezi med gradniki na lastnosti materialov. • Kristalna zgradba trdnin: Amorfnost in kristaliničnost, Kristalne strukture, Kristalografske smeri, Kristalografske	• Introduction: Classification of materials, Metals, Ceramics, Polymers, Composite, Semiconductors, Biomaterials. What is Materials Science and Engineering? • Atomic Structure and Interatomic Bonding: Bohr model, Quantum-mechanic model, Atomic bonding, Primary interatomic bonds, Secondary bonding, Interatomic bonding and properties of materials • The structure of crystalline solids: Amorphous and crystalline materials, Crystal structure, Points, directions and planes in the unit cell, Linear, planar and volume atomic density, Metalic crystal structures, Crystal structures of ionic materials, Density computations, Structure

ravnine, linearna, ploskovna in volumenska atomska gostota materiala, Struktura kovin, Struktura keramičnih materialov, Teoretična gostota materialov, Struktura polimerov, Polimorfizem in alotropija, Vpliv strukture materialov na njihove lastnosti.

- Napake v strukturi trdnin: Opis in pomen točkastih napak v materialih, Stehiometrija in podtehiometrija keramičnih materialov, Trdne raztopine, Nastanek in pomen dislokacij, Dvodimenzijske napake v kristalih, Volumenske napake v kristalih

- Difuzija v trdnem: Mehanizem difuzije v trdnem, Stacionarna difuzija, Določitev aktivacijske energije difuzije v trdnem, Nestacionarna difuzija in praktične rešitve 2. Fickovega zakona, Permeabilnost polimerov.

- Mehanske lastnosti snovi: Nateznostni preiskus, Opis osnovnih mehanskih lastnosti različnih skupin materialov, Elastična deformacija, Upogibni testi, Plastična deformacija materialov, Drsni sistemi, Zdrs v monokristalu, Plastična deformacija polikristaliničnega materiala, Utrjevanje materialov, Toplotna obdelava utrjenih materialov, Trdota

- Zlom materialov: Duktilen in krhek lom materialov, Udarni testi, Teoretična zlomna trdnost, Griffithova teorija, Zlomna žilavost, Utrujanje materialov, Lezenje.

- Fazni diagrami: Enokomponentni fazni diagrami, Gibbsovo fazno pravilo, Večkomponentni sistemi, Meja topnosti v trdnem, Tipični primeri dvokomponentnih faznih diagramov, Fazno pravilo vzvoda, Ravnotežni in neravnotežni fazni prehodi, Trikomponentni fazni diagrami, Jekla

- Fazne spremembe v materialih: Termodinamska gonilna sila fazne spremembe, Homogena in heterogena nukleacija, Hitrost fazne spremembe, TTT diagrami (time-temperature-transition), Difuzijske in brezdifuzijske fazne

of polymers, Crystalline structure and properties of materials

- Imperfections in solids: Point defects, Stoichiometric and non-stoichiometric materials, Solid solutions, Dislocations, Surface defects, Volume defects.
- Diffusion in solids: Diffusion mechanisms, Steady-state diffusion, Activation energy for diffusion, Nonsteady-state diffusion, Practical solutions of Fick's 2nd law, Permeability of polymers.
- Mechanical properties of materials: The tensile test, Stress-strain behaviour of various materials, Elastic deformation, Bend tests, Plastic deformation, Slip systems, Slip in single crystals, Plastic deformation of polycrystalline materials, Strengthening of materials, Recovery of mechanical properties, Hardness of materials.
- Mechanical failure of materials: Ductile and brittle fracture, Impact fracture testing, Principles of fracture mechanics, Griffith theory, Fracture toughness, Fatigue, Creep.
- Phase diagrams: Thermodynamic introduction, The Gibbs phase rule, Binary and ternary phase diagrams, Solubility limit, Examples of typical binary phase diagrams, Interpretation of phase diagrams, Equilibrium and nonequilibrium phase transitions, The Fe-Fe3C phase diagram, Steel.
- Phase transformations in materials: Thermodynamic introduction, Homogeneous and heterogeneous nucleation, Kinetics of phase transformation, Temperature-time-transition diagrams, Diffusion and nondiffusion phase transitions in steels, Precipitation strengthening, Shape memory mateials, Phase transformations in non-metallic systems.
- Electrical properties of materials: Band theory, Conductivity in metals and alloys, p and n semiconductors, Application of semiconductors, Insulators.
- Thermal properties of materials: Heat capacity and specific heat of mateials, Thermal expansion, thermal conductivity, Thermal shock.
- Magnetic properties of materials: Clasificatin

transformacije, Difuzijske in brezdifuzijske fazne transformacije v jeklih, Precipitacijsko utrjevanje, Materiali s spominom oblike, Nekatere fazne transformacije v nekovinskih sistemih

- Električne lastnosti materialov: Teorija pasov, Principi električne prevodnosti v kovinah, Polprevodniki p in n tipa, Nekatere aplikacije polprevodniških materialov, Izolatorji
- Termične lastnosti materialov: Toplotna kapaciteta materialov, Specifična toplota, Termična ekspanzija materialov, Toplotna prevodnost materialov, Toplotni šok
- Magnetne lastnosti materialov: Klasifikacija magnetnih materialov, Osnove magnetizma, Feromagnetni-, ferimagnetni-, paramagnetni- in diamagnetni-materiali, Trdo- in mehko-magnetni materiali, Aplikacije magnetnih materialov

Optične lastnosti materialov: Odboj, absorpcija in prepustnost materialov za svetlobo, Optična vlakna, Luminiscenca.

of magnetic materials, Basic concepts of magnetism, Ferromagnetic, ferrimagnetic, paramagnetic and diamagnetic materials, Soft and hard magnetic materials, Application of magnetic materials.
Optical properties of materials: Reflection, absorption and transmission of light in materials, Optical fibers, Luminescence.

Temeljna literatura in viri / Readings:

1. Shackelford J.F., Introduction to Materials Science for Engineers, 7.th.ed.Prentice Hall PTR, New Jersey, 2008, 605 strani (60 %)
2. Callister W.D. Jr, Rethwisch, D. G., Materials science and Engineering- An Introduction, 9.th.ed. John Wiley& Sons, New York, 2013, 960 strani (20%)
3. Askeland D. R., Pradeep P. Fulay P.P., and Wright W. J., The Scinece and Engineering of Materials, 6.th.ed. Cengage Learning, Australia, 2010, 921 strani (20%)

Cilji in kompetence:

Študent bo pridobil znanja potrebna za osnovno oceno uporabnosti in primernosti določenih materialov za posamezne funkcije ali za kvalitetno napoved možnosti odpovedi gradiv, ki se uporabljajo bodisi kot komponente ali sestavni deli različnih struktur (gradbeni elementi ali strukture, reaktorske posode, stroji, naprave, sistemi in podobno). Pridobil bo celovita znanja o lastnostih materialov s poudarkom na kemijskih, fizikalnih in mehanskih lastnostih. Razumel bo zakaj in katere lastnosti so neodvisne od

Objectives and Competences:

The student acquires knowledge necessary for basic evaluation of usefulness and suitability of particular materials for individual functions or for predicting failure risk of materials used as components in various structures (construction elements or structures, reactor vessels, machines, devices, systems, ect.) The student acquires comprehensive knowledge of material properties especially chemical, physical and mechanical. Understanding why and which properties are preparation process independent and which are preparation and preparation

priprave, katere lastnosti pa so v bistvu odvisne od izbire procesa priprave in z njim določene mikrostrukture. Ob tem bo spoznal konkretne materiale (kovine, polimerne snovi, keramiko, kompozite idr.), ki se uporabljajo v industrijskih in drugih aplikacijah ter pridobil znanja potrebna za pravilno tolmačenje podatkov v priročnikih in bazah podatkov. To je še posebej pomembno kadar je gradivo izpostavljeno korozivni sredini ali drugim pogojem in obremenitvam, kjer prihaja do interakcije kemijskih, fizikalnih in mehanskih vplivov.	determined microstructure dependent. Acquaintance with specific materials (metals, polymers, ceramics, composites…) which are used in industrial and other applications. Acquisition of knowledge necessary for proper interpretation of manual and database data which is of special importance when materials are exposed to corrosive milieu or other conditions, where there is interaction between chemical, physical and mechanical influences.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študente bomo uvajali k samostojnemu, logičnemu in kritičnemu razmišljanju o lastnostih in uporabi različnih materialov.	Knowledge and Comprehension The student is encouraged to independent logical and critical thinking about properties and use of different materials.
Uporaba V okviru predmeta bo študent spoznal soodvisnost med sestavo, strukturo in mikrostrukturo materialov in njihovo uporabnostjo za različne namene ter pridobil znanja potrebna za sodelovanje z drugimi strokovnjaki pri izboru primernega materiala za določeno aplikacijo. Seznanjen bo z osnovnimi podatki potrebnimi za analizo tveganja in nevarnosti odpovedi pod normalnimi pogoji obratovanja in možnosti, da bo pri dodatnih obremenitvah materialov, zaostrenih ali izrednih razmerah prišlo do sprememb, ki povečajo tveganja do mere, nesprejemljive za varno obratovanje.	Application The course covers codependence between composition, structure microstructure and application for different uses. The student acquires knowledge of cooperation with experts from other fields when choosing adequate material for a certain application. The student is introduced to basic data necessary for risk assessment and failure risk under normal conditions of operation, under extreme conditions which cause changes increasing the risk until safe operation is impossible.
Refleksija Študent pridobi znanje za smoterno analizo uporabe izbranega materiala ter možnosti, da pri njegovi uporabi zaradi izrednih pogojev pride do neželenih sprememb.	Analysis The student acquires knowledge for rational analysis of use of a chosen material and risk of unwanted changes due to extreme conditions.
Prenosljive spretnosti Razvita sposobnost kritičnega razmišljanja in logičnega sklepanja. Sposobnost študija domače in tuje literature ter predstavitve rezultatov.	Skill-transference Ability Ability of critical thinking and deduction; Ability of studying relevant literature from the field of polymer materials and results presentation.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**

Predavanja, seminarji, laboratorijske vaje.	Lectures, computational seminars, practical course.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Opravljene laboratorijske vaje so pogoj za pristop k izpitu. Pisni izpit 50% Ustni izpit 50%		Accomplished laboratory practice are prerequisites to exam attendance. Written exam 50% Oral exam 50%.

Reference nosilca / Lecturer's references:

1. ŠTUKOVNIK, Petra, **MARINŠEK, Marjan**, MIRTIČ, Breda, BOKAN-BOSILJKOV, Violeta. Influence of alkali carbonate reaction on compressive strength of mortars with air lime binder. Construction & building materials, 2015, vol. 75, str. 247-254
2. JAPIĆ, Dajana, BITENC, Marko, **MARINŠEK, Marjan**, CRNJAK OREL, Zorica. The impact of nano-milling on porous ZnO prepared from layered zinc hydroxide nitrate and zinc hydroxide carbonate. Materials research bulletin, 2014, vol. 60, str. 738-745
3. **MARINŠEK, Marjan**, ŠALA, Martin, JANČAR, Boštjan. A study towards superior carbon nanotubes-supported Pd-based catalysts for formic acid electro-oxidation : preparation, properties and characterisation. Journal of power sources, 2013, vol. 235, no. 1, str. 111-116