

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet: Nekovinski materiali - RRP
Course title: Non-metallic materials - RRP

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Strojništvo - razvojno raziskovalni program, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	Letni

Univerzitetna koda predmeta/University course code: 2008-U

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45		30			50	5

Nosilec predmeta/Lecturer: Lidija Slemenik Perše

Vrsta predmeta/Course type: Obvezni splošni predmet / Compulsory general course

Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Izpolnjevanje pogojev za vpis v Univerzitetni študijski program I. stopnje Strojništvo - Razvojno raziskovalni program.

Prerequisites:

Meeting the enrollment conditions for the Academic study programme of Mechanical Engineering - Research and Development program.

Vsebina:

. Vsebina 1. Predavanja: ZGRADBA SNOVI in KEMIJSKE VEZI
- Razdelitev snovi in njihove lastnosti, za konitosti kemijskih sprememb, agregatna stanja, atomi, molekule, vrste in lastnosti kemijskih vezi, van der Waalove interakcije.
2. Vsebina 2. Predavanja: LASTNOSTI in ZGRADBA TRDNIH SNOVI
- Stehiometrija in IUPAC nomenklatura, periodni system, amorfna in kristalinična struktura, vpliv kristaliničnosti na mehanske lastnosti, kristali – zgrajba, rast kristalov, napake v kristalni strukturi.
3. Vsebina 3. Predavanja: KEMIJSKA KINETIKA in KATALIZA
- Kemijsko ravnotežje, Le Chatelierjev princip, hitrost in mehanizem reakcije (vpliv reaktantov, temperature in tlaka, agregatnega stanja, katalizatorjev), homogena in heterogena kataliza.
4. Vsebina 4. Predavanja: KEMIJSKE LASTNOSTI SNOVI in KEMIJSKI PROCESI v STROJNIŠTVU
- Kisline in baze (pH), reaktivnost, topnost, gorljivost, procesi zgorevanja, degradacija snovi, zaščita nekovinskih materialov, procesi lepljenja.

Content (Syllabus outline):

. Content of Lecture 1: MATERIAL STRUCTURE and CHEMICAL BONDS
- Materials and their properties, characteristics of chemical changes, state of matter, atoms, molecules, types and properties of chemical bonds, van der Waals interactions.
2. Content of Lecture 2: PROPERTIES and STRUCTURE OF SOLIDS
- Stoichiometry and IUPAC nomenclature, Periodic system, amorphous and crystalline structure, effect of crystallinity on mechanical properties, crystals - structure, growth, structural defects.
3. Content of Lecture 3: CHEMICAL KINETICS and CATALYSIS
- Chemical equilibrium, Le Chatelier's principle, rate and mechanism of reaction (effect of reactants, temperature, pressure, state of matter, catalysts), homogeneous, heterogeneous catalysis.
4. Content of Lecture 4: CHEMICAL PROPERTIES and CHEMICAL PROCESSES in MECHANICAL ENGINEERING
- Acids and bases (pH), reactivity, solubility, flammability, combustion, degradation, protection of non-metallic materials, bonding processes.

<p>5. Vsebinska 5. Predavanja: POVEZAVA MED STRUKTURO IN LASTNOSTMI SNOVI</p> <ul style="list-style-type: none"> - Strukturne lastnosti suspenzij, emulzij, makromolekul, osnove reologije – vpliv zunanje obremenitve na strukturne lastnosti nekovinskih materialov, razumevanje odziva materialov na podlagi določenih reoloških lastnosti. <p>6. Vsebinska 6. Predavanja: ELEKTROKEMIJA</p> <ul style="list-style-type: none"> - Osnove elektrokemije, redoks reakcije, redoks potenciali, termodinamika redoks reakcij, galvanski člani, elektroliza, uporaba elektrokemije v industriji. <p>7. Vsebinska 7. Predavanja: KERAMIKA in STEKLO</p> <ul style="list-style-type: none"> - Razdelitev in pregled osnovnih skupin nekovinskih materialov, osnovne značilnosti keramike in stekla, zgradba keramike; mikrostruktura keramičnih materialov, postopki izdelave keramike, stekla. <p>8. Vsebinska 8. Predavanja: POLIMERNI MATERIALI</p> <ul style="list-style-type: none"> - Definicije pojmov, značilnosti polimernih materialov, razdelitev polimerov v osnovne skupine, posebni polimerni materiali. <p>9. Vsebinska 9. Predavanja: OSNOVE ORGANSKE KEMIJE in SINTETIČNI POLIMERI</p> <ul style="list-style-type: none"> - Zgradba organskih spojin, ogljikovodiki, osnovne reakcije alkanov, alkenov, alkinov; osnovne skupine sintetičnih polimerov, lastnosti in primeri uporabe termoplastov, duroplastov, elastoplastov. <p>10. Vsebinska 10. Predavanja: TERMIČNE ZNAČILNOSTI NEKOVINSKIH MATERIALOV</p> <ul style="list-style-type: none"> - Fazni prehodi, karakteristične temperature prehodov, toplotni razteznostni koeficient, proces fizikalnega staranja, vpliv hitrosti segrevanja oz. ohlajanja na fazne prehode, koncept prostega volumna, metode za določitev termičnih lastnosti nekovinskih materialov. <p>11. Vsebinska 11. Predavanja: NEKOVINSKI KOMPOZITI</p> <ul style="list-style-type: none"> - Osnovne komponente in vrste kompozitnih struktur, vrste in lastnosti ojačitvenih komponent (vlakna, delci, nodelci), vrste polimernih matrič, postopki izdelave, računanje mehanskih lastnosti. <p>12. Vsebinska 8. Predavanja: VISKOELASTIČNE LASTNOSTI NEKOVINSKIH MATERIALOV</p> <ul style="list-style-type: none"> - Osnove viskoelastičnosti, teorija linearne viskoelastičnosti, mehanski modeli za popis viskoelastičnih odzivov, osnovne materialne funkcije, statične in dinamične materialne funkcije, Poissonovo število. <p>13. Vsebinska 13. Predavanja: ČASOVNO-ODVISNE ZNAČILNOSTI POLIMERNIH MATERIALOV</p> <ul style="list-style-type: none"> - Časovno odvisno mehansko vedenje polimerov, materialne (prenosne) funkcije (statične in dinamične), fizikalno ozadje procesov lezenja in relaksacije, mehanski spekter materiala (relaksacijski, retardacijski), fizikalni pomen mehanskega spektra. <p>14. Vsebinska 14. Predavanja: VPLIV TEMPERATURE, TLAKA in VLAGE NA ČASOVNO-ODVISNO MEHANSKO VEDENJE POLIMERNIH MATERIALOV</p> <ul style="list-style-type: none"> - Vpliv vlage, temperature in tlaka na mehanske lastnosti, eksperimentalne metode in principi karakterizacije časovno odvisnega vedenja polimerov: 	<p>5. Content of Lecture 5: STRUCTURE - PROPERTY RELATIONSHIP</p> <ul style="list-style-type: none"> - Structural properties of suspensions, emulsions, macromolecules, basic rheology - effect of external loading on structural properties of non-metallic materials, understanding the response of materials based on rheological properties. <p>6. Content of Lecture 6: ELECTROCHEMISTRY</p> <ul style="list-style-type: none"> - Fundamentals of electrochemistry, redox reactions, redox potentials, thermodynamics of redox reactions, galvanic cells, electrolysis, application of electrochemistry in industry. <p>7. Content of Lecture 7: CERAMICS and GLASS</p> <ul style="list-style-type: none"> - Basic groups of non-metallic materials, basic characteristics of ceramics and glass, structure and microstructure of ceramic materials, manufacturing processes of ceramics and glass. <p>8. Content of Lecture 8: POLYMERS</p> <ul style="list-style-type: none"> - Basic definitions, characteristics of polymeric materials, basic groups of polymers, specific polymeric materials. <p>9. Content of Lecture 9: BASICS of ORGANIC CHEMISTRY AND SYNTHETIC POLYMERS</p> <ul style="list-style-type: none"> - Structure of organic compounds, hydrocarbons, basic reactions of alkanes, alkenes, alkynes; basic groups of synthetic polymers, properties and use of thermoplastics, duroplasts, elastoplastics. <p>10. Content of Lecture 10: THERMAL CHARACTERISTICS OF NON-METALLIC MATERIALS</p> <ul style="list-style-type: none"> - Phase transitions, characteristic transition temperatures, thermal expansion coefficient, physical aging, effect of heating or cooling rate on phase transitions, free volume concept, methods for determination of thermal properties of non-metallic materials. <p>11. Content of Lecture 11: NON-METALLIC COMPOSITES</p> <ul style="list-style-type: none"> - Basic components and types of composite structures, types and properties of reinforcement components (fibers, particles, nanoparticles), types of polymer matrices, fabrication processes, calculation of mechanical properties. <p>12. Content of Lecture 12: VISCOELASTIC PROPERTIES of NON-METALLIC MATERIALS</p> <ul style="list-style-type: none"> - Fundamentals of viscoelasticity, theory of linear viscoelasticity, mechanical models for the description of viscoelastic responses, basic material functions, static and dynamic material functions, Poisson number. <p>13. Content of Lecture 13: TIME-DEPENDENT CHARACTERISTICS of POLYMER MATERIALS</p> <ul style="list-style-type: none"> - Time dependent mechanical behavior of polymers, material (transfer) functions (static and dynamic), physical background of creep and relaxation processes, material mechanical spectrum (relaxation, retardation), physical significance of mechanical spectrum. <p>14. Content of Lecture 14: The EFFECT of TEMPERATURE, PRESSURE and MOISTURE on the TIME-DEPENDENT MECHANICAL BEHAVIOUR of POLYMER MATERIALS</p>
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<p>Boltzmannov superpozicijski princip, izohrone, sumarna krivulja, premaknitveni faktorji, WLF enačba, Doolittle enačba.</p> <p>15. Vsebina 15. Predavanja: RECIKLIRANJE POLIMERNIH MATERIALOV</p> <p>- Vrste recikliranja, vpliv strukture na izbiro postopka recikliranja, vpliv recikliranja na termične, strukturne in mehanske lastnosti.</p>	<p>- The effect of moisture, temperature and pressure on mechanical properties, experimental methods and principles of characterization of the time-dependent behavior of polymers: Boltzmann superposition principle, isochrones, master curves, shift factors, WLF equation, Doolittle equation.</p> <p>15. Content of Lecture 15: RECYCLING of POLYMER MATERIALS</p> <p>- Types of recycling processes, the impact of structure on the selection of the recycling process, the impact of recycling on thermal, structural and mechanical properties.</p>
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Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> 1. F. Lazarini in J. Brenčič: Splošna in Anorganska kemija, Založba FKKT, Ljubljana 201 2. D. F. Shriver, P.W. Atkins, Inorganic Chemistry, Oxford-University Press, 2010. 3. Ferry J.D.: Viscoelastic properties of polymers. John Wiley & Sons, 1980. 4. Ward I.M., and John Sweeney. Mechanical properties of solid polymers. John Wiley & Sons, 2012. 5. McCrum N.G., Buckley C.P., Bucknall C.B., Principles of Polymer Engineering, Oxford University Press, New York, 1997.
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Cilji in kompetence:

<p>Cilji:</p> <ol style="list-style-type: none"> 1. Cilj 1: spoznati pomen kemije v inženirstvu s poudarkom na realnih primerih v strojništvu 2. Cilj 2: spoznati povezavo poznavanja zgradbe snovi in njen vpliv na kemijske in fizikalne lastnosti materiala 3. Cilj 3: spoznati lastnosti nekovinskih materialov pri različnih okoljskih pogojih 4. Cilj 4: spoznati lastnosti nekovinskih materialov pri različnih pogojih obremenjevanja 5. Cilj 5: spoznati pomen trajnostnega razvoja <p>Kompetence:</p> <ol style="list-style-type: none"> 1. Kompetenca 1: sinteza osnov kemije v strojniške aplikacije (S6-RRP + P1-RRP) 2. Kompetenca 2: sposobnost analize zgradbe snovi ter njenega vpliva na kemijske in fizikalne lastnosti materiala (S1-RRP, S8-RRP + P2-RRP) 3. Kompetenca 3: sposobnost napovedovanja vedenja nekovinskih materialov pri različnih okoljskih pogojih (S7-RRP + P3-RRP) 4. Kompetenca 4: sposobnost napovedovanja vedenja nekovinskih materialov pri različnih pogojih obremenjevanja (S2-RRP + P6-RRP) 5. Kompetenca 5: sposobnost izbire ustreznega postopka predelave po končani življenjski dobi izdelka (S9-RRP + P5-RRP) 	<p>Objectives and competences:</p> <p>Aims:</p> <ol style="list-style-type: none"> 1. Aim 1: to understand the importance of chemistry in engineering with a focus on real-life examples in mechanical engineering 2. Aim 2: to understand the connection between the structure and the chemical and physical properties of the material 3. Aim 3: to learn about the properties of non-metallic materials under different environmental conditions 4. Aim 4: to learn about the properties of non-metallic materials under various loading conditions 5. Aim 5: to understand the importance of sustainable development <p>Competences:</p> <ol style="list-style-type: none"> 1. Competence 1: the ability to use the basic knowledge of chemistry in mechanical engineering (S6-RRP + P1-RRP) 2. Competence 2: the ability to analyze the structure of the material and its effect on the chemical and physical properties (S1-RRP, S8-RRP + P2-RRP) 3. Competence 3: the ability to predict the behavior of non-metallic materials under different environmental conditions (S7-RRP + P3-RRP) 4. Competence 4: the ability to predict the behavior of non-metallic materials under different loading conditions (S2-RRP + P6-RRP) 5. Competence 5: the ability to select the appropriate recycling process after the end of the product's lifetime (S9-RRP + P5-RRP)
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Predvideni študijski rezultati:

<p>Znanja:</p> <p>Z1: Poglobljeno strokovno teoretično in praktično znanje kemije v inženirstvu s poudarkom na dejanskih realnih primerih snovi in nekovinskih materialov v strojništvu.</p>	<p>Intended learning outcomes:</p> <p>Knowledge:</p> <p>Z1: In-depth theoretical and practical knowledge of chemistry in engineering with a focus on actual real-life examples of non-metallic materials in mechanical</p>
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<p>Osnovno znanje kemije s povezavo poznavanja zgradbe snovi in njen vpliv na kemijske ter fizikalne lastnosti materiala.</p> <p>Pogljobljeno strokovno teoretično in praktično znanje na področju vedenja nekovinskih materialov pri različnih okoljskih vplivih in obremenitvah.</p> <p>Spretnosti:</p> <ol style="list-style-type: none"> 1. S1 Izvajanje kompleksnih karakterizacijskih tehnik in metod za določevanje različnih lastnosti nekovinskih materialov. 2. S1.2 Obvladovanje zahtevnih, kompleksnih lastnosti nekovinskih materialov ob samostojni uporabi pridobljenega znanja v realnih delovnih situacijah. 3. S1.3 Diagnosticanje in reševanje problemov uporabe nekovinskih materialov v industrijskih procesih na področju strojništva. 4. S1.4 Osnova za izvirne rešitve napak nekovinskih produktov oz. tehnoloških procesov predelave nekovinskih materialov ter kritično refleksijo. 	<p>engineering. Basic knowledge of chemistry with relation between the knowledge of structure and its effect on chemical and physical properties of material.</p> <p>In-depth theoretical and practical knowledge of the behavior of non-metallic materials at various environmental impacts and loads.</p> <p>Skills:</p> <ol style="list-style-type: none"> 1. S1 Implementation of complex characterization techniques and methods for determination of various properties of non-metallic materials. 2. S1.2 Mastering demanding and complex properties of non-metallic on the basis of creative use of acquired knowledge in specialised professional fields. 3. S1.3 Solving problems of using non-metallic materials in industrial processes. 4. S1.4 Ability of unique solutions in technological processes and critical reflections.
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<p>Metode poučevanja in učenja:</p> <ol style="list-style-type: none"> 1. Metoda 1: Klasične oblike poučevanja: P1 Avdiorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki. P5 Uporaba študijskega gradiva v obliki skripta, e-verzija predstavitve predavanj P9 Skupinsko delo (razprave za –proti, strukturirana diskusija, viharjenje možganov) 2. Metoda 2: Moderne in prožne oblike poučevanja: P10 Uporaba anket v realnem času P14 Virtualni eksperimenti P15 Uporaba video vsebin kot priprava na predavanja 	<p>Learning and teaching methods:</p> <ol style="list-style-type: none"> 1. Method 1: Conventional teaching methods: P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases. P2 Presenting the content according to the explained system. P5 Application of study material (textbook, e-book of the lectures). P9 Team work (discussions pro and contra, structured discussion, brainstorming) 1. Method 2: Contemporary and flexible teaching methods: P10 Application of questionnaires in real time. P14 Virtual experiments. P15 Application of videos for preparations to the lectures and exercises.
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Načini ocenjevanja:	Delež/Weight	Assessment:
- Teoretične vsebine (predavanja).	60,00 %	- Theoretical part (lectures).
- Samostojno delo na vajah.	20,00 %	- Individual work during laboratory practice.
- Delo na laboratorijskih vajah (vključno s poročili).	20,00 %	- Laboratory work (report included).

<p>Reference nosilca/Lecturer's references:</p> <p>Lidija Slemenik Perše</p> <ol style="list-style-type: none"> 1. HAJZERI, Metka, SLEMENIK PERŠE, Lidija, KOŽELJ, Matjaž, OREL, Boris, SURCA, Angelja Kjara. Structural investigation of ormolytes for EC devices : IR spectroscopic characterization and relation between viscoelastic properties, conductivity and optical modulation. Solar energy materials and solar cells, ISSN 0927-0248. [Print ed.], Aug. 2015, vol. 139, str. 51-64. 2. SLEMENIK PERŠE, Lidija, ČOLOVIĆ, Marija, HAJZERI, Metka, OREL, Boris, SURCA, Angelja Kjara. Electrolytes based on alkoxysilyl-functionalized ionic liquids : viscoelastic properties and conductivity. Soft matter, ISSN 1744-683X, Aug. 2014, vol. 10, iss.30, str. 5532-5540. 3. HAJZERI, Metka, SURCA, Angelja Kjara, SLEMENIK PERŠE, Lidija, ČOLOVIĆ, Marija, HERBIG, Bettina, POSSET, Uwe, MAČEK, Marjeta, OREL, Boris. Sol-gel vanadium oxide thin films for a flexible electronically conductive polymeric substrate. V: ROUGIER, Aline (ur.), GUY, Campet (ur.). Proceedings of the 9th International Meeting on Electrochromism, September 5-9, 2010, Bordeaux, France. Amsterdam: North-Holland, 2012. Vol. 99, iss. 1, str. 62-72. Solar energy materials & solar cells, vol. 99, no. 1, 2012.

4. KUNIČ, Roman, MIHELČIČ, Mohor, OREL, Boris, **SLEMENIK PERŠE, Lidija**, BIZJAK, Aleš, KOVAČ, Janez, BRUNOLD, Stefan. Life expectancy prediction and application properties of novel polyurethane based thickness sensitive and thickness insensitive spectrally selective paintcoatings for solar absorbers. Solar energy materials and solar cells. [Print ed.]. 2011, letn. 95, št.11, str. 2965-2975.
5. AULOVA, Alexandra, BEK, Marko, **SLEMENIK PERŠE, Lidija**. Effect of calendaring temperatures on mechanical properties of polypropylene foils. V: Book of abstract : MTDM 2018. The 11th International Conference on the Mechanics of Time Dependent Materials, September 4th-7th, 2018.