UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	TEORIJA VISKOELASTIČNOSTI
Course title:	THEORY OF VISCOELASTICITY

Študijski programi in stopnja	**Študijska smer**	**Letnik**	**Semestri**
Strojništvo, tretja stopnja, doktorski	Konstrukcijsko mehanske inženirske znanosti (smer)		Celoletni

Univerzitetna koda predmeta/University course code: 7119

Predavanja	**Seminar**	**Vaje**	**Klinične vaje**	**Druge oblike študija**	**Samostojno delo**	**ECTS**
90					160	10

Nosilec predmeta/Lecturer: Lidija Slemenik Perše

Izvajalci predavanj:	
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type: Izbirni predmet /Elective course

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Veljajo splošni pogoji za doktorski študij.	General prerequisites for the third level studies.

Vsebina:	**Content (Syllabus outline):**
Vedenje polimernih materialov in pripadajočih kompozitov in nanokompozitov se spreminja s časom. Na to časovno odvisnost močno vplivajo temperatura, tlak, vlaga, ter velikost in oblika mehanske obremenitve. Analiza teh odvisnosti je vsebina tega predmeta. Definicija osnovnih fizikalnih pojmov in konceptov. Značilnosti časovno-odvisnega vedenja materialov in konstrukcij. Značilnosti nelinearnega časovno odvisnega vedenja polimerov, kompozitov, nanokompozitov in hibridnih materialov. Strukturne razlike med materiali in njihov vpliv na časovno odvisne mehanske lastnosti. Problem mejne plasti. Kritična nanodimenzija polnil in vlaken. Materialne funkcije v časovnem in frekvenčnem prostoru. Problemi reševanja inverznega problema Fredholmovih integralov prvega reda. Mehanski spekter. Algoritem Emri-Tschoegl. Vpliv temperature, tlaka in vlage. Absorpcija energije pri dinamični obremenitvi. Fizikalno staranje. Nelinearni viskoelastični model Knauss-	The behavior of polymer materials and related composites and nano-composites changes over time. This time-dependence is strongly influenced by temperature, pressure, humidity, as well as the size and shape of mechanical loading. The analysis of these dependencies constitutes the content of this course. Basic definitions and concepts. Characteristics of nonlinear time-dependent behaviour of polymers, composites, nano-composites and hybrid materials. Structural differences between materials and their effect on time-dependent mechanical properties. Interface issue. Critical nano-dimension of fillers and fibers. Material functions in time and frequency domain. Problems relating to the solving of the inverse problem of the Fredholm integrals of the first kind. Mechanical spectrum. The Emri-Tschoegl algorithm. Effects of temperature, pressure and humidity. Energy absorption at dynamic loading. Physical ageing. The Knauss-Emri nonlinear viscoelastic model.

Emri.	

Temeljna literatura in viri/Readings:

[1] Emri, I.: Viscoelasticity and Applications,- Lecture Notes on AE 221.- Pasadena, CA: California Institute of Technology, 2001
[2] Ferry, J.D.: Viscoelastic Properties of Polymers.- 3rd ed.- New York: J. Wiley & Sons, 1980
[3] Schwarzl: Mechanische Eigenschaften von Polymeren.- Springer-Verlag, 1990
[4] Tschoegl, N.W.: The Phenomenological Theory of Linear Viscoelastic Behavior.- Springer-Verlag, 1989
[5] Emri, I.: Rheology of Solid Polymers; Rheology reviews 2005. [S.l.]: British Society of Rheology, 2005, str. 49-100.
[6] Wineman, A.S., Rajagopal, K.R.: Mechanical Response of Polymers, an Introduction; Cambridge University Press, 2000

Cilji in kompetence:	**Objectives and competences:**
Cilji: Namen predmeta je seznanti študente s trenutnim stanjem znanj na področju teorije linearne in nelinearne viskoelastičnosti in pripadajočim določanjem materialnih funkcij v časovnem in frekvenčnem prostoru. **Kompetence:** Predmet pripravlja študente za uporabo znanja viskoelastičnosti. Študent razume posebnosti časovno odvisnega vedenja polimernih konstrukcijskih materialov in prednosti, ki jih tovrstni materiali nudijo v znanosti in tehniki. Obvladuje matematične pristope za popisovanje vedenja časovno-odvisnih materialov v časovnem in frekvenčnem prostoru in napovedovanje življenske dobe izdelkov izdelanih iz tovrstnih materialov. Splošne kompetence: Obvladanje raziskovalnih metod, postopkov in procesov, razvoj kritične in samokritične presoje, sposobnost uporabe znanja v praksi, razvoj komunikacijskih sposobnosti in spretnosti, posebej komunikacije v mednarodnem okolju, kooperativnost, delo v skupini.	**Goals:** The aim of this course is to acquaint students with the state-of-art knowledge in the field of the theory of linear and nonlinear viscoelasticity and the related determination of material functions in the time and frequency domain. **Competences:** This course prepares students to apply knowledge of viscoelasticity. Student understands specifics of the time-dependent behavior of polymeric structural materials advantages that these materials offer in science and engineering. Students will master the mathematical techniques for modeling the behavior of time-dependent materials in time and frequency domain, as well as the durability of products made of these materials. General Competences: The student will master research methods, procedures and processes. The student will develop critical thinking. The student will develop communications skills to present research achievement in the international environment. Work in team (in international environment).

Predvideni študijski rezultati:	**Intended learning outcomes:**
Predmet pripravlja študente za uporabo znanja viskoelastičnosti. Študent razume posebnosti časovno odvisnega vedenja polimernih konstrukcijskih materialov in prednosti, ki jih tovrstni materiali nudijo v znanosti in tehniki. Obvladuje matematične pristope za popisovanje vedenja časovno-odvisnih materialov v časovnem in frekvenčnem prostoru in napovedovanje življenske dobe izdelkov izdelanih iz tovrstnih materialov. Splošne kompetence: Obvladanje raziskovalnih metod, postopkov in procesov, razvoj kritične in samokritične presoje, sposobnost uporabe znanja v praksi, razvoj komunikacijskih sposobnosti in spretnosti, posebej komunikacije v mednarodnem okolju, kooperativnost, delo v skupini.	This course prepares students to apply knowledge of viscoelasticity. Student understands specifics of the time-dependent behavior of polymeric structural materials advantages that these materials offer in science and engineering. Students will master the mathematical techniques for modeling the behavior of time-dependent materials in time and frequency domain, as well as the durability of products made of these materials. General Competences: The student will master research methods, procedures and processes. The student will develop critical thinking. The student will develop communications skills to present research achievement in the international environment. Work in team (in international environment).

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, seminarsko delo,e-izobraževanje, konzultacije. Seminarsko delo v čim večji meri navezujoče se na področje doktorskega raziskovanja. Študij z uporabo priporočene literature.	Lectures, laboratory practice & seminar work, e-education, consulting. The seminar work is related, as much as possible, to the student's doctoral research field. Study on a recommended literature basis.

Načini ocenjevanja:	Delež/Weight	Assessment:
Ustni izpit, poročilo o seminarskem delu. Pogoj za opravljanje ustnega izpita je uspešno izdelano in pozitivno ocenjeno seminarsko delo. Način (projekt, ustno izpraševanje): • projekt (seminarska naloga) (60%) • ustno izpraševanje (40%)		Oral exam, report on seminar work. The condition for admission to oral exam is successful completion of seminar work, rewarded with a passing grade. Method (project, oral examination): • project (seminar assignment) (60%) • oral examination (40%)

Reference nosilca/Lecturer's references:

doc.dr. Lidija Slemenik Perše

RODOŠEK, Mirjana, KOŽELJ, Matjaž, SLEMENIK PERŠE, Lidija, CERC KOROŠEC, Romana, GABERŠČEK, Miran, SURCA, Angelja Kjara. Protective coatings for AA 2024 based on cyclotetrasiloxane and various alkoxysilanes. *Corrosion science*, ISSN 0010-938X. [Print ed.], 2017, str. 1-14

AVSENIK, Lidija, KLINAR, Dušan, TUŠAR, Marjan, SLEMENIK PERŠE, Lidija. Use of modified slow tire pyrolysis product as a rejuvenator for aged bitumen. *Construction & building materials*, ISSN 0950-0618. [Print ed.], Sep. 2016, vol. 120, str. 605-616

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.

SLEMENIK PERŠE, Lidija, MIHELČIČ, Mohor, OREL, Boris. Rheological and optical properties of solar absorbing paints with POSS-treated pigments. *Materials chemistry and physics*, ISSN 0254-0584. [Print ed.], Jan. 2015, vol. 149/150, str. 368-377.

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

RODOŠEK, Mirjana, RAUTER, Aleksander, SLEMENIK PERŠE, Lidija, KEK-MERL, Darja, SURCA, Angelja Kjara. Vibrational and corrosion properties of poly(dimethylsiloxane)-based protective coatings for AA 2024 modified with nanosized polyhedral oligomeric silsesquioxane. *Corrosion science*, ISSN 0010-938X. [Print ed.], Aug. 2014, vol. 85, str. 193-203

RAUTER, Aleksander, SLEMENIK PERŠE, Lidija, OREL, Boris, BENGŰ, Başak, SUNETCI, Onder, SURCA, Angelja Kjara. Ex situ IR and Raman spectroscopy as a tool for studying the anticorrosion processes in (3-glycidoxypropyl)trimethoxysilane-based sol-gel coatings. *Journal of electroanalytical chemistry*, ISSN 1572-6657, 2013, vol. 703, str. 97-107

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*, (Solar energy materials & solar cells, ISSN 0927-0248, vol. 99, no. 1, 2012). Amsterdam: North-Holland. 2012, vol. 99, iss. 1, str. 62-72.