Univerza *v Ljubljani*
Fakulteta *za gradbeništvo in geodezijo*

Učni načrti

Magistrski študijski program druge stopnje

GRADBENIŠTVO (MA)
Gradbene konstrukcije

Course Syllabi

2nd cycle master study

CIVIL ENGINEERING (MA)
Structural Engineering

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UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Matematika 3
Course title:	Mathematics 3

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type: Obvezni splošni / Obligatory general

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		30			75	5

Nosilec predmeta / Lecturer: izr. prof. dr. Gašper Jaklič

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Opravljen izpit iz predmetov Matematika I in Matematika II oz. primerljive vsebine matematike v obsegu najmanj 15 KT.

Prerequisites:

Passed exams in Mathematics I and Mathematics II or other courses with comparable content with min. 15 ECTS.

Vsebina:

Linearni in evklidski prostori: linearna neodvisnost, baza, linearna preslikava, ničelni prostor in zaloga vrednosti, matrična predstavitev, prehodna matrika, rang, lastne vrednosti in lastni vektorji, skalarni produkt, norma, ortogonalnost, Gram-Schmidtova ortogonalizacija, pravokotna projekcija (vektor najboljše aproksimacije), Fourierovi koeficienti, metoda najmanjših kvadratov, predoločeni sistemi, normalna enačba, regresijska premica. Numerična linearna algebra: numerično računanje in napake, linearni sistemi, matrični razcepi: LU, QR, SVD. Navadne diferencialne enačbe: linearna DE n-tega reda, LDE s konstantnimi koeficienti, linearni sistemi DE 1. reda, matrična rešitev začetnega problema, robni problem. Parcialne diferencialne enačbe: enačbe matematične fizike, nihanje strune, d'Alembertova rešitev, toplotna enačba, Fourierove vrste, začetni in robni problem. Osnove teorije grafov: matrična

Content (Syllabus outline):

Linear and euclidean spaces: linear independence, basis, linear mappings, nullspace and range, matrix representation, transitional matrix, rank, eigenvalues and eigenvectors, scalar product, norm, orthogonality, Gram-Schmidt orthogonalisation, orthogonal projection (vector of best approximation), Fourier coefficients, least squares method, overdetermined systems, normal system, regression line. Numerical linear algebra: numerical computation and errors, linear systems, matrix decompositions: LU, QR, SVD. Ordinary differential equations: linear DE of order n, LDE with constant coefficients, linear systems of DE of first order, matrix solution of initial problem, boundary value problem. Partial differential equations: equations of mathematical physics, vibrating string, d'Alembert solutions, heat equation, Fourier series, initial and boundary value problem. Basics on graph theory: matrix presentation, isomorphism, path, cycle, walk,

predstavitev, izomorfnost, pot, cikel, sprehod, vpeto drevo, Hamiltonov in Eulerjev graf.	spanning tree, Hamiltonian and Eulerian cycle.

Temeljni literatura in viri / Readings:

Demmel, J.W. 2000. Uporabna numerična linearna algebra. Ljubljana, DMFA – založništvo.
Gerald, C. F., Wheatley, P. O. 1993. Applied Numerical Analysis, Addison-Wesley Publishing Company.
Lampret, V. 2013. Matematika 1 - prvi del: preslikave, števila, vektorski prostori. Ljubljana, UL FGG.
Meyer, C. D. 2001. Matrix Analysis and Applied Linear Algebra, SIAM.
Dostopno na: http://matrixanalysis.com/ .
Pinchover, Y., Rubinstein, J. 2005. An Introduction to Partial Differential Equations, Cambridge University Press.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Nadgraditi pridobljeno matematično znanje omogočiti razumevanje matematičnega aparata, ki ga uporabljajo strokovni predmeti - Usposobiti za pravilno postavitev in numerično reševanje konkretnih problemov. Pridobljene kompetence: - Sposobnost kritične presoje podatkov in dobljenih računskih rezultatov - Sposobnost uporabe matematičnega znanja v inženirski praksi.	Objectives: - To upgrade the acquired mathematical knowledge - To enable understanding of mathematical tools used by engineering courses - To train for correct posing and numerical solving of given practical problems. Gained competences: - Capability of a critical judgement of data and obtained numerical results - To be able to use mathematical knowledge in engineering problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Formulacija konkretnih problemov v matematičnem jeziku - Identifikacija ustreznega matematičnega modela za reševanje inženirskega problema - Poznavanje teoretičnih osnov za praktično iskanje rešitev - Sposobnost kritične presoje rezultatov - Poznavanje računalniških orodij (Mathematica, Matlab) - Dosežena matematična podlaga za strokovne predmete	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model - Basic theoretical knowledge for using in practical problems - Capability of critical judgement of obtained numerical results - Ability to use computational tools (Mathematica, Matlab) - Establishing mathematical background for the engineering courses

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, domače naloge, konzultacije	Lectures, tutorials, consultations, internet

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Izpit (teoretičen del)	**30 %**	Exam (theoretical part)
Računske naloge in sprotno delo	**70 %**	Exercises and homework

Reference nosilca / Lecturer's references:

JAKLIČ, Gašper. Uniform approximation of a circle by a parametric polynomial curve. Computer Aided Geometric Design, ISSN 0167-8396, 2016, vol. 41, str. 36-46.http://dx.doi.org/10.1016/j.cagd.2015.10.004. [COBISS.SI-ID 17654873]

JAKLIČ, Gašper, KANDUČ, Tadej. Hermite and Lagrange interpolation in R[sup]d by G[sup]1 cubic splines with small strain energy. Journal of numerical mathematics, ISSN 1570-2820, 2015, vol. 23, iss. 3, str. 257-270. http://dx.doi.org/10.1515/jnma-2015-0017. [COBISS.SI-ID 17654617]

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. High order parametric polynomial approximation of conic sections. Constructive approximation, ISSN 0176-4276, 2013, vol. 38, iss. 1, str. 1-18. http://dx.doi.org/10.1007/s00365-013-9189-z. [COBISS.SI-ID 16716121]

JAKLIČ, Gašper, MODIC, Jolanda. On Euclidean distance matrices of graphs. The electronic journal of linear algebra, ISSN 1081-3810, 2013, vol. 26, str. 574-589. http://www.math.technion.ac.il/iic/ela/ela-articles/articles/vol26_pp574-589.pdf. [COBISS.SI-ID 16734553]

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, ŽAGAR, Emil. On geometric interpolation by planar parametric polynomial curves. Mathematics of computation, ISSN 0025-5718, 2007, vol. 76, no. 260, str. 1981-1993. http://www.ams.org/mcom/2007-76-260/S0025-5718-07-01988-6/home.html. [COBISS.SI-ID 14340953]

JAKLIČ, Gašper, PISANSKI, Tomaž, RANDIĆ, Milan. Characterization of complex biological systems by matrix invariants. Journal of computational biology, ISSN 1066-5277. [Print ed.], 2006, vol. 13, št. 9, str. 1558-1564. http://www.liebertonline.com/toc/cmb/13/9. [COBISS.SI-ID 14157401]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Numerične metode
Course title:	Numerical methods

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: prof. dr. Boštjan Brank

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Motivacija za študij metode končnih elementov (MKE); 1D linearna MKE: od diferencialne enačbe do sistema enačb; 1D končni elementi za prevajanje toplote in pretok tekočine; interpolacija, preslikave območij, numerična integracija; ploskovni končni elementi za ravninske probleme; izoparametrični končni elementi; končni elementi za plošče; končni elementi za lupine; reševanje enostavnih primerov z računalniškimi programi po MKE:
- Priprava numeričnih modelov,
- FEM analize,
- Kritična ocena rezultatov.

Content (Syllabus outline):

Motivation for studying the finite element method (FEM); one-dimensional linear FEM: from a differential equation to a system of linear equations; one-dimensional linear FEM for elasticity and heat and fluid flows; interpolation and numerical integration in FEM; finite elements for plane stress and plane strain elasticity; isoparametric finite elements; finite elements for elastic plates; finite elements for elastic shells; solving structural examples with FEM software:
- Preparation of good numerical models,
- FEM analysis,
- Critical evaluation of numerical results.

Temeljni literatura in viri / Readings:

B. Brank. 2014. Osnove metode končnih elementov - skripta.
J. N. Reddy. 2006. An introduction to the finite element method. Mc Graw Hill.
T.J.R. Hughes. 2000. The finite element method. Dover.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati osnove linearne metode končnih elementov - Naučiti se uporabljati računalniški program po metodi končnih elementov - Naučiti se pripraviti pravilen numerični model obravnavanega problema. Kompetence: - Zna uporabljati računalniške programe, ki delujejo po metodi končnih elementov - Zna pripraviti ustrezen numerični model - Zna kritično oceniti rezultate numerične analize.	Objectives: - To study FEM - To learn how to prepare a FEM model for a specific engineering problem - To learn how to use FEM software for a structural analysis - To learn how to interpret and critically assess results of FEM analysis. Competences: - To be able to solve simple engineering problems using FEM - To get familiar with software tools for FEM structural analysis - To be able to critically evaluate results of numerical analysis.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Priprava dobrih modelov za analizo končnih elementov - Spoznati osnove metode končnih elementov - Uporabiti metodo končnih elementov pri reševanju enostavnejših problemov	- To be able to prepare good models for a FEM analysis - To be able to solve simple civil engineering problems by using FEM software - To be able to interpret and critically evaluate results of a FEM numerical analysis - To understand basics of linear FEM

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja v učilnici. Primeri z računalniki pod nadzorom učitelja.	Lectures are given in a classroom. Examples are worked out by students on computers (in a computer room) under teacher's supervision.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Računski del izpita: modeliranje in analiza problema z računalnikom	**50 %**	FEM modelling, analysis and evaluating of results of a civil engineering problem
Teoretični del izpita	**50 %**	Theoretical knowledge on FEM basis

Reference nosilca / Lecturer's references:

JUKIĆ, Miha, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Embedded discontinuity finite element formulation for failure analysis of planar reinforced concrete beams and frames. Engineering structures, ISSN 0141-0296. [Print ed.], maj 2013, letn. 50, št. 5, str. 115-125, ilustr., doi: 10.1016/j.engstruct.2012.07.028.

DUJC, Jaka, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Stress-hybrid quadrilateral finite element with embedded strong discontinuity for failure analysis of plane stress solids. International journal for numerical methods in engineering, ISSN 0029-5981, jun. 2013, letn. 94, št. 12, str. 1075-1098, ilustr., doi: 10.1002/nme.4475.

BOHINC, Uroš, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Discretization error for the Discrete Kirchoff plate finite element approximation. Computer Methods in Applied Mechanics and Engineering, ISSN 0045- 7825. [Print ed.], feb. 2014, letn. 269, str. 415-436, ilustr., doi: 10.1016/j.cma.2013.11.011

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Gradbena fizika
Course title:	Building physics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		15			45	3

Nosilec predmeta / Lecturer: prof. dr. Zvonko Jagličič

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Porazdelitev temperature in prenos toplote v snovi in prenos toplote s sevanjem; osnovne metode reševanja difuzijske enačbe, robni in začetni pogoji; relativna in absolutna vlažnost, merjenje vlažnosti, vlaga v gradbenih materialih, transport vlage in vodne pare v poroznih snoveh, vpliv vlage na mehanske in toplotne lastnosti gradbenih materialov; izviri zvoka in razširjanje zvoka v prostoru, reverberacija, zaznavanje in merjenje jakosti zvoka, karakterizacija in kontrola hrupa v zgradbah. Vaje Seminarske vaje (računske vaje).	Lectures Temperature distribution, heat transfer in materials and radiation; basic methods for solving diffusion equations, boundary and initial conditions; relative and absolute humidity, measurements of humidity, moisture in building materials, moisture and vapour transfer in porous materials, influence of moisture on thermal and mechanical properties of materials; sound sources, sound waves, wave propagation, reverberation, acoustic measurements, characterisation of sound and noise control in buildings. Tutorials Problem solving classes.

Temeljni literatura in viri / Readings:

R. Kladnik. 1983. Nestacionarni Temperaturni Pojavi v Ovojnem sklopu Zgradbe, skripta FAGG (80 str.).
Izbrana poglavja iz:
A. V. Luikov. 1975. Heat and mass transfer in capillary porous bodies. Pergamon, Oxford.
D. A. Biess and C. H. Hansen. 2003. Engineering Noise Control, Theory and Practice, 3rd edition. Spon Press.
J. Peternelj, Z. Jagličić. 2014. Osnove gradbene fizike. Ljubljana, UL FGG.

Cilji in kompetence:

Cilji:
- Ponuditi študentom poglobljeno znanje tistih naravnih pojavov, ki so pomembni v gradbeni stroki: prenos toplote, vlaga in materiali, ter zvok in zaščita pred hrupom.

Pridobljene kompetence:
- Študent pridobi specifična znanja s področja prenosa toplote in transporta vlage v gradbenih materialih in razume osnovne zvočne pojave v zgradbah.
- Sposobnost fizikalno-matematične formulacije problema in sposobnost izbire primernega matematičnega orodja za dosego kvantitativnih rezultatov. Obvlada osnovne matematične metode reševanja difuzijske in valovne enačbe.

Objectives and competences:

Objectives:
- To expand knowledge and acquire new skills important for applications in civil engineering: heat transfer, moisture and materials, acoustics and noise control.

Gained competences:
- To gain specific knowledge from the field of heat and moisture transfer in building materials and to understand basic acoustics phenomena in buildings.

- Ability to formulate engineering problems using appropriate physical and mathematical methods. Student has sufficient mathematical skills to solve diffusion equations and wave equations.

Predvideni študijski rezultati:

- Pridobljeno poglobljeno znanje transporta toplote in vlage in zvočnih pojavov v zgradbah.
- Razumevanje fizikalnih procesov povezanih s temi pojavi in sposobnost matematične formulacije problemov.
- Obvladovanje osnovnih matematičnih metod, ki omogočajo reševanje praktičnih problemov na teh področjih.
-Doseženo znanje študent uporabi, v omejenem obsegu, pri problemih, ki so povezani z varčno rabo energije v zgradbah, zaščito pred hrupom in vplivom vremenskih faktorjev na zgradbe in gradbene materiale.
- Študent spozna, da fizikalne zakonitosti, ki opisujejo naravo in svet okoli nas, temeljijo na eksperimentih. Takšno razmišljanje napeljuje na sistematičen in splošen pristop k reševanju problemov, ki je uporaben v različnih situacijah.
- Sposobnost uporabe znanstvene literature in implementacija pridobljenih znanj v gradbeno stroko.

Intended learning outcomes:

- In-depth knowledge of heat and moisture transport across structural components in buildings, sound effects in buildings.
- Understanding of physical processes involved in these phenomena and mastering mathematical methods used for their analysis.
- Knowledge of essential mathematical methods for solving practical problems in building physics
- Having the ability to use the above skills for solving practical problems connected with economic use of energy in buildings, noise control and influence of weather conditions on buildings and building materials.
- To emphasize the view that physical laws are based on and proved by experiments. This kind of attitude reinforces the general and systematic approach to problem solving applicable under different circumstances.
- Ability to use scientific and technical literature and to implement the gained knowledge in practical problems in civil engineering.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in računske vaje. Izdelava domačih nalog.	Lectures and problem solving classes (tutorials). Home assignments.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit	**30 %**	Written exam
Predstavitev samostojno izdelanih nalog in ustni zagovor	**70 %**	Oral defence of home assignments

Reference nosilca / Lecturer's references:

KRANJC, Tomaž, PETERNELJ, Jože. Heat flow in composite rods : an old problem reconsidered. Int. j. heat mass transfer. [Print ed.], apr. 2011, letn. 54, št. 9-10, str. 2203-2206.
KRANJC, Tomaž, PETERNELJ, Jože, KOZAK, Jernej. The rate of heat flow through a flat vertical wall due to conjugate heat transfer. Int. j. heat mass transfer. [Print ed.], februar 2010, letn. 53, št. 5/6, str. 1231-1236.
KRANJC, Tomaž, PETERNELJ, Jože. The Rate of Heat Flow through Non-Isothermal Vertical Flat Plate. V: BELMILOUDI, Aziz (ur.). Heat trasfer - theoretical analysis, experimental investigations and industrial systems. First published January, 2011. Rijeka: InTech Open Access, 2011, str. 617- 634.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Nelinearna mehanika
Course title:	Nonlinear continuum mechanics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type:	Obvezni strokovni / Obligatory professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		30	15		90	6

Nosilec predmeta / Lecturer:	prof. dr. Igor Planinc
Jeziki / Languages: Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Lectures: Predpostavka o zvezno porazdeljeni masi in posledice; materialne in prostorske koordinate; deformacija kot nelinearna preslikava; deformacijski gradient kot linearna lokalna preslikava; polarni razcep; lokalne spremembe dolžine, vektorja ploskve, ploščine in prostornine; deformacije v konstrukcijah; Tenzor deformacij kot mera deformiranosti; tenzor deformacij izražen s pomiki; raztegi; tenzor raztegov; glavni raztegi in smeri; spektralni razcepi značilnih tenzorjev; potence in druge funkcije tenzorjev; Posplošeni tenzorji deformacij; materialni odvod tenzorjev po času; pomik, hitrost in pospešek delca; rotacija, kotna hitrost in kotni pospešek; odvodi po času značilnih tenzorjev: hitrostni gradient, hitrost deformacijskega tenzorja, spin, hitrost Cauchy-Greenovih tenzorjev, hitrost Green-Lagrangevega in Euler-Almansijevega tenzorja; napetosti v konstrukcijah; površinska obtežba; vektor napetosti; Cauchyjevi postulat, recipročnost in formula; tenzorji napetosti; zveze med raznimi tenzorji napetosti; Izreki o ohranitve mase, o	Lectures: Body as an object having continuously distributed mass; embedding of the body into the mathematical space; material and spatial coordinates; deformation as a regular non-linear map; deformation gradient as a local linear deformation map; the polar decomposition of the deformation gradient; Local length, area and volume in undeformed and deformed configurations; deformation of a body; the strain tensor as a measure of the deformation degree; the strain tensor expressed in terms of displacements; the linearized strain tensor; Stretches; the stretch tensor; principal stretches and directions; spectral decomposition of symmetric tensors; spectral decompositions of various material and spatial deformation tensors; tensor functions; exponential and logarithmic tensor functions; generalized strain tensors; material time derivative of tensors; displacements, velocity and acceleration; rotations, angular velocity and angular acceleration; time derivatives of characteristic tensors: velocity gradient, rate of deformation, spin, the rate of

gibalni in vrtilni količini v globalni obliki; lokalna oblika gibalnih enačb; objektivnost tenzorjev; materialna in prostorska objektivnost; pregled objektivnosti doslej vpeljanih količin; objektivnost odvodov tenzorjev po času; korotacijski in konvekcijski odvod; objektivni odvodi Cauchyjevega tenzorja napetosti; Jaumannov, Truesdellov, Oldroydov, Green-Naghdijev odvod tenzorja napetosti po času; šibka oblika gibalnih enačb konstrukcije; princip virtualnega dela (PVD) v telesnih in prostorskih koordinatah; izpeljava lokalnih enačb gibanja iz PVD; Opis uporabe PVD za numerično reševanje; konstitucijske enačbe; Hiperelastični modeli; izotropen material z adicijsko specifično deformacijsko energijo; Izotropen material izražen z glavnimi raztegi ali z glavnimi logaritemskimi raztegi; hiperelastični materiali z vezmi; nestisljivost in nerazteglјivost; St. Venant- Kirchhoffov material; Neo-Hookov material; prikaz uporabe računalniškega programa FlagSHyP za analizo deformiranja teles z nelinearno metodo končnih elementov (avtorja J. Bonet in R. D. Wood, Swansea, UK), ki ga je za Matlab pripravil R. Flajs.	Cauchy-Green tensor, the rate of Green-Lagrange tensor, the rate of Euler- Almansi tensor; Stresses; Surface tractions; The stress vector, the Cauchy postulate, reciprocity and the Cauchy formula; The stress tensor; material and spatial stress tensors; conservation laws: conservation of mass, linear and angular momentum in global and local forms; objectivity of tensors; material and spatial objectivity; objectivity of typical tensors of mechanics; objectivity of time rates of tensors; co-rotational and convective time derivatives of tensors; the Jaumann, Truesdell, Oldroyd and Green-Naghdi time rates of the Cauchy stress tensor; weak form of the dynamic equilibrium equations of bodies; the principle of virtual work (PVW) in material and spatial forms; the derivation of the local dynamic equilibrium equations from PVW; the basic concepts of implementation and application of PVW in the method of finite elements; constitutive equations; hyper-elastic materials; isotropic material model based on an additive specific strain energy function; Isotropic material model using principal stretches or logarithmic principal stretches; hyper-elastic material model with constraints; inextensible or incompressible materials; examples of classical hyper- elastic material models: StVenant-Kirchhoff and Neo-Hookean material models; numerical experiments using FlagSHyP, the computer program based on the non-linear finite element analysis introduced by J. Bonet and R.D. Wood, Swansea, UK, and reprogrammed for the Matlab environment by R. Flajs.

Temeljni literatura in viri / Readings:

Lai W.M., Rubin D., Krempl E. 1996. Introduction to continuum mechanics, 3rd edition, Butterworth-Heinemann, chapters 3, 4 and 5.
Bonet J., Wood R.D. 2008. Nonlinear continuum mechanics for finite element analysis, 2nd edition, Cambridge University press, chapters 4, 5, 6 and 10.
Bonet J., Gil A.J., Wood R.D. 2012. Worked examples in nonlinear continuum mechanics for finite element analysis, Cambridge university press.
Kelly P., Solid mechanics, Part III: Foundations of continuum solid mechanics; Material models in continuum solid mechanics.
Dostopno na: http://www.des.auckland.ac.nz/uoa/piaras-kelly .
Računalniški program FLagSHyP z navodili za uporabo (Bonet J., Wood R.D., Flajs R.).

Cilji in kompetence:	**Objectives and competences:**
Cilj - Poglobiti in nadgraditi znanje mehanike s 1. stopnje s poglavji nelinearne mehanike z namenom, da bi študent razumel mehanski del	Objectives - Students deepen and enhance their knowledge of non-linear continuum mechanics. - At the completion of the course, students are

teoretičnega ozadja sodobnih računalniških programov za analizo konstrukcij. - Po opravljenih vseh obveznostih so študenti seznanjeni s koncepti nelinearne mehanike kontinuuma in razumejo osnovno teoretično ozadje modernih računalniških programov za analizo prostorskih konstrukcij; - Razumeti bi morali povezavo med mehanskimi koncepti, numeričnimi metodami za reševanje enačb nelinearne mehanike in modeliranjem konstrukcij; - Razumejo, znajo interpretirati in inženirsko presojati vhodne podatke in rešitve računalniškega programa. Pridobljene kompetence - Zna povezovati znanja iz matematike, fizike, mehanike konstrukcij, računalništva in gradbenega inženirstva z namenom določitve mejne nosilnosti in duktilnosti inženirskih konstrukcij; - Sposobnost, da se v kratkem času nauči uporabljati novih komercialnih računalniških programov za analizo konstrukcij; - Sposobnost ustvarjalnega pristopa k modeliranju konstrukcij; - Zna zasnovati eksperimente za določitev parametrov hiper elastičnega materiala.	acquainted with concepts of non-linear continuum mechanics and should understand the theoretical background of modern computer programs for the analysis of structural systems; - They should understand how the mechanical concepts and numerical methods are combined in modelling spatial structures to result in an efficient mechanical analysis; - They must be able to understand, interpret and judge data and results of the analysis. Competences - Ability to combine various disciplines like mathematics, physics, structural mechanics, computers and constructional engineering in assessing the carrying capacity and ductility of various engineering structures; - Ability to be ready for use of commercial structural analysis computer programs in a short time; - Ability to analyse problems in an innovative way; - Students are able to design experiments for the determination of parameters of hyper- elastic materials.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Po opravljenih vseh obveznostih bo študent povečal svoje znanje o metodah reševanja in občutno dvignil raven razumevanja obnašanja konstrukcij v nelinearnem področju. - Študent bo sposoben predstaviti in razložiti osnovne koncepte, fenomene in metode reševanja mehanike konstrukcij. Znati bi moral nastaviti osnovne enačbe problema. - Poglobljeno razumevanje je eden glavnih ciljev predmeta. Študent mora razumeti koncepte, principe in izpeljave enačb, ki vodijo problem. - Sposoben mora biti zapisati konkretne enačbe za preprost problem. - Znati mora uporabiti računalniški program za analizo zahtevnejših primerov in rezultate strokovno predstaviti drugim študentom. - Znanje in razumevanje sta potrebni pri študiju predmetov študija v višjih semestrih.	- Once the course is completed, students should increase their skills of solution methods and improve their comprehension of non-linear mechanics. - Students should be able to explain basic concepts, phenomena and methods in non- linear mechanics. They should be able to set the governing equations of the mechanical model. - Comprehension is a one of the main objectives of the course. Students should well understand concepts, principles and how the equations have been set; that is why the applications presented in tutorials are limited to simple problems to illustrate the theory. - Its application in practice is illustrated only through the use of the computer program in seminars. - Both skills and comprehension are well related to several courses in the second, third and the fourth semester.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Klasična predavanja in vaje pred tablo. Študent se uči prek reševanja domačih nalog. Pri težavah mu pomagata učitelj in asistent na predvidenih govorilnih urah. Morebitne težave skupine študentov se obravnavajo v predavalnici.	Teaching is performed traditionally by a teacher giving lectures. These are complemented by his teaching assistant through tutorials and seminars. Students must regularly work and learn at home to complete their compulsory individual home assignments. Any problems met in solving home assignments or in lectures are discussed within the class.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Domače naloge	**45 %**	Home assignments
Ustni izpit	**55 %**	Oral examination

Reference nosilca / Lecturer's references:

ZUPAN, Eva, SAJE, Miran, ZUPAN, Dejan. On a virtual work consistent three-dimensional Reissner-Simo beam formulation using the quaternion algebra, Acta mechanica, 2013, vol. 224, No. 8, p. 1709–1729.
HOZJAN, Tomaž, SAJE, Miran, SRPČIČ, Stane, PLANINC, Igor. Geometrically and materially non- linear analysis of planar composite structures with an interlayer slip. Computers & Structures, 2013, vol. 114–115, p. 1–17.
ČEŠAREK, Peter, SAJE, Miran, ZUPAN, Dejan. Dynamics of flexible beams: Finite-element formulation based on interpolation of strain measures. Finite elements in analysis and design, 2013, vol. 72, p. 47–63.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Statika gradbenih konstrukcij
Course title:	Structural analysis

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15		30		75	5

Nosilec predmeta / Lecturer: prof. dr. Tatjana Isaković

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja in vaje Inženirsko modeliranje temperaturnih vplivov v konstrukcijah ter modeliranje premičnih obtežb s posebnim poudarkom na prometni obtežbi mostov, inženirsko modeliranje konstrukcij s prostorskimi linijskimi modeli, metoda končnih elementov (MKE) za linijske prostorske konstrukcije, vpliv strižne togosti na odziv, račun učinkov temperaturnih vplivov in premikov podpor z MKE, račun vplivnic, uporaba računalniškega programa za analizo učinkov temperaturnih vplivov, premikov podpor in pomične obtežbe. Seminar Individualna seminarska naloga, v okviru katere študent na primeru konkretnega objekta uporabi znanja, pridobljena v okviru predavanj in vaj. Študent: naredi analizo obtežbe, pripravi ustrezen računalniški model konstrukcije in obtežbe, naredi analizo konstrukcije (s programom in "peš" računom), določil kombinacije učinkov posameznih	Lectures and tutorials Engineering modelling of temperature actions according to relevant standards; engineering modelling of traffic load on bridges according to relevant standards; 3D modelling of more complex building structures and bridges with beam- column elements; influence lines; analysis of structures subjected to moveable load; envelopes of the effects of movable actions; 3D finite element analysis of structures subjected to temperature actions, settlements, and moving load using beam-column elements; shear stiffness in FEM; advanced use of the computer programme: analysis of structures subjected to temperature actions, settlement, and moveable load. Calculation of the influence lines and envelopes. Project work Each student should apply all knowledge presented in the framework of lectures and tutorials within individual project, which includes: analysis of

vplivov v kritičnih prerezih, pripravi tehnično poročilo.	actions on a structure, modelling of actions and structure, analysis of structure (using the programme and hand calculations), combinations of action effects, and preparation of a technical report.

Temeljni literatura in viri / Readings:

J. Duhovnik. 2005. Statika linijskih konstrukcij I, Univerza v Ljubljani, UL FGG (str. 67–102, 201-215).
B. Lutar, J. Duhovnik. 2004. Metoda končnih elementov za linijske konstrukcije, Univerza v Mariboru, Fakulteta za gradbeništvo.
Izbrana poglavja iz standardov SIST EN 1990, SIST EN 1991-1-1, SIST EN 1991-1-3, SIST EN 1991- 1–4, SIST EN 1991-1-5, SIST EN 1991-2.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Študent pridobi znanje, ki je potrebno za analizo prostorskih in bolj zahtevnih linijskih konstrukcij, ki so obremenjene z bolj zahtevnimi vrstami vplivov, - poglobi znanje o metodah, na katerih temeljijo sodobni računalniški programi za analizo konstrukcij, ki je pridobljeno na 1. stopnji študija, - pridobi znanje za račun konstrukcij za primer spremenljivih (pomičnih) obtežb. - Teoretično znanje uporabi na konkretnem primeru v okviru individualne seminarske naloge. Kompetence - Študent razume in obvlada modeliranje in analizo bolj zahtevnih konstrukcij, obremenjenih z bolj zahtevnimi vrstami vplivov.	Objectives - Students obtain and extend the knowledge about 3D analysis (using beam-column elements) of more complex structures subjected to more complex actions. - They extend their knowledge about the methods that most of computer programmes for the analysis of structures are based on. - They gain knowledge about the analysis of structures subjected to moveable loads, thermal loads and settlements. - Theoretical knowledge is applied on practical individual assignment (project). Competences - Students are able to analyse complex structures, subjected to complex actions.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Znanje in razumevanje principov inženirskega modeliranja gradbenih konstrukcij kot prostorskih linijskih konstrukcij, temperaturnih vplivov in prometne obtežbe na mostovih; razumevanje poenostavitev pri modeliranju konstrukcij in vplivov na konstrukcije; razumevanje teorije MKE; razumevanje fizikalnega pomena podatkov in rezultatov analiz; kontrole smiselnosti rezultatov računalniških programov. - Uporaba principov inženirskega modeliranja vplivov in konstrukcij. - Vzpostavitev relacij med dejanskimi gradbenimi konstrukcijami in ustreznimi računskimi modeli; med dejanskimi vplivi na konstrukcije in modeli, ter med fizikalnim odzivom konstrukcije in njegovim matematičnim modelom	- Knowledge and understanding of the principles of engineering modelling of moveable actions on structures, thermal actions and settlements. Knowledge and understanding of the procedures used for the analysis of the effects of moveable load, thermal actions and settlements. - Understanding of the response of complex structures (that can be modelled with beam-column elements) subjected to thermal actions, settlements and moveable load. - Knowledge and skills to control analyses and the results of analyses with computer programmes with the special emphasis on the physical significance. - Ability to use the principles of engineering modelling of actions on structures.

- Identifikacija konstrukcij, ki se lahko modelirajo kot linijske prostorske konstrukcije; priprava podatkov za analizo prostorskih linijskih konstrukcij pri različnih vrstah obtežb; uporaba računalniških programov, interpretacija rezultatov računalniških programov, uporabe rezultatov analiz v nadaljnjem procesu projektiranja zahtevnejših gradbenih konstrukcij; samostojna uporaba standardov.	- Relationship between real structures and their numerical models. - Relationship between real actions on structures and their numerical models. - Relationship between the response of structure and its numerical model. - Ability to analyse more complex structures subjected to static as well as moveable loads. Ability to analyse structures subjected to thermal actions and settlements. Ability to analyse more complex structures using computer programmes and ability to control and analyse the output data for regular and exceptional actions. Ability to use the results of analyses in the next phases of structural design. - Independent use of standards.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar, vaje	Lectures, seminar (project) and tutorials

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga Pisni izpit Oba dela morata biti pozitivna. Študent mora uspešno zaključiti semninar preden se lahko prijavi na izpit.	**40 %** **60 %**	Seminar (project) Exam Both parts should be positive. Student must successfully complete the seminar (project) prior to the registration for exam.

Reference nosilca / Lecturer's references:

ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Applicability of Pushover Methods to the Seismic Analyses of an RC Bridge, Experimentally Tested on Tree Shake Tables. Journal of earthquake engineering, ISSN 1363-2469, 2011, št. 2, letn. 15, str. 303-320, ilustr., doi: 10.1080/13632461003802009.
ZOUBEK, Blaž, FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Estimation of the cyclic capacity of beam-to-column dowel connections in precast industrial buildings. Bulletin of earthquake engineering, ISSN 1570-761X, 2014
VIDRIH, Zlatko, FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Numerical investigation on smart magnetically controlled elastomeric bearings. Journal of vibration and control, ISSN 1077-5463. [Tiskana izd.], nov. 2012, letn. 18, št. 13, str. 2073-2084

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Zasnova gradbenih konstrukcij
Course title:	Conceptual design of building and civil engineering structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	1
Civil Engineering - second cycle MA	Structural engineering	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15				45	3

Nosilec predmeta / Lecturer: prof. dr. Matej Fischinger

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Predavanja izhajajo iz teze, da je ključna naloga konstrukterja pokriti prostor oziroma premostiti razpon. Uspešnost rešitve te naloge (povečanje možnega razpona ob sočasni optimizaciji tehnološke rešitve in stroškov) temelji na razumevanju prenosa notranjih sil v konstrukcijah in poznavanju prednosti različnih materialov in tehnoloških rešitev. Zgornja teza bo najprej ilustrirana z (zgodovinskim) razvojem konstrukcijskih sistemov stavb in mostov, kjer bodo na konkretnih primerih prikazani ključne faze v napredku konstrukterstva in ilustrirane značilne uporabe različnih materialov in tehnologij. Sistematično bodo pokazane možnosti izbire konstrukcijskih sistemov stavb in mostov. Podana bodo okvirna navodila, v katerih primerih je možno in smiselno uporabljati posamezne sisteme. Pri tem bodo upoštevane specifike posameznih materialov (betona, prednapetega betona, jekla, sovprežnih rešitev jeklo/beton, lesa in zidanih izvedb. Ponovitev in razširitev znanj o določanju vplivov na konstrukcije. Podane bodo metode določitve	Lectures Lectures are based on the thesis that the key task of a structural engineer is to bridge the span and cover the space. The success in this objective (i.e. to increase the span considering the optimal technological solution and costs) depends on the understanding of the load transfer within the structure and the knowledge of the advantages of different structural materials and technological solutions. Therefore the lectures address the following topics: The outlined thesis is first illustrated by the (historical) development of structural systems of buildings and bridges. The key milestones in the progress of structural engineering are illustrated by the case studies of specific structures and typical use of different materials and technologies. The possibilities in the choice of the structural systems for buildings and bridges are systematically analysed. Indicative guidelines are provided when it is possible and reasonable to choose a specific structural system, taking into account specific characteristics of different materials (reinforced/

začetnih dimenzij. Optimizacija prenosa obremenitev v temeljna tla. Sistemi in področja uporabnosti različnih rešitev plitkega in globokega temeljenja. Delovanje konstrukcije kot celote pri rednih in izrednih (eksplozija,požar, potres) vplivih. Pomen duktilnosti in robustnosti. Zasnova stavb na potresnih območjih. Principi in postopki načrtovanja nosilnosti, zagotavljanja duktilnosti in konstruiranja potresno odpornih stavb. V vseh predavanjih bo narejena povezava na relevantne zahteve za zasnovo konstrukcij v sistemu standardov Evrokod. Seminar Izbira začetnih dimenzij. Poda(jo) se skica(e) objekta(ov) z že določenim konstrukcijskim sistemom in razponi na določeni lokaciji. Uporabljeni so različni materiali. Potrebno je oceniti velikost vplivov in argumentirano predlagati začetne dimenzije elementov konstrukcije (vključno s temelji). Idejna zasnova objekta, ne da bi bila definirana konstrukcijska rešitev in predpisan material. Študent/ka si zamisli več možnih konstrukcijskih sistemov iz primernega materiala in izbere začetne dimenzije. Z analizo prednosti in pomanjkljivosti, ki je podprta z rezultati preprostega računskega modela (lahko tudi eksperimenta), argumentira svojo izbiro in napiše poročilo.	concrete, pre-stressed concrete, steel-concrete composite, timber and masonry). The existing knowledge about the actions/loads on structures is expanded and improved. The methods for preliminary sizing are given. Optimization of the load transfer into the foundation soil as well as the systems and applicability of different solutions for shallow and deep foundations are presented. Structural integrity at permanent and variable actions as well as at accidental (i.e. fire) and earthquake actions are discussed. The importance of the ductility and robustness are explained. The conceptual design of buildings in seismic regions is outlined. The principles of the capacity design, ductility and detailing of the earthquake- resistant structures are explained. All topics are closely connected with the adequate requirements in the structural Eurocodes. Seminar Preliminary sizing. A sketch of a (building) structure is given. The building system (including spans) and the location of the construction site were already chosen. Different materials are used in the structure. Students shall estimate the actions and argue the choice of the initial dimensions of the structural elements. Conceptual design of a structure. In this case the structural system and the materials are not given (prescribed). Students shall foresee different options for the structural system using different options for materials. For each solution they should choose initial dimensions. In the written report the final choice shall be justified by the pro/cons analysis and supported by simple calculations.

Temeljni literatura in viri / Readings:

Evropski standardi za projektiranje konstrukcij SIST-EN 1990–1998.
Priročnik za projektiranje gradbenih konstrukcij po Evrokod standardih (ur. D. Beg in A. Pogačnik). 2009. IZS.
Splošne tehnične specifikacije za cestne premostitvene objekte (mostove). 2005. RS, Ministrstvo za promet in zveze.
Slak T., Kilar V. 2005. Potresno odporna gradnja in zasnova konstrukcij varhitekturi. Ljubljana, UL FA.
Earthquake Engineering Slide Information System), IKPIR FGG, CD.
Dostopno na: www.ikpir.fgg.unilj.si/easypbl
M. Fischinger et.al.: Zasnova gradbenih konstrukcij - skripta.

Cilji in kompetence:	**Objectives and competences:**
Ključna naloga konstrukterja je čim bolj optimalno pokriti prostor oziroma premostiti razpon. Pri tem mora upoštevati različne vidike uporabe konstrukcije. Po izkušnjah vemo, da tega študent/ka, ki je do sedaj obravnaval/a le posamezne elemente iz vnaprej izbranih materialov in znanih dimenzij, ne zna. Cilj predmeta je torej naučiti študenta/ko, da razume prenos vplivov preko celotne konstrukcije v temeljna tla ter sam/a izbere problemu ustrezen konstrukcijski sistem iz primernega materiala. Pridobljene kompetence: - Sposobnost izbire in ocena ustreznosti primernega konstrukcijskega sistema (vključno s temelji) ter materiala ob podanih funkcionalnih zahtevah in lokaciji objekta. - Identifikacija kritičnih vplivov in kombinacij vplivov. - Upoštevaje posebnih zahtev pri zasnovi potresno odpornih objektov. - Sposobnost izbire začetnih dimenzij.	As mentioned, the goal of a structural engineer is to cover the space or to bridge the span in a most optimal way. Doing this he/she should consider different aspects of the use of the structure. The experience has demonstrated that a student, who was used to solve only the problems related to isolated elements with given dimensions and made of a predefined material, is not able to achieve this goal. Consequently the objective of this course is to teach the student to understand the load transfer through the entire structure into the foundation soil and to choose competently the structural system which suits this purpose. The expected acquired competences therefore include: - The ability of the choice and critical evaluation of a suitable structural system (including foundations) and material considering the given functional requirements and the location of the construction site. - The identification of the critical actions and their combinations. - Consideration of the special requirements in the conceptual design of earthquake resistant structures. - The ability to choose initial dimensions of structural elements.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje temeljnih principov dobre zasnove in izbire konstrukcijskih sistemov gradbenih konstrukcij - Razumevanje dodatnih principov in zahtev pri zasnovi potresno odpornih konstrukcij - Razumevanje delovanja konstrukcijskih sklopov in konstrukcije kot celote. - Razumevanje pomena duktilnosti in robustnosti konstrukcijskih rešitev - Razumevanje prednosti različnih materialov in konstrukcijskih sistemov za reševanje različnih konstrukterskih nalog - Znanje izbire začetnih dimenzij konstrukcijskih elementov - Razumevanje relevantnih določil v Evrokodih - Kompetentna ocena ustreznosti arhitektonske zasnove - Izbira začetnih dimenzij konstrukcije - Uporaba relevantnih določil Evrokoda. - Spoznanje, da je dobra zasnova konstrukcijskega	- Understanding of the fundamental principles of good conceptual design and appropriate choice of the structural systems; - Understanding of the additional principles in the case of the earthquake resistant structures; - Understanding the role of the structure and its subassemblies; - Understanding the role of ductility and robustness of structural solutions; - Understanding the advantages of different structural systems and materials in solving various problems in structural engineering; - The knowledge of preliminary sizing; - Understanding of structural Eurocodes. - A competent assessment of the adequacy of architectural design; - The choice of the initial dimensions; - The application of the relevant requirements in Eurocodes. - The students become aware that a conceptual

sistema in izbira materiala ključna za uspeh projekta in da slabe zasnove ne more rešiti/opravičiti še tako natančna analiza. - Argumentirana izbira med več možnostmi. - Globalni pogled namesto parcialnih rešitev.	design is a key factor of a successful project and that even the most sophisticated analysis cannot justify and save the ill-conceived structure. - Argued choice among several options; - The global (broad-minded) view instead of partial solutions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Začetna predavanja samo usmerijo študenta (oblika se uporablja za oba spola) in mu dajo primerno predznanje, da se lahko sam poskusi z izbiro konstrukcijskega sistema in materiala ter z določanjem začetnih dimenzij. To znanje mora biti zadostno, da ohranja primerno motivacijo in veselje do dela. V večini predhodnega študija se rešujejo vnaprej definirani parcialni problemi. Iskanje med številnimi možnimi rešitvami na globalnem nivoju bodo novost za študenta in ga bodo tako vpeljala v projektno delo, ki je značilno za prakso. Pričakuje se, da bo študent/ka sam zaznal (»na študenta osredotočen študij«), kakšno znanje še potrebuje in se mu bodo ta znanja posredovala v času, ko ga bodo zanimala (»Just-in-time« princip).	The initial lectures only provide the basic knowledge and guidelines needed. Then the student can test his/hers own ability to choose adequate structural system, initial dimensions and materials for the outlined goals of the structural project. The knowledge provided by the initial lectures should be sufficient to maintain adequate motivation and pleasure to work. Solving only partial problems, which are fully defined in advance, is typical for the first cycle of the study at this faculty. Therefore, searching for global solutions among many possible options is a novelty for the student. This activity is guiding him/her into the project-based work, which is typical in the design practice. It is expected that the student will detect him/herself which knowledge is needed to fulfil the assignment ("student-centred work"). This knowledge is forwarded to the student in time when it is needed ("just-in-time principle").

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Izdelava seminarskih nalog Izpit Oba dela morata biti pozitivna.	**50 %** **50 %**	Seminar work Final exam /presentation of the work Both parts should be positive.

Reference nosilca / Lecturer's references:

FAJFAR, Peter, FISCHINGER, Matej, BEG, Darko. 2009. Evrokod 8 : projektiranje potresno odpornih konstrukcij. V: BEG, Darko (ur.), POGAČNIK, Andrej (ur.). Priročnik za projektiranje gradbenih konstrukcij po evrokod standardih. Ljubljana, Inženirska zbornica Slovenije, str. 8.1-8.241, ilustr.
EASY (Earthquake Engineering Slide Information System), IKPIR FGG, CD.
Dostopno na: www.ikpir.fgg.unilj.si/easypbl .
REJEC, Klemen, ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Seismic shear force magnification in RC cantilever structural walls, designed according to Eurocode 8. Bulletin of earthquake engineering, ISSN 1570-761X, apr. 2012, letn. 10, št. 2, str. 567-586, ilustr., doi: 10.1007/s10518-011-9294-y.
KRAMAR, Miha, ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Seismic Collapse Risk of Precast Industrial Buildings with Strong Connections. Earthquake engineering & structural dynamics, ISSN 0098-8847. [Print ed.], 2010, letn. 39, št. 8, str. 847-868, ilustr.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Prenova in preizkušanje konstrukcij
Course title:	Retrofitting and experimental analysis of structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15		30		75	5

Nosilec predmeta / Lecturer: izr. prof. dr. Vlatko Bosiljkov

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	Content (Syllabus outline):
Splošni pojmi povezani s trajnostjo, popravilom in utrditvijo konstrukcij (osnovni pojmi, definicije, vzroki propadanja in sprememb konstrukcije, znižanje uporabnosti, preventivni ukrepi, kriteriji za pristop k sanaciji, relevantni predpisi in standardi, posebnosti posameznih tipov objektov). Osnove diagnostike konstrukcije (preiskave za ugotavljanje stanja in kakovosti materialov in konstrukcijskih elementov, neporušne in porušne preiskave). Ukrepi za zvišanje preostale življenjske dobe konstrukcije in vgrajenih materialov (izbira materialov glede na predvidene vplive na življenjsko dobo konstrukcije, združljivost različnih materialov v konstrukciji, načrtovanje konstrukcijskih detajlov, načrtovanje zaščitnih ukrepov proti zunanjim vplivom in kombinaciji trenutnih in dolgotrajnih vplivov). Tehnična regulativa s področja trajnosti, popravil in utrditve konstrukcij (priporočila, standardi, predpisi vključno z Evrokodi, projektiranje in kontrola izvedbe, zagotavljanje kakovosti). Eksperimentalno podprt razvoj metod popravil in utrditev. Popravilo	General terms regarding sustainability, repair and retrofitting of structures (basic terms, definitions, factors influencing deterioration and provoking structural problems, serviceability states, mitigation actions, criteria for design of retrofitting actions, codes and standards, actions in dependence from the type of structure/ building). Diagnosis of structures (non-destructive and destructive testing methods for the evaluation of the state of built materials and structures Measures for improvement of the remaining life cycle (LC) of the structure and built materials (material choice in respect to the designed LC of the structure, materials compatibility, design of structural details and protective measures in respect to external influences and combined current and long-term loading conditions). Code requirements regarding sustainability, repairs and retrofitting of structures (recommendations, standards, EU codes, design and control of execution on-site, quality assurance). Experimentally supported development of methods for repairs and retrofitting. Repair and retrofitting of

in utrditev konstrukcij nizkogradnje in visokogradnje s posebnim povdarkom na objekte kulturne dediščine. Splošni pojmi o preiskavah gradbenih konstrukcij (namen preiskav, preizkušanci, obtežbe, meritve in opazovanja, spremljajoče preiskave). Modelne preiskave gradbenih konstrukcij(osnove teorije modelov, modeliranje konstrukcij, modelni materiali, praktični primeri). Oprema za simulacijo statične in dinamične obtežbe. Meritve in registracija fizikalnih količin (fizikalne količine, zajemanje in registriranje podatkov, obdelava podatkov, sestavljanje poročil).	the infrastructure assets, high rise buildings, dwellings and with special emphasis on assets of cultural heritage. General terms regarding testing of civil engineering structures (testing purpose, specimens, loading conditions, measuring systems and monitoring of structures, accompanying tests). Model scale testing of civil engineering structures (basic of model theory, modelling structures, model materials, practical examples). Equipment for applying static and dynamic load. Measuring and data acquisition of different physical quantities (physical quantities, data acquisition and registration, data processing, test reports).

Temeljni literatura in viri / Readings:

J. Douglas, E.A. Noy. 2011. Building Surveys and Reports. Wiley-Blackwell, 4th Edition.

Building Construction under Seismic Conditions in the Balcan Region, Vol. 5, Repair and Strengthening of Reinforced Concrete, Stone and Brick Masonry Buildings. 1983. Vienna, UNDP /UNIDO.

Building Construction under Seismic Conditions in the Balcan Region, Vol. 6, Repair and Strengthening of Historical Monuments and Buildings in Urban Nuclei. 1983. Vienna, UNDP /UNIDO.

SIST EN 1998-3:2005 Eurocode 8: Design of structures for earthquake resistance – Part 3: Assessment and retrofitting of buildings.

M. Tomažević. 1991. Introduction into experimental analysis of structures. Ljubljana, UL.

Cilji in kompetence:	**Objectives and competences:**
- Spoznati glavne vplive na življenjsko dobo, uporabnost in odpornost konstrukcije. - Spoznati ukrepe za zviševanje preostale življenjske dobe objektov. - Usposabljanje za sistematični pristop k snovanju in projektiranju popravil in utrditev konstrukcij ter njihovega vzdrževanja kot preventivnega ukrepa. - Spoznavanje eksperimentalno podprtega razvoja metod in tehnik sanacij. - Spoznavanje metod merjenja količin pri obremenitvah konstrukcij. - Uvajanje v sistematični pristop k izvedbi preiskav konstrukcij. - Razvijanje osnov za vrednotenje ekonomike sanacijskih ukrepov.	- Acquiring knowledge regarding influencing factors for life expectancy, serviceability and resistance of structures. - Acquiring knowledge regarding measures how to increase the life expectancy of CE assets. - Training for systematic approach in planning and design of repair and retrofitting actions as well as for proper maintenance as mitigation action. - Knowledge in respect to experimentally supported development of methods for repair and retrofitting. - Knowledge in data acquisitions during testing of structures. - Introduction into systematic approach for planning and design of testing the structures. - Development of basics regarding the costs of retrofitting actions.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobitev znanja s področja materialov in propadanja konstrukcij, načini prenove in obnove, metode testiranja, pridobivanje in obdelava podatkov, laboratorijsko (model in prototip) in terensko testiranje konstrukcij. - Procesi propadanja materialov in osnov o trajnosti konstrukcij in načinov zvišanja preostale življenjske dobe objektov. Omogoča tudi obvladovanje strokovnega znanja za projektiranje, izvajanje in vzdrževanje objektov. - Praktična uporaba rezultatov eksperimentalnega ugotavljanja lastnosti konstrukcij pri reševanju najbolj zahtevnih primerov propadlosti ali preobremenjenosti konstrukcij. Pridobljeno znanje je osnova za zaposlitev v podjetjih, ki se ukvarjajo z vzdrževalnimi in sanacijskimi deli od inženiringa do izvedbe. - Znanja in spretnosti pridobljena pri laboratorijskih vajah in seminarju omogočajo boljše poznavanje konstrukcij in razumevanje njihovega odziva na različne obremenitve. - Nabor specializiranih znanj s področja vzdrževanja in sanacij objektov se lahko poveže v širši sklop s konstrukcijskim seminarjem kot nadgradnja osnovnih znanj pridobljenih pri predavanjih ali kot samostojni seminar.	- Obtaining knowledge related to material and structural decay, methods for repair and retrofitting, testing methods, data acquisition and processing, laboratory (model and prototype) and in-situ tests of structures. - Decay processes of materials and basics of sustainability of structures and solutions to increase the life expectancy of CE objects. Enables professional approach for design, execution and maintenance of CE assets. - Practical application of experimental results of properties of structures for solving problems related to either decay or overloading of structures. Acquired knowledge serve as a solid base for job position in companies that are focused on maintenance and retrofitting actions from the stage of planning to execution level. - Knowledge and skills gained through laboratory and seminar work enables better understanding of engineering structures and their respond in respect to different loading conditions. - Set of specialized skills from the field of maintenance and retrofitting of CE assets can be easily incorporated through broader aspect related to seminar from the course from Structures as upgrading of basic structural knowledge or they can be applied through the seminar of its own.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja na osnovi učbenika, ki ga pripravi nosilec predmeta s sodelavci. Seminar kot uvajanje v projektiranje sanacijskih posegov in vzdrževanje objektov. Manjše skupine študentov (do 4) izdelajo seminarsko nalogo. Laboratorijske vaje v skupini do 15 študentov, kjer se ti seznanijo z osnovnimi merilnimi tehnikami in metodami in preskušanja konstrukcij na primeru modela in konstrukcijskih elementov v naravni velikosti.	Lectures are based on the book prepared by the professor in charge together with co-workers. Seminar represent solid base for design of planning maintenance and retrofitting actions. Small groups of students (up to 4) working together on case study. Laboratory work in groups up to 15 students, where they are introduced to the basic measuring techniques and methods for testing structures on model level and structural elements on prototype level.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga	**40 %**	Seminar
Laboratorijske vaje	**30 %**	Laboratory work
Izpit	**30 %**	Exam

Reference nosilca / Lecturer's references:

BOSILJKOV, V., D`AYALA, D., NOVELLI, V. Evaluation of uncertainties in determining the seismic vulnerability of historic masonry buildings in Slovenia: use of macro-element and structural element modelling. Bulletin of earthquake engineering, ISSN 1570-761X, [v tisku] 2014, letn. XX, št. X, str. 1-19, ilustr., doi: 10.1007/s10518-014-9652-7.
CATTARI, S., LAGOMARSINO, S., BOSILJKOV, V., D`AYALA, D. Sensitivity analysis for setting up the investigation protocol and defining proper confidence factors for masonry buildings. Bulletin of earthquake engineering, ISSN 1570-761X, [v tisku] 2014, letn. XX, št. X, str. 1-23, ilustr., doi: 10.1007/s10518-014-9648-3.
KRŽAN, M., GOSTIČ, S., BOSILJKOV, V. Application of different in-situ testing techniques and vulnerability assessment of Kolizej palace in Ljubljana. Bulletin of earthquake engineering, ISSN 1570-761X, [v tisku] 2014, letn. XX, št. X, str. 1-22, ilustr., doi: 10.1007/s10518-014-9639-4. JARC SIMONIČ,

M., GOSTIČ, S., BOSILJKOV, V., ŽARNIĆ, R. In-situ and laboratory tests of old brick masonry strengthened with FRP in innovative configurations and design considerations. Bulletin of earthquake engineering, ISSN 1570-761X, [v tisku] 2014, letn. XX, št. X, str. 1-22, ilustr., doi: 10.1007/s10518-014-9644-7.
URANJEK, M.; BOSILJKOV, V.; ŽARNIĆ, R.; BOKAN-BOSILJKOV V. 2012. In situ tests and seismic assessment of a stone-masonry building, Materials and Structures, Vol.: 45, Issue: 6, p., 861- 879, June 2012.
BOSILJKOV, V.; URANJEK, M.; ŽARNIĆ, R.; BOKAN-BOSILJKOV, V. (2010) An integrated diagnostic approach for the assessment of historic masonry structures. Journal of cultural heritage, Vol.: 11, Issue: 3, p.: 239-249, Published: JUL-SEP 2010.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Nelinearna analiza konstrukcij
Course title:	Non-linear analysis of structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			30		75	5

Nosilec predmeta / Lecturer: prof. dr. Jože Korelc

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Definicija stabilnosti konstrukcij: tipi nestabilnosti; mehanski modeli stabilnosti; konzervativni - nekonzervativni sistemi; problem začetne nestabilnosti; uklonske oblike in kritične uklonske obtežbe sistemov z več prostostnimi stopnjami. Analitične rešitve osnovnih stabilitetnih fenomenov konstrukcij: upogibni uklon; izbočenje ploskovnih elementov; bočna zvrnitev; torzijski uklon; elasto-plastičen uklon; nelinearni odziv realnih konstrukcij in občutljivost nelinearnega odziva konstrukcij na imperfektnost. Nelinearna numerična analiza: numerične metode določevanja ravnotežnih poti konstrukcij; nelinearna metoda končnih elementov na primerih. Uvod v napredne numerične metode: kontaktni problemi, večnivojsko modeliranje materialov in	Classical stability analysis; mathematical definition of stability of structures, classification of instability points (bifurcation and limit points), conservative-non- conservative systems; initial instability problem, buckling forces and buckling shapes. Formulation and analytical solution of basic stability problems (elastic and elasto-plastic buckling of columns, lateral buckling, local buckling of plates); imperfection sensitivity. Nonlinear numerical analysis: numerical equilibrium path following methods; nonlinear finite element analysis of structures with exercises. Introduction to methods for numerical simulation of advanced problems such as: contact problems; multi-scale problems; coupled problems.

konstrukcij, sklopljeni problemi, reševanje sklopljenih problemov.	

Temeljni literatura in viri / Readings:

Zdenek p. Bažant, Luigi Cedolin. 2003. Stability of structures. Dover, chapters 1, 2, 4, 5, 6,7 8.
M. A. Crisfield. 1991. Non-linear finite element analysis of solids and structures vol.1. John Wiley & sons, chapters 4, 9.
P. Wriggers. 2008. Nonlinear finite element methods. Berlin, Springer.
E-learning: Collection of exercises with solutions.
Dostopno na: http:// symech .fgg.uni-lj.si/ nak/ Selected lectures in pdf format: http:// symech .fgg.uni-lj.si/ nak/Skripta/ .

Cilji in kompetence:	**Objectives and competences:**
- Cilj: spoznati fenomene povezane z stabilnostjo in splošnim nelinearnim odzivom konstrukcij ter metode za njihovo numerično obravnavo. - Kompetence: sposobnost izdelave nelinearne analize odziva konstrukcije na dano obtežbo, kot osnova postopkov projektiranja konstrukcij.	- Objectives: to learn about all the phenomena related to stability and nonlinear response of structures and the methods for numerical simulation of the above phenomena. - Competences: capability to perform and interpret results of fully nonlinear static analysis of structures as a basis for the design of structures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje nelinearnih fenomenov na splošno. - Razumeti osnovne načine izgube stabilnosti gradbenih konstrukcij (upogibni uklon, izbočitev in bočno zvrnitev). - Sposobnost doseženo znanje uporabiti pri strokovnih predmetih s področja projektiranja konstrukcij in posledično v inženirski praksi. - Sposobnost povezave numerične analize konstrukcije, ter standardov in predpisov z realnim obnašanje konstrukcij v nelinearnem območju. - Sposobnost formuliranja enostavnih nelinearnih končnih elementov.	- Understanding of nonlinear phenomena in general - Ability to recognize and calculate all the basic instability types relevant for the limit state design of structures (buckling, lateral buckling, torsional buckling) - Ability to connect the outcomes of the programs for nonlinear structural analysis and the requirements of the design codes - Ability to understand and prepare the necessary input data for the programs for nonlinear structural analysis - Ability to formulate simple nonlinear finite elements.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, Udeležba na mednarodnem seminarju "Sodobne simbolno-numerično-eksperimentalne metode nelinearne analize konstrukcij in materialov".	Lectures, tutorials, attendance at International Short Course on Experimental and Numerical Modelling of M5 Problems in Engineering

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarske vaje Ustni izpit (vsebuje tako teoretične kot tudi računske naloge) Oba dela mora biti ocenjena pozitivno.	**40 %** **60 %**	Seminar tasks Exam (theoretical and practical tasks) Both parts should be positive.

Reference nosilca / Lecturer's references:

KORELC, Jože. Direct computation of critical points based on Crout's elimination and diagonal subset test function. Computers & Structures, ISSN 0045-7949. [Print ed.], februar 2010, letn. 88, št. 3-4, str. 189-197, ilustr., doi: 10.1016/j.compstruc.2009.10.001.
LENGIEWICZ, Jakub, KORELC, Jože, STUPKIEWICZ, Stanislaw. Automation of finite element formulations for large deformation contact problems. International journal for numerical methods in engineering, ISSN 0029-5981, mar. 2011, letn. 85, št. 10, str. 1252-1279, ilustr., doi: 10.1002/nme.3009.
KRISTANIČ, Niko, KORELC, Jože. Optimization method for the determination of the most unfavorable imperfection of structures. Comput. Mech., [in press] 2008, str. 1-14, ilustr.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Računalniško integrirana graditev
Course title:	Computer integrated construction

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type:	Obvezni strokovni / Obligatory professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		15	15		75	5

Nosilec predmeta / Lecturer:	prof. dr. Žiga Turk

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

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

Vsebina:	**Content (Syllabus outline):**
Predavanja vloga gradbene informatike; kaj je gradbena informatika in njena zgodovina; specifični problemi gradbene informatike, modeli in paradigme oblikovanja in načrtovanja in vloga IT, tehnološki, znanstveni in razvojnociklični okviri IT; uvajanje informatike v podjetja; strateški vidiki informatizacije na področju gradbeništva; vloga in mesto informatike v gradbenem podjetju in družbi; reinženiring poslovih procesov in uvajanje IT, gradbena informatika kot poklicna priložnost; tematski zemljevid gradbene informatike, modeliranje kot metoda reševanja problemov; računalniško integrirana graditev; komunikacijska integracija, informacijska integracija; procesna integracija; povezovanje znanja, rezultati; računalniško integrirana graditev; sočasno inženirstvo (concurrent engineering); virtualna podjetja, eDelo, ePoslovanje; česa računalniki ne zmorejo. Laboratorijske in seminarske vaje	Lectures Role of construction informatics; definition of construction informatics and its history; specific problems of construction informatics (uniqueness); models and paradigms of design and planning and the role of IT; technological, scientific and development frameworks of IT in Construction; introduction of information technology in enterprises; strategic aspects of information in the field of construction; role of IT in construction company and broader in society; construction business process; reengineering and introduction of ITC the ITC as a career opportunity; hematic map construction information; modelling as a method of problem solving; computer-integrated construction. How: integration of communication, information integration, process integration, integration of knowledge results in computer-integrated construction and concurrent engineering (concurrent) engineering; virtual enterprises eWork, eBusiness; what computers are not able to.

O posamezne vaje in seminar iz računalniško integrirane graditve in uporabo orodij na projektnem problemu.	Laboratory and tutorials Individual exercises and seminar in computer integrated construction and use of tools in the project problem.

Temeljni literatura in viri / Readings:

Turk, Ž, Računalniško integrirana graditev, 27 snopičev prosojnic, spletna učilnica FGG.
Različni avtorji, Global Center for Excellence in Computing teaching modules, http://www.asce.org/gcec/Zarli, Alain et al. (2004). Building a Better Future, eBook, ICCI Consortium.
Hardin, Brad. BIM and construction management: proven tools, methods, and workflows. John Wiley & Sons, 2011.
Eastman, Chuck, et al. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons, 2011.
Raphael, Benny, and Ian FC Smith. Fundamentals of computer-aided engineering. John Wiley & Sons, 2003.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati pomen informatike kot povezovalnega gradnika med subjekti gradbene industrije in procesi, ki v njej potekajo. - Spoznati osnovno teoretično in tehnološko ozadje rešitev problema povezovanja v industriji. - Poglobiti razumevanje o neposrednih in strateških vidikih informatizacije v gradbeništvu - Postaviti konceptualni okvir tematik gradbene informatike, ki ga bodo v toku študija na smeri izpopolnili drugi predmeti. - Razumeti pomen specialistovega področja v gradbeni industriji in z njo povezanih panogah. Pridobljene kompetence - Sposobnost strateškega in kritičnega razmišljanja o uporabi informacijskih tehnologijah v gradbeništvu. - Sposobnost uporabe tehnoloških rešitev.	Objectives: - Understand the importance of information technology as an integrating element among the entities of construction industry and its processes. - Recognize basic theoretical and technological backgrounds for the solutions of connecting the industry. - Deepen the understanding of the direct and strategic aspects of informatization in construction - Establish a conceptual framework of themes and topics of construction informatics, which will (in the course of study be detailed by other courses) - Understand the importance of information specialists in the field of construction industry and related industries. Acquired competences - Ability of strategic and critical thinking about the use of information technology in construction. - Ability the use of technological solutions, software.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Vloga informatike v družbi nasploh in v gradbeništvu posebej. - Pregled nad temami gradbene informatike. strateški vidiki informatizacije na področju gradbeništva. - Razumevanje znanstvenih metod dela v gradbeni informatiki. - Raba ključnih orodij za delo in učenje na daljavo. - Uporaba znanstvenih metode pri informatizaciji procesov v gradbeništvu.	- The role of information technology in society in general and in construction in particular. - An overview of the topics of construction informatics. - The strategic aspects of information in the field of construction. - Understanding of scientific methods in construction Informatics. - Use of the key tools for distance working and distance learning.

- Kritična analiza uporabe IKT v gradbeništvu. - Sposobnost uporabiti metode znanstvenega dela v okviru gradbene informatike tudi na druga področja. - Sposobnost sistematične analize uporabe informacijskih tehnologij. - Sposobnost organiziranja IKT podpore projektom. - Sposobnost postati informacijski manager (CIO) projekta.	- Use of the key tools for the three kinds of integration (information-knowledge, process, communication). - Using scientific methods in the computerization processes in construction. - Critical analysis of the use of ICT in construction. - Ability to use the methods of scientific work in the context of construction information to other areas - Ability of systematic analysis of the use of information technologies. - Ability to organize ICT project support. - Ability to become an IT manager (CIO) of a project, of BIM manager of a project.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja z diskusijo s študenti. Vaje in demonstracije v šoli. Samostojno delo s korekturami doma.	Lectures including discussion with students. Distance learning. Project based leaning. Teamwork.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Teoretično znanje na izpitu	**40 %**	Theoretical exam
Sodelovanje na vajah in predavanjih	**20 %**	Activity and collaboration
Projektni izdelek	**40 %**	Project work quality

Reference nosilca / Lecturer's references:

MEŽA, Sebastjan, TURK, Žiga, DOLENC, Matevž. Component based engineering of a mobile BIM¬based augmented reality system. Automation in construction, ISSN 0926¬5805. [Print ed.], jun. 2014, letn. 42, št. X, str. 1-12, ilustr. http://www.sciencedirect.com/science/article/pii/S0926580514000363, doi: http://dx.doi.org/10.1016/j.autcon.2014.02.011.
TODOROVIĆ, Miloš, TURK, Žiga. Upoštevanje trajnostnih kriterijev pri projektiranju z orodjem BIM = Designing using sustainability criteria with BIM tools. Gradbeni vestnik, ISSN 0017¬2774, okt. 2011, letn. 60, št. 10, str. 279¬284, ilustr.
KLINC, Robert, TURK, Žiga, DOLENC, Matevž. Engineering collaboration 2.0 : requirements and expectations. Journal of information technology in construction, ISSN 1874¬4753, 2009, letn. 14, pos. št., str. 473¬488, ilustr. http://www.itcon.org/2009/31.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Verjetnostni račun in statistika
Course title:	Probability theory and statistics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type: Obvezni splošni / Obligatory general

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		30			60	4

Nosilec predmeta / Lecturer: izr. prof. dr. Marjeta Kramar Fijavž, doc. dr. Mitja Lakner

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Opravljen izpit iz predmetov Matematika I in Matematika II oz. drugih predmetov s primerljivo vsebino.

Prerequisites:

Passed exams in Mathematics I and Mathematics II or other courses with comparable content.

Vsebina:

Računanje z dogodki, neodvisni in nezdružljivi dogodki.

Definicije verjetnosti, pogojna verjetnost, formula o popolni verjetnosti, Bayesova formula.

Slučajne spremenljivke: diskretne in zvezne, porazdelitvena funkcija, gostota verjetnosti, matematično upanje, disperzija, posebne porazdelitve: Bernoullijeva, binomska, geometrijska, Poissonova, eksponentna, enakomerna, normalna.

Slučajni vektorji: diskretni in zvezni; robne in pogojne porazdelitve, neodvisnost, koreliranost, kovarianca, dvorazsežna normalna porazdelitev, funkcije slučajnega vektorja.

Osnove stohastičnih procesov.

Limitni izreki: neenakosti Markova in Čebiševa, centralni limitni izrek.

Osnove statistike: vzorčenje, ocenjevanje parametrov, metoda momentov, metoda največjega verjetja, intervali zaupanja, preskušanje

Content (Syllabus outline):

Algebra of events, independent and exclusive events.

Definitions of probability, conditional probability, total probability, Bayes' Theorem.

Random variables: discrete and continuous, cumulative distribution function, probability density function, mathematical expectation, variance, special distributions: Bernoulli, binomial, geometric, Poisson, exponential, uniform, normal.

Random vectors: discrete and continuous, marginal and conditional distributions, independence, correlation, covariance, bivariate normal distribution, functions of random vectors.

Basics in stochastic processes.

Limit theorems: Markov and Chebyshev's inequality, the central limit theorem.

Basics in statistics: sampling, estimation of parameters, the method of moments, the method of maximum likelihood, confidence intervals, hypothesis testing.

domnev.	

Temeljni literatura in viri / Readings:

J. A. Baglivo. 2005. Mathematica Laboratories or Mathematical Statistics: emphasizing simulation and computer intensive methods, ASA-SIAM.
R. Jamnik. 1995. Verjetnostni račun in statistika. Ljubljana, DMFA – založništvo.
D. C. Montgomery, G. C. Runger. 2007. Applied Statistics and Probability for Engineers. John Wiley & Sons.
G. Turk. 2012. Verjetnostni račun in statistika. Ljubljana, UL FGG.
K. Siegrist. 1997-2011. Virtual Laboratories in Probability and Statistics.
Dostopno na: http://www.math.uah.edu/stat/ .

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Poznavanje osnov verjetnostnega računa in osnovnih statističnih metod - Omogočiti razumevanje matematičnega aparata, ki ga uporabljajo strokovni predmeti - Usposobiti za pravilno postavitev in reševanje konkretnih problemov s pomočjo statističnih metod. Pridobljene kompetence: - Poznavanje različnih statističnih metod - Sposobnost uporabe matematičnega znanja v inženirski praksi.	Objectives: - To obtain basic knowledge in probability theory and simple statistical methods - To enable the understanding of mathematical tools used by engineering courses - To train for correct posing and solving of given practical problems using statistical methods. Gained competences: - Familiarity with various statistical methods - To be able to use mathematical knowledge in engineering problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Formulacija konkretnih problemov v matematičnem jeziku - Identifikacija ustreznega matematičnega modela - Poznavanje teoretičnih osnov za praktično iskanje rešitev - Doseženo matematično znanje uporabljajo strokovni predmeti - Statistika je glavno orodje za analizo kvantitativnih podatkov - Spretnost uporabe literature in modernih tehnologij, - Poznavanje računalniških orodij (Mathematica, Matlab)	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model - Basic theoretical knowledge for using in practical problems - Statistics is the main tool for quantitative data analysis - Skills in using literature and modern technologies - Ability to use computational tools (Mathematica, Matlab)

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje	Lectures, tutorials, consultations, internet

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Izpit (teoretičen del)	**30 %**	Exam (theoretical part)
Računske naloge in sprotno delo	**70 %**	Exercises and homework

Reference nosilca / Lecturer's references:

ENGEL, Klaus, KRAMAR FIJAVŽ, Marjeta, KLÖSS, Bernd, NAGEL, Rainer, SIKOLYA, Eszter. Maximal controllability for boundary control problems. Appl. math. optim., 2010, vol. 62, no. 2, str. 205-227.
KRAMAR FIJAVŽ, Marjeta, MUGNOLO, Delio, SIKOLYA, Eszter. Variational and semigroup methods for waves and diffusion in networks. Appl. math. optim., 2007, vol. 55, no. 2, str. 219-240.
KRAMAR FIJAVŽ, Marjeta, SIKOLYA, Eszter. Spectral properties and asymptotic periodicity of flows and networks. Math. Z., 2005, vol. 249, no. 1, str. 139-162. Dostopno na: http://springerlink.metapress.com/app/home/issue.asp?wasp=9ed0dca63b2b46c3ad74b3d0e2855bcc&referrer=parent&backto=journal,5, 116;linkingpublicationresults,1:100443,1.

LAKNER, Mitja, PETEK, Peter. The one-equator property. Exp. math., 1997, let. 6, št. 2, str. 109-115.
LIPAR, Peter, LAKNER, Mitja, MAHER, Tomaž, ŽURA, Marijan. Estimation of road centerline curvature from raw GPS data. The Balt. j. road bridge eng., 2011, letn. 6, št. 3, str. 163-168, ilustr., doi: 10.3846/bjrbe.2011.21.
KRAMAR FIJAVŽ, Marjeta, LAKNER, Mitja, ŠKAPIN-RUGELJ, Marjeta. An equal-area method for scalar conservation laws. The Anziam journal, 2012, vol. 53, iss. 2, str. 156–170. Dostopno na: http://dx.doi.org/10.1017/S1446181112000065.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Geotehnika visokih gradenj
Course title:	Geotechnics of buildings

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60		15	30		105	7

Nosilec predmeta / Lecturer: doc. dr. Boštjan Pulko

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Klasifikacija gradbenih jam glede na način izkopa z izračunom zemeljskih pritiskov in dimenzioniranjem zagatnih sten in drugih podpornih konstrukcij; metode za osuševanje/ tesnitev gradbenih jam; tehnologija izvedbe; geostatični izračuni zaščitnih konstrukcij gradbenih jam.
Plitvo temeljenje: priprava temeljnih tal za plitvo temeljenje (izboljšave tal, pospešitev konsolidacije); vrste plitvih temeljev in njihovo dimenzioniranje; nosilnost temeljnih tal - plitvo temeljenje; količnik (modul) reakcije tal in aplikacija pri izračunu temeljnih konstrukcij; metode za izračun kontaktnih tlakov in dimenzioniranje točkovnih, pasovnih temeljev in temeljnih nosilcev; vrste in tehnologija izvedbe temeljnih plošč; metode za izračun kontaktnih tlakov in dimenzioniranje temeljnih plošč.
Globoko temeljenje: vrste pilotov, namen uporabe in način izvedbe; razporeditev obtežbe na kole; izračun nosilnosti vertikalno obremenjenih

Content (Syllabus outline):

Lectures
Classification of excavation pits with regard to excavation technique and type of retaining structure; calculation of earth pressures; methods for drainage/sealing excavation pits; technology of construction; design of retaining structures.
Shallow foundations: preparation of ground for shallow foundation (ground improvements, acceleration of consolidation); analysis and design of shallow foundations; bearing capacity (shallow foundations); modulus of soil reaction and its application in the design of shallow foundations; calculation of contact pressures underneath foundations (isolated footings, strip footings); mat foundations - types and design methods.
Deep foundations: types of deep foundations, purpose and construction methods; group of piles; load distribution; bearing capacity of axially loaded piles and groups of axially loaded piles; transversely (horizontally) loaded piles; standards related to design and execution of piles (Eurocode 7); static and dynamic load tests of piles; construction

posameznih pilotov in skupine osno obremenjenih pilotov; prečno obremenjeni piloti; standardizacija na področju globokega temeljenja (Evrokod 7); statične in dinamične obremenilne preizkušnje pilotov; nadzor pri izvajanju in zagotavljanje kvalitete izvedenih kolov; temeljenje na vodnjakih, kesonih in s koli podprte plošče. Vaje/seminar a) Izdelava idejne zasnove projekta gradbene jame in idejne zasnove plitvega temeljenja v gradbeni jami. b) Izdelava idejnega projekta globokega temeljenja objekta.	monitoring and quality control; construction and design of wells, caisson and mat foundations supported with piles. Practical work/seminar a) Conceptual design and analysis of the excavation pit and shallow foundation. b) Conceptual design and analysis of pile foundation.

Temeljni literatura in viri / Readings:

Šuklje, L. 1984. Mehanika tal. Ljubljana, Univerza v Ljubljani, FAGG.
SIST EN 1997-1:2005 Evrokod 7-1: Geotehnično projektiranje 1. del: Splošna pravila.
Priročnik za projektiranje gradbenih konstrukcij po Evrokod standardih. 2009. Ljubljana, IZS.
Braja, M. Das, 1999. Principles of Foundation Engineering (4th ed.).
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati načine izvedbe in načrtovanja gradbene jame, temeljenja gradbenih objektov in metod za izboljšanje nosilnosti temeljnih tal - Seznaniti se z načini izvedbe in z geotehničnimi izračuni globokega temeljenja na kolih in vodnjakih in tehnikami preizkušanja nosilnosti in kontrole kvalitete izvedbe globokega temeljenja. Pridobljene kompetence - Sposobnost presoje geotehničnih razmer in projektiranja gradbenih jam, izboljšanja temeljnih tal in temeljenja gradbenih objektov - Sposobnost načrtovanja, izvedbe in kontrole tehnološko različno izvedenih kolov in vodnjakov.	Objectives: - Knowledge and ability to perform the design of deep excavations - Knowledge about methods for improving ground bearing capacity - Geotechnical and structural design of shallow and deep foundations - Testing and supervision of foundation construction - Load testing and quality control of piles deep foundation. Competences - Ability to assess geotechnical conditions and to design deep excavations, ground improvement and different types of foundations - Ability to supervise foundation construction works and to perform quality control and load tests.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje o temeljenju gradbenih objektov in razumevanje interakcije (medsebojnih vplivov) med objektom in temeljnimi tlemi. - Pridobljeno poglobljeno znanje o globokem temeljenju objektov in osvojene računske spretnosti za načrtovanje pilotov in vodnjakov. - Doseženo znanje uporabljajo pri izdelavi magistrske naloge oz. v inženirski praksi.	- In-depth knowledge of foundation construction and understanding the soil- structure interaction - In-depth knowledge of deep foundation techniques and design skills. - Design of structural foundations in engineering practice. - Good knowledge of foundation techniques is key to safety and usability of engineering constructions/ buildings.

- Dobro poznavanje tehnik temeljenja je ključno za varnost in uporabnost inženirskih gradenj. - Sposobnost razumevanja prilagajanja inženirskih ukrepov vsakokratnim terenskim razmeram. - Sposobnost razumevanja vpliva tal na gradbeno konstrukcijo. - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju plitvega in globokega temeljenja objektov.	- Ability to understand and adapt to respective ground conditions. - The ability to understand the impact of ground conditions on the engineering construction. - The ability to critically analyse ground conditions and computational results obtained during the design of shallow and deep foundations of structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, samostojno delo	Lectures, practical examples and individual work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Dva kolokvija ali pisni izpit in samostojno	**20 %**	Seminar (individual work)
Izdelana naloga	**80 %**	Two midterm exams or final written exam

Reference nosilca / Lecturer's references:

PULKO, Boštjan. Primerjava metod za statistično analizo temeljnih plošč = Comparision of methods for static analysis of mat foundations. Gradbeni vestnik, ISSN 0017-2774, sep. 2012, letn. 61, št. 9, str. 198-205, fotograf.

PULKO, Boštjan, MAJES, Bojan, MIKOŠ, Matjaž. Reinforced concrete shafts for the structural mitigation of large deepseated landslides : an experience from the Macesnik and the Slano blato landslides (Slovenia). Landslides, ISSN 1612-510X. [Print ed.], [v tisku] 2012, letn. xx, št. x, str. 1-11, ilustr., doi: 10.1007/s10346-012-0372-2.

PULKO, Boštjan, MAJES, Bojan, LOGAR, Janko. Geosynthetic-encased stone columns - analytical calculation model. Geotextiles and geomembranes, ISSN 0266-1144. [Print ed.], feb. 2011, letn. 29, št. 1, str. 29-39, ilustr., doi: 10.1016/j.geotexmem.2010.06.005.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Praktično usposabljanje
Course title:	Practical training

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1	2
Civil Engineering - second cycle MA	Structural engineering	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
6				80	34	4

Nosilec predmeta / Lecturer: doc. dr. Andreja Istenič Starčič

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Študent se seznani in opravlja delo, ki ga opravlja diplomant tega študija v praksi. Predvsem: se seznani z organizacijsko strukturo in tehnologijo gradbenega podjetja, se seznani s predpisi o varstvu pri delu in njihovi izvedbi v praksi, de seznani se z aktualnim dogajanjem v gradbenem podjetju, spozna menedžerski vidik dela v podjetju, dela na terenu – aktualnem gradbišču, oziroma v pisarni - samostojno opravi dela na aktualnem projektu pod vodstvom mentorja, razvija uporabo znanstvenoraziskovalnih metod v širšem spektru problemov v stroki, razvija kritične refleksije, socialne in komunikacijske zmožnosti za vodenje skupinskega dela, pokaže iniciativnost in samostojnost pri vodenju najzahtevnejših delovnih sistemov pod nadzorom mentorja.

Content (Syllabus outline):

Student is introduced to the performance of work done by graduate in practice. Especially, students are: aware of the organizational structure and technology of building companies, familiar with the regulations about safety at work and their implementation in practice, familiar with current developments in a construction company, introduced to executive aspect of work when undertaking field work - current site, or in office - self- performed work on current project under the guidance of a mentor; they develop the use of scientific research methods in a broad spectrum of problems in the profession, develop critical reflection, social and communication skills for teamwork management, show initiative and independence in the management of most complex work systems under the supervision of mentor.

Temeljni literatura in viri / Readings:

Viri so izbrani v sodelovanju z mentorjem praktičnega usposabljanja glede na vsebine, ki so predpisane in z njimi razpolaga organizacija, ki izvaja praktično usposabljanje.
Resources are selected in collaboration with the supervisor of practical training in relation to the contents prescribed and disposed of by the organization conducting the practical training.
Interna in druga gradiva v delovni organizaciji.
Smernice za praktično usposabljanje na Univerzi v Ljubljani. 2007. Ljubljana, UL. Dostopno na spletu.
Govekar, Okoliš et.al. 2010. Praktično usposabljanje študentov v delovnih organizacijah in primeri dobrih praks. Ljubljana, UL FF, Center za pedagoško izobraževanje.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:

Cilji
- Študent v okviru praktičnega usposabljanja spozna operativno delo v ciljnih poklicih in organizacijsko strukturo subjektov na področju gradbeništva.
- Praksa, izvedena med izobraževalnim procesom, ima tudi motivacijski cilj ter namen.
- Študent spozna dejavnike kariernega načrtovanja in razvoja in procese povezane s kariernim razvojem.
- Študentu se omogoči samoevalvacijo kompetenc in dejavnikov, ki podpirajo procese poklicne identifikacije v povezavi akademskega okolja in delovnih okolij.
- Študent spozna značilnosti učenja na delovnem mestu in značilnosti delovnih okolij ter značilnosti opazovanja in registriranja delovnih procesov.

Pridobljene kompetence
- Obvladovanje uporabe in prenosa teoretičnih znanj, ki jih študent pridobi med študijem pri predavanjih, vajah ter seminarjih, v inženirsko prakso.
- Sposobnost za povezovanje teorije in dela v praksi.

Objectives and competences:

Objectives
- In the context of practical training student learns about operational work in targeted occupations and organizational structure of entities in the construction field.
- The practice during the educational process has also motivational goal and purpose.
- Students learn about the elements of career planning and development and processes related to career development.
- Student is facilitated to do self-evaluation of competences and factors that support the processes of professional identification in relation to academic environment and working environments.
- Students learn about the characteristics of workplace learning and the characteristics of working environments and the characteristics of observation of workflows.

Gained competences
- Control of the application and transfer of theoretical knowledge acquired while studying in academic environment (lectures, tutorials and seminars) to engineering practice. Ability to integrate theory and practical work.

Predvideni študijski rezultati:

- Študent pridobi praktična znanja in izkušnje na področju nalog in storitev gradbene stroke.
- Pridobljena znanja mu koristijo pri izdelavi magistrskega dela.
- Študent se po opravljeni praksi lažje in hitreje uvaja v delo po končanem študiju, razume različne gradbene subjekte in njihovo vlogo v družbi.
- Študent se na podlagi sinteze pridobljenih znanj tekom študija lahko sooči z aktualnimi delovnimi nalogami oz. uporabi aktualna znanja in pripomočke pri izpolnjevanju nalog, ki jih opravlja

Intended learning outcomes:

- Students will acquire practical knowledge and experience in the field of tasks and services of the construction field.
- Obtained knowledge will be useful in the preparation of master thesis.
- During the practice students are more efficiently introduced to the work needed after completing their studies, understand various construction entities and their role in society.
- Synthesis of knowledge acquired during the study may be confronted with the actual work and tasks

organizacija, v kateri poteka praktično usposabljanje. - Pridobljena znanja in spretnosti pripomorejo h kakovostnejšemu razumevanje vsebin posameznih predmetov v študijskem procesu, tudi pri izdelavi magistrskega dela, kakor tudi kasneje pri uvajanju na prvo delovno mesto. - Študent zna ovrednotiti svoje delo glede na zastavljene in dosežene cilje. Strokovno delo reflektira na osnovi zbranih informacij. Študent razvija kompetence za načrtovanje lastne kariere in samoevalvacijo znanja in kompetenc.	through the application of core knowledge and tools in fulfilling the tasks carried out by the organization in which the practical training takes place. - Knowledge and skills to help achieve higher quality of comprehension of the content of individual courses in the study process, also in the writing of master thesis, as well as later in the introduction to the first employment. - Student is able to evaluate work against the objectives and targets achieved. Professional work is reflected on the basis of the information collected. Students develop competences for career planning and self-assessment of knowledge and competencies.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Terensko delo, mentorstvo, demonstracije, konzultacije, pisanje in vodenje dnevnika in portfolia prakse.	Field work, mentoring, demonstrations, consultations, writing and keep a diary and portfolio of practices.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Dnevnik prakse	**40 %**	Diary of practical work,
Portfolio	**30 %**	Portfolio
Ustni zagovor	**30 %**	Oral presentation
Predmet se ocenjuje z »opravil« / »ni opravil«		The course is assessed with "passed" /"not done"

Reference nosilca / Lecturer's references:

ISTENIČ STARČIČ, Andreja. Students' perception of field placement in professional competency and identity construction : transdisciplinary study in education, health and engineering. V: MILLWATER, Jan (ur.), EHRICH, Lisa Catherine (ur.), BEUTEL, Denise (ur.). Practical experiences in professional education : a transdisciplinary approach. Mt Gravatt: Post Pressed, 2011, str. 155-170, tabele.
ŠUBIC KOVAČ, Maruška, ISTENIČ STARČIČ, Andreja. Kompetence diplomantov gradbeništva - evropski raziskovalni projekt TUNING = Competences of graduates in civil engineering - the European Research Project TUNING. Gradb. vestn., julij 2006, letn. 55, str. 178-186, ilustr.
FOUCHAL, Farid, HASSAN, Tarek M., BLEICHER, David, ISTENIČ STARČIČ, Andreja. Industrialised, Integrated, Intelligent Construction Training Concept. V: WALLIS, Ian (ur.). Industrialised, Integrated, Intelligent Construction : I3con, Handbook 1. Berkshire: Bsria: I3con, 2009, str. 184-193.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Vodenje projektov
Course title:	Project management

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	3
Civil Engineering - second cycle MA	Structural engineering	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: prof. dr. Jana Šelih

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Projekt kot sistem, cilji projekta, komponente in relacije v projektu, odnos z okoljem. Organizacija izvajanja projektov, stalna in nestalna projektna organiziranost. Področja projektnega vodenja. Specifika in faze projektov v gradbeništvu. Strukturiranje projekta, matrika odgovornosti. Planiranje in spremljanje projektov. Oblikovanje projektnega tima. Upravljanje s tveganji.

Vaje
Izdelava lastnega projekta od zasnove do generalnega plana. Modeliranje tveganj pri projektih v gradbeništvu in simulacija vplivov.

Content (Syllabus outline):

Lectures
Project as a system, project goals, project components and their relationships, project environment interaction. Project execution organisation, permanent and temporary project organisation. Areas of project management Specific features and project phases in construction projects. Project structuring, responsibility matrix Project planning and monitoring. Formation of a project team. Risk management

Tutorial
Preparation of a case study. Risk simulation in construction projects, impact simulation.

Temeljni literatura in viri / Readings:

Česen, A., Kern, T., Bajec, M. 2008**.** Vodnik po znanju projektnega vodenja, 3. Izdaja. Založba Moderna organizacija.
Rant, M., Jeraj, M., Ljubič, T. 1998. Vodenje projektov.
Šelih, J. 2005. Vodenje gradbenih projektov, delovno gradivo. Ljubljana, UL FGG.

Cilji in kompetence:

- Pridobitev znanj o posameznih udeležencih v procesu graditve,
- Pridobitev znanj o fazah projekta (s poudarkom na gradbenem projektu),
- Pridobitev znanj o procesu vodenja projekta.

Objectives and competences:

- Acquisition of basic knowledge regarding construction project participants,
- Acquisition knowledge of project phases (with emphasis on construction projects),
- Acquisition of the process of project management.

Predvideni študijski rezultati:

- Osvojeno znanje s področja projektnega vodenja (proces, udeleženci, medsebojni odnosi, oblike sodelovanja),
- Sposobnost uporabe računalniških orodij za vodenje projektov.

Intended learning outcomes:

- Acquired knowledge from the field of project management (process, stakeholders, participants' relations),
- Ability to use computer – supported project management tools.

Metode poučevanja in učenja:

Predavanja, seminarske vaje, lab.vaje

Learning and teaching methods:

Lectures, tutorial

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit (teoretični del)	**50 %**	Written exam (theory)
Pisni izpti (računski del)	**50 %**	Written exam (examples**)**

Reference nosilca / Lecturer's references:

FORCA, S., SRDIČ, A., ŠELIH, J. 2006. Follow up and analysis of time delays in project management. V: Semolič, B. (ur.), Kerin, A. (ur.), Stare, A. (ur.). Value management - how to ensure value for project stakeholders : proceedings and congress programme. Ljubljana, ZPM Slovensko združenje za projektni management, 1-4.
ŠELIH, J., SRDIČ, A. 2007. Time and cause delay analysis in construction projects. V: Milašinović, D. (ur.). Medunar. Konf. 2006. Savremeni problemi u granevinarstvu. Subotica: Građevinski fakultet.
ŠELIH, J. 2007. Residential building stock refurbishment design supported by a multi criteria decision support system. WSEAS Trans. Syst. 6/6, 1124-1131.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Dinamika gradbenih konstrukcij in potresno inženirstvo
Course title:	Structural dynamics and earthquake engineering

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	3
Civil Engineering - second cycle MA	Structural engineering	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60			45		105	7

Nosilec predmeta / Lecturer: prof. dr. Matej Fischinger, prof. dr. Matjaž Dolšek

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

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

Prerequisites:

Vsebina:

Predavanja
Uvod v dinamiko gradbenih konstrukcij; dinamični odziv sistemov z eno prostostno stopnjo; dinamični odziv sistemov z več prostostnimi stopnjami (računski modeli in enačbe gibanja, lastno in vsiljeno nihanje, spektri odziva, poenostavljene metode); analiza konstrukcij pri potresni obtežbi; osnovni pojmi o potresih in potresni obtežbi (uvod, splošno o potresih, jakost potresa, potresi v prostoru in času, značilnosti gibanja tal na lokaciji, projektni spektri); načela potresnoodpornega projektiranja (nosilnost in duktilnost, togost, dušenje, zasnova konstrukcij); obnašanje konstrukcij stavb in mostov med potresi; standard Evrokod 8.

Vaje
Laboratorijske vaje (v rač. učilnici): dinamični odziv konstrukcij.
Individualne naloge (v rač. učilnici): analiza stavbe ali mostu pri potresni obtežbi.

Content (Syllabus outline):

Lectures
Introduction into structural dynamics; dynamic response of the single degree of freedom systems; dynamic response of multi degree of freedom systems (computational models and equations of motion, free and forced vibration, response spectra, simplified procedures); seismic analysis of structures; basic concepts of earthquakes and seismic action (introduction, generally about earthquakes, seismic intensity, spatial and time distribution of earthquakes, characteristics of ground motion at a location, design spectra); principles of earthquake-resistant design (strength and ductility, stiffness, damping, conceptual design); seismic behaviour of building and bridge structures; structural standard Eurocode 8.

Tutorial/Seminar:
- Tutorial (in the CAD lab): dynamic response of structures;
- Individual assignments (in the CAD lab): seismic analysis of a building or bridge.

Temeljni literatura in viri / Readings:

P. Fajfar. 1995. Osnove potresnega inženirstva. Ljubljana, UL FGG, 83 str.
P. Fajfar. 1984. Dinamika gradbenih konstrukcij. Ljubljana, UL FGG, str.1-20, 27-88, 109-119, 132-342, 412-519.
SIST EN. 1998. Projektiranje potresnoodpornih konstrukcij.
EASY (earthquake engineering slide information system), IKPIR FGG, CD.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:

Cilji
- Podati osnove dinamike gradbenih konstrukcij ter osnovne pojme o potresih, potresni obtežbi in potresnoodpornem projektiranju.

Pridobljene kompetence
- Razumevanje posledic potresov in obvladovanje različnih načinov zaščite pred njimi
- Sposobnost uporabe metod analize dinamičnih problemov
- Razumevanje in obvladovanje osnov projektiranja potresnoodpornih objektov

Objectives and competences:

Objectives
- To present the basic concepts of structural dynamics, earthquakes, seismic loading (action), and earthquake-resistant design.

Acquired competences:
- Ability to understand the consequences of earthquakes and the competence to apply different earthquake protection measures;
- Ability to apply different methods of dynamic analysis;
- Ability to understanding the fundamentals of earthquake-resistant design of structures and the competence of their application.

Predvideni študijski rezultati:

- Seznanitev z dinamičnimi problemi v gradbeništvu in metodami za njihovo reševanje.
- Razumevanje osnovnih značilnosti dinamičnega odziva in inženirskega modeliranja konstrukcij.
- Seznanitev s potresi in njihovimi posledicami ter z ukrepi za zmanjševanje posledic.
- Zavedanje o pomembnosti problemov v zvezi s potresi in in odgovornosti gradbenikov na vseh področjih njihovega delovanja.
- Razumevanje potresa kot naravnega pojava, nihanja tal in obnašanja objektov med potresi.
- Osvojene računske spretnosti za analizo gradbenih objektov pri potresnih obremenitvah
- Doseženo znanje se uporablja pri načrtovanju potresnoodpornih gradbenih objektov.
- Študent premišljuje o odnosu med posledicami potresa (in drugih naravnih nesreč) in o vloženih sredstvih za zmanjševanje posledic malo verjetnih dogodkov, o (ne)zanesljivosti matematičnih modelov za dejanske objekte in vplive na njih, o inovativnih možnostih za zmanjševanje posledic potresov.
- Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov;
- Sposobnost upoštevanja vpliva naravnih nesreč pri načrtovanju človekove dejavnosti v prostoru

Intended learning outcomes:

- To learn about the dynamic problems in structural and civil engineering and the methods to solve these problems;
- To understand the basic characteristics of the dynamic response and the basic principles of engineering modelling of structures;
- To get information about earthquakes and their consequences and to learn about earthquake protection measures;
- Awareness of the importance of problems related to earthquakes and of the responsibility of civil engineers in all areas of their activity;
- To understand the natural phenomenon of earthquake, the ground motion, and the behaviour of structures subjected to earthquakes;
- To acquire the knowledge of the numerical methods to analyse buildings and bridges subjected to earthquake action.
- The acquired knowledge is applicable in the earthquake-resistant design of structures;
- Student contemplates about the relation between the consequences of earthquakes (as well as other natural disasters) and the investments in the protection against low- probability events, about uncertainty of mathematical models to simulate actual structures and actions, as well as about

- Sposobnost uporabe metod analize dinamičnih problemov; - Sposobnost uporabe predpisov za projektiranje novih in za preverjanje obstoječih objektov; - Sposobnost uporabe literature in spletnih virov.	innovative opportunities/measures to reduce the consequences of earthquakes. - Ability of critical evaluation of the input data and results; - Ability to consider the impact of natural disasters in the environmental planning; - Ability to use the methods of dynamic analysis; - Ability of the application of the structural codes for the design and strengthening of structures; - Ability to find and to use information in e-literature and web sources.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje se izvajajo vzporedno.	The lectures and the tutorial are organized in parallel.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Samostojna naloga (se izdela med letom)	**30 %**	Individual work (made during the year)
Računski del izpita	**30 %**	Exam (computational part)
Teoretični del izpita	**40 %**	Exam (theory)

Reference nosilca / Lecturer's references:

FAJFAR, Peter, DOLŠEK, Matjaž. A practice-oriented estimation of the failure probability of building structures. Earthquake eng. Struct. Dyn.. [Print ed.], 2012, letn. 41, št. , str. 531-547, ilustr., doi: 10.1002/eqe.1143.
DOLŠEK, Matjaž, FAJFAR, Peter. The effects of masonry infills on the seismic response of a four- storey reinforced concrete frame - a deterministic assessment. Eng. Struct.. [Print ed.], julij 2008, letn. 30, št. 7, str. 1991-2001, graf. Prikazi, doi: 10.1016/j.engstruct.2008.01.001.
DOLŠEK, Matjaž, FAJFAR, Peter. The effects of masonry infills on the seismic response of a four- storey reinforced concrete frame - a probabilistic assessment. Eng. Struct.. [Print ed.], November 2008, letn. 30, št. 11, str. 3186-3192, graf. Prikazi, doi: 10.1016/j.engstruct.2008.04.031.

DOLŠEK, M. 2010. Development of computing environment for the seismic performance assessment of reinforced concrete frames by using simplified nonlinear models. Bulletin of earthquake engineering, letn. 8, št. 6, str. 1309-1329, doi: 10.1007/s10518-010-9184-8.
DOLŠEK, M. 2009. Incremental dynamic analysis with consideration of modeling uncertainites. Earthquake engineering & structural dynamics, letn. 38, št. 6, str. 805-825, doi: 10.1002/eqe.869. DOLŠEK, M. 2012. Simplified method for seismic risk assessment of buildings with consideration of aleatory and epistemic uncertainty. Structure and infrastructure engineering, letn. 8, št. 10, str. 939-953, doi: 10.1080/15732479.2011.574813.
BROZOVIČ M., DOLŠEK, M. 2013. Envelope-based pushover analysis procedure for the approximate seismic response analysis of buildings. Earthquake engineering & structural dynamics, [v tisku], letn. XX, št. X, str. 1-10, doi: 10.1002/eqe.2333.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Izbrana poglavja iz masivnih konstrukcij
Course title:	Selected chapters from concrete and masonry structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	3
Civil Engineering - second cycle MA	Structural engineering	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: izr. prof. dr. Jože Lopatič, izr. prof. dr. Sebastjan Bratina, doc. dr. Drago Saje

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Tehnologija betona (projektiranje sestave betona s posebnimi zahtevami, toplotna obdelava betona, betoniranje v izjemnih pogojih); optimalno dimenzioniranje armiranih in prednapetih nosilnih elementov (izhodišča optimizacije, prevedba problema optimizacije nosilnih elementov v matematični program); račun in tehnološki postopek adhezijsko prednapetih elementov
- statično nedoločene prednapete linijske konstrukcije; dimenzioniranje in konstrukcijska izvedba ploskovnih betonskih konstrukcij (sten, stenastih nosilcev, plošč in lupin); dimenzioniranje in konstrukcijska izvedba betonskih temeljev; zagotavljanje požarne varnosti betonskih konstrukcij; prednapete zidane konstrukcije.

Vaje
- seminarske vaje (računski primeri),
- laboratorijske vaje (numerične simulacije v računalniški učilnici).

Content (Syllabus outline):

Lectures
Concrete technology (design of concrete mixtures with special demands, thermal treatment of concrete, concreting in extreme conditions); optimum design of reinforced and prestressed load-carrying elements (starting points for optimisation, formulation of the problem of optimisation of load-bearing elements by mathematical program); calculation and technological procedure of elements prestressed with pretensioned tendons; statically indeterminate prestressed planar structures; design and structural implementation of plane reinforced concrete structures (walls, deep beam and slabs) and shells; design and detailing of concrete foundations; assuring fire safety of concrete structures; prestressed masonry structures.

Tutorials:
- seminar tutorials (computational examples),
- laboratory tutorials (numerical simulations in computer classroom).

Temeljni literatura in viri / Readings:

G. Rombach. 2002. Spannbetonbau, Ernst&sohn, str. 195-270.
M.J. Tomlinson. 2001. Foundation design and construction-seventh edition. Pearson education ltd, Str. 137-174, 345-389.
T. Paulay, M. J.N. Priestly. 1992. Seismic design of reinforced concrete and masonry buildings. John Wiley&sons, str. 158- 361.
S.S.J. Moy. 1996. Plastic methods for steel and concrete structures. Macmillan, str. 188-239.
Structural connections for precast concrete buildings (fib bulletin 43), 2008. Fib ceb – fip.
Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 2, Evrokod 6, Evrokod 8 (SIST EN 1990, SIST EN 1992-1-1, SIST EN 1992-1-2, SIST EN1996-1-1, SIST EN 1998-1).
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:

Cilji
- Nadgraditi osnovno poznavanje obnašanja masivnih konstrukcij
- Podati podlage za računsko modeliranje masivnih konstrukcij
- Podati teoretične osnove za načrtovanje zahtevnejših masivnih konstrukcij

Pridobljene kompetence
- Sposobnost snovanja in projektiranja zahtevnejših masivnih konstrukcij

Objectives and competences:

Objectives
- To upgrade the basic knowledge of the behaviour of concrete and masonry structures,
- To define the bases for computational modelling of concrete and masonry structures,
- To define the theoretical bases for the design of demanding concrete and masonry structures.

Acquired competences
- Ability to conception and design demanding concrete and masonry structures.

Predvideni študijski rezultati:

- Poglobitev in razširitev znanja s področja dimenzioniranja, računskega modeliranja in konstrukcijske izvedbe masivnih konstrukcij
- Poznavanje posebnih metod analize, dimenzioniranja in konstruiranja betonskih konstrukcij in detajlov
- Sposobnost razvoja novih metod in programske opreme za načrtovanje masivnih konstrukcij
- Poglobljeno razumevanje obnašanja masivnih konstrukcij
kot podlaga za njihovo smotrno načrtovanje
- Sposobnost uporabe strokovne literature, standardov in računalniških programov za načrtovanje masivnih konstrukcij
- Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju masivnih konstrukcij.

Intended learning outcomes:

- Upgrading and expanding of knowledge from the area of design, computational modelling and detailing of concrete and masonry structures.
- Knowledge of special methods for the analysis, conception and design of concrete structures and details.
- Ability to develop new methods and software for the design of concrete and masonry structures.
- Deeper understanding of the behaviour of concrete and masonry structures as a condition for their sensible design.
- Ability to use professional literature, standards and software for the design of concrete and masonry structures.
- Ability to critically assess the input data and the acquired computational results in the design of concrete and masonry structures.

Metode poučevanja in učenja:

Predavanja in seminarske vaje v klasični učilnici, laboratorijske vaje v računalniški učilnici.

Learning and teaching methods:

Lectures and seminar tutorials in classical classroom, laboratory tutorials in computer classroom.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Vaje	**20 %**	Tutorials
Računski izpit (možno opraviti s kolokviji)	**40 %**	Computational part of exam
Teoretični izpit	**40 %**	Theoretical part of exam

Reference nosilca / Lecturer's references:

F. SAJE, J. LOPATIČ, A Time-Dependent Analysis of Reinforced Prestressed and Composite Concrete Structures, Int. J. eng. Model., 1997, vol. 10, str. 17-24.
J. LOPATIČ, Vpliv dolgotrajnih visokih nivojev napetosti na tlačno trdnost betona, Gradbeni vestnik, Ljubljana, ISSN 0017-2774, April 2003, letn. 52, strani 74-80, 2003.
J. LOPATIČ, F. SAJE,. Non-linear analysis of time-dependent response of civil engineering structures. V: TOPPING, Barry H. V. (ur.), MONTERO, G. (ur.), MONTENEGRO, R. (ur.). Proceedings of the eighth International conference on computational structures technology, Las Palmas de Gran Canaria-Spain, 12-15 September 2006. Stirling: Civil-Comp, cop. 2006.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Jeklene konstrukcije
Course title:	Steel structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	3
Civil Engineering - second cycle MA	Structural engineering	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			30		75	5

Nosilec predmeta / Lecturer: doc. dr. Primož Može

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Plastična analiza jeklenih konstrukcij s poudarkom na togi metodi plastičnih členkov; globalna analiza jeklenih konstrukcij (metode, začetne nepopolnosti, modeliranje, dimenzioniranje elementov, presoja rezultatov); utrujanje (nizkociklično, visokociklično); spoji (klasifikacija, dimenzioniranje, duktilnost); potresno odporno projektiranje jeklenih konstrukcij (zasnova, duktilnost, ukrepi za zagotavljanje potresne odpornosti); sovprežne konstrukcije (osnove, dimenzioniranje nosilcev; elastično, elasto-plastično, dimenzioniranje stebrov); stabilnost ojačenih pločevin (osnove, ojačitve; dimenzioniranje ojačenih panelov na relevantne vplive). Vaje Seminarske vaje: računski primeri - praktična uporaba metod projektiranja, ki jih študent spozna pri predavanjih.	Lectures Plastic analysis of steel structures, emphasizing the plastic hinge method; global analysis of steel structures (methods, initial imperfections, modelling, design of the elements, assessment of the results); fatigue (low-cycle and high-cycle fatigue); joints (classification, design, ductility); seismic design of steel structures (structural design, ductility, measures to ensure seismic resistance); composite structures (basis, elastic and plastic design of beams and columns); stability of stiffened plates (basis, stiffeners, design of stiffened panels). Individual work Seminar: practical examples – application of design methods given in the lectures.

Temeljni literatura in viri / Readings:

D. Beg, A. Pogačnik. 2009. Priročnik za projektiranje gradbenih konstrukcij po evrokod standardih. Ljubljana, IZS.
ESDEP - The European Steel Design Education Programme, spletna učilnica UL FGG.
P Može, Študijsko gradivo - izbrane teme, spletna učilnica UL FGG.
NS Trahair, MA Bradford, David Nethercot, L Gardner, The Behaviour and Design of Steel Structures to EC3, Fourth Edition, 2008, 490 p.3

Luís Simões da Silva, Rui Simões, Helena Gervásio. 2016. Design of Steel Structures: Eurocode 3: Design of Steel Structures, Part 1-1 – General Rules and Rules for Buildings. ECCS – European Convention for Constructional Steelwork
Jean-Pierre Jaspart, Klaus Weynand. 2016. Design of Joints in Steel and Composite Structures. ECCS – European Convention for Constructional Steelwork

Cilji in kompetence:

Cilji
- Nadgraditi osnovno znanje s področja projektiranja jeklenih konstrukcij z znanjem o zahtevnejših metodah projektiranja
- Pridobiti znanja, ki bodo v pomoč pri pridobitvi licence pooblaščenega inženirja pri Inženirski zbornici Slovenije.

Pridobljene kompetence
- Sposobnost projektiranja jeklenih konstrukcij na nivoju sistemov (npr. stavb),
- Sposobnost reševanja posebnih problemov jeklenih konstrukcij (utrujanje, potres, ojačene pločevine, sovprežne konstrukcije).

Objectives and competences:

Objectives
- To enhance basic knowledge through the use of sophisticated design methods;
- To acquire skills necessary to obtain a license for authorized engineer at the Slovenian Chamber of Engineers.

Competences
- Ability to design steel structures (buildings, bridges);
- Ability to solve specific problems in the field of steel structures (fatigue, earthquake, stiffened plates, composite structures).

Predvideni študijski rezultati:

- Spoznati in razumeti metode analize in dimenzioniranja sistemov,
- Spoznati osnove plastične analize jeklenih konstrukcij in razumeti pomen duktilnosti,
- Spoznati in razumeti obnašanje jeklenih konstrukcij med potresom uporaba - študent se bo naučil teoretična znanja uporabiti v inženirski praksi.
- Ena glavnih značilnosti projektiranja konstrukcij je sprejemanje velikega števila odločitev v nizu. Na osnovi pridobljenega teoretičnega in praktičnega znanja bo študent sposoben kritične presoje posameznega problema, izločitve neustreznih rešitev in utemeljene izbire ene od ustreznih rešitev.
- Sposobnost uporabe računalniških programov za analizo konstrukcij,
- Sposobnost kritične presoje rezultatov obsežnih računalniških analiz,
- Sposobnost kritične presoje strokovnih

Intended learning outcomes:

- To know and understand the analysis methods and the design of systems.
- To know the basics of plastic analysis of steel structures and to understand the phenomena and the importance of ductility.
- To know and understand the behaviour of steel structures subjected to earthquake. Student should learn to use the theoretical knowledge in engineering practice.
- One of the main features of structural design is decision making. Based on the acquired theoretical and practical knowledge student should be able to critically judge individual problem, to eliminate inappropriate solutions and to justify the choice of possible solution.
- Ability to use computer programs for structural analysis.
- Ability to critically judge results of numerous numerical analyses.
- Ability for critical judgement of technical problems.

problemov, - Pridobivanje spretnosti za uporabo literature, interneta in drugih informacijskih tehnologij.	- Acquisition of skills for the use of literature, Internet and other information technologies.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predmet se izvaja v obliki predavanj in računskih vaj.	The course consists of lectures and computational exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Računski del izpita	**40 %**	Practical exam
Teoretični del izpita (običajno v obliki ustnega zagovora)	**50 %**	Theoretical exam (usually oral)
Pravilno izdelane vaje	**10 %**	Approved elaborated examples

Reference nosilca / Lecturer's references:

Čermelj, B., Može, P. and Sinur, F. (2016), "On the prediction of low-cycle fatigue in steel welded beam-to-column joints", *Journal of Constructional Steel Research*. **117** 49-63.
Može, P. and Beg, D. (2014), "A complete study of bearing stress in single bolt connections", *Journal of Constructional Steel Research*. **95** 126-140.
Može, P., Cajot, L.-G., Sinur, F., Rejec, K. and Beg, D. (2014), "Residual stress distribution of large steel equal leg angles", *Eng Struct*. **71**(0), 35-47.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Verjetnostne metode in zanesljivost konstrukcij
Course title:	Probabilistic methods and reliability of structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	3
Civil Engineering - second cycle MA	Structural engineering	2	3

Vrsta predmeta / Course type:	Obvezni strokovni / Obligatory professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer:	prof.dr. Goran Turk

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

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

Opravljen izpit iz predmetov Matematika 3, Verjetnostni račun in statistika.

Prerequisites:

Passed exams in Mathematics 3, Theory of probability and statistics.

Vsebina:

Predavanja
Verjetnostni račun: definicija verjetnosti, slučajnih spremenljivk, vektorjev, momenti in funkcije slučajnih spremenljivk in vektorjev.
Porazdelitve verjetnosti: logaritemsko normalna, porazdelitve ekstremnih vrednosti, porazdelitve beta, gama.
Karakteristične vrednosti, definicija, določitev na osnovi rangiranja, ob predpostavki o porazdelitvi iz velikih in malih vzorcev, Bayesove metode.
Osnovni problem zanesljivosti konstrukcij, posplošitev na poljubno porazdelitev, posplošitev na večdimenzionalni prostor, nelinearno mejno funkcijo. Metoda prvega reda – drugega momenta. Metoda Monte Carlo. Generiranje vzorcev slučajnih spremenljivk in vektorjev. Zanesljivost sistemov: vzporedni in zaporedni sistemi.
Vaje
Z vajami v računalniški učilnici bodo študentje

Content (Syllabus outline):

Lectures
Theory of probability (review): definition of probability, random variables and vectors, moments, derived distributions. Statistical distributions: log-normal distribution, extreme value distributions, beta and gamma distributions. Characteristic values, definition; determination by the ranking method and by assumed distribution, Bayesian approach. The basic problem of reliability of structures, generalization for arbitrary distribution, generalization for multidimensional space and non-linear limit function. FOSM – first order second moment method. Monte Carlo method, random sample generation. System reliability, parallel and series systems.
Tutorials
Different problems will be solved by students in computer lab.

reševali različne probleme, ki jih bomo spoznali in opisali na predavanjih.	

Temeljni literatura in viri / Readings:

G. Turk. 2012. Verjetnostni račun in statistika. Ljubljana. Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo.
R. Jamnik. 1986. Verjetnostni račun in statistika. Ljubljana, DZS.
J. R. Benjamin, C.A. Cornell. 1980. Probability, Statistics and Decision for Civil Engineers, McGraw Hill.
N.T. Kottegoda, R. Rosso, Statistics. 1997. Probability and Reliability for Civil and Environmental Engineering, McGraw-Hill.
R. E. Melchers, Structural Reliability. 1987. Analysis and Prediction. John Viley and Sons.
H. O. Madsen, S. Krenk, N.C. Lind. 1986. Methods of Structural Safety. Prentice-Hall.

Cilji in kompetence:	**Objectives and competences:**
- Aktivno razumevanje osnov verjetnostnega računa, razlikovanje med slučajnimi in determinističnimi količinami. - Razumevanje pomena slučajnih spremenljivk in vektorjev. - Poznavanje osnovnih statističnih porazdelitev s poudarkom na tistih, ki so posebne pri zanesljivosti konstrukcij. - Spoznavanje osnovnih metod zanesljivosti konstrukcij in njihova uporaba. - Razumevanje osnov verjetnostnih in statističnih metod, uporabljenih v različnih pravilnikih in standardih.	- Understanding of the basic concepts of theory of probability, understanding the difference between deterministic and random values. - Understanding the meaning of random variables and vectors. - Knowledge about statistical distribution with the emphasis on those which are commonly used in reliability of structures. - Knowledge about and ability to use some basic methods in reliability of structures. - Understanding some basic probabilistic and statistical methods used in different codes and standards.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznati mora osnovne metode zanesljivosti konstrukcije: metode prvega reda in Monte Carlo. - Razumeti mora razliko med pojmi slučajna spremenljivka, parametri slučajne spremenljivke, ocene parametrov, statistike. - Razumeti mora povezavo med varnostnimi faktorji iz pravilnikov in zanesljivostjo konstrukcije, indeksom zanesljivosti, verjetnostjo porušitve. - Razumeti mora osnove projektiranja konstrukcij s stališča zanesljivosti konstrukcij.	- Knowledge about basic methods: first order reliability method (FORM) and Monte Carlo method. - Understanding the difference between terms: random variable, random variable parameters and estimates of parameters. - Understanding the connection between safety factors from the codes, reliability of structure, reliability index, probability of failure. - Understanding the basic reliability concepts in structural design.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja s prikazi uporabe različnih metod. Vaje v računalniški učilnici, na katerih se študentje naučijo uporabe različnih metod zanesljivosti konstrukcij na preprostih primerih.	Lectures with the use of different modern approaches, demonstration of software. Tutorials in computer lab where students learn about several methods applied to relatively simple reliability problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Samostojna naloga	**20 %**	Individual work
Računske naloge, izdelane med semestrom	**40 %**	Practical exercise during the semester
Ustni izpit - teoretični del	**40 %**	Final exam – theoretical, oral examination

Reference nosilca / Lecturer's references:

TURK, Goran. Verjetnostni račun in statistika. 1. izd. Ljubljana: Fakulteta za gradbeništvo in geodezijo, 2012. VI, 264 str., ilustr. ISBN 978-961-6884-04-4.
SCHNABL, Simon, PLANINC, Igor, TURK, Goran. Buckling loads of two-layer composite columns with interlayer slip and stochastic material properties. Journal of engineering mechanics, ISSN 0733-9399, 2013, letn. 139, št. 8, str. 1124-1132.
MARJETIČ, Aleš, AMBROŽIČ, Tomaž, TURK, Goran, STERLE, Oskar, STOPAR, Bojan. Statistical Properties of Strain and Rotation Tensors in Geodetic Network. Journal of surveying engineering, ISSN 0733-9453, avgust 2010, letn. 136, št. 3, str. 102-110.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Magistrsko delo
Course title:	Master thesis

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type:	Obvezni strokovni / Obligatory professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
				150	150	10

Nosilec predmeta / Lecturer:	učitelj na študijskem programu / teacher at the study programme

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Odobrena tema in mentor s strani Študijskega odbora Oddelka za gradbeništvo skladno s Pravilnikom o študiju na I. in II. stopnji.	Approved topic and supervisor by the Study Board of the Department of Civil Engineering according to the Rules of 1st and 2nd cycle studies.

Vsebina:	**Content (Syllabus outline):**
Magistrsko delo se izdela pod mentorstvom izbranega učitelja. Delo se javno predstavi ob zaključku študija. Vsebovati mora: - Uvod - Delovno hipotezo - Pregled virov - Material in metode - Rezultate - Razpravo - Povzetek Praviloma se v magistrskem delu obravnavajo praktični strokovni problemi ali raziskovalne in razvojne teme s področja gradbeništva ter podajajo rešitve, do katerih pridejo s pomočjo študija in izsledkov lastnega raziskovalnega dela.	Master thesis shall be made under the supervision of a selected teacher. The work is presented in public at the end of the study. It must include: - Introduction - The working hypothesis - Overview of sources - Material and methods - Results - Discussion - Summary The thesis will ordinarily deal with practical professional problems or research and development themes from the area of civil engineering that provide further solutions which come out from the study and from the results of students' own work.

Temeljni literatura in viri / Readings:

Literatura s področja vsebine magistrskega dela.
T.Koler-Povh, G. Turk: Navodila za oblikovanje visokošolskih del na FGG in navajanje virov, FGG UL, Ljubljana, 2011, 39 strani, priloge. Dostopno na:
http://www3.fgg.uni-lj.si/fileadmin/user_upload/UL_FGG_-_Pr_10_Navodila_za_oblikovanje_visokosolskih_del_na_UL_FGG_2011_07.pdf

Literature from the field of the contents of the thesis.
Instructions for creating higher part of the Faculty of Civil and Geodetic Engineering and citation of sources.

Cilji in kompetence:

Cilji
- Uporabiti pridobljena znanja v poglobljenem študiju na temi magistrskega dela.
- Pod mentorstvom izdelati koncept dela, v katerem so opredeljeni namen, cilji, metode in viri za izdelavo tega dela.
- Razvijanje samostojnega, kritičnega in etičnega načina dela.

Pridobljene kompetence:
- Z javno predstavitvijo magistrskega dela pridobiti komunikacijske spretnosti in sposobnosti.

Objectives and competences:

Objectives
- To use the knowledge gained by in-depth study on the thesis topic.
- Under supervisor's supervision student prepares a concept, where the purposes, goals, methods and references for the thesis are presented.
- To develop independent, critical and ethical way of working.

Acquired competences:
- With public presentation student obtains communication skills and abilities.

Predvideni študijski rezultati:

- Pridobi znanja na vseh fazah, ki so del samostojnega reševanja konkretnih problemov in nalog na področju gradbeništva, sodelovanja in tudi skupinskega dela v okviru različnih subjektov na področju gradbeništva.
- Razume gradbeništvo kot interdisciplinarno panogo, vezano na ostale naravoslovne in tehniške vede in na okolje.
- Doseženo znanje uporabi v inženirski praksi.
- Uporaba teoretičnih znanj v praksi.
- Povezovanje ter inovativna dejavnost pri delu.
- N a črtovanje, izvedba in kritično vrednotenje pri reševanju problemov ter prezentacija izsledkov strokovnih nalog in raziskav.
- Sodelovanje, vključevanje strokovnjakov in skupno reševanje problemov.

Intended learning outcomes:

- Students acquire knowledge in all phases, which are part of a real problem and tasks in civil engineering, as well as cooperation and teamwork within various entities in civil engineering.
- They understand civil engineering as an interdisciplinary field, connected to other natural and technical sciences and the environment.
- They learn how to use the theoretical knowledge in engineering practice.
- Reflection.
- Use of theoretical knowledge in practice.
- Planning, execution and critical evaluation in problem solving and presentation of results of technical tasks and research.
- Including, participation, involvement of experts and joint problem solving.

Metode poučevanja in učenja:

Mentorsko vodeno samostojno delo.

Learning and teaching methods:

Independent work under supervision.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Magistrska naloga	**50 %**	Master thesis
Zagovor	**50 %**	Defence

Reference nosilca / Lecturer's references:

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Interdisciplinarni seminar računalniško podprtega projektiranja konstrukcij
Course title:	Interdisciplinary seminar on computer aided design of structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
	90		60		150	10

Nosilec predmeta / Lecturer: prof. dr. Matej Fischinger, prof. dr. Tatjana Isaković

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Predmet je del modula Interdisciplinarni projektni študij računalniško podprtega projektiranja konstrukcij.	The course is a part of the module Interdisciplinary Project Study of Computer-Aided Design of Structures.

Vsebina:	**Content (Syllabus outline):**
Gradbenik izdela seminarsko nalogo v sodelovanju z arhitektom. Predavanja Predavanja potekajo v dveh delih – pred začetkom izdelave projektnih nalog ter sproti med izdelavo nalog glede na specifične potrebe in želje študentov ter posebnosti vsakoletnega izbora obravnavanih objektov. Splošna uvodna predavanja obravnavajo: - Specifične aplikacije znanj, pridobljenih pri predmetih Zasnova konstrukcij in Informacijska tehnologija, za reševanje konkretne naloge - Dopolnjeno je znanje iz področja metod geotehničnega projektiranja plitvega in globokega temeljenja ter zemeljskih del - Predstavljene so napredne metode analize in konstruiranja, ki so nadgradnja do sedaj pridobljenih znanj na področju konstrukterstva. - Predstavljene so teoretične osnove za priporočeno programsko opremo ter napredne	The student of structural engineering works together with the student of architecture on the joint seminar project. Lectures are organized in two parts – (a) A short course is organized prior to the start of the work on the project (b) Lectures are organized during the work on the project assignment, based on the specific needs and requirements of the students and according to the specifics of the projects chosen in a particular year. The general introductory lectures address: - The specific application of the knowledge obtained at the courses Conceptual design of structures and Information technology related to the particular project chosen by the students; - The knowledge in the field of shallow and deep foundations is enhanced; - The advanced methods of analysis and design are presented to upgrade the already acquired knowledge in the field of structural engineering;

funkcije v programih za projektiranje. - Podrobneje so razloženi principi projektiranja potresno odpornih stavb. - Podrobneje so obdelane relevantne zahteve v sistemu standardov Evrokod, še zlasti tiste, ki se posebej nanašajo na izbrane objekte. Z vmesnimi predstavitvami delnih rezultatov za posamezne naloge se vsi študentje seznanijo z rešitvami celotnega spektra objektov, ki so obravnavani v posameznem letu. Sprotna predavanja se organizirajo kot nadgradnja individualnih konzultacij. Sistematično se obdelajo posamezni zanimivi problemi, ki se pojavijo pri reševanju individualnih nalog ter se predstavijo vsem študentom. Seminar in laboratorijske vaje Arhitekt predstavi idejno zasnovo objekta. V diskusiji z arhitektom gradbenik predlaga vsaj dve možni konstrukcijski rešitvi. Na podlagi preprostejših računskih modelov in analiz poda argumente za dokončno izbiro enega konstrukcijskega sistema. Ta se podrobneje obdela. Izdela se projekt vključno z izvedbenimi načrti najpomembnejših elementov. Na koncu se pripravi vizualizacija objekta, ki se uporabi na javni predstavitvi projekta, ki je obenem zaključni izpit. Študenta sodelujeta na daljavo s pomočjo ustreznih IT orodij, ki omogočajo projektiranje na daljavo. Ves razvoj projektne dokumentacije arhivirata s pomočjo informacijsko podprtih postopkov.	- The theoretical fundamentals and the advanced functions of the recommended computer programs for the design of structures are presented; - The principles of the design of the earthquake resistant structures are explained in more detail; - The requirements in the Eurocodes and in particular those related to the chosen projects are explained in more detail. Intermediate presentations of the work are organized. In this way all the students become familiar with the structural and design solutions proposed in all the projects, addressed in a particular year. Real-time lectures are organized as an outgrowth of the individual consultations. In this way all the students are exposed to the interesting problems, which have been solved within the individual projects. Seminar and tutorial The architect presents the initial conceptual outline of the structure. The structural engineer proposes at least two different structural solutions, which are discussed with the architect. The structural engineer performs some simplified analyses using simplified structural models to argue the final choice of one structural solution. More detailed analysis is done for this structure and the design of the typical structural elements (including reinforcement or/and workshop plans) is made. At the end, the visualization of the structure is prepared and used in the public presentation, which is considered as the final exam. Both students use the IT based tools for the distance communication and design. The IT based procedures are also used to prepare and store all the documentation of the project.

Temeljni literatura in viri / Readings:

Literatura, ki se poišče sproti v zvezi s konkretno nalogo.
Evropski standardi za projektiranje konstrukcij SIST- EN 1990 – 1998.
FAJFAR, Peter, FISCHINGER, Matej, BEG, Darko. 2009. Evrokod 8 : projektiranje potresno odpornih konstrukcij. V: BEG, Darko (ur.), POGAČNIK, Andrej (ur.). Priročnik za projektiranje gradbenih konstrukcij po evrokod standardih. Ljubljana, Inženirska zbornica Slovenije, str. 8.1-8.241
EASY (earthquake engineering slide information system), ikpirfgg, CD.
Dostopno na: www.ikpir.fgg.uni-lj.si/easypbl .
Projektni študij gradbeništva in arhitekture s pomočjo www:http://itc.fgg.uni-lj.si/projects/pbl/ .

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je naučiti kako projektirati kompleksno realno konstrukcijo iz poljubnega materiala v sodelovanju s partnerjem druge stroke ter ob upoštevanju principov in postopkov računalniško integrirane graditve. Pridobljene kompetence - Poznavanje postopkov projektiranja in ustreznih standardov. - Razumevanje mehanizmov prenosa obtežbe preko konstrukcijskih sklopov v temeljna tla in principov zagotavljanja potresne odpornosti konstrukcij stavb in mostov. - Sposobnost uporabe računskih metod in programske opreme za projektiranje kompleksnih nosilnih konstrukcij stavb in mostov ter njihovih temeljev in sodobnih IT podprtih orodij v projektiranju, komunikaciji na daljavo in vizualizaciji objektov.	The objective of the course is to teach how to design a complex realistic structure made of arbitrary chosen materials. The work is done in the cooperation with the partner of a different profession using the procedures of the computer integrated construction. The acquired competences are: - Knowledge of the design procedures and relevant standards; - Ability to understand the load transfer through the structural elements into the foundation soil and the principles of the earthquake-resistant design of buildings and bridges; - Ability to use the procedures and computer programs to design complex building and bridge structures and their foundations as well as the ability to use the up-to-date IT supported tools for: (a) distance communication, (b) distance design, and visualisation of the structures.
Predvideni študijski rezultati:	**Intended learning outcomes:**
- Znanje samostojnega reševanja kompleksnih problemov v sodelovanju s strokovnjakom druge stroke. - Sinteza ozkih znanj pridobljenih v posameznih fazah študija. - Obvladanje in razumevanje temeljnih principov računalniško integrirane gradnje. - Razumevanje delovanja konstrukcijskih sklopov in konstrukcije kot celote ter prenosa obtežbe v temeljna tla. - Razumevanje dejavnikov za zagotavljanje duktilnosti in nosilnosti potresno odpornih konstrukcij in znanje oblikovanja ustreznih konstrukcijskih detajlov. - Sposobnost uporabe računskih metod in programske opreme za projektiranje kompleksnih nosilnih konstrukcij stavb in njihovih temeljev. - Uporaba It orodij za komuniciranje, vodenje projektne dokumentacije in grafično predstavitev projektov. - Kompetentna uporaba evropskih standardov projektiranje konstrukcij Evrokod. - Spoznanje, da je za uspešen projekt potrebna konstruktivna uskladitev različnih interesov, ter da so realni problemi precej bolj kompleksni od študijskih in zato njihovo reševanje zahteva primerno ravnovesje med točnostjo in inženirskimi	- The skill how to solve a complex problem in cooperation with the partner of a different profession; - The synthesis of the partial pieces of knowledge gained in the previous stages of the study; - Accomplishing and understanding the fundamental principles of the computer integrated construction; - Understanding the function of the structure and its subassemblies and the transfer of the loads into the foundation soil; - Understanding the factors that provide the ductility and strength of the earthquake- resistant structures and the knowledge how to design the relevant structural details. - The ability to use numerical procedures and computer programs to design complex structures (including their foundations); - The ability to apply IT tools for communication, management of project documentation and graphical presentation of structures; - The competent use of the European structural design standards Eurocode. - The students become aware that: (a) A successful project requires constructive compromise among the various interests; (b) The real-life problems are substantially more complex than study examples and, therefore, they

poenostavitvami. - Prenosljive spretnosti: a) Argumentirana izbira med več možnostmi b) Delo v skupini in sodelovanje med strokami c) Spretnost pri uporabi sodobnih orodij informacijske tehnologije.	require suitable balance between the “exactness” and engineering simplifications. - Transferable skills (a) Argued choice among several options; (b) The work in a group and the cooperation among different professions; (c) The skill in the use of the up-to-date tools based on the information technology.
Metode poučevanja in učenja:	**Learning and teaching methods:**
Metode poučevanja in učenja temeljijo na več sodobnih principih, ki so projektno delo, interdisciplinarno delo v skupini z arhitektom, sodelovanje in projektiranje s pomočjo IT orodij na daljavo, vodenje projektne dokumentacije z IT orodji, na študenta osredotočen študij in posredovanje znanja v času, ko ga študent potrebuje (»just-in-time«). Začetna predavanja samo usmerijo študenta (oblika se uporablja za oba spola) in mu dajo primerno predznanje, da se lahko sam poskusi s projektom. Večino dodatnega znanja pridobi ob izdelavi projekta – poišče ga sam ali pa se (v primeru širše zanimivih tem) organizirajo dodatna predavanja. Iskanje med številnimi možnimi rešitvami, ki so sprejemljive iz različnih vidikov različnih strok in zahtev, je novost za študenta in ga vpelje v projektno delo, ki je značilno za prakso. S predstavitvami dela vsem študentom in medsebojno diskusijo zelo različnih projektov se močno poveča širina pridobljenega znanja. Predvsem pomembno pa je spoznavanje s projektiranjem na daljavo. Obvladovanje takšnega načina dela bo v bližnji bodočnosti pomembna komparativna prednost.	The teaching and learning methods are based on several up-to-date pedagogical principles, such as: (a) project-based learning; (b) interdisciplinary work in a group with an architect; (c) the use of IT-based tools for distance communication and design; (d) The use of IT-based tools for management of the project documentation; (e) student-cantered-work; (f) just-in-time lectures. The initial lectures only provide the basic knowledge and guidelines needed. Then the student can test his/hers own ability to face the challenges of the project. He/she gains most of the additional knowledge through the work on the project, either alone or by attending the additional lectures, which are organized in the case of the topics of broader interest. The student should make an argued choice among several possible solutions, which should be acceptable also from the point of view of view of different professions and requirements. Compared to the traditional learning process, this is a novelty for the student, which leads her/him into the project work that is typical for the design practice. Intermediate presentations to all students and discussions of all the projects significantly enhance the broadness of the acquired knowledge. Of a particular importance is the learning about the distance design that will offer important comparative advantages in the near future.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Sprotno ocenjevanje samostojnosti, inicijativnosti in zavzetosti med projektnim delom	**60 %**	The ongoing assessment of independence, initiative and commitment during the project work.
Poročilo	**20 %**	Project report.
Predstavitev in zagovor dela	**20 %**	Presentation and argumentation of the work.

Reference nosilca / Lecturer's references:

FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Distance learning of structural engineering supported by information technology. Scientific journal on applied information technology, ISSN 1683-1373. [Online ed.], 2002, vol. 1, issue 1, str. [1-11], graf. prikazi.

FAJFAR, Peter, FISCHINGER, Matej, BEG, Darko. Evrokod 8 : projektiranje potresno odpornih konstrukcij. V: BEG, Darko (ur.), POGAČNIK, Andrej (ur.). Priročnik za projektiranje gradbenih konstrukcij po evrokod standardih. Ljubljana: Inženirska zbornica Slovenije, 2009, str. 8.1-8.241, ilustr.

REJEC, Klemen, ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Seismic shear force magnification in RC cantilever structural walls, designed according to Eurocode 8. Bulletin of earthquake engineering, ISSN 1570-761X, apr. 2012, letn. 10, št. 2, str. 567-586, ilustr., doi: 10.1007/s10518-011-9294-y.

ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Applicability of Pushover Methods to the Seismic Analyses of an RC Bridge, Experimentally Tested on Tree Shake Tables. Journal of earthquake engineering, ISSN 1363-2469, 2011, št. 2, letn. 15, str. 303-320, ilustr., doi: 10.1080/13632461003802009.

ZOUBEK, Blaž, FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Estimation of the cyclic capacity of beam-to-column dowel connections in precast industrial buildings. Bulletin of earthquake engineering, ISSN 1570-761X, 2014

VIDRIH, Zlatko, FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Numerical investigation on smart magnetically controlled elastomeric bearings. Journal of vibration and control, ISSN 1077-5463. [Tiskana izd.], nov. 2012, letn. 18, št. 13, str. 2073-2084

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Seminar iz projektiranja masivnih konstrukcij
Course title:	Design of concrete and masonry structures seminar

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type:	Izbirni strokovni / Elective professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
	90		60		150	10

Nosilec predmeta / Lecturer:	izr. prof. dr. Jože Lopatič, izr. prof. dr. Sebastjan Bratina, doc. dr. Drago Saje

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Predmet je del modula Masivne konstrukcije.	The course is a part of the module Concrete structures.

Vsebina:	**Content (Syllabus outline):**
Seminar Načela snovanja in projektiranja masivnih konstrukcij; projektna obtežba masivnih gradbenih konstrukcij; ključna merila za smotrno izbiro tipa konstrukcijskega sistema; prevedba nosilnega sistema konstrukcije v ustrezen računski model; pregled osnovnih skupin elementov nosilnih konstrukcij masivnih stavb in mostov s pripadajočimi značilnostmi glede nosilnosti in deformabilnosti ter konstrukcijskih posebnosti; montažne betonske konstrukcije (posebnosti obnašanja montažnih betonskih konstrukcij, učinkovito projektiranje elementov montažnih betonskih konstrukcij s poudarkom na izvedbi vozlišč in vezi). Vaje so sestavljene iz dveh delov: - izdelava dela projekta za pridobitev gradbenega	Seminar Principles of the design of concrete and masonry structures; design loads of concrete and masonry structures; key criteria for effective selection of the type of structural. System, translation of load-bearing system of a structure into appropriate computational model; overview of basic groups of structural members for concrete and masonry buildings and concrete bridges, related properties regarding ultimate resistance and deformability as well as structural specifics; prefabricated concrete structures (specifics of the behaviour of prefabricated concrete structures, efficient design of prefabricated concrete members with the emphasis on the execution of joints and ties) Tutorials consist of two parts: - detail design of the load-bearing structure of an

dovoljenja in projekta za izvedbo poslovne, stanovanjske ali druge poljubne obsežnejše stavbe - izdelava dela projekta za pridobitev gradbenega dovoljenja in projekta za izvedbo armiranega ali prednapetega betonskega mostu.	office, residential or any other demanding building and elaboration of a part of project documentation, - detail design of a reinforced or prestressed concrete bridge and elaboration of a part of project documentation.

Temeljni literatura in viri / Readings:

T. Paulay, M. J. N. Priestly. 1992. Seismic design of reinforced concrete and masonry buildings. John Wiley&sons, 695 str.
F. Leonhardt. 1994. Brücken/Bridges. Deutsche verlags-Anstalt, 308 str.
M. Rosignoli. 2002. Bridge launching. Thomas Telford, 342 str.
K.S. Elliot. 2002. Precast Concrete Structures. Buterworth-Heinemann, 375 str.
M.J. Tomlinson. 2001. Foundation Design and Construction-seventh edition. Pearson Education Ltd, str. 137-174, 345-389.
W.G. Curtin, G. Shaw, J.K. Beck, W.A. Bray. 2006. Structural masonry designers' manual-third edition. Blackwell Science, 335 str.
Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 1, Evrokod 2, Evrokod 6, Evrokod 7, Evrokod 8 (SIST EN 1990, SIST EN 1991-1, SIST EN 1991-1-3, SIST EN 1991-1-4, SIST EN 1991-2, SIST EN 1992-1-1, SIST EN 1992-2, SIST EN1996-1-1, SIST EN 1997-1-1, SIST EN 1998-1).
Študijsko gradivo predavateljev je na spletnem mestu katedre za masivne in lesene konstrukcije
Dostopno na: http://www.fgg.uni-lj.si/kmlk/index.htm .

Cilji in kompetence:	**Objectives and competences:**
Cilji - Poznavanje bistvenih zahtev, ki jih morajo izpolnjevati gradbene konstrukcije, - Poglobitev temeljnih znanj s področja izbire, snovanja in projektiranja zahtevnejših masivnih konstrukcij, - Pridobitev izkušenj za timsko delo, - Pridobitev izkušenj za javno predstavitev in argumentirano utemeljitev svojih strokovnih zamisli oziroma izdelanega projekta. Pridobljene kompetence - Sposobnost snovanja in projektiranja zahtevnejših masivnih stavb in inženirskih konstrukcij.	Objectives - Knowledge of the main demands for building structures, - Deepening of basic knowledge from the area of selection, conception and design of demanding concrete and masonry structures, - Gaining experiences for team work, - Gaining experiences for public presentation and argumentation of ideas or elaborated project. Acquired competences - Ability to conceptual design and detail design of demanding concrete and masonry buildings and concrete bridges.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje meril za izbiro nosilne konstrukcije - Poznavanje učinkovitih računskih metod in programskih orodij za analizo, dimenzioniranje in konstruiranje masivnih konstrukcij, - Razumevanje obnašanja masivnih konstrukcij pod vplivom statične in dinamične obtežbe, - Razumevanje pomena duktilnosti betonskih konstrukcij za zagotavljanje njihove varnosti, - Kritična presoja ustreznosti izbranega konstrukcijskega sistema, materiala, računskega modela in dobljenih računskih rezultatov ter	- Knowledge of the criteria for the selection of a structural system, - Knowledge of efficient computational methods and software for the conception, design and analysis of concrete structures, - Understanding of the behaviour of concrete and masonry structures under the static and dynamic loading, - Understanding of the importance of ductility of concrete structures for assuring their safety, - Critical assessment of adequacy of the selected

konstrukcijske izvedbe, - Sposobnost uporabe strokovne literature, tehnične regulative in programske opreme za načrtovanje masivnih konstrukcij, - Pridobljen občutek za prenos sil oziroma potek obremenitev po elementih nosilnih konstrukcij.	structural system, material, computational model, the acquired computational results and detailing, - Ability to use professional literature, technical regulation and software for the design of concrete and masonry structures, - Acquired sense for the transfer of forces between structural members.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Seminar in vaje v računalniški učilnici.	Seminar and tutorials in computer classroom.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminar in zagovor Pisni izpit (odpade če kandidat pri vajah in zagovoru doseže 85 % možnih točk)	**70 %** **30 %**	Seminar and defence Written exam (not required if the candidate achieves 85% of the possible points in tutorials and their defence)

Reference nosilca / Lecturer's references:

F. SAJE, J. LOPATIČ, A Time-Dependent Analysis of Reinforced Prestressed and Composite Concrete Structures, Int. j. eng. model., 1997, vol. 10, str. 17-24.
J. LOPATIČ, Vpliv dolgotrajnih visokih nivojev napetosti na tlačno trdnost betona, Gradbeni vestnik, Ljubljana, ISSN 0017-2774, April 2003, letn. 52, strani 74-80, 2003.
J. LOPATIČ, F. SAJE,. Non-linear analysis of time-dependent response of civil engineering structures. V: TOPPING, Barry H. V. (ur.), MONTERO, G. (ur.), MONTENEGRO, R. (ur.). Proceedings of the eighth International conference on computational structures technology, Las Palmas de Gran Canaria-Spain, 12-15 September 2006. Stirling: Civil-Comp, cop. 2006.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Seminar iz projektiranja jeklenih konstrukcij
Course title:	Design of steel structures - seminar

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
	90		60		150	10

Nosilec predmeta / Lecturer: doc. dr. Primož Može

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Predmet je del modula Jeklene konstrukcije.

Prerequisites:

The course is a part of the module Steel structures.

Vsebina:

Seminar
Vsak študent izdela svoj projekt jeklene stavbe in inženirske konstrukcije (most, rezervoar, antenski stolp …) v obsegu projekta za pridobitev gradbenega dovoljenja; vsebina vsakega od projektov: zasnova konstrukcije, obtežbe, računski model, izračun notranjih sil in pomikov, presoja in kontrola računskih rezultatov, dimenzioniranje elementov in spojev, zasnova ključnih konstrukcijskih detajlov, oblikovanje vsebine projekta (tehnično poročilo, statični izračun in dimenzioniranje), pri enem od obeh projektov izris delavniških načrtov s pomočjo ustrezne programske opreme (skrajšan obseg projekta za izvedbo).
Strokovne ekskurzija (zanimiva gradbišča, delavnice za izdelavo jeklenih konstrukcij); seminar obsega nekaj spremljajočih predavanj, kjer sodelujejo tudi predavatelji iz strokovne prakse (zasnova in elementi različnih vrst jeklenih konstrukcij, korozijska zaščita, požarna odpornost jeklenih

Content (Syllabus outline):

Seminar:
Each student has to draw a project of a steel building and engineering structure (bridge, tank, telecommunication tower …); the project has to contain: conceptual design, definition of loads, FEM model, calculation of internal forces and displacements, assessment and control of computed results, design of elements and joints, design of key structural details, design content of the project (technical report, structural analysis, design), drawing plans by using appropriate software.
Technical excursions (interesting construction sites, workshop manufacturing steel structural elements).

konstrukcij, tolerance mer pri izdelavi jeklenih konstrukcij, tehnologija izdelave in montaže jeklenih konstrukcij, kontrola izdelave in montaže jeklenih konstrukcij, predstavitev zanimivih izvedenih konstrukcij).	

Temeljni literatura in viri / Readings:

D. Beg, A. Pogačnik. 2009. Priročnik za projektiranje gradbenih konstrukcij po evrokod standardih. Ljubljana, IZS.
ESDEP - The European Steel Design Education Programme, spletna učilnica UL FGG.
P Može, Študijsko gradivo - izbrane teme, spletna učilnica UL FGG.
NS Trahair, MA Bradford, David Nethercot, L Gardner, The Behaviour and Design of Steel Structures to EC3, Fourth Edition, 2008, 490 p.3.

Luís Simões da Silva, Rui Simões, Helena Gervásio. 2016. Design of Steel Structures: Eurocode 3: Design of Steel Structures, Part 1-1 – General Rules and Rules for Buildings. ECCS – European Convention for Constructional Steelwork.
Jean-Pierre Jaspart, Klaus Weynand. 2016. Design of Joints in Steel and Composite Structures. ECCS – European Convention for Constructional Steelwork.
D Beg, U Kuhlmann, L Davaine, B Braun. 2010. Design of plated structures. ECCS – European Convention for Constructional Steelwork.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Sinteza znanja, pridobljenega med študijem in uporaba tega znanja na praktičnih primerih projektiranja jeklenih konstrukcij, - Pridobiti znanja, ki bodo v pomoč pri pridobitvi licence pooblaščenega inženirja pri Inženirski zbornici Slovenije. Pridobljene kompetence - Sposobnost celovitega pristopa k projektiranju jeklenih konstrukcij.	Objectives - Syntheses of knowledge gained during previous studies and use of this knowledge in practical design of steel structures. - Assist in obtaining a license authorized engineer at Slovenian Chamber of Engineers. Competences - Ability of an integrated approach to the design of steel structures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznati in razumeti tehnologijo projektiranja različnih vrst jeklenih konstrukcij - Pridobiti izkušnje pri projektiranju - Pridobiti nekatera funkcionalna inženirska znanja (npr. o kontroli izdelave in montaže jeklenih konstrukcij) - Študent se bo naučil teoretična znanja, pridobljena med študijem, uporabiti v inženirski praksi. - Ena glavnih značilnosti projektiranja konstrukcij je sprejemanje velikega števila odločitev v nizu. Na osnovi pridobljenega teoretičnega in praktičnega znanja bo študent sposoben kritične presoje posameznega problema, izločitve neustreznih	-To know and understand the design technology of different steel structures - To gain experiences in the design - To gain the practical engineering knowledge (control of construction and manufacturing of steel structures). - Student should learn to use the acquired theoretical knowledge in engineering practice. - One of the main features of structural design is decision making. Based on the acquired theoretical and practical knowledge student should be able to critically judge individual problem, to eliminate inappropriate solutions and to justify the choice of the possible solutions.

rešitev in utemeljene izbire ene od ustreznih rešitev. - Sposobnost uporabe računalniških programov za analizo konstrukcij in risanje delavniških načrtov - Sposobnost kritične presoje strokovnih problemov.	- Ability to use computer programs for structural analysis and drawing of steel structures. - Ability for critical judgement of technical problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predmet se izvaja v obliki seminarja in predavanj.	The course consists of seminars and lectures.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Samostojna naloga	**40 %**	Approved project work
Zagovor naloge	**30 %**	Defence of the approved project work
Ustni izpit	**30 %**	Oral exam
Študenti, ki za samostojno nalogo in njen ustni zagovor dosežejo vsaj 57 točk od 70 so oproščeni ustnega izpita.		Students who defence its independent work with at least 57 points of 70 are exempt from the oral exam.

Reference nosilca / Lecturer's references:

Može, P. and Beg, D. (2010), "High strength steel tension splices with one or two bolts", *Journal of Constructional Steel Research*. **66**(8-9), 1000-1010.
Može, P. and Beg, D. (2011), "Investigation of high strength steel connections with several bolts in double shear", *Journal of Constructional Steel Research*. **67**(3), 333-347.
Može, P., Cajot, L.-G., Sinur, F., Rejec, K. and Beg, D. (2014), "Residual stress distribution of large steel equal leg angles", *Eng Struct*. **71**(0), 35-47.
Čermelj, B., Može, P. and Sinur, F. (2016), "On the prediction of low-cycle fatigue in steel welded beam-to-column joints", *Journal of Constructional Steel Research*. **117** 49-63.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Informacijska in komunikacijska tehnologija za projektno delo
Course title:	ICT for building project work

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
20	10	30			60	4

Nosilec predmeta / Lecturer: doc. dr. Tomo Cerovšek

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Predmet je del modula Interdisciplinarni projektni študij računalniško podprtega projektiranja konstrukcij.

Prerequisites:

The course is a part of the module Interdisciplinary project study of computer-aided design of structures.

Vsebina:

Predavanja
Principi računalniško integrirane graditve. Pristop integriranega prakse - projektnega dela. Procesni vidiki sodelovanja na gradbenih projektih. Topologija sistemov za sodelovanje in njihova uporaba. Asinhroni in sinhroni komunikacijski sistemi za projektno delo. Tehnologije za sodelovanje glede na fazo/projekt/deležnike. Komunikacija in aplikacije na osnovi informacijskih modelov zgradb. Osnove informacijskega modeliranja stavb za sodelovanje. Uporaba referenčnih modelov stavb pri projektiranju. Uporaba parametričnega modeliranja pri projektiranju objektov.
Vaje
- vzpostavitev sistemov za sodelovanje,
- izdelava digitalne projektne dokumentacije.

Seminar
- izdelava informacijskega modela zgradb.

Content (Syllabus outline):

Lectures
Basic principles of Computer Integrated Construction (CIC). Integrated practice and traditional projects. Process view on collaboration in projects. Topology of collaboration system and their use. Asynchronous and synchronous collaboration. Overview of collaborative technologies by project phase/project type/stakeholders. Communication and application based on BIM. Introduction to BIM Collaboration. Use of reference models in building design.

Lab work
- Using collaboration systems in real life,
- support for collaborative project,
- authoring and exchange of project documents.

Seminar
- Collaborative authoring environments and project communication using BIM.

Temeljni literatura in viri / Readings:

ECPPM zborniki konferenc European conference on product and process modelling in the building industry 1998-2013.
Dostopno na: http://www.ecppm.org .
ELVIN G., Integrated Practice in Architecture, Mastering Design-Build, Fast-Track, and Building information Modelling. 2007. John Wiley & Sons, str. 238.
COLEMAN, D., LEVINE, S. Collaboration 2.0: Technology and Best Practices for Successful Collaboration in a Web 2.0 World, HappyAbout.info.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:

Cilji
- Podati osnovne principe računalniško podrtega sodelovanja,
- Podati celoten pregled nad komunikacijo v okviru gradbenega projekta skozi vse faze,
- Podati osnove metod in tehnik modeliranja produktov in procesov za skupinsko delo.

Pridobljene kompetence
- Sposobnost uporabe it za delo v skupinah
- Sposobnost upravljanja projektnih skupin z uporabo informacijskih tehnologij
- Sposobnost izdelave digitalne projektne dokumentacije - sposobnost rabe informacijskih in komunikacijskih tehnologij za upravljanje procesov in za reinženiring tehničnih procesov.
- Sposobnost učinkovite komunikacije na osnovi informacijskih modelov zgradb
- Sposobnost izdelave digitalnega priročnika projekta.

Objectives and competences:

Objectives
- Provide a theoretical view and practical know- how on collaboration technologies,
- Gain the ability to critically evaluate, plan, implement and use collaboration systems in daily business operations,
- Gain the ability to model processes and products for successful collaborative teamwork.

Competences
- Ability to use IT to work in project groups
- Ability to manage small project teams using IT
- Ability to author and exchange digital project communication
- Ability to make use of ICT for management of collaborative project teamwork
- Ability to effective and efficiently communicate using RTC and portal technology.

Predvideni študijski rezultati:

- Poznavanje tehnik učinkovitega komuniciranja v okviru gradbenih projektov.
- Poznavanje metod izmenjave projektnih informacij geografsko distribuiranih skupin.
- Sposobnost izdelave informacijskih modelov za učinkovito projektno delo.
- Sposobnost izdelave interdisciplinarnih specifikacij za sodelujoče na projektih.
- Poznavanje učinkovitega skupinskega dela in učenja na daljavo.

Izdelki študentov:
- vzpostavitev infrastrukture za sodelovanje,
- informacijski model zgradbe,
- digitalne projektna dokumentacija na osnovi modelov.

Intended learning outcomes:

Upon successful completion of the module, students will be able to:
- Thoroughly understand the Internet, www concepts, and trends relevant for the collaborative technologies.
- Evaluate various modes of web communication and measure the value of collaborative work/technologies.
- Appraise various systems for web communication and collaboration, and understand barriers/limitations.
- Make use of collaborative authoring and info retrieval, model-based collaboration and project extranets.
- Appraise the use of integrated project delivery, project teamwork, and creation of high performance teams.

	- Collaboratively identify, plan, implement, control, and maintain collaborative technologies in aec rojects.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Učenje poteka na osnovi strnjenih, vsebinsko bogatih uvodnikov (v fizičnih učilnicah), kratkih seminarskih vaj (v virtualni učilnici) in konzultacij (tudi preko spletnih konferenc). Avdio vizualni pripomočki so vključeni v koncept predavanj, predvsem za spodbujanje diskusije. Predavanja bodo zagotovila predznanje z osnovnimi teoretičnimi osnovami, koncept in bodo pripravila študente za projektno delo. Demonstracije in vaje bodo zagotovile študentom seznanjanje s tehnologijami IKT in sodelovalnimi sistemi. Projektno delo bo vzpodbudilo študente k bolj intenzivni strokovni komunikaciji in razširjeni uporabi sinhronih in asinhronih sodelovalnih sistemov.	Instruction is by means of condensed introductory in-class lectures (real classroom), tutorials (virtual classroom) and consultations (virtual classroom). Audio visual aids are used by the tutor in the form of slide projections mainly to elaborate on lecture content and to stimulate discussion. The lecture programme will seek to introduce the basic theories and concepts of the subject matter and prepare students for tutorials and for project work. The tutorials will provide students with examples of web based communication and collaboration systems. Project work will stimulate students for project communication and extensive use of synchronous and asynchronous collaboration.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Kolokvij	**70 %**	Mid term examination
ali		or
izpit	**70 %**	exam
Seminar	**20 %**	Seminar work
Projekt	**10 %**	Project

Reference nosilca / Lecturer's references:

CEROVŠEK, Tomo. BIM cube and systems-of-systems framework. V: GUDNASSON, Gudni (ur.), SCHERER, Raimar J. (ur.). eWork and eBusiness in Architecture, Engineering and Construction : Proceedings of the European Conference on Product and Process Modelling 2012, Reykjavik, Iceland, 25-27 July 2012. Boca Raton: CRC Press; London: Taylor & Francis, cop. 2012, str. 421- 428, ilustr.
CEROVŠEK, Tomo, ZUPANČIČ-STROJAN, Tadeja, KILAR, Vojko. Framework for model-based competency management for design in physical and virtual worlds. Journal of information technology in construction, ISSN 1874-4753, 2010, vol. 15, str. 1-22, ilustr.
http://www.itcon.org/2010/1.
CEROVŠEK, Tomo. IMREC: A reference collection for information management and retrieval in engineering (IMRE). V: CIB W78 W102 2011, Joint Conference, 28th CIB W78 2011 International Conference, 6th CIB W102 2011 International Conference, 26-28 October, Sophia Antipolis, France. Program and proceedings : Computer Knowledge Building. Sophia Antipolis: CIB, 2011, str. 1-9, ilustr.
http://itc.scix.net/data/works/att/w78-2011-Paper-107.pdf.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Numerično modeliranje trdnin
Course title:	Numerical modelling of solids

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: prof. dr. Jože Korelc

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski in/ali angleški / Slovene and/or English
Vaje / Tutorial:	Slovenski in/ali angleški / Slovene and/or English

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

Prerequisites:

Vsebina:

Predavanja
Struktura in principi programskih orodij in sistemov za izvedbo numeričnih simulacij v tehniki. Pregled numeričnih metod (metoda končnih elementov, metoda robnih elementov, metoda končnih volumnov …). Formulacija in implementacija nelinearnih končnih elementov. Avtomatizacija metode končnih elementov. Končni elementi za trdnine in konstrukcije. Napredne numerične metode: kontaktni problemi, večnivojsko modeliranje materialov in konstrukcij. Sklopljeni problemi: načini reševanja sklopljenih problemov, primer: termo-hidro- mehanski problem. Numerična implementacija konstitutivnih modelov tipičnih gradbenih materialov.

Laboratorijske vaje
Numerične simulacije nekaterih tehničnih problemov z metodo končnih elementov. Izpeljava nelinearnih končnih elementov.

Content (Syllabus outline):

Lectures
Structure and technology of software systems for numerical simulations in engineering. Overview of numerical methods for the simulation of solids (finite element methods, finite volume, boundary element methods). Formulation and implementation of nonlinear finite elements. Automation of nonlinear finite element method. Finite elements for solids and structures. Advanced numerical methods: multi-scale models, multi-filed models, coupled problems. Numerical implementation of selected material models.

Exercises
Numerical simulation of typical nonlinear engineering problems using finite element method. Derivation of nonlinear finite element codes.

Temeljni literatura in viri / Readings:

Zdenek P. Bažant, Luigi Cedolin. 2003. Stability of structures, Dover, chapters 1, 2, 4, 5, 6, 7, 8.
M. A. Crisfield. 1991. Non-linear finite element analysis of solids and structures vol.1. John Wiley & sons, chapters 4, 9.
P. Wriggers. 2008. Nonlinear finite element methods. Berlin, Springer.
Selected lectures in pdf format http:// symech .fgg.uni-lj.si/nak/Skripta/ .

Cilji in kompetence:

Cilji
- Spoznati se s principi splošnih numeričnih okolij in sistemov za izvedbo numeričnih simulacij v tehniki, različnimi numeričnimi metodami ter podrobneje s specializiranimi okolji za nelinearno metodo končnih elementov
- Spoznati se z nelinearno metodo končnih elementov za rešitev zahtevnih problem

Pridobljene kompetence
- Zna uporabljati računalniške programe, pri reševanju zahtevnejših (nelinearnih) tehničnih problemov.
- Zna implementirati zahtevne končne elemente

Objectives and competences:

Objectives
- Knowledge about advantages and disadvantages of a general numerical tools for the solution of engineering problems in particular finite element environments
- Knowledge about nonlinear finite elements methods for the solution of complex problems

Competences
- Understanding of numerical software for the solution of complex engineering problems
- Ability to implement complex nonlinear finite element

Predvideni študijski rezultati:

- Razumevanje prednosti in slabosti različnih pristopov k numeričnemu modeliranju v tehniki.
- Razumevanje teoretičnih osnov nelinearne metode končnih elementov.
- Uporaba pridobljenega znanja pri analizi zahtevnejših, sklopljenih tehniških primerov z računalnikom.
- Povezava pridobljenega znanja s praktičnim reševanjem problemov.
- Povezava pridobljenega znanja z že poslušanimi teoretičnimi in praktičnimi predmeti.
- Uporaba komercialnih in raziskovalnih računalniških programov, ki delujejo po metodi končnih elementov, pri reševanje različnih tehniških problemov.
- Kritična ocena rezultatov simulacije.

Intended learning outcomes:

- Knowledge about advantages and disadvantages of computing methods for numerical modelling of all phenomena related to mechanical behaviour of solids.
- Understanding of nonlinear phenomena and nonlinear analysis in general.
- Knowledge about the existence of various material models for solids and the expected consequences of choosing a particular material model.
- Ability to connect the outcomes of the programs for nonlinear structural analysis and the requirements of the design codes.
- Ability to understand and prepare the necessary input data for the programs for nonlinear analysis of solids.
- Ability to choose the proper numerical model of a structure that would be able to simulate all phenomena relevant for the design.
- Ability to program simple nonlinear elements and implementing or modifying existing material models for solids and structures.

Metode poučevanja in učenja:

Predavanja se izvajajo v učilnici z različnimi učnimi pripomočki. Vse vaje se izvajajo v računalniškem

Learning and teaching methods:

Lectures, exercises, attendance of International Short Course on Experimental and Numerical

laboratoriju, kjer se uporabljajo komercialni in raziskovani računalniški programi po metodi končnih elementov. Študentje jih izvajajo deloma individualno, deloma skupinsko.	Modelling of M5 Problems in Engineering.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarske vaje	**40 %**	Seminar tasks (results collected every 4 weeks)
Ustni izpit (vsebuje tako teoretične kot tudi računske naloge	**60 %**	Exam (theoretical and practical tasks)

Reference nosilca / Lecturer's references:

KORELC, Jože. Direct computation of critical points based on Crout's elimination and diagonal subset test function. Computers & Structures, ISSN 0045-7949. [Print ed.], februar 2010, letn. 88, št. 3-4, str. 189-197, ilustr., doi: 10.1016/j.compstruc.2009.10.001.
LENGIEWICZ, Jakub, KORELC, Jože, STUPKIEWICZ, Stanislaw. Automation of finite element formulations for large deformation contact problems. International journal for numerical methods in engineering, ISSN 0029-5981, mar. 2011, letn. 85, št. 10, str. 1252-1279, ilustr., doi: 10.1002/nme.3009.
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, ilustr., doi: 10.1002/nme.2903.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Povezani problemi
Course title:	Coupled problems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: prof. dr. Dejan Zupan, prof.dr. Goran Turk

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski in/ali angleški / Slovene and/or English
Vaje / Tutorial:	Slovenski in/ali angleški / Slovene and/or English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Predmet je del mednarodnega magistrskega modula Inženirsko modeliranje. Opravljen izpit iz predmetov Matematika 3, Numerične metode, Nelinearna mehanika, Statika gradbenih konstrukcij, Nelinearna analiza konstrukcij.	The course is a part of the module Engineering modelling. Passed exams in Mathematics 3, Numerical methods, Nonlinear mechanics, Statics of building structures, Nonlinear analysis of structures.

Vsebina:	**Content (Syllabus outline):**
Predavanja Splošno o povezanih problemih. Enačbe toplotne prevodnosti, prehoda vlage, kemijskih vplivov, mehanskega odziva konstrukcije in medsebojna povezanost enačb. Numerične metode reševanja povezanih problemov: (1) Preprosti integratorji po času; metoda ''mid-point''; (2) Reševanje parcialnih diferencialnih enačb po metodi končnih elementov; (3) Reševanje nelinearnih algebrajskih enačb z iteracijskimi metodami. Vaje Seznanjanje z numeričnimi metodami, vgrajenimi v računalniški program Matlab. Seznanitev z ostalimi uveljavljenimi metodami na osnovi avtorskih programov v okolju Matlab. Podrobnejša seznanitev s knjižnico za reševanje	Lectures Introduction to coupled problems. Equations and models of chemical processes, heat and moisture transfer, and mechanical behaviour of structures with emphasizing the interaction between equations. Numerical methods for solving coupled problems: (1) Elementary time integrators; mid-point rule; (2) Finite element method for solving partial differential equations; (3) Incremental iterative methods for solving nonlinear algebraic equations. Tutorials Introduction to numerical methods, implemented into program Matlab. Introduction to other methods, implemented in Matlab by subject holders. Advanced use of Partial Differential Equation Toolbox in Matlab.

parcialnih diferencialnih enačb.	

Temeljni literatura in viri / Readings:

O.C. Zienkiewicz, R.L. Taylor. 2000. The Finite Element Method. Oxford, Butterworth Heineman.
The MathWorks. 2006. Partial Differential Equation Toolbox. Natick.
Spletne strani KM
Dostopno na: http://www.km.fgg.uni-lj.si .

Cilji in kompetence:	**Objectives and competences:**
Razumevanje razlik med nevezanim in povezanim pristopom. Poznavanje osnovnih numeričnih postopkov pri reševanju vezanih problemov. Znanje uporabe teh računalniških programov za računsko oceno odziva konstrukcije pri povezanih vplivih.	Understanding the differences between coupled and uncoupled formulations. Knowledge of the use of computer programs for coupled analyses.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Cilji - Spoznati pomen povezanega reševanja problemov v konstrukcijah. - Spoznati in razumeti povezanost enačb za prenos toplote, vlage, pare, mehanskih deformacij in kemijskih sprememb v konstrukciji. - Spoznati osnovne pristope pri numeričnem reševanju vezanih problemov. - Povezati in uporabiti že pridobljena znanja s področja reševanja nelinearnih enačb gradbenih konstrukcij pri spoznavanju metod reševanja vezanih problemov. - Predstaviti razlike med vezanim in nevezanim reševanjem problemov na konkretnih primerih. Pridobljene kompetence - Poznavanje problematike povezanega reševanja problemov v konstrukcijah. - Poznavanje zvez med fizikalnimi in kemijskimi pojavi v konstrukcijah. - Razumevanje osnovnih idej numeričnih metod in računskih postopkov reševanja vezanih enačb. - Sposobnost uporabe računskih programov za reševanje in napoved obnašanja konstrukcij pri povezanih problemih.	Goals - To learn the importance of coupled formulation of engineering problems. - To learn and understand the interaction between chemical processes, heat and moisture transfers, and mechanical behaviour of structures - To employ previous knowledge on numerical methods in structural analysis for solving coupled problems. - To show the differences between coupled and uncoupled solutions. Acquired competence - Knowledge of the coupled-problem approach in structural analysis. - Knowledge of the interaction between mechanical and chemical phenomena in structures. - Comprehension of standard strategies in solving coupled problems. - Ability to use and understand computer programs for coupled problems and autonomous interpretation of results.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, demonstracije, avtorski program z uporaba sodobnih numeričnih orodij za reševanje vezanih problemov. Uporaba akademskega odprtokodnega programa.	Lectures, seminars, demonstrations, computer based learning employing modern methods. Use of open-source program, developed by course coordinators.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Računski del	**50 %**	Practical exam
Teoretični del	**50 %**	Theoretical oral exam

Reference nosilca / Lecturer's references:

ZUPAN, Eva, SAJE, Miran, ZUPAN, Dejan. Dynamics of spatial beams in quaternion description based on the Newmark integration scheme. Computational mechanics, ISSN 0178-7675, 2013, letn. 51, št. 1, str. 47-64.
ČEŠAREK, Peter, SAJE, Miran, ZUPAN, Dejan. Dynamics of flexible beams: Finite-element formulation based on interpolation of strain measures. Finite elements in analysis and design, ISSN 0168-874X. [Print ed.], sept. 2013, letn. 72, str. 47-63.
ZUPAN, Eva, SAJE, Miran, ZUPAN, Dejan. Quaternion-based dynamics of geometrically nonlinear spatial beams using the Runge-Kutta method. Finite elements in analysis and design, ISSN 0168- 874X. [Print ed.], jul. 2012, letn. 54, str. 48-60.

VRANKAR, Leopold, LIBRE, Nicolas Ali, LING, Leevan, TURK, Goran, RUNOVC, Franc. Solving moving-boundary problems with the wavelet adaptive radial basis functions method. Computers & Fluids, ISSN 0045-7930. [Print ed.], 2013, vol. 86, str. 37-44.
SCHNABL, Simon, PLANINC, Igor, TURK, Goran. Buckling loads of two-layer composite columns with interlayer slip and stochastic material properties. Journal of engineering mechanics, ISSN 0733-9399, 2013, letn. 139, št. 8, str. 1124-1132, ilustr., doi: 10.1061/(ASCE)EM.1943-7889.0000478.
SRPČIČ, Stane, SRPČIČ, Jelena, SAJE, Miran, TURK, Goran. Mechanical analysis of glulam beams exposed to changing humidity. Wood Science and Technology, ISSN 0043-7719, 2009, letn. 43, št. 1/2, str. 9-22.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Modeliranje geotehničnih konstrukcij
Course title:	Numerical modelling of geotechnical structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			30		75	5

Nosilec predmeta / Lecturer: izr. prof. dr. Janko Logar, doc. dr. Boštjan Pulko

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski in/ali angleški / Slovene and/or English
	Vaje / Tutorial:	Slovenski in/ali angleški / Slovene and/or English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Predmet je del mednarodnega magistrskega modula Inženirsko modeliranje. Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika, Numerične metode.	The course is a part of the module Engineering modelling. Passed exams in Soil Mechanics and Engineering Geology, Geotechnics, Numerical methods.

Vsebina:	**Content (Syllabus outline):**
Predavanja Osnove mehanike kritičnega stanja tal; obnašanje zemljin pri majhnih deformacijah; nelinearni elastoplastični materialni modeli: osnovna načela, Mohrov in Coulombov model, Cam Clay model, modeli s kapo, Hardening soil model, matematična formulacija in določanje materialnih parametrov iz rezultatov preiskav; MKE v ravnini in prostoru, končni elementi v geotehniki, interakcija med konstrukcijami in tlemi; numerično reševanje nelinearnih problemov; povezani problemi: formulacija in hkratno reševanje ravnovesnih in difuzijske enačbe (konsolidacija), drenirana in nedrenirana stanja; metode modeliranja dinamičnih problemov: masna matrika in matrika dušenja, časovna integracija. Vaje Določanje materialnih parametrov za različne modele iz rezultatov laboratorijskih in terenskih	Lectures Basics of critical state soil mechanics; behaviour of soils at small strains; non-linear elasto-plastic material models: basic principles, Mohr Coulomb model, Cam Clay model, Cap models, Hardening Soil model, the mathematical formulation and determination of material parameters from classic soil tests; FEM in 2D and 3D, finite elements in geotechnical engineering, interaction between structures and ground; numerical solution of nonlinear problems; coupled problems: formulation and simultaneous solving of equilibrium and diffusion equations (consolidation), drained and un-drained conditions; modelling of dynamic problems: mass; matrix and damping matrix, time integration Practical exercises Determination of material parameters for different soil models based on the results of laboratory and field investigations of soil. Different numerical

preiskav tal; numerično modeliranje različnih geotehničnih objektov (plitvi in globoki temelji, varovanje gradbene jame, posedanje tal pod nasipom, zemeljska pregrada, predor).	modelling of geotechnical structures (shallow and deep foundations, protection of the excavation, settlements beneath the embankment, earth dam, tunnel).

Temeljni literatura in viri / Readings:

Atkinson, J. 2007. The mechanics of soils and foundations, second edition, Taylor & Francis, 442 p.
Schweiger, H.F., Logar, J., Pulko, B. 2004. Seminar iz uporabe programa Plaxis, UL FGG, Katedra za mehaniko tal, 160 str.
Brinkgreve, R. 2012. Plaxis, users manual.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati načela mehanike kritičnega stanja tal - Spoznati nelinearne materialne modele za zemljine - Naučiti se principov numeričnega reševanja nelinearnih problemov - Seznaniti se z načeli numeričnega reševanja povezanih problemov (konsolidacija) Pridobljene kompetence: - Sposobnost samostojne uporabe nelinearnih numeričnih analiz za reševanje geotehničnih problemov - Sposobnost analize in presoje rezultatov nelinearnih numeričnih analiz v geotehniki.	Objectives: - To learn about the principles of critical state soil mechanics - To learn about the non-linear material models for soil - To learn the principles of numerical solution of nonlinear problems - To get acquainted with the principles of how to solve coupled problems (consolidation) Competences: - The ability to use non-linear numerical analysis to solve geotechnical problems - Ability to analyse and audit the results of nonlinear numerical analysis in geotechnical engineering.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje mehanike kritičnega stanja tal - Poznavanje osnovnih načel elastoplastičnih modelov in konkretnih materialnih modelov - Razumevanje načel numeričnega reševanja nelinearnih problemov - Razumevanje reševanja problema konsolidacije - Poznavanje načel dinamičnih analiz tal - Obvladovanje uporabe nelinearnih numeričnih orodij za geotehnične analize. - Vzpostavitev odnosa do numeričnega modela kot zgolj poenostavljene slike realne konstrukcije. - Videti kako se matematična formulacija modela reflektira v rezultatih analize. - Sposobnost uporabe nelinearnih numeričnih orodij za geotehnične analize - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov - Sposobnost določanja materialnih parametrov za izbrane materialne modele.	- Understanding of the critical state soil mechanics - Knowledge of the basic principles of elasto- plastic models and concrete material models - Understanding of the principles of the numerical solution of nonlinear problems - Understanding of solving the problem of consolidation - Knowledge of the principles of dynamic analysis of soil - Use of non-linear numerical tools in geotechnical engineering. - Establishing a relation to the numerical model as simplified picture of real behaviour. - To see how the mathematical formulation of the model reflects the results of the analysis. - Ability to use non-linear numerical tools in geotechnical analysis - Ability of critical analysis of the input data and obtained computational results - Ability to determine material parameters for the selected material models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje v računalniški učilnici.	Lectures and practical work using advanced finite-element software.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Samostojno izdelane vaje	**40 %**	Individual practical work
Izpit	**60 %**	Exam

Reference nosilca / Lecturer's references:

KUDER, Sebastjan, LOGAR, Janko. Numerični model za analizo obnašanja tlačno obremenjenih, vtisnjenih jeklenih pilotov v Luki Koper = Numerical model for the prediction of behaviour of driven steel piles under axial compression loading in the Port of Koper. Gradbeni vestnik, ISSN 0017-2774, avgust 2008, letn. 57, št. 8, str. 207-214, ilustr.

TURK, Goran, LOGAR, Janko, MAJES, Bojan. Modelling soil behaviour in uniaxial strain conditions by neural networks. Advances in engineering software, ISSN 0965-9978. [Print ed.], 2001, vol. 32, str. 805-812, graf. prikazi.

RAVNIKAR TURK, Mojca, LOGAR, Janko. Numerical analyses of the performance of the Vogršček earth dam. V: 75th Annaual Meeting of the ICOLD, St. Petersburg, Russia, June 24-29, 2007. Dam safety management : role of state, private companies and public in designing, constructing and operating of large dams : symposium : proceedings. St. Petersburg: B. E. Vedeneev VNIIG, 2007, sess. 3-6, 8 str., graf. prikazi.

PULKO, Boštjan. Primerjava metod za statistično analizo temeljnih plošč = Comparision of methods for static analysis of mat foundations. Gradbeni vestnik, ISSN 0017-2774, sep. 2012, letn. 61, št. 9, str. 198-205, fotograf.

PULKO, Boštjan, MAJES, Bojan, MIKOŠ, Matjaž. Reinforced concrete shafts for the structural mitigation of large deepseated landslides : an experience from the Macesnik and the Slano blato landslides (Slovenia). Landslides, ISSN 1612-510X. [Print ed.], [v tisku] 2012, letn. Xx, št. x, str. 1- 11, ilustr., doi: 10.1007/s10346-012-0372-2.

PULKO, Boštjan, MAJES, Bojan, LOGAR, Janko. Geosynthetic-encased stone columns - analytical calculation model. Geotextiles and geomembranes, ISSN 0266-1144. [Print ed.], feb. 2011, letn. 29, št. 1, str. 29-39, ilustr., doi: 10.1016/j.geotexmem.2010.06.005.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Numerične metode v dinamiki tekočin
Course title:	Numerical methods in fluid dynamics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			30		75	5

Nosilec predmeta / Lecturer: prof. dr. Matjaž Četina

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski in/ali angleški / Slovene and/or English
Vaje / Tutorial:	Slovenski in/ali angleški / Slovene and/or English

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

Predmet je del mednarodnega magistrskega modula Inženirsko modeliranje.

Prerequisites:

The course is a part of the module Engineering modelling.

Vsebina:

Predavanja
Osnovne enačbe dinamike tekočin: kontinuitetna, dinamična, enačba stanja, energijska, konvekcijsko difuzijska za transport snovi, izvorni členi za biogeokemične procese. Princip reševanja hidrodinamičnih problemov, začetni in robni pogoji.
Nestalni tok s prosto gladino: vrste valov, St.Venantove enačbe, numerične metode reševanja, začetni in robni pogoji. Dvodimenzijski problemi, primeri gibanja nenewtonskih tekočin (drobirski tokovi, snežni plazovi).
Račun vodnega udara v ceveh pod tlakom.
Račun masnih nihanj v vodostanih.
Opis tridimenzijskih numeričnih modelov za račun tokov in širjenja onesnaženja v površinskih vodah: Reynoldsove enačbe, modeli turbulence, numerične metode reševanja.

Laboratorijske vaje
Meritve vodnega skoka v šolskem žlebu ter

Content (Syllabus outline):

Lectures
Basic equations of fluid dynamics: continuity, dynamic, eq. of state, energy eq., advection-diffusion transport eq., source terms for biogeochemical processes. Basic principles of solving hydrodynamic problems, initial and boundary conditions.
Unsteady free surface flows: waves in fluids, St.Venant equations, numerical methods, initial and boundary conditions. Two- dimensional problems, movement of non- Newtonian fluids (debris flows, snow avalanches).
Water hammer analysis in pipeline systems under pressure.
Computation of mass oscillations in surge tanks.
Description of three-dimensional numerical models for computation of flows and pollutant spreading in surface waters: Reynolds equations, turbulence models, numerical methods.
Laboratory tutorials
Measurements of hydraulic jump and mass

masnih nihanj na fizičnem modelu vodostana. Uporaba 1D in 2D računalniških programov za račun poplavnih valov ter vodnega udara – samostojno in skupinsko delo v računalniški učilnici. Uporaba 2D in 3D računalniških programov za simulacijo tokov in širjenja onesnaženja v rekah, jezerih in morju.	oscillations in surge tank in hydraulic laboratory. The use of 1D and 2D computer codes to compute flood waves in open channels and water hammer in pipes (individual and group work on computers). The use of 3D computer codes for computation of flows and transport of pollutants in rivers, lakes and coastal seas.

Temeljni literatura in viri / Readings:

Peyret, R. 1996. Handbook of Computational Fluid Mechanics, Academic Press.
Pozrikidis, C. 1997. Introduction to Theoretical and Computational Fluid Dynamics, Oxford University Press.
Jørgensen, S.E., Bendoricchio, G. 2001. Fundamentals of Ecological Modelling, 3rd Ed., Elsevier, Amsterdam.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi znanje dinamike tekočin s teoretičnimi osnovami nestalnega toka in gibanja nenewtonskih tekočin ter načini numeričnega reševanja osnovnih enačb. - Podati načine uporabe matematičnih modelov oz. računalniških programov za račun poplavnih valov, drobirskih tokov in snežnih plazov kot osnove za dimenzioniranje hidrotehničnih objektov. - Spoznati, kako povezati pridobljena znanja s področja dinamike tekočin in okoljskega inženirstva v kompleksne ekološke modele. Kompetence - Sposobnost pravilne definicije gonilnih sil, njim primerne izbire ustreznih osnovnih enačb in pravilne uporabe računalniških programov za določanje merodajnih količin pri nestalnih tokovih. - Obvladovanje procesov umerjanja, validacije in kritične ocene rezultatov matematičnih modelov tokov in širjenja onesnaženja. - Sposobnost posploševanja in razumevanja sorodnih pojavov nestalnega toka s prosto gladino in v ceveh pod tlakom. - Sposobnost izdelave kvantitativnih inženirskih ocen sprememb kakovosti v površinskih vodah vsled posegov v naravne procese.	Objectives - To deepen knowledge of fluid dynamics with basic principles of unsteady flows and non-Newtonian fluids, including numerical solutions of basic equations. - To show the use of mathematical models and computer codes for the computation of flood waves, debris flows and snow avalanches as a basis to design hydraulic structures. - To find out how to combine knowledge from fluid dynamics and environmental engineering in complex ecological models. Acquired competence - Ability to determine basic equations according to forcing factors and to use appropriate computer codes for unsteady flow computations. - To control the processes of calibration, validation and critical assessment of the results of mathematical models of flows and pollutant spreading. - Ability to generalize and to understand the analogy between unsteady free surface flows and pipe flows under pressure. - Ability to produce quantitative engineering assessments of water quality changes in surface waters.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje lastnosti nestalnega toka v odprtih koritih (valovi) in ceveh pod tlakom (vodni udar). - Razumevanje procesov kakovostnih sprememb v vodnih telesih in sposobnost njihovih kvantitativnih napovedi z numeričnimi modeli. - Doseženo znanje uporabljajo pri izdelavi	- To be acquainted with unsteady flow in open channels (waves) and water hammer in pipes - To understand processes of water quality changes in water bodies with the ability to use numerical models for quantitative predictions. - The knowledge can be used in complex

najzahtevnejših hidravličnih izračunov pri urejanju vodotokov ter pri izdelavi ocen vplivov človekovih posegov v vodno okolje. - Študentje morajo dobro razumeti fizikalne osnove prehodnih pojavov v hidravličnih sistemih in iskati analogijo med pojavi v odprtih koritih in ceveh pod tlakom. - Interdisciplinarno znanje omogoča pravilno povezovanje modulov (hidrodinamični, biogeokemični) v kompleksne ekološke modele. - Sposobnost sestave lastnih računalniških programov na osnovi ustrezno izbranih enačb. - Sposobnost uporabe in kritične presoje tujih računalniških programov za hidravlične in okoljske izračune.	hydraulic computations of river training and in assessments of water quality changes due to human impact on water bodies. - The knowledge can be used in complex hydraulic computations of river training and in assessments of water quality changes due to human impact on water bodies. - Interdisciplinary knowledge enables correct integration of modules (hydrodynamic, biogeochemical) into complex ecological models. - Ability to choose appropriate basic equations and to produce own computer codes. - Ability to apply and critically assess licensed computer codes for hydraulic and environmental computations.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in laboratorijske vaje.	Lectures and laboratory practicals.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način(pisni izpit, ustno izpraševanje, naloge, projekti)		Type (examination, oral, coursework, project)
Domače naloge (pisno, oddaja več vaj)	**50 %**	Homework (written, several exercises)
Pisni izpit (izpit iz teorije)	**50 %**	Written exam (theory)

Reference nosilca / Lecturer's references:

DŽEBO, Elvira, ŽAGAR, Dušan, ČETINA, Matjaž, PETKOVŠEK, Gregor. Reducing the computational time of the SPH method with a coupled 2-D/3-D approach. Stroj. Vestn., Oct. 2013, vol. 59, no. 10, str. 575-584.
KRZYK, Mario, KLASINC, Roman, ČETINA, Matjaž. Two-dimensional mathematical modelling of a dam-break wave in a narrow steep stream. Stroj. Vestn., apr. 2012, vol. 58, no. 4, str. 255-262.
PETKOVŠEK, Gregor, DŽEBO, Elvira, ČETINA, Matjaž, ŽAGAR, Dušan. Application of Non-Discrete Boundaries with Friction to Smoothed Particle Hydrodynamics. Stroj. Vestn., 2010, letn. 56, št. 5, str. 307-315.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Tehnologija materialov na osnovi mineralnih veziv
Course title:	Technology of materials with mineral binders

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: prof. dr. Violeta Bokan Bosiljkov

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Mikrostruktura in lastnosti v strjenem stanju; konstitutivni materiali, zasnova mešanic in lastnosti pri zgodnji starosti; historični materiali na osnovi mineralnih veziv; posebne vrste betonov: - določila standarda SIST EN 206 - določila standarda SIST 1026. Vaje Laboratorijske vaje (izdelava različnih mešanic z mineralnim vezivom, preverjanje njihovih reoloških lastnosti v svežem stanju, preverjanje njihovih mehanskih in obstojnostnih lastnosti, analiza strukture teh materialov s pomočjo optičnega mikroskopa, uporaba različnih neporušnih metod preiskav za oceno lastnosti materialov z mineralnimi vezivi ter za spremljanje transportnih procesov ter procesov propadanja teh materialov).	Lectures Microstructure and properties in the hardened state; constitutive materials, design of mixtures and properties an early age; historical materials based on mineral binders; special types of concretes: - the provisions of standard SIST EN 206 - the provisions of standard SIST 1026. Tutorials Laboratory work (production of various mixtures with inorganic binder, testing of their rheological properties in the fresh state, testing their mechanical and durability properties, analysis of the structure of the materials using an optical microscope, the use of different non-destructive test methods to assess the properties of materials with mineral binders and to monitor transport processes and the processes of degradation of the materials).

Temeljni literatura in viri / Readings:

Mehta, P.K., Monteiro, P.J.M. 2006. Concrete: Microstructure, Properties and Materials, 3. Izdaja. McGraw-Hill, 659 strani.
Skarendahl, A., Billberg, P. (Eds.). 2006. Casting of Self Compacting Concrete. Final report of RILEM TC 188-CSC, RILEM Report 35. RILEM Publications S.A.R.L., 26 strani.
The Scottish Lime Centre. 2003. Preparation and Use of Lime Mortars, Historic Scotland, 66 strani.
J. Válek, C. Groot and J.J. Hughes (Eds.). 2010. 2nd Conference on Historic Mortars - HMC 2010 and RILEM TC 203-RHM final workshop. RILEM Proceedings pro078, 1383 str.

Cilji in kompetence:

Cilji
- Spoznati mikrostrukturo materialov na osnovi mineralnih veziv.
- Spoznati in razumeti vpliv lastnosti uporabljenih osnovnih materialov in razmerij med njimi na lastnosti materialov na osnovi mineralnih veziv v svežem in strjenem stanju.
- Spoznati transportne mehanizme v teh materialih in vzroke za njihovo propadanje.
- Spoznati in razumeti določila standardov SIST EN 206 ter SIST 1026.
- Spoznati načine recikliranja in ponovne uporabe materialov na osnovi mineralnih veziv.

Pridobljene kompetence
- Sposobnost izbire ustreznih osnovnih ali recikliranih materialov ter kemijskih in mineralnih dodatkov ter zasnove mešanice z mineralnim vezivom tako, da bodo izpolnjevale zahteve glede lastnosti v svežem in strjenem stanju.
- Sposobnost prepoznavanja vzrokov za propadanje materialov.
- Sposobnost izbire kompatibilnih materialov na osnovi mineralnih veziv za obnovo ali rekonstrukcijo poškodovanih objektov.

Objectives and competences:

Objectives
- Get to know the microstructure of materials based on mineral binders.
- Get to know and to understand the impact of the characteristics of the basic materials and the relationships between them on the properties of materials with mineral binders in fresh and hardened state.
- Get to know transport mechanisms in these materials and the causes of their deterioration.
- Get to know and to understand the provisions of the standards SIST EN 206 and SIST 1026.
- Get to know principles of recycling and reuse of materials based on mineral binders.

Acquired competences
- Ability to choose adequate basic or recycled materials and chemical admixtures and mineral additives, and to design a mixture with inorganic binder in such way that requirements regarding properties in fresh and hardened state will be fulfilled.
- Ability to identify the causes of the deterioration of materials.
- Ability to select compatible materials based on mineral binders for the repair or reconstruction of damaged buildings.

Predvideni študijski rezultati:

- Razumevanje relacij med lastnostmi konstitutivnih materialov in razmerji med njimi ter lastnostmi materialov na osnovi mineralnih veziv v svežem in strjenem stanju.
- Razumevanje procesov propadanja materialov.
- Razumevanje pomena kompatibilnosti materialov, ki se uporabljajo za obnovo ali revitalizacijo, z materiali v obstoječi konstrukciji.
- Pridobljeno znanje omogoča reševanje relativno zahtevnih problemov v inženirski praksi in je istočasno dobro izhodišče za poglobljeno raziskovalno delo na obravnavanem področju.

Intended learning outcomes:

- Understanding the relations between the properties of constituent materials and relationships between them and properties of materials based on mineral binders in fresh and hardened state.
- Understanding the processes of degradation of materials.
- Understand the importance of compatibility of materials used for repair or revitalization of building/construction, with original materials of the building/construction.
- Acquired knowledge allows solving relatively complex engineering problems and is at the same

- Pridobljena znanja in spretnosti omogočajo optimalno izbiro ter zasnovo materialov na osnovi mineralnih veziv v praksi - Sposobnost razumevanja obnašanja materialov na podlagi lastnosti njihove mikrostrukture. - Sposobnost razumevanja kompatibilnosti različnih materialov. - Sposobnost izbire ustreznih preskusnih metod za ovrednotenje lastnosti materialov.	time good starting point for in-depth research work in this area. - Acquired knowledge and skills enable optimal selection and design of materials based on mineral binders in practice. - Ability to understand the behaviour of materials from the properties of their microstructure. - Ability to understand the compatibility of different materials. - Ability to select appropriate test methods for evaluating the properties of the materials.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Osnovni del snovi se podaja v obliki predavanj na podlagi temeljne literature in podlag v slovenščini, ki jih pripravi nosilec predmeta. Predavanjem sledijo laboratorijske vaje v skupinah po 15 študentov. V okviru vaj študentje izdelajo elaborat – poročilo o opravljenih preiskavah.	The main part of the course is provided in the form of lectures on the basis of textbooks and other literature in the Slovene language, prepared by lecturer. Lectures are followed by laboratory tutorials in groups of 15 students. In the context of tutorials students will prepare seminar work - a report on the executed tests.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ocena elaborata	**40 %**	Seminar work and its defence
Dva kolokvija ali izpit	**60 %**	Two mid-terms or examination

Reference nosilca / Lecturer's references:

ŠTUKOVNIK, Petra, PRINČIČ, Tina, PEJOVNIK, Stane, BOKAN-BOSILJKOV, Violeta. Alkali-carbonate reaction in concrete and its implications for a high rate of long-term compressive strength increase. Construction & building materials, ISSN 0950-0618. [Print ed.], jan. 2014, letn. 50, str. 699-709, doi: 10.1016/j.conbuildmat.2013.10.007.
HOČEVAR, Andraž, KAVČIČ, Franci, BOKAN-BOSILJKOV, Violeta. Reološki parametri svježih betona - usporedba reometara = Rheological parameters of fresh concrete - comparison of rheometers. Građevinar, ISSN 0350-2465, 2013, letn. 65, št. 2, str. 99-109, ilustr.
Dostopno na: http://www.casopis- gradjevinar.hr/assets/Uploads/JCE_65_2013_2_1_rad-765.pdf in http://www.casopis- gradjevinar.hr/assets/Uploads/JCE_65_2013_2_1_765_EN.pdf.
BOKAN-BOSILJKOV, Violeta, BOSILJKOV, Vlatko, ŽARNIĆ, Roko. Applications and properties of pure lime facades - case study. Conservar património, ISSN 1646-043X, december 2008, št. 8, str. 49- 57.
URANJEK, Mojmir, BOSILJKOV, Vlatko, ŽARNIĆ, Roko, BOKAN-BOSILJKOV, Violeta. Lime Based Grouts for Strengthening of Historical Masonry Buildings in Slovenia. V: VALEK, Jan (ur.), HUGHES, John J. (ur.). Historic Mortars : Characterisation, Assessment and Repair, (RILEM bookseries, ISSN 2211-0844, vol. 7). Dordrecht … [etc.]: Springer, cop. 2012, str. 393-409.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Napredna gradiva
Course title:	Advanced construction and building materials

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type:	Izbirni strokovni / Elective professional
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15		30		60	4

Nosilec predmeta / Lecturer:	prof. dr. Violeta Bokan Bosiljkov

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

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Pregled sodobnega razvoja materialov in tehnologij, ki omogočajo ta razvoj (nanotehnologije n.pr.) ter posebnih lastnosti materialov. Podrobnejši prikaz lastnosti in uporabnosti naprednih materialov po štirih osnovnih skupinah: keramike, kovine, polimeri in kompoziti. Prikaz posebnosti pri uporabi naprednih materialov pri snovanju konstrukcij z vidika projektiranja, izvedbe in vzdrževanja. Osnove za ocenjevanje življenjskega cikla naprednih materialov, v primerjavi z klasičnimi materiali, ter ocene stroškov uporabe in vzdrževanja konstrukcij. Seminar Manjše skupine študentov (do 4 študenti v skupini) izdelajo predlog konstrukcijskega elementa ali sklopa narejenega iz naprednega materiala in analizirajo njegove lastnosti, ter ga primerjajo z enakim elementom oz. sklopom narejenim iz klasičnega materiala. Vaje	Lectures Overview of the development of modern materials and technologies that facilitate this development (e.g. nanotechnology) and specific material properties. Detailed presentation of properties and applicability of advanced materials according to four basic categories: ceramics, metals, polymers and composites. Presentation of specifics in the use of advanced materials when designing structures in terms of design, execution and maintenance. Basics of life cycle assessment of advanced materials, when compared with conventional materials, and the estimation of cost of serviceability and maintenance of structures. Seminar Small groups of students (up to 4 students per group) prepare a proposal for a structural element or set of elements made of advanced material. They analyse its behaviour and properties, and compare it with the same element or set of elements made of common material. Tutorials

Spoznavanje strukture naprednih materialov z optičnim mikroskopom. Preskušanje osnovnih mehanskih in tehnoloških lastnosti naprednih materialov, analiza rezultatov preskusov in primerjava z relevantnimi lastnostmi klasičnih materialov. Uporaba eksperimentalno in analitično dobljenih podatkov pri seminarski nalogi.	Analysis of the structure of advanced materials with optical microscope. Testing of basic mechanical and technological properties of advanced materials. Analysis of test results and comparison with relevant properties of conventional materials. Application of the experimentally and analytically obtained data in the seminar work.

Temeljni literatura in viri / Readings:

Shackelford J.F. 2008. Introduction to Materials Science for Engineers. Prentice Hall, 7th Edition.
Christian U. Grosse. 2007. Advances in Construction Materials 2007. Berlin, Heidelberg, Springer Verlag.
Axel Ritter. 2006. Smart Materials in Architecture, Interior Architecture and Design. A Birkhäuser book.
Bjorn Berge. 2009. Ecology of Building Materials. Taylor&Francis, 2nd Edition.

Cilji in kompetence:	**Objectives and competences:**
- Cilji: spoznati razvoj sodobnih in naprednih materialov ter možnosti snovanja novih tipov konstrukcij in izdelave nekonstrukcijskih elementov s posebnimi lastnostmi in uporabnostjo. - Pridobljene kompetence: sposobnost presoje smiselnosti uporabe naprednih materialov, z vidika možnosti snovanja zahtevnih konstrukcij, in presoje njihove ekonomičnosti povezane tudi z oceno življenjskih stroškov.	- Objectives: onsight in the development of modern and advanced materials and in the possibility of designing new types of structures as well as fabrication of non-structural elements with special properties and application possibilities. - Acquired competences: the ability to select reasonable applications of advanced materials, from the aspect of the design of complex structures, and the assessment of their economy, involving also the cost of living.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje osnovnih lastnosti naprednih materialov in njihova uporaba pri snovanju sodobnih konstrukcij. Presoja primernosti uporabe naprednih ali klasičnih materialov. - Uporaba pri snovanju konstrukcijskih elementov in sklopov iz naprednih materialov, ki se uporabljajo v gradbeništvu (armirane plastike, lamelirano steklo, samozgoščevalni betoni, lesni kompoziti) - Pridobljena znanja omogočajo kritično presojo in odločanje o uporabi različnih vrst materialov v skladu z zahtevami po nosilnosti, trajnosti, uporabnosti in ekonomičnosti. - Nabor specializiranih znanj se lahko poveže v širši sklop s konstrukcijskim seminarjem kot nadgradnja osnovnih znanj pridobljenih pri predavanjih ali kot samostojni seminar.	- Understanding the basic properties of advanced materials and their use in the design of modern structures. Appropriate selection of either advanced or conventional materials, for specific application. - Application for design of construction elements or sets of elements made of advanced building and construction materials (reinforced plastic, laminated glass, self-compacting concrete, wood composites). - The acquired knowledge enables critical assessment and decision-making about the use of different types of materials in accordance with the requirements regarding the load- bearing capacity, durability, application and economy. - A set of specialized skills can be linked to a broader set in the framework of the construction seminar as an upgrade of basic knowledge acquired during lectures or as an independent seminar.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja na osnovi učbenika, ki ga pripravi nosilec predmeta s sodelavci. Seminar kot uvajanje v projektiranje konstrukcij iz naprednih materialov. Manjše skupine študentov (do 4) izdelajo seminarsko nalogo. Laboratorijske vaje v skupini do 15 študentov, kjer se ti seznanijo z osnovnimi lastnostmi naprednih materialov.	Lectures on the basis of a textbook prepared by the lecturer and co-workers. The seminar as an introduction to the design process of structures made of advanced materials. Small groups of students (up to 4) prepare and defend a seminar work. Laboratory tutorials in a group of 15 students, where they learn about the basic properties of advanced materials.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga	**40 %**	Seminar work and its defend
Kolokvij ali izpit	**60 %**	Colloquium or examination

Reference nosilca / Lecturer's references:

BOKAN-BOSILJKOV, Violeta. SCC mixes with poorly graded aggregate and high volume of limestone filler. Cem. concr. res.., 2003, vol. 33, no. 9, str. 1279-1286.

PRINČIČ, Tina, ŠTUKOVNIK, Petra, PEJOVNIK, Stane, SCHUTTER, Geert De, BOKAN-BOSILJKOV, Violeta. Observations on dedolomization of carbonate concrete aggregates, implications for ACR and expansion. Cement and concrete research, ISSN 0008-8846. [Print ed.], dec. 2013, letn. 54, str. 151-160, ilustr., doi: 10.1016/j.cemconres.2013.09.005.

DUH, David, ŽARNIĆ, Roko, BOKAN-BOSILJKOV, Violeta. Strategies for finding the adequate air void threshold value in computer assisted determination of air void characteristics in hardened concrete. Computers and Concrete, ISSN 1598-8198, april 2008, letn. 5, št. 2, str. 101-116.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Požarna varnost
Course title:	Fire safety

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: izr. prof. dr. Tomaž Hozjan

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Splošno o požarnem inženirstvu. Pregled osnovnih pojmov. Evropski standardi in predpisi. Požarna obtežba. Modeli standardnih in realnih požarov. Ukrepi aktivne požarne zaščite. Evakuacijske poti, sistemi za javljanje in gašenje. Ukrepi pasivne požarne zaščite. Vpliv visoke temperature na lastnosti materialov. Določitev časovnega in krajevnega poteka temperature po konstrukciji. Posebnosti pri različnih materialih in tipih konstrukcij. Računsko ugotavljanje požarne odpornosti nosilnih konstrukcij.

Vaje
- Seminarske vaje (izdelava požarnega elaborata za enostaven objekt).

Content (Syllabus outline):

Lectures
Introduction to fire engineering. Overview of basic concepts. European standards and regulations. Fire load. Models of standard and real fires. Measures of active fire protection. Evacuation routes, fire detection and fire fighting. Measures of passive fire protection. Influence of high temperatures on material behaviour. Determination of time and space distribution of temperature in a structure. Special features of the different types of materials and structures. Determination of the fire resistance of load-bearing structures.

Tutorial
Seminar exercises (design of fire study for a simple object).

Temeljni literatura in viri / Readings:

A. H. Buchanan. 2005. Structural Design for Fire Safety. John Wiley & Sons Ltd.
F. Wald & al. 2004. Vypočet požarni odolnosti stavebnih konstrukci. Tehniška univerza v Pragi.
Eurokod EN 1991-1-2 in požarni deli Eurokodov za lesene, armiranobetonske in jeklene konstrukcije.
Pravilnik o požarni varnosti v stavbah, URL RS 31/04 10/05 83/05 14/07.
Tehnična smernica TSG-1-001:2010 požarna varnost v stavbah.
Študijsko gradivo na spletni strani KM.

Cilji in kompetence:

- Nadgraditi osnovno konstruktorsko znanje z načeli projektiranja požarno varnih zgradb; v povezavi z drugimi naravoslovnimi, temeljnimi mehanskimi in strokovnimi predmeti, spoznati in razumeti mehanizme delovanja materialov, elementov in konstrukcij pri visokih temperatura.
- Spoznati in razumeti osnovne zakonitosti nastanka in razvoja požarov v zgradbah in naravnem okolju ter inženirske modele požarne obtežbe.
- Privzgojiti občutek za pomen aktivnih in pasivnih ukrepov požarne zaščite v luči sociološkihh, naselitvenih, ekonomskih in drugih faktorjev.
- Vpeljati osnovna načela požarno varnega projektiranja lesenih, armiranobetonskih in jeklenih konstrukcij.
- Navajati študente na določitev in predstavitev požarnih problemov, zajem eksperimentalnih podatkov, izbiro metode reševanja ter predstavitev in kritično oceno rezultatov.

Objectives and competences:

- To upgrade basic engineering knowledge with the principles of design of fire-resistant buildings; in relation to other natural sciences, basic mechanical and technical courses to identify and understand the behaviour of material, elements and structures at high temperatures.
- To recognize and understand the basic principles of growth and development of fires in buildings and in natural environments, and to understand the engineering design fire load models.
- To obtain a sense of the importance of active and passive fire protection measures in the light of sociological, urban, economic and other factors.
- To introduce the basic principles of fire safety design of timber, reinforced concrete and steel structures.
- To prepare students for the determination and presentation of fire problems, capture experimental data, selecting appropriate methods of solving and presentation and critical evaluation of the results.

Predvideni študijski rezultati:

- Razumevanje pomena požarnega inženirstva.
- Razumevanje fizikalnih osnov nastanka in razvoja požara ter vpliva visokih temperature na materiale in konstrukcije. Poznavanje osnovnih ukrepov aktivne in pasivne požarne zaščite.
- Znanje osnovnih metod za računsko oceno požarne odpornosti lesenih, armiranobetonskih in jeklenih konstrukcij.

Intended learning outcomes:

- Understanding the importance of fire safety engineering.
- Understanding the basics of physical phenomena of fire and the influence of high temperatures on materials and structures. Knowledge of the basic measures of active and passive fire protection.
- Knowledge of the basic methods of constructing an assessment of the fire resistance of timber, reinforced concrete and steel structures.

Metode poučevanja in učenja:

Predavanja, seminarske vaje.

Learning and teaching methods:

Lectures, seminar exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Praktični del	**50 %**	Practical part
Teoretični del	**50 %**	Theoretical part

Reference nosilca / Lecturer's references:

KOLŠEK, Jerneja, PLANINC, Igor, SAJE, Miran, HOZJAN, Tomaž. The fire analysis of a steel-concrete side-plated beam. Finite elements in analysis and design, ISSN 0168-874X. [Print ed.], okt. 2013, letn. 74, str. 93-110.

HOZJAN, Tomaž, SAJE, Miran, SRPČIČ, Stane, PLANINC, Igor. Fire analysis of steel-concrete composite beam with interlayer slip. Computers & Structures, ISSN 0045-7949. [Print ed.], 2011, letn. 89, št. 1-2, str. 189-200.

BRATINA, Sebastjan, HOZJAN, Tomaž. Ocena požarne odpornosti armiranobetonske podporne konstrukcije v galeriji Šentvid in pokritem vkopu Šentvid z uporabo napredne računske metode v skladu s standardom SIST EN 1992-1- 2:2005. Ljubljana: Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, 2010. 143 str.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Prednapeti beton
Course title:	Prestressed concrete

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: izr. prof. dr. Jože Lopatič, izr. prof. dr. Sebastjan Bratina

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Prednapeti betonski okvirji; ploskovne prednapete konstrukcije (stene, stenasti nosilci, plošče, lupine); posebnosti prednapenjanja s kabli brez povezave in z zunanjimi kabli; analiza in projektiranje prednapetih mostnih konstrukcij grajenih po posebnih tehnologijah gradnje (narivanje prekladne konstrukcije, prosta konzolna gradnja); računsko določanje požarne odpornosti prednapetih betonskih konstrukcij in ukrepi za njeno zagotavljanje

Vaje
- seminarske vaje (računski primeri)
- laboratorijske vaje (numerične simulacije obnašanja prednapetih konstrukcij v računalniški učilnici).

Content (Syllabus outline):

Lectures
Prestressed concrete frames; prestressed concrete slabs and walls; prestressed concrete shells; specifics of prestressing with unbonded and external tendons; analysis and design of prestressed bridge superstructures made according to special construction technologies, (incremental launching, free cantilever method); computational definition of fire resistance of prestressed concrete structures and measures for its assurance.

Tutorials
- seminar tutorials (computational examples)
- laboratory tutorials (numerical simulations of the behaviour of prestressed structures in computer classroom).

Temeljni literatura in viri / Readings:

G. Rombach. 2002. Spannbetonbau. Ernst&sohn, str. 447-514.
M. Rossignoli. 2002. Bridge launching. Thomas Telford, str. 1-206.
Post–tensioning in buildings (fib bulletin 31). 2005. Fib ceb – fip.
Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 2, Evrokod 8 (SIST EN 1990, SIST EN 1992-1-1, SIST EN 1992-1-2, SIST EN 1998-1).
Spletno mesto katedre za masivne in lesene konstrukcije:http://www.fgg.uni-lj.si/kmlk/index.htm.

Cilji in kompetence:

Cilji
- Nadgraditi osnovno poznavanje obnašanja prednapetih betonskih konstrukcij;
- Podati podlage za računsko modeliranje prednapetih betonskih konstrukcij;
- Podati teoretične podlage za načrtovanje zahtevnejših prednapetih konstrukcij.

Pridobljene kompetence:
- Sposobnost snovanja in projektiranja zahtevnejših prednapetih konstrukcij.

Objectives and competences:

Objectives
- To upgrade the basic knowledge of the behaviour of prestressed concrete structures;
- To present the bases for the computational modelling of prestressed concrete structures;
- To present the theoretical bases for the design of demanding prestressed concrete structures.

Acquired competences
- Ability to conceptual design and design demanding prestressed structures.

Predvideni študijski rezultati:

- Poglobitev in razširitev znanja s področja tehnologije prednapetih konstrukcij.
- Poznavanje naprednih tehnologij gradnje prednapetih konstrukcij.
- Poznavanje obnašanja prednapetih konstrukcij v pogojih požara.
- Razumevanje nosilnih mehanizmov betonskih konstrukcij prednapetih z nepovezanimi oziroma zunanjimi kabli.
- Razumevanje teoretičnih podlag za smotrno načrtovanje varnih, gospodarnih in trajnih prednapetih betonskih konstrukcij.
-Sposobnost uporabe strokovne literature, standardov in računalniških programov v procesu načrtovanja prednapetih betonskih konstrukcij.
- Sposobnost kritične presoje vpliva vhodnih podatkov na računske rezultate pri načrtovanju prednapetih konstrukcij.

Intended learning outcomes:

- Deepening and extension of knowledge from the area of technology of prestressed structures.
- Knowledge of advanced construction technologies of prestressed structures.
- Knowledge of the behaviour of prestressed structures in fire conditions.
- Understanding the load-bearing mechanisms of concrete structures, prestressed with unbonded and external tendons.
- Understanding theoretical bases for sensible design of safe, economic and durable prestressed concrete structures.
-Ability to use professional literature, standards and software in the process of design of prestressed concrete structures.
- Ability to make a critical judgement of the influence of input data on the computational results in the design of prestressed structures.

Metode poučevanja in učenja:

Predavanja in seminarske vaje v klasični učilnici, laboratorijske vaje v računalniški učilnici.

Learning and teaching methods:

Lectures and seminar tutorials in classical classroom, laboratory tutorials in computer classroom.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Vaje	**30 %**	Tutorials
Računski del izpita	**35 %**	Computational part of exam
Teoretični del izpita	**35 %**	Theoretical part of exam

Reference nosilca / Lecturer's references:

F. SAJE, J. LOPATIČ, A Time-Dependent Analysis of Reinforced Prestressed and Composite Concrete Structures, Int. j. eng. model., 1997, vol. 10, str. 17-24.
J. LOPATIČ, F. SAJE,. Non-linear analysis of time-dependent response of civil engineering structures. V: TOPPING, Barry H. V. (ur.), MONTERO, G. (ur.), MONTENEGRO, R. (ur.). Proceedings of the eighth International conference on computational structures technology, Las Palmas de Gran Canaria-Spain, 12-15 September 2006. Stirling: Civil-Comp, cop. 2006.
D. SAJE, J. LOPATIČ, The effect of constituent materials on the time development of the compressive strength of highstrength concrete. Mag. Concr. Res., 2010, letn. 62, št. 4, str. 291-300, ilustr.

M. MARKOVIČ, M. SAJE, I. PLANINC, S. BRATINA, On strain softening in finite element analysis of reinforced concrete planar frames subjected to fire, Engineering Structures, 2012, letn. 45, str. 349-361.
M. MARKOVIČ, N. KRAUBERGER, M. SAJE, I. PLANINC, S. BRATINA, Non-linear analysis of pre-tensioned concrete planar beams, Engineering Structures, 2013, letn. 46, str. 279-293.
U. BAJC, M. SAJE, I. PLANINC, S. BRATINA, Non-linear analysis of cracked tensile reinforced concrete bars: a comparison of numerical methods. V: TOPPING, Barry H. V. (ur.), IVÁNYI, Peter (ur.), Proceedings of the Fourteenth International Conference on Civil, Structural and Environmental Engineering Computing, 3-6 September 2013, Cagliari, Sardinia, Italy.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Sovprežne konstrukcije
Course title:	Composite structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: doc. dr. Primož Može

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Predavanja
Osnove (vrste in posebne značilnosti sovprežnih stavb in mostov, osnovne predpostavke za račun in dimenzioniranje). Globalna analiza sovprežnih konstrukcij (metode, vpliv razpok, vpliv krčenja in tečenja betona). Upogibni nosilci (elastična in plastična nosilnost prerezov, vezna sredstva, delna sovprežnost, vertikalni in vzdolžni strig, bočna zvrnitev, kontinuirni sistemi in reološki vplivi). Stropne konstrukcije (vrste, metode dimenzioniranja). Stebri (vrste prečnih prerezov, tlačna, upogibna in tlačno-upogibna nosilnost, značilni interakcijski diagrami moment- osna sila, uklon, vpliv teorije drugega reda). Spoji (posebnosti, nosilnost, duktilnost). Mejna stanja uporabnosti (osnove, kontrola razpok, kontrola pomikov). Tehnologija gradnje (pregled tehnoloških postopkov gradnje, faznost gradnje in njen vpliv na projektiranje).

Vaje
Seminarske vaje: računski primeri.
Praktična uporaba metod projektiranja, ki jih

Content (Syllabus outline):

Lectures
Basics of composite structures (types and specific characteristics of composite buildings and bridges, the basic assumptions for global analysis and design). Global analysis of composite structures (methods, impact of cracks, influence of the concrete creep and shrinkage). Beams (elastic and plastic cross-section design, shear studs, partial shear connection, vertical and longitudinal shear, lateral-torsional buckling, continuous systems and the effects of rheology). Ceiling structures (types, methods for design). Columns (cross-section types, cross-section resistance (axial force, bending moment and interaction of axial force and bending moment), interaction diagram, flexural buckling, influence of second order analysis). Joints (features, load capacity, ductility). Serviceability limit states (the basic, cracks control, deflection check). Construction technology (overview of the technological processes of construction, construction phases and their impact on the design).
Tutorials
Tutorial: Practical examples.

študent spozna pri predavanjih.	Practical application of design methods.

Temeljni literatura in viri / Readings:

B Androić, D Dujmović, I Lukanović. 2012. Projektiranje spregnutih konstrukcija prema Eurocode 4. Akademija Tehničkih Znanosti Hrvatske. ISBN 978-953-55633-1-0
D. Horvatič. 2003. Spregnute konstrukcije čelik – beton. Zagreb, Masmedia.
D. L. Mullett. 1998. Composite floor systems. 320 str., London, Blackwell science.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi osnovno znanje s področja projektiranja sovprežnih konstrukcij z znanjem o zahtevnejših metodah projektiranja; - Pridobiti znanja, ki bodo v pomoč pri pridobitvi licence pooblaščenega inženirja pri Inženirski zbornici Slovenije. Pridobljene kompetence - Sposobnost projektiranja sovprežnih konstrukcij na nivoju sistemov (npr. stavbe, mostovi).	Objectives - To upgrade the basic knowledge by using sophisticated design methods; - To acquire skills, necessary to obtain a license for authorized engineer at the Slovenian Chamber of Engineers. Competences - Ability to design composite structures (buildings, bridges).

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznati in razumeti principe elastične in plastične analize sovprežnih konstrukcij, - Spoznati in razumeti obnašanje statično nedoločenih sovprežnih konstrukcij, - Spoznati in razumeti tehnološke postopke gradnje sovprežnih konstrukcij. - Študent se bo naučil teoretična znanja uporabiti v inženirski praksi: ena glavnih značilnosti projektiranja konstrukcij je sprejemanje velikega števila odločitev v nizu. Na osnovi pridobljenega teoretičnega in praktičnega znanja bo študent sposoben kritične presoje posameznega problema, izločitve neustreznih rešitev in utemeljene izbire ene od ustreznih rešitev. - Sposobnost uporabe računalniških programov za analizo sovprežnih konstrukcij, - Sposobnost kritične presoje strokovnih problemov pridobivanje spretnosti za uporabo literature, interneta in drugih informacijskih tehnologij.	- To know and understand the principles of elastic and plastic analysis of composite elements. - To know and understand the behaviour of statically undetermined composite structures. - To know and understand the technology of construction process of composite structures. - Student should learn to apply the theoretical knowledge in engineering practice: One of the main features of structural design is decision making. Based on the acquired theoretical and practical knowledge student should be able to critically judge individual problem, to eliminate inappropriate solutions and to justify the choice of the possible solutions. - Ability to use computer programs to analyse composite structures. - Ability for critical judgement of technical problems. - Acquisition of skills for the use of literature, internet and other information technologies.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predmet se izvaja v obliki seminarja in predavanj.	The course consists of lectures and computational exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Samostojna naloga	**40 %**	Approved project work
Zagovor naloge	**30 %**	Defence of the approved project work
Ustni izpit	**30 %**	Oral exam

Reference nosilca / Lecturer's references:

Može, P. and Beg, D. (2010), "High strength steel tension splices with one or two bolts", *Journal of Constructional Steel Research*. **66**(8-9), 1000-1010.
Može, P. and Beg, D. (2011), "Investigation of high strength steel connections with several bolts in double shear", *Journal of Constructional Steel Research*. **67**(3), 333-347.
Može, P. and Beg, D. (2014), "A complete study of bearing stress in single bolt connections", *Journal of Constructional Steel Research*. **95** 126-140.
Može, P., Beg, D. and Lopatič, J. (2007), "Net cross-section design resistance and local ductility of elements made of high strength steel", *Journal of Constructional Steel Research*. **63**(11), 1431-1441.
Može, P., Cajot, L.-G., Sinur, F., Rejec, K. and Beg, D. (2014), "Residual stress distribution of large steel equal leg angles", *Eng Struct*. **71**(0), 35-47.
Čermelj, B., Može, P. and Sinur, F. (2016), "On the prediction of low-cycle fatigue in steel welded beam-to-column joints", *Journal of Constructional Steel Research*. **117** 49-63.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Inženirske lesene konstrukcije
Course title:	Engineering timber structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: izr. prof. dr. Jože Lopatič

Jeziki / Languages:		
	Predavanja / Lectures:	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

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

Vsebina:	**Content (Syllabus outline):**
Predavanja Tehnologija izdelave gradbenih lesnih proizvodov in posebnosti pri njihovem dimenzioniranju (lameliran lepljeni les, slojeviti furnirni les, plošče z usmerjenim iverjem, lamelirane plošče). Posebnosti dokazovanja varnosti lameliranih lepljenih konstrukcij proti porušitvi. Račun pomikov lesenih konstrukcij z upoštevanjem podajnosti veznih sredstev (vpliv zdrsa, reoloških pojavov, stisljivosti elementov pravokotno na vlakna in začetne nepopolnosti). Dimenzioniranje in konstruiranje kompleksnih priključkov, vozlišč in detajlov lesenih konstrukcij. Ploskovni elementi lesenih konstrukcij (stene in stropovi). Zagotavljanje potresne odpornosti lesenih konstrukcij. Požarna odpornost lesenih konstrukcij (računsko določanje požarne odpornosti s poenostavljenimi in naprednimi računskimi metodami, ukrepi za zagotavljanje požarne odpornosti). Lesene stavbe (projektna obtežba, osnovne skupine nosilnih elementov lesenih stavb, zasnova in izbira nosilne konstrukcije stavbe, modeliranje in analiza nosilne konstrukcije,	Lectures Manufacturing technologies of engineered wood products for structural purposes and specifics of their design (glued laminated timber, laminated veneer lumber – LVL, parallel strand lumber – PSL, laminated strand lumber – LSL, oriented strand boards - OSB, cross laminated timber – CLT). Verification of structural safety of glued laminated timber structures by numerical simulations. Timber walls and floors. Calculation of deflection of timber structures taking into account the flexibility of fasteners (influence of slip), rheology of material, compressibility of elements perpendicular to fibres and initial imperfections of joints. Design of complex joints, nodes and details of timber structures. Assuring earthquake resistance of timber structures. Fire resistance of timber structures (computational definition of fire resistance with simplified and advanced computational methods, measures to assure fire resistance). Timber buildings (design load, basic groups of load- bearing elements of timber buildings, conceptual design and selection of load-bearing structure of a building, modelling and

konstruiranje elementov nosilne konstrukcije). Leseni mostovi (zasnova, projektna obtežba, osnovni gradniki nosilne konstrukcije mostu, prevedba dejanske konstrukcije v ustrezen računski model, konstruiranje nosilnih elementov). Vaje - seminarske vaje (računski primeri), - laboratorijske vaje (računalniško podprta izdelava projektne naloge).	analysis of load-bearing structure, design of elements of load-bearing structure). Timber bridges (design load, basic structural elements of load-bearing structure of a bridge, conceptual design, modelling of actual structure by adequate computational model, design of load-bearing elements). Tutorials: - seminar tutorials (computational examples), - laboratory tutorials (computer-aided elaboration of project work).

Temeljni literatura in viri / Readings:

S. Thelanderson, H.J. Larsen (urednika). 2003. Timber engineering. John Wiley & sons, str. 169-427.
F. Colling. 2004. Holzbau-beispiele. Vieweg, 174 str.
T. Herzog, J.Natterer, R Schweitzer, M. Volz. 2004. Timber Construction Manual. Birkhäuser Architecture.
J. Kolb. 2008. Systems in Timber Engineering. Birkhäuser Architecture.
Z. Žagar. 2003. Drvene konstrukcije II. Pretei d.o.o., str. 164-312.
Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 1, Evrokod 5, Evrokod 8 (SIST EN 1990, SIST EN 1991-1, SIST EN 1991-1-3, SIST EN 1991-1-4, SIST EN 1995-1-1, SIST EN 1998-1).
Študijsko gradivo predavatelja je na spletnem mestu katedre za masivne in lesene konstrukcije
Dostopno na: http://www.fgg.uni-lj.si/kmlk/index.htm .

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi temeljno poznavanje obnašanja lesenih konstrukcij, - Podati teoretične podlage za snovanje, računsko modeliranje in načrtovanje kompleksnih lesenih konstrukcij. Pridobljene kompetence - Sposobnost snovanja in projektiranja zahtevnejših inženirskih lesenih konstrukcij poglobitev in razširitev znanja s področja tehnologije lesenih konstrukcij, - Razumevanje obnašanja lesenih konstrukcij vzajemnih, razmerah (požar, potres) - Razumevanje nosilnih mehanizmov inženirskih lesenih konstrukcij, - Kritična presoja ustreznosti izbranega nosilnega mehanizma in računskega modela konstrukcije - Sposobnost uporabe strokovne literature, standardov in računalniških programov v procesu načrtovanja lesenih konstrukcij, - Sposobnost utemeljene izbire med več možnimi nosilnimi sistemi.	Objectives - To upgrade the basic knowledge of the behaviour of timber structures, - To present the theoretic bases for the conceptual design, computational modelling and design of complex timber structures, Acquired competences - Ability to conceive concept and design demanding engineering timber structures - Deepening and expansion of the knowledge from the area of technology of timber structures, - Understanding the behaviour of timber structures in extreme conditions (fire, earthquake) - Understanding of load-bearing mechanisms of engineering timber structures, - Critical valuation of the adequacy of the selected load- bearing mechanism and computational model of a structure, - Ability to use professional literature, standards and software in the process of design of timber structures, - Ability to make a well-grounded selection from several possible structural systems.

Predvideni študijski rezultati:	Intended learning outcomes:
- Poglobitev in razširitev znanja s področja tehnologije lesenih konstrukcij, - Razumevanje obnašanja lesenih konstrukcij vzajemnih razmerah (požar, potres). - Razumevanje nosilnih mehanizmov inženirskih lesenih konstrukcij, - Kritična presoja ustreznosti izbranega nosilnega mehanizma in računskega modela konstrukcije, - Sposobnost uporabe strokovne literature, standardov in računalniških programov v procesu načrtovanja lesenih konstrukcij - Sposobnost utemeljene izbire med več možnimi nosilnimi sistemi.	- Deepening and expansion of the knowledge from the area of technology of timber structures, - Understanding the behaviour of timber structures in extreme conditions (fire, earthquake) - Understanding of load-bearing mechanisms of engineering timber structures, - Critical valuation of the adequacy of the selected load- bearing mechanism and computational model of a structure, - Ability to use professional literature, standards and software in the process of design of timber structures, - Ability to make a well-grounded selection from several possible structural systems.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja in seminarske vaje v klasični učilnici, laboratorijske vaje v računalniški učilnici.	Lectures and seminar tutorials in classical classroom, laboratory tutorials in computer classroom.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Vaje	**30 %**	Tutorials
Računski del izpita	**35 %**	Computational part of exam
Teoretični del izpita	**35 %**	Theoretical part of exam

Reference nosilca / Lecturer's references:

LOPATIČ, J., ČAS, B., Vpliv Vpliv podajnosti stika na obnašanje sestavljenih lesenih nosilcev, Zbornik 21. zborovanja gradbenih konstruktorjev Slovenije, Bled, 14. - 15. oktober 1999. Ljubljana: Slovensko društvo gradbenih konstruktorjev, 1999, str. 175-182, graf. Prikazi.
ČAS, Bojan, LOPATIČ, Jože, SAJE, Miran, SCHNABL, Simon, PLANINC, Igor. Experimental and numerical analysis of composite wood beams : paper 199.Proceedings of the Tenth International Conference on Civil, Structural and Environmental Engineering Computing. Rome, Italy, 30 August-2 September 2005. Stirling [Scotland]: Civil-Comp Press, 2005.
PLANINC, I., SCHNABL, S., SAJE, M., LOPATIČ, J., ČAS, B., Numerical and experimental analysis of timber composite beams with interlayer slip. Eng. Struct.. [Print ed.], 2008, str. 1-11.

LOPATIČ, J., SAJE, D., SAJE, F., Creep of timber structures. International journal for engineering modelling, ISSN 1330- 1365, 2005, vol. 18, no. 1/2, str. 1-10.
SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Shrinkage and creep of steel fiber reinforced normal strength concrete. Journal of testing and evaluation, ISSN 0090-3973, 2013, letn. 41, št.6, str. 959-969, ilustr., doi: 10.1520/JTE20120134.
SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Autogenous and Drying Shrinkage of Fibre Reinforced High-Performance Concrete. Journal of advanced concrete technology, ISSN 1346-8014, feb. 2012, letn. 10, št. 2, str. 59-73, ilustr., doi: 10.3151/jact.10.59.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Lupinaste konstrukcije
Course title:	Shell structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30			30		60	4

Nosilec predmeta / Lecturer: prof. dr. Boštjan Brank

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Prerequisites:

Vsebina:

Začnemo z vprašanjem: "Zakaj študirati obnašanje lupinastih konstrukcij?" V odgovor predstavimo tipične lupine v gradbeništvu (silose, rezervoarje, kupole in predore) in različne vrste konstrukcij, ki se obnašajo kot lupine, kot so ukrivljene lupine, ravne lupine, palične lupine in membrane. Nadaljujemo z izpeljavo in uporabo osnov diferencialne geometrije ploskev, pri čemer si pomagamo s programom Mathematica. Predstavimo membransko in upogibni teorijo lupin. Detaljno obravnavamo membransko teorijo osno simetričnih lupin, upogibno teorijo cilindričnih lupin ter linearno elastično analizo poljubnih lupin z metodo končnih elementov. Seznanimo se s problemom uklona in imperfektnosti. V laboratoriju izvedemo uklonske preizkuse na pločevinkah, z namenom, da dobimo predstavo o fenomenu uklona pri lupinastih konstrukcijah. Uklonsko stabilnost lupinastih konstrukcij preverjamo tudi računsko: uporabimo metodo končnih elementov in linearno uklonsko analizo. V skladu z EC3 projektiramo jekleni cilindrični rezervoar. Tekom semestra se trudimo, da so vsi

Content (Syllabus outline):

We start with the question: "Why it is important to study behaviour of shell structures?". As an answer we introduce typical shells in civil engineering (silos, tanks, domes and tunnels) and various types of structures that behave like shells, such as curved shells, flat shells, truss shells and membranes. We proceed with derivation and use of basic differential geometry of surface with the help of programme Mathematica. We present membrane and bending theories of shells. The membrane theory of axial symmetric shells and the bending theory of cylindrical shells are treated in detail as well as linear elastic analysis of shells by the finite element method. We learn about the problem of shell buckling and imperfections. In the laboratory we perform experimental tests on small cans in order to illustrate the shell buckling phenomena. We also compute the stability of shell structures by using the finite element method and linear buckling analysis. We design a steel cylindrical shell in accordance with EC3. During the course, all theoretical developments are being accompanied by examples either in the computer laboratory or in the

teoretični prikazi podkrepljeni z laboratorijskim delom v računalniški učilnici in v laboratoriju.	experimental laboratory.

Temeljni literatura in viri / Readings:

B. Brank. 2014. Lupinaste konstrukcije, skripta.
F. Frey, M.-A. Studer. 2003. Analyse des structures et mileux continus: coques. Presses Polytechniques Laussane.
A. Zingoni. 1997. Shell structures in civil and mechanical engineering. Thomas Telford.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati gradbene lupinaste konstrukcije - Razumeti obnašanje ukrivljenih konstrukcij - Spoznati problematiko uklona pri lupinah - Spoznati principe analize in projektiranja lupin Kompetence - Zna pravilno pristopiti k analizi lupine - Zna izračunati notranje sile in pomike lupine - Zna analizirati stabilnost lupine - Zna kritično oceniti rezultate analize	Objectives - To learn about shell structures used in civil engineering - To understanding the behaviour of shell structures - To understand the problem of shell buckling - To learn about shell structure analysis and design Competences - To be able to model and analyse a shell structure with the finite element method - To be able to calculate internal forces and displacements of a shell structure - To be able to perform a buckling analysis - To be able to evaluate results of numerical analysis of shell structure

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Znanje o teoriji lupin - Znanje o uporabi metode končnih elementov za analizo lupin - Znanje o stabilnostni problematiki pri lupinah - Znanje o projektiranju lupin	- To get knowledge about shell theory - To use the finite element method for shell structure analysis - To get knowledge about shell buckling - To get knowledge about the design of shell structures

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja v učilnici. Primeri pod nadzorom učitelja.	Lectures are carried out in a classroom. Examples are worked out on computers by students under teacher's surveillance.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Računski del izpita: analiza lupinaste konstrukcije z računalnikom	**50 %**	Finite element modelling and analysis of a shell structure
Teoretični del izpita	**50 %**	Theory of shell structures

Reference nosilca / Lecturer's references:

PETROVČIČ, Simon, GUGGENBERGER, Werner, BRANK, Boštjan. Jekleni silosi za sipke materiale. 1. del, Vplivi pri polnjenju in praznjenju = Steel silos for particulate solid materials. Part 1, Actions at filling and discharge. Gradbeni vestnik, ISSN 0017-2774, mar. 2009, letn. 58, str. 70-78, ilustr.
BRANK, Boštjan. Assessment of 4-node EAS-ANS shell elements for large deformation analysis. Computational mechanics, ISSN 0178-7675, 2008, letn. 42, št. 1, str. 39-51, ilustr. http://www.springerlink.com/content/l5661k6817320676/fulltext.pdf, doi: 10.1007/s00466-007- 0233-3.
BRANK, Boštjan. Nonlinear shell models with seven kinematic parameters. Computer Methods in Applied Mechanics and Engineering, ISSN 0045-7825. [Print ed.], 2005, letn. 194, str. 2336-2362, graf. prikazi.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Mehanika kamnin in podzemni objekti
Course title:	Rock mechanics and underground structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45			45		90	6

Nosilec predmeta / Lecturer: izr. prof. dr. Janko Logar

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Opravljen izpit iz predmetov Mehanika tal in inženirska geologija, Geotehnika.

Prerequisites:

Passed exams in Soil mechanics and engineering geology, Geotechnical Engineering.

Vsebina:

Teorija
Osnove mehanike kamnin: klasifikacija, lastnosti razpok, preiskave kamnin, trdnost in togost kamnin, Hoekov in Brownov porušni kriterij, strukturno pogojene nestabilnosti; zgodovinski pregled podzemnih gradenj, pregled vrst in namenov gradnje podzemnih prostorov; stabilnost podzemnih prostorov v kamninah; zasnova portalnega območja predora; tehnologije gradnje podzemnih prostorov: strojni izkopi (TBM), Nova Avstrijska metoda, podporni ukrepi; značilna obnašanja podzemnih prostorov glede na sestavo in lastnosti tal ter primarna napetostna stanja; načela in metode projektiranja predorov in drugih podzemnih objektov:
- stabilnost čela predora
- predori v zemljinah (tehnologije gradnje, podporni ukrepi)
- vpliv anizotropije kamnine na deformacije ob izkopu predora
- organizacija dela, meritve med gradnjo, varnost in oprema

Content (Syllabus outline):

Theory
Fundamentals of rock mechanics: rock mass classiffication, strength and stiffness of rock, Hoek-Brown failure criterion, structurally controlled instabilities; historical overview of underground construction, type and purpose of underground structures; stability of underground structures in rock; conceptual design of portal structures technological aspects of underground structures: mechanized excavation (TBM), New Austrian tunnelling method, rock mass support; typical behaviour types of underground structures with respect to rock mass properties and primary stress state; principles and methods of design of tunnels and other underground structures:
- face stability
- tunnels in soils (construction technology and support measures)
- influence of rock anisotropy on deformation patterns of tunnel lining
- organization of underground works, monitoring, safety and equipment

- obračun del pri izgradnji predorov (matrična metoda). Vaje - klasifikacija kamnin, ugotavljanje mehanskih lastnosti kamnin - stabilnost portalnih vkopov - stabilnost podzemnih prostorov v kamninah - načrtovanje prečnega prereza predora - načrtovanje portala predora - stabilnost čela predora - analiza geotehničnih meritev med gradnjo predora - izdelava popisa del in predračuna po matrični metodi.	- tunnelling contracts Tutorials - rock mass classification, rock mass properties - stability of portal cuts - stability of underground structures in rock - design of tunnel cross-section - design of pre-cut - stability of tunnel face, face support - analysis and interpretation of geotechnical monitoring during construction - bill of quantities, cost estimate based on matrix method.

Temeljni literatura in viri / Readings:

Chapman, D. N., Metje, N., Stärk, A. 2010. Introduction to tunnel construction. Spon, 390 str.
Elektronski viri:
Hoek, E.: (2007) Practical Rock Engineering.
Dostopno na: http://www.rocscience.com/hoek/corner/Practical_Rock_Engineering.pdf
The Austrian Practice of NATM Tunneling Contracts. 2011. Austrian Society for Geomechanics.
Dostopno na: http://www.oegg.at/fileadmin/files/Austrian-practice-of_tunnelling- contracts_Engl.pdf
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati osnove mehanike kamnin - Spoznati vrste podzemnih prostorov - Spoznati možne tehnologije gradnje podzemnih prostorov - Razumeti obnašanje konstrukcije predorov v odvisnosti od zgradbe tal in prvotnih napetosti v tleh in osnove dimenzioniranja podpornih ukrepov. Pridobljene kompetence - Sposobnost ocene stabilnosti podzemnega prostora v kamninah - Sposobnost zasnove in analize portalnega dela predora - Sposobnost samostojne zasnove podpornih ukrepov.	Objectives - To understand basics of rock mechanics - To recognize types of underground structures and construction technologies - To understand the behaviour of underground structure with respect of rock mass properties and primary stress state in order to design support measures. Competences - To assess the stability of underground opening in rock - To conceptually design and analyse the tunnel portal - To design tunnel support.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje tehnologij gradnje podzemnih prostorov v kamninah in zemljinah - Razumevanje vloge posameznih podpornih ukrepov ter časovnega zaporedja del - Poznavanje osnov mehanike kamnin - Razumevanje vloge geoloških pogojev in prvotnih napetostnih stanj v tleh pri gradnji podzemnih	- Knowing the tunnelling technologies in rock and soil - Understanding the role of individual support measures and working sequence - Understanding the basics of rock mechanics - Understanding the impact of different geological conditions and primary stress state on the

prostorov. - Zasnova, načrtovanje in gradnja predorov, priprava razpisne dokumentacije. - Razumevanje posebnosti gradnje podzemnih prostorov: izrazita povezanost z naravno/geološko pogojenimi razmerami in neposredna interakcija tal s konstrukcijskimi elementi. - Sposobnost izvedbe stabilnostne analize podzemnih blokov in klinov v kamninah - Sposobnost zasnove prečnega profila predora s podpornimi ukrepi - Razumevanje izvedenih meritev v predoru med gradnjo.	underground construction. - Conceptual design, planning and construction of tunnels, preparation of tender documents. Understanding what is unique in tunnelling: inherent connection with natural/geological conditions and rock-structure interaction - Ability to perform stability analysis of underground rock blocks and wedges - Ability to design of tunnel cross-section with support measures - Interpretation of displacement measurements of rock mass during tunnelling.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske in terenske vaje, samostojno delo.	Lectures, laboratory and field work, individual project work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Samostojno izdelane vaje	**40 %**	Individual project
Izpit	**60 %**	Exam

Reference nosilca / Lecturer's references:

KLOPČIČ, Jure, ŽIVEC, Tina, ŽIBERT, Marko, AMBROŽIČ, Tomaž, LOGAR, Janko. Influence of the geological structure on the displacements measured ahead of the Šentvid tunnel face in small diameter exploratory tunnel = Einfluß der Geologie auf die in einem Erkundungsstollen vor der Ortsbrust des Sentvid-Tunnels gemessenen Verschiebungen. Geomechanik und Tunnelbau, ISSN 1865-7362. [Print ed.], feb. 2013, letn. 6, št. 1, str. 25-47, ilustr., doi: 10.1002/geot.201300004.
KLOPČIČ, Jure, LOGAR, Janko. Vpliv anizotropije hribinske mase na velikost in smer pomikov zaradi izkopa predora = Influence of anisotropy of rock mass on magnitude and direction of displacements due to tunnelling. Gradbeni vestnik, ISSN 0017-2774, jan. 2013, letn. 62, str. 3-14, ilustr. KLOPČIČ, Jure, AMBROŽIČ, Tomaž, MARJETIČ, Aleš, GAMSE, Sonja, PULKO, Boštjan, LOGAR, Janko. Use of automatic target recognition system for the displacement measurements in a small diameter tunnel ahead of the face of the motorway tunnel during excavation. Sensors, ISSN 1424- 8220, 2008, vol. 8, no. 12, str. 8139-8155, ilustr. http://www.mdpi.com/1424-8220/8/12/8139.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Modeliranje geotehničnih konstrukcij
Course title:	Numerical modelling of geotechnical structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	1, 2	2, 4
Civil Engineering - second cycle MA	Structural engineering	1, 2	2, 4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45	15		30		90	6

Nosilec predmeta / Lecturer: izr. prof. dr. Janko Logar, doc. dr. Boštjan Pulko

Jeziki / Languages:	
Predavanja / Lectures:	slovenski / Slovene
Vaje / Tutorial:	slovenski / Slovene

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

Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika.

Prerequisites:

Passed exams in Soil Mechanics and Engineering Geology and Geotechnics.

Vsebina:

Predavanja
Osnove mehanike kritičnega stanja tal; obnašanje zemljin pri majhnih deformacijah; nelinearni elastoplastični materialni modeli: osnovna načela, Mohrov in Coulombov model, Cam Clay model, modeli s kapo, Hardening soil model, matematična formulacija in določanje materialnih parametrov iz rezultatov preiskav; MKE v ravnini in prostoru, končni elementi v geotehniki, interakcija med konstrukcijami in tlemi; numerično reševanje nelinearnih problemov; povezani problemi: formulacija in hkratno reševanje ravnovesnih in difuzijske enačbe (konsolidacija), drenirana in nedrenirana stanja; metode modeliranja dinamičnih problemov: masna matrika in matrika dušenja, časovna integracija.

Vaje
Določanje materialnih parametrov za različne modele iz rezultatov laboratorijskih in terenskih preiskav tal numerično modeliranje različnih geotehničnih objektov (plitvi in globoki temelji,

Content (Syllabus outline):

Lectures
Basics of critical state soil mechanics, behaviour of soils at small strains; non-linear elasto-plastic material models: basic principles, Mohr Coulomb model, Cam Clay model, Cap models, Hardening Soil model, the mathematical formulation and determination of material parameters from classic soil tests; FEM in 2D and 3D, finite elements in geotechnical engineering, interaction between structures and ground; numerical solution of nonlinear problems; coupled problems: formulation and simultaneous solving of equilibrium and diffusion equations (consolidation), drained and un-drained conditions; modelling of dynamic problems: mass matrix and damping matrix, time integration.

Practical exercises:
Determination of material parameters for different soil models based on the results of laboratory and field investigations of soil. Different numerical modelling of geotechnical structures (shallow and

varovanje gradbene jame, posedanje tal pod nasipom, zemeljska pregrada, predor).	deep foundations, protection of the excavation, settlements beneath the embankment, earth dam, tunnel).

Temeljni literatura in viri / Readings:

Atkinson, J. 2007. The mechanics of soils and foundations, second edition. Taylor & Francis, 442 p.
Schweiger, H.F., Logar, J., Pulko, B. (2004). Seminar iz uporabe programa Plaxis. Ljubljana, UL FGG, Katedra za mehaniko tal, 160 str.
Elektronski viri:
Brinkgreve, R. 2012. Plaxis, users manual.
Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati načela mehanike kritičnega stanja tal - spoznati nelinearne materialne modele za zemljine - naučiti se principov numeričnega reševanja nelinearnih problemov - seznaniti se z načeli numeričnega reševanja povezanih problemov (konsolidacija). Pridobljene kompetence - Sposobnost samostojne uporabe nelinearnih numeričnih analiz za reševanje geotehničnih problemov, - Sposobnost analize in presoje rezultatov nelinearnih numeričnih analiz v geotehniki.	Objectives - To learn about the principles of critical state soil mechanics - to learn about the non-linear material models for soil - to learn the principles of numerical solution of nonlinear problems - to get acquainted with the principles of how to solve coupled problems (consolidation). Competences - The ability to use non-linear numerical analysis to solve geotechnical problems, - Ability to analyse and audit the results of nonlinear numerical analysis in geotechnical engineering.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje mehanike kritičnega stanja tal - Poznavanje osnovnih načel elastoplastičnih modelov in konkretnih materialnih modelov - Razumevanje načel numeričnega reševanja nelinearnih problemov - Razumevanje reševanja problema konsolidacije - Poznavanje načel dinamičnih analiz tal. - Obvladovanje uporabe nelinearnih numeričnih orodij za geotehnične analize. - Vzpostavitev odnosa do numeričnega modela kot zgolj poenostavljene slike realne konstrukcije. - Videti kako se matematična formulacija modela reflektira v rezultatih analize. - Sposobnost uporabe nelinearnih numeričnih orodij za geotehnične analize - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov - Sposobnost določanja materialnih parametrov za izbrane materialne modele.	- Understanding of the critical state soil mechanics - Knowledge of the basic principles of elasto-plastic models and concrete material models - Understanding of the principles of the numerical solution of nonlinear problems - Understanding of solving the problem of consolidation - Knowledge of the principles of dynamic analysis of soil. - Use of non-linear numerical tools in geotechnical engineering. - Establishing a relation to the numerical model as simplified picture of real behaviour. - To see how the mathematical formulation of the model reflects the results of the analysis. - Ability to use non-linear numerical tools in geotechnical analysis - Ability of critical analysis of the input data and obtained computational results

	- Ability to determine material parameters for the selected material models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje v računalniški učilnici.	Lectures and practical work using advanced finite-element software.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Samostojno izdelane vaje	**40 %**	Individual practical work
Izpit	**60 %**	Exam

Reference nosilca / Lecturer's references:

KUDER, Sebastjan, LOGAR, Janko. Numerični model za analizo obnašanja tlačno obremenjenih, vtisnjenih jeklenih pilotov v Luki Koper = Numerical model for the prediction of behaviour of driven steel piles under axial compression loading in the Port of Koper. Gradbeni vestnik, ISSN 0017-2774, avgust 2008, letn. 57, št. 8, str. 207-214, ilustr.

TURK, Goran, LOGAR, Janko, MAJES, Bojan. Modelling soil behaviour in uniaxial strain conditions by neural networks. Advances in engineering software, ISSN 0965-9978. [Print ed.], 2001, vol. 32, str. 805-812, graf. Prikazi.

RAVNIKAR TURK, Mojca, LOGAR, Janko. Numerical analyses of the performance of the Vogršček earth dam. V: 75th Annaual Meeting of the ICOLD, St. Petersburg, Russia, June 24-29, 2007. Dam safety management : role of state, private companies and public in designing, constructing and operating of large dams : symposium : proceedings. St. Petersburg: B. E. Vedeneev VNIIG, 2007, sess. 3-6, 8 str., graf. Prikazi.

PULKO, Boštjan. Primerjava metod za statistično analizo temeljnih plošč = Comparision of methods for static analysis of mat foundations. Gradbeni vestnik, ISSN 0017-2774, sep. 2012, letn. 61, št. 9, str. 198-205, fotograf.

PULKO, Boštjan, MAJES, Bojan, MIKOŠ, Matjaž. Reinforced concrete shafts for the structural mitigation of large deepseated landslides : an experience from the Macesnik and the Slano blato landslides (Slovenia). Landslides, ISSN 1612-510X. [Print ed.], [v tisku] 2012, letn. Xx, št. x, str. 1- 11, ilustr., doi: 10.1007/s10346-012-0372-2.

PULKO, Boštjan, MAJES, Bojan, LOGAR, Janko. Geosynthetic-encased stone columns - analytical calculation model. Geotextiles and geomembranes, ISSN 0266-1144. [Print ed.], feb. 2011, letn. 29, št. 1, str. 29-39, ilustr., doi: 10.1016/j.geotexmem.2010.06.005.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Nelinearna potresna analiza armiranobetonskih mostov
Course title:	Nonlinear seismic analysis of reinforced concrete bridges

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Gradbene konstrukcije	2	4
Civil Engineering - second cycle MA	Structural engineering	2	4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	60				90	6

Nosilec predmeta / Lecturer: prof. dr. Tatjana Isaković

Jeziki / Languages:	
Predavanja / Lectures:	angleški / English
Vaje / Tutorial:	angleški/ English

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

Osnovno predznanje na področju Projektiranja armiranobetonskih konstrukcij, Dinamike in potresne analize konstrukcij, Statike linijskih konstrukcij, Trdnosti in Gradiv. Znanje angleškega jezika.

Prerequisites:

Basic knowledge about: Analysis and design of reinforced concrete structures, Dynamics and seismic analysis of structures, Structural analysis, Strength of materials, Construction and building materials. Knowledge of English language.

Vsebina:

Predmet predstavlja uvod v nelinearno analizo armiranobetonskih konstrukcij s posebnim poudarkom na armiranobetonskih mostovih.
Vsebina:

- Osnovne zahteve sodobnih standardov za projektiranje armiranobetonskih mostov na potresnih področjih
- Osnovni numerični modeli za nelinearno analizo armiranobetonskih mostov
- Osnove sodobne poenostavljene statične potisne analize mostov
- Vpliv pomanjkljivih konstrukcijskih detajlov na potresni odziv mostov
- Sodobna programska orodja za nelinearno analizo konstrukcij.

Content (Syllabus outline):

The course is an introduction to nonlinear analysis of reinforced concrete structures with a special emphasis on reinforced concrete bridges.
Content:

- Basic requirements of modern standards for seismic design of reinforced concrete bridges
- The basic numerical models for nonlinear analysis of reinforced concrete bridges
- The basics of state-of-the-art simplified nonlinear static pushover based analysis of bridges
- The influence of substandard structural details to the seismic response of bridges
- The state-of-the-art software for the nonlinear analysis of structures.

The course will be delivered in the frame of

Predmet se bo izvajal v okviru ERASMUS+ projekta »Forecast Engineering – From Past Design to Future Decisions« Izvajal se bo v strnjeni obliki: 2 x 1 teden. Teoretična znanja, ki bodo pridobljena na predavanjih bodo, uporabljena na konkretnem primeru pri izdelavi seminarske naloge. Seminarska naloga bo vsebovala tudi vnaprejšnjo napoved cikličnega odziva mostnih stebrov, ki bodo vključeni v eksperimentalno bazo podatkov, ki bo narejena v okviru projekta »Forecast Engineering – From Past Design to Future Decisions«. Skupine študentov bodo obravnavale različne primere z različnimi konstrukcijskimi detajli. Na koncu dela bo organizirana javna predstavitev in diskusija rezultatov vseh seminarskih nalog. Število študentov iz UL je omejeno na največ 5.	ERASMUS+ project »Forecast Engineering – From Past Design to Future Decisions«. It will be organized in the condensed form: 2 x 1 week. Theoretical knowledge, that will be obtained at lectures, will be implemented in the frame of the projects. A part of the project work will include blind prediction of cyclic response of RC bridge columns, which will be included in the experimental database of the project »Forecast Engineering – From Past Design to Future Decisions«. Groups of students will analyse different cases with different structural details. At the end of the course a public presentations and discussions of the results of all projects will be organized. The number of students from UL is limited to 5.

Temeljni literatura in viri / Readings:

Kappos, Andreas J. (ed.), Saiidi, M. Saiid (ed.), Aydinoglu, M. Nuray (ed.), Isaković, Tatjana (ed.). Seismic design and assessment of bridges : inelastic methods of analysis and case studies, (Geotechnical, geological and earthquake engineering, Vol. 21). Dordrecht [etc.]: Springer, cop. 2012. XII, 221 str., ilustr. ISBN 978-94-007-3942-0. ISBN 978-94-007-3943-7

Priestely MJN, Seible F., and GM Calvi, Sesismic Design and Retrofit of Bridges, John Wiley and Sons, 1996, Selected Chapters

Otani S., Hysteresis Models of Reinforced Concrete for Earthquake Response Analysis, Journal of Faculty of Engineering, University of Tokyo, Vol. XXXVI, No. 2. 1981, pp 407-441.

CEN, 2004, EN 1998-1: Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings. Brussels: European Committee for Standardisation.

CEN, 2005, EN 1998-2: Eurocode 8: Design of structures for earthquake resistance - Part 2: Bridges. Brussels: European Committee for Standardisation.

CEN, 2005, EN 1998-3: Eurocode 8: Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings. Brussels: European Committee for Standardisation.

CEN, 2004, EN 1992-1-1: Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings. Brussels: European Committee for Standardisation.

OpenSees (2016) "Open System for Earthquake Engineering Simulation, User Command-Language Manual, ver 2.5.0", http://opensees.berkeley.edu/wiki/index.php/Command_Manual

Tcl Language-https://www.tcl.tk/about/language.html

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je, da se študenti naučijo kakšne so osnovne zahteve za projektiranje mostov na potresnih področjih, ter kako lahko ocenimo njihov potresni odziv s pomočjo poenostavljene nelinearne potisne analize. Kompetence: Študent razume sodobne postopke za projektiranje mostov na potresnih področjih, razume in obvlada osnovne numerične modele in postopke za njihovo nelinearno potresno analizo in	The objective of the course is to train the students to be able to make an assessment of the seismic response of RC bridges by means of the simplified nonlinear pushover based analysis and to be familiar with the basic requirements of modern standards for their seismic analysis and design. Competences: Students understand the modern principles for design of bridges in seismic areas; they understand and know how to apply basic

lahko uporablja sodobna programska orodja za nelinearno analizo konstrukcij. Po uspešno opravljenem predmetu bo študent lahko sodeloval v projektnih skupinah, ki se ukvarjajo s projektiranjem zahtevnejših konstrukcij, ki vključuje tudi nelinearno analizo konstrukcij.	numerical models and procedures for nonlinear seismic analysis of RC bridges and they are able to use the state-of-the-art software for non-linear analysis of structures. Upon successful completion of this course students will be able to include into the project teams working on the design of complex structures, which includes the nonlinear analysis.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje razlik med elastično in nelinearno analizo konstrukcij - Znanje in razumevanje temeljnih principov poenostavljene nelinearne potresne analize armiranobetonskih mostov. - Znanje in razumevanje prednosti in pomanjkljivosti poenostavljene nelinearne analize armiranobetonskih mostov. Sposobnost njene kompetentne uporabe. - Poznavanje in razumevanje osnovnih inženirskih modelov, ki se najbolj pogosto uporabljajo za nelinearno potresno analizo armiranobetonskih mostov. - Poznavanje osnovnih zahtev za projektiranje armirano betonskih mostov na potresnih področjih, s posebnim poudarkom na Evrokod standardih. - Poznavanje in osnovna uporaba sodobnih programskih orodij za nelinearno analizo armiranobetonskih konstrukcij.	- Understanding of differences between elastic and nonlinear analysis of structures. - Knowledge and understanding of the basic principles of simplified nonlinear pushover based seismic analysis of RC bridges. - Knowledge and understanding of basic advantages and deficiencies of simplified nonlinear analysis. The ability of its competent use. - Knowledge and understanding of basic engineering models, which are typically used for the nonlinear seismic analysis of bridges. - Knowledge about the basic requirements of modern standards for the seismic design of RC bridges, with an emphasis to Eurocode standards. - Knowledge about state-of-the-art software for the nonlinear analysis of structures. The ability of its use.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Organizirano delo bo potekalo v strnjeni obliki, dvakrat po en teden. Potrebna teoretična znanja bodo predstavljena na predavanjih. Ta znanja bodo uporabljena v okviru seminarja. Študenti bodo razdeljeni v skupine. Vsaka skupina bo izdelala seminarsko nalogo, kjer bo treba narediti nelinearno potisno analizo mostu. Seminar bo vseboval tudi vnaprejšnjo napoved odziva armiranobetonskih stebrov, ki bo primerjan z rezultati eksperimentov. Študent bo vključen v skupinsko in projektno delo. Skupinsko delo in konzultacije z mentorji bodo potekali na daljavo z uporabo sodobnih IT orodij.	The organize work will be performed in the condensed form – 2 times 1 week. The theoretical background will be presented within lectures. It will be used in the frame of the project work. Student s will be included into project teams. Project teams will perform the pushover based nonlinear analysis of a bridge. The projects will also include the blind prediction of the response of RC columns, which will be compared with the experimental results. Students will be included into project and team work. Project and team work as well as consultations with mentors will include IT supported distance collaboration.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga	**30 %**	Project
Sprotno ocenjevanje samostojnosti, iniciativnosti in zavzetosti pri izdelavi seminarske naloge	**30 %**	The ongoing assessment of independence, initiative and commitments during the project work.
Javna predstavitev seminarske naloge	**10%**	Public presentation of the project
Kritična diskusija in povzetek rezultatov seminarskih nalog	**30%**	Critical discussion and summary of the results of projects
Vsi deli morajo biti pozitivno ocenjeni.		All parts should be graded positively

Reference nosilca / Lecturer's references:

Izbrane reference/Selected references:
Članica projektne skupine PT3 za prenovo in dopolnitev evropskega standarda EN 1998-3: Eurocode 8: Projektiranje potresnoodpornih konstrukcij – 3. del: Ocena in prenova stavb in mostov/ Member of the project team PT3 for further developments of the European standard EN 1998-3: Eurocode 8: Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings and bridges

ANŽLIN, Andrej, FISCHINGER, Matej, ISAKOVIĆ, Tatjana. Cyclic response of I-shaped bridge columns with substandard transverse reinforcement. Engineering structures, ISSN 0141-0296. [Print ed.], sept. 2015, Vol. 99, pp. 642-652

ISAKOVIĆ, Tatjana. Assessment of Existing Structures Using Inelastic Static Analysis. V: BEER, Michael (ed.). Encyclopedia of Earthquake Engineering. Berlin: Springer, 2014, pp. 1-14, doi: 10.1007/978-3-642-36197-5_201-1

KAPPOS, Andreas J. (ed.), SAIIDI, M. Saiid (ed.), AYDINOGLU, M. Nuray (ed.), ISAKOVIĆ, Tatjana (ed.). Seismic design and assessment of bridges : inelastic methods of analysis and case studies, (Geotechnical, geological and earthquake engineering, Vol. 21). Dordrecht [etc.]: Springer, cop. 2012. XII, 221 str., ilustr. ISBN 978-94-007-3942-0. ISBN 978-94-007-3943-7

ISAKOVIĆ, Tatjana. Evrokodi : gradivo za izobraževalni tečaj o Evrokodih : projektiranje potresno odpornih mostov po pravilih iz Evrokoda 8/2 : navodila in komentar izbranih določil. Ljubljana: Inženirska zbornica Slovenije: Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, 2010.

ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Higher modes in simplified inelastic seismic analysis of single column bent viaducts. Earthquake engineering & structural dynamics, ISSN 0098-8847. [Print ed.], 2006, Vol. 35, No. 1, pp 95-114

ISAKOVIĆ, Tatjana, FISCHINGER, Matej. Engineering modelling for inelastic seismic response of RC bridge columns. International journal for engineering modelling, ISSN 1330-1365, 1998, vol. 11, no. 3/4, pp. 67-72