Univerza v Ljubljani
Fakulteta za gradbeništvo in geodezijo

Učni načrti

Magistrski študijski program druge stopnje

GRADBENIŠTVO (MA)

Course Syllabi

2nd Cycle Master Study

CIVIL ENGINEERING (MA)

Velja od 2024/2025 | Valid from 2024/2025

Veljavni študijski program na dan 20.1.2024 | Valid study programme at January 20, 2024

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UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MATEMATIKA 3**
Course title:	**MATHEMATICS 3**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1617

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Gašper Jaklič
Vrsta predmeta/Course type:	obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. primerljive vsebine matematike v obsegu najmanj 15 KT.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content with min. 15 ECTS.

Vsebina:	Content (Syllabus outline):
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.	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

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

Temeljna 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	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model - Basic theoretical knowledge for using in practical problems

- Sposobnost kritične presoje rezultatov - Poznavanje računalniških orodij (Mathematica, Matlab) - Dosežena matematična podlaga za strokovne predmete	- 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/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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:	**METODE KONČNIH ELEMENTOV V GRADBENIŠTVU**
Course title:	**FINITE ELEMENT METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1453

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Brank
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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,

- FEM analize, - Kritična ocena rezultatov.	- Critical evaluation of numerical results.

Temeljna 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/Weight	Assessment:
Računski del izpita: modeliranje in analiza problema z računalnikom	50,00 %	FEM modelling, analysis and evaluating of results of a civil engineering problem
Teoretični del izpita	50,00 %	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:	**GEOTEHNIKA NIZKIH GRADENJ**
Course title:	**GEOTECHNICS OF INFRASTRUCTURAL FACILITIES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1488

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Janko Logar
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika.	Passed exams in Soil Mechanics and Engineering Geology and Geotechnics.

Vsebina:	Content (Syllabus outline):
Predavanja Metode izboljšanja tal (preobremenitev, radialna konsolidacija, dinamična komprimacija, gruščnati koli, injektiranje, jet grouting, metode površinskega in globinskega mešanja z anorganskimi in organskimi vezivi); strujanje podzemne vode skozi zasičena izotropna in anizotropna tla, vzgon, kritični hidravlični gradient, hidravlične porušitve (hidravlični lom tal, notranja erozija, piping); zemeljske pregrade: strujanje vode skozi pregrado, ukrepi za zmanjšanje neugodnih posledic, načrtovanje filtrov, stabilnost zemeljskih pregrad v statičnih pogojih in v	Lectures Methods of soil improvement (pre-loading, radial consolidation, dynamic compaction, stone columns, grouting, jet grouting, methods of surface and deep mixing with inorganic and organic binders); groundwater flow through saturated isotropic and anisotropic soil, buoyancy, critical hydraulic gradient, hydraulic fracture (hydraulic failure, internal erosion, piping); earth dams: flow of water through dam, measures to reduce the adverse consequences, filter design, stability of earth dams under static and dynamic (seismic) conditions; liquefaction of soil;

slučaju potresne obtežbe; likvifakcija tal; raba geosintetikov za tesnjenje, filtriranje, ločevanje in armiranje; analiza in upravljanje z geotehnično pogojenimi tveganji. Vaje Račun učinka izboljšave tal z vertikalnimi drenažami, gruščnatimi koli, preobtežbo (peš in z uporabo računalniških orodij); analiza strujanja vode skozi in pod zemeljsko pregrado; stabilnostna analiza prečnega prereza zemeljske pregrade v statičnih pogojih in pogojih delovanja seizmičnih vplivov; analiza likvifakcije tal na osnovi rezultatov terenskih in laboratorijskih preiskav tal; dimenzioniranje mineralnih filtrov v pregradi; dimenzioniranje in izbira geosintetikov za namen ločevanja, filtracije, tesnjenja; analiza in načrt armirane brežine; izdelava kataloga tveganj in analize tveganja za izbran geotehnični projekt.	use of geosynthetics: sealing, filtration, separation and reinforcement; analysis and management of geotechnical risks. Exercises Ground improvement with vertical drains, stone columns, pre-loading (analytical methods and by using computer tools); analysis of the groundwater flow through dam and subsoil; stability analysis of earth dam under static and seismic conditions, seismic impact; analysis of soil liquefaction based on the results of field and laboratory tests of soils; sizing of mineral filters in earth dam; the design and choice of geosynthetics for separation, filtration and sealing; analysis and design of reinforced earth; risk analysis for a selected geotechnical project.

Temeljna literatura in viri/Readings:

SIST EN1997-1:2005 Evrokod 7-1: Geotehnično projektiranje - 1. del Splošna pravila.

SIST EN1997-2:2007 Evrokod 7-2: Geotehnično projektiranje - 2. del Preiskovanje in preskušanje tal.

Vaníček I, Vaníček M. 2008. Earth Structures in Transport, Water and Environmental Engineering, Springer, 637 str.

Moseley, M.P., Kirsch, K. 2006. Ground improvement, Taylor & Francis, London, 432 p.

Recommendations for Design and Analysis of Earth Structures using Geosynthetic Reinforcement

EBGEO, Ernst & Sohn, DGGT, 2011.

Nonveiller, E. 1983. Nasute brane, projektiranje i građenje, Školska knjiga Zagreb.

Clayton, C.R.I. 2001. Managing geotechnical risk, Thomas Thelford. Elektronski viri:

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
- Spoznati metode izboljšanja tal, njihove dobre strani in omejitve v posameznih pogojih tal in predvidene vrste gradnje - Spoznati zakonitosti strujanja podzemne vode in precejanje skozi zemeljske pregrade ter potencialne probleme, ki iz tega izhajajo ter možne rešitve - Seznaniti študenta z vplivi potresa na tla in geotehnične objekte (vpliv na stabilnost in likvifakcijo)	- To learn about methods of soil-improvement, their benefits and restrictions based on specific ground conditions and type of construction - To learn about groundwater flow and percolation through earth dams (structures) and potential problems and possible solutions - To acquaint student with the effects of earthquakes on the ground and geotechnical facilities (impact on stability and liquefaction)

- Predstaviti možnost uporabe geosintetičnih materialov v geotehničnem inženirstvu - Predstaviti geotehnično pogojena tveganja in preproste možnosti analize in upravljanja s tveganji	- To present the possibility of using geosynthetic materials in geotechnical engineering - To present the geotechnical risks and to perform simple risk management analysis.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent pozna metode izboljšanja tal in se zna odločiti katera je primerna v določenih pogojih - Razume in pozna metode za račun stacionarnega toka vode skozi zasičena izotropna in anizotropna tla ter skozi zemeljske pregrade - Zna analizirati vpliv strujanja vode glede na možnost pojava hidravličnega lom tal in notranje erozije - Razume vpliv potresne obtežbe na zemeljske pregrade in zna vpliv upoštevati v analizi stabilnosti - Razume pojav likvifakcije tal in ga zna ovrednotiti - Pozna možnosti uporabe geosintetikov glede filtracije, separacije, tesnenja in armiranja - Razume geotehnično pogojena tveganja in jih zna analizirati.	- Student knows the methods of soil improvement and is able to decide which is suitable under certain conditions - Student understands and knows methods for stationary flow of water through saturated isotropic and anisotropic soil and through earth dams - Ability to analyze the impact of groundwater flow depending on the optional occurrence of hydraulic failure and internal erosion - Understanding of the impact of seismic actions on earth dams and how to take them into account (stability analysis) - Understanding of the phenomena of liquefaction of soil and how to evaluate the associated risk - Knowledge of geosynthetics with respect to filtration, separation, sealing and reinforcement - Understanding of geotechnical risks and how to analyze them.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, vaje v računalniški učilnici, samostojno delo.	Lectures, tutorials, exercises in the computer lab, individual work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični izpit	35,00 %	Theoretical exam
Računski izpit ali 2 kolokvija	50,00 %	Written exam or 2 midterm tests
Samostojno delo	15,00 %	Individual work (Seminar)

Reference nosilca/Lecturer's references:

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.

ŠTRUKELJ, Andrej, ŠKRABL, Stanislav, ŠTERN, Ksenija, LOGAR, Janko. The assesment of pile shaft resistance based on axial strain measurements during the loading test. Acta geotechnica Slovenica, ISSN 1854-0171, 2005, letn. 2, št. 2, str. 12-23.

LOGAR, Janko, FIFER BIZJAK, Karmen, KOČEVAR, Marko, MIKOŠ, Matjaž, RIBIČIČ, Mihael, MAJES, Bojan. History and present state of the Slano Blato landslide. Natural hazards and earth system sciences, ISSN 1561-8633, 2005, 5, str. [447]-457.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**HIDRAVLIČNO MODELIRANJE**
Course title:	**HYDRAULIC MODELLING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1487

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	15	0	45	0	105	7

Nosilec predmeta/Lecturer:	Gašper Rak, Matjaž Četina, Gorazd Novak
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Hidromehanika in Hidravlika oz. osvojena ustrezna primerljiva znanja	Passed exams in Hydromechanics and Hydraulics or adequate comparable knowledge.

Vsebina:	Content (Syllabus outline):
a. Sklop “Hidravlika nestalnega toka” Predavanja: Nestalni tok s prosto gladino (vrste valov, osnovne Saint Venantove enačbe, metode reševanja – metoda karakteristik, eksplicitne in implicitne metode končnih razlik, začetni in robni pogoji, osnove dvodimenzijskih problemov, osnove in primeri gibanja nenewtonskih tekočin – snežni plazovi, drobirski tokovi). Vodni udar v ceveh pod tlakom (opis pojava, izpeljava dinamične in kontinuitetne enačbe, metoda karakteristik, začetni in robni pogoji, ukrepi za blažitev vodnega udara). Vodostani (opis, izpeljava kontinuitetne in dinamične	a. The "Hydraulics of unsteady flow" Lectures: Unsteady free surface flow (types of waves, basic Saint Venant equations, solving methods - the method of characteristics, explicit and implicit finite difference methods, initial and boundary conditions, basics of two-dimensional problems, basics and examples of the movement of non- Newtonian fluids - avalanches, debris flows). Water hammer in pipes under pressure (description of the phenomenon, the derivation of the dynamic and continuity equations, method of characteristics, initial and boundary conditions, measures to mitigate water hammer).

enačbe, enačba nedušenega nihanja, metode reševanja, stabilnost vodostanov, vrste vodostanov, njihova izbira in način računanja). Teorija valov malih amplitud, analitične rešitve osnovnih enačb. Vaje Laboratorijske vaje (potujoči vodni skok, meritve na fizičnem modelu vodostana, uporaba računalniških programov za račun poplavnih, obratovalnih in poplavnih valov ter vodnega udara – delo v računalniški učilnici). b. Sklop "Hidravlika II" Predavanja: Stalni neenakomerni tok (zahtevni primeri robnih pogojev, opis programske opreme). Fizični hidravlični modeli (dimenzijska analiza, principi teorije podobnosti, distorzirani modeli, proces konstruiranja modela, kriteriji za izbiro fizičnega ali matematičnega modela). Modeliranje hidravličnih objektov (opis hidravličnih lastnosti posameznih objektov oz. naprav, njihovo modeliranje, robni pogoji in načrtovanje ter preverjanje tehničnih zahtev). Modeliranje zahtevnejših cevovodnih sistemov z orodji umetne inteligence (opis hidravličnih lastnosti, karakteristike elementov modeliranja in obratovalnih razmer, verifikacija-umerjanje-validacija modelov cevovodnih sistemov). Vaje Laboratorijske vaje (modelna podobnost, osnove merilne tehnike in enostavni merilni sistemi, meritve na fizičnih modelih pregrad, usedalnikov ipd., hidravlično dimenzioniranje sistemov). Seminar Izdelava samostojne seminarske naloge, ki obsega: uporabo 1D ali 2D modela za račun zahtevnejšega primera neenakomernega toka v vodotoku ali hidravlično modeliranje zahtevnejšega cevovodnega sistema ali hidravlično modeliranje zahtevnejšega hidrotehničnega objekta.	Surge tanks (description and derivation of the dynamic equation, equation of undamped oscillations, solution methods, stability of surge tanks, types of surge tanks and their selection and methods of computation). The theory of waves of small amplitude, analytic solutions of basic equations. Tutorials Laboratory tutorials (travelling hydraulic jump, measurements on a physical model of a surge tank, the use of computer programs for examples of flood, operating and flood waves and water hammer - work in the computer lab). b. "Hydraulics II" Lectures: Steady non-uniform flow (complex cases of boundary conditions, simulation software). Physical hydraulic models (dimensional analysis, principles of the theory of similarity, distorted models, model design processes, criteria for the selection of a physical or mathematical model). Modelling of hydraulic structures (description of the hydraulic properties of objects or devices and their modelling, boundary conditions and the design and verification of technical requirements). Modelling of complex pipe systems using the tools of artificial intelligence (description of hydraulic properties, characteristic elements of modelling and operating conditions, verification – calibration - validation of hydraulic models of pipe systems). Tutorials Laboratory work (model similarity, measurement techniques and simple measuring systems, measurements on physical models of dams, sedimentation tanks, etc.., hydraulic dimensioning of systems). Seminar Elaboration of individual seminar/project report comprising: use of 1D or 2D models for complex case of steady non-uniform flow in open channels or hydraulic modelling of complex pipe systems or hydraulic modelling of complex hydraulic structure.

Temeljna literatura in viri/Readings:

Steinman, F. 2010. Hidravlika, učbenik. Ljubljana, UL FGG, str. 295.

Rajar, R. 1980. Hidravlika nestalnega toka, univerzitetni učbenik. Ljubljana, UL FGG, str. 279.

Ivetić, M. 1996. Računska hidraulika – tečenje u cevima. Beograd, Građevinski fakultet, str. 306.

US Army Corps of Engineers: HEC-RAS.

Dostopno na: http://www.hec.usace.army.mil/software/hec-ras .

US Environmental Protection Agency: EPANET.

Dostopno na: http://www.epa.gov/nrmrl/wswrd/dw/epanet.html .

Cilji in kompetence:	**Objectives and competences:**
Cilji a. Sklop “Hidravlika nestalnega toka” - Nadgraditi znanje hidravlike stalnega toka s teoretičnimi osnovami in načini reševanja nestalnega toka s prosto gladino in nestacionarnih pojavov v ceveh pod tlakom. - Podati načine uporabe matematičnih modelov oz. računalniških programov za račun poplavnih, obratovalnih in porušitvenih valov kot osnove za dimenzioniranje hidrotehničnih objektov. b. Sklop “Hidravlika II” - Spoznati zahtevnejše primere stalnega neenakomernega toka v odprtih vodotokih in v vodnogospodarskih sistemih ter njihova obratovalna stanja, z upoštevanjem specifičnih robnih pogojev. - Podati proces izdelave hidravličnih fizičnih modelov, prikaz ustreznih merilnih metod in opreme s podpornimi računalniškimi programi. - Nadgraditi osnovno znanje hidravlike z modeliranjem zahtevnejših hidravličnih objektov in naprav. - Podati načine hidravličnega modeliranja zahtevnejših sistemov, vključno z verifikacijo, kalibracijo in validacijo modelov. Kompetence a. Sklop “Hidravlika nestalnega toka” - Sposobnost pravilne definicije gonilnih sil, njim primerne izbire ustreznih osnovnih enačb in pravilne uporabe računalniških programov za določanje merodajnih količin pri nestalnih tokovih. - Sposobnost posploševanja in razumevanja sorodnih pojavov nestalnega toka s prosto gladino in v cevnih sistemih pod tlakom. b. Sklop “Hidravlika II”	Objectives a. “Hydraulics of unsteady flow” - Upgrade the knowledge of hydraulics of steady flow with theoretical foundations and methods of solving unsteady free surface flow and non-stationary phenomena in pipes under pressure. - Provide uses of mathematical models or computer programs for the calculation of flood, operating and dam-break flood waves as the basis for the design of hydraulic structures. b. “Hydraulics II” - Knowledge of complex steady non-uniform flows in open channels and in water management systems, their operating modes and specific boundary conditions. - Provide process of planning and construction of hydraulic physical models, appropriate measuring methods and equipment to support computer programs. - Upgrade the basic knowledge of hydraulic modelling to handle with complex hydraulic structures and facilities. - Overview of the diversity of hydraulic modelling for complex systems or structures, including verification, calibration and validation procedures for particular hydraulic model. Competences a. "Hydraulics of unsteady flow" - Ability to correctly define the driving forces, appropriate selection of the relevant basic equations and the correct application of computer programs for unsteady flows. - Ability to generalize and to understand the related phenomena of unsteady free surface flow and flow in pipe systems under pressure.

- Sposobnost oceniti, kdaj zadošča matematični model in kdaj je nujen fizični model. - Razumeti negotovost rezultatov fizičnega modeliranja oz. izračunov. - Obvladovanje procesov umerjanja, validacije in kritične ocene rezultatov matematičnih modelov ter prenosa s fizičnih modelov v naravo za najzahtevnejše primere tokov v hidrotehnični praksi.	b. "Hydraulics II" - Ability to assess whether the use of mathematical model is appropriate or physical models are necessary. - Understand the uncertainty of the results (from physical or mathematical models). - Acquire adequate skills for calibration and validation processes, critical evaluation of the results of mathematical models and the transfer of results of physical models to nature for complex flows in the field of hydraulics.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje za račun najzahtevnejših primerov stalnega neenakomernega toka v odprtih koritih. - Razumevanje in sposobnost analize cevovodnih sistemov in naprav z naprednimi orodji. - Razumevanje in sposobnost analize zahtevnejših postrojev hidrotehničnih objektov. - Poznavanje lastnosti nestalnega toka v odprtih koritih (valovi) in ceveh pod tlakom (vodni udar). - Doseženo znanje uporabljajo pri izdelavi najzahtevnejših hidravličnih izračunov pri urejanju vodotokov, energetski izrabi rek ter načrtovanju vodovodov in kanalizacij. - Študentje morajo dobro razumeti fizikalne osnove prehodnih pojavov v hidravličnih sistemih, iskati analogijo med pojavi v odprtih koritih in ceveh pod tlakom ter spoznati povezanost elementov na hidrotehničnih objektih. Tako razumejo, kaj poenostavitve enačb pomenijo za točnost rezultatov. - Sposobnost sestave lastnih računalniških programov na osnovi ustrezno izbranih enačb. - Sposobnost zasnovati hidravlični fizični model z ustrezno merilno opremo in analize veličin. - Sposobnost uporabe in kritične presoje tujih računalniških programov za hidravlične izračune. - Sposobnost upoštevanja prehodnih pojavov pri pravilnem dimenzioniranju hidravličnih sistemov.	- Acquired in-depth knowledge of complex cases of steady non-uniform flow in open channels. - Understanding of and ability to analyse pipe systems and facilities with advanced tools. - Understanding of and ability to analyse complex devices or installations at hydro- technical facilities. - Knowledge of the characteristics of unsteady flow in open channels (waves) and pressurized pipes (water hammer). - Achieved knowledge used for the elaboration of complex hydraulic calculations in water river management, energy utilization of rivers and planning of water supply systems and sewer systems. - Students need profound understanding of the physical basis of transient phenomena in hydraulic systems, search for analogies between the phenomena in open channels and pressurised pipe systems and identify the connection of elements of hydraulic structures. This facilitates their understanding of the equation simplification for the accuracy of the results. - Ability to structure their own computer programs based on appropriately selected equations. - Ability to design hydraulic physical models with an appropriate measuring equipment and analysis variables. - Ability to use and critically assess foreign computer programs for hydraulic calculations. - Ability to take into account transient phenomena in the correct dimensioning of hydraulic systems.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, seminar in laboratorijske vaje.	Lectures, seminar and laboratory tutorials.

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit (izpit iz teorije sklopov a. in b.)	50,00 %	Written exam (theory of part a. and b.)
Seminarska naloga (pisno, oddaja seminarja sklopa b.)	25,00 %	Seminar work (written, submission of part b.)
Domače naloge (pisno, oddaja vaj sklopa a.)	25,00 %	Home practicals (written, submission of practicals part a.)

Reference nosilca/Lecturer's references:

KRZYK, Mario, ČETINA, Matjaž. Analysis of flow in a curved channel using the curvilinear orthogonal numerical mesh. *Strojniški vestnik*. Sep. 2018, vol. 64, no. 9, str. 536-542. DOI: 10.5545/sv-jme.2017.5183.

BOMBAČ, Martin, NOVAK, Gorazd, MLAČNIK, Jure, ČETINA, Matjaž. Extensive field measurements of flow in vertical slot fishway as data for validation of numerical simulations. *Ecological engineering*. [Print ed.]. 2015, letn. 84, str. 476-484. DOI: 10.1016/j.ecoleng.2015.09.030.

DŽEBO, Elvira, ŽAGAR, Dušan, KRZYK, Mario, ČETINA, Matjaž, PETKOVŠEK, Gregor. Different ways of defining wall shear in smoothed particle hydrodynamics simulations of a dam-break wave. *Journal of hydraulic research*. 2014, letn.52, št. 4, str.453-464. DOI: 10.1080/00221686.2013.879611.

NOVAK, Gorazd, PENGAL, Polona, SILVA T., Ana, DOMINGUEZ, Jose Manuel, TAFUNI, Angel, ČETINA, Matjaž, ŽAGAR, Dušan. Interdisciplinary design of a fish ramp using migration routes analysis. *Ecological modelling*. [Print ed.]. jan. 2023, vol. 475, 12 str. DOI: 10.1016/j.ecolmodel.2022.110189.

NOVAK, Gorazd, DOMÍNGUEZ, José M., TAFUNI, Angel, SILVA T., Ana, PENGAL, Polona, ČETINA, Matjaž, ŽAGAR, Dušan. 3-D numerical study of a bottom ramp fish passage using smoothed particle hydrodynamics. *Water*. 1 Jun. 2021, vol. 13, iss. 11, [article no.] 1595, str. 1-19. DOI: 10.3390/w13111595.

BOMBAČ, Martin, ČETINA, Matjaž, NOVAK, Gorazd. Study on flow characteristics in vertical slot fishways regarding slot layout optimization. *Ecological engineering*. [Print ed.]. okt. 2017, letn. 107, str. 126-136. DOI: 10.1016/j.ecoleng.2017.07.008.

ŠKERJANEC, Mateja, KREGAR, Klemen, ŠTEBE, Gašper, RAK, Gašper. 2022. Analysis of floating objects based on non-intrusive measuring methods and machine learning. Geomorphology: an international journal of pure and applied geomorphology, 408. DOI: 10.1016/j.geomorph.2022.108254.

RAK, Gašper, HOČEVAR, Marko, STEINMAN, Franci. 2018. Construction of water surface topography using LIDAR data. Strojniški vestnik, 64 (9): 555-565. DOI: 10.5545/sv-jme.2017.4619.

RAK, Gašper, HOČEVAR, Marko, STEINMAN, Franci. 2020. Non-intrusive measurements of free-water-surface profiles and fluctuations of turbulent, two-phase flow using 2-D laser scanner. Measurement science & technology: 1-14. DOI: 10.1088/1361-6501/ab727f.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**HIDROLOŠKO MODELIRANJE**
Course title:	**HYDROLOGICAL MODELLING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1587

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	60	0	90	6

Nosilec predmeta/Lecturer:	Mojca Šraj
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmeta Hidrologija ali ustrezna primerljiva znanja.	Passed exam in Hydrology or adequate comparable knowledge.

Vsebina:	Content (Syllabus outline):
Predavanja: Modeli, klasifikacija, uporaba osnov teorije sistemov. Osnove uporabe stohastike v hidrologiji. Hidrogram enote in sintetični hidrogram enote. Metode za oceno točnosti rezultatov modeliranja. Regionalizacija hidroloških pojavov. Poplave in hidrološke prognoze. Modeliranje podzemnih voda. Vplivi posameznih objektov na spremembo režima voda. Vaje: Laboratorijske vaje v računalniški učilnici z uporabo hidroloških modelov (HEC-HMS, HBV ipd.) in	Lectures Models, classification, application of basics of systems theory. Basics of application of stochastic in hydrology. Unit hydrograph (UH) and synthetic unit hydrograph. Methods for estimating accuracy of modelling results. Regionalisation in hydrology. Floods and hydrological forecast. Groundwater modelling. Influence of individual structures on changes in water regime. Tutorials

modelov podtalnice (MODFLOW, PESTAN – avtomatska kalibracija) v kombinaciji z osnovnimi GIS orodji (SAGA) za določitev vhodnih podatkov v modele.	Lab tutorials in computer classroom using hydrological models (HEC-HMS, HBV, etc.) and groundwater flow models (MODFLOW, PESTAN – automatic calibration) in combination with the basic GIS tools for the model input data assessment.

Temeljna literatura in viri/Readings:

BRILLY, Mitja, ŠRAJ, Mojca. 2006. Modeliranje površinskega odtoka in navodila za program HEC-HMS. Ljubljana, Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, VII, 172 str.

ŠRAJ, Mojca. 2010. Model podzemnega toka = Ground water flow model. Ljubljana, Fakulteta za gradbeništvo in geodezijo, 22 str.

ŠRAJ, Mojca, NARTNIK, Miha, BRILLY, Mitja. 2009. Priročnik za uporabo programa MODFLOW in 3D Groundwater Explorerja. Ljubljana Fakulteta za gradbeništvo in geodezijo, VI, 247 str.

Maidment, D. R. 1992. Handbook of Hydrology, izbrana poglavja. McGraw-Hill, 1424 str.

Kresic, N. 1997. Quantitative Solutions in Hydrogeology and groundwater modeling, izbrana poglavja. New York, Lewis Publishers, 461 str.

Strani ARSO z bazami hidroloških in meteoroloških podatkov.

Dostopno na: http://www.arso.gov.si/ .

Hidrološko izrazje v slovenskem, angleškem, francoskem in nemškem jeziku.

Dostopno na: ftp://ksh.fgg.uni-lj.si/acta/a32_1.pdf .

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi osnovno znanje hidrologije pri uporabi hidroloških modelov. - Podati osnove izdelave hidroloških modelov. - Podati teoretične osnove za analizo rezultatov hidroloških modelov. Kompetence - Sposobnost kritične uporabe različnih hidroloških modelov pri urejanju vodnega režima.	Objectives - Upgrading of basic knowledge in hydrology by application of hydrologic models. - Basics of hydrological modelling. - Theoretical background of analysing the results of hydrological models. Competences - Ability of using different hydrological models for water regime managemen.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje iz hidrološkega modeliranja. - Osvojene računske spretnosti za pripravo podatkov, umerjanje hidroloških modelov in analizo rezultatov.	- Advanced knowledge in hydrological modeling. - Computer skills in data preparation, model calibration and results analysing. - Using knowledge for the preparation of master degree and/or in engineering practice.

- Doseženo znanje uporabljajo pri izdelavi diplomskega dela oz. v inženirski praksi. Refleksija: - Dobro razumevanje gibanja vode in vpliva različnih ukrepov na hidrološki vodni režim. - Sposobnost abstraktne formulacije naravnih procesov. - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ukrepov. - Sposobnost ugotavljanja skladnosti modelov dogajanja z opazovanim razvojem v naravi. - Sposobnost upoštevanja dinamike naravnih procesov pri načrtovanju človekove dejavnosti v prostoru. - Sposobnost uporabe računalniških programov za analizo hidroloških pojavov.	Reflection: - Good understanding of water motion and influence of different measures on water regime. - Ability of abstract formulation of natural processes. - Ability of critical judgment of input data and calculated results for planning measures. - Ability to assess compliance of models with observations in nature. - Ability to consider the dynamic of hydrological processes for planning human activity in space. - Ability of using software for hydrologic analyses.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, meritve, uporaba IKT, skupinsko in problemsko zasnovano delo, interaktivno delo preko spletne učilnice (forumi, klepetalnice, kvizi, lekcije, dnevniki, individualno reševanje nalog, Wiki).	Lectures, lab tutorials, measurements, using ICT, group and problem-based work, interactive work through e-classroom (forums, chats, quizzes, lessons, blogs, individual exercises, Wiki).

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
teoretični del	20,00 %	theoretical part
Oddane vaje 2 kolokvija ali izpit:	40,00 %	Coursework/lab exercises two mid-term exams or final exam:
računski del	40,00 %	practical part

Reference nosilca/Lecturer's references:

ŠRAJ, Mojca, BEZAK, Nejc. Comparison of time trend- and precipitation-informed models for assessing design discharges in variable climate. Journal of Hydrology, 2020, letn. 589, str. 1-10,

LAVTAR, Katarina, BEZAK, Nejc, ŠRAJ, Mojca. Rainfall-runoff modeling of the nested non-homogeneous Sava river sub-catchments in Slovenia. Water, 2020, letn. 12, št. 1, 128, str. 1-13.

SEZEN, Cenk, BEZAK, Nejc, BAI, Yun, ŠRAJ, Mojca. Hydrological modelling of karst catchment using lumped conceptual and data mining models. Journal of Hydrology, 2019, letn. 576, št. sept., str. 98-110.

BLÖSCHL, Günter, HALL, Julia, VIGLIONE, Alberto, PERDIGÃO, R. A. P., PARAJKA, Juraj, MERZ, Bruno, LUNN, David, ARHEIMER, Berit, ARONICA, G. T., BILIBASHI, A., BOHAČ, Milan, BONACCI, Ognjen, BORGA, Marco, ČANJEVAC, Ivan, CASTELLARIN, Attilio, CHIRICO, G. B., CLAPS, P., FROLOVA, Natal´ja Leonidovna, GANORA, Daniele, GORBACHOVA, Liudmyla, GÜL, Ali, HANNAFORD, J., HARRIGAN, S., KIREEVA, Maria, KISS, A.,

KJELDSEN, Thomas Rodding, KOHNOVÁ, Silvia, KOSKELA, Jarkko, LEDVINKA, O., MACDONALD, Neil, MAVROVA-GUIRGUINOVA, M., MEDIERO, Luis, MERZ, R., MOLNAR, P., MONTANARI, Alberto, MURPHY, Conor, OSUCH, M., OVCHARUK, Valeriya, RADEVSKI, Ivan, SALINAS, Jose Luis, SAUQUET, E., ŠRAJ, Mojca, SZOLGAY, J., VOLPI, Elena, WILSON, Donna, ZAIMI, K., ŽIVKOVIĆ, Nenad. Changing climate both increases and decreases European river floods. Nature, 2019, letn. 573, št. sept., str. 108-111.

ŠRAJ, Mojca, VIGLIONE, Alberto, PARAJKA, Juraj, BLÖSCHL, Günter. The influence of non-stationarity in extreme hydrological events on flood frequency estimation. Journal of Hydrology and Hydromechanics, 2016, letn. 64, št. 4, str. 426-437.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**POTRESNO INŽENIRSTVO**
Course title:	**SEISMIC ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1491

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Dolšek
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmeta Osnove potresnega inženirstva na prvi stopnji ali osvojena primerljiva znanja.	Passed exam in Fundamentals of Earthquake Engineering or similar course.

Vsebina:	Content (Syllabus outline):
Predavanja Uvod v dinamiko gradbenih konstrukcij; dinamični odziv sistemov z eno prostostno stopnjo; osnove dinamičnega odziva sistemov z več prost. stopnjami; 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); osnovni pojmi in načela potresnoodpornega projektiranja (nosilnost in duktilnost, togost, dušenje, zasnova konstrukcij); obnašanje geotehničnih in hidrotehničnih; (pregrade, cevovodi,	Lectures Introduction to dynamics of structures, the dynamic response of the single-degree- of-freedom system under seismic action; the dynamic response of structures with multi-degree-of-freedom; basics of earthquakes and seismic action (introduction, causes for earthquakes, intensity measures, earthquakes in space and time, characteristics of seismic ground motion, concept of reduction of seismic forces, the design spectrum); basic concepts and principles of earthquake- resistant design of structures (strength,

vodovodna in kanalizacijska omrežja) objektov med potresi; poenostavljen način računa pri potresni obtežbi. Vaje Laboratorijske vaje (v računalniški učilnici): dinamični odziv sistemov z eno prostostno stopnjo. Individualne naloge (v rač.učilnici): analiza enostavnega hidrotehničnega ali geotehničnega objekta pri potresni obtežbi.	ductility, stiffness, damping, basics for preliminary design); behaviour of geotechnical and hydrotechnical structures (dams, pipelines, water and sewer system); simplified seismic analysis. Tutorials in computer lab: Dynamic response of single-degree-of- freedom system. Seismic analysis of hydrotechnical or geotechnical structure.

Temeljna literatura in viri/Readings:

P.Fajfar. 1995. Fundamentals of earthquake engineering (in Slovenian). Ljubljana,UL FGG, 83 pp.

P.Fajfar. 1984. Dynamics of structures (in Slovenian). Ljubljana, UL FGG, str.1-20, 27-88, 109-119, 132-144, 325-338.

M. Dolšek. 2007. Seismic analysis of simple buildings using ETABS (in Slovenian).

P.Fajfar, M.Fischinger, D.Beg, M.Dolšek, T.Isaković, M.Kreslin, M.Rozman, Z.Vidrih, B. Čermelj. 2009. Eurocode 8: Design of earthquake-resistant structures (in Slovenian), (In Manual for design of structures using Eurocode 8, Eds. D. Beg and A.Pogačnik) (selected chapters).

Forign students can use literature in English after consultation with the Lecturer.

EASY (Earthquake Engineering Slide Information System), IKPIR FGG, CD.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati osnove dinamike gradbenih konstrukcij ter osnovne pojme o potresih, potresni obtežbi in potresnoodpornem projektiranju s posebnim poudarkom na geotehničnih in hidrotehničnih objektih. Pridobljene kompetence: - Razumevanje posledic potresov in obvladovanje različnih načinov zaščite pred njimi - Sposobnost uporabe enostavnih metod analize dinamičnih problemov - Razumevanje in obvladovanje enostavnih načinov računanja potresnoodpornih objektov	Objectives: - Understand the basics of structural dynamics, basic terminology about earthquakes, basic concepts of seismic action and earthquake-resistant design with an emphasis on the geotechnical and hydrotechnical structures. Competencies: - Students will acquire a sense of the consequences of earthquakes and will be informed with the methods of earthquake mitigation. - Student can compute dynamic response of simple structures. She/he is able to roughly assess the seismic resistance of simple structures and identify earthquake-resistant buildings. - Student is also capable of applying simple procedures for the seismic analysis of simple buildings.

Predvideni študijski rezultati:	Intended learning outcomes:
- 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 geotehničnih in hidrotehničnih objektov med potresi. - Razumevanje osnovnih značilnosti dinamičnega odziva in inženirskega modeliranja konstrukcij. - osvojene računske spretnosti za analizo enostavnih hidrotehničnih in geotehničnih objektov pri potresnih obremenitvah uporaba - doseženo znanje se uporablja pri načrtovanju geotehničnih in hidrotehničnih 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 - Sposobnost uporabe enostavnih metod analize dinamičnih problemov. - Sposobnost identifikacije očitno potresno neustreznih objektov. - Sposobnost uporabe literature in spletnih virov.	- Student learns about earthquakes, their consequences on structures and the measures for preventing seismic losses. - Student become aware about the problems related to earthquakes and the responsibility of engineer in the area of his work. Understand basic features of dynamic response of structures and engineering modelling of structures. - Became aware about the earthquakes as a natural phenomenon and understand basics of ground motions due to earthquakes and seismic behaviour of geotechnical and hydrotechnical structures. - Student also understands the basics of dynamic response and engineering modelling of structures - Student also learns the basic principles of earthquake-resistant design of hydrotechnical and geotechnical structures. - Students think about the relationship between the effects of the earthquake (and other natural disasters) and the funds invested for mitigating the consequences of unlikely events, the uncertainty of mathematical models used for simulation of seismic response of structures and the opportunities for innovative reduction of seismic losses. - Capability of evaluation of input data and the results obtained from software - The ability to take into account the impact of natural disasters in planning of human activities in natural environment. - Ability to identify structures which are not safe against earthquakes - Ability to use literature, software tools and online resources.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, vaje.	Lectures on blackboard (theory and practical examples. Lectures using PowerPoint. Tutorials in computer lab.

Načini ocenjevanja:	Delež/Weight	Assessment:
Računski del izpita	30,00 %	Practical part
Vaje	30,00 %	Exercises during year Written exam:

Teoretičen del izpita	40,00 %	Written exam: Theoretical part

Reference nosilca/Lecturer's references:

CELAREC, Daniel, DOLŠEK, Matjaž. Practice-oriented probabilistic seismic performance assessment of infilled frames with consideration of shear failure of columns. Earthquake eng. Struct. Dyn. [Print ed.], jul. 2013, letn. 42, št. 9, str. 1339-1360, ilustr., doi: 10.1002/eqe.2275.

BROZOVIČ, Marko, DOLŠEK, Matjaž. Envelope-based pushover analysis procedure for the approximate seismic response analysis of buildings. Earthquake eng. Struct. Dyn.. [Print ed.], [v tisku] 2013, letn. XX, št. X, str. 1-10, ilustr., doi: 10.1002/eqe.2333.

CELAREC, Daniel, DOLŠEK, Matjaž. The impact of modelling uncertainties on the seismic performance assessment of reinforced concrete frame buildings. Eng. Struct.. [Print ed.], jul. 2013, letn. 52, št. , str. 340-354, ilustr., doi:10.1016/j.engstruct.2013.02.036.

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.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MODELIRANJE GEOTEHNIČNIH KONSTRUKCIJ**
Course title:	**MODELLING OF GEOTECHNICAL STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1529

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	30	0	90	6

Nosilec predmeta/Lecturer:	Boštjan Pulko, Janko Logar
Vrsta predmeta/Course type:	obvezni splošni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika oziroma usvojena enakovredna znanja, hkratni vpis predmeta Numerične metode.	Passed exams in Soil Mechanics and Engineering Geology, Geotechnics and simultaneous enrolment in the course 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	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

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, varovanje gradbene jame, posedanje tal pod nasipom, zemeljska pregrada, predor).	nonlinear problems; coupled problems: formulation and simultaneous solving of equilibrium and diffusion equations (consolidation), drained and un-drained conditions; modeling 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 deep foundations, protection of the excavation, settlements beneath the embankment, earth dam, tunnel).

Temeljna 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 analyze 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	- Understanding of the critical state soil mechanics - Knowledge of the basic principles of elasto- plastic models and concrete material models

- 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 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/Weight**	**Assessment:**
Izpit	60,00 %	Exam
Samostojno izdelane vaje	40,00 %	Individual practical work

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:	**NUMERIČNO MODELIRANJE TRDNIN**
Course title:	**NUMERICAL MODELLING OF SOLIDS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1559

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Jože Korelc
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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.

implementacija konstitutivnih modelov tipičnih gradbenih materialov. Laboratorijske vaje Numerične simulacije nekaterih tehničnih problemov z metodo končnih elementov. Izpeljava nelinearnih končnih elementov.	Exercises Numerical simulation of typical nonlinear engineering problems using finite element method. Derivation of nonlinear finite element codes.

Temeljna 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. Dostopno na: http:// symech .fgg.uni-lj.si/nak/Skripta/ .

Cilji in kompetence:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- 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.	- 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.

- Uporaba komercialnih in raziskovalnih računalniških programov, ki delujejo po metodi končnih elementov, pri reševanje različnih tehniških problemov. - Kritična ocena rezultatov simulacije.	- 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:	**Learning and teaching methods:**
Predavanja se izvajajo v učilnici z različnimi učnimi pripomočki. Vse vaje se izvajajo v računalniškem laboratoriju, kjer se uporabljajo komercialni in raziskovani računalniški programi po metodi končnih elementov. Študentje jih izvajajo deloma individualno, deloma skupinsko.	Lectures, exercises, attendance of International Short Course on Experimental and Numerical Modelling of M5 Problems in Engineering.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Ustni izpit (vsebuje tako teoretične kot tudi računske naloge)	60,00 %	Exam (theoretical and practical tasks)
Seminarske vaje	40,00 %	Seminar tasks (results collected every 4 weeks)

Reference nosilca/Lecturer's references:

KORELC, Jože. Automation of primal and sensitivity analysis of transient coupled problems. Computational mechanics, ISSN 0178-7675, 2009, letn. 44, št. 5, str. 631-649, ilustr., doi: 10.1007/s00466-009-0395-2.

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:	**PROJEKTIRANJE GRADBENIH KONSTRUKCIJ**
Course title:	**DESIGN OF BUILDING STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1458

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Drago Saje
Vrsta predmeta/Course type:	obvezni strokovni/obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Postopek projektiranja gradbenih konstrukcij. Posebnosti obnašanja lesenih, betonskih in zidanih konstrukcij. Principi smotrne izbire konstrukcijskega sistema v odvisnosti od izbranega materiala. Projektna obtežba. Osnove projektiranje lesenih konstrukcij (mehanske in reološke lastnosti materiala, dimenzioniranje linijskih lesenih elementov, temeljna pravila izvedbe priključkov lesenih konstrukcij). Osnove projektiranja betonskih konstrukcij (dimenzioniranje in konstrukcijska izvedba linijskih konstrukcij, plošč in sten ter temeljev). Definicija masivnih betonov, problemi	Lectures Design procedure for building structures; specifics of the behaviour of timber, concrete and masonry structures; principles for sensible selection of a structural system in dependence of the selected material; design load; basics for the design of timber structures (mechanical and rheological properties of material, design of planar timber elements, basic rules for the execution of joints of timber structures); basics for the design of concrete structures (design and structural execution of planar structures, slabs and walls as well as foundations), Definition of mass concrete, problems related to

povezani z masivnimi betoni. Osnove analize vplivov materialnih lastnosti in vplivov okolice na razmere v masivnem betonu. Osnovni ukrepi za kvalitetno izgradnjo konstrukcij iz masivnega betona. Vaje: Seminarske vaje (računski primeri).	mass concrete; basics for the analysis of the influences of material properties and the impact of the environment on the conditions in mass concrete; basic measures for quality construction of mass concrete structures. Tutorials: Seminar tutorials (computational examples).

Temeljna literatura in viri/Readings:

H. Nilson, D. Darwin, C.W. Dolan. 2003. Design of Concrete Structures-thirteenth edition. McGraw-Hill, strani 321-374, 412-479, 545-574, 599-633.

W.G. Curtin, G. Shaw, J.K. Beck, W.A. Bray. 2006. Structural Masonry Designers Manual-third edition. , Blackwell Science, strani 1-72S.

Thelanderson, H.J. Larsen (urednika). 2003. Timber Engineering. John Wiley & Sons, strani 1-11, 131-168, 221-240.

Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 1, Evrokod 2, Evrokod 5, Evrokod 6, Evrokod 8 (SIST EN 1990, SIST EN 1991-1, SIST EN 1991-1-3, SIST EN 1991-1-4, SIST EN 1992-1-1, SIST EN 1995-1-1, SIST EN1996-1-1, SIST EN 1998-1).

Beg D., Pogačnik A. (urednika). Priročnik za projektiranje gradbenih konstrukcij po Evrokod standardih, Inženirska zbornica Slovenije, 2009

Spletno mesto Katedre za masivne in lesene konstrukcije: http://www.fgg.uni-lj.si/kmlk/index.htm.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati razlike v obnašanju konstrukcij iz različnih materialov - Podati osnove za snovanje in projektiranje gradbenih konstrukcij - Podati podlage za izbiro ustreznega računskega modela nosilne gradbene konstrukcije - Poznavanje problematike masivnih betonov in ukrepov za preprečitev poškodb, ki lahko nastanejo ob gradnji masivnih betonov. Pridobljene kompetence: - Sposobnost snovanja in projektiranja enostavnih masivnih in lesenih konstrukcij.	Objectives: - To present the differences in the behaviour of structures made of different materials, - To present the bases for the conception and design of building structures, - To present the bases for the selection of adequate computational model of a load-bearing structure, - To know the issues of mass concretes and the measures to prevent the damages that may appear in the construction of mass concretes. Acquired competences: - Ability to concept and design simple mass concrete and timber structures.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Poznavanje temeljnih načel projektiranja gradbenih konstrukcij - Poznavanje primernih nosilnih sistemov konstrukcij iz različnih materialov - Razumevanje delovanja osnovnih nosilnih mehanizmov konstrukcij - Poznavanje posebnosti pristopa k projektiranju konstrukcij iz različnih materialov - Pridobljeno znanje študentom omogoča projektiranje enostavnih gradbenih konstrukcij, v primeru zahtevnejših konstrukcij pa so sposobni preudarne presoje o morebitni potrebni vključitvi specialistov - Sposobnost uporabe strokovne literature, standardov in enostavnih računalniških programov v procesu projektiranja gradbenih konstrukcij.	- Knowledge of the basic principles of the design of building structures - Knowledge of appropriate load-bearing systems of structures made of different materials - Understanding of the basic mechanisms of load-bearing structures - Knowledge of the specifics how to approach the design of structures made of different materials - The acquired knowledge allows students to design simple building structures; in case of demanding structures, they are able to make a well-grounded assessment if specialists need to be engaged - Ability to use professional literature, standards and simple software in the process of the design of building structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in večji del vaj v klasični učilnici, manjši del vaj pa tudi v računalniški učilnici.	Lectures and large part of tutorials in classical classroom, small part of tutorials in computer classroom.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični del izpita	40,00 %	Theoretical part of exam
Računski del izpita	30,00 %	Computational part of exam
Vaje	30,00 %	Tutorials

Reference nosilca/Lecturer's references:

SAJE, Drago, SAJE, Franc. Sanacija cerkve v Šentjurju na Dolenjskem. V: SAJE, Franc (ur.), LOPATIČ, Jože (ur.). Zbornik 18. zborovanja gradbenih konstruktorjev Slovenije, Bled, 17. - 18. oktober 1996. Ljubljana: Slovensko društvo gradbenih konstruktorjev. 1996, str. 195-200.

LOPATIČ, Jože, SAJE, Drago, SAJE, Franc. Non-linear analysis of time-dependent response of concrete structures. International journal for engineering modelling, ISSN 1330-1365, 2010, letn. 23, št. 1/4, str. 1-11.

SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Shrinkage of polypropylene fibre reinforced high performance concrete. Journal of materials in civil engineering, ISSN 0899-1561, 2011, vol. 23, iss. 7, str. 941-952.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**VERJETNOSTNI RAČUN IN STATISTIKA**
Course title:	**THEORY OF PROBABILITY AND STATISTICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1618

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Marjeta Kramar Fijavž
Vrsta predmeta/Course type:	Obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. drugih predmetov s primerljivo vsebino.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content.

Vsebina:	Content (Syllabus outline):
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.	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.

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 domnev.	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.

Temeljna 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	- Formulation of practical problems in mathematical language

- 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)	- 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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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.

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:	**VODENJE PROJEKTOV**
Course title:	**PROJECT MANAGEMENT**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1496

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	obvezni strokovni

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

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

Vsebina:	Content (Syllabus outline):
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.	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.

Temeljna literatura in viri/Readings:

- Rant, M., Jeraj, M., & Ljubič, T. (1998). Vodenje projektov: projektni pristop, projektna organizacija, vodenje projektov, projektni proces, terminsko planiranje projektov, mrežno planiranje (2. izd.). POIS.
- Česen, A., Kern, T., Bajec, M. (2008)**.** Vodnik po znanju projektnega vodenja, 3. Izdaja. Založba Moderna organizacija
- Golob, K. (2021). Investicijski procesi in vodenje projektov: [gradivo za strokovne izpite]. 2. ponatis. Ljubljana: Inženirska zbornica Slovenije.
- Project Management Institute, ed. The Standard for Project Management and a Guide to the Project Management Body of Knowledge (PMBOK Guide). Seventh edition. Newtown Square, Pennsylvania: Project Management Institute, Inc, 2021.

Cilji in kompetence:	**Objectives and competences:**
• pridobitev znanj o posameznih udeležencih v procesu graditve, • pridobitev znanj o fazah projekta (s poudarkom na gradbenem projektu), • pridobitev znanj o procesu vodenja projekta.	• 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:	**Intended learning outcomes:**
• osvojeno znanje s področja projektnega vodenja (proces, udeleženci, medsebojni odnosi, oblike sodelovanja), • sposobnost uporabe računalniških orodij za vodenje projektov.	• acquired knowledge from the field of project management (process, stakeholders, participants' relations), • ability to use computer – supported project management tools.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, lab.vaje	Lectures, tutorial

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit (teoretični del)	50,00 %	Written exam (theory)
Pisni izpti (računski del)	50,00 %	Written exam (examples)

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**UREJANJE VODOTOKOV**
Course title:	**RIVER ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1651

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	30	15	0	15	120	8

Nosilec predmeta/Lecturer:	Matjaž Mikoš
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Hidravlično modeliranje in Hidrološko modeliranje.	Passed exams in Hydraulic modelling, Hydrological modeling.

Vsebina:	Content (Syllabus outline):
Predavanja Osnove urejanja vodotokov: rečna hidravlika, rečna mehanika (prodonosnost in kalnost), rečna morfologija, erozija in sedimentacija. Klasično urejanje vodotokov: ukrepi varstva pred visokimi vodami, urejanje struge vodotoka, dimenzioniranje in vzdrževanje posameznih vodnih zgradb, jezovne zgradbe in ribji prehodi. Sonaravno urejanje vodotokov: rečni koridor, hidromorfološko stanje vodotokov, osnove inženirske biologije, katalog	Lectures River engineering basics: river hydraulics, river mechanics (bed load and suspended loads), river morphology, erosion and sedimentation. Classic river engineering: flood protection works, river channel works, dimensioning and maintenance of different river structures, weirs and fish passages. Natural river engineering: river corridor, hydromorphological status of rivers, basics of bioengineering, catalogue of river bioengineering

sonaravnih ureditev, načrtovanje in vzdrževanje sonaravnih ureditev. Seminarske vaje Računske vaje iz rečne hidravlike in mehanike. Modeliranje toka voda in plavin na fizičnem modelu za razumevanja osnov rečne morfologije in delovanja vodnih objektov. Seminar Hidravlični račun izbranega odseka vodotoka z uporabo najnovejše različice programa HEC-RAS. Terensko delo Zasnova in izvedba tehničnih ureditev na rekah (gradbišča). Analiza zrnavosti rečnih sedimentov.	river works, planning and maintenance of river bioengineering works. Tutorials Computational tutorials in river hydraulics and mechanics. Modelling of river water and sediment flow on a physical (hydraulic) model to understand basics of river morphology and effects of river training works. Seminar Hydraulic computation of a selected river reach using the newest version of the computer code HEC-RAS. Field work Preliminary design and execution of technical river training works (construction sites). Grain-size anaysis of river sediments.

Temeljna literatura in viri/Readings:

Mikoš, M. 2008. Urejanje vodotokov – skripta, verzija. Ljubljana, UL FGG, Katedra za splošno hidrotehniko, 220 str.

Patt, H., Jürging, P., Kraus, W. 2004. Naturnaher Wasserbau - Entwicklung und Gestaltung von Fließgewässern, Springer Verlag, 423 p.

Hydrologic Engineering Center. Dostopno na: http://www.hec.usace.army.mil/software/hec-ras/.

Spletne strani resornega ministrstva (MKO) s področja vodne infrastrukture (vodnih objektov).

Spletne strani Atlasa okolja. Dostopno na: http://gis.arso.gov.si/atlasokolja/.

Spletne strani gospodarske javne infrastrukture (GJI) v Sloveniji.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Nadgraditi osnovno znanje hidravlike z znanjem rečne hidravlike, mehanike in morfologije. - Podati pregled klasičnih in modernih (sonaravnih) metod urejanja vodotokov z osnovami njihovega načrtovanja, dimenzioniranja in vzdrževanja. Kompetence:	Objectives: - Upgrade of basic knowledge of hydraulics with knowledge of river hydraulics, mechanics and morphology. - Giving an overview of classical and modern (bioengineering) river engineering methods with the basics of their planning, design and maintenance. Competencies:

- Sposobnost terenskega prepoznavanja razmer na vodotoku. - Sposobnost izdelave ureditvenih načrtov odsekov vodotokov.	- Ability to field identification of conditions in a stream. - Ability to prepare river engineering plans for stream reaches.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje iz rečne hidravlike in mehanike (dinamike). - Razumevanje procesov erozije in sedimentacije. - Osvojene računske spretnosti za hidravlično modeliranje in načrtovanje ureditvenih ukrepov na vodotokih. - Sposobnost abstraktne formulacije naravnih procesov in upoštevanja dinamike naravnih procesov pri načrtovanju človekove dejavnosti v prostoru. - Sposobnost kritične presoje vhodnih podatkov in računskih rezultatov pri načrtovanju ukrepov.	- Acquired in-depth knowledge of river hydraulics and mechanics (dynamics). - Understanding of erosion and sedimentation processes. - Learned numerical skills for hydraulic modelling and designing of training works in rivers. - Ability to abstract formulations of natural processes and taking into account the dynamics of natural processes in spatial planning of human activities. - Ability for critical analysis of input data and calculation results when planning interventions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, seminar, terensko delo.	Lectures, seminar tutorials, seminar work, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Seminarske vaje	10,00 %	Seminar tutorials
Seminar	40,00 %	Seminar coursework
Terensko delo	10,00 %	Written and/or oral examination
Pisni in/ali ustni izpit	40,00 %	Written and/or oral examination

Reference nosilca/Lecturer's references:

MIKOŠ, M., BIZJAK, A. 2007. Gewässerstrukturgüterkartierungen in Slowenien anhand verschiedener Methoden. Österreichische Wasser- und Abfallwirtschaft 59/1-2, 163-167.

MIKOŠ, M., ROJNIK, F., FAZARINC, R. 2004. River engineering measures in an Alpine river after a major debris flow event. Proceedings of the 10th Interpraevent Congress, Vol. 4, 181-192.

MIKOŠ, M., PENDER, G., HOEY, T., SHVIDCHENKO, A., PETKOVŠEK, G. 2003. Numerical simulation of graded sediment transport. Water and maritime engineering 56/1, 47-51.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**HIDROTEHNIČNI OBJEKTI**
Course title:	**HYDRAULIC STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1517

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	0	60	0	0	120	8

Nosilec predmeta/Lecturer:	Andrej Kryžanowski
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Zgodovinski pregled razvoja pregradnega inženirstva. Podlage za načrtovanje pregradnih objektov (planiranje, projektiranje, strokovne podlage za načrtovanje). Načrtovanje pregradnih objektov (betonske, nasute). Odvzem vode iz naravnih vodotokov (globinske in površinske odvzemne zgradbe) ter prelivanje vode prek jezovne zgradbe (prelivi, kaskade, vodni odskoki, prelivne drče, podslapja). Zapornice in zajezni objekti (različne vrste površinskih in globinskih zapornic). Zgradbe za	Lectures Historical background of dam engineering. Bases for planning of dam structures (planning, design, expert groundwork for planning). Planning of dam structures (concrete, embankment dams). Abstraction of water from natural watercourses (withdrawal works, for surface water or groundwater), and water flow through weir structures (spillways, cascades, water jumps, slides, stilling basins). Gates and dam structures (various types of surface and submerged gates). Inlet and

dovod in odvod vode (zajetja, peskolovi, kanali, rovovske zgradbe, tlačni cevovodi, vodostani). Vaje Zasnova in statično stabilitetni preračun težnostne pregrade s programom CADAM. Hidravlični dimenzioniranje evakuacijskih objektov - preliv, drča, podslapje, spajanje s spodnjo vodo. Statično dimenzioniranje zapornic (osnovni tipi zapornic). Statično-stabilitetni preračun različnih tipov pregrad (težnostne, nasute, ločne) s programom DIANA.	outlet works (reservoirs, desanding facilities, canals, pipes, pressure conduits, surge chambers). Tutorials Design, static and stability analysis of gravity dams using CADAM. Hydraulic dimensioning of evacuation structures. Spillway, slides, stilling basin, joining with tailwater. Static dimensioning of gates (basic types of gates). Static and stability calculation of various types of dams (gravity, embankment, arch dams) using DIANA.

Temeljna literatura in viri/Readings:

Pemič, A., Mikoš, M. 2008. Inženirska hidrotehnika – skripta verzija 2008, UL FGG, Katedra za splošno hidrotehniko, 400 str.

Strobl, T. Zunic, F. 2006. Wasserbau: Aktuelle Grundlagen – Neue Entwicklungen, Springer, 604 str.

Giesecke, J., Mosonyi. E. 1998. Wasserkraftanlagen, Springer, Berlin, str.101-396, str.591-657.

Blindt, H. 1987. Wasserbauten aus Beton, Ernst & Sohn, Berlin, 493 str.

Nonveiller, E. 1983. Nasute brane, Školska knjiga, Zagreb, 359 str.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Uporabiti osnovno znanje hidravlike in urejanja vodotokov za hidravlični preračun objektov na pregradah. - Podati teoretične osnove za zasnovo in preračun pregradnih in hidrotehničnih objektov. Kompetence - Sposobnost zasnove pregrad in hidrotehničnih objektov na jezovnih zgradbah. - Sposobnost prepoznavanja, spremljave in načrtovanje procesa umeščanja pregrad v okolje in prostor. - Sposobnost dimenzioniranja pregradnih in hidrotehničnih objektov.	Objectives - To use the basic knowledge in hydraulics and water management for hydraulic calculation of dam structures. - To give theoretical bases for design and calculation of dams and hydraulic structures. Competences - Ability to design dam and hydraulic structures on weir structures. - Ability to recognise, monitor and plan the process of site selection and placement. - Ability of dimensioning dams and hydraulic structures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje za zasnovo in načrtovanje pregrad in hidrotehničnih objektov na vodnih zgradbah.	- In-depth knowledge for design and planning of dams and hydraulic structures in water works.

- Osvojene računske spretnosti za dimenzioniranje pregrad in hidrotehničnih objektov na jezovnih zgradbah. - Pridobljeno poglobljeno znanje za prepoznavanje procesa umeščanja pregrad v okolje in prostor. - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju hidrotehničnih objektov. - Sposobnost izdelati projektne zasnove za pregrade in hidrotehnične objekte. - Sposobnost načrtovanja procesa umeščanja posegov v okolje in prostor.	- Acquisition of calculation skills for dimensioning of dams and hydraulic structures on weir structures. - Acquisition of in-depth knowledge for recognition of the site selection and placement process. - Ability of critical assessment of input data and obtained calculation results in design of hydraulic structures. - Ability to elaborate design concepts for dams and hydraulic structures. - Ability to plan the process of site selection and placement.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in seminarske vaje.	Lectures and tutorials.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje	50,00 %	Tutorials
Pisni izpit	50,00 %	Written examination

Reference nosilca/Lecturer's references:

KRYŽANOWSKI, Andrej, MIKOŠ, Matjaž, ŠUŠTERŠIČ, Jakob, UKRAINCZYK, Velimir, PLANINC, Igor. Testing of concrete abrasion resistance in hydraulic structures on the lower Sava river. Stroj. vestn., apr. 2012, vol. 58, no. 4, str. 245-254.

KRYŽANOWSKI, Andrej, MIKOŠ, Matjaž, ŠUŠTERŠIČ, Jakob, PLANINC, Igor. Abrasion Resistance of Concrete in Hydraulic Structures. ACI mater. j., julij-avgust 2009, letn. 106, št. 4, str. 349-356.

MIKOŠ, Matjaž, KRYŽANOWSKI, Andrej. Debris-flow breakers as an unconventional dam type. V: Dams - recent experiences on research, design, construction and service : international symposium : proceedings, Skopje, 17th - 18th November, 2011. Skopje: Macedonian committee on large dams, 2011, str. 63-70.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**EKSPERIMENTALNE METODE V GEOTEHNIKI**
Course title:	**EXPERIMENTAL METHODS IN GEOTECHNICAL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1670

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	10	0	30	5	90	6

Nosilec predmeta/Lecturer:	Matej Maček, Janko Logar
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija, Geotehnika.	Passed exams in Soil mechanics and engineering geology, Geotechnical Engineering.

Vsebina:	Content (Syllabus outline):
Predavanja Načrtovanje geotehničnih preiskav; metode laboratorijskih preiskav zemljin; makroskopska identifikacija kamnin, ki vsebujejo glino in potencialno patogene minerale; preiskave za identifikacijo obnašanja zemljin s poudarkom na patogenih lastnostih (izvedba preiskav nabrekanja in kolapsa); izvedba in vrednotenje direktne strižne in triosne preiskave zemljin; izvedba meritev sukcije in izdelava retencijske krivulje; metode terenskih raziskav tal (geotehnično vrtanje, izvedba in vrednotenje presiometrske, dilatometrske, SPT, CPT	Lectures Geotechnical investigation programme; methods of laboratory soil testing; macroscopic identification of rocks with clay and potentially pathogenic minerals; tests for identification of pathogenic soil behaviour (swelling and collapse); execution and evaluation of direct shear and triaxial shear test; execution of suction measurements and the assessment of water retention curve; in-situ ground testing (drilling, execution and evaluation of pressuremeter, flat dilatometer, SPT and CPT tests, vane test, permeability tests); fundamentals of geophysical site

preiskave in krilne sonde, meritve vodoprepustnosti na terenu); osnove geofizikalnih metod raziskav tal (geoseizmične metode, geoelektrične metode, georadar); geotehnična opazovanja na terenu (inklinometrske meritve, ekstenziometrske meritve, meritve pornih tlakov v tleh, merjenje sidrnih sil, uporaba geodetskih meritev pri geotehničnih gradnjah); geotehnične meritve za kontrolo zemeljskih del (meritve gostote z nadomestnimi metodami in izotopsko sondo, meritve togosti s krožno ploščo, izvedba nalivalnega preizkusa); osnove laboratorijskih in terenskih preiskav kamnin; osnove meritev okoljskih parametrov v laboratoriju in na terenu; analiza rezultatov laboratorijskih in terenskih raziskav tal. Ocena karakterističnih vrednosti. Povratne analize, občutljivostne analize. Vaje Samostojna izvedba in analiza preiskave nabrekanja in kolapsa, direktne strižne preiskave in triosne preiskave; samostojna izvedba in analiza drugih izbranih; laboratorijskih preiskav; samostojna izdelava izbranih terenskih preiskav in vrednotenje; ocena karakterističnih vrednosti materialnih parametrov na podlagi izvedenih preiskav; računalniške vaje (povratna analiza posedkov - metoda Asaoka, stabilnosti); izdelava programa geotehničnih raziskav za konkretno gradnjo; izdelava programa geotehničnega opazovanja.	investigations (geoseismic methods, electrical resistivity, ground penetrating radar); geotechnical monitoring (inclinometers, extensometer, pore pressure measurements, load cells, use of geodetic measurements in geotechnical works); geotechnical control of earthworks (density measurements, stiffness measurements with plate load test, permeability measurements); fundamentals of laboratory and in-situ rock testing; fundamentals of assessment of environmental parameters of ground in laboratory and in-situ; evaluation of results of in-situ and laboratory tests; assessment of characteristic ground properties. Back analysis, sensitivity analysis. Tutorials Individual execution and evaluation of swelling and collapse tests, direct shear test, triaxial shear test and other selected tests; individual execution and evaluation of selected in-situ tests; assessment of characteristic soil properties based on the results of laboratory and field tests; computing: back analysis of s settlements; (Asaoka method) and global stability; plan of geotechnical investigations for selected structure; plan of geotechnical monitoring for selected structure.

Temeljna literatura in viri/Readings:

SIST EN 1997-2 Evrokod 7-2: Geotehnično projektiranje 2. del: Preiskovanje in preskušanje tal.

Joyce, M.D. 1982. Site investigation practice. E. & F.N. Spon, London, 369 str.

Milsom J. 1995. Field geophysics, Geological society of London Handbook, John Wiley & sons, 182 str.

Handy, R.L., Spangler M.G. 2007. Geotechnical Engineering: Soil and Foundation Principles and Practice, Mc Graw Hill, 904 str.

Standardi za izvedbo posameznih preiskav.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Študent spozna načela geotehničnega raziskovanja tal in metode za karakterizacijo tal na terenu in v laboratoriju - Spozna standarde za izvedbo posameznih raziskav	To understand principles of geotechnical investigations and methods for ground characterization in-situ and in laboratory - To know the standards for main laboratory and field tests

- Spozna posebnosti preiskovanja vezljivih in nevezljivih zemljin, kamnin in podzemne vode - Sposoben je izdelati program geotehničnih raziskav - Sposobnen je izvesti in interpretirati posamezne laboratorijske in terenske raziskave.	- To realize the particularities of investigation of fine or coarse grain soils, rocks and groundwater - Ability to prepare a plan of geotechnical investigations - Ability to perform and evaluate laboratory and in-situ tests.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent je sposoben zasnovati program geotehničnih raziskav in geotehničnega opazovanja glede na sestavo tal in vrsto objekta - Pozna in razume posamezne vrste laboratorijskih in terenskih raziskav ter njihove rezultate in omejitve - Zna samostojno izvesti poglavitne laboratorijske in terenske geotehnične preiskave in analizirati njihove rezultate - Iz rezultatov izvedenih raziskav zna oceniti karakteristične vrednosti materialnih parametrov - Razume in pozna možnost preverjanja dobljenih rezultatov s povratno analizo.	- Ability to prepare the ground investigation programme and propose geotechnical monitoring under given site conditions and type of structure - Knowledge and understanding of individual laboratory and in-situ test method, their strengths and weaknesses - Ability to individually perform main laboratory and field tests and evaluate the results - Ability to assess characteristic soil properties from test results - Ability to employ back analysis in order to verify ground properties.

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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Laboratorijske in terenske vaje	50,00 %	Laboratory and field work
Izpit	50,00 %	Exam

Reference nosilca/Lecturer's references:

MAČEK, M., SMOLAR, J., PETKOVŠEK, A. (2019) The reliability of CPTu and DMT for the mechanical characterisation of soft tailings. Bulletin of engineering geology and the environment 78(4): 2237-2252.

MAČEK, Matej, MAUKO, Alenka, MLADENOVIČ, Ana, MAJES, Bojan, PETKOVŠEK, Ana. A comparison of methods used to characterize the soil specific surface area of clays. Applied clay science, ISSN 0169-1317. [Print ed.], oktober 2013, letn. 83-84, str. 144-152, doi: http://dx.doi.org/10.1016/j.clay.2013.08.026.

MAČEK, Matej, MAJES, Bojan, PETKOVŠEK, Ana. Influence of mould suction on the volume - change behaviour of compacted soils during inundation = Vpliv vrojene sukcije na volumensko obnašanje zgoščenih zemljin med vlaženjem. Acta geotechnica Slovenica, ISSN 1854-0171, 2011, vol. 8, [no]. 2, str. 67-79.

PETKOVŠEK, Ana, MAČEK, Matej, PAVŠIČ, Primož, BOHAR, Feri. Fines characterization through the methylene blue and sand equivalent test: comparison with other experimental techniques and application of

criteria to the aggregate quality assessment. Bulletin of engineering geology and the environment, ISSN 1435-9529, 2010, vol. 69, no. 4, str. 561-574, doi: 10.1007/s10064-010-0274-2.

LOGAR, Janko, ROBAS, Alenka, MAJES, Bojan. First experiences with flat dilatometer test in Slovenia. V: FAILMEZGER, R. A. (ur.), ANDERSON, J. B. (ur.). Flat Dilatometer Testing : Proceedings from the Second International Conference on the Flat Dilatometer, Washington, D.C., April 2-5, 2006. Lancaster, Virginia: In-Situ Soil Testing, 2006, str. 373-379, ilustr., graf. Prikazi.

LOGAR, Janko, KUDER, Sebastjan, ROBAS, Alenka, BATTELINO, Lilian, STRNIŠA, Gorazd. Flat dilatometer in Port of Koper and observed ground behaviour. V: 14th European Conference on Soil Mechanics and Geotechnical Engineering, Madrid, Spain, 24-27 September 2007. Geotechnical engineering in urban environments : proceedings of the 14th European conference on soil mechanics and geotechnical engineering, Madrid, Spain, 24-27 September 2007. Rotterdam: Millpress Science Publishers, cop. 2007-2008, vol. 5, str. 609-613, ilustr.

ROBAS, Alenka, LOGAR, Janko. Napoved nosilnosti osno obremenjenih navpičnih pilotov na osnovi presiometrskih meritev = Prediction of bearing capacity of axialy loaded vertical piles on the basis of pressuremeter tests. V: LOGAR, Janko (ur.), PETKOVŠEK, Ana (ur.). Razprave petega posvetovanja slovenskih geotehnikov, Nova Gorica 2008, Nova Gorica, 12. do 14. junij 2008. Ljubljana: Slovensko geotehniško društvo, 2008, str. 233-242.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PRAKTIČNO USPOSABLJANJE**
Course title:	**PRACTICAL TRAINING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Letni, Zimski

Koda učne enote na članici/UL Member course code:	1468

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
6	0	0	0	80	34	4

Nosilec predmeta/Lecturer:	Andreja Istenič Starčič
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

skupinskega dela, pokaže iniciativnost in samostojnost pri vodenju najzahtevnejših delovnih sistemov pod nadzorom mentorja.	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.

Temeljna 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:	**Objectives and competences:**
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 - 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:	Intended learning outcomes:
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 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.	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 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/Weight	Assessment:
Dnevnik prakse	40,00 %	Diary of practical work
Portfolio	30,00 %	Portfolio
Ustni zagovor	30,00 %	Oral presentation

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:	**HUDOURNIŠTVO**
Course title:	**TORRENT CONTROL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1671

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	15	90	6

Nosilec predmeta/Lecturer:	Matjaž Mikoš
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Hidravlično modeliranje, Hidrološko modeliranje ali pridobljena primerljiva znanja.	Passed exams in Hydraulic modelling and Hydrological modelling or acquired comparable knowledge.

Vsebina:	Content (Syllabus outline):
Predavanja Uvod v urejanje hudournikov: zgodovinski pregled, problematika in koncept urejanja, zakonodaja in načrtovanje, standardizacija. Osnove urejanja hudournikov in povirij: hidrologija povirij, erozija tal, hudourniška hidravlika, nastanek in dinamika masnih tokov (drobirski in blatni tokovi, padajoče kamenje in skalni podori), mehanika in dinamika snežne odeje in snežnih plazov, prodna bilanca.	Lectures Introduction to torrent control: historical overview, problems and concepts of control, legislation and planning, standardisation. Basics of torrent, erosion, rockfall and avalanche control: headwater hydrology, soil erosion, torrent hydraulics, initiation and dynamics of mass movements (debris flows and mudflows, stone falls and rockfalls, mechanics and dynamics of snow cover and avalanches, sediment balance. Torrent, erosion, rockfall, and avalanche control: soil erosion control (soil bioengineering),

Urejanje hudournikov in povirij: varstvo pred površinsko erozijo (protierozijske vegetativne zaščite), varstvo pred hudourniško erozijo (objekti v hudourniških strugah), varstvo pred delovanjem snežnih plazov (protilavinske zgradbe). Osnove preventivnega delovanja: zakonodaja, aktivni in pasivni ukrepi, pojem upravljanja s tveganji in ravnanja ob nevarnih dogodkih, dokumentiranje vodnih ujm in plazenja tal, kartiranje pojavov in nevarnosti, ranljivost in ogroženost. Modeliranje nevarnih geološko in hidrološko pogojenih pojavov in njihovo delovanje na objekte, pogoji gradnje, primeri varne gradnje. Seminarske vaje Računske vaje iz hudourniške hidravlike in erozije tal ter dimenzioniranja izbranih vrst hudourniških objektov. Struktura in uporaba enodimenzijskega matematičnega modela padajočega kamenja in dvodimenzijskega modela gibanja drobirskih tokov. Terensko delo Kartiranje hudourniških pojavov in zasnova ureditvenih ukrepov.	torrent control (torrent control works), avalanche control (avalanche protection works). Basics of preventive activities: legislation, active and passive measures, the terms of risk management and handling during hazardous events, documentation of water- related disasters and landsliding, mapping of phenomena and hazards, vulnerability and risks. Modelling of dangerous geological and hydrological phenomena and their impacts on structures, construction conditions, examples of safe construction. Tutorials Computational tutorials in torrent hydraulics and soil erosion, as well as in design of selected types of torrent control works. Structure and use of a one-dimensional mathematical model for rockfalls and of a two-dimensional mathematical model for debris flows. Field work Mapping of torrential processes and preliminary design of control measures.

Temeljna literatura in viri/Readings:

Mikoš M. 2008. Inženirska hidrotehnika – zbirka rešenih primerov, verzija 2008, UL FGG, Katedra za splošno hidrotehniko, 200 p.

Mikoš M. 2009. Osnove hudourništva – varstvo pred hudourniki in zemeljskimi plazovi, UL FGG, Katedra za splošno hidrotehniko, 217 p.

Sodnik J., Mikoš M. 2013. Vodarstvo in vzdrževanje vodne infrastrukture v Sloveniji = Water management and maintenance of water infrastructure in Slovenia. Gradbeni vestnik 62(8): 166-173.

Hydrologic Engineering Center. Dostopno na: http://www.hec.usace.army.mil/software/hec-ras/.

Spletne strani resornega ministrstva (MKO) s področja vodne infrastrukture (vodnih objektov).

Spletne strani Atlasa okolja. Dostopno na: http://gis.arso.gov.si/atlasokolja/.

Spletne strani gospodarske javne infrastrukture (GJI) v Sloveniji.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi znanje iz urejanja vodotokov z znanji o urejanju hudournikov in povirij (hudourniških območij). - Podati teoretične osnove za načrtovanje in dimenzioniranje hudourniških objektov.	Objectives - Upgrade of knowledge of river engineering with knowledge of torrent, erosion, rockfall, and avalanche control (in torrential watersheds). - Giving theoretical basics for planning and design of torrent control works.

- Podati osnove modernega pristopa k obvladovanju geološko in hidrološko pogojenih naravnih tveganj. Kompetence - Sposobnost izdelave celovitih ureditvenih načrtov urejanja voda na nivoju povodij. - Sposobnost dimenzioniranja in projektiranja določenih vrst hudourniških objektov. - Sposobnost izdelave načrtov ogroženosti za varstvo pred naravnimi nesrečami.	- Giving basics of modern approach to governance of geological and hydrological natural hazards. Competencies - Ability to prepare integrated river basin management plans. - Ability to design and plan selected types of torrent control works. - Ability to prepare risk plans for protection against natural disasters.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje - Poglobljeno znanje iz hudourniške hidravlike in mehanike/dinamike. - Razumevanje procesov erozije tal v prostoru. - Osvojene računske spretnosti za načrtovanje ureditvenih ukrepov na hudournikih in v povirjih. - Razumevanje pomembnosti preventivnega obnašanja pri posegih v prostor. - Znanje o pristopih ob interventnih ukrepih. - Doseženo znanje uporabljajo pri izdelavi magistrske naloge oz. v inženirski praksi. Prenosljive spretnosti - Sposobnost abstraktne formulacije naravnih procesov. - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ukrepov. - Sposobnost upoštevanja dinamike naravnih procesov pri načrtovanju človekove dejavnosti v prostoru.	Understanding and knowledge - Acquired in-depth knowledge of torrent hydraulics and mechanics/dynamics. - Understanding of spatial soil erosion processes. - Learned numerical skills for planning of control works in torrents and in torrential headwaters. - Understanding of the importance of preventive behaviour at spatial interventions. - Knowledge about approaches of intervention preventive measures. - Achieved knowledge applied in writing of master thesis or in engineering practice. Transferable skills - Ability of abstract formulations of natural processes. - Ability for critical analysis of input data and calculation results when planning interventions. - Ability to take into account natural process dynamics in spatial planning of human activities.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, terensko delo.	Lectures, seminar tutorials, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Seminarske vaje	40,00 %	Seminar tutorials
Terensko delo	10,00 %	Field work report
Pisni in/ali ustni izpit	50,00 %	Written and/or oral examination

Reference nosilca/Lecturer's references:

SODNIK, J., MIKOŠ M. 2013. Vodarstvo in vzdrževanje vodne infrastrukture v Sloveniji. Gradbeni vestnik 62(8), 166-173.

MIKOŠ, M. 2012. Prispevek k zgodovinskemu pregledu razvoja hudourništva in hudourničarstva v Sloveniji. Gozdarski vestnik 70(10), 429-439.

SODNIK, J., MIKOŠ, M. 2010. Modeling of a debris flow from the Hrenovec torrential watershed above the village of Kropa = Modeliranje drobirskega toka v hudourniškem območju Hrenovec nad Kropo. Acta geographica Slovenica 50(1), 59-84.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**STABILNOST POBOČIJ**
Course title:	**SLOPE STABILISATION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1752

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	5	0	30	5	60	4

Nosilec predmeta/Lecturer:	Matjaž Mikoš, Matej Maček
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmeta Hidrološko modeliranje.	Passed exam in Hydrological modeling.

Vsebina:	Content (Syllabus outline):
Predavanja Oblike pobočnih procesov, vzroki nastanka, sprožilni dejavniki, terenske raziskave. Hidrotehnični in geotehnični ukrepi za umirjanje in stabilizacijo zemeljskih plazov in kamninskih podorov. Osnove ravnanja z naravnimi tveganji: zakonodaja, ureditev, aktivni in pasivni ukrepi, dokumentiranje plazenja tal, kartiranje pojavov in nevarnosti. Seminarske vaje	Lectures Forms of slope processes, causes of their formation, triggering factors, field research. Hydrotechnical and geotechnical measures for mitigation and stabilisation of landslides and rockfalls. Basics of handling natural risks: legislation, arrangements, active and passive measures, documentation of landsliding, mapping of phenomena and hazards. Tutorials

Sanacija zemeljskih plazov v Sloveniji kot študijski primeri izvedenih sanacijskih ukrepov. Terensko delo Prepoznavanje ogroženih pobočij, koncepti sanacije aktivnih zemeljskih plazov in podorov.	Mitigation of landslides in Slovenia as case studies of executed mitigation measures. Field work Recognition of risky slopes, mitigation concepts of active landslides and rockfalls.

Temeljna literatura in viri/Readings:

Brilly, M., Mikoš, M., Šraj, M. 1999. Vodne ujme: varstvo pred poplavami, erozijo in plazovi, 1. izdaja, UL FGG, univerzitetni učbenik, 186 p.

Ribičič, M. 2005. Metodologija ukrepanja ob ogrožujočih plazovih. UL NTF, 78 p.

Vidrih, R. 2008. Potresna dejavnost Zgornjega Posočja = Seismic activity of the Upper Posočje area. ARSO, MOP RS, 509 p.

Elektronski spletni učni pripomoček N.I.T. (Naravne nevarnosti In Tveganja) za področje obvladovanja tveganj

Učno gradivo v spletni učilnici UL FGG

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Nadgraditi osnovno znanje o mehaniki zemljin s posebnostmi masnih gibanj. - Podati osnove preventivnega in interventnega inženirskega delovanja pred geološko pogojenimi dejavniki tveganja. - Podati osnove načrtovanja raziskav in trajnih sanacijskih ukrepov na aktivnih zemeljskih plazovih. - Podati osnove modernega pristopa k obvladovanju geološko in hidrološko pogojenih naravnih tveganj. Pridobljene kompetence: - Sposobnost vodenja aktivnosti za raziskovanje in sanacijo plazov ter inženirskega ukrepanja ob naravnih nesrečah.	Objectives: - Upgrade of basic knowledge of soil mechanics to particular characteristics of mass movements. - Provide the basics for preventive and interventional engineering activities against geologically conditioned risk factors. - Provide the basics of planning research and sustainable mitigation measures on active landslides. - Provide the basics of the modern approach to mitigation of geological and water-related natural risks. Competences: - Ability to manage activities for research and rehabilitation of landslides and of engineering measures in natural disasters.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poglobljeno razumevanje procesov v naravi. - Poglobljeno znanje iz dinamike masnih gibanj in njihove sanacije.	- Acquired in-depth knowledge of processes in nature. - Acquired in-depth knowledge of dynamics of mass movements and their mitigation.

- Razumevanje pomembnosti preventivnega obnašanja pri posegih v prostor. - Sposobnost prepoznavanja ranljivosti naravnih in umetnih pobočij za sprožitev masnih gibanj. - Sposobnost razumevanja prilagajanja inženirskih ukrepov terenskim razmeram in nujnosti postopne izvedbe načrtovanih ukrepov. - Sposobnost upoštevanja dinamike naravnih procesov pri načrtovanju človekove dejavnosti v prostoru.	- Understanding of the importance of preventive behaviour in spatial interventions. - Ability to recognize the vulnerability of natural and man-made slopes for triggering mass movements. - Ability to understand adaptation of engineering measures to terrain conditions and the necessity of gradual implementation of the planned measures. - Ability to take into account the dynamics of natural processes in the spatial design of human activitie

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, terensko delo.	Lectures, seminar tutorials, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Seminarske vaje	20,00 %	Seminar tutorials
Terensko delo	20,00 %	Field work report
Pisni in/ali ustni izpit	60,00 %	Written and/or oral examination

Reference nosilca/Lecturer's references:

PERANIĆ, J., ARBANAS, Ž., CUOMO, S., MAČEK, M. (2018). Soil-water characteristic curve of residual soil from a flysch rock mass. Geofluids: 1-15.

MAČEK, M., SMOLAR, J., PETKOVŠEK, A. (2017). Influences of rheometer size and the grain size on rheological parameters of debris flow. V: Mikoš, M. (ur.), et al. Advancing culture of living with landslides. Vol. 2, Advances in landslide science. Cham: Springer: 399-406.

MAČEK, M., MAJES, B., PETKOVŠEK, A. (2016). Lessons learned from 6 years of suction monitoring of the Slano blato landslide. Rivista Italiana di Geotecnica 5: 21-33.

BEZAK, N., MIKOŠ, M., ŠRAJ, M. (2016). Copula-based IDF curves and empirical rainfall thresholds for flash floods and rainfall-induced landslides. Journal of Hydrology 541, 272-284.

HÜBL, J., MIKOŠ, M. (2014). Monitoring von Murgängen = Debris flow monitoring. Wildbach- und lawinenverbau 78(173), 50-66.

PULKO, B., MAJES, B., MIKOŠ, M. (2014). Reinforced concrete shafts for the structural mitigation of large deep-seated landslides: an experience from the Macesnik and the Slano blato landslides (Slovenia). Landslides 11(1), 81-91.

MIKOŠ, M., ČARMAN, M., PAPEŽ, J., JANŽ, M. (2014). Legislation and procedures for the assessment of landslide, rockfall and debris flow hazards and risks in Slovenia = Rechtsvorschriften und Verfahren für die Beurteilung der Rutschungs-, Steinschlags- und Murganggefährdungen und Risiken in Slowenien. Wildbach- und Lawinenverbau 78/174, 212-221.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MEHANIKA KAMNIN IN PODZEMNI OBJEKTI**
Course title:	**ROCK MECHANICS AND UNDERGROUND STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1626

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Janko Logar, Vojkan Jovičić
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija, Geotehnika.	Passed exams in Soil mechanics and engineering geology, Geotechnical Engineering

Vsebina:	Content (Syllabus outline):
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	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

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 - 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.	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 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.

Temeljna 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	Objectives - To understand basics of rock mechanics - To recognize types of underground structures and construction technologies

- 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.	- 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 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.	- 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 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/Weight**	**Assessment:**
Izpit	60,00 %	Exam

Samostojno izdelane vaje	40,00 %	Individual project

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.

JUREČIČ, Nina, ZDRAVKOVIĆ, Lidija, JOVIČIĆ, Vojkan. Predicting ground movements in London Clay. Proceedings of the Institution of Civil Engineers - Geotechnical engineering, ISSN 1353-2618. [Print ed.], 2012, vol. 164, issue 4, str. 1-17, doi: 10.1680/geng.11.00079.

JOVIČIĆ, Vojkan, ŠUŠTERŠIČ, Jakob, VUKELIČ, Željko. The application of fibre reinforced shotcrete as primary support for a tunnel in flysch. Tunnelling and underground space technology, ISSN 0886-7798. [Print ed.], 2009, vol. 24, no. 6, str. 723-730.

LIKAR, Jakob, JOVIČIĆ, Vojkan. The causes of excessive settlement above Trojane Tunnel and remedial measures. Tunnelling and underground space technology, ISSN 0886-7798. [Print ed.], 2004, vol. 19, no. 4/5, str. 386-387. http://authors.elsevier.com/sd/article/S0886779804000847.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MAGISTRSKO DELO**
Course title:	**MASTER THESIS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1481

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	0	0	0	150	150	10

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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	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

- 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.	- 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.

Temeljna 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:	**Objectives and competences:**
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 • 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:	**Intended learning outcomes:**
• 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.	• 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.

• Načrtovanje, izvedba in kritično vrednotenje pri reševanju problemov ter prezentacija izsledkov strokovnih nalog in raziskav. • Sodelovanje, vključevanje strokovnjakov in skupno reševanje problemov.	• 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:	**Learning and teaching methods:**
Mentorsko vodeno samostojno delo.	Independent work under supervision.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Magistrska naloga	50,00 %	Master thesis
Zagovor	50,00 %	Defence

Reference nosilca/Lecturer's references:

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**HIDRAVLIČNI STROJI IN NAPRAVE**
Course title:	**HYDRAULIC MACHINES AND DEVICES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)		Letni, Zimski

Koda učne enote na članici/UL Member course code:	1519

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Gašper Rak, Marko Hočevar
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Hidromehanika in Hidravlika oz. osvojena ustrezna primerljiva znanja.	Passed exams in Fluid mechanics and Hydraulics.

Vsebina:	Content (Syllabus outline):
Predavanja - Teoretične podlage turbinskih strojev: Eulerjeva turbinska enačba, zakoni podobnosti, tok v turbinski kaskadi. - Teoretične podlage hidravličnih naprav na vodnih zgradbah, zasnova postrojev in pogoji delovanja. - Eksperimentalno modeliranje in določanje integralnih karakteristik hidravličnih strojev in naprav v skladu s standardi in predpisi. Vaje	Lectures - Theoretic foundations of turbine machinery: Euler turbine equation, similarity laws, flow in turbine cascade. - Theoretic foundations of hydraulic machinery on Hydraulic structures, facility design and operating conditions. - Experimental modelling and determination of integral characteristics of hydraulic machines in accordance with standards and legislation.

Izbor hidravličnega stroja in določitev osnovnih geometrijskih karakteristik rotorja hidravličnega stroja za poljubno izbrane integralne hidroenergetske pogoje, prenos modelnih rezultatov na izvedbo. Meritve integralnih karakteristik hidravličnega stroja (turbina) v laboratoriju KMTe. Teoretično-eksperimentalno delo na modelnih hidravličnih sistemih v laboratoriju KMTe s simuliranjem dejanskih razmer na prototipih v praksi.	Tutorials Selection of a hydraulic machine and determination of basic geometrical characteristics of a hydraulic machine's rotor for arbitrary selected integral hydropower conditions, transfer of model results to a prototype. Measurements of integral characteristics of a hydraulic machine (turbine) in KMTe lab. Theoretical-experimental work on model hydraulic systems within KMTe laboratory with the simulation of real conditions found in practical prototype operations.

Temeljna literatura in viri/Readings:

P. Novak, A.I.B. Moffat and C. Nalluri. 2007. Hydraulic Structures, Fourth Edition. New York, Taylor & Francis Group,

Lakshminarayana, B. 1996. Fluid dynamics and heat transfer of turbomachinery. New York, J. Wiley & Sons.

Turton, R.K. 1984. Principles of turbomachinery. London, E. & F.N. Spon.

Učno gradivo v spletni učilnici

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati osnovne fizikalne zakonitosti energijskih pretvorb in specifičnosti ter hidrodinamske pojave v hidrotehničnih sistemih, opremljenih s hidravličnimi stroji in napravami. - Predstaviti področja uporabe hidravličnih strojev in naprav ter povezanost z okoljem preko hidravličnih robnih pogojev. - Spoznati eksperimentalne metode – modelna preizkušanja hidravličnih strojev. Kompetence - Razumevanje zakonitosti energijskih pretvorb v hidravličnih strojih in napravah ter sposobnost izbire hidromehanske opreme glede na tehnične zahteve in dane integralne pogoje. - Razumevanje principov meritev delovnih karakteristik hidravličnih strojev in naprav.	Objectives - Knowledge of basic physical laws of energy conversions and specifics. Knowledge of hydrodynamic phenomena in Water Management Systems, equipped with hydraulic machinery and devices. - Presentation of application of hydraulic machines and their connection with the environment through hydraulic boundary conditions. - Knowledge of experimental methods – model testing of hydraulic machinery. Competences - Understanding of energy conversion laws in hydraulic machinery and determination of required Water Management equipment in accordance with technical requirements and integral conditions. - Understanding of principles of operating characteristics measurements in hydraulic machinery.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Pridobljeno poglobljeno znanje o energijskih pretvorbah v turbinskih strojih in na hidromehanski opremi. - Pridobljeno znanje o eksperimentalnih metodah na mikro in makro nivoju na področju vodnogospodarskih sistemov. - Sposobnost uporabe in kritične presoje hidravličnih postrojenj na širšem področju Vodnih gradenj.	- Gained broad knowledge about energy conversions in turbine machinery and in Water Management facilities. - Gained knowledge about experimental methods on micro- and macro scales in the field of Water Management Systems. - Ability of application and critical assessment of hydraulic machines and facilities in the broad field of Water structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in uporaba pridobljenih znanj pri izdelavi seminarskih vaj.	Lectures and application of obtained knowledge in tutorials.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje	50,00 %	Coursework/exercises
Pisni in/ali ustni izpit	50,00 %	Written and/or oral examination

Reference nosilca/Lecturer's references:

Bajcar, Tom, Gosar, Leon, Širok, Brane, Steinman, Franci, Rak, Gašper. 2010. Influence of flow field on sedimentation efficiency in a circular settling tank with peripheral inflow and central effluent. Chemical engineering and processing, 49 (5): 514-522. DOI: 10.1016/j.cep.2010.03.019.

Rak, Gašper, Hočevar, Marko, Steinman, Franci. 2017. Measuring water surface topography using laser scanning. Flow measurement and instrumentation, 56: 35-44. DOI: 10.1016/j.flowmeasinst.2017.07.004.

Rak, Gašper, Steinman, Franci, Hočevar, Marko, Dular, Matevž, Jezeršek, Matija, Pavlovčič, Urban. 2020. Laser ranging measurements of turbulent water surfaces. European journal of mechanics. B, Fluids, 81: 165-172. DOI: 10.1016/j.euromechflu.2020.02.001.

Podnar, A., Dular, M., Širok, B., Hočevar, M. 2019. Experimental analysis of cavitation phenomena on Kaplan turbine blades using flow visualization. Journal of fluids engineering: Transactions of the ASME, 141 (7): 1-13. DOI: 10.1115/1.4041985.

Podnar, Andrej, Hočevar, Marko, Novak, Lovrenc, Dular, Matevž. 2021. Analysis of bulb turbine hydrofoil cavitation. Applied sciences, 11 (6): 1-18. DOI: 10.3390/app11062639.

Hočevar, Marko, Novak, Lovrenc, Drešar, Primož, Rak, Gašper. 2022. The status quo and future of hydropower in Slovenia. Energies, 15 (19): 1-13. DOI: 10.3390/en15196977.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**VODNE MOČI**
Course title:	**HYDROELECTRIC POWER**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)		Letni, Zimski

Koda učne enote na članici/UL Member course code:	1550

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Andrej Kryžanowski
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Proizvodnja električne energije v RS in vloga vodne energije. Osnove načrtovanja energetske rabe vodnih virov (dimenzioniranje akumulacij, ekonomske in finančne osnove vrednotenja, opredelitev specifičnih pokazateljev investicije, zakonska regulativa pri načrtovanju vodnih elektrarn in umeščanju v elektroenergetski sistem). Oprema vodnih elektrarn (turbine, generatorji, prenos energije). Tipi vodnih elektrarn (akumulacijske, pretočne, črpalne, elektrarne v nizu, male HE). Optimizacijski hidravlični modeli obratovanja HE (akumulacijske elektrarne, pretočne elektrarne v	Lectures Electricity generation in the Republic of Slovenia and the role of hydro power. Fundamentals of energy use planning of water resources (dimensioning of reservoirs, economic and financial baselines of evaluation, definition of specific investment indicators, legislation governing HPP planning and placement in the electric power system). Equipment of HPPs (turbines, generators, energy transport). Types of hydropower plants (reservoir, run-of- river, pumped storage, series of HPPs, small HPPs). Optimising hydraulic models of HPP operation (reservoir HPPs, series of run-of-river HPPs).

nizu). Optimizacija obratovanja HE in vloga HE v elektroenergetskem sistemu. Okoljski vidiki načrtovanja in obratovanja vodnih elektrarn. Vaje Račun energetske proizvodnje za akumulacijsko elektrarno. Ekonomska optimizacija derivacijskih objektov. Preveritev izvedljivosti projekta vodne elektrarne.	Optimisation of HPP operation and the role of HPPs in the electric power system. Environmental aspects of planning and operation of hydropower plants. Tutorials Calculation of power generation for a reservoir power station. Economic optimisation of derivation structures. Feasibility assessment of a HPP project.

Temeljna literatura in viri/Readings:

Pemič, A., Mikoš, M. 2008. Inženirska hidrotehnika – skripta. Ljubljana, UL FGG, Katedra za splošno hidrotehniko, 400 str.

Giesecke, J., Mosonyi, E. 1998. Wasserkraftanlagen. Berlin, Springer, str. 1-100 & str. 397-590.

ASME. 1996. Hydropower mechanical engineering, HCI publications, Kansas City, poglavja 2-7 in 10.

Mosonyi, E. 1991. High-head power plants - Vol 2/A, Akademia Kiado, Budapest, 519 str.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi znanje s področja hidrotehničnih objektov v smeri izrabe vodnih moči. - Podati teoretične osnove za načrtovanje vodnih elektrarn. Kompetence - Sposobnost izdelave idejne zasnove vodne elektrarne. - Sposobnost ocene izvedljivosti vodne elektrarne.	Objectives - To upgrade the knowledge of hydraulic structures in the sense of water power exploitation. - To give theoretical bases of HPP planning. Competences - Ability to elaborate the preliminary concept design of a hydropower plant. - Ability to assess the feasibility of the hydropower plant.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje s področja hidro energetike. - Razumevanje procesa načrtovanja in umestitve vodne elektrarne v elektroenergetski sistem. - Osvojene računske spretnosti za izdelavo idejne zasnove vodne elektrarne in izdelave študije izvedljivosti.	- Acquisition of in-depth knowledge of the hydropower sector. - Understanding of the planning process and placement of the hydropower plant in the electrical power system. - Acquisition of calculation skills for the preparation of the HPP preliminary concept design, and the feasibility study.

- Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju energetske rabe vodnih virov. - Sposobnost izdelati tehnično, finančno in ekonomsko presojo izvedljivosti energetske rabe vodnega vira.	- Ability of critical assessment of input data and obtained calculation results in design of energy use of water resources. - Ability to elaborate technical, financial and economic feasibility assessment of power exploitation of the water resource in question.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in seminarske vaje.	Lectures and tutorials.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje	50,00 %	Coursework/exercises
Pisni izpit	50,00 %	Written examination

Reference nosilca/Lecturer's references:

KRYŽANOWSKI, Andrej, BRILLY, Mitja, PORENTA, Marijan, TOMŠIČ, Ladislav. Hydro potential and development opportunities in Slovenia. The international journal on hydropower & dams, 2008, letn. 15, št. 5, str. 41-46, ilustr.

KRYŽANOWSKI, Andrej. Possibilities of exploitation of hydroelectric power potential in Slovenia. V: Sharing experience for safe and sustainable water storage : proceedings [of the] 9th ICOLD European Club Symposium, 10-12 April 2013, Venice, Italy. Roma: ITCOLD (Italian Committee on Large Dams), cop. 2013, str. [1-7].

KRYŽANOWSKI, Andrej. Possibilities of exploitation of hydroelectric power potential in Slovenia. V: Dams - recent experiences on research, design, construction and service : international symposium : proceedings, Skopje, 17th - 18th November, 2011. Skopje: Macedonian committee on large dams, 2011, str. 1-8

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NUMERIČNE METODE V DINAMIKI TEKOČIN**
Course title:	**NUMERICAL METHODS IN FLUID DYNAMICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)		Letni, Zimski

Koda učne enote na članici/UL Member course code:	1602

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer:	Matjaž Četina
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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:	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

Reynoldsove enačbe, modeli turbulence, numerične metode reševanja. Laboratorijske vaje Meritve vodnega skoka v šolskem žlebu ter 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,	surface waters: Reynolds equations, turbulence models, numerical methods. Laboratory tutorials Measurements of hydraulic jump and mass. 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.

Temeljna 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 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.	- 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 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/Weight	Assessment:
Domače naloge (pisno, oddaja več vaj)	50,00 %	Homework (written, several exercises)
Pisni izpit (izpit iz teorije)	50,00 %	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:	**GEOTEHNIKA OKOLJA**
Course title:	**ENVIRONMENTAL GEOTECHNICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Geotehnika - hidrotehnika (smer)		Letni, Zimski

Koda učne enote na članici/UL Member course code:	1329

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	15	75	5

Nosilec predmeta/Lecturer:	Matej Maček
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika ali osvojena primerljiva znanja.	Passed exams in Soil Mechanics and Engineering Geology, Geotechnics or comparable knowledge.

Vsebina:	Content (Syllabus outline):
Predavanja Uvod v geotehniko okolja: zgodovina geotehnike okolja, razlike v pristopih obravnave geoloških tal v klasični geotehniki in v geotehniki okolja. Zemljina kot prevodnik, izolator ali akumulator onesnaževal. Uvod v nesaturirano zemljino, karakteristična krivulja zemljina - voda. Viri radona v naravnem okolju. Hidrogeologija in transport kontaminantov v tleh. Alternativni materiali v gradbeništvu in geotehnika okolja. Raba alternativnih materialov-sekundarnih surovin kot zemljinam nadomestnih	Lectures Introduction to environmental geotechnics: history, differences in approaches used in classical and environmental geotechnics. Soil as conductor, barrier or accumulator of pollutants. Introduction to unsaturated soils, soil-water characteristic curve. Sources of radon in nature. Hydrogeology and transport of pollutants in ground. Alternative materials in civil and environmental engineering. Use of alternative materials – secondary raw materials instead of natural soils and their potential

materialov in njihovi potencialni vplivi na okolje. Izluževalni in perkolacijski testi. Raba geosintetikov za zaščito okolja. Odlagališča odpadkov I: vrste odlagališč, izbor lokacije, konstrukcijska zasnova talnega ustroja, materiali za talni ustroj, stabilnost in deformabilnost odlagališča, zajem in odvajanje izcedne vode. Odlagališča odpadkov II: zapiranje odlagališč odpadkov, konstrukcijska zasnova pokrova, račun vodne bilance, lizimetri, kontrola odlagališča po zaprtju. Remediacija onesnaženih tal: metode prepoznavanja, strategije remediacije, tehnologije remediacije. Vrste in izvedbene značilnosti objektov za monitoring podzemne vode. Osnove iz geotermalne energije. Zakonodaja na področju geotehnike okolja, podzakonski akti, standardi. Vaje in terensko delo Laboratorijske preiskave zemljin in odpadkov: presoja adsorpcijskih lastnosti, kationske izmenjalne kapacitete, nabrekalnega potenciala, strukturnega kolapsa. Laboratorijske preiskave nesaturiranih zemljin, retencijska krivulja, povezava prepustnosti, retencijske krivulje in Proctorjeve krivulje. Računi stabilnosti deponij odpadkov in pokrovov ter toka vode skozi pokrove in umetne bariere. Anizotropija vodoprepustnosti v tleh.	environmental impact. Leaching and percolation test. Use of geosynthetics for environmental protection. Landfills I: types of landfills, choice of location, design and materials for bottom liner system, stability and deformability of landfill, collection and drainage of seepage water. Landfills II: Closure of landfills, design of cover layer, calculation of water balance, lysimeters, control of abandoned landfills. Remediation of polluted land: methods of recognition, strategies and technologies of remediation. Types and properties of structures and devices for groundwater monitoring. Fundamentals of geothermal energy. Regulation in the field of environmental geotecnics, implications of regulations on engineering design, standards. Tutorials and field work Laboratory tests on soils and wastes: adsorption capacity, cation exchange capacity, swelling potential, structural collapse. Laboratory tests of unsaturated soil samples, retention curve, interdependence of permeability, retention curve and Proctor curve. Stability analyses of landfills and cover layers. Calculation of water seepage through cover layers and artificial barriers. Anisotropy of ground permeability.

Temeljna literatura in viri/Readings:

Van Impe, W.F., Bouazza, A., 1996. Fundamentals of Environmental geotechnics. Ghent State University.

Evrokod 7-2: Preiskovanje in preskušanje tal.

Daniel E. D. 1993. Geotechnical Practice for Waste Disposal. Chapman&Hall.

Salomons, W. in Forstner, U. 1993. Environmental Management of Solid Waste. Dredged Material and Mine Tailings. Springer-Verlag.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Razumeti pomen razlik med klasičnimi geotehničnimi zgradbami in zgradbami v geotehniki okolja. - Nadgraditi osnovno znanje o lastnostih zemljin in o umetnih materialih v geotehniki ter o gibanju vode skozi zemljino s posebnim poudarkom na	Objectives: - To understand the difference between classical geotechnical structures and structures in environmental engineering. - To enhance knowledge on soil properties, groundwater movement and artificial materials in geotechnical engineering with emphasize on

adsorpciji, kationski izmenjavi in retencijskih sposobnostih. - Spoznati lastnosti odpadkov in lastnosti odpadkov sekundarnih surovin kot alternativnih materialov v gradbeništvu ter postopkih njihovega raziskovanja in ocenjevanja primernosti za rabo. - Nadgraditi osnovna znanja o gibanju vode v tleh z znanji o gibanju polutantov v tleh. - Podati temeljna znanja o načrtovanju, gradnji ter zapiranju odlagališč odpadkov, o ščitenju tal na območju odlagališč in prometnic in o sanaciji in remediaciji rudniških in industrijskih jalovišč in kontaminiranih tal. - Spoznati objekte za opazovanje podzemne vode in specifiko njihovega načrtovanja, izvedbe in vzdrževanja. Pridobljene kompetence: - Sposobnost projektiranja, nadzorovanja gradenj in zapiranja deponij odpadkov, jalovišč, sanacije onesnaženih tal in opazovanja, - Sposobnost vodenja aktivnosti za raziskovanje na področju opuščenih, aktivnih ali novih objektov, ki imajo pomembne vplive na okolje, - Sposobnost načrtovanja monitoringa kontaminacije, - Sposobnost odločanja o tehnični in okoljski primernosti rabe alternativnih materialov v nizkih gradnjah.	adsorption, cation exchange capacity and retention properties. - To study properties of wastes and secondary raw materials as alternative materials in civil engineering and procedures for their testing and assessment of their suitability in engineering applications. - To combine the knowledge on groundwater movement with fundamentals of transport of polutants . - To study fundamental principles of design, construction and closure of landfills, ground protection in landfill areas and traffic routes, remediation of mining and industrial contaminated areas. - To know the facilities for groundwater monitoring and specific aspects of their design, construction and maintenance. Competences: - Capability to design and supervise construction and closure of landfills, remediation of contaminated land, environmental monitoring. - To manage activities for the exploration of abandoned or active and new facilities with significant environmental impact. - To prepare the programme of environmental monitoring. - To take decisions on technical and environmental suitability of the use of alternative materials in civil engineering.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje toka vode in polutantov v zemljini in skozi naravne in umetne bariere - Razumevanje razlik med zemljinami, “inertnimi” zemljinami in aktivnimi „odpadki” - Razumevanje razlik med naravnimi gradivi in gradivi iz alternativnih materialov - Razumevanje konceptualne zasnove aktivnih in pasivnih ukrepov za preprečevanje onesnaženja tal in podzemne vode.	- Understanding of groundwater movement and pollutant transport through natural and artificial barriers - Understanding the difference between “inert” soils and active “wastes” - Understanding the difference between natural and artificial building materials - Understanding conceptual design of active and passive measures for the protection of ground and groundwater against pollution

- Doseženo znanje uporabljajo pri izdelavi magistrske naloge in v inženirski praksi kot inženirji projektanti, soglasodajalci ali nadzorniki. - Dobro razumevanje zakonitosti interakcij tla/podzemna voda/človekova dejavnost/objekt/odpadek/polutant/širjenje polutanta. - Sposobnost prepoznavanja ranljivosti okolja za onesnaženje - Sposobnost prepoznavanja samozaščitnih lastnosti tal - Sposobnost načrtovanja, gradnje.	- Knowledge will be used during the preparation of Master thesis and in engineering practice as designers, supervising engineers, decision makers - Thorough understanding of the interaction between ground, groundwater, human activities, structures, wastes, pollutants and pollutant transport - Ability to recognize the vulnerability of the environment for contamination - Ability to recognize the self protecting properties of ground - Ability to design and construct

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje ter terensko delo. Uporaba pridobljenih znanj pri izdelavi individualnih nalog	Lectures, tutorials, field work. Individual project work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje in individualne naloge	30,00 %	Tutorials and individual work
Pisni izpit	70,00 %	Written exam

Reference nosilca/Lecturer's references:

MAČEK, Matej, SMOLAR, Jasna, PETKOVŠEK, Ana (2018) Settlement prediction of gypsum sludge based on different test methods. V: Jovanovski, M. (ur.). Proceedings of the 16th Danube - European Conference on Geotechnical Engineering. Ernst & Sohn.

SMOLAR, Jasna, MAČEK, Matej, PETKOVŠEK, Ana (2016) Geotechnical and environmental characterization of boiler slag as fill material. Journal of geotechnical and geoenvironmental engineering 42(8): 1-7.

MAČEK, Matej, SMOLAR, Jasna, PETKOVŠEK, Ana (2013) Extension of measurement range of dew-point potentiometer and evaporation method. V: Delage, P. (ur.) Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering. Presses des Ponts: 1137-1142

MAČEK, Matej, MAUKO, Alenka, MLADENOVIČ, Ana, MAJES, Bojan, PETKOVŠEK, Ana. A comparison of methods used to characterize the soil specific surface area of clays. Appl. clay sci.. [Print ed.], oktober 2013, letn. 83-84, str. 144-152.

MAČEK, Matej, MAJES, Bojan, PETKOVŠEK, Ana. Influence of mould suction on the volume - change behaviour of compacted soils during inundation = Vpliv vrojene sukcije na volumensko obnašanje zgoščenih zemljin med vlaženjem. Acta geotech. Slov., 2011, vol. 8, [no]. 2, str. 67-79.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MATEMATIKA 3**
Course title:	**MATHEMATICS 3**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1617

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Gašper Jaklič
Vrsta predmeta/Course type:	obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. primerljive vsebine matematike v obsegu najmanj 15 KT.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content with min. 15 ECTS.

Vsebina:	Content (Syllabus outline):
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.	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

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

Temeljna 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	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model - Basic theoretical knowledge for using in practical problems

- Sposobnost kritične presoje rezultatov - Poznavanje računalniških orodij (Mathematica, Matlab) - Dosežena matematična podlaga za strokovne predmete	- 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/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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:	**METODE KONČNIH ELEMENTOV V GRADBENIŠTVU**
Course title:	**FINITE ELEMENT METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1453

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Brank
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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,

- FEM analize, - Kritična ocena rezultatov.	- Critical evaluation of numerical results.

Temeljna 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/Weight	Assessment:
Računski del izpita: modeliranje in analiza problema z računalnikom	50,00 %	FEM modelling, analysis and evaluating of results of a civil engineering problem
Teoretični del izpita	50,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1465

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	0	0	45	3

Nosilec predmeta/Lecturer:	Zvonko Jagličić
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

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.	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.

Vaje Seminarske vaje (računske vaje).	Tutorials Problem solving classes.

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

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.	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/Weight**	**Assessment:**
Predstavitev samostojno izdelanih nalog in ustni zagovor	70,00 %	Oral defence of home assignments
Pisni izpit	30,00 %	Written exam

Reference nosilca/Lecturer's references:

PAJEK, Luka, KUNIČ, Roman, JAGLIČIĆ, Zvonko. Fazno spremenljive snovi (PCM) in njihova uporaba v stavbah = Phase change materials (PCM) and their application in buildings. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije, ISSN 0017-2774. [Tiskana izd.], mar. 2018, letn. 67, str. 51-62, ilustr. [COBISS.SI-ID 8369249]

COTIČ, Patricia, KOLARIČ, Dejan, BOKAN-BOSILJKOV, Violeta, BOSILJKOV, Vlatko, JAGLIČIĆ, Zvonko. Determination of the applicability and limits of void and delamination detection in concrete structures using infrared thermography. NDT & E International, ISSN 0963-8695. [Print ed.], 2015, letn. 74, št. sept., str. 87-93, ilustr., doi: 10.1016/j.ndteint.2015.05.003. [COBISS.SI-ID 7065697]

PETERNELJ, Jože, JAGLIČIĆ, Zvonko. Osnove gradbene fizike : [univerzitetni učbenik]. Ljubljana: Fakulteta za gradbeništvo in geodezijo, 2014. II, 166 str., ilustr. ISBN 978-961-6884-15-0. [COBISS.SI-ID 271577856]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NELINEARNA MEHANIKA**
Course title:	**NON-LINEAR MECHANICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1463

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	15	0	90	6

Nosilec predmeta/Lecturer:	Igor Planinc
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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;	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

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 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.	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 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.

Temeljna 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 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.	Objectives - Students deepen and enhance their knowledge of non-linear continuum mechanics. - At the completion of the course, students are 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.	- Once the course is completed, students should increase their skills of solution methods and improve their comprehension of non-linear mechanics.

- 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.	- 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/Weight**	**Assessment:**
Ustni izpit	55,00 %	Oral examination
Domače naloge	45,00 %	Home assignments

Reference nosilca/Lecturer's references:

RUŽIĆ, Dušan, KOLŠEK, Jerneja, PLANINC, Igor, SAJE, Miran, HOZJAN, Tomaž. Non-linear fire analysis of restrained curved RC beams. Engineering structures, 2015, vol. 84, str. 130-139, ISSN 0141-0296.

BAJC, Urška, SAJE, Miran, PLANINC, Igor, BRATINA, Sebastjan. Semi-analytical buckling analysis of reinforced concrete columns exposed to fire. Fire safety journal, 2015, letn. 71, str. 110-122, ISSN 0379-7112.

SCHNABL, Simon, JELENIĆ, Gordan, PLANINC, Igor. Analytical buckling of slender circular concrete-filled steel tubular columns with compliant interfaces. Journal of constructional steel research, 2015, letn. 104, str. 252-262, ISSN 0143-974X.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**STATIKA GRADBENIH KONSTRUKCIJ**
Course title:	**STRUCTURAL ANALYSIS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1464

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	0	30	0	75	5

Nosilec predmeta/Lecturer:	Tatjana Isaković
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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.	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

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 vplivov v kritičnih prerezih, pripravi tehnično poročilo.	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 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.

Temeljna 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 - 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.	- 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. - 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/Weight**	**Assessment:**
Seminarska naloga Oba dela morata biti pozitivna. Študent mora uspešno zaključiti semninar preden se lahko prijavi na izpit.	40,00 %	Seminar (project) Both parts should be positive. Student must successfully complete the seminar (project) prior to the registration for exam.
Pisni izpit	60,00 %	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:	**CONCEPTION OF BUILDING STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code: 1623

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	0	0	0	45	3

Nosilec predmeta/Lecturer: Matija Gams

Vrsta predmeta/Course type: Obvezni strokovni /Obligatory professional

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

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	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:

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 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.	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/ 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.

Temeljna 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	- Understanding of the fundamental principles of good conceptual design and appropriate choice of the structural systems;

- 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 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.	- 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 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/Weight**	**Assessment:**
Izdelava seminarskih nalog	50,00 %	Seminar work
Izpit Oba dela morata biti pozitivna.	50,00 %	Final exam /presentation of the work Both parts should be positive.

Reference nosilca/Lecturer's references:

TRILLER, Petra, TOMAŽEVIČ, Miha, GAMS, Matija. Seismic behaviour of masonry buildings built of low compressive strength units. Bulletin of earthquake engineering, ISSN 1570-761X, Dec. 2018, vol. 16, iss. 12, str. 6191-6219, ilustr., doi: 10.1007/s10518-018-0418-5. [COBISS.SI-ID 2402151]

GAMS, Matija, TOMAŽEVIČ, Miha, BERSET, Thierry. Seismic strengthening of brick masonry by composite coatings : an experimental study. Bulletin of earthquake engineering, ISSN 1570-761X, Apr. 2017, str. 1-30, ilustr., doi: 10.1007/s10518-017-0136-4. [COBISS.SI-ID 2292327]

TOMAŽEVIČ, Miha, GAMS, Matija, BERSET, Thierry. Strengthening of stone masonry walls with composite reinforced coatings. Bulletin of earthquake engineering, ISSN 1570-761X, Jul. 2015, vol. 13, issue 7, str. 2003-2027, ilustr., doi: 10.1007/s10518-014-9697-7. [COBISS.SI-ID 2073703]

TOMAŽEVIČ, Miha, GAMS, Matija. Shaking table study and modelling of seismic behaviour of confined AAC masonry buildings. Bulletin of earthquake engineering, ISSN 1570-761X, jun. 2012, vol. 10, issue 3, str. 863-893, ilustr., doi: 10.1007/s10518-011-9331-x. [COBISS.SI-ID 1837927]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PRENOVA IN PREIZKUŠANJE KONSTRUKCIJ**
Course title:	**REPAIR AND TESTING OF STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1466

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	0	30	0	75	5

Nosilec predmeta/Lecturer:	Vlatko Bosiljkov
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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,	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,

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 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).	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 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).

Temeljna 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.	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.

- Uvajanje v sistematični pristop k izvedbi preiskav konstrukcij. - Razvijanje osnov za vrednotenje ekonomike sanacijskih ukrepov.	- 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	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

modela in konstrukcijskih elementov v naravni velikosti.	model level and structural elements on prototype level.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Laboratorijske vaje	30,00 %	Laboratory work
Seminarska naloga	40,00 %	Seminar
Izpit	30,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1489

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer:	Jože Korelc
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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.	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.

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 konstrukcij, sklopljeni problemi, reševanje sklopljenih problemov.	Introduction to methods for numerical simulation of advanced problems such as: contact problems; multi-scale problems; coupled problems.

Temeljna 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/ .knjižni viri:
Zdenek p. Bažant, Luigi Cedolin (2003), Stability of structures, Dover, poglavlja 1, 2, 4, 5, 6,7 8
M. A. Crisfield, non-linear finite element analysis of solids and structures vol.1, john wiley & sons, 1991, poglavja 4, 9
P. Wriggers. Nonlinear finite element methods. Springer, Berlin, 2008.
elektronski viri: spletna uèilnica, http://fgg.uni-lj.si/symech/

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.	- 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

- Sposobnost formuliranja enostavnih nelinearnih končnih elementov.	- 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/Weight**	**Assessment:**
Ustni izpit (vsebuje tako teoretične kot tudi računske naloge) Oba dela mora biti ocenjena pozitivno.	60,00 %	Exam (theoretical and practical tasks) Both parts should be positive.
Seminarske vaje	40,00 %	Seminar 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.

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1461

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	15	0	75	5

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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;	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

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

Temeljna 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.	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:

- Sposobnost uporabe tehnoloških rešitev.	- 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. - 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.	- 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. - 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/Weight**	**Assessment:**
Projektni izdelek	40,00 %	Project work quality
Teoretično znanje na izpitu	40,00 %	Theoretical exam
Sodelovanje na vajah in predavanjih	20,00 %	Activity and collaboration

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:	**THEORY OF PROBABILITY AND STATISTICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1618

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Marjeta Kramar Fijavž
Vrsta predmeta/Course type:	Obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. drugih predmetov s primerljivo vsebino.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content.

Vsebina:	Content (Syllabus outline):
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.	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.

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 domnev.	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.

Temeljna 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	- Formulation of practical problems in mathematical language

- 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)	- 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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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.

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1462

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	0	15	30	0	105	7

Nosilec predmeta/Lecturer:	Boštjan Pulko
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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;

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 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.	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 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

Temeljna 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:	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.

- 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.	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. 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.	- 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. 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/Weight**	**Assessment:**
Samostojno izdelana naloga	20,00 %	Seminar (individual work)
Dva kolokvija ali pisni izpit	80,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1468

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
6	0	0	0	80	34	4

Nosilec predmeta/Lecturer:	Andreja Istenič Starčič
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

skupinskega dela, pokaže iniciativnost in samostojnost pri vodenju najzahtevnejših delovnih sistemov pod nadzorom mentorja.	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.

Temeljna 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:	**Objectives and competences:**
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 - 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:	Intended learning outcomes:
- 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 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.	- 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 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/Weight	Assessment:
Dnevnik prakse	40,00 %	Diary of practical work
Portfolio	30,00 %	Portfolio
Ustni zagovor	30,00 %	Oral presentation

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1496

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Obvezni strokovni v/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

Izdelava lastnega projekta od zasnove do generalnega plana. Modeliranje tveganj pri projektih v gradbeništvu in simulacija vplivov.	Tutorial Preparation of a case study. Risk simulation in construction projects, impact simulation.

Temeljna literatura in viri/Readings:

- Rant, M., Jeraj, M., & Ljubič, T. (1998). Vodenje projektov: projektni pristop, projektna organizacija, vodenje projektov, projektni proces, terminsko planiranje projektov, mrežno planiranje (2. izd.). POIS.
- Česen, A., Kern, T., Bajec, M. (2008)**.** Vodnik po znanju projektnega vodenja, 3. Izdaja. Založba Moderna organizacija
- Golob, K. (2021). Investicijski procesi in vodenje projektov: [gradivo za strokovne izpite]. 2. ponatis. Ljubljana: Inženirska zbornica Slovenije.
- Project Management Institute, ed. The Standard for Project Management and a Guide to the Project Management Body of Knowledge (PMBOK Guide). Seventh edition. Newtown Square, Pennsylvania: Project Management Institute, Inc, 2021.

Cilji in kompetence:	**Objectives and competences:**
- Pridobitev znanj o posameznih udeležencih v procesu graditve, - Pridobitev znanj o fazah projekta (s poudarkom na gradbenem projektu), - Pridobitev znanj o procesu vodenja projekta.	- 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:	**Intended learning outcomes:**
- Osvojeno znanje s področja projektnega vodenja (proces, udeleženci, medsebojni odnosi, oblike sodelovanja), - Sposobnost uporabe računalniških orodij za vodenje projektov.	- Acquired knowledge from the field of project management (process, stakeholders, participants' relations), - Ability to use computer – supported project management tools.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, lab.vaje	Lectures, tutorial

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit (teoretični del)	50,00 %	Written exam (theory)
Pisni izpti (računski del)	50,00 %	Written exam (examples)

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466.

http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**DINAMIKA GRADBENIH KONSTRUKCIJ IN POTRESNO INŽENIRSTVO**
Course title:	**STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1497

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	0	0	45	0	105	7

Nosilec predmeta/Lecturer:	Matjaž Dolšek
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional
Jeziki/Languages:	Predavanja/Lectures: Slovenščina Vaje/Tutorial: Slovenščina

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

Vsebina:	Content (Syllabus outline):
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	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

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.	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.

Temeljna 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:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- Seznanitev z dinamičnimi problemi v gradbeništvu in metodami za njihovo reševanje. - Razumevanje osnovnih značilnosti dinamičnega odziva in inženirskega modeliranja konstrukcij.	- 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;

- 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 - Sposobnost uporabe metod analize dinamičnih problemov; - Sposobnost uporabe predpisov za projektiranje novih in za preverjanje obstoječih objektov; - Sposobnost uporabe literature in spletnih virov.	- 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 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/Weight**	**Assessment:**
Računski del izpita	30,00 %	Exam (computational part)
Samostojna naloga (se izdela med letom)	30,00 %	Individual work (made during the year)
Teoretični del izpita	40,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1498

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Drago Saje, Jože Lopatič, Sebastjan Bratina
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

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).	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).

Temeljna 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:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- Poglobitev in razširitev znanja s področja dimenzioniranja, računskega modeliranja in konstrukcijske izvedbe masivnih konstrukcij	- Upgrading and expanding of knowledge from the area of design, computational modelling and detailing of concrete and masonry structures.

- 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.	- 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:	**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/Weight**	**Assessment:**
Vaje	20,00 %	Tutorials
Teoretični izpit	40,00 %	Theoretical part of exam
Računski izpit (možno opraviti s kolokviji)	40,00 %	Computational 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.

BRATINA, S., HOZJAN, T., 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: UL FGG, 2010, 143 str.

MARKOVIČ, M., KRAUBERGER, N., SAJE, M., PLANINC, I., BRATINA, S., Non-linear analysis of pre-tensioned concrete planar beams, Engineering Structures, 2013, letn. 46, str. 279-293.

BAJC, U., PLANINC, I., BRATINA, S., Non-linear time-dependent analysis of cracked reinforced concrete bar, Advances in structural engineering, 2018, letn. 21, str. 949-961.

SAJE, Drago, LOPATIČ, Jože. The effect of constituent materials on the time development of the compressive strength of high-strength concrete. Magazine of Concrete Research, ISSN 0024-9831, 2010, letn. 62, št. 4, str. 291-300.

SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Shrinkage of polypropylene fibre reinforced high performance concrete. Journal of materials in civil engineering, ISSN 0899-1561, 2011, vol. 23, iss. 7, str. 941-952.

SAJE, Drago. Reduction of the early autogenous shrinkage of high strength concrete. Advances in Materials Science and Engineering, ISSN 1687-8434. [Print ed.], 2015, str. 1-8, ilustr. http://www.hindawi.com/journals/amse/2015/310641/, http://drugg.fgg.uni-lj.si/, doi: 10.1155/2015/310641.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**JEKLENE KONSTRUKCIJE II**
Course title:	**STEEL STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1499

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer:	Primož Može
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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	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).

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.	Individual work Seminar: practical examples – application of design methods given in the lectures.

Temeljna 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:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- Spoznati in razumeti metode analize in dimenzioniranja sistemov, - Spoznati osnove plastične analize jeklenih	- To know and understand the analysis methods and the design of systems.

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 problemov, - Pridobivanje spretnosti za uporabo literature, interneta in drugih informacijskih tehnologij.	- 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. - 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/Weight**	**Assessment:**
Pravilno izdelane vaje	10,00 %	Approved elaborated examples
Teoretični del izpita (običajno v obliki ustnega zagovora)	50,00 %	Theoretical exam (usually oral)
Računski del izpita	40,00 %	Practical exam

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:	**PROBABILITY METHODS AND RELIABILITY OF STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code: 1500

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer: Goran Turk

Vrsta predmeta/Course type: Obvezni strokovni /Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika 3, Verjetnostni račun in statistika.	Passed exams in Mathematics 3, Theory of probability and statistics.

Vsebina:	Content (Syllabus outline):
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	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

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

Temeljna 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.	- 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.

- Razumeti mora povezavo med varnostnimi faktorji iz pravilnikov in zanesljivostjo konstrukcije, indeksom zanesljivosti, verjetnostjo porušitve. - Razumeti mora osnove projektiranja konstrukcij s stališča zanesljivosti konstrukcij.	- 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/Weight**	**Assessment:**
Samostojna naloga	20,00 %	Individual work
Računske naloge, izdelane med semestrom	40,00 %	Practical exercise during the semester
Ustni izpit - teoretični del	40,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1481

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	0	0	0	150	150	10

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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	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

- 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.	- 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.

Temeljna 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:	**Objectives and competences:**
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 • 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:	**Intended learning outcomes:**
• 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.	• 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.

• Načrtovanje, izvedba in kritično vrednotenje pri reševanju problemov ter prezentacija izsledkov strokovnih nalog in raziskav. • Sodelovanje, vključevanje strokovnjakov in skupno reševanje problemov.	• 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:	**Learning and teaching methods:**
Mentorsko vodeno samostojno delo.	Independent work under supervision.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Magistrska naloga	50,00 %	Master thesis
Zagovor	50,00 %	Defence

Reference nosilca/Lecturer's references:

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NUMERIČNO MODELIRANJE TRDNIN**
Course title:	**NUMERICAL MODELLING OF SOLIDS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1559

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Jože Korelc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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	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.

implementacija konstitutivnih modelov tipičnih gradbenih materialov. Laboratorijske vaje Numerične simulacije nekaterih tehničnih problemov z metodo končnih elementov. Izpeljava nelinearnih končnih elementov.	Exercises Numerical simulation of typical nonlinear engineering problems using finite element method. Derivation of nonlinear finite element codes.

Temeljna 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. Dostopno na: http:// symech .fgg.uni-lj.si/nak/Skripta/ .

Cilji in kompetence:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- 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.	- 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.

- Uporaba komercialnih in raziskovalnih računalniških programov, ki delujejo po metodi končnih elementov, pri reševanje različnih tehniških problemov. - Kritična ocena rezultatov simulacije.	- 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:	**Learning and teaching methods:**
Predavanja se izvajajo v učilnici z različnimi učnimi pripomočki. Vse vaje se izvajajo v računalniškem laboratoriju, kjer se uporabljajo komercialni in raziskovani računalniški programi po metodi končnih elementov. Študentje jih izvajajo deloma individualno, deloma skupinsko.	Lectures, exercises, attendance of International Short Course on Experimental and Numerical Modelling of M5 Problems in Engineering.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Ustni izpit (vsebuje tako teoretične kot tudi računske naloge)	60,00 %	Exam (theoretical and practical tasks)
Seminarske vaje	40,00 %	Seminar tasks (results collected every 4 weeks)

Reference nosilca/Lecturer's references:

KORELC, Jože. Automation of primal and sensitivity analysis of transient coupled problems. Computational mechanics, ISSN 0178-7675, 2009, letn. 44, št. 5, str. 631-649, ilustr., doi: 10.1007/s00466-009-0395-2.

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1560

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Dejan Zupan, Goran Turk
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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	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)

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 parcialnih diferencialnih enačb.	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.

Temeljna 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.	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.

Pridobljene kompetence	Acquired competence
- 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.	- 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/Weight**	**Assessment:**
Računski del	50,00 %	Practical exam
Teoretični del	50,00 %	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:	**TEHNOLOGIJA MATERIALOV NA OSNOVI MINERALNIH VEZIV**
Course title:	**TECHNOLOGY OF MATERIALS WITH MINERAL BINDERS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1561

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Violeta Bokan-Bosiljkov
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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	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

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).	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).

Temeljna 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:	**Objectives and competences:**
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.	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.

- Sposobnost izbire kompatibilnih materialov na osnovi mineralnih veziv za obnovo ali rekonstrukcijo poškodovanih objektov.	- 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:	**Intended learning outcomes:**
- 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. - 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.	- 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 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/Weight**	**Assessment:**
Ocena elaborata	40,00 %	Seminar work and its defence
Dva kolokvija ali izpit	60,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1562

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
15	15	0	30	0	60	4

Nosilec predmeta/Lecturer:	Violeta Bokan-Bosiljkov
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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.	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

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 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.	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 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.

Temeljna 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	- 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

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.	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/Weight**	**Assessment:**
Seminarska naloga	40,00 %	Seminar work and its defend
Kolokvij ali izpit	60,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code: 1552

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer: Tomaž Hozjan

Vrsta predmeta/Course type: Izbirni strokovni/Elective professional

Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

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

Vsebina:	Content (Syllabus outline):
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.	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.

Vaje - Seminarske vaje (izdelava požarnega elaborata za enostaven objekt).	Tutorial Seminar exercises (design of fire study for a simple object).

Temeljna 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:	**Objectives and competences:**
- 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 sociooloških, 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.	- 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:	**Intended learning outcomes:**
- 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.	- 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.

- Znanje osnovnih metod za računsko oceno požarne odpornosti lesenih, armiranobetonskih in jeklenih konstrukcij.	- Knowledge of the basic methods of constructing an assessment of the fire resistance of timber, reinforced concrete and steel structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje.	Lectures, seminar exercises.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični del	50,00 %	Theoretical part
Praktični del	50,00 %	Practical 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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1537

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Jože Lopatič, Sebastjan Bratina
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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	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.

Vaje - seminarske vaje (računski primeri) - laboratorijske vaje (numerične simulacije obnašanja prednapetih konstrukcij v računalniški učilnici).	Tutorials - seminar tutorials (computational examples) - laboratory tutorials (numerical simulations of the behaviour of prestressed structures in computer classroom).

Temeljna 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:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- 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.	- 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.

- 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.	- 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:	**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/Weight**	**Assessment:**
Vaje	30,00 %	Tutorials
Računski del izpita	35,00 %	Computational part of exam
Teoretični del izpita	35,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1536

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Primož Može
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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

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 študent spozna pri predavanjih.	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. Practical application of design methods.

Temeljna 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	- 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.

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.	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/Weight**	**Assessment:**
Samostojna naloga	40,00 %	Approved project work
Zagovor naloge	30,00 %	Defence of the approved project work
Ustni izpit	30,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code: 1553

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer: Jože Lopatič

Vrsta predmeta/Course type: Izbirni strokovni/Elective professional

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

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	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

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, 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).	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 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).

Temeljna 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.	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,

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.	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/Weight**	**Assessment:**
Teoretični del izpita	35,00 %	Theoretical part of exam

Računski del izpita	35,00 %	Computational part of exam
Vaje	30,00 %	Tutorials

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1549

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Brank
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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.	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

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

Temeljna 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	- To get knowledge about shell theory
- Znanje o uporabi metode končnih elementov za analizo lupin	- To use the finite element method for shell structure analysis
- Znanje o stabilnostni problematiki pri lupinah	- To get knowledge about shell buckling

- Znanje o projektiranju lupin	- 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/Weight**	**Assessment:**
Računski del izpita: analiza lupinaste konstrukcije z računalnikom	50,00 %	Finite element modelling and analysis of a shell structure
Teoretični del izpita	50,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1626

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Janko Logar, Vojkan Jovičić
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija, Geotehnika.	Passed exams in Soil mechanics and engineering geology, Geotechnical Engineering

Vsebina:	Content (Syllabus outline):
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	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

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 - 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.	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 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.

Temeljna 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	Objectives - To understand basics of rock mechanics - To recognize types of underground structures and construction technologies

- 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.	- 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 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.	- 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 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/Weight**	**Assessment:**
Izpit	60,00 %	Exam

Samostojno izdelane vaje	40,00 %	Individual project

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.

JUREČIČ, Nina, ZDRAVKOVIĆ, Lidija, JOVIČIĆ, Vojkan. Predicting ground movements in London Clay. Proceedings of the Institution of Civil Engineers - Geotechnical engineering, ISSN 1353-2618. [Print ed.], 2012, vol. 164, issue 4, str. 1-17, doi: 10.1680/geng.11.00079.

JOVIČIĆ, Vojkan, ŠUŠTERŠIČ, Jakob, VUKELIČ, Željko. The application of fibre reinforced shotcrete as primary support for a tunnel in flysch. Tunnelling and underground space technology, ISSN 0886-7798. [Print ed.], 2009, vol. 24, no. 6, str. 723-730.

LIKAR, Jakob, JOVIČIĆ, Vojkan. The causes of excessive settlement above Trojane Tunnel and remedial measures. Tunnelling and underground space technology, ISSN 0886-7798. [Print ed.], 2004, vol. 19, no. 4/5, str. 386-387. http://authors.elsevier.com/sd/article/S0886779804000847.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MODELIRANJE GEOTEHNIČNIH KONSTRUKCIJ**
Course title:	**MODELLING OF GEOTECHNICAL STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code: 1529

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	15	0	30	0	90	6

Nosilec predmeta/Lecturer: Boštjan Pulko, Janko Logar

Vrsta predmeta/Course type: Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika.	Passed exams in Soil Mechanics and Engineering Geology and Geotechnics.

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	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

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, varovanje gradbene jame, posedanje tal pod nasipom, zemeljska pregrada, predor).	diffusion equations (consolidation), drained and un-drained conditions; modeling 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 deep foundations, protection of the excavation, settlements beneath the embankment, earth dam, tunnel).

Temeljna 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 analyze 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	- 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

- 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 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/Weight**	**Assessment:**
Samostojno izdelane vaje	40,00 %	Individual practical work
Izpit	60,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Letni

Koda učne enote na članici/UL Member course code:	1740

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	60	0	0	0	90	6

Nosilec predmeta/Lecturer:	Tatjana Isaković
Vrsta predmeta/Course type:	Izbirni strokovni/Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Osnovno predznanje na področju Projektiranja armiranobetonskih konstrukcij, Dinamike in potresne analize konstrukcij, Statike linijskih konstrukcij, Trdnosti in Gradiv. Znanje angleškega jezika.	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:	Content (Syllabus outline):
Predmet predstavlja uvod v nelinearno analizo armiranobetonskih konstrukcij s posebnim poudarkom na armiranobetonskih mostovih. Vsebina:	The course is an introduction to nonlinear analysis of reinforced concrete structures with a special emphasis on reinforced concrete bridges. Content:

- 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. 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. Skupine študentov bodo obravnavale različne primere z različnimi konstrukcijskimi detajli. Na koncu dela bo organizirana javna predstavitev in diskusija rezultatov vseh seminarskih nalog.	- 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. 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. 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.

Temeljna 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 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.	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 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:

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.	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.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Sprotno ocenjevanje samostojnosti, iniciativnosti in zavzetosti pri izdelavi seminarske naloge	30,00 %	The ongoing assessment of independence, initiative and commitments during the project work.
Seminarska naloga	30,00 %	Project
Javna predstavitev seminarske naloge	10,00 %	Public presentation of the project
Kritična diskusija in povzetek rezultatov seminarskih nalog. Vsi deli morajo biti pozitivno ocenjeni.	30,00 %	Critical discussion and summary of the results of projects. All parts should be graded positively

Reference nosilca/Lecturer's 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

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**ZIDANE KONSTRUKCIJE**
Course title:	**MASONRY STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer)		Zimski

Koda učne enote na članici/UL Member course code:	1800

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Matija Gams, Vlatko Bosiljkov
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja *Gradiva* (zidaki in malta, rege, polnilni beton, armaturno jeklo); *Zidovje* – mehanske lastnosti (tlačna, strižna, referenčna natezna in upogibna trdnost, deformacijske lastnosti (elastični, strižni modul, duktilnost), tečenje, raztezek zaradi vlage ali krčenje in raztezek zaradi temperature); *Nearmirano zidovje* (URM) (specifike nosilnih elementov zidovja – zid, steber, pilaster, lok); *Povezano* (C) *in armirano zidovje (RM)*; *Dodatne komponente za zidovje* (vlagozaporne plasti, zidna stremena, sidrni trakovi, obešala in konzole, pripomočki za prednapenjanje, prefabricirane preklade); *Stropne konstrukcije*	Lectures *Masonry material* (units and mortar, joints, grouting, reinforcement); *Masonry* – mechanical properties (compressive, shear, reference tensile and flexural strength, deformation properties (elastic, shear modulus, ductility), creep, moisture expansion, shrinkage, temperature expansion); *Unreinforced masonry (URM)* (characteristics of load bearing walls, column, pilaster, arches); *Confined (C) and reinforced masonry (RM); Ancillary components* (damp proof courses, ties, straps, hangers, brackets, prefabricated lintels, prestressing devices); *Floor structures* (prefabricated, traditional and arched

(prefabricirane, tradicionalne in ločne stropne konstrukcije); *Nekonstrukcijski i sekundarni elementi*; *Modularna zasnova zidane stavbe* (moduli, zasnova, tlorisna oblika in višina zgradbe, razporeditev zidov, okenske in vratne odprtine); *Analiza konstrukcij* (standardi in specifike zidarije pri nas in v tujini, obnašanje konstrukcije v nezgodnih pogojih (drugih kot potres in požar), vplivi drugega reda, analiza elementov konstrukcij (pri navpični, strižni in izvenravninski obremenitvi, zidovi sestavljenih prerezov); *Izračun nosilnosti elementov konstrukcije* (URM (tlak, strig, izvenravninsko, kombinacija osna obtežba in strig), RM (pri upogibu, upogibu in osni obtežbi, strižna obtežba), CM (kombinacija osna obtežba in strig) in zidovje kot polnilo); *Načrtovanje sestave zidov – drugi vplivi* (sestave konstrukcijskih sklopov pogojenih funkcionalnimi zahtevami); *Način in pogoji izvedbe* (detajli, utori, izdelava zidovja, križanja ipd.); *Preverjanje potresne odpornosti zidanih zgradb* (osnovni principi preverjanja, računsko modeliranje obnašanja, specifike računa potresne odpornosti zidanih zgradb); *Projektiranje enostavnega URM objekta; Projektiranje zahtevnega objekta (nelinearna potisna analiza); Specifike preprojektiranja obstoječih tradicionalnih objektov* (karakterizacija obstoječega materiala opečnatega in kamnitega zidovja, določanje teksture in morfologije zidovja, določanje mehanskih lastnosti, izbira ustreznega modela za izračun zidane konstrukcije v odvisnosti od tipa stavbe, lege, geometrije in sestave materiala). Vaje: - laboratorijske in numerične vaje.	structures); *Non-structural and secondary elements*; *Modular building design* (modular design, dimensions, height, wall configuration, openings); *Structural analysis* (code requirements and diversity of masonry material here and abroad, structural behaviour in accidental situations (other than earthquake and fire), second order effect, analysis of structural members (under vertical, shear and out-of-plane loading conditions, walls of composite and flanged sections); *Calculation of ultimate limit state* (URM (compressive, shear, out-of-plane, combined vertical and shear loading), RM (flexure with and without vertical loading, shear loading), CM (combined vertical and shear loading) and masonry infill); *Application of building science for environmental loads* (structural complexes); *Detailing and execution* (details, chases and recesses, bricklaying, wall-floor and wall-roof connections etc.); *Seismic assessment of masonry buildings* (basic principles, numerical modelling, seismic design); *Simplified calculation methods for URM structures; Design of masonry structure (nonlinear pushover analysis); Problems related to redesign of existing traditional buildings* (characterization of existing masonry material, assessment of texture and morphology, determine mechanical parameters for masonry, correct choice of effective numerical strategy for the evaluation of masonry building depending from the type of building, its position, geometry and type of used material). Tutorials: - laboratory and numerical tutorials.

Temeljna literatura in viri/Readings:

R.G. Drysdale, A.A. Hamid, L.R. Baker. 1994. Masonry Structures – Behavior and Design, Prentice Hall

A.W. Hendry, B.P.Sinha, S.R. Davies. 1997. Design of masonry structures – Third edition of Load Bearing Brickwork Design, E&FN Spon.

W. Jäger, G. Marzahn. 2009. Mauerwerk, Bemessung nach DIN 1053-100, Ernst & Sohn

M. Muravljov, B. Stevanović. 1999. Zidane i drvene konstrukcije zgrada, Gradjevinski fakultet Univerziteta u Beogradu, Srbija.

Z. Sorić. 2004. Zidane konstrukcije I. Udžbenici Sveučilišta u Zagrebu, Hrvaška.

M. Tomaževič. 1987. Zidane zgradbe na potresnih območjih, UL FAGG, Ljubljana, Slovenija.

Deli standardov in nacionalni dodatki za njihovo aplikacijo (SIST EN 1990, SIST EN1996-1-1, SIST EN1996-1-2, SIST EN1996-2, SIST EN1996-3, SIST EN 1998-1, SIST EN 1998-3).

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Razumeti specifike tradicionalne in sodobne zidarije ter ločiti postopke preverjanja nosilnosti v odvisnosti od stopnje zahtevnosti objekta in tipa zidovja. - Osnovno poznavanje obnašanja konstrukcijskih elementov zidanih stavb pri različnih obtežbah. - Razumeti specifike obnašanja (mehaniko loma) zidovja kot kompozita pri večosnih obremenitvah. - Podati teoretične osnove za načrtovanje zidanih konstrukcij pri projektiranju enostavnih in bolj zahtevnih konstrukcij. - Projektiranje ob upoštevanju modularne koordinacije. - Učinkovito modeliranje zidanih konstrukcij v primeru potresne obtežbe v odvisnosti od tipa stavbe. Pridobljene kompetence: - Sposobnost analize in projektiranja enostavnih in bolj zahtevnih zidanih konstrukcij.	Objectives: - To understand problems related to traditional and contemporary masonry and diversification of methods for their assessment. - To obtain basic knowledge on the behaviour of masonry structural elements under different loading conditions. - To understand the behaviour of masonry as composite material under multiaxial loading conditions. - To define the theoretical bases for computational modelling of simplified and demanding masonry structures. - Modular design of masonry buildings. - Efficient modelling strategy for different types of masonry structures in the case of seismic loading. Acquired competences: - Ability to analyse and conceptualize simplified and design demanding masonry structures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Ustrezni postopek določanja projektnih mehanskih parametrov za sodobno in tradicionalno zidovje. - Priprava vhodnih parametrov za izračun zidane konstrukcije v odvisnosti od tipa zidovja in konstrukcije. - Sposobnost dimenzioniranja, računskega modeliranja in konstrukcijske izvedbe tradicionalnih in sodobnih zidanih konstrukcij. - Poznavanje in dimenzioniranje izvedbe detajlov. - Sposobnost analize obstoječih tradicionalnih opečnatih in kamnitih zidanih stavb. - Sposobnost načrtovanja novih stavb ob upoštevanju funkcionalnih zahtev za konstrukcijske sklope. - Sposobnost preverjanja potresne odpornosti zidane konstrukcije.	- Efficient procedure to determine design values for contemporary and traditional masonry. - Preparation of necessary input data for the assessment of masonry structures depending from the type of masonry and structure. - Ability of designing, computational modelling and construction of contemporary and traditional masonry structures. - Knowledge of special methods for the analysis and design of masonry details. - Ability to analyse existing traditional masonry buildings made from brickwork and stonework. - Deeper understanding of the behaviour of contemporary masonry structures through application of building science for environmental loads.

- Sposobnost uporabe rezultatov računalniških programov za načrtovanje zidanih konstrukcij.	- Ability to seismic assess masonry structure. - Ability to critically assess the input data and the acquired computational results in the design of masonry structures.

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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje	20,00 %	Tutorials
Teoretični izpit	40,00 %	Theoretical part of exam
Računski izpit	40,00 %	Computational part of exam

Reference nosilca/Lecturer's references:

1. **BOSILJKOV, Vlatko**. Computational modelling of laterally loaded masonry walls as a part of support activities for the evaluation of slovenian national parameters for Eurocode 6. V: IBRAHIMBEGOVIĆ, Adnan (ur.), BRANK, Boštjan (ur.), KOŽAR, Ivica (ur.). *3rd International Conference on Multiscale Computational Methods for Solids and Fluids*, September 20-22, 2017, Ljubljana, Slovenia. Ljubljana: Faculty of Civil and Geodetic Engineering. 2017, str. 11-14, ilustr.

2. KRŽAN, Meta, GOSTIČ, Samo, CATTARI, Serena, **BOSILJKOV, Vlatko**. Acquiring reference parameters of masonry for the structural performance analysis of historical buildings. *Bulletin of earthquake engineering*, ISSN 1570-761X, jan. 2015, letn. 13, št. 1, str. 203-236, doi: 10.1007/s10518-014-9686-x.

3. KARATZETZOU, A., PITILAKIS, Kyriazis, KRŽAN, Meta, **BOSILJKOV, Vlatko.** Soil-foundation-structure interaction and vulnerability assessment of the Neoclassical School in Rhodes, Greece. *Bulletin of earthquake engineering*, ISSN 1570-761X, 2015, letn. 13, št. 1, str. 411-428, doi: 10.1007/s10518-014-9637-6.

4. CATTARI, Serena, LAGOMARSINO, Sergio, **BOSILJKOV, Vlatko**, D`AYALA, Dina. Sensitivity analysis for setting up the investigation protocol and defining proper confidence factors for masonry buildings. *Bulletin of earthquake engineering*, ISSN 1570-761X, 2015, letn. 13, 1, str. 129-151, ilustr., doi: 10.1007/s10518-014-9648-3.

5. **BOSILJKOV, Vlatko**, PAGE, Adrian W., SIMUNDIC, Goran, ŽARNIĆ, Roko. Shear Capacity of the Flange-Web Intersections of Brick Masonry Non Rectangular Sections. *Journal of structural engineering*, ISSN 0733-9445. [Print ed.], 2010, letn. 136, št. 5, str. 574-585, doi: 10.1061/(ASCE)ST.1943-541X.0000139.

6. **BOSILJKOV, Vlatko**, PAGE, Adrian W., BOKAN-BOSILJKOV, Violeta, ŽARNIĆ, Roko. Evaluation of the seismic performance of brick masonry walls. *Structural control & health monitoring,* ISSN 1545-2255. [Print ed.], feb. 2010, letn. 17, št. 1, str. 100-118, ilustr., doi: 10.1002/stc.299.

7. TOMAŽEVIČ, Miha, LUTMAN, Marjana, **BOSILJKOV, Vlatko**. Robustness of hollow clay masonry units and seismic behaviour of masonry walls. *Construction & building materials*, ISSN 0950-0618. [Print ed.], 2006, vol. 20, nr. 10, str. 1028-1039.

8. TRILLER, Petra, TOMAŽEVIČ, Miha, **GAMS, Matija**. Seismic strengthening of clay block masonry buildings with composites : an experimental study of a full scale three-storey building model. Bulletin of earthquake engineering, ISSN 1570-761X, Apr. 2019, str. 1-32, ilustr., doi: 10.1007/s10518-019-00609-0.

9. TRILLER, Petra, TOMAŽEVIČ, Miha, **GAMS, Matija**. Seismic behaviour of masonry buildings built of low compressive strength units. Bulletin of earthquake engineering, ISSN 1570-761X, Dec. 2018, vol. 16, iss. 12, str. 6191-6219, ilustr., doi: 10.1007/s10518-018-0418-5.

10. **GAMS, Matija**, TOMAŽEVIČ, Miha, BERSET, Thierry. Seismic strengthening of brick masonry by composite coatings : an experimental study. Bulletin of earthquake engineering, ISSN 1570-761X, Apr. 2017, str. 1-30, ilustr., doi: 10.1007/s10518-017-0136-4.

11. **GAMS, Matija**, ANŽLIN, Andrej, KRAMAR, Miha. Simulation of shake table tests on out-of-plane masonry buildings. Part III, Two-step fem approach. International journal of architectural heritage : conservation, analysis and restoration, ISSN 1558-3058. [Print ed.], Sep. 2016. doi: 10.1080/15583058.2016.1237589.

12. TOMAŽEVIČ, Miha, **GAMS, Matija**, BERSET, Thierry. Strengthening of stone masonry walls with composite reinforced coatings. Bulletin of earthquake engineering, ISSN 1570-761X, Jul. 2015, vol. 13, issue 7, str. 2003-2027, ilustr., doi: 10.1007/s10518-014-9697-7.

13. JÄGER A., **GAMS, Matija**. Practical design of masonry subjected to horizontal loads based on Eurocode 6 shear model. V: MODENA, Claudio (ur.), DA PORTO, Francesca (ur.), VALLUZZI, Maria Rosa (ur.). Brick and Block Masonry : Trends, Innovations and Challenges, Proceedings of the 16th International Brick and Block Masonry Conference (IBMAC 2016), 26-30 June 2016, Padova, Italy. Boca Raton.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**INTERDISCIPLINARNI SEMINAR RAČUNALNIŠKO PODPRTEGA PROJEKTIRANJA KONSTRUKCIJ**
Course title:	**INTERDISCIPLINARY SEMINAR ON COMPUTER AIDED DESIGN OF STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Interdisciplinarni projektni študij računalniškega podprtega projektiranja konstrukcij (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1625

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	90	0	60	0	150	10

Nosilec predmeta/Lecturer:	Matija Gams, Tatjana Isaković
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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	The student of structural engineering works together with the student of architecture on the joint seminar project. Lectures are organized in two parts –

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 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.	(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; 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.

Temeljna 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.	- The skill how to solve a complex problem in cooperation with the partner of a different profession;

- 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 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.	- 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 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	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.

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 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/Weight**	**Assessment:**
Sprotno ocenjevanje samostojnosti, inicijativnosti in zavzetosti med projektnim delom	60,00 %	The ongoing assessment of independence, initiative and commitment during the project work.
Poročilo	20,00 %	Project report.
Predstavitev in zagovor dela	20,00 %	Presentation and argumentation of the work.

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.

TRILLER, Petra, TOMAŽEVIČ, Miha, GAMS, Matija. Seismic behaviour of masonry buildings built of low compressive strength units. Bulletin of earthquake engineering, ISSN 1570-761X, Dec. 2018, vol. 16, iss. 12, str. 6191-6219, ilustr., doi: 10.1007/s10518-018-0418-5. [COBISS.SI-ID 2402151]

GAMS, Matija, TOMAŽEVIČ, Miha, BERSET, Thierry. Seismic strengthening of brick masonry by composite coatings : an experimental study. Bulletin of earthquake engineering, ISSN 1570-761X, Apr. 2017, str. 1-30, ilustr., doi: 10.1007/s10518-017-0136-4. [COBISS.SI-ID 2292327]

TOMAŽEVIČ, Miha, GAMS, Matija, BERSET, Thierry. Strengthening of stone masonry walls with composite reinforced coatings. Bulletin of earthquake engineering, ISSN 1570-761X, Jul. 2015, vol. 13, issue 7, str. 2003-2027, ilustr., doi: 10.1007/s10518-014-9697-7. [COBISS.SI-ID 2073703]

TOMAŽEVIČ, Miha, GAMS, Matija. Shaking table study and modelling of seismic behaviour of confined AAC masonry buildings. Bulletin of earthquake engineering, ISSN 1570-761X, jun. 2012, vol. 10, issue 3, str. 863-893, ilustr., doi: 10.1007/s10518-011-9331-x. [COBISS.SI-ID 1837927]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**INFORMACIJSKA IN KOMUNIKACIJSKA TEHNOLOGIJA ZA PROJEKTNO DELO**
Course title:	**INFORMATION AND COMMUNICATION TECHNOLOGY FOR PROJECT WORK**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Interdisciplinarni projektni študij računalniškega podprtega projektiranja konstrukcij (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1523

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
20	10	30	0	0	60	4

Nosilec predmeta/Lecturer:	Tomo Cerovšek, Žiga Turk
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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):
Predavanja Principi računalniško integrirane graditve. Pristop integriranega prakse - projektnega dela. Procesni vidiki sodelovanja na gradbenih projektih. Topologija sistemov za sodelovanje in njihova uporaba.	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

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.	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.

Temeljna 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:	**Objectives and competences:**
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.	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

- Sposobnost učinkovite komunikacije na osnovi informacijskih modelov zgradb - Sposobnost izdelave digitalnega priročnika projekta.	- Ability to effective and efficiently communicate using RTC and portal technology.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- 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.	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/Weight**	**Assessment:**

Kolokvij ali izpit	70,00 %	Mid term examination or exam
Seminar	20,00 %	Seminar work
Projekt	10,00 %	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.

TURK, Žiga. Ten questions concerning building information modelling. Building and environment, ISSN 0360-1323, Okt. 2016, letn. 107, str. 274-284, ilustr. [COBISS.SI-ID 7627617]

BIZJAK, Igor, KLINC, Robert, TURK, Žiga. A framework for open and participatory designing of built environments. Computers, Environment and Urban Systems, ISSN 0198-9715, November 2017, vol. 66, str. 65-82. [COBISS.SI-ID 2839491]

TURK, Žiga, KLINC, Robert. Potentials of blockchain technology for construction management. Procedia engineering, ISSN 1877-7058, 2017, vol. 196, str. 638-645, ilustr. [COBISS.SI-ID 8131425]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NUMERIČNO MODELIRANJE TRDNIN**
Course title:	**NUMERICAL MODELLING OF SOLIDS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Inženirsko modeliranje (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1559

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Jože Korelc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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

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.	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.

Temeljna 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. Dostopno na: http:// symech .fgg.uni-lj.si/nak/Skripta/ .

Cilji in kompetence:	**Objectives and competences:**
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 - 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:	**Intended learning outcomes:**
- 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.	- 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.

- 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.	- 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:	**Learning and teaching methods:**
Predavanja se izvajajo v učilnici z različnimi učnimi pripomočki. Vse vaje se izvajajo v računalniškem laboratoriju, kjer se uporabljajo komercialni in raziskovani računalniški programi po metodi končnih elementov. Študentje jih izvajajo deloma individualno, deloma skupinsko.	Lectures, exercises, attendance of International Short Course on Experimental and Numerical Modelling of M5 Problems in Engineering.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Ustni izpit (vsebuje tako teoretične kot tudi računske naloge)	60,00 %	Exam (theoretical and practical tasks)
Seminarske vaje	40,00 %	Seminar tasks (results collected every 4 weeks)

Reference nosilca/Lecturer's references:

KORELC, Jože. Automation of primal and sensitivity analysis of transient coupled problems. Computational mechanics, ISSN 0178-7675, 2009, letn. 44, št. 5, str. 631-649, ilustr., doi: 10.1007/s00466-009-0395-2.

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Inženirsko modeliranje (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1560

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Dejan Zupan, Goran Turk
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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)	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.

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 parcialnih diferencialnih enačb.	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.

Temeljna 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.	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.

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.	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/Weight**	**Assessment:**
Računski del	50,00 %	Practical exam
Teoretični del	50,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Inženirsko modeliranje (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1762

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer:	Boštjan Pulko, Janko Logar
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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	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

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

Temeljna 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	- Understanding of the critical state soil mechanics

- 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.	- 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/Weight**	**Assessment:**
Samostojno izdelane vaje	40,00 %	Individual practical work
Izpit	60,00 %	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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Inženirsko modeliranje (modul)	2. letnik	Letni, Zimski

Koda učne enote na članici/UL Member course code: 1602

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	30	0	75	5

Nosilec predmeta/Lecturer: Matjaž Četina

Vrsta predmeta/Course type: Izbirni strokovni/Elective professional

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

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

Vsebina:	**Content (Syllabus outline):**
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:	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

Reynoldsove enačbe, modeli turbulence, numerične metode reševanja. Laboratorijske vaje Meritve vodnega skoka v šolskem žlebu ter 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,	for computation of flows and pollutant spreading in surface waters: Reynolds equations, turbulence models, numerical methods. Laboratory tutorials Measurements of hydraulic jump and mass. 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.

Temeljna 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 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.	- 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 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/Weight	Assessment:
Domače naloge (pisno, oddaja več vaj)	50,00 %	Homework (written, several exercises)
Pisni izpit (izpit iz teorije)	50,00 %	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:	**SEMINAR IZ PROJEKTIRANJA JEKLENIH KONSTRUKCIJ**
Course title:	**THE DESIGN OF STEEL STRUCTURES - SEMINAR**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Jeklene konstrukcije (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1526

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	90	0	60	0	150	10

Nosilec predmeta/Lecturer:	Primož Može
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
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	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.

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 konstrukcij, tolerance mer pri izdelavi jeklenih konstrukcij, tehnologija izdelave in montaže jeklenih konstrukcij, kontrola izdelave in montaže jeklenih konstrukcij, predstavitev zanimivih izvedenih konstrukcij).	Technical excursions (interesting construction sites, workshop manufacturing steel structural elements).

Temeljna 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 rešitev in utemeljene izbire ene od ustreznih rešitev. - Sposobnost uporabe računalniških programov za analizo konstrukcij in risanje delavniških načrtov - Sposobnost kritične presoje strokovnih problemov.	-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. - 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/Weight**	**Assessment:**
Samostojna naloga	40,00 %	Approved project work
Zagovor naloge	30,00 %	Defence of the approved project work
Ustni izpit (Študenti, ki za samostojno nalogo in njen ustni zagovor dosežejo vsaj 57 točk od 70 so oproščeni ustnega izpita.)	30,00 %	Oral exam (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:	**SEMINAR IZ PROJEKTIRANJA MASIVNIH KONSTRUKCIJ**
Course title:	**THE DESIGN OF CONCRETE AND MASONRY STRUCTURES SEMINAR**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Gradbene konstrukcije (smer), Masivne konstrukcije (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1525

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	90	0	60	0	150	10

Nosilec predmeta/Lecturer:	Drago Saje, Jože Lopatič, Sebastjan Bratina
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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	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

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 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.	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 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.

Temeljna 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,	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.

- 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.	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 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.	- 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 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/Weight**	**Assessment:**
Seminar in zagovor	70,00 %	Seminar and defence
Pisni izpit (odpade če kandidat pri vajah in zagovoru doseže 85 % možnih točk)	30,00 %	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.

BRATINA, S., HOZJAN, T., Ocena požarne odpornosti notranje betonske obloge in vmesne plošče v novi predorski cevi Karavanke ob pričakovanih požarnih scenarijih (RABT-ZTV, 100 MW naravni požar) z uporabo naprednih računskih metod, Ljubljana: UL FGG, 2017, 77 str.

BRATINA, S., SAJE, M., PLANINC, I., On materially and geometrically non-linear analysis of reinforced concrete planar beams, International journal of solids and structures, ISSN 0020-7683, 2004, letn. 41, št. 24-25, str. 7181-7207.

BAJC, U., PLANINC, I., BRATINA, S., Non-linear time-dependent analysis of cracked reinforced concrete bar, Advances in structural engineering, 2018, letn. 21, št. 7, str. 949-961.

SAJE, Drago, LOPATIČ, Jože, SAJE, Franc. Time dependent response of bridges to load and ambient conditions. V: DHIR, Ravindra K. (ur.). Role of concrete bridges in sustainable development : proceedings of the International Symposium dedicated to Professor Jirí Stráský, Technical University of Brno, Czech Republic held on 3-4 September 2003 at the University of Dundee, Scotland, UK. London: Thomas Telford. 2003, str. 205-214.

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.

SAJE, Drago, SAJE, Franc. Selection of a concrete bridge girder cross section. V: DHIR, Ravindra K. (ur.), MCCARTHY, Michael J. (ur.), CALISKAN, Sinan (ur.). Concrete for transportation infrastructure : proceedings of the international conference held at the University of Dundee, Scotland, UK on 5-7 July 2005. London: Telford. 2005.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MATEMATIKA 3**
Course title:	**MATHEMATICS 3**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1617

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Gašper Jaklič
Vrsta predmeta/Course type:	obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. primerljive vsebine matematike v obsegu najmanj 15 KT.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content with min. 15 ECTS.

Vsebina:	Content (Syllabus outline):
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,	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

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

Temeljna 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	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model

- Poznavanje teoretičnih osnov za praktično iskanje rešitev - Sposobnost kritične presoje rezultatov - Poznavanje računalniških orodij (Mathematica, Matlab) - Dosežena matematična podlaga za strokovne predmete	- 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/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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:	**METODE KONČNIH ELEMENTOV V GRADBENIŠTVU**
Course title:	**FINITE ELEMENT METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1453

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Brank
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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 analize, - Kritična ocena rezultatov.	- FEM analysis, - Critical evaluation of numerical results.

Temeljna 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/Weight	Assessment:
Računski del izpita: modeliranje in analiza problema z računalnikom	50,00 %	FEM modelling, analysis and evaluating of results of a civil engineering problem
Teoretični del izpita	50,00 %	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:	**GEOTEHNIKA NIZKIH GRADENJ**
Course title:	**GEOTECHNICS OF INFRASTRUCTURAL FACILITIES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1619

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	30	45	0	0	120	8

Nosilec predmeta/Lecturer:	Janko Logar
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika	Passed exams in Soil Mechanics and Engineering Geology and Geotechnics.

Vsebina:	Content (Syllabus outline):
Predavanja Metode izboljšanja tal (preobremenitev, radialna konsolidacija, dinamična komprimacija, gruščnati koli, injektiranje, jet grouting, metode površinskega in globinskega mešanja z anorganskimi in organskimi vezivi); strujanje podzemne vode skozi zasičena izotropna in anizotropna tla, vzgon, kritični hidravlični gradient, hidravlične porušitve (hidravlični lom tal, notranja erozija, piping); zemeljske pregrade: strujanje vode skozi pregrado, ukrepi za zmanjšanje neugodnih posledic, načrtovanje filtrov,	Lectures Methods of soil improvement (pre-loading, radial consolidation, dynamic compaction, stone columns, grouting, jet grouting, methods of surface and deep mixing with inorganic and organic binders); groundwater flow through saturated isotropic and anisotropic soil, buoyancy, critical hydraulic gradient, hydraulic fracture (hydraulic failure, internal erosion, piping); earth dams: flow of water through dam, measures to reduce the adverse consequences, filter design, stability of earth dams under static and

stabilnost zemeljskih pregrad v statičnih pogojih in v slučaju potresne obtežbe; likvifakcija tal; raba geosintetikov za tesnjenje, filtriranje, ločevanje in armiranje; analiza in upravljanje z geotehnično pogojenimi tveganji. osnove mehanike kamnin (klasifikacije kamnin, mehanske lastnosti kamnin, Hoekov in Brownov porušni kriterij, analiza stabilnosti blokov in klinov, Schmidtova projekcija, Marklandov test, analitične in numerične metode). Osnove načrtovanja in gradnje predorov (tehnologije gradnje, mehanizacija, podporni ukrepi, primarna in sekundarna napetostna stanja, principi in metode za projektiranje, geotehnični monitoring) osnove numerične geotehnike (nelinearni elastoplastični modeli za zemljine, principi nelinearnih numeričnih analiz. Vaje Račun učinka izboljšave tal z vertikalnimi drenažami, gruščnatimi koli, preobtežbo (peš in z uporabo računalniških orodij); analiza strujanja vode skozi in pod zemeljsko pregrado; stabilnostna analiza prečnega prereza zemeljske pregrade v statičnih pogojih in pogojih delovanja seizmičnih vplivov; analiza likvifakcije tal na osnovi rezultatov terenskih in laboratorijskih preiskav tal; dimenzioniranje mineralnih filtrov v pregradi; dimenzioniranje in izbira geosintetikov za namen ločevanja, filtracije, tesnjenja; analiza in načrt armirane brežine; izdelava kataloga tveganj in analize tveganja za izbran geotehnični projekt. Klasifikacija kamnin in ocena mehanskih parametrov s pomočjo Hoekovega in Brownovega porušnega kriterija. Strukturna analiza stabilnosti kamninskih blokov in klinov. Načrt podpiranja prečnega prereza predora. Numerična analiza predora in izbranega zemeljskega objekta (nasip, podporna konstrukcija, vkop z oporno konstrukcijo …).	dynamic (seismic) conditions; liquefaction of soil; use of geosynthetics: sealing, filtration, separation and reinforcement; analysis and management of geotechnical risks. Fundamentals of rock mechanics (classification of rock, mechanical properties of rock, Hoek&Brown failure criterion, structurally controlled instability of blocks and wedges, Schmidt's projection, Markland test, analytical and numerical methods). Basics of design and construction of tunnels (technology, machinery, support measures, primary and secondary stress states, principles and methods for the design, geotechnical monitoring). Fundamentals of numerical methods in geotechnics (nonlinear elasto-plastic models for soils, principles of non-linear numerical analysis). Tutorials Ground improvement with vertical drains, stone columns, pre-loading (analytical methods and by using computer tools); analysis of the groundwater flow through dam and subsoil; stability analysis of earth dam under static and seismic conditions, seismic impact; analysis of soil liquefaction based on the results of field and laboratory tests of soils; sizing of mineral filters in earth dam; the design and choice of geosynthetics for separation, filtration and sealing; analysis and design of reinforced earth; risk analysis for a selected geotechnical project. Classification of rocks and evaluation of mechanical parameters using Hoek&Brown's failure criteria. Structural analysis of the stability of rock blocks and wedges. Design of tunnel cross section. Numerical analysis of a tunnel and selected earth structure (embankment, retaining structure, earth-cut with retaining structure, ...)

Temeljna literatura in viri/Readings:

SIST EN1997-1:2005 Evrokod 7-1: Geotehnično projektiranje - 1. del Splošna pravila.

SIST EN1997-2:2007 Evrokod 7-2: Geotehnično projektiranje - 2. del Preiskovanje in preskušanje tal.

Vaníček I, Vaníček M. 2008. Earth Structures in Transport, Water and Environmental Engineering, Springer, 637 str.

Moseley, M.P., Kirsch, K. 2006. Ground improvement, Taylor & Francis, London, 432 p.

Recommendations for Design and Analysis of Earth Structures using Geosynthetic Reinforcement

EBGEO, Ernst & Sohn, DGGT, 2011.

Nonveiller, E. 1983. Nasute brane, projektiranje i građenje, Školska knjiga Zagreb.

Clayton, C.R.I. 2001. Managing geotechnical risk, Thomas Thelford.

Chapman, D., Metje, N., Stärk, A. (2010). Introduction to tunnel construction, Spon press.

Hoek, E.: (2007) Practical Rock Engineering, dosegljivo na http://www.rocscience.com/hoek/corner/Practical_Rock_Engineering.pdf

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
- Spoznati metode izboljšanja tal, njihove dobre strani in omejitve v posameznih pogojih tal in predvidene vrste gradnje	- To learn about methods of soil-improvement, their benefits and restrictions based on specific ground conditions and type of construction
- Spoznati zakonitosti strujanja podzemne vode in precejanje skozi zemeljske pregrade ter potencialne probleme, ki iz tega izhajajo ter možne rešitve	- To learn about groundwater flow and percolation through earth dams (structures) and potential problems and possible solutions
- Seznaniti študenta z vplivi potresa na tla in geotehnične objekte (vpliv na stabilnost in likvifakcijo)	- To acquaint student with the effects of earthquakes on the ground and geotechnical facilities (impact on stability and liquefaction)
- Predstaviti možnost uporabe geosintetičnih materialov v geotehničnem inženirstvu	- To present the possibility of using geosynthetic materials in geotechnical engineering
- Predstaviti geotehnično pogojena tveganja in preproste možnosti analize in upravljanja s tveganji	- To present the geotechnical risks and to perform simple risk management analysis.
- Spoznati se z osnovami mehanike kamnin	- To learn about the basics of rock mechanics
- Spoznati osnovne principe načrtovanja in gradnje predorov	- To recognize basic principles of planning and tunnel construction
- Usposobiti študenta za osnovno razumevanje in uporabo nelinearnih numeričnih orodij za geotehnične analize	- To provide basic understanding and use of nonlinear numerical tools for geotechnical analysis

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent pozna metode izboljšanja tal in se zna odločiti katera je primerna v določenih pogojih	- Student knows the methods of soil improvement and is able to decide which is suitable under certain conditions
- Razume in pozna metode za račun stacionarnega toka vode skozi zasičena izotropna in anizotropna tla ter skozi zemeljske pregrade	- Student understands and knows methods for stationary flow of water through saturated isotropic and anisotropic soil and through earth dams
- Zna analizirati vpliv strujanja vode glede na možnost pojava hidravličnega lom tal in notranje erozije	- Ability to analyze the impact of groundwater flow depending on the optional occurrence of hydraulic failure and internal erosion
- Razume vpliv potresne obtežbe na zemeljske pregrade in zna vpliv upoštevati v analizi stabilnosti	- Understanding of the impact of seismic actions on earth dams and how to take them into account (stability analysis)
- Razume pojav likvifakcije tal in ga zna ovrednotiti	

- Pozna možnosti uporabe geosintetikov glede filtracije, separacije, tesnenja in armiranja - Razume geotehnično pogojena tveganja in jih zna analizirati. - Pozna klasifikacijske sisteme kamnin (RQD, RMR, GSI, Q) - Zna analizirati stabilnost blokov in klinov kamnine z uporabo ustreznih orodij - Razume osnovne principe načrtovanja in gradnje predorov - Študent je sposoben preprostih numeričnih geotehničnih analiz z uporabo nelinearnih numeričnih modelov	- Understanding of the phenomena of liquefaction of soil and how to evaluate the associated risk - Knowledge of geosynthetics with respect to filtration, separation, sealing and reinforcement - Understanding of geotechnical risks and how to analyze them. - Knowledge about rock classification systems (RQD, RMR, GSI, Q) - Ability to analyze the stability of rock blocks and wedges with using appropriate tools - Understanding of basic design principles and construction techniques of tunnels - Student is capable of performing basic numerical geotechnical analysis using non- linear numerical models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, vaje v računalniški učilnici, samostojno delo.	Lectures, tutorials, exercises in the computer lab, individual work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računski izpit ali 2 kolokvija	50,00 %	Written exam or 2 midterm tests
Samostojno delo	15,00 %	Individual work (Seminar)
Teoretični izpit	35,00 %	Theoretical exam

Reference nosilca/Lecturer's references:

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.

ŠTRUKELJ, Andrej, ŠKRABL, Stanislav, ŠTERN, Ksenija, LOGAR, Janko. The assesment of pile shaft resistance based on axial strain measurements during the loading test. Acta geotechnica Slovenica, ISSN 1854-0171, 2005, letn. 2, št. 2, str. 12-23.

LOGAR, Janko, FIFER BIZJAK, Karmen, KOČEVAR, Marko, MIKOŠ, Matjaž, RIBIČIČ, Mihael, MAJES, Bojan. History and present state of the Slano Blato landslide. Natural hazards and earth system sciences, ISSN 1561-8633, 2005, 5, str. [447]-457.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**ZAGOTAVLJANJE IN KONTROLA KAKOVOSTI**
Course title:	**QUALITY CONTROL AND QUALITY ASSURANCE**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1455

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Zgodovinski pregled na področju vodenja kakovosti, temeljni pojmi (kontrola, zagotavljanje, vodenje kakovosti), vidiki kakovosti, pomen kakovosti gradbenega objekta. Relevantna zakonodaja in standardizacija (pomen, uporabnost standardov, priprava in izdajanje standardov). Statistična kontrola procesov v serijski proizvodnji gradbenih proizvodov. Potrjevanje skladnosti gradbenih proizvodov (pregled gradbenih proizvodov, spremljajoča harmonizirana evropska zakonodaja, standardi za gradbene proizvode, sistemi potrjevanja	Lectures Historical overview of quality management development , fundamental terms (control, assurance, management of quality, aspects of quality, importance of quality of a structure). Relevant legislature and standardisation (importance and relevance, application of standards, preparation of standards). Statistical process control in serial production of construction products. Conformity assessment for construction products (overview of construction products, accompanying legislature, standards for construction products, conformity

skladnosti). Povezava kakovosti in poslovne uspešnosti gradbenega podjetja, stroški kakovosti. Zagotavljanje kakovosti v vseh fazah gradbenega projekta (s posebnim poudarkom na kakovosti projektiranja), vodenje kakovosti v gradbenem projektu. Integrirani sistemi vodenja kakovosti v organizacijah (sistemi vodenja kakovosti, sistemi ravnanja z okoljem, sistemi za zdravje in varstvo pri delu). Kvalitativne metode zagotavljanja kakovosti. Študijski obisk slovenskih institucij, ki delujejo na področju zagotavljanja kakovosti v gradbeništvu.	assessment systems). Relationship between quality and business success, costs of quality. Quality assurance in all stages of construction project (with special emphasis to quality of design), quality management in construction project. Integrated management systems (QMS, EMS, OHSAS). Qualitative methods for quality assurance. Site visits (to Slovenian institutions working in the field of quality assurance in civil engineering).

Temeljna literatura in viri/Readings:

- Šelih, J., 2015. Zagotavljanje in kontrola kakovosti, Učno gradivo, FGG.
- Howarth, T., Greenwood, D., 2018. Construction quality management: principles and practice, Second edition. ed. Routledge Taylor & Francis Group, London New York.
- Rumane, A.R., 2018. Quality Management in Construction Projects, Second Edition. Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742.
- Marsden,P.,2019.DigitalQualityManagementin Construction, 1st ed. Routledge. https://doi.org/10.1201/9780429423062
- ASCE, 2012. Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors, Third Edition. ed. American Society of Civil Engineers, Reston, VA. https://doi.org/10.1061/9780784411896

Cilji in kompetence:	**Objectives and competences:**
Cilji - Podati osnove vodenja kakovosti ter njihovo aplikacijo v gradbeništvu - Podati sistematiziran pregled ukrepov in metod za vodenje kakovosti v gradbenem projektu. Pridobljene kompetence - Razumevanje pomena kakovosti gradbenega objekta v vseh fazah njegovega življenjskega cikla - Sposobnost izdelave plana kakovosti za vse faze gradbenega projekta.	Objectives - To provide fundamentals of quality management and their application in construction - To give systematic overview of actions and methods for quality management in construction project. Acquired competences - Understanding of the importance of quality of a structure in all life cycle stages - To be able to prepare quality plans for all stages of the construction project.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno temeljno znanje o pomenu kakovosti gradbenega objekta - Razumevanje povezanosti med doseženim nivojem kakovosti gradbenega objekta in fazami ter dejavnostmi gradbenega projekta	- Acquirement of fundamental knowledge related to the importance of structure-s quality - Understanding how the achieved level of quality of the structure and phases and activities of the construction project are connected

- Osvojene računske spretnosti za načrtovanje statistične kontrole procesov - Razumevanje nekvantitativnih metod za zagotavljanje kakovosti - Sposobnost abstraktne formulacije vodstvenih procesov v organizaciji - Sposobnost kritične presoje podatkov, pridobljenih v procesih kakovosti, pri načrtovanju sistemov kakovosti.	- Acquired skills for planning of statistical process control - Understanding of descriptive methods for quality assessment - Ability of abstract formulation of management processes within an enterprise - Ability of critical assessment of data acquired in quality management processes, and their use in planning of QMS.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, oboje z uporabo IKT.	Lectures, seminar tutorial, supported by ICT tools.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Written exam
Samostojna naloga	50,00 %	Individual work

Reference nosilca/Lecturer's references:

KOUTAMANIS, Alexander, DAINTY, Andrew, KVAN, Thomas, TURK, Žiga. The enigma of BIM. Architecture, Structures and Construction. 2021, letn. nov., [9] str., ilustr. ISSN 2730-9894. https://link.springer.com/article/10.1007/s44150-021-00017-6, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=136007, DOI: 10.1007/s44150-021-00017-6. [COBISS.SI-ID 103345411]

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

TURK, Žiga. Kakovost in odličnost metoda, ne cilj. V: ČUK, Jožko (ur.). Dvajset let kakovosti in odličnosti : [knjiga izdana ob dvajsetem jubileju Slovenskega združenja za kakovost in odličnost]. Ljubljana: Slovensko združenje za kakovost, 2011. Str. 80-85. ISBN 978-961-92534-5-8. [COBISS.SI-ID 8132449]

TURK, Žiga, FISCHINGER, Matej. Learning engineering from breakdown cases. V: IABSE symposium Rio de Janeiro 1999 : [Brazil, August 25-27] : structures for the future - the search for quality : report = rapport = Bericht. Rio de Janeiro: IABSE, 1999. IABSE reports, vol. 83. ISBN 3-85748-100-6. [COBISS.SI-ID 1268833]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**OPERATIVNO PLANIRANJE IN SPREMLJANJE PROJEKTOV**
Course title:	**OPERATIVE PLANNING AND MONITORING OF PROJECTS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1456

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	15	0	75	5

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja: Operativno planiranje kot element vodenja projektov. Tehnika mrežnega planiranja in metoda kritične poti. Viri za izvedbo gradbenega projekta in njihova vključitev v projektni model. Optimizacija terminskega plana z vidika virov. Stroški gradbenih projektov in optimizacija terminskega plana z vidika stroškov. Elementi spremljave poteka izvedbe gradbenega projekta. Analiza zamud in porazdelitev odgovornosti. Tehnika planiranja lokacijskih planov	Lectures: Operational planning as element of project management. Critical path methods. Resources required for the construction project execution, inclusion of resources into project model. Optimisation of schedule, from the viewpoint of resources. Costs of construction projects, optimisation of schedule for the viewpoint of costs. Elements of monitoring the execution. Delay analysis, allocation of responsibility. Techniques for planning the location plans (linear plans,

(linearni plani in ciklogrami). Modeliranje projektnih tveganj v operativnih planih (stohastično planiranje). Labaratorijske vaje: uporaba različnih programskih orodij za operativno planiranje gradbenih projektov	cyclograms). Modelling project risks in operational plans (stochastic planning). Tutorial: Use of various computer-supported tools for operational planning of construction projects.

Temeljna literatura in viri/Readings:

Rodošek E. 1985. Operativno planiranje, učbenik. Ljubljana.

Hegazy, Tarek. 2002. Computer-based construction project management.

Griffis, Fletcher Hughes. 2000. Construction planning for engineers.

Project Management for Construction. Dostopno na: http://www.ce.cmu.edu/pmbook/index.html .

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi splošno znanje vodenja projektov z metodami in tehnikami operativnega planiranja - Podati ključne elemente terminskega plana in spremljajočih planov - Podati definicije optimalnosti operativnega plana - Podati poglobljeno znanje o tehnikah optimizacije operativnega plana - Podati elemente spremljave in analize plana ter ukrepanja pri odstopanjih. Pridobljene kompetence - Sposobnost izdelave detaljnega modela projekta - Razumevanje povezave med stroški, časom in kakovostjo kot ključnih parametrov operativnega plana - Sposobnost variantne obdelave modela in izdelave operativnega plana - Sposobnost uporabe računalniških orodij za različne tehnike operativnega planiranja.	Objectives - To upgrade the general knowledge of project management with methods and techniques of operational planning - To provide key elements of schedule and accompanying plans - To provide the definition of optimal operational plan - To give in-depth knowledge on operational plan optimisation techniques - To present elements of monitoring and analysis of plan, and actions related to identified deviations. Acquired competences - Ability to prepare detailed project model - Understanding the relationship among costs, time and quality, as key parameters of the operational plan - Ability to study alternatives for the model and for the operational plan - Ability to use computer supported tools for different operational planning techniques.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno znanje o modeliranju projektov (deterministični in stohastični modeli) - Razumevanje prednosti in smiselnosti uporabe posameznih metod terminskega planiranja	- Acquired knowledge on modelling of projects (deterministic and stochastic models) - Understanding advantages and suitability of use of individual scheduling methods

- Osvojeno znanje uporabe računalniške podpore za operativno planiranje - Dobro razumevanje metod in tehnik izdelave operativnih planov izvedbe gradbenih objektov ter kriterijev in meril za njihovo optimalnost - Sposobnost modeliranja poslovnih procesov - Sposobnost analitične obravnave problema in sintezne obdelave rešitev - Sposobnost uporabe računalniškega programa za simulacijo.	- Acquired knowledge in the field of computer-supported operational planning - Thorough understanding of methods and techniques for the preparation of operational plans in construction, and related criteria and measures for their optimality - Ability to model business processes - Ability to tackle the problem analytically, and to synthesize the solutions - Ability to use Appropriate software for simulation.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in seminarske vaje z uporabo IKT (potekajo vzporedno preko celega semestra).	Lectures and seminar tutorial by using ICT tools (running parallel to the lectures, during the whole semester).

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Written exam
Samostojna naloga z računskim primerom in njen zagovor	50,00 %	Individual work (with case study) and its defence

Reference nosilca/Lecturer's references:

KLINC, Robert, GABRŠČEK, Dani, ČESNIK, Jure, ŽIBERT, Marko, HOSTNIK, Martin, LOGAR, Janko. Development of a semiautomatic parametric method for creation of an I-BIM model of a tunnel for use in FEM software. Journal of advanced transportation. [Online ed.]. mar. 2021, vol. 2021, str. 1-18, ilustr. ISSN 2042-3195. https://www.hindawi.com/journals/jat/2021/8843277/, DOI: 10.1155/2021/8843277. [COBISS.SI-ID 55664131]

BIZJAK, Igor, KLINC, Robert, TURK, Žiga. A framework for open and participatory designing of built environments. Computers, Environment and Urban Systems. [Print ed.]. November 2017, vol. 66, str. 65-82. ISSN 0198-9715. DOI: 10.1016/j.compenvurbsys.2017.08.002. [COBISS.SI-ID 2839491]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**GOSPODARJENJE Z NEPREMIČNINAMI**
Course title:	**REAL ESTATE MANAGEMENT**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1457

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač, Daniel Kozelj
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Temeljni pojmi s področja ekonomike nepremičnin; življenjski cikel nepremičnine od investicije do rabe nepremičnine; urbana ekonomika in analiza trga nepremičnin; razvojni potencial zemljišč; investiranje v nepremičnine, vloga in pojmovna opredelitev posameznih vrst investicij, metode vrednotenja investicijskih projektov na mikro- in makroekonomski ravni; pomen, pravne podlage in metode za vrednotenje upravičenosti in učinkovitosti investicij javnega sektorja; obdavčenje nepremičnin; posredovanje v prometu z	Lectures Basic concepts related to real estate economics, real estate life cycle(from real estate development to real estate reuse); urban economics and real estate market analysis; land development potential; investing in real estate, role and conceptual definition of certain types of investments, methods of evaluating investment projects at micro- and macro-economic levels; legal basis and evaluation methods to measure efficiency of public investment; taxation of real estate; real estate brokers' activities, legal and cost aspects of real estate brokers'

nepremičninami, pravni in stroškovni vidiki posredovanja v prometu z nepremičninami; nepremičnine kot faktor produkcije, »facility management«; trg in tržno vrednotenje nepremičnin; osnove posamičnega in množičnega tržnega vrednotenja nepremičnin. Vaje Seminarske vaje (računske vaje).	activities; property as factor of production facility management; real estate market and real estate valuation; basics of individual and mass real estate valuation. Tutorial Calculation exercises.

Temeljna literatura in viri/Readings:

Šubic Kovač, M. 2013. Gospodarjenje z nepremičninami, študijsko gradivo, Ljubljana, UL FGG, 186 strani.

Bajt, A., Štiblar F. 2002. Ekonomija, Ekonomska analiza in politika, GV založba, Ljubljana, str.103- 148.

Geltner, M.D., Miller, N.G. 2010. Commercial Real Estate Analysis and Investment, South Western Thomson Learning, 898 strani, izbrana poglavja.

Aktualni predpisi: http://www.gov.si .

Cilji in kompetence:	**Objectives and competences:**
Študent se pri tem predmetu seznani: - Z znanji s področja ekonomike nepremičnin in projektnega managementa, - Z vrednotenjem investicijskih projektov na mikro in makro ravni, - S "facility management", - S terminologijo in postopki vrednotenja nepremičnin. Po opravljenem izpitu študent pridobi naslednje predmetno specifične kompetence: - Pozna in razume vsebine s področja ekonomike nepremičnin, - Pozna, razume, zna načrtovati in uporabljati različne postopke, ki so potrebni za vrednotenje razvojnega potenciala zemljišč v prostorskem planiranju, vrednotenje investicijskih projektov na mikro in makro ravni, za posredovanje v prometu z nepremičninami - Pozna in razume izrazoslovje ter proces posamičnega in množičnega vrednotenja nepremičnin.	Objectives - To get students familiar with real estate economics and project management - To get students familiar with the evaluation of investment projects at micro and macro levels - To get students familiar with facility management - To familiarise student with terminology and with the process of individual/mass real estate valuation. Competences - To know and understand the contents in the field of real estate economics - To know and understand (as well as to know how to design and use) various procedures, needed for the valuation of land development potential, evaluation of investment projects at micro and macro levels for the purpose of real estate brokerage - To know and understand the terminology and the process of individual/mass real estate valuation.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Študent spozna bistvene karakteristike s področja ekonomike nepremičnin od faze prostorskega načrtovanja do obratovanja nepremičnin. - Študent pridobljena znanja uporabi pri izdelavi prostorskih aktov, odločitvah o investicijah, vrednotenju in trženju nepremičnin. - Študent na podlagi sinteze znanj s področja prava, ekonomike, prostorskega planiranja in gradnje inženirskih objektov (tehnični in organizacijski vidik) kritično presoja investicijske odločitve v praksi. - Uporaba domače in tuje strokovne literature s področja gospodarjenja z nepremičninami in uporaba ustrezne računalniške opreme.	- Student is familiar with basic characteristics in the field of real estate economics from the spatial planning phase to the final phase – operation of the real estate. - Acquired knowledge can be used when making spatial planning documents, when deciding on investment, real estate valuation and real estate marketing. - Synthesis of knowledge in the field of property law, geodesy, spatial planning and civil engineering (technical and organizational aspect) allows student to critically consider investment decisions in practice. - Use of national and international professional literature in the field of real estate management and appropriate computer software.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje z uporabo IKT.	Lectures and tutorial are presented using visual aids.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
izpit teoretičen del	50,00 %	Theoretical part
izpit računski del Vsak del mora biti ocenjen pozitivno.	50,00 %	Calculation exercises. Each part of the exam must be graded positively.

Reference nosilca/Lecturer's references:

GOLUŽA, Maruša, ŠUBIC KOVAČ, Maruška, KOS, Drago, BOLE, David. How the state legitimizes national development projects : the third development axis case study, Slovenia. *Acta geographica Slovenica*, ISSN 1581-6613. [Tiskana izd.], 2021, 61, št. 2, str. 109-121, ilustr., zvd., tabele. https://ojs.zrc-sazu.si/ags/article/view/9572/9625, doi: 10.3986/AGS.9572.

ŠUBIC KOVAČ, Maruška. A causal analysis between construction, real estate, and economic growth : a case study of Slovenia. V: ABDULAI, Raymond Talinbe (ur.). *Real estate, construction and economic development in emerging market economies*, (Routledge studies in international real estate). 1st ed. London; New York: Routledge. 2016, str. 64-87, ilustr.

KAFOL STOJANOVIĆ, Ajda, KOZELJ, Daniel, ŠUBIC KOVAČ, Maruška. Assessment of water distribution system capacity as settlement-development decision-making expert basis at the local level = Ocena zmogljivosti vodovodnega sistema kot strokovna podlaga za odločanje o usmerjanju razvoja naselij na lokalni ravni. Geodetski vestnik : glasilo Zveze geodetov Slovenije, ISSN 0351-0271. [Tiskana izd.], 2020, letn. 64, št. 3, str. 389-401, ilustr., doi: 10.15292/geodetski-vestnik.2020.03.389-401.

BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, Sep. 2019, vol. 27, iss. 3, str. 759-781, ilustr.

ZEVNIK, Jure, KRAMAR FIJAVŽ, Marjeta, KOZELJ, Daniel. Generalized normalized cut and spanning trees for water distribution network partitioning. Journal of water resources planning and management, ISSN 0733-

9496. [Print ed.], 2019, letn. 145, št. 10, str. 1-12, ilustr., doi: 10.1061/(ASCE)WR.1943-5452.0001100. [COBISS.SI-ID 8860001].

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKTIRANJE GRADBENIH KONSTRUKCIJ**
Course title:	**DESIGN OF BUILDING STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1458

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Drago Saje
Vrsta predmeta/Course type:	obvezni strokovni/obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Postopek projektiranja gradbenih konstrukcij. Posebnosti obnašanja lesenih, betonskih in zidanih konstrukcij. Principi smotrne izbire konstrukcijskega sistema v odvisnosti od izbranega materiala. Projektna obtežba. Osnove projektiranje lesenih konstrukcij (mehanske in reološke lastnosti materiala, dimenzioniranje linijskih lesenih elementov, temeljna pravila izvedbe priključkov lesenih konstrukcij). Osnove projektiranja betonskih konstrukcij (dimenzioniranje in konstrukcijska izvedba linijskih konstrukcij, plošč in sten ter	Lectures Design procedure for building structures; specifics of the behaviour of timber, concrete and masonry structures; principles for sensible selection of a structural system in dependence of the selected material; design load; basics for the design of timber structures (mechanical and rheological properties of material, design of planar timber elements, basic rules for the execution of joints of timber structures); basics for the design of concrete structures (design and structural execution of planar structures, slabs and walls as well as foundations),

temeljev). Definicija masivnih betonov, problemi povezani z masivnimi betoni. Osnove analize vplivov materialnih lastnosti in vplivov okolice na razmere v masivnem betonu. Osnovni ukrepi za kvalitetno izgradnjo konstrukcij iz masivnega betona. Vaje: Seminarske vaje (računski primeri).	Definition of mass concrete, problems related to mass concrete; basics for the analysis of the influences of material properties and the impact of the environment on the conditions in mass concrete; basic measures for quality construction of mass concrete structures. Tutorials: Seminar tutorials (computational examples).

Temeljna literatura in viri/Readings:

H. Nilson, D. Darwin, C.W. Dolan. 2003. Design of Concrete Structures-thirteenth edition. McGraw-Hill, strani 321-374, 412-479, 545-574, 599-633.

W.G. Curtin, G. Shaw, J.K. Beck, W.A. Bray. 2006. Structural Masonry Designers Manual-third edition. , Blackwell Science, strani 1-72S.

Thelanderson, H.J. Larsen (urednika). 2003. Timber Engineering. John Wiley & Sons, strani 1-11, 131-168, 221-240.

Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 1, Evrokod 2, Evrokod 5, Evrokod 6, Evrokod 8 (SIST EN 1990, SIST EN 1991-1, SIST EN 1991-1-3, SIST EN 1991-1-4, SIST EN 1992-1-1, SIST EN 1995-1-1, SIST EN1996-1-1, SIST EN 1998-1).

Beg D., Pogačnik A. (urednika). Priročnik za projektiranje gradbenih konstrukcij po Evrokod standardih, Inženirska zbornica Slovenije, 2009

Spletno mesto Katedre za masivne in lesene konstrukcije: http://www.fgg.uni-lj.si/kmlk/index.htm.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati razlike v obnašanju konstrukcij iz različnih materialov - Podati osnove za snovanje in projektiranje gradbenih konstrukcij - Podati podlage za izbiro ustreznega računskega modela nosilne gradbene konstrukcije - Poznavanje problematike masivnih betonov in ukrepov za preprečitev poškodb, ki lahko nastanejo ob gradnji masivnih betonov. Pridobljene kompetence: - Sposobnost snovanja in projektiranja enostavnih masivnih in lesenih konstrukcij.	Objectives: - To present the differences in the behaviour of structures made of different materials, - To present the bases for the conception and design of building structures, - To present the bases for the selection of adequate computational model of a load-bearing structure, - To know the issues of mass concretes and the measures to prevent the damages that may appear in the construction of mass concretes. Acquired competences: - Ability to concept and design simple mass concrete and timber structures.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Poznavanje temeljnih načel projektiranja gradbenih konstrukcij - Poznavanje primernih nosilnih sistemov konstrukcij iz različnih materialov - Razumevanje delovanja osnovnih nosilnih mehanizmov konstrukcij - Poznavanje posebnosti pristopa k projektiranju konstrukcij iz različnih materialov - Pridobljeno znanje študentom omogoča projektiranje enostavnih gradbenih konstrukcij, v primeru zahtevnejših konstrukcij pa so sposobni preudarne presoje o morebitni potrebni vključitvi specialistov - Sposobnost uporabe strokovne literature, standardov in enostavnih računalniških programov v procesu projektiranja gradbenih konstrukcij.	- Knowledge of the basic principles of the design of building structures - Knowledge of appropriate load-bearing systems of structures made of different materials - Understanding of the basic mechanisms of load-bearing structures - Knowledge of the specifics how to approach the design of structures made of different materials - The acquired knowledge allows students to design simple building structures; in case of demanding structures, they are able to make a well-grounded assessment if specialists need to be engaged - Ability to use professional literature, standards and simple software in the process of the design of building structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in večji del vaj v klasični učilnici, manjši del vaj pa tudi v računalniški učilnici.	Lectures and large part of tutorials in classical classroom, small part of tutorials in computer classroom.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični del izpita	40,00 %	Theoretical part of exam
Računski del izpita	30,00 %	Computational part of exam
Vaje	30,00 %	Tutorials

Reference nosilca/Lecturer's references:

SAJE, Drago, SAJE, Franc. Sanacija cerkve v Šentjurju na Dolenjskem. V: SAJE, Franc (ur.), LOPATIČ, Jože (ur.). Zbornik 18. zborovanja gradbenih konstruktorjev Slovenije, Bled, 17. - 18. oktober 1996. Ljubljana: Slovensko društvo gradbenih konstruktorjev. 1996, str. 195-200.

LOPATIČ, Jože, SAJE, Drago, SAJE, Franc. Non-linear analysis of time-dependent response of concrete structures. International journal for engineering modelling, ISSN 1330-1365, 2010, letn. 23, št. 1/4, str. 1-11.

SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Shrinkage of polypropylene fibre reinforced high performance concrete. Journal of materials in civil engineering, ISSN 0899-1561, 2011, vol. 23, iss. 7, str. 941-952.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**INTELIGENTNI TRANSPORTNI SISTEMI**
Course title:	**INTELLIGENT TRANSPORT SYSTEMS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1554

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	0	15	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Nadgradnja splošnih znanj o teoriji prometnega toka in prometnem planiranju; opazovanje prometa, merilne naprave v cestnem prometu; sistemi vodenja prometa na medmestni prometni mreži, sistem posredovanja prometnih informacij (dinamično vodenje po cestni mreži) oziroma aktivni dinamični sistemi povečanja propustnosti ceste; cestno-vremenski informacijski sistem in zimska služba, meteorološka stanja vozišča; sistemi elektronskega plačevanja in cestninjenja; sistemi upravljanja prometa v mestih, cestna problematika v	Lectures Upgrade of general knowledge about the theory of traffic flow and planning of traffic, monitoring of traffic, measuring devices in road traffic, traffic management systems in intercity traffic network, system of communicating traffic information (dynamic management in road network) or active dynamic systems of increasing road permeability, roadside weather information system and winter service, meteorological conditions of carriageway, electronic toll collection systems, traffic management systems in urban areas, traffic issues in

naseljih, prometni režimi prometna signalizacija in oprema v naseljih; naprave za umirjanje prometa v naseljih; parkirišča in garažne hiše, sistem vodenja in plačevanja parkiranja, potrebe po parkirnih površinah; sistemi vodenja blagovnega prometa, tehtanje vozil; sistemi storitev v javnem prometu, avtobusna postajališča; prometna signalizacija in prometna oprema; sistemi za upravljanje z izrednimi dogodki, dela na cesti, promet in okolje. Seminarske vaje (računske vaje) in laboratorijske vaje (demonstracijske vaje na računalniških modelih). Terensko delo - zbiranje in analiza podatkov.	urban areas, traffic regimes, traffic control and equipment in urban areas, traffic calming devices in inhabited areas, parking areas and garage houses, system for fee paying managing and parking, needs for parking surfaces, systems of managing heavy goods traffic, weigh in motion of vehicles, systems of public traffic services, bus stops, traffic control and traffic equipment, systems for incident detection and managing, road works, traffic and environment. Tutorial and laboratory practice (demonstration exercises on computer models) Fieldwork - data collection and analysis.

Temeljna literatura in viri/Readings:

SITSA – Slovenska ITS arhitektura: aktualni razvoj ITS, 2006. Ljubljana, FGG - PTI, (elektronski dokument). Highway capacity manual, HCM2000. 2000. Washington, ZDA, 16 poglavje. http://www.spcregion.org/downloads/ops/fhwa_trafficcontrolsystemshandbook_10-2005- final.pdf

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati osnovne pojme upravljanja prometa in inteligentnih transportnih sistemov in storitev (ITS), - Spoznati najpomembnejše sisteme ITS v okviru cestnega prometa, - Naučiti se določiti potrebne parametre ter kriterije za uporabo v ITS, - Usposobiti se za izdelovanje projektov iz področja prometnih gradenj in avtomatskega vodenega prometa. Pridobljene kompetence: - Sposobnost izdelave zahtevnih analiz, študij in projektov za prometne objekte iz področja ITS, - Sposobnost izvajanja nadzora in spremljanje prometa s pomočjo ITS.	Objectives: - To learn about the basic concepts of traffic and transportation management and Intelligent Transport Systems and Services (ITS). - To learn about the most important ITS systems within road traffic - To learn how to set the required parameters and criteria for applications in ITS - To be able to produce projects in the areas of traffic and transportation engineering and automated guided traffic and transport. Acquired competences: - The ability to manufacture complex analyzes, studies and projects for transportation infrastructure in the field of ITS - Ability to conduct surveillance and traffic monitoring by using ITS.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznavanje ITS kot ukrep pri optimizaciji upravljanja prometa na prometni infrastrukturi oziroma kot ukrep izkoriščanja obstoječe prometne	- Knowledge of ITS as a measure for the optimization and/or management of traffic flows on transport infrastructure or as a measure of exploitation of

infrastrukture, to je predvsem brez ali z minimalnim vložkom v novogradnje - Razumevanje soodvisnosti, ki vplivajo na optimalno, varno in ekonomično dogajanje v prometu. - Študent bo sposoben zbrati in obdelati parametre prometnega toka na terenu in določiti odvisnosti med njimi za dimenzioniranje odprte ceste in za dimenzioniranje samostojnega križišča oziroma za potencialno uvedbo ITS. - Doseženo znanje uporabljajo pri izdelavi diplomskega dela oz. v inženirski praksi - Dobro razumevanje prednosti, ki jih predstavljajo ITS v prometnem inženirstvu - Sposobnost abstraktne formulacije procesov v cestnem prometu - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ITS - Sposobnost upoštevanja dinamike prometnih procesov pri načrtovanju dejavnosti ITS v prostoru - Sposobnost uporabe računalniških modelov v prometnem inženirstvu.	existing transport infrastructure, especially with no or minimal investment in new infrastructure - Understanding the interdependencies that affect the optimum, safe and economical developments in transportation. - Students will be able to collect and process parameters of traffic flow in the field and determine dependencies between them for the design of open roads and intersections, or for potential deployment of ITS. - Achieved knowledge used in the preparation of the thesis or in engineering practice - Good understanding of the advantages posed by ITS in transportation engineering - Ability of abstract formulation processes in road traffic - Ability for critical analysis of input data and computational results obtained in the design of ITS - Ability to take into account the dynamics of transport processes in planning activities in the area of ITS - Ability to use computer models in transport engineering

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, terensko delo.	Lectures, tutorials and laboratory work, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit	50,00 %	Theory - oral or written exam
Izdelava in zagovor vaj	50,00 %	Exercise defense

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of utility functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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.

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**OPTIMIZACIJSKE METODE V GRADBENIŠTVU**
Course title:	**OPTIMISATION METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1485

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Linearno programiranje (splošni problem, grafične metode, metoda simpleksov, transportni problemi, metoda stopalnikov, metoda modi, degeneracija, celoštevilčno linearno programiranje). Nelinearno programiranje (metode reševanja problemov brez omejitev, brez uporabe odvodov, z uporabo odvodov; metode reševanja problemov z omejitvami. Lagrangevi multiplikatorji, transformacijske metode, metode kazenskih funkcij).	Lectures Linear programming (general problem, graphical methods, the simplex method, transport problems, stepping stone method, MODI, degeneration, integer linear programming). Nonlinear programming (methods for solving problems without constraints, without the use of derivatives, with the use of derivatives; methods for solving problems with constraints: Lagrange multipliers, transformation methods, penalty functions).

Diskretno dinamično programiranje. Genetski algoritmi. Večkriterialno odločanje.	Discrete dynamic programming. Genetic Algorithms. Multiple criteria decision making.

Temeljna literatura in viri/Readings:

Žura M. 2008. Matematično programiranje – študijsko gradivo

Vadnjal A. 1971. Rešeni problemi linearnega programiranja.

Vadnjal A. 1976. Diskretno dinamično programiranje.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati teoretične osnove optimizacije - Spoznati metode reševanja optimizacijskih problemov - Na številnih praktičnih primerih pridobiti sposobnost prepoznavanja problemov in njihove matematične formulacije. Pridobljene kompetence - Sposobnost prepoznavanja problemov v gradbeništvo kot problemov matematičnega programiranja - Sposobnost matematičnega formuliranja problemov - Sposobnost uporabe ustreznih metod in orodij za reševanje problemov.	Objectives - Give the theoretical basis of optimization - To know how to solve optimization problems - On the basis of many practical cases to obtain ability to identify problems and develop their mathematical formulation. Acquired competences - Ability to recognize problems in construction as problems of mathematical programming - Ability to formulate mathematical problems - Ability to use appropriate methods and tools for problem solving.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Prepoznavanje problemov v gradbeništvo kot problemov matematičnega programiranja - Poznavanje osnov optimizacijskih metod Uporaba - Sposobnost matematičnega formuliranja - Sposobnost reševanja problemov z uporabo računalniških programov - Sposobnost interpretacije rezultatov - Na podlagi pridobljenih znanj bo študent sposoben prepoznavanja podobnih problemov, njihove matematične formulacije in reševanja - Pridobljene spretnosti bodo v večji meri uporabne v naslednjem letniku zlasti pri predmetu Planiranje izgradnje prometne infrastrukture	- Identifying problems in construction as a problem mathematical programming - Knowing the basics of optimization methods Use: - Ability to formulate mathematically - Ability to solve problems by using computer programs - Ability to interpret results: - Based on the acquired knowledge student will be able to identify similar problems, derive their mathematical formulation and solution - Acquired skills will be useful in next year, especially in the course Planning construction of transport infrastructure

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, seminarske in računalniške vaje	Lectures and exercises.

Načini ocenjevanja:	Delež/Weight	Assessment:
Teoretični del	50,00 %	Theoretical exam
Računski del	50,00 %	Practical assignment

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of ulity functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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.

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**VERJETNOSTNI RAČUN IN STATISTIKA**
Course title:	**THEORY OF PROBABILITY AND STATISTICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1618

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Marjeta Kramar Fijavž
Vrsta predmeta/Course type:	Obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. drugih predmetov s primerljivo vsebino.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content.

Vsebina:	Content (Syllabus outline):
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.	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.

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 domnev.	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.

Temeljna 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	- Formulation of practical problems in mathematical language

- 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)	- 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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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.

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:	**UPRAVLJANJE INFORMACIJ IN SODELOVANJE S PRISTOPOM BIM**
Course title:	**MANAGEMENT OF INFORMATION AND COLLABORATION IN BIM**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1786

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Tomo Cerovšek
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
• Koncepti upravljanja projektov BIM. • Nove vloge in odgovornosti pri sodelovalnih projektih BIM. • Strateško načrtovanje projektov BIM. • EIR – informacijske zahteve naročnika. • Namen BIM na projektih • LOD – stopnja določenosti. • Protokoli BIM. • Načrt izvedbe BIM. • Sestava projektne skupine BIM. • Pogodbena vprašanja uporabe BIM.	• BIM Project Management Concepts. • New roles and responsibilities in collaborative BIM Projects. • Strategic planning of BIM project • EIR – Employers Information Requirements. • The purpose of BIM on projects • LOD – Level of Detail. • BIM Protocols. • BIM execution plan (BEP) • Constructing the BIM Team. • Contractual Issues in BIM.

• Intelekutalne lastnina v sodelovalni okoljih. • Implementacija BIM. • Strategije za sodelovanje z BIM. • Razvoj sodelovalnega projekta BIM. • Napredne komunikacije preko modelov.	• IPR in Collaborative Environments. • BIM Implementation. • BIM Collaboration Strategies. • Collaborative BIM Project Development. • Advanced Model Based Communication.

Temeljna literatura in viri/Readings:

Eastman, C., Teiholz, P., Sacks, R., Liston, K. BIM Handbook A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors, New Jersey: John Wiley & Sons, 2013, 640 pp.
Weygant, R. S. BIM Content Development: Standards, Strategies, and Best Practices. John Wiley & Sons, 2011, 464 pp.
Barnes, P. T., Davies, N. BIM in principle and practice, ICE publishing, 2014, 160 pp.
Garber, R. BIM Design: Realising the Creative Potential of Building Information Modelling (AD Smart), John Wiley & Sons, 2014, 244 pp.
Reddy, K. P. BIM for Building Owners and Developers, Wiley 2012, 240 pp.
Dougherty, J. M. Claims, disputes and litigation involving BIM, Routledge 2015, 222 pp.
British Standards. PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using Building information modelling, British Standards, 2013.

Cilji in kompetence:	**Objectives and competences:**
Cilji: • Pregled teorije in standardov BIM. • Razumevanje vloge in potenciala BIM za industrijo. • Razumevanje kritičnih vidikov pri uvajanju BIM glede na projektne zahteve. • Sposobnost načrtovanja uporabe BIM znotraj gradbenih projektov in zagotavljanje ustrezne ravni podrobnosti. • Sposobnost načrtovanja uporabe BIM pri gradbenih projektih in zagotavljanje ustrezne ravni podrobnosti. • Oceniti zmožnost in sposobnost za uvedbo BIM v določenem projektu. • Sposobnost priprave ustreznih postopkov in izdelave protokolov BIM. Pridobljene kompetence: Predmet bo obsegal glavne koncepte, ki so potrebni za razumevanje uporabe BIM. V podrobnosti bodo obravnavani potrebne teoretične koncepte, ki bodo utrjeni s praktičnimi nalogami, ki bodo študentom podale zahtevano praktično znanje. Posamezni študenti bodo predstavili svoje rezultate in dokazali svoje znanje s pisnim izpitom.	Objectives: • Get an overview of BIM theory and standards. • Understand the role and potential of BIM for the industry. • Understand critical aspects in BIM implementation responding to project requirements. • Be able to plan use of BIM in Building projects and provide the right level of detail. • Be able to comply with legal and project collaboration requirements. • Assess capacity and capability for BIM implementations on specific project. • Be able to put in place appropriate management procedures and BIM protocols. Gained competences: The unit will cover major concepts that are required for the understanding the use of BIM. The unit will cover required theoretical concepts, which will be supported by hands-on assignments that will provide students required practical know-now. Individual students shall present their results as well as prove their knowledge through a written exam.

Predvideni študijski rezultati: **Intended learning outcomes:**

Učni program zajema pomembne teme za izvedbo projekta BIM z upravljanjem informacij skozi faze gradbenega projekta. Da bi zagotovili uvedbo nove paradigme v proces BIM so nove vloge in odgovornosti pojasnjene skupaj s strateškimi vprašanji, povezanimi z zrelostjo BIM bodisi za nove, samostojne ali portfeljske projekte. Da bi zagotovili zadovoljivo raven podrobnosti za določeno uporabo BIM, bo učni načrt zajemal koncept stopenj razvoja komponent. Splošen pristop bo pokrival celoten sklop aktivnosti, ki so potrebne za izvajanje protokolov BIM in s tem povezanih tipov pogodbenih razmerij, vključno z integrirano izvedbo projektov (IPD), menedžerskim pristopom in projekti 'fast-track'. Ključna vprašanja v zvezi z uporabo posebnih orodij in storitev ter zahtevami glede sodelovanja in sodelovanjem samim.	The syllabus covers important topics for the implementation of BIM project from the information management and building project stages. In order to assure introduction of a new paradigm into the BIM process, the new roles and responsibilities are explained along with strategic issues related to BIM Maturity either for new standalone or portfolio projects. In order to provide sufficient level of detail for particular BIM uses, the syllabus will cover the concept of level of development. The overall approach will cover a complete set of activities that are needed in implementation of BIM Protocols and related contract types, including IPD, design-build and fast track projects. Critical issues related to the use of specific tools and services as well as requirements about collaboration and collaboration itself.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja bodo vključevala osnovno teoretično znanje, študije primerov, vaje (virtualna učilnica) in konzultacije (virtualna učilnica). Predavatelj bo uzporabljal avdio-vizualne tehnike telekonference in spodbujal razpravo. K področju predmeta se bo pristopilo z različnih zornih kotov in z različnimi strategijami ter metodologijami izvajanja. Učni proces se bo izvajal v obliki predavanj in praktičnih nalog v zaporedju: • Priprava specifikacij skupine strokovnjakov BIM za izbran projekt. • Priprava strategije in področja načrtovanja z BIM. • Iskanje in opis 5 primerov za vsak LOD. • Izdelava poenostavljenega LOD 100 in LOD 200. • Priprava vzorčne EIR za izbrani projekt. • Izpolnitev ocenjevalnega evaluacijskega sistema za izbrano podjetje. • Razvoj vodilnega načrta za dostavo informacij glede na projektne zahteve. • Razvoj scenarija za izdajo dovoljenj za izbran projekt. • Označitev modela z ustrezno shemo izdajanja dovoljenj. • Ključno branje s področja sodelovanja BIM in sočasnega inženiringa. • Izdelava povezane datoteke in vzpostavitev strežnika BIM. • Razvoj sodelovalne sočasne rabe BIM.	Lectures will include basic theoretical knowledge, case studies, tutorials (virtual classroom) and consultations (virtual classroom). The lecturer shall use audio visual teleconferencing techniques and will encourage discussion. The subject matter will be covered from different perspectives with various implementation strategies and methodologies. The teaching process will consist of lectures and hands-on assignments, as follows: • For a selected project prepare BIM team specification. • Prepare a strategy and plan areas of BIM. • Find and describe 5 examples for each LOD. • Make a LOD 100 and LOD 200 simplified model. • Prepare a sample EIR for a selected project. • Fill-in Assessment forms for your company. • Develop a Master Information Delivery Plan. • Develop a licensing scenario for your project. • Tag a model with appropriate licensing scheme. • Essential reading on BIM Collaboration & Concurrent Engineering. • Make a linked file and BIM Server implementation. • Develop a collaborative BIM Use. • Prepare a simple model for client communications.

• Priprava preprostega modela za komunikacijo z naročnikom projekta.	

Načini ocenjevanja:	Delež/Weight	Assessment:
Sprotno delo pri predmetu	70,00 %	Course work
Izpit	30,00 %	Exam

Reference nosilca/Lecturer's references:

Cerovšek, Tomo. A review and outlook for a 'Building Information Model' (BIM) : a multi-standpoint framework for technological development. Advanced engineering informatics, 2011, letn. 25, št. 2, str. 224-244, ilustr., doi: 10.1016/j.aei.2010.06.003. [COBISS.SI-ID 5052769]

Cerovšek, Tomo, Zupančič-Strojan, Tadeja, Kilar, Vojko. Framework for model-based competency management for design in physical and virtual worlds. J. inf. tech. constr., 2010, vol. 15, str. 1-22, ilustr. http://www.itcon.org/2010/1. [COBISS.SI-ID 2380932]

Cerovšek, Tomo. A framework for CPD and 5D BIM process reuse. 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. 1-10, ilustr. http://itc.scix.net/data/works/att/w78-2011-Paper-157.pdf. [COBISS.SI-ID 5705825]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MODELIRANJE V ARHITEKTURI IN INŽENIRSTVU**
Course title:	**MODELLING IN ARCHITECTURE AND ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1787

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz Upravljanje informacij in sodelovanje s pristopom BIM.	Passed exam in Management of information and collaboration in BIM.

Vsebina:	Content (Syllabus outline):
• Uvod v zahteve in uporabe modelov v arhitekturi in inženiristvu. • Uporaba BIM v arhitekturni in inženirski stroki. • Strategije modeliranja v skladu s predvidenimi uporabami BIM. • Privzeti predmeti in novi predmeti v arhitekturi in inženirstvu. • Norme za modeliranje in priporočila. • Modeliranje BIM za arhitekturo: vidiki uporabe in študije primerov. • Modeliranje BIM za gradbeništvo: vidiki uporabe in študije primerov.	• Introduction to modelling requisites and uses according to architecture and engineering specialties (AES). • BIM uses in Architecture and Engineering specialties. • Modelling strategies versus BIM uses. • Default objects and new objects in AES. • Modelling norms and recommendations. • BIM modelling for Architecture: applied aspects and case studies. • BIM modelling for Structural Engineering: applied aspects and case studies.

• Modeliranje BIM za napeljave: vidiki uporabe in študije primerov. • Modeliranje za posebne primere, kot so nadzor konstrukcij in upravljanje infrastrukture.	• BIM modelling for MEP Engineering: applied aspects and case studies. • Modelling for particular cases, such as structural monitoring and infrastructure management.

Temeljna literatura in viri/Readings:

Azenha et al. Lecture notes to be provided during the operation of the Curricular Unit, 2015
Smith, D. K., Tardif, M. Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers, Wiley, 2009, 216 pp.
Olsen, P. B., Kærgaard, L. S., Holst, N., Breiner, O. M., Pape, D. W. A practical guide to BIM in construction and infrastructure projects, MT Højgaard, 2015, 84 pp.
Nawari O. N., Kuenstle, M. Building Information Modeling: Framework for Structural Design, CRC Press, 2015, 284 pp.
Regulatory documents from UK, Singapore, Finland and other relevant countries.
Eastman, C., Teiholz, P., Sacks, R., Liston, K. BIM Handbook A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors, New Jersey: John Wiley & Sons, 2013, 640 pp.
buildingSMART, 2015 (http://www.buildingsmart.org/)

Cilji in kompetence:	**Objectives and competences:**
• Sposobnost razlikovanja zahtev in uporab, ki so zanimive za vsako področje gradbeništva (arhitektura in inženirstvo). • Prepoznavanje in opis ustreznih praks modeliranja glede na namen uporabe modelov. • Naštevanje, uporaba in kritika večih priporočil za modeliranje, ki obstajajo na mednarodni ravni. • Sposobnost razumevanja in izdelave BIM-modelov za arhitekturo, konstrukcije in instalacije. • Razumevanje dodatnih, posebnih primerov modeliranja za nadzor in upravljanje.	• Be able to differentiate the requisites and uses that are of interest for each construction specialty (Architecture and Engineering). • Identify and describe adequate modelling practices in view of intended uses for the models. • List, apply and criticize some major modelling recommendations that exist at international level. • Capability to understand and perform BIM models for the specialties of Architecture, Structural Engineering and MEP Engineering. • Understand further particular cases of modelling, targeted for monitoring and management.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Obstaja neposredna povezava med vsemi zgoraj naštetimi učnimi cilji in vsebinami učnega načrta. Pristopi k modeliranju BIM, BIM-strategijami, normami, priporočili, aplikacijami in študijami primerov so neposredno omenjeni znotraj predmeta na njim primernih mestih v okviru študijskih rezultatov.	There is a direct relationship between all the learning objectives formulated above and the contents of the syllabus. Indeed, the BIM modelling approaches, strategies, norms, recommendations, applications and case studies are directly mentioned across the syllabus in coherence with their corresponding identified positions in the context of learning outcomes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Metodologija je primerna za cilje predmeta in vključuje teoretična znanja, ki jih predstavi	The methodology corresponds to the objectives of the unit, including the presentation of theoretical

predavatelj, ključno uporabo programske opreme za modeliranje (tako za arhitekturo kot za gradbeništvo), praktične naloge, ki jih bodo študenti opravili, javno predstavitev in skupno razpravo programskih nalog (ki predstavljajo različne osnovne izzive) in izpit, ki pokriva vsa ta področja. Predmet se izvaja 3 polne tedne skupaj z naknadnim ocenjevanjem (modularna oblika). Predmet sledi razrednemu pristopu, s predavanji zjutraj in delom popoldne. Naloge vključujejo: vaja o modeliranju BIM v arhitekturi; vaja o modeliranju BIM v gradbeništvu; in za zaključek vaja o modeliranju BIM napeljav. Celotno študijsko gradivo je na voljo pred začetkom predmeta skupaj z nizom vzorčnih vprašanj. Študentom bodo na voljo akademske licence ustrezne programske opreme.	knowledge by the lecturer, the critical use of modelling software (for both Architecture and Engineering specialties), practical assignments to be developed by the students, public presentation and joint discussion of the programming assignments (that adopt different basic challenges), and an exam covering all subjects taught. The unit lasts for 3 weeks on a full-time basis and with subsequent assessment (modular format). The unit follows an in-class approach, with classes in the morning and works during the afternoon. The assignments include: an exercise about Architectural BIM Modelling; an exercise about Structural Engineering BIM Modelling; and finally an exercise on BIM Modelling for MEP. All study elements are provided before starting the unit, together with a set of sample questions. Academic licenses of the relevant software are provided to the students.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Sprotno delo pri predmetu	60,00 %	Course work
Izpit	40,00 %	Exam

Reference nosilca/Lecturer's references:

Turk, Žiga. Ten questions concerning building information modelling. Building and environment, ISSN 0360-1323. [Print ed.], Okt. 2016, letn. 107, str. 274-284, ilustr., doi: 10.1016/j.buildenv.2016.08.001.

Turk, Žiga. Responsible research and innovation in construction. Procedia engineering, ISSN 1877-7058, dec. 2016, letn. 164, str. 461-466, ilustr. http://www.sciencedirect.com/science/article/pii/S1877705816339868.

Turk, Žiga. Construction informatics: definition and ontology. Advanced engineering informatics, ISSN 1474-0346, 2006, letn. 20, št. 2, str. 187-199, graf. prikazi.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PARAMETRIČNO MODELIRANJE V BIM**
Course title:	**PARAMETRIC MODELLING IN BIM**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1788

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Matevž Dolenc, Vlado Stankovski
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljena izpita iz Upravljanje informacij in sodelovanje s pristopom BIM in Modeliranje v arhitekturi in inženirstvu.	Passed exams in Management of information and collaboration in BIM and Modelling in Architecture and Engineering.

Vsebina:	Content (Syllabus outline):
Niz glavnih tem zajetih v učnemu načrtu tega predmeta vključuje: • Uvod v programiranje in algoritme. • Spoznavanje programskih jezikov, tako z zgodovinskih kot praktičnih vidikov. • Programski algoritmi in splošni koncepti (spremenljivke, zanke, pogojni stavki). • Objektno orientirano programiranje - učenje preko C #. • Integrativno uvajanje C # skripte v BIM-okolje.	The set of main topics covered in this curricular unit involves: • Introduction to programming and algorithms. • Familiarization with programming languages, from both historical and practical points of view. • Programming algorithms and general concepts (variables, loops, conditional statements). • Object oriented programming – Learning through C#. • Integrative deployment of C# scripts in BIM environment.

• Objektno orientirano modeliranje: ozadje in osnove. • Uporaba objektno orientiranega modeliranja v okviru BIM: primeri vizualnih programskih jezikov kot so Grasshopper in Rhinoceros, Archicad, Dynamo in Revit. • Napredna uporaba predmetov znotraj BIM-platform.	• Object oriented modelling: background and fundamentals. • Applications of object oriented modelling in BIM context: examples of visual programming languages such as Grasshopper and Rhinoceros. • Advanced object usage in BIM platforms.

Temeljna literatura in viri/Readings:

Azenha et al. Lecture notes to be provided during the operation of the Curricular Unit, 2015.
Smith, D. K., Tardif, M. Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers, Wiley, 2009, 216 pp.
Jack Purdum, J. "Beginning Object-Oriented Programming with C#", John Wiley & Sons, ISBN: 978-1-118-33692-2, 2012, 624 pp.
Tedeschi, A. Parametric Architecture with Grasshopper English Edition – Edizioni Le Penseur, 2011.
Tedeschi, A. AAD Algorithms-Aided Design. Parametric Strategies using Grasshopper English Edition – Edizioni Le Penseur, 2014, 496 pp.
Modelab, Dynamo primer – V1.3, 2015 (http://dynamoprimer.com/)
Eastman, C., Teiholz, P., Sacks, R., Liston, K. BIM Handbook A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors, New Jersey: John Wiley & Sons, 2013, 640 pp.
buildingSMART, 2015 (http://www.buildingsmart.org/)

Cilji in kompetence:	**Objectives and competences:**
• Zagotovitev visoke ravni znanja o ozadju objektno orientiranega programiranja. • Sposobnost v celoti razumeti osnovne koncepte objektno orientiranega modeliranja. • Uporaba objektno orientiranega programiranja (C #) z namenom razširitve zmogljivosti obstoječih platform BIM v smer prilagojenih zmožnosti. • Obvladovanje vizualnih programskih jezikov za napredno ustvarjanje objektov. • Sposobnost napredne uporabe objektov v okviru BIM preko interaktivnih razredov / obravnavane bodo urejevalci družin.	• Create profound level of knowledge on the background of object oriented programming. • Be capable of fully understanding the underlying concepts of object oriented modelling. • Apply object oriented programming (C#) in order to extend the capacities of existing BIM platforms towards customized capacities. • Master the use of visual programming languages for advanced object creation. • Be capable of advanced object usage in BIM context through interactive class; family editors and object libraries will be addressed.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Učni načrt vsebuje osnoven in zahteven nivo programiranja v objektno usmerjenem jeziku, ki se uporablja znotraj BIM-platforme. Poleg tega učni načrt obravnava objektno orientirano modeliranje, vizualno programiranje in napredno uporabo objektov v BIM-u. Učni načrt je neposredno usklajen z učnimi rezultati, saj so dosežene sposobnosti in znanja eksplicitno del različnih tem učnega načrta.	The syllabus contains introductory and advanced levels of programming in an object oriented language, which is in turn applied to a BIM platform. Furthermore, the syllabus deals with object oriented modelling, visual programming and advanced object usage in BIM context. The alignment with the learning outcomes is direct, as the attained capabilities and knowledge are explicitly part of several syllabus topics.

Metode poučevanja in učenja:	Learning and teaching methods:
Metodologija je primerna za cilje predmeta in vključuje teoretičnega znanja, ki ga predstavi predavatelj, ključno uporabo naprednih programskih jezikov (tako konvencionalnih kot vizualnih), praktične naloge, ki jih bodo študenti razvili, javno predstavitev in skupno razpravo programskih nalog (ki predstavljajo različne osnovne izzive) in izpit, ki pokriva vsa ta področja. Predmet traja 3 polne tedne skupaj z naknadnim ocenjevanjem (modularna oblika). Predmet sledi razrednemu pristopu, s predavanji zjutraj in delom popoldne. Naloge vključujejo: vaja o osnovnih uporabah objektno orientiranih jezikov; izdelavo C# skripte za uporabo znotraj BIM; razvoj vizualnega programiranja s ciljem modeliranja kompleksnih oblik. Celotno študijsko gradivo je na voljo pred začetkom predmeta skupaj z nizom vzorčnih vprašanj. Študentom bodo na voljo akademske licence ustrezne programske opreme.	The methodology is adequate for the objectives of the unit, including the presentation of theoretical knowledge by the lecturer, the critical use of advanced programming languages (both conventional and visual), practical assignments to be developed by the students, public presentation and joint discussion of the programming assignments (that include different basic challenges), and an exam covering all subjects taught. The unit lasts for 3 weeks on a full-time basis and with subsequent assessment (modular format). The unit follows an in-class approach, with classes in the morning and works during the afternoon. The assignments include: an exercise about basic application of an object oriented language; the creation of a script in BIM context through the use of C#; development of visual programming targeted to the modelling of complex shapes. All study elements are provided before starting the unit, together with a set of sample questions. Academic licenses of the relevant software are provided to the students.

Načini ocenjevanja:	Delež/Weight	Assessment:
Izpit	40,00 %	Exam
Naloge	60,00 %	Assignments

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: 10.1016/j.autcon.2014.02.011.

Dolenc, Matevž, Klinc, Robert. Information-Communication Technology for Architecture, Engineering and Construction: State-of-the-Art and Beyond. V: TSOMPANAKIS, Yiannis (ur.), TOPPING, Barry H. V. (ur.). Computational Technology Reviews : vol. 4, (Computational Technology Reviews, 2044-8430). Stirlingshire: Saxe-Corbung Pubications, 2011, str. 177-192, ilustr., doi: 10.4203/ctr.4.7.

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.

König, Matija, Dirnbek, Jaka, Stankovski, Vlado. Architecture Of An Open Knowledge Base For Sustainable Buildings Based On Linked Data Technologies. Automation In Construction, ISSN 0926-5805. [Print Ed.], Nov. 2013, Letn. 35, Str. 542-550, Ilustr., Doi: 10.1016/J.Autcon.2013.07.002.

Stankovski, Vlado, Swain, Martin, Kravtsov, Valentin, Niessen, Thomas, Wegener, Dennis, Kindermann, Jörg, Dubitzky, Werner. Grid-enabling data mining applications with

2. DataMiningGrid: An architectural perspective. FGCS, ISSN 0167-739X. [Print ed.], 2008, letn. 24, št. 4, str. 259-279.

Stankovski, Vlado, Trnkoczy, Jernej, Swain, Martin, Dubitzky, Werner, Kravtsov, Valentin, Schuster, Assaf, Niessen, Thomas, Wegener, Dennis, May, Michael, Röhm, Matthias, Franke, Jürgen. Digging deep into the data mine with DataMiningGrid. IEEE internet computing, ISSN 1089-7801, 2008, letn. 12, št. 6, str. 69-76.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NAPREDNI BIM PODATKOVNI SISTEMI IN INTEROPERABILNOST**
Course title:	**ADVANCED BIM DATA-SYSTEMS AND INTEROPERABILITY**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1789

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Tomo Cerovšek, Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz Upravljanje informacij in sodelovanje s pristopom BIM.	Passed exam in Management of information and collaboration in BIM.

Vsebina:	Content (Syllabus outline):
• Uvod v podatkovne sisteme in definicija interoperabilnosti. • Ovire in razlogi za interoperabilnost. • Vloga kontroliranih slovarjev. • Izmenjava BIM podatkov. • Odprti pristop BIM. • Interoperabilnost BIM-podatkov. • Uvod v ISO STEP 10303 in Express jezik. • IFC - Industry Foundation Classes. • IFC certificiranje. • IFD: mednarodni okvir za slovarje.	• Introduction to Data Systems and Definition of Interoperability. • Barriers and Drivers to Interoperability. • The role of Controlled Vocabularies. • BIM Data Exchange. • Open BIM Approach. • BIM Data Interoperability. • Introduction to ISO STEP 10303 and Express. • IFC – Industry Foundation Classes. • IFC Certification. • IFD: international framework for dictionaries. • Cross- Discipline BIM Project Interoperability.

• Meddisciplinska interoperabilnosti projekta BIM. • Interoperabilnost analize arhitekturnega modela. • Interoperabilnost koordinacije konstrukcijskega modela. • Interoperabilnost koordinacije MEP modela.	• Architectural Model Analysis Interoperability. • Structural Model Coordination Interoperability. • MEP Model Coordination Interoperability.

Temeljna literatura in viri/Readings:

Eastman, C. M. Building product models, Computer Environments Supporting Design and Construction, CRC Press, 1999, 424 pp.
ISO 12006-2 Building construction - Organization of information about construction works Part 2: Framework for classification of information.
ISO 15926 Industrial automation systems and integration -Integration of life-cycle data for process plants including oil and gas production facilities- Part 1: Overview and fundamental principles.
ISO 4157-1 Construction drawings -Designation systems - Part 1: Buildings and parts of buildings.
ISO 4157-2 Construction drawings -Designation systems - Part 2: Room names and numbers .
ISO/PAS 16739 Industry Foundation Classes, Release 2x, Platform Specification (IFC2x Platform).

Cilji in kompetence:	**Objectives and competences:**
Cilji: • Sposobnost vrednotenja vprašanj interoperabilnosti glede izmenjav pri pristopu BIM s tehničnega, semantičnega in organizacijskega vidika. • Metode razvoja shem in zbirk podatkov, ki so pomembni za BIM. • Metode za izmenjavo specifikacij gradbenih izdelkov. • Postopki vrednotenja, ki so pomembni za uspešno izvedbo projekta. • Interoperabilnost izmenjav projektnih informacij v infrastrukturnih in gradbenih projektih z BIM. Pridobljene kompetence: Predmet bo obravnaval glavne koncepte s področja interoperabilnosti, ki so potrebni za obvaldovanje problematike interoperabilnosti. Predmet bo obsegal teoretične koncepte povezane s tehničnimi, semantičnimi in organizacijskimi vprašanji inteoperabilnosti, ki bodo utrjeni s praktičnimi nalogami, ki bodo študentom podale zahtevano praktično znanje. Študenti bodo samostojno pripravili projekte in izkazali svoje znanje s pisnim izpitom.	Objectives: • Be able to assess interoperability issues in BIM Exchange from technical, semantic and organizational points of view. • Methods for the development of schemata and databases relevant to BIM. • Methods for the exchange of building product specifications. • Assessment procedures relevant for successful implementation of a project. • Interoperability issues in BIM based exchange of project information in infrastructure and building projects. Gained competences: The unit will cover major interoperability concepts that are required for managing interoperability issues. The unit will cover the required theoretical concepts related to technical, semantic and organizational interoperability, which will be supported by hands-on assignments that will provide students with the required practical know-now. Individual students shall prepare individual projects, as well as prove their knowledge through a written exam.

Predvideni študijski rezultati: **Intended learning outcomes:**

Učni načrt bo predstavil osnovne pojme, pomembne za računalniško integrirano gradnjo, kar zajema formate, sheme in API-je. Metodološki pristop k razvoju skupnih slovarjev, pomembnih za izmenjavo BIM-podatkov, bo zagotovil vpogled v standardizacijo shem in njihov razvoj z uporabo ISO STEP in njegovega glavnega rezultata IFC. Poleg tega bo izmenjava specifikacij gradbenih izdelkov zajeta ustrezen okvir standardizacije in IFD. Vprašanja interoperabilnosti izmenjav na podlagi BIM bodo zajemala večtokovno usklajevanje z zveznimi modeli in nadaljno izmenjavo podatkov, kot tudi odprt BIM-pristop z referenčnimi in koordinacijskimi modeli za različne panoge.	The syllabus will introduce basic concepts relevant for computer integrated construction, covering format, schemata and APIs. The methodological approach to the development of common vocabularies relevant for the BIM data exchange will provide an insight into schemata standardization and their development using ISO STEP and its major outcome IFC. In addition, the exchange of building product specifications will be covered by relevant standardization and IFD framework. Interoperability issues in BIM based exchange will cover mixedstream coordination with federated models and downstream data exchange as well as open BIM approach with reference and coordination models for different disciplines.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja bodo vključevala osnovno teoretične vsebine, študije primerov, vaje (virtualna učilnica) in konzultacije (virtualna učilnica). Predavatelj bo uzporabljal avdio-vizualne tehnike telekonference in spodbujal razpravo. Vsebina predmeta bo obravnavana iz različnih vidikov in z različnimi strategijami ter metodologijami izvajanja. Učni proces se bo izvajal v obliki predavanj in praktičnih nalog v zaporedju: • Problemi interoperabilnosti na podlagi testnih podatkov. • Uporaba klasifikacij za BIM-elemente (RVT, PLN). • Dvosmerni preizkus znotraj posameznega avtorskega okolja. • Preizkus odprtega BIM v različnih avtorskih okoljih. • Opis notranje sheme izbranih elementov. • Izvleček preprostega podseta SPF in njegova interpretacija. • Preizkus certificirane MVD rešitve. • Prilagajanje BPM za izbrano MVD. • Primer opisa IFD. • Obveznjo branje glede meddisciplinske interoperabilnosti BIM. • Razvoj BIM - BEM pretvorbe. • Študija primera izmenjave konstrukcijskega modela. • Študija primera izmenjave MEP modela.	Lectures will include basic theoretical knowledge, case studies, tutorials (virtual classroom) and consultations (virtual classroom). The lecturer shall use audio visual teleconferencing techniques and will encourage discussion. The subject matter will be approached from different perspectives with various implementation strategies and methodologies. The teaching process will consist of lectures and hands-on assignments as follows: • Interoperability issues based on sample data test. • Use of classifications for BIM Elements (RVT, PLN). • Roundtrip test within single authoring environment. • Open BIM test in diverse authoring environment. • Describe Internal Schemata of Selected Elements. • Extract a simple sub-set of SPF and interpret it. • Make a test of a Certified MVD solution. • Customize BPM for a selected MVD. • Make an example of IFD description. • Essential reading on Cross-disciplinary BIM Interoperability. • Develop BIM – BEM Conversion. • A case study of Structural Model Exchange. • A case study in exchange of MEP models.

Načini ocenjevanja:	Delež/Weight	Assessment:
Sprotno delo pri predmetu	70,00 %	Course work
Izpit	30,00 %	Exam

Reference nosilca/Lecturer's references:

Cerovšek, Tomo. A review and outlook for a 'Building Information Model' (BIM) : a multi-standpoint framework for technological development. Advanced engineering informatics, 2011, letn. 25, št. 2, str. 224-244, ilustr., doi: 10.1016/j.aei.2010.06.003. [COBISS.SI-ID 5052769].

Cerovšek, Tomo. Informacijski modeli zgradb in standardizacija : razvoj in uporaba ISO STEP, CIS2 in IFC. Gradb. vestn., avg. 2005, letn. 54, str. 190-208, ilustr. [COBISS.SI-ID 225059584].

Petrinja, Etiel, Stankovski, Vlado, Turk, Žiga. A provenance data management system for improving the product modelling process. Automation in construction, ISSN 0926-5805. [Print ed.], 2007, letn. 16, št. 4, str. 485-497, graf. prikazi.

Pazlar, Tomaž, Turk, Žiga. Interoperability in practice : geometric data exchange using the IFC standard. Journal of information technology in construction, ISSN 1874-4753, 2008, vol. 13, str. 362-380. http://www.itcon.org/data/works/att/2008_24.content.00881.pdf

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MODELIRANJE 4D, 5D, 6D IN APLIKACIJE**
Course title:	**4D, 5D, 6D MODELLING AND APPLICATIONS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1790

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Aleksander Srdić, Marijan Žura
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljena izpita iz Upravljanje informacij in sodelovanje s pristopom BIM in Modeliranje v arhitekturi in inženirstvu.	Passed exams in Management of information and collaboration in BIM and Modelling in Architecture and Engineering.

Vsebina:	Content (Syllabus outline):
• Pomen BIM (4D, 5D, 6D). • Upravljanje poslovnih procesov. • Upravljanje gradbenih procesov. • Integrirana izvedba projekta in poenotena projektna komunikacija. • BIM 4D: orodja za vodenje projektov. • Planiranje, kalkulacije, upravljanje stroškov. • BIM 5D: Orodja za stroškovno upravljanje projekta. • Obratovanje in upravljanje z energijo. • BIM 6D: Orodja za upravljanje objektov.	• The Value of BIM (4D, 5D, 6D). • Business Process Management. • Construction Process Management. • Integrated Project delivery and Unified Project Communication. • BIM 4D: tools for project management. • Project scheduling, estimation and cost management. • BIM 5D: Tools for Project cost management. • Facility and Energy Management. • BIM 6D: Tools for Facility Management.

• BIM na gradbišču. • BIM vloge in pocedure. • Upravljanje pogodb in BIM. • Javna e-naročila in BIM. • Skupni okolja za podatke.	• BIM to Field. • BIM roles and procedures. • Contract Management and BIM. • eProcurement and BIM. • Common Data Environment.

Temeljna literatura in viri/Readings:

Caputi, M., Stefani, M. et al. Il Building Information Modeling – BIM: Valore, gestione e soluzioni operative, Maggioli Editore, 2015, 300 pp.
Barnes, P., Davies. N., BIM in Principle and Practice, ICE Publishing, 2014, 136 pp.
Eastman C., Teicholz, P. BIM for Facility Managers, IFMA Foundation for Wiley, 2013, 352 pp.
Hardin, B. BIM and Construction Management: proven tools, methods and workflows, Sybex – imprint of Wiley, 2009, 340 pp.
Smith, D. K., Tardif, M. Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers, Wiley, 2009, 216 pp
Regulatory documents from UK and other relevant countries.
buildingSMART, 2015 (http://www.buildingsmart.org/)

Cilji in kompetence:	**Objectives and competences:**
• Razumevanje pomena BIM in njegov vpliv na "bolj" menedžerski vidik načrtovanja in gradnje (tj. upravljanje poslovnih procesov, vodenje gradbenih projektov, integrirano izvedbo projektov). • Sposobnost razlikovanja zahtev in uporab, ki so zanimive za namene različnih BIM-razsežnosti (npr. 4D planiranje, 5D vrednotenje / računovodstvo, 6D upravljanje). • Detajlna opredelitev poslovnih procesov, ki vplivajo 4D, 5D in 6D BIM in opis pristopa digitalizacije v smislu delovnih tokov in mehanizmov izmenjave podatkov (vklj. vloge za upravljanje s podatki, dostava podatkov in sistemski vmesniki). • Navedbe referenc različnih praks, ki obstajajo na mednarodni ravni. • Razumevanje, kako lahko okolja za skupne podatke – CDE (kot je določeno znotraj evropskih praks) nudijo podporo drugim poslovnim procesom, kot so upravljanje pogodb, razpisov in e-naročanja ter BIM na gradbišču. • Razumevanje, kako prilagoditi 4D, 5D in 6D BIM za modeliranje in aplikacije glede posebnosti arhitekture, gradbeništva in inštalacij za gradbene objekte, vključno z linearnimi objekti.	• Understand the value of BIM and the impacts on the “predominately” managerial aspects of Design and Construction (i.e. Business process management, construction project management, integrated project delivery). • Be able to differentiate the requisites and uses that are of interest for different BIM dimensions (i.e. 4D- programming, 5D estimating/accounting, 6D facility management). • Define in detail the business processes impacted by BIM 4D, 5D and 6D and describe the digitalization approach in terms of workflows, data exchange mechanisms, (incl. data management roles, data drops and system interfaces). • Provide references to practices that exist at international level. • Understand how the Common Data Environment (as prescribed in European practices) can support other business processes such as contract management, tendering and eProcurement, BIM to Field. • Understand how to adapt BIM 4D, 5D and 6D to modelling and applications for the specialties of Architecture, Structural Engineering and MEP Engineering for all types of construction entities, including liear construction.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Obstaja neposredna povezava med vsemi zgoraj naštetimi učnimi cilji in vsebinami učnega načrta.	There is a direct relationship between the learning objectives formulated above and the contents of the

Dejansko so 4., 5. in 6. dimenzije BIM modeliranja neposredno omenjene znotraj predmeta na njim primernih mestih v okviru študijskih rezultatov.	syllabus. Indeed, the 4th, 5th and 6th dimension of BIM modelling are directly mentioned across the syllabus in coherence with their correspondingly identified positions in the context of learning outcomes.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Metodologija je primerna za cilje predmeta in vključuje teoretičnega znanja, ki ga predstavi predavatelj, ključno uporabo programske opreme za modeliranje (ne nujno v povezavi z arhitekturo ali gradbeništvom, ampak nujno potrebne za digitalizacijo njunih poslovnih procesov), praktične naloge, ki jih bodo študenti opravili, javno predstavitev in skupno razpravo programskih nalog (ki predstavljajo različne osnovne izzive) in izpit, ki pokriva vsa ta področja. Predmet traja 3 polne tedne /14 dni) skupaj z kratko prekinitvijo in z naknadnim ocenjevanjem (modularna oblika). Predmet sledi razrednemu pristopu, s predavanji zjutraj in delom popoldne. Naloge vključujejo: vaja o planiranju (4D), vaja o cenitvi (5D) in končno, vaja o izdelavi načrta vzdrževanja (6D). Po koncu 10. Predavanja bomo preizkusili študente glede tem o uporabi BIM na gradbišču. Celotno študijsko gradivo je na voljo pred začetkom predmeta skupaj z nizom vzorčnih vprašanj. Študentom bodo na voljo akademske licence ustrezne programske opreme.	The methodology is adequate for the objectives of the unit, including the presentation of theoretical knowledge by the lecturer, the critical use of appropriate software tools (not necessarily related to both Architecture and Engineering specialties but indispensable to digitalize its business processes), practical assignments to be developed by the students, public presentation and joint discussion of the programming assignments (that adopt different basic challenges), and an exam covering all subjects taught. The unit lasts for 3 weeks (14 days) with a small interruption and foresees subsequent assessment (modular format). The unit follows an in-class approach, with classes in the morning and works during the afternoon. The case studies include: an exercise about Programming (4D); an exercise about Estimating (5D); and finally an exercise on Creation of a Maintenance Plan (6D). At the end of lecture 10 we will test the students on BIM to field related topics. All study elements are provided before starting the unit, together with a set of sample questions. Academic licenses of the relevant software are provided to the students.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Študije primerov	40,00 %	Case studies
Test	25,00 %	Test
Uporaba programov	25,00 %	Software use
Aktivno udejstvovanje v razredu	10,00 %	Active participation to class
Potrebnih je najmanj 40% na vseh področjih (pisni izpit in vsako poročilo).		A Minimum of 40% in each task is required (written examination and all reports).

Reference nosilca/Lecturer's references:

ŠEMROV, Darja, MARSETIČ, Rok, ŽURA, Marijan, TODOROVSKI, Ljupčo, SRDIČ, Aleksander. Reinforcement learning approach for train rescheduling on a single-track railway. Transportation research. Part B,

Methodological, ISSN 0191-2615. [Print ed.], 2016, letn. 86, št. apr., str. 250-267, ilustr., doi: 10.1016/j.trb.2016.01.004.

SRDIČ, Aleksander, ŠELIH, Jana. Delays in Construction Projects: Causes and Mitigation. Organization, technology & management in construction, ISSN 1847-5450. [Print ed.], dec. 2015, letn. 7, št. 3, str. 1383-1389. http://www.grad.hr/otmcj/clanci/vol%207_3/05.pdf, doi: 10.5592/otmcj.2015.3.5. [COBISS.SI-ID 7385441].

SRDIČ, Aleksander, CAMPOS, Lucila M. S., TRIERWEILLER, Andrea C., ŠELIH, Jana. Environmental management in project oriented companies within construction sector. Organization, technology & management in construction, ISSN 1847-5450. [Print ed.], dec. 2013, letn. 5, št. 2, str. 892-899. http://www.grad.hr/otmcj/volumes.htm. [COBISS.SI-ID 6462817].

LIPAR, Peter, LAKNER, Mitja, MAHER, Tomaž, ŽURA, Marijan. Estimation of road centerline curvature from raw GPS data. The Baltic journal of road and bridge engineering, ISSN 1822-427X. [Print ed.], 2011, letn. 6, št. 3, str. 163-168, ilustr., doi: 10.3846/bjrbe.2011.21.

STRNAD, Irena, ŽURA, Marijan. Genetic algorithms application to EVA mode choice model parameters estimation. International journal of mathematical models and methods in applied sciences, ISSN 1998-0140, 2011, letn. 5, št. 3, str. 533-541, ilustr. http://www.naun.org/main/NAUN/ijmmas/19-905.pdf.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PRENOVA IN ANALIZA TRAJNOSTI S PRISTOPOM BIM**
Course title:	**BIM BASED REHABILITATION AND SUSTAINABILITY ANALYSIS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1791

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	30	0	0	75	5

Nosilec predmeta/Lecturer:	Mitja Košir, Vlatko Bosiljkov
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
• Splošna organizacija in vodenje različnih stopenj načrtovanja, razpisnih dejavnosti, gradnje in upravljanja objektov rekonstrukcije obstoječe zgradbe. • Ponovna uporaba obstoječe zgradbe: Raziskava. Raziskava geometrije, materialov in poškodb. • Orodja, metode in instrumenti za raziskave obstoječih zgradb. • 3D modeliranje rezultatov raziskav za predhodno diagnozo škode in fotoralistično obnovo. • Konstrukcijski model in usklajevanje med konstrukcijskim in arhitekturnim modelom.	• General organization and management of the various phases of design, tender activity, construction and facility management of the retrofit of existing building. • Reuse of the existing building: Survey. Geometric, material and damages survey. • Tools, methods, and instruments for the survey of the existing buildings. • The 3D modelling of the survey results for the preliminary diagnosis of the damages and photorealistic reconstruction. • Structural model and coordination between structural model and architectural model.

• Model za dinamično konstrukcijsko analizo zgradbe. • Zasnova sanacije in ovojnice gradbeniških detajlov. • Rešitve za ponovno uporabo obstoječih zgradb: modeliranje, načrtovanje proračuna, vrednotenje. • Trajnostna obnova s sistemom ocenjevanja LEED, uporaba programa Revit za LEED vrednotenje. • MEP modeliranje, odkrivanje kolizij v zgradbi. • BIM v BEM: upravljanje z energijo in analize - 1. del. • BIM v BEM: upravljanje z energijo in analize - 2. del. • Vrednotenje stroškov življenskega cikla (LCC) pri gradnji in ocena povračila. • Stopnje v projektu obnove obstoječe zgradbe, preverjanje modela.	• Model for the dynamic structural analysis of the building. • Design of rehabilitation and envelope's construction details. • Solutions for the reuse of existing buildings: Modelling, Budgeting, Estimating. • Sustainable reuse with LEED rating system, use of Revit for the evaluation of LEED. • MEP modeling , clash detection in buildings. • BIM to BEM: Energy management and analysis. – Part 1 • BIM to BEM: Energy management and analysis. – Part 2 • LCC in the construction and evaluation of the payback. • Phases in the project of reuse of existing building, model checking.

Temeljna literatura in viri/Readings:

Lecture notes to be provided during the operation of the Curricular Unit.
LEED v4 for Building Design And Construction, Ed US GBC, 804 pp. (http://www.usgbc.org/)
Friedman, D. Historical Building Construction: Design, Materials, and Technology, Ed W. W. Norton & Company, 2010, 305 pp.
Kurnitski, J. Cost Optimal and Nearly Zero-Energy Buildings (nZEB): Definitions, Calculation Principles and Case Studies (Green Energy and Technology), Springer, 2013, 176 pp.

Cilji in kompetence:	**Objectives and competences:**
• Sposobnost razlikovanja zahtev in uporab, ki so zanimive za vsako področje gradbeništva (arhitektura in inženiring). • Prepoznavanje in opis ustreznih praks modeliranja glede na namen modelov. • Naštevanje, uporaba in kritika večih priporočil za modeliranje, ki obstajajo na mednarodni ravni. • Sposobnost razumevanja in izdelave BIM-modelov različnih strok • Razumevanje dodatnih, posebnih primerov modeliranja za nadzor in upravljanje.	• Be able to differentiate the requisites and uses that are of interest for each construction specialty (Architecture and Engineering). • Identify and describe adequate modelling practices in view of intended uses for the models. • List, apply and criticize several modelling recommendations that exist at international level. • Capability to understand and perform BIM models for the specialties of Architecture, Structural Engineering and MEP Engineering. • Understand further particular cases of modelling, targeted for monitoring and management.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Tekom tega predmeta je študent izpostavljen študiju realnih primerov in ima možnost uporabiti pridobljeno znanje z integriranim projektom uporabe BIM-sistemov v gradbeniškem okolju.	Within this unit the student is exposed to a real case study and has the opportunity to apply the knowledge acquired in the course through the integrated project for the application of BIM frameworks in contexts of the construction industry.

Metode poučevanja in učenja:	Learning and teaching methods:
Predmet temelji na posebnem modelu učenja, to je razvoju integriranega BIM-projekta. Ta učni model omogoča študentom, da razvijejo svoje sposobnosti povezovanja znanj in iskanja praktičnih rešitev, ki se uporabljajo v študijah realnih primerov. Metoda poučevanja je sestavljena iz razvoja raziskav in praktičnega dela pod vodstvom predavateljev skozi realizacijo integriranega projekta. Študenti razvijajo individualno in skupinsko delo skozi razvoj izvedbenih BIM-načrtov, BIM-modelov in uvajanje ustreznih rab BIM. Posebna pozornost je namenjena povezovanju in koordiniranju.	The unit is based on a specific learning model, i.e. the development of an integrated BIM project. This learning model allows students to develop their capacity to interrelate knowledge and seek for practical solutions applied in real case studies. The teaching method covers the development of research and practical work, under the guidance of the lecturers, by implementing an integrated project. The students develop individual and group work skills through the development of BIM execution plans, BIM models and deployment of corresponding BIM uses. Particular focus is given to integration and coordination.

Načini ocenjevanja:	Delež/Weight	Assessment:
Sprotno delo pri predmetu	70,00 %	Course work
Izpit	30,00 %	Exam

Reference nosilca/Lecturer's references:

BOSILJKOV, Vlatko, D`AYALA, Dina, NOVELLI, Viviana. 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, 2015, letn. 13, št. 1, str. 311-329, ilustr., doi: 10.1007/s10518-014-9652-7.

CATTARI, Serena, LAGOMARSINO, Sergio, BOSILJKOV, Vlatko, D`AYALA, Dina. Sensitivity analysis for setting up the investigation protocol and defining proper confidence factors for masonry buildings. Bulletin of earthquake engineering, ISSN 1570-761X, 2015, letn. 13, 1, str. 129-151, ilustr., doi: 10.1007/s10518-014-9648-3.

KOŠIR, Mitja, IGLIČ, Nataša, KUNIČ, Roman. Optimisation of heating, cooling and lighting energy performance of modular buildings in respect to locations climatic specifics. Renewable energy, ISSN 0960-1481. [Print ed.], 2018, letn. 129, dec., str. 527-539, ilustr., doi: 10.1016/j.renene.2018.06.026.

PAJEK, Luka, HUDOBIVNIK, Blaž, KUNIČ, Roman, KOŠIR, Mitja. Improving thermal response of lightweight timber building envelopes during cooling season in three European locations. Journal of cleaner production. [Print ed.]. jul. 2017, letn. 156, str. 939-952, ISSN 0959-6526. DOI: 10.1016/j.jclepro.2017.04.098.

TÖRÖK, Teja, KOŠIR, Mitja, DOVJAK, Mateja. Celovito ocenjevanje trajnostnih vidikov gradnje na primeru enodružinske hiše = Holistic assessment of sustainability aspects on a case of single family detached house. Gradbeni vestnik: glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2016, letn. 65, str. 234-252, ISSN 0017-2774.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MAGISTRSKO DELO**
Course title:	**DISSERTATION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Informacijsko modeliranje zgradb - BIM A+ (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1792

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	0	0	0	450	450	30

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	Obvezni strokovni/Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljeni vsi izpiti 2. letnika BIM A+	Passed all exams from the 2nd year of BIM A+

Vsebina:	Content (Syllabus outline):
Učni načrt magistrskega dela je specifičen za vsakega študenta, odvisno od izbrane teme. To je raziskovalno delo in vključuje razvoj pisnega izdelka, ki opiše opravljene raziskave. Delo temelji predvsem na izbranem integriranem projektu, ki je nadziran in zajema metodologijo informacijskega modeliranje zgradb (BIM). Skupinsko delo obsega več BIM interesnih skupin, projektih stopenj in uporab BIM.	The syllabus of the dissertation is specific to each student, depending on the assigned topic. This is a research work and involves the development of written synthesis of the research. The workis based mainly on the integrated project selected and supervised and encompasses the methodology of Building Information Modelling. The work, made in groups, should encompass several BIM stakeholders, project stages, and BIM uses.

Temeljna literatura in viri/Readings:

The search for information sources and relevant literature for the development of the dissertation should be carried out by the student under the supervision of his supervisor.

Cilji in kompetence:	**Objectives and competences:**
Namen je, da študenti nadgrajujejo iskanje informacij o konceptih, modelih in metodo raziskovalnega dela z namenom razvoja in predstavitve izvirnega magistrskega dela. Raziskava temelji na izvajanju nalog, ki podpirajo razvoj dela in izdelavo pisnega zaključnega dela in njegove javne razprave. Konsolidacija pridobljenega znanja v zadnjih enotah programa. Integriran projekt, katerega cilj je popolna študija integriranega BIM-primera. Predvideno je, da študenti razvijajo svoje sposobnosti integracije znanj, obvladovanja kompleksnih vprašanj, sposobnost razumevanja in reševanja problemov v novih situacij in multidisciplinarnih okoljih, razvoja rešitev in razmisleka o temi raziskave.	This unit purpose is that students develop the search for information on concepts, models and instruments relative to the planing of the research work, in order to develop and present an original dissertation work. Consolidation of the acquired knowledge during the past UCs of the course. Integrated project aiming at a full BIM-integrated case study. The research is based on the implementation of the proposed tasks, supporting the development of work leading to the written document and its public discussion. In this context, it is intended that students develop their ability to integrate knowledge, handle complex questions, as well as their ability to understand and solve problems in new situations and multidisciplinary contexts, developing solutions and reflections on the subject under study.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Plan, razvoj in predstavitev magistrskega dela.	To plan, to evelop and to present the dissertation work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predmet temelji na posebnem modelu učenja, kjer posameznik opravlja raziskovalno delo, ki ga koordinira mentor, ki spodbuja raziskav in razvoja na določeno vsebino magistrskega dela. Ta učni model omogoča študentom, da razvijejo svoje sposobnosti povezovanja znanj, obvladovanja kompleksnih vprašanj, iskanja rešitev in sprejemanja ocen v razmerah z omejenimi ali nepopolnimi informacijami. Na koncu mora študent dokazati svojo sposobnost komuniciranja svojih zaključkov in znanja na jasen in nedvoumen način. Metoda poučevanja je sestavljena iz razvoja raziskav in praktičnega dela pod vodstvom predavateljev skozi realizacijo integriranega projekta. Študenti razvijajo individualno in skupinsko delo skozi razvoj izvedbenih BIM-načrtov, BIM-modelov in uvajanje	The unit is based in a specific learning model, where an individual research work, coordinated by the supervisor, is developed in order to encourage research and development on specific content of the thesis. This learning model allows students to develop their capacity to integrate knowledge, handle complex issues, develop solutions and make judgments in situations of limited or incomplete information. At the end, the student should demonstrate the ability to communicate his conclusions and knowledge in a clear and unambiguous way. The teaching method consists of the development of research and practical work, under the guidance of the lecturers, by implementing an integrated project. The students develop individual and group

ustreznih rab BIM. Posebna pozornost je namenjena povezovanju in koordiniranju. Metoda poučevanja je sestavljena iz razvoja individualnega raziskovalnega dela pod vodstvom mentorja, kjer so raziskane določene vsebine magistrskega dela. Oceno dela sestavi komisija, ki delo pregleda, pri čemer se upošteva dejanska kakovost pisnega izdelka, ki odraža opravljeno raziskovalno delo. Upošteva se tudi javni zagovor dela razdeljen na ustno predstavitev magistrskega dela in njegovo poznejšo razpravo.	work skills through the development of BIM execution plans, BIM models and deployment of corresponding BIM uses. Particular focus is given to integration and coordination. The teaching method consists in the development of individual research work, under the guidance of the supervisor, where the specific contents of the dissertation are researched. The evaluation of the dissertation consists on its examination by the thesis committee, taking into account the intrinsic quality of the written document that reflects the research work done. It is also considered the public discussion divided between the oral presentation of the work and the subsequent discussion period.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Ocena magistrskega dela	60,00 %	The score of the dissertation
Javen zagovor in razprava	40,00 %	Public presentation and discussion

Reference nosilca/Lecturer's references:

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MATEMATIKA 3**
Course title:	**MATHEMATICS 3**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1617

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Gašper Jaklič
Vrsta predmeta/Course type:	obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. primerljive vsebine matematike v obsegu najmanj 15 KT.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content with min. 15 ECTS.

Vsebina:	Content (Syllabus outline):
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.	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

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

Temeljna 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	- Formulation of practical problems in mathematical language - Identification of the appropriate mathematical model - Basic theoretical knowledge for using in practical problems

- Sposobnost kritične presoje rezultatov - Poznavanje računalniških orodij (Mathematica, Matlab) - Dosežena matematična podlaga za strokovne predmete	- 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/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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:	**METODE KONČNIH ELEMENTOV V GRADBENIŠTVU**
Course title:	**FINITE ELEMENT METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1453

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Boštjan Brank
Vrsta predmeta/Course type:	obvezni strokovni/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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,	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,

- FEM analize, - Kritična ocena rezultatov.	- Critical evaluation of numerical results.

Temeljna 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/Weight	Assessment:
Računski del izpita: modeliranje in analiza problema z računalnikom	50,00 %	FEM modelling, analysis and evaluating of results of a civil engineering problem
Teoretični del izpita	50,00 %	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:	**GEOTEHNIKA NIZKIH GRADENJ**
Course title:	**GEOTECHNICS OF INFRASTRUCTURAL FACILITIES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1619

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	30	45	0	0	120	8

Nosilec predmeta/Lecturer:	Janko Logar
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika	Passed exams in Soil Mechanics and Engineering Geology and Geotechnics.

Vsebina:	Content (Syllabus outline):
Predavanja Metode izboljšanja tal (preobremenitev, radialna konsolidacija, dinamična komprimacija, gruščnati koli, injektiranje, jet grouting, metode površinskega in globinskega mešanja z anorganskimi in organskimi vezivi); strujanje podzemne vode skozi zasičena izotropna in anizotropna tla, vzgon, kritični hidravlični gradient, hidravlične porušitve (hidravlični lom tal, notranja erozija, piping); zemeljske pregrade: strujanje vode skozi pregrado, ukrepi za zmanjšanje neugodnih posledic, načrtovanje filtrov, stabilnost zemeljskih pregrad v statičnih pogojih in v	Lectures Methods of soil improvement (pre-loading, radial consolidation, dynamic compaction, stone columns, grouting, jet grouting, methods of surface and deep mixing with inorganic and organic binders); groundwater flow through saturated isotropic and anisotropic soil, buoyancy, critical hydraulic gradient, hydraulic fracture (hydraulic failure, internal erosion, piping); earth dams: flow of water through dam, measures to reduce the adverse consequences, filter design, stability of earth dams under static and dynamic (seismic) conditions; liquefaction of soil;

slučaju potresne obtežbe; likvifakcija tal; raba geosintetikov za tesnjenje, filtriranje, ločevanje in armiranje; analiza in upravljanje z geotehnično pogojenimi tveganji. osnove mehanike kamnin (klasifikacije kamnin, mehanske lastnosti kamnin, Hoekov in Brownov porušni kriterij, analiza stabilnosti blokov in klinov, Schmidtova projekcija, Marklandov test, analitične in numerične metode). Osnove načrtovanja in gradnje predorov (tehnologije gradnje, mehanizacija, podporni ukrepi, primarna in sekundarna napetostna stanja, principi in metode za projektiranje, geotehnični monitoring) osnove numerične geotehnike (nelinearni elastoplastični modeli za zemljine, principi nelinearnih numeričnih analiz. Vaje Račun učinka izboljšave tal z vertikalnimi drenažami, gruščnatimi koli, preobtežbo (peš in z uporabo računalniških orodij); analiza strujanja vode skozi in pod zemeljsko pregrado; stabilnostna analiza prečnega prereza zemeljske pregrade v statičnih pogojih in pogojih delovanja seizmičnih vplivov; analiza likvifakcije tal na osnovi rezultatov terenskih in laboratorijskih preiskav tal; dimenzioniranje mineralnih filtrov v pregradi; dimenzioniranje in izbira geosintetikov za namen ločevanja, filtracije, tesnjenja; analiza in načrt armirane brežine; izdelava kataloga tveganj in analize tveganja za izbran geotehnični projekt. Klasifikacija kamnin in ocena mehanskih parametrov s pomočjo Hoekovega in Brownovega porušnega kriterija. Strukturna analiza stabilnosti kamninskih blokov in klinov. Načrt podpiranja prečnega prereza predora. Numerična analiza predora in izbranega zemeljskega objekta (nasip, podporna konstrukcija, vkop z oporno konstrukcijo …).	use of geosynthetics: sealing, filtration, separation and reinforcement; analysis and management of geotechnical risks. Fundamentals of rock mechanics (classification of rock, mechanical properties of rock, Hoek&Brown failure criterion, structurally controlled instability of blocks and wedges, Schmidt's projection, Markland test, analytical and numerical methods). Basics of design and construction of tunnels (technology, machinery, support measures, primary and secondary stress states, principles and methods for the design, geotechnical monitoring). Fundamentals of numerical methods in geotechnics (nonlinear elasto-plastic models for soils, principles of non-linear numerical analysis). Tutorials Ground improvement with vertical drains, stone columns, pre-loading (analytical methods and by using computer tools); analysis of the groundwater flow through dam and subsoil; stability analysis of earth dam under static and seismic conditions, seismic impact; analysis of soil liquefaction based on the results of field and laboratory tests of soils; sizing of mineral filters in earth dam; the design and choice of geosynthetics for separation, filtration and sealing; analysis and design of reinforced earth; risk analysis for a selected geotechnical project. Classification of rocks and evaluation of mechanical parameters using Hoek&Brown's failure criteria. Structural analysis of the stability of rock blocks and wedges. Design of tunnel cross section. Numerical analysis of a tunnel and selected earth structure (embankment, retaining structure, earth-cut with retaining structure, ...)

Temeljna literatura in viri/Readings:

SIST EN1997-1:2005 Evrokod 7-1: Geotehnično projektiranje - 1. del Splošna pravila.

SIST EN1997-2:2007 Evrokod 7-2: Geotehnično projektiranje - 2. del Preiskovanje in preskušanje tal.

Vaníček I, Vaníček M. 2008. Earth Structures in Transport, Water and Environmental Engineering, Springer, 637 str.

Moseley, M.P., Kirsch, K. 2006. Ground improvement, Taylor & Francis, London, 432 p.

Recommendations for Design and Analysis of Earth Structures using Geosynthetic Reinforcement

EBGEO, Ernst & Sohn, DGGT, 2011.

Nonveiller, E. 1983. Nasute brane, projektiranje i građenje, Školska knjiga Zagreb.

Clayton, C.R.I. 2001. Managing geotechnical risk, Thomas Thelford.

Chapman, D., Metje, N., Stärk, A. (2010). Introduction to tunnel construction, Spon press.

Hoek, E.: (2007) Practical Rock Engineering, dosegljivo na http://www.rocscience.com/hoek/corner/Practical_Rock_Engineering.pdf

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
- Spoznati metode izboljšanja tal, njihove dobre strani in omejitve v posameznih pogojih tal in predvidene vrste gradnje	- To learn about methods of soil-improvement, their benefits and restrictions based on specific ground conditions and type of construction
- Spoznati zakonitosti strujanja podzemne vode in precejanje skozi zemeljske pregrade ter potencialne probleme, ki iz tega izhajajo ter možne rešitve	- To learn about groundwater flow and percolation through earth dams (structures) and potential problems and possible solutions
- Seznaniti študenta z vplivi potresa na tla in geotehnične objekte (vpliv na stabilnost in likvifakcijo)	- To acquaint student with the effects of earthquakes on the ground and geotechnical facilities (impact on stability and liquefaction)
- Predstaviti možnost uporabe geosintetičnih materialov v geotehničnem inženirstvu	- To present the possibility of using geosynthetic materials in geotechnical engineering
- Predstaviti geotehnično pogojena tveganja in preproste možnosti analize in upravljanja s tveganji	- To present the geotechnical risks and to perform simple risk management analysis.
- Spoznati se z osnovami mehanike kamnin	- To learn about the basics of rock mechanics
- Spoznati osnovne principe načrtovanja in gradnje predorov	- To recognize basic principles of planning and tunnel construction
- Usposobiti študenta za osnovno razumevanje in uporabo nelinearnih numeričnih orodij za geotehnične analize	- To provide basic understanding and use of nonlinear numerical tools for geotechnical analysis

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent pozna metode izboljšanja tal in se zna odločiti katera je primerna v določenih pogojih	- Student knows the methods of soil improvement and is able to decide which is suitable under certain conditions
- Razume in pozna metode za račun stacionarnega toka vode skozi zasičena izotropna in anizotropna tla ter skozi zemeljske pregrade	- Student understands and knows methods for stationary flow of water through saturated isotropic and anisotropic soil and through earth dams
- Zna analizirati vpliv strujanja vode glede na možnost pojava hidravličnega lom tal in notranje erozije	- Ability to analyze the impact of groundwater flow depending on the optional occurrence of hydraulic failure and internal erosion
- Razume vpliv potresne obtežbe na zemeljske pregrade in zna vpliv upoštevati v analizi stabilnosti	- Understanding of the impact of seismic actions on earth dams and how to take them into account (stability analysis)
- Razume pojav likvifakcije tal in ga zna ovrednotiti	- Understanding of the phenomena of liquefaction of soil and how to evaluate the associated risk
- Pozna možnosti uporabe geosintetikov glede filtracije, separacije, tesnenja in armiranja	

- Razume geotehnično pogojena tveganja in jih zna analizirati. - Pozna klasifikacijske sisteme kamnin (RQD, RMR, GSI, Q) - Zna analizirati stabilnost blokov in klinov kamnine z uporabo ustreznih orodij - Razume osnovne principe načrtovanja in gradnje predorov - Študent je sposoben preprostih numeričnih geotehničnih analiz z uporabo nelinearnih numeričnih modelov	- Knowledge of geosynthetics with respect to filtration, separation, sealing and reinforcement - Understanding of geotechnical risks and how to analyze them. - Knowledge about rock classification systems (RQD, RMR, GSI, Q) - Ability to analyze the stability of rock blocks and wedges with using appropriate tools - Understanding of basic design principles and construction techniques of tunnels - Student is capable of performing basic numerical geotechnical analysis using non- linear numerical models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, vaje v računalniški učilnici, samostojno delo.	Lectures, tutorials, exercises in the computer lab, individual work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računski izpit ali 2 kolokvija	50,00 %	Written exam or 2 midterm tests
Samostojno delo	15,00 %	Individual work (Seminar)
Teoretični izpit	35,00 %	Theoretical exam

Reference nosilca/Lecturer's references:

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.

ŠTRUKELJ, Andrej, ŠKRABL, Stanislav, ŠTERN, Ksenija, LOGAR, Janko. The assesment of pile shaft resistance based on axial strain measurements during the loading test. Acta geotechnica Slovenica, ISSN 1854-0171, 2005, letn. 2, št. 2, str. 12-23.

LOGAR, Janko, FIFER BIZJAK, Karmen, KOČEVAR, Marko, MIKOŠ, Matjaž, RIBIČIČ, Mihael, MAJES, Bojan. History and present state of the Slano Blato landslide. Natural hazards and earth system sciences, ISSN 1561-8633, 2005, 5, str. [447]-457.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**ZAGOTAVLJANJE IN KONTROLA KAKOVOSTI**
Course title:	**QUALITY CONTROL AND QUALITY ASSURANCE**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1455

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Zgodovinski pregled na področju vodenja kakovosti, temeljni pojmi (kontrola, zagotavljanje, vodenje kakovosti), vidiki kakovosti, pomen kakovosti gradbenega objekta. Relevantna zakonodaja in standardizacija (pomen, uporabnost standardov, priprava in izdajanje standardov). Statistična kontrola procesov v serijski proizvodnji gradbenih proizvodov. Potrjevanje skladnosti gradbenih proizvodov (pregled gradbenih proizvodov, spremljajoča harmonizirana evropska zakonodaja, standardi za gradbene proizvode, sistemi potrjevanja skladnosti). Povezava kakovosti in poslovne	Lectures Historical overview of quality management development , fundamental terms (control, assurance, management of quality, aspects of quality, importance of quality of a structure). Relevant legislature and standardisation (importance and relevance, application of standards, preparation of standards). Statistical process control in serial production of construction products. Conformity assessment for construction products (overview of construction products, accompanying legislature, standards for construction products, conformity assessment systems). Relationship between quality

uspešnosti gradbenega podjetja, stroški kakovosti. Zagotavljanje kakovosti v vseh fazah gradbenega projekta (s posebnim poudarkom na kakovosti projektiranja), vodenje kakovosti v gradbenem projektu. Integrirani sistemi vodenja kakovosti v organizacijah (sistemi vodenja kakovosti, sistemi ravnanja z okoljem, sistemi za zdravje in varstvo pri delu). Kvalitativne metode zagotavljanja kakovosti. Študijski obisk slovenskih institucij, ki delujejo na področju zagotavljanja kakovosti v gradbeništvu.	and business success, costs of quality. Quality assurance in all stages of construction project (with special emphasis to quality of design), quality management in construction project. Integrated management systems (QMS, EMS, OHSAS). Qualitative methods for quality assurance. Site visits (to Slovenian institutions working in the field of quality assurance in civil engineering).

Temeljna literatura in viri/Readings:

- Šelih, J., 2015. Zagotavljanje in kontrola kakovosti, Učno gradivo, FGG.
- Howarth, T., Greenwood, D., 2018. Construction quality management: principles and practice, Second edition. ed. Routledge Taylor & Francis Group, London New York.
- Rumane, A.R., 2018. Quality Management in Construction Projects, Second Edition. Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742.
- Marsden,P.,2019.DigitalQualityManagementin Construction, 1st ed. Routledge. https://doi.org/10.1201/9780429423062
- ASCE, 2012. Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors, Third Edition. ed. American Society of Civil Engineers, Reston, VA. https://doi.org/10.1061/9780784411896

Cilji in kompetence:	**Objectives and competences:**
Cilji - Podati osnove vodenja kakovosti ter njihovo aplikacijo v gradbeništvu - Podati sistematiziran pregled ukrepov in metod za vodenje kakovosti v gradbenem projektu. Pridobljene kompetence - Razumevanje pomena kakovosti gradbenega objekta v vseh fazah njegovega življenjskega cikla - Sposobnost izdelave plana kakovosti za vse faze gradbenega projekta.	Objectives - To provide fundamentals of quality management and their application in construction - To give systematic overview of actions and methods for quality management in construction project. Acquired competences - Understanding of the importance of quality of a structure in all life cycle stages - To be able to prepare quality plans for all stages of the construction project.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno temeljno znanje o pomenu kakovosti gradbenega objekta - Razumevanje povezanosti med doseženim nivojem kakovosti gradbenega objekta in fazami ter dejavnostmi gradbenega projekta	- Acquirement of fundamental knowledge related to the importance of structure-s quality - Understanding how the achieved level of quality of the structure and phases and activities of the construction project are connected

- Osvojene računske spretnosti za načrtovanje statistične kontrole procesov - Razumevanje nekvantitativnih metod za zagotavljanje kakovosti - Sposobnost abstraktne formulacije vodstvenih procesov v organizaciji - Sposobnost kritične presoje podatkov, pridobljenih v procesih kakovosti, pri načrtovanju sistemov kakovosti.	- Acquired skills for planning of statistical process control - Understanding of descriptive methods for quality assessment - Ability of abstract formulation of management processes within an enterprise - Ability of critical assessment of data acquired in quality management processes, and their use in planning of QMS.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, oboje z uporabo IKT.	Lectures, seminar tutorial, supported by ICT tools.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Written exam
Samostojna naloga	50,00 %	Individual work

Reference nosilca/Lecturer's references:

KOUTAMANIS, Alexander, DAINTY, Andrew, KVAN, Thomas, TURK, Žiga. The enigma of BIM. Architecture, Structures and Construction. 2021, letn. nov., [9] str., ilustr. ISSN 2730-9894. https://link.springer.com/article/10.1007/s44150-021-00017-6, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=136007, DOI: 10.1007/s44150-021-00017-6. [COBISS.SI-ID 103345411]

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

TURK, Žiga. Kakovost in odličnost metoda, ne cilj. V: ČUK, Jožko (ur.). Dvajset let kakovosti in odličnosti : [knjiga izdana ob dvajsetem jubileju Slovenskega združenja za kakovost in odličnost]. Ljubljana: Slovensko združenje za kakovost, 2011. Str. 80-85. ISBN 978-961-92534-5-8. [COBISS.SI-ID 8132449]

TURK, Žiga, FISCHINGER, Matej. Learning engineering from breakdown cases. V: IABSE symposium Rio de Janeiro 1999 : [Brazil, August 25-27] : structures for the future - the search for quality : report = rapport = Bericht. Rio de Janeiro: IABSE, 1999. IABSE reports, vol. 83. ISBN 3-85748-100-6. [COBISS.SI-ID 1268833]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**OPERATIVNO PLANIRANJE IN SPREMLJANJE PROJEKTOV**
Course title:	**OPERATIVE PLANNING AND MONITORING OF PROJECTS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1456

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	15	0	75	5

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja: Operativno planiranje kot element vodenja projektov. Tehnika mrežnega planiranja in metoda kritične poti. Viri za izvedbo gradbenega projekta in njihova vključitev v projektni model. Optimizacija terminskega plana z vidika virov. Stroški gradbenih projektov in optimizacija terminskega plana z vidika stroškov. Elementi spremljave poteka izvedbe gradbenega projekta. Analiza zamud in porazdelitev odgovornosti. Tehnika planiranja lokacijskih planov (linearni plani in ciklogrami). Modeliranje projektnih tveganj v operativnih planih (stohastično planiranje).	Lectures: Operational planning as element of project management. Critical path methods. Resources required for the construction project execution, inclusion of resources into project model. Optimisation of schedule, from the viewpoint of resources. Costs of construction projects, optimisation of schedule for the viewpoint of costs. Elements of monitoring the execution. Delay analysis, allocation of responsibility. Techniques for planning the location plans (linear plans,

Labaratorijske vaje: uporaba različnih programskih orodij za operativno planiranje gradbenih projektov	cyclograms). Modelling project risks in operational plans (stochastic planning). Tutorial: Use of various computer-supported tools for operational planning of construction projects.

Temeljna literatura in viri/Readings:

Rodošek E. 1985. Operativno planiranje, učbenik. Ljubljana.

Hegazy, Tarek. 2002. Computer-based construction project management.

Griffis, Fletcher Hughes. 2000. Construction planning for engineers.

Project Management for Construction. Dostopno na: http://www.ce.cmu.edu/pmbook/index.html .

Cilji in kompetence:	**Objectives and competences:**
Cilji - Nadgraditi splošno znanje vodenja projektov z metodami in tehnikami operativnega planiranja - Podati ključne elemente terminskega plana in spremljajočih planov - Podati definicije optimalnosti operativnega plana - Podati poglobljeno znanje o tehnikah optimizacije operativnega plana - Podati elemente spremljave in analize plana ter ukrepanja pri odstopanjih. Pridobljene kompetence - Sposobnost izdelave detaljnega modela projekta - Razumevanje povezave med stroški, časom in kakovostjo kot ključnih parametrov operativnega plana - Sposobnost variantne obdelave modela in izdelave operativnega plana - Sposobnost uporabe računalniških orodij za različne tehnike operativnega planiranja.	Objectives - To upgrade the general knowledge of project management with methods and techniques of operational planning - To provide key elements of schedule and accompanying plans - To provide the definition of optimal operational plan - To give in-depth knowledge on operational plan optimisation techniques - To present elements of monitoring and analysis of plan, and actions related to identified deviations. Acquired competences - Ability to prepare detailed project model - Understanding the relationship among costs, time and quality, as key parameters of the operational plan - Ability to study alternatives for the model and for the operational plan - Ability to use computer supported tools for different operational planning techniques.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno znanje o modeliranju projektov (deterministični in stohastični modeli) - Razumevanje prednosti in smiselnosti uporabe posameznih metod terminskega planiranja	- Acquired knowledge on modelling of projects (deterministic and stochastic models) - Understanding advantages and suitability of use of individual scheduling methods

- Osvojeno znanje uporabe računalniške podpore za operativno planiranje - Dobro razumevanje metod in tehnik izdelave operativnih planov izvedbe gradbenih objektov ter kriterijev in meril za njihovo optimalnost - Sposobnost modeliranja poslovnih procesov - Sposobnost analitične obravnave problema in sintezne obdelave rešitev - Sposobnost uporabe računalniškega programa za simulacijo.	- Acquired knowledge in the field of computer-supported operational planning - Thorough understanding of methods and techniques for the preparation of operational plans in construction, and related criteria and measures for their optimality - Ability to model business processes - Ability to tackle the problem analytically, and to synthesize the solutions - Ability to use Appropriate software for simulation.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in seminarske vaje z uporabo IKT (potekajo vzporedno preko celega semestra).	Lectures and seminar tutorial by using ICT tools (running parallel to the lectures, during the whole semester).

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Written exam
Samostojna naloga z računskim primerom in njen zagovor	50,00 %	Individual work (with case study) and its defence

Reference nosilca/Lecturer's references:

KLINC, Robert, GABRŠČEK, Dani, ČESNIK, Jure, ŽIBERT, Marko, HOSTNIK, Martin, LOGAR, Janko. Development of a semiautomatic parametric method for creation of an I-BIM model of a tunnel for use in FEM software. Journal of advanced transportation. [Online ed.]. mar. 2021, vol. 2021, str. 1-18, ilustr. ISSN 2042-3195. https://www.hindawi.com/journals/jat/2021/8843277/, DOI: 10.1155/2021/8843277. [COBISS.SI-ID 55664131]

BIZJAK, Igor, KLINC, Robert, TURK, Žiga. A framework for open and participatory designing of built environments. Computers, Environment and Urban Systems. [Print ed.]. November 2017, vol. 66, str. 65-82. ISSN 0198-9715. DOI: 10.1016/j.compenvurbsys.2017.08.002. [COBISS.SI-ID 2839491]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**GOSPODARJENJE Z NEPREMIČNINAMI**
Course title:	**REAL ESTATE MANAGEMENT**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1457

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	30	0	0	75	5

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač, Daniel Kozelj
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional
Jeziki/Languages:	Predavanja/Lectures: Slovenščina Vaje/Tutorial: Slovenščina

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

Vsebina:	Content (Syllabus outline):
Predavanja Temeljni pojmi s področja ekonomike nepremičnin; življenjski cikel nepremičnine od investicije do rabe nepremičnine; urbana ekonomika in analiza trga nepremičnin; razvojni potencial zemljišč; investiranje v nepremičnine, vloga in pojmovna opredelitev posameznih vrst investicij, metode vrednotenja investicijskih projektov na mikro- in makroekonomski ravni; pomen, pravne podlage in metode za vrednotenje upravičenosti in učinkovitosti investicij javnega sektorja; obdavčenje nepremičnin; posredovanje v prometu z nepremičninami, pravni in stroškovni vidiki	Lectures Basic concepts related to real estate economics, real estate life cycle(from real estate development to real estate reuse); urban economics and real estate market analysis; land development potential; investing in real estate, role and conceptual definition of certain types of investments, methods of evaluating investment projects at micro- and macro-economic levels; legal basis and evaluation methods to measure efficiency of public investment; taxation of real estate; real estate brokers' activities, legal and cost aspects of real estate brokers' activities; property as factor of production facility

posredovanja v prometu z nepremičninami; nepremičnine kot faktor produkcije, »facility management«; trg in tržno vrednotenje nepremičnin; osnove posamičnega in množičnega tržnega vrednotenja nepremičnin. Vaje Seminarske vaje (računske vaje).	management; real estate market and real estate valuation; basics of individual and mass real estate valuation. Tutorial Calculation exercises.

Temeljna literatura in viri/Readings:

Šubic Kovač, M. 2013. Gospodarjenje z nepremičninami, študijsko gradivo, Ljubljana, UL FGG, 186 strani.

Bajt, A., Štiblar F. 2002. Ekonomija, Ekonomska analiza in politika, GV založba, Ljubljana, str.103- 148.

Geltner, M.D., Miller, N.G. 2010. Commercial Real Estate Analysis and Investment, South Western Thomson Learning, 898 strani, izbrana poglavja.

Aktualni predpisi: http://www.gov.si .

Cilji in kompetence:	**Objectives and competences:**
Študent se pri tem predmetu seznani: - Z znanji s področja ekonomike nepremičnin in projektnega managementa, - Z vrednotenjem investicijskih projektov na mikro in makro ravni, - S "facility management", - S terminologijo in postopki vrednotenja nepremičnin. Po opravljenem izpitu študent pridobi naslednje predmetno specifične kompetence: - Pozna in razume vsebine s področja ekonomike nepremičnin, - Pozna, razume, zna načrtovati in uporabljati različne postopke, ki so potrebni za vrednotenje razvojnega potenciala zemljišč v prostorskem planiranju, vrednotenje investicijskih projektov na mikro in makro ravni, za posredovanje v prometu z nepremičninami - Pozna in razume izrazoslovje ter proces posamičnega in množičnega vrednotenja nepremičnin.	Objectives - To get students familiar with real estate economics and project management - To get students familiar with the evaluation of investment projects at micro and macro levels - To get students familiar with facility management - To familiarise student with terminology and with the process of individual/mass real estate valuation. Competences - To know and understand the contents in the field of real estate economics - To know and understand (as well as to know how to design and use) various procedures, needed for the valuation of land development potential, evaluation of investment projects at micro and macro levels for the purpose of real estate brokerage - To know and understand the terminology and the process of individual/mass real estate valuation.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Študent spozna bistvene karakteristike s področja ekonomike nepremičnin od faze prostorskega načrtovanja do obratovanja nepremičnin. - Študent pridobljena znanja uporabi pri izdelavi prostorskih aktov, odločitvah o investicijah, vrednotenju in trženju nepremičnin. - Študent na podlagi sinteze znanj s področja prava, ekonomike, prostorskega planiranja in gradnje inženirskih objektov (tehnični in organizacijski vidik) kritično presoja investicijske odločitve v praksi. - Uporaba domače in tuje strokovne literature s področja gospodarjenja z nepremičninami in uporaba ustrezne računalniške opreme.	- Student is familiar with basic characteristics in the field of real estate economics from the spatial planning phase to the final phase – operation of the real estate. - Acquired knowledge can be used when making spatial planning documents, when deciding on investment, real estate valuation and real estate marketing. - Synthesis of knowledge in the field of property law, geodesy, spatial planning and civil engineering (technical and organizational aspect) allows student to critically consider investment decisions in practice. - Use of national and international professional literature in the field of real estate management and appropriate computer software.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje z uporabo IKT.	Lectures and tutorial are presented using visual aids.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
izpit teoretičen del	50,00 %	Theoretical part
izpit računski del Vsak del mora biti ocenjen pozitivno.	50,00 %	Calculation exercises. Each part of the exam must be graded positively.

Reference nosilca/Lecturer's references:

GOLUŽA, Maruša, ŠUBIC KOVAČ, Maruška, KOS, Drago, BOLE, David. How the state legitimizes national development projects : the third development axis case study, Slovenia. *Acta geographica Slovenica*, ISSN 1581-6613. [Tiskana izd.], 2021, 61, št. 2, str. 109-121, ilustr., zvd., tabele. https://ojs.zrc-sazu.si/ags/article/view/9572/9625, doi: 10.3986/AGS.9572.

ŠUBIC KOVAČ, Maruška. A causal analysis between construction, real estate, and economic growth : a case study of Slovenia. V: ABDULAI, Raymond Talinbe (ur.). *Real estate, construction and economic development in emerging market economies*, (Routledge studies in international real estate). 1st ed. London; New York: Routledge. 2016, str. 64-87, ilustr.

KAFOL STOJANOVIĆ, Ajda, KOZELJ, Daniel, ŠUBIC KOVAČ, Maruška. Assessment of water distribution system capacity as settlement-development decision-making expert basis at the local level = Ocena zmogljivosti vodovodnega sistema kot strokovna podlaga za odločanje o usmerjanju razvoja naselij na lokalni ravni. Geodetski vestnik : glasilo Zveze geodetov Slovenije, ISSN 0351-0271. [Tiskana izd.], 2020, letn. 64, št. 3, str. 389-401, ilustr., doi: 10.15292/geodetski-vestnik.2020.03.389-401.

BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, Sep. 2019, vol. 27, iss. 3, str. 759-781, ilustr.

ZEVNIK, Jure, KRAMAR FIJAVŽ, Marjeta, KOZELJ, Daniel. Generalized normalized cut and spanning trees for water distribution network partitioning. Journal of water resources planning and management, ISSN 0733-

9496. [Print ed.], 2019, letn. 145, št. 10, str. 1-12, ilustr., doi: 10.1061/(ASCE)WR.1943-5452.0001100. [COBISS.SI-ID 8860001].

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKTIRANJE GRADBENIH KONSTRUKCIJ**
Course title:	**DESIGN OF BUILDING STRUCTURES**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1458

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Drago Saje
Vrsta predmeta/Course type:	obvezni strokovni/obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Postopek projektiranja gradbenih konstrukcij. Posebnosti obnašanja lesenih, betonskih in zidanih konstrukcij. Principi smotrne izbire konstrukcijskega sistema v odvisnosti od izbranega materiala. Projektna obtežba. Osnove projektiranje lesenih konstrukcij (mehanske in reološke lastnosti materiala, dimenzioniranje linijskih lesenih elementov, temeljna pravila izvedbe priključkov lesenih konstrukcij). Osnove projektiranja betonskih konstrukcij (dimenzioniranje in konstrukcijska izvedba linijskih konstrukcij, plošč in sten ter temeljev). Definicija masivnih betonov, problemi	Lectures Design procedure for building structures; specifics of the behaviour of timber, concrete and masonry structures; principles for sensible selection of a structural system in dependence of the selected material; design load; basics for the design of timber structures (mechanical and rheological properties of material, design of planar timber elements, basic rules for the execution of joints of timber structures); basics for the design of concrete structures (design and structural execution of planar structures, slabs and walls as well as foundations), Definition of mass concrete, problems related to

povezani z masivnimi betoni. Osnove analize vplivov materialnih lastnosti in vplivov okolice na razmere v masivnem betonu. Osnovni ukrepi za kvalitetno izgradnjo konstrukcij iz masivnega betona. Vaje: Seminarske vaje (računski primeri).	mass concrete; basics for the analysis of the influences of material properties and the impact of the environment on the conditions in mass concrete; basic measures for quality construction of mass concrete structures. Tutorials: Seminar tutorials (computational examples).

Temeljna literatura in viri/Readings:

H. Nilson, D. Darwin, C.W. Dolan. 2003. Design of Concrete Structures-thirteenth edition. McGraw-Hill, strani 321-374, 412-479, 545-574, 599-633.

W.G. Curtin, G. Shaw, J.K. Beck, W.A. Bray. 2006. Structural Masonry Designers Manual-third edition. , Blackwell Science, strani 1-72S.

Thelanderson, H.J. Larsen (urednika). 2003. Timber Engineering. John Wiley & Sons, strani 1-11, 131-168, 221-240.

Ustrezni deli standardov za gradbene konstrukcije Evrokod 0, Evrokod 1, Evrokod 2, Evrokod 5, Evrokod 6, Evrokod 8 (SIST EN 1990, SIST EN 1991-1, SIST EN 1991-1-3, SIST EN 1991-1-4, SIST EN 1992-1-1, SIST EN 1995-1-1, SIST EN1996-1-1, SIST EN 1998-1).

Beg D., Pogačnik A. (urednika). Priročnik za projektiranje gradbenih konstrukcij po Evrokod standardih, Inženirska zbornica Slovenije, 2009

Spletno mesto Katedre za masivne in lesene konstrukcije: http://www.fgg.uni-lj.si/kmlk/index.htm.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati razlike v obnašanju konstrukcij iz različnih materialov - Podati osnove za snovanje in projektiranje gradbenih konstrukcij - Podati podlage za izbiro ustreznega računskega modela nosilne gradbene konstrukcije - Poznavanje problematike masivnih betonov in ukrepov za preprečitev poškodb, ki lahko nastanejo ob gradnji masivnih betonov. Pridobljene kompetence: - Sposobnost snovanja in projektiranja enostavnih masivnih in lesenih konstrukcij.	Objectives: - To present the differences in the behaviour of structures made of different materials, - To present the bases for the conception and design of building structures, - To present the bases for the selection of adequate computational model of a load-bearing structure, - To know the issues of mass concretes and the measures to prevent the damages that may appear in the construction of mass concretes. Acquired competences: - Ability to concept and design simple mass concrete and timber structures.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Poznavanje temeljnih načel projektiranja gradbenih konstrukcij - Poznavanje primernih nosilnih sistemov konstrukcij iz različnih materialov - Razumevanje delovanja osnovnih nosilnih mehanizmov konstrukcij - Poznavanje posebnosti pristopa k projektiranju konstrukcij iz različnih materialov - Pridobljeno znanje študentom omogoča projektiranje enostavnih gradbenih konstrukcij, v primeru zahtevnejših konstrukcij pa so sposobni preudarne presoje o morebitni potrebni vključitvi specialistov - Sposobnost uporabe strokovne literature, standardov in enostavnih računalniških programov v procesu projektiranja gradbenih konstrukcij.	- Knowledge of the basic principles of the design of building structures - Knowledge of appropriate load-bearing systems of structures made of different materials - Understanding of the basic mechanisms of load-bearing structures - Knowledge of the specifics how to approach the design of structures made of different materials - The acquired knowledge allows students to design simple building structures; in case of demanding structures, they are able to make a well-grounded assessment if specialists need to be engaged - Ability to use professional literature, standards and simple software in the process of the design of building structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in večji del vaj v klasični učilnici, manjši del vaj pa tudi v računalniški učilnici.	Lectures and large part of tutorials in classical classroom, small part of tutorials in computer classroom.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični del izpita	40,00 %	Theoretical part of exam
Računski del izpita	30,00 %	Computational part of exam
Vaje	30,00 %	Tutorials

Reference nosilca/Lecturer's references:

SAJE, Drago, SAJE, Franc. Sanacija cerkve v Šentjurju na Dolenjskem. V: SAJE, Franc (ur.), LOPATIČ, Jože (ur.). Zbornik 18. zborovanja gradbenih konstruktorjev Slovenije, Bled, 17. - 18. oktober 1996. Ljubljana: Slovensko društvo gradbenih konstruktorjev. 1996, str. 195-200.

LOPATIČ, Jože, SAJE, Drago, SAJE, Franc. Non-linear analysis of time-dependent response of concrete structures. International journal for engineering modelling, ISSN 1330-1365, 2010, letn. 23, št. 1/4, str. 1-11.

SAJE, Drago, BANDELJ, Branko, ŠUŠTERŠIČ, Jakob, LOPATIČ, Jože, SAJE, Franc. Shrinkage of polypropylene fibre reinforced high performance concrete. Journal of materials in civil engineering, ISSN 0899-1561, 2011, vol. 23, iss. 7, str. 941-952.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**INTELIGENTNI TRANSPORTNI SISTEMI**
Course title:	**INTELLIGENT TRANSPORT SYSTEMS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1554

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	0	15	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Nadgradnja splošnih znanj o teoriji prometnega toka in prometnem planiranju; opazovanje prometa, merilne naprave v cestnem prometu; sistemi vodenja prometa na medmestni prometni mreži, sistem posredovanja prometnih informacij (dinamično vodenje po cestni mreži) oziroma aktivni dinamični sistemi povečanja propustnosti ceste; cestno-vremenski informacijski sistem in zimska služba, meteorološka stanja vozišča; sistemi elektronskega plačevanja in cestninjenja; sistemi upravljanja prometa v mestih, cestna problematika v naseljih, prometni režimi prometna signalizacija in	Lectures Upgrade of general knowledge about the theory of traffic flow and planning of traffic, monitoring of traffic, measuring devices in road traffic, traffic management systems in intercity traffic network, system of communicating traffic information (dynamic management in road network) or active dynamic systems of increasing road permeability, roadside weather information system and winter service, meteorological conditions of carriageway, electronic toll collection systems, traffic management systems in urban areas, traffic issues in urban areas, traffic regimes, traffic control and

oprema v naseljih; naprave za umirjanje prometa v naseljih; parkirišča in garažne hiše, sistem vodenja in plačevanja parkiranja, potrebe po parkirnih površinah; sistemi vodenja blagovnega prometa, tehtanje vozil; sistemi storitev v javnem prometu, avtobusna postajališča; prometna signalizacija in prometna oprema; sistemi za upravljanje z izrednimi dogodki, dela na cesti, promet in okolje. Seminarske vaje (računske vaje) in laboratorijske vaje (demonstracijske vaje na računalniških modelih). Terensko delo - zbiranje in analiza podatkov.	equipment in urban areas, traffic calming devices in inhabited areas, parking areas and garage houses, system for fee paying managing and parking, needs for parking surfaces, systems of managing heavy goods traffic, weigh in motion of vehicles, systems of public traffic services, bus stops, traffic control and traffic equipment, systems for incident detection and managing, road works, traffic and environment. Tutorial and laboratory practice (demonstration exercises on computer models) Fieldwork - data collection and analysis.

Temeljna literatura in viri/Readings:

SITSA – Slovenska ITS arhitektura: aktualni razvoj ITS, 2006. Ljubljana, FGG - PTI, (elektronski dokument).

Highway capacity manual, HCM2000. 2000. Washington, ZDA, 16 poglavje.
http://www.spcregion.org/downloads/ops/fhwa_trafficcontrolsystemshandbook_10-2005- final.pdf

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati osnovne pojme upravljanja prometa in inteligentnih transportnih sistemov in storitev (ITS), - Spoznati najpomembnejše sisteme ITS v okviru cestnega prometa, - Naučiti se določiti potrebne parametre ter kriterije za uporabo v ITS, - Usposobiti se za izdelovanje projektov iz področja prometnih gradenj in avtomatskega vodenega prometa. Pridobljene kompetence: - Sposobnost izdelave zahtevnih analiz, študij in projektov za prometne objekte iz področja ITS, - Sposobnost izvajanja nadzora in spremljanje prometa s pomočjo ITS.	Objectives: - To learn about the basic concepts of traffic and transportation management and Intelligent Transport Systems and Services (ITS). - To learn about the most important ITS systems within road traffic - To learn how to set the required parameters and criteria for applications in ITS - To be able to produce projects in the areas of traffic and transportation engineering and automated guided traffic and transport. Acquired competences: - The ability to manufacture complex analyzes, studies and projects for transportation infrastructure in the field of ITS - Ability to conduct surveillance and traffic monitoring by using ITS.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznavanje ITS kot ukrep pri optimizaciji upravljanja prometa na prometni infrastrukturi oziroma kot ukrep izkoriščanja obstoječe prometne	- Knowledge of ITS as a measure for the optimization and/or management of traffic flows on transport infrastructure or as a measure of exploitation of

infrastrukture, to je predvsem brez ali z minimalnim vložkom v novogradnje - Razumevanje soodvisnosti, ki vplivajo na optimalno, varno in ekonomično dogajanje v prometu. - Študent bo sposoben zbrati in obdelati parametre prometnega toka na terenu in določiti odvisnosti med njimi za dimenzioniranje odprte ceste in za dimenzioniranje samostojnega križišča oziroma za potencialno uvedbo ITS. - Doseženo znanje uporabljajo pri izdelavi diplomskega dela oz. v inženirski praksi - Dobro razumevanje prednosti, ki jih predstavljajo ITS v prometnem inženirstvu - Sposobnost abstraktne formulacije procesov v cestnem prometu - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ITS - Sposobnost upoštevanja dinamike prometnih procesov pri načrtovanju dejavnosti ITS v prostoru - Sposobnost uporabe računalniških modelov v prometnem inženirstvu.	existing transport infrastructure, especially with no or minimal investment in new infrastructure - Understanding the interdependencies that affect the optimum, safe and economical developments in transportation. - Students will be able to collect and process parameters of traffic flow in the field and determine dependencies between them for the design of open roads and intersections, or for potential deployment of ITS. - Achieved knowledge used in the preparation of the thesis or in engineering practice - Good understanding of the advantages posed by ITS in transportation engineering - Ability of abstract formulation processes in road traffic - Ability for critical analysis of input data and computational results obtained in the design of ITS - Ability to take into account the dynamics of transport processes in planning activities in the area of ITS - Ability to use computer models in transport engineering

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, terensko delo.	Lectures, tutorials and laboratory work, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit	50,00 %	Theory - oral or written exam
Izdelava in zagovor vaj	50,00 %	Exercise defense

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of utility functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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.

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**OPTIMIZACIJSKE METODE V GRADBENIŠTVU**
Course title:	**OPTIMISATION METHODS IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1485

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Linearno programiranje (splošni problem, grafične metode, metoda simpleksov, transportni problemi, metoda stopalnikov, metoda modi, degeneracija, celoštevilčno linearno programiranje). Nelinearno programiranje (metode reševanja problemov brez omejitev, brez uporabe odvodov, z uporabo odvodov; metode reševanja problemov z omejitvami. Lagrangevi multiplikatorji, transformacijske metode, metode kazenskih funkcij). Diskretno dinamično programiranje. Genetski algoritmi. Večkriterialno odločanje.	Lectures Linear programming (general problem, graphical methods, the simplex method, transport problems, stepping stone method, MODI, degeneration, integer linear programming). Nonlinear programming (methods for solving problems without constraints, without the use of derivatives, with the use of derivatives; methods for solving problems with constraints: Lagrange multipliers, transformation methods, penalty functions). Discrete dynamic programming. Genetic Algorithms. Multiple criteria decision making.

Temeljna literatura in viri/Readings:

Žura M. 2008. Matematično programiranje – študijsko gradivo Vadnjal A. 1971. Rešeni problemi linearnega programiranja. Vadnjal A. 1976. Diskretno dinamično programiranje.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati teoretične osnove optimizacije - Spoznati metode reševanja optimizacijskih problemov - Na številnih praktičnih primerih pridobiti sposobnost prepoznavanja problemov in njihove matematične formulacije. Pridobljene kompetence - Sposobnost prepoznavanja problemov v gradbeništvo kot problemov matematičnega programiranja - Sposobnost matematičnega formuliranja problemov - Sposobnost uporabe ustreznih metod in orodij za reševanje problemov.	Objectives - Give the theoretical basis of optimization - To know how to solve optimization problems - On the basis of many practical cases to obtain ability to identify problems and develop their mathematical formulation. Acquired competences - Ability to recognize problems in construction as problems of mathematical programming - Ability to formulate mathematical problems - Ability to use appropriate methods and tools for problem solving.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Prepoznavanje problemov v gradbeništvo kot problemov matematičnega programiranja - Poznavanje osnov optimizacijskih metod Uporaba - Sposobnost matematičnega formuliranja - Sposobnost reševanja problemov z uporabo računalniških programov - Sposobnost interpretacije rezultatov - Na podlagi pridobljenih znanj bo študent sposoben prepoznavanja podobnih problemov, njihove matematične formulacije in reševanja - Pridobljene spretnosti bodo v večji meri uporabne v naslednjem letniku zlasti pri predmetu Planiranje izgradnje prometne infrastrukture	- Identifying problems in construction as a problem mathematical programming - Knowing the basics of optimization methods Use: - Ability to formulate mathematically - Ability to solve problems by using computer programs - Ability to interpret results: - Based on the acquired knowledge student will be able to identify similar problems, derive their mathematical formulation and solution - Acquired skills will be useful in next year, especially in the course Planning construction of transport infrastructure

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, seminarske in računalniške vaje	Lectures and exercises.

Načini ocenjevanja:	Delež/Weight	Assessment:
Teoretični del	50,00 %	Theoretical exam
Računski del	50,00 %	Practical assignment

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of ulity functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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.

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**RAČUNALNIŠKO INTEGRIRANA GRADITEV**
Course title:	**COMPUTER-INTEGRATED CONSTRUCTION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1461

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	15	0	75	5

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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;	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

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

Temeljna 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.	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:

- Sposobnost uporabe tehnoloških rešitev.	- 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. - 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.	- 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. - 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/Weight**	**Assessment:**
Projektni izdelek	40,00 %	Project work quality
Teoretično znanje na izpitu	40,00 %	Theoretical exam
Sodelovanje na vajah in predavanjih	20,00 %	Activity and collaboration

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:	**THEORY OF PROBABILITY AND STATISTICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1618

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Marjeta Kramar Fijavž
Vrsta predmeta/Course type:	Obvezni splošni/Obligatory general

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljen izpit iz predmetov Matematika I in Matematika II oz. drugih predmetov s primerljivo vsebino.	Passed exams in Mathematics I and Mathematics II or other courses with comparable content.

Vsebina:	Content (Syllabus outline):
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.	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.

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 domnev.	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.

Temeljna 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	- Formulation of practical problems in mathematical language

- 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)	- 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

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Računske naloge in sprotno delo	70,00 %	Exercises and homework
Izpit (teoretičen del)	30,00 %	Exam (theoretical part)

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.

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:	**PRAKTIČNO USPOSABLJANJE**
Course title:	**PRACTICAL TRAINING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	1. letnik	Letni

Koda učne enote na članici/UL Member course code:	1468

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
6	0	0	0	80	34	4

Nosilec predmeta/Lecturer:	Andreja Istenič Starčič
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

skupinskega dela, pokaže iniciativnost in samostojnost pri vodenju najzahtevnejših delovnih sistemov pod nadzorom mentorja.	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.

Temeljna 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:	**Objectives and competences:**
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 - 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:	Intended learning outcomes:
- 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 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.	- 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 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/Weight	Assessment:
Dnevnik prakse	40,00 %	Diary of practical work
Portfolio	30,00 %	Portfolio
Ustni zagovor	30,00 %	Oral presentation

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 programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1496

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	0	30	0	60	4

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Obvezni strokovni v/Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
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	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

Izdelava lastnega projekta od zasnove do generalnega plana. Modeliranje tveganj pri projektih v gradbeništvu in simulacija vplivov.	Tutorial Preparation of a case study. Risk simulation in construction projects, impact simulation.

Temeljna literatura in viri/Readings:

- Rant, M., Jeraj, M., & Ljubič, T. (1998). Vodenje projektov: projektni pristop, projektna organizacija, vodenje projektov, projektni proces, terminsko planiranje projektov, mrežno planiranje (2. izd.). POIS.
- Česen, A., Kern, T., Bajec, M. (2008)**.** Vodnik po znanju projektnega vodenja, 3. Izdaja. Založba Moderna organizacija
- Golob, K. (2021). Investicijski procesi in vodenje projektov: [gradivo za strokovne izpite]. 2. ponatis. Ljubljana: Inženirska zbornica Slovenije.
- Project Management Institute, ed. The Standard for Project Management and a Guide to the Project Management Body of Knowledge (PMBOK Guide). Seventh edition. Newtown Square, Pennsylvania: Project Management Institute, Inc, 2021.

Cilji in kompetence:	**Objectives and competences:**
- Pridobitev znanj o posameznih udeležencih v procesu graditve, - Pridobitev znanj o fazah projekta (s poudarkom na gradbenem projektu), - Pridobitev znanj o procesu vodenja projekta.	- 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:	**Intended learning outcomes:**
- Osvojeno znanje s področja projektnega vodenja (proces, udeleženci, medsebojni odnosi, oblike sodelovanja), - Sposobnost uporabe računalniških orodij za vodenje projektov.	- Acquired knowledge from the field of project management (process, stakeholders, participants' relations), - Ability to use computer – supported project management tools.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje, lab.vaje	Lectures, tutorial

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit (teoretični del)	50,00 %	Written exam (theory)
Pisni izpti (računski del)	50,00 %	Written exam (examples)

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466.

http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MEHANIZACIJA IN TEHNOLOGIJA GRADNJE CEST**
Course title:	**ROAD CONSTRUCTION MACHINERY AND TECHNOLOGY**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1474

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	0	15	30	0	105	7

Nosilec predmeta/Lecturer:	Robert Rijavec, Matej Maček
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional
Jeziki/Languages:	Predavanja/Lectures: Slovenščina Vaje/Tutorial: Slovenščina

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

Vsebina:	Content (Syllabus outline):
Predavanja Gradbena mehanizacija. Elementi in karakteristični prečni prerezi ceste in vozišča. Osnovni cestogradbeni materiali, umetni materiali, sekundarne surovine in kemično stabilizirani materiali. Osnovne preiskave in orientirane raziskave na pogoje uporabe cestogradbenih materialov. Karakteristične plasti v cestnem prerezu. Gibanje in delovanje vode v cestnem telesu in v plasteh vozišča. Postopki gradnje in utrjevanja plasti in postopki preverjanja kakovosti Vaje	Lectures Construction machinery; elements and characteristic cross-sections of road and carriageway, basic road-construction materials, artificial materials, secondary raw materials and chemically stabilized materials, basic tests and investigations according to the conditions of using road-construction materials, characteristic layers in road cross-section, water movement and actions in road elements and in carriageway layers, procedures of construction and compaction of layers and procedures of quality check.

Izdelava elaborata o izboru ustrezne gradbene mehanizacije za gradnjo cest. Izdelava Tehnološkega elaborate gradnje cest v vkopu, nasipu, mešanemu prečnemu profilu ceste in na prehodu zemljinski objekt – gradbeni objekt. Seminar Dimenzioniranje vozišč nih konstrukcij.	Tutorial Elaboration of a report on the selection of adequate road construction machinery, elaboration of technological report on road construction in excavation, slope, mixed cross-section, road transition from ground to bridge. Seminar Dimensioning of road structure

Temeljna literatura in viri/Readings:

Žmavc, J. 2007. Gradnja cest: vozišč ne konstrukcije. 2. izd. Ljubljana: Fakulteta za gradbeništvo in geodezijo.

Žmavc, J. 2010. Vzdrževanje cest. 1. izd. Ljubljana: DRC, Družba za raziskave v cestni in prometni stroki Slovenije.

Mehmedbašić, S. 2007. Mehanizacija u građevinarstvu: osnovi za izbor mašina i proračun učinaka. Sarajevo: Građevinski fakultet.

SIST EN 1997-1:2005 Evrokod 7-1: Geotehnično projektiranje.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Pridobiti osnovna znanja o gradbeni mehanizaciji - Pridobiti osnovna znanja o karakterističnih prečnih prerezih ceste in vozišč ne konstrukcije glede na pogoje v geološkem okolju in glede na prometne obremenitve - Pridobiti osnovna znanja o vplivih okolja in vremenskih razmer na obnašanje ceste in vozišča - Nadgraditi osnovna znanja o geo-materialih, o postopkih za njihovo poboljšanje in kemično stabiliziranje in pridobiti poglobljena znanja o proizvedenih cestogradbenih materialih - Pridobiti osnovna znanja o merilih in postopkih za vrednotenje kakovosti gradnje - Pridobiti znanja za dimenzioniranje vseh vrst vozišč nih konstrukcij Pridobljene kompetence: - Sposobnost izdelave tehnoloških elaboratov za gradnjo cest - Sposobnost vodenja nadzora zemeljskih del pri gradnji cest - Sposobnost načrtovanja in dimenzioniranja vozišč.	Objectives - To acquire basic knowledge of construction machinery - To acquire basic knowledge of characteristic cross sections of road and pavement structure according to the conditions in geological environment and the traffic load - To acquire basic knowledge about the effects of environmental and weather conditions on the pavement - To upgrade basic knowledge of geo-materials, procedures for their hardening chemical stabilization and to acquire in-depth knowledge of the road construction materials - To acquire basic knowledge about the criteria and procedures for the evaluation of the quality of construction - To acquire knowledge for the design of all kinds of pavements - Ability to prepare technological studies for the construction of road - Ability of management control in the construction of earthworks

	- Ability to design and dimension pavement.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznati različno gradbeno mehanizacijo - Poznavanje škodljivih vplivov okolja in materialov na trajnost in funkcionalnost vozišč - Poznavanje tehnologij gradenj cest in nadzorovanja kakovosti izvedenih del - Znati dimenzionirati voziščne konstrukcije - Doseženo znanje uporabljajo pri izdelavi diplomskega dela oz. v inženirski praksi pri načrtovanju, gradnji in nadzoru cest in v proizvodnji cesto-gradbenih materialov - Razumevanje obnašanja ceste in voziščne konstrukcije v specifičnih pogojih okolja in prometa, ki je ključna za varnost in uporabnost. - Sposobnost prepoznavanja povečane. ranljivosti cest v določenih pogojih okolja - Sposobnost racionalnega pristopa pri načrtovanju, gradnji in vzdrževanju cest - Sposobnost razumevanja prilagajanja inženirskih ukrepov vsakokratnim terenskim razmeram.	- Knowledge of road construction machines - Knowledge of harmful effects of the environment and materials on the durability and functionality of roads - Knowledge of technologies and quality control procedures - Ability to design pavement structure Use: - Achieved knowledge used in the preparation of final thesis in design, supervision and construction of roads and in the production of road construction materials - Understanding of the behavior of road and pavement structure in specific conditions of the environment and traffic, which is crucial for safety and usefulness. - Ability to recognize the increased vulnerability of roads in certain environmental conditions - Ability of a rational approach to the design, construction and maintenance of roads - Ability to adapt to different weather, geological and traffic conditions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje.	Lectures and exercises.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Poročilo o terenskem in laboratorijskem delu	15 %	Field work and laboratory report
Seminarska naloga in zagovor (gradbena mehanizacija)	15 %	Individual seminar work and oral defence (construction machinery)
Pisni izpit (teoretičen in računski del)	70 %	Written exam (theory, calculation tasks)

Reference nosilca/Lecturer's references:

KOŠMRLJ, Tanja, VALIČ, Marko, RIJAVEC, Robert. Counting and classification accuracies of automatic counters based on different detection technologies. V: FABJAN, Daša (ur.). Transportna logistika v znanosti in praksi : zbornik referatov = Transportation logistics in science and practice = conference proceedings. 8. mednarodno posvetovanje o prometni znanosti = 8th International Conference on Traffic Science - ICTS 2004, 11.-12. November 2004, Nova Gorica. Portorož: Fakulteta za pomorstvo in promet, 2004.

RIJAVEC, Robert, KOKOT, Darko, AMBROŽ, Miha, JAMNIK, Julijana, BROZOVIČ, Robert. Predlog mejnih stanj torne sposobnosti asfaltnega vozišča za napravo SCRIMTEX. V: Referati = Proceedings. 11. slovenski kongres o cestah in prometu = 11th Slovenian Road and Transport Congress, Portorož, 24.-25. oktobra 2012. Ljubljana: DRC, Družba za raziskave v cestni in prometni stroki Slovenije, 2012.

ŠEMROV, Darja, RIJAVEC, Robert, LIPAR, Peter. Dimensioning of cycle lanes based on the assessment of comfort for cyclists. Sustainability. Avg. 2022, letn. 14, št. 16, art. 10172, 12 str.

PETKOVŠEK, Ana, MAČEK, Matej (2013) Zmrzlinska odpornost vozišč v luči toplotne hidravlične prevodnosti materialov v coni zmrzovanja. V: Zbornik referatov, Združenje asfalterjev Slovenije: 145-156.

MAČEK, Matej, MAJES, Bojan, PETKOVŠEK, Ana. Influence of mould suction on the volume - change behaviour of compacted soils during inundation = Vpliv vrojene sukcije na volumensko obnašanje zgoščenih zemljin med vlaženjem. Acta geotechnica Slovenica, ISSN 1854-0171, 2011, vol. 8, [no]. 2, str. 67-79.

PETKOVŠEK, Ana, MAČEK, Matej, PAVŠIČ, Primož, BOHAR, Feri. Fines characterization through the methylene blue and sand equivalent test: comparison with other experimental techniques and application of criteria to the aggregate quality assessment. Bulletin of engineering geology and the environment, ISSN 1435-9529, 2010, vol. 69, no. 4, str. 561-574.

PETKOVŠEK, Ana, JURJAVČIČ, Primož, MAČEK, Matej, COTIČ, Zvonko (2008) Sistemi za kontinuirano kontrolo zgoščanja - končno v redni rabi tudi v Sloveniji. Gradbeni vestnik 57(12): 330-343.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MESTNE PROMETNE POVRŠINE**
Course title:	**URBAN ROADS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1475

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	15	15	0	75	5

Nosilec predmeta/Lecturer:	Peter Lipar
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Sistematika mestne cestne mreže – administrativna in funkcionalna; projektni elementi mestnih cest – v situaciji, v podolžnem profilu, v prečnem prerezu, preglednost; projektni elementi križišč – oblike, računski elementi; prometni otoki, pregledno polje, avtobusna postajališča; mirujoči promet – različne oblike parkiranja umirjanje prometa v naseljih – namen in ukrepi na mreži in na vozišču; kolesarske površine – različne oblike, projektni elementi; površine za pešce – cone za pešce, nadhodi, podhodi; nivojska prečkanja; prometna signalizacija – vertikalna, horizontalna.	Road classification – administrative and functional; road design elements – plan, longitudinal profile, cross section, sight field; intersection design – shapes, traffic islands, bus, bays; parking facilities; traffic calming – purpose and measures; bicycle facilities – design elements; pedestrian facilities – pedestrian zones, over and under passes, pedestrian crossings; traffic signalization, vertical and horizontal.

Temeljna literatura in viri/Readings:

Tehnični normativi in navodila za projektiranje mestnih prometnih površin. 1991. Ljubljana, FGG – PTI.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati osnove mestne prometne politike - Podati osnove za kategorizacijo mestnih prometnih površin - Detajlno obdelati projektne elemente posameznih vrst mestnih prometnih površin - Opredeliti možne ukrepe za izboljšanje prometne varnosti na mestnih prometnih površinah Pridobljene kompetence: - Sposobnost načrtovanja mestnih prometnih površin - Sposobnost projektiranja mestnih prometnih površin - Možnost ocenitve ustreznosti mestne prometne politike	Objectives: - To understand basic concepts of urban transport policies - To understand basic road classification - To process design elements of various types of urban road surfaces - To identify possible measures to improve road safety in urban traffic areas Acquired competences: - Ability of urban road planning - Ability of urban road design - Possibility to assess the adequacy of urban transport policy

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznavanje osnovnih potreb za normalno funkcioniranje različnih oblik prometa na mestnih prometnih površinah - Pridobljeno znanje o reševanju problematike prometne varnosti - Spoznavanje principov projektiranja Uporaba: - Pridobljeno znanje se uporablja za uspešno načrtovanje in projektiranje mestnih prometnih površin v praksi. - Pravilna ocena o porabi prostora in poznavanje značilnosti posameznih oblik prometa so osnova za pravilno načrtovanje in projektiranje mestnih prometnih površin. - Zmožnost zaznavanja potencialnih prometno nevarnih situacij pri projektiranju. - Sposobnost pravilne izbire ukrepov iz nabora možnih rešitev.	- To meet basic needs for normal functioning of various forms of transport in urban traffic areas - Knowledge about solving the problem of traffic safety - Learning about the principles of urban road design - The acquired knowledge is used for successful planning and design of urban road surfaces in practice. - Correct assumption of the use of space and knowledge of the characteristics of individual modes of transport are the basis for proper planning and design of urban traffic areas - Ability to detect potential dangerous traffic situations in the design - Ability of correct selection of actions from a set of possible solutions - Ability to connect partial solutions in a whole.

- Zmožnost povezovanja parcialnih rešitev v celoto.	

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje.	Lectures, practical work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Vaje	40,00 %	Practical work
Pisni in/ali ustni izpit	60,00 %	Exam

Reference nosilca/Lecturer's references:

LIPAR Peter; JUVANC Alojz, Racionalizacija pri projektiranju cest, 1. Slovenski kongres o cestah in prometu, Zbornik kongresnih gradiv in referatov, str 115-119, Bled.

LIPAR Peter, Vrednotenje vplivov ceste in prometa na okolje s pomočjo GIS in določitev optimalne variante, Zbornik predstavitev nekaterih slovenskih strokovnih člankov o cestah – ob zaključni konferenci OECD/RTRP v Sloveniji, str. 60-64, Ljubljana 1995.

LIPAR Peter, GROOTE Wouter, Za trajnostno mobilnost v Srednji in Vzhodni Evropi, 5. Slovenski kongres o cestah in prometu, Povzetek referatov str. 16, 1-7, celotni referat na CD, Bled 2000.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**INFORMACIJSKO MODELIRANJE ZGRADB**
Course title:	**INFORMATION MODELLING OF BUILDINGS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	2. letnik	Zimski

Koda učne enote na članici/UL Member course code:	1479

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	15	30	0	90	6

Nosilec predmeta/Lecturer:	Tomo Cerovšek
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Uvod v informacijsko modeliranje zgradb (BIM). Načini uvajanja in uporabe BIM v gradbeništvu. Sintaksa, struktura in semantika podatkov. Načrtovanje podatkovnih modelov in jezik Express. Zbirke podatkov za informacijsko modeliranje zgradb. Pregled aspektnih modelov in ogrodij BIM. Metode, standardi in orodja za interoprabilnost BIM. Standardi za izmenjavo podatkov ifc, cis2, landxml, cobie. Uporaba BIM za energetsko učinkovitost in trajnostno gradbeništvo Parametrično modeliranje informacijskih modelov zgradb.	Lectures Introduction to building information modelling BIM Uses and implementations in building projects throughout project phases. Syntax, structure and semantics of data. Design of data structures and language Express. Databases for building information modelling. Overview of aspect models. Methods, standards and tools for BIM Interoperability. Standards for BIM data exchange: IFC, CIS2, LandXML, COBIE. Use of BIM for Energy Efficient and sustainable design. Parametrical modelling.

Vaje Izdelave sheme za konstrukcijske elemente ali gradbene (pol)proizvode. Izdelava delov informacijskih modelov zgradb. Izdelava parametričnega modela gradbeni. Informacijsko modeliranje istega gradbenega produkta z več orodji. Parametrizacija in povezovanje z informacijskimi modeli zgradb. Seminar Projekt iz informacijskega modeliranja zgradb.	Lab work Development of schemata for structural elements and/or building products. Development of building information models. Development of parametric models of the same building element using different tools. Parameterization and interlinking of BIM. Seminar BIM Project.

Temeljna literatura in viri/Readings:

EASTMAN C, TEIHOLZ P, SACKS R & LISTON K. 2013. BIM Handbook A Guide to Building Information

Modelling for Owners, Managers, Designers, Engineers, and Contractors, New Jersey: John Wiley & Sons.

WEYGANT, RS. 2011. BIM Content Development: Standards, Strategies, and Best Practices. John Wiley & Sons.

BRITISH STANDARDS. PAS 1192 Specification for information management for the capital/delivery phase of construction projects using Building information modelling. 2013. British Standards.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznati osnovne koncepte informacijskega modeliranja zgradb - Pripraviti študente na uvajanje in uporabo informacijskih modelov zgradb - Pripraviti študente na nadgradnjo uporabe informacijskih modelov zgradb. Pridobljene kompetence: - Izdelati shemo informacijskih modelov zgradb - Izdelati konkreten informacijski model in pridobiti ustrezne podatke - Uporabiti informacijski model zgradb za vizualizacijo, dokumentacijo in analize - Analitično obravnavati izmenjavo informacijskih modelov in vlogo pri komunikaciji - Sodelovati pri gradbenih projektih, ki temeljijo na informacijskih modelih zgradb.	Objectives: - Become familiar with basic concepts of schematic (BIM Schema) and concrete building information modelling (BIM Model) - Prepare students to be BIM Change agents who will implement BIM in the industry - Prepare students to upgrade the BIM Uses Competences: - Ability to develop a BIM Schema - Ability to develop infrastructure or building BIM model - Making use of BIM for different purposes - Analytical study of the use of BIM for project communication and exchange of data - Collaboration in BIM based projects.

Predvideni študijski rezultati: **Intended learning outcomes:**

- Poznavanje teoretičnih osnov in standardov za BIM - Poznavanje metod izdelave shem in zbirk podatkov za BIM - Razumevanja pomena in potenciala BIM - Razumevanje kritičnih vsebin in elementov pri implementaciji BIM - Sposobnost planiranja uporabe in implementacije BIM - Sposobnost kritične presoje uvajanja BIM glede na zrelost sodelujočih in konkreten projekt - Sposobnost analizirati in odpraviti ovire za interoperabilnost BIM.	- Knowledge and understanding of BIM theory and standards - Methods of development of schemata and databases that are relevant to BIM - The role and potential of BIM for the industry - Critical aspects in BIM implementation - BIM planning and execution - Assessment procedures that are relevant for successful implementation of a project - Interoperability issues in BIM based exchange of project information in infrastructure and building projects

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja sledijo problemsko naravnanemu delu na konkretnem projektu. Vsebine so delno posredovane v obliki multimedijskih gradiv.	Learning is supported by online learning content management systems with interactive content. Student work is individual as well as in groups

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Projekt BIM	30,00 %	BIM Project
Preizkus teoretičnega znanja	20,00 %	Written exam
Sprotno delo - naloge	50,00 %	Course-work

Reference nosilca/Lecturer's references:

CEROVŠEK, Tomo. A review and outlook for a 'Building Information Model' (BIM) : a multi- standpoint framework for technological development. Advanced engineering informatics, ISSN 1474-0346, 2011, letn. 25, št. 2, str. 224-244, ilustr., doi: 10.1016/j.aei.2010.06.003.

CEROVŠEK, Tomo. The lifecycle of BIM : a university project case study (MEP coordination). V: HORE, Alan (ur.), MCAULEY, Barry (ur.), WEST, Roger (ur.). Proceedings of CITA BIM gathering conference, 14-15 November 2013. [Dublin]: Construction IT Alliance, 2013, str. 253-260, ilustr.

SLAK, Tomaž, CEROVŠEK, Tomo, ZUPANČIČ-STROJAN, Tadeja, KILAR, Vojko. A comperative study of model-based framework for the AEC competency evaluation ofbuilding [!] tenders. Tehnics tehnologies education management, ISSN 1840-1503, 2013, vol. 8, no. 1, str. 449-463, ilustr. http://www.ttem.ba/pdf/ttem_8_1_web.pdf.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MAGISTRSKO DELO**
Course title:	**MASTER THESIS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1481

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	0	0	0	150	150	10

Nosilec predmeta/Lecturer:	
Vrsta predmeta/Course type:	Obvezni strokovni /Obligatory professional

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

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	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

- 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.	- 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.

Temeljna 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:	**Objectives and competences:**
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 • 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:	**Intended learning outcomes:**
• 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.	• 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.

• Načrtovanje, izvedba in kritično vrednotenje pri reševanju problemov ter prezentacija izsledkov strokovnih nalog in raziskav. • Sodelovanje, vključevanje strokovnjakov in skupno reševanje problemov.	• 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:	**Learning and teaching methods:**
Mentorsko vodeno samostojno delo.	Independent work under supervision.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Magistrska naloga	50,00 %	Master thesis
Zagovor	50,00 %	Defence

Reference nosilca/Lecturer's references:

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**TEORIJA PROMETNEGA TOKA IN ANALIZA PREPUSTNOSTI**
Course title:	**TRAFFIC FLOW THEORY AND CAPACITY ANALYSIS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1494

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	15	0	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Osnove o teoriji prometnega toka (zgodovinski pregled, osnovni namen in problemi s katero se ukvarja ta znanost, področja uporabe). Gibanje posameznega vozila. Osnovni parametri prometnega toka. Značilne karakteristike prometnega toka. Teoretični in empirični odnosi med parametric prometnega toka. Matematični modeli medsebojnih odvisnosti v prometnem toku. Matematični modeli za opisovanje zakonitosti gibanja vozil pri različnih pogojih v prometnem toku. Osnove teorije strežbe v prometnem inženirstvu. Kapaciteta različnih prometnih rešitev (območja oviranih prometnih tokov – nivojska križišča , območja delno oviranih	Basics about traffic flow theory (historic overview, basic purpose and problems dealt with by this area of science, areas of use), movement of individual vehicle, basic traffic flow parameters, traffic flow characteristics, theoretical and empirical relations between traffic flow parameters, mathematical models of interdependencies in traffic flow, mathematical models for the description of vehicle flow laws in different traffic flow conditions, basic theories of queuing theory in traffic engineering, capacity of different traffic solutions (areas of hindered traffic flows – road intersections, areas of

prometnih tokov – izven nivojska križišča, območja neoviranih prometnih tokov – odseki cest.	partially hindered traffic flows freeway facilities, areas of unhindered traffic flow – road sections).

Temeljna literatura in viri/Readings:

Maher T. 2008. Teorija prometnega toka – skripta, dopolnjena verzija. Ljubljana, UL FGG, Prometnotehniški inštitut, 180 str.

Maher T. 2008. Kapacitetna prometnih površin, skripta, dopolnjena verzija. Ljubljana, UL FGG, Prometnotehniški inštitut, 190 str.

Kerner B.S. 2004. The physics of traffic. Springer.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
- Nadgraditi osnovno znanje prometnega inženirstva - Podati teoretične osnove v teoriji prometnega toka in spoznati kapacitetne modele kot osnovo za načrtovanje in dimenzioniranje prometnih objektov (križišča, odseki cest, ostale prometne površine) - Podati pregled ukrepov in metod pridobljene - Sposobnost izdelave zahtevnih analiz, študij in projektov za prometne objekte - Sposobnost izvajanja nadzora nad izvajanjem zahtevnih prometnih objektov	-To upgrade basic knowledge of transportation engineering - To provide the theoretical basis of the theory of traffic flow and to meet performance-based models as a basis for planning and design of traffic facilities (junction segments, roads, other traffic surfaces) - To give an overview of the measures and methods of acquired competencies - Ability to manufacture complex analyses, studies and projects for transport facilities - Ability to exercise control over the implementation of complex transport facilities

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje iz teorije prometnega toka - Razumevanje procesov ki potekajo v prometu - Osvojene računske spretnosti za načrtovanje prometnih objektov - Doseženo znanje uporabljajo pri izdelavi magistrske naloge oz. v inženirski praksi - Dobro razumevanje zakonitosti v prometnem toku so osnova za načrtovanje in dimenzioniranje ustreznih prometno tehničnih rešitev in objektov v prometnem inženirstvu - Sposobnost abstraktne formulacije procesov v cestnem prometu	- Acquired in-depth knowledge of traffic flow theory - Understanding of the processes taking place in the road transport - Mastered computational skills for planning of transportation infrastructure - Achieved knowledge used in the preparation of master thesis or in engineering practice - Good understanding of the laws of traffic flow is the basis for planning and design of appropriate transport facilities and technical solutions in the transportation engineering - Ability of abstract formulation processes in road traffic

- Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ukrepov - Sposobnost upoštevanja dinamike prometnih procesov pri načrtovanju dejavnosti v prostoru - Sposobnost uporabe računalniških modelov v prometnem inženirstvu	- Ability for critical analysis of input data and computational results obtained in the planning of measures - Ability to take into account the dynamics of transport processes in the planning of activities in space - Ability to use computer models in the transportation engineering

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, terensko delo.	Lectures, tutorials and laboratory work, field work

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit	50,00 %	Theory - oral or written exam
Zagovor vaj	50,00 %	Exercise defense

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of utility functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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.

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PLANIRANJE GRADNJE IN VZDRŽEVANJE PROMETNIC**
Course title:	**CONSTRUCTION PLANNING AND ROAD MAINTENANCE**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1557

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Pristopi k planiranju izgradnje prometne infrastrukture. Zbiranje podatkov (štetja, ankete, meritve). Matematični modeli (štirifazni model: generacija, distribucija, izbira prometnega sredstva, obremenjevanje mreže). Vrednotenje variant (cost-benefit analiza, multikriterialna analiza). Modeli za upravljanje z vozišči. Vaje	Lectures: Approaches to planning the construction of transport infrastructure. Collection of data (counting, surveys, measurements). Mathematical models (four-phase model: generation, distribution, mode choice, assignment). Evaluation of variants (cost-benefit analysis, multi-criteria analysis). Models for Pavement Management. Tutorials Use of Visum program for making transport models.

Seminarske vaje (računske vaje) in računalniške vaje (uporaba programa VISUM za izdelavo transportnih modelov).	

Temeljna literatura in viri/Readings:

Žura M. 2008. Prometno planiranje – študijsko gradivo

Bruton M. 1975. Introduction to transportation planning.

Banks J. 1998. Introduction to transportation engineering.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Spoznati metode zbiranja podatkov - podati teoretične osnove modelov za napoved prometnih obremenitev - na praktičnih primerih pridobiti sposobnost modeliranja Pridobljene kompetence - Sposobnost organizacije zbiranja in obdelave podatkov - Sposobnost izdelave transportnih modelov - Sposobnost interpretacije rezultatov	Objectives - Understand the methods of data collection - Give the theoretical basis of models for traffic forecasting - In practical situations obtain the ability of modelling Acquired competences - Ability to organize data collection and processing - Ability to develop transport models - Ability to interpret results

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje odvisnosti števila in vzorcev potovanj od rabe površin in socialnoekonomskih karakteristik - Poznavanje osnov matematičnih modelov posameznih faz - Sposobnost izdelave računalniškega modela prometnega omrežja - Sposobnost organizacije zbiranja in obdelave potrebnih podatkov - Sposobnost interpretacije rezultatov	- Knowledge of influence of land use and socio-economic characteristics on traffic volumes and patterns - Knowledge of basic mathematical models of individual phases - The ability to build a computer model of the transport network - Ability to organize the collection and processing of the necessary data - Ability to interpret results

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in računalniške vaje.	Lectures and exercises.

Načini ocenjevanja: **Delež/Weight** **Assessment:**

Teoretični del	50,00 %	Theoretical exam
Računski del	50,00 %	Practical assignment

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of ulity functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**STVARNO PRAVO**
Course title:	**PROPERTY LAW**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1482

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Ana Vlahek
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Pojem prava in delitev na javno in zasebno pravo. Pravni viri, ki urejajo nepremičnine. Temelji lokalne samouprave. Temelji prava Evropske unije. Temeljni pojmi nepremičninskega prava (nepremičnina, sestavina, pritiklina, parcela, pripadajoče zemljišče, javno dobro idr.). Načela stvarnega prava. Lastninska pravica, solastnina in skupna lastnina. Etažna lastnina, kataster stavb in vpis etažne lastnine v zemljiško knjigo, vzpostavitev etažne lastnine. Omejene stvarne pravice (stvarne služnosti, osebne služnosti, stvarno breme, nujna pot, hipoteka in zemljiški dolg, stavbna pravica). Nepremičninske evidence in zemljiška knjiga.	Notion of law, delimitation of public and private law. Sources of law regulating immovable property. Basics of local self-government. Basics of EU law Basic notions of law of immovables (immovable, element, appurtenance, parcel, corresponding plot, property in public domain, etc.). Principles of property law. Ownership, co-ownership, joint ownership. Divided co-ownership, building cadastre, entry of divided co-ownership in the land register, creation of divided co-ownership. Limited proprietary rights (real easements, personal easements, encumbrance, way of necessity, mortgage, land debt, right of superficies). Real

Omejitve lastninske pravice v javnem interesu in drugi javnopravni režimi na zemljiščih.	estate and other cadastres, land register. Limitation of ownership in the public interest and other public regimes on immovables.

Temeljna literatura in viri/Readings:

Juhart, M., Tratnik, M., Vrenčur, R., Plavšak, N., Geč, M. 2007. Stvarno pravo. GV založba.

(predvsem v delu, ki obravnava nepremičnine / in particular chapters on real-estate)

Veljavna zakonodaja, ki ureja nepremičnine (Dostopno na: www.dz-rs.si in www.pisrs.si), seznam se sproti oblikuje in dopolnjuje. / Relevant legislation regulating immovables (Dostopno na: www.dz-rs.si and www.pisrs.si), the list is updated regularly.

Drugo gradivo, sporočeno na predavanjih in na vajah ter v ŠIS. / Other study material is disseminated at the lectures and tutorials as well as via the student information system.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Osnovni cilj predmeta je študenta na vsebinsko celovit način seznaniti z osnovami stvarnega prava, s poudarkom na pravni ureditvi nepremičnin. Študent pridobi naslednje kompetence: - Pozna osnove stvarnega prava in zemljiške knjige. - Nadaljnja uporaba znanja stvarnega prava omogoča študentu razumevanje pri praktičnem delu pri izpeljavi strokovnih geodetskih del pri evidentiranja nepremičnin in sodnih postopkih.	Objectives: - The basic objective of the course is to introduce student the complete contents of basic property law, with the emphasis on legal system for real estate. Student acquires the following competences: - Knowledge of basic property law, and land register. - Further use of knowledge on property law enables student to understand practical work related to the implementation of geodetic work in the sense of real estate recording and in legal procedures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent mora poznati osnove prava ter povezovati zakonodajo na področju upravljanja z nepremičninami. - Poznati mora osnove zakonodaje o geodetski dejavnosti, poznavanje področja urejanja prostora,	Student must know the basics of law and connect legislation in the area of administration with real estate. - Student must know the basics of legislation related to geodetic activity, knowledge from the area of

evidentiranja nepremičnin, varstva okolja ter gradnje objektov.	spatial planning, recording of real estate, environmental protection and construction.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje teoretične, delno v računalniški učilnici.	Lectures, theoretical tutorials, partly in computer classroom.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit (teoretičen del)	80,00 %	Writen exam (theoretical part)
Naloge in sprotno delo	20,00 %	Homework and on-going work

Reference nosilca/Lecturer's references:

VLAHEK, Ana. Časovne predpostavke in vsebina zahtevkov naročnika v primeru nepravilne izpolnitve podjemne in gradbene pogodbe v slovenski ureditvi. Pravni letopis. 2012. str. 69-83, 232-233, ilustr.

VLAHEK, Ana. Stavbna pravica - sedem let po njeni uveljavitvi. Pravni letopis. 2010. str. 165-191.

VLAHEK, Ana. Pravnoposlovni prenos lastninske pravice na premičninah med živimi v francoski pravni ureditvi. Pravnik, 2010, letn. 65, št. 3/4, str. 171-194.

VLAHEK, Ana. Amicus curiae, sodelovanje med slovenskimi sodišči, UVK in Evropsko komisijo v konkurenčnopravnih zadevah. Pravosod. bilt., 2009, letn. 30, [št.] 4, str. 301-330.

VLAHEK, Ana. Pridobivanje lastninske pravice na nepremičninah v Sloveniji s strani tujcev. Pravnik (Print). [Tiskana izd.], 2008, letn. 63, št. 1/3, str. 7-36.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**VREDNOTENJE NEPREMIČNIN**
Course title:	**REAL ESTATE VALUATION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1555

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač
Vrsta predmeta/Course type:	izbirni - strokovni/Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja: Trg in tržno vrednotenje nepremičnin: predmet ocenjevanja, ocenjevana vrednost in načini ocenjevanja vrednosti nepremičnin; ocenjevanje vrednosti zemljišč, ocenjevanje vrednosti nepremičnin v postopku komasacije, ocenjevanje vrednosti nepremičnin v primerih stvarne služnosti in v primerih drugih omejitev lastninske pravice, ocenjevanje vrednosti v specifičnih primerih. Upoštevanje elementov trajnostnega razvoja v postopku ocenjevana vrednosti nepremičnin. Postopek posamičnega vrednotenja nepremičnin in uporaba standardov. Javno dostopni podatki za	Lectures: Real estate market and market real estate valuation: valuation subject, value and real estate valuation approaches: land valuation in specific cases, real estate valuation in the process of consolidation, real estate valuation in cases of easement and other restrictions of rights. Real estate valuation in specific cases, taking into account elements of sustainable development. Process of individual real estate valuation and application of standards. Public records for real estate valuation reporting.

izdelavo cenitvenega poročila. Pridobivanje podatkov, analiza trga nepremičnin. Samostojna izdelava cenitvenega poročila.	Acquisition of data, analysis of the real estate market. Making a real estate report.

Temeljna literatura in viri/Readings:

Šubic Kovač, M. 2023. Vrednotenje nepremičnin, Študijsko gradivo, UL FGG, Ljubljana, dostopno v spletni učilnici.

Petersen, H. 2005. Marktorientierte Immobilienbewertung, Richard Boorberg Verlag, 85 str.

International valuation standards. International Valuation Standards Committee, IVSC.

Šubic Kovač, M. 1997. Ocenjevanje tržne vrednosti stavbnih zemljišč, Ministrstvo za pravosodje RS, 94 str.

Šubic Kovač, M. 1998. Vrednotenje stavbnih zemljišč. Ljubljana, UL FGG, 179 str.

The Appraisal of Real Estate. 2008. Appraisal Institute (izbrana poglavja).

Slovenska zakonodaja, pravilniki s področja obravnave: Uradni list RS. Dostopno na: http://www.uradni-list.si, www.dz-rs.si, www.pisrs.si/

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Spoznavanje izrazoslovja in procesa vrednotenja nepremičnin ter razumevanje različnih načinov vrednotenja. Kompetence: - Pozna in razume izrazoslovje, proces in načine posamičnega vrednotenja nepremičnin. - Pozna in razume različne metode vrednotenja nepremičnin. - Sposobnost pridobivanja in analiziranja podatkov o trgu nepremičnin. - Sposobnost samostojno izdelati cenitveno poročilo. - Sposobnost prilagajanje novim razmeram pri razvoju stroke.	Objective: - To acquire knowledge regarding terminology and the process of real estate valuation; understanding various real estate valuation methods. Competences: - To know and understand the terminology and the process of real estate valuation - To know and understand various methods of real estate valuation - Ability to acquire and analyse data regarding real estate market - Ability to make an individual real estate report - Ability to adjust to changing conditions in the field of real estate valuation.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent pridobi znanje o načinih vrednotenja nepremičnin in jih zna uporabiti v praksi ter pri razvoju stroke. - Študent na osnovi pridobljenih znanj in spoznanj pri tem predmetu lahko kritično presoja razvoj vrednotenja nepremičnin, zahteve strank pri izdelavi cenitvenega poročila.	- Student acquires knowledge about various methods of real estate valuation and knows how to use them in practice and in the process of development of the field of real estate valuation. - Student has the ability to critically consider developments in the field of real estate valuation

- Študent zna izdelati cenitveno poročilo s pomočjo metode primerljivih poslov.	and customers' requirements when making real estate report. - Student is able to make a real estate report using market approach method.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar, seminarske vaje z uporabo IKT.	Lectures, seminar using visual aids.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Projekt (cenitveno poročilo)	100,00 %	Project (real estate report)

Reference nosilca/Lecturer's references:

ŠUBIC KOVAČ, Maruška. Kako do kakovostnega cenitvenega poročila?. Vestnik za sodne izvedence in cenilce. 2021, letn. 2021/12, št. 42, str. 113-130, ilustr. ISSN 2670-4544.

ŠUBIC KOVAČ, Maruška. Acquisition of Land and Compensation in Infrastructure Projects in the Republic of Slovenia. V: HEPPERLE, Erwin (ur.), LISEC, Anka (ur.). Opportunities and Constraints of Land Management in Local and Regional Development : Integrated Knowledge, Factors and trade-offs. 1. Aufl. Zürich: Hochschulverlag, 2018. Str. 187-201. ISBN 978-3-7281-3927-6, ISBN 978-3-7281-3928-3. https://www.research-collection.ethz.ch/handle/20.500.11850/289657.

STOPAR, Iris, ŠUBIC KOVAČ, Maruška. Vrednotenje zemljišč v primeru stvarne služnosti : študija primera v Sloveniji = Land valuation in case of easement : the case study in Slovenia. Geodetski vestnik : glasilo Zveze geodetov Slovenije. [Tiskana izd.]. 2016, letn. 60, št. 4, str. 685-716, ilustr. ISSN 0351-0271. http://geodetski-vestnik.com/60/4/gv60-4_stopar.pdf, DOI: 10.15292/geodetski-vestnik.2016.04.685-716.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROMETNA EKOLOGIJA**
Course title:	**TRAFFIC ECOLOGY**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1493

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Peter Lipar
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Osnove o varstvu okolja (zgodovinski pregled, pojem varstva okolja, varstvo okolja in urejanje prostora, oblike okoljevarstvenega delovanja, vplivi prometa na okolje). Presoje vplivov na okolje: pojem in pomen, vpogled v zgodovino, oblike presoje, zakonski okvir in postopek, izvedba presoje (opredelitev cilja, orodja, metode dela …). Hrupne obremenitve okolja: veljavna zakonodaja o varstvu okolja in hrupu, karte hrupne obremenjenosti, definicije, protihrupni ukrepi.	Foundations of Environmental Protection (historical overview, concept of environmental protection, environmental protection and spatial planning, forms of environmental action, impacts of transportation on the environment). Environmental Impact Assessments: concept and significance, historical perspective, forms of assessment, legal framework and procedure, implementation of assessments (defining objectives, tools, methods of work, etc.). Noise Pollution: current environmental and noise protection legislation, noise exposure maps, definitions, noise mitigation measures. Roadside Landscape

Urejanje obcestne krajine: zrak in podnebje (emisije prometa), umeščanje ceste v krajino, ureditve za živali, rastlinstvo, varovana območja, kulturna dediščina, kakovost krajine, gozdarstvo in gozd, kmetijstvo in kmetijske površine, poselitev. Vaje Vaje: umeščanje trase ceste v prostor z upoštevanjem vseh predhodno pridobljenih znanj, demonstracijske vaje na računalniških modelih-ekskurzije, izdelava presoje vplive na okolje Seminar: samostojna izdelava seminarja na eno od tem, ki so bile obravnavane na predavanjih ali na vajah.	Management: air and climate (traffic emissions), road integration into the landscape, arrangements for animals, vegetation, protected areas, cultural heritage, landscape quality, forestry and forests, agriculture and agricultural areas, settlements. Exercises: placing the road route in space while considering all previously acquired knowledge, demonstration exercises on computer models - excursions, conducting environmental impact assessments. Seminar work: independent preparation of a seminar on one of the topics covered in lectures or exercises.

Temeljna literatura in viri/Readings:

Maher T. 2008. Prometni hrup in zaščita pred njim – skripta, dopolnjena verzija. Ljubljana, UL FGG, Prometnotehniški inštitut, 132 str. 132.

Maher T. 2008. Živalim prijazne ceste, skripta, dopolnjena verzija. Ljubljana, UL FGG, Prometnotehniški inštitut, 103 str.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati osnovne opredelitve, vpogled v zgodovino, oblike dejavnosti in pojavne oblike varstva okolja, oziroma okoljevarstvene zahteve - Podati pregled ukrepov in metod prostorskega načrtovanja kot oblike varstva okolja v prometnem inženirstvu Pridobljene kompetence: - Sposobnost izdelave osnovnih analiz in študij iz področja prostorskega načrtovanja - Sposobnost sodelovanja in izdelovanja celovitih presoj vplivov prometa na okolje - Razumeti in upoštevati okoljevarstvene zahteve v prometnem inženirstvu (preventive in/ali sanacija)	Objectives: - Provide basic definitions, historical insights, forms of activities, and manifestations of environmental protection, or environmental requirements. Provide an overview of measures and methods of spatial planning as a form of environmental protection in transportation engineering. Acquired competencies: Ability to conduct basic analyses and studies in the field of spatial planning. Ability to collaborate and produce comprehensive assessments of the impacts of transportation on the environment. Understand and adhere to environmental requirements in transportation engineering (prevention and/or remediation).

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje iz prometne ekologije	- Acquired in-depth knowledge of road ecology - Understanding of the processes in the siting of roads in space, methods to protect the environment

- Razumevanje procesov pri umeščanju prometnic v prostor, metod varovanja okolja zaradi škodljivih vplivov prometnic na okolje, - Osvojene računske spretnosti za načrtovanje ureditvenih in omilitvenih ukrepov v prometnem inženirstvu - Doseženo znanje uporabljajo pri izdelavi diplomskega dela oz. v inženirski praksi - Dobro razumevanje zakonitosti v prometnem toku so osnova za načrtovanje in dimenzioniranje ustreznih prometno tehničnih rešitev in objektov v prometnem inženirstvu - Sposobnost abstraktne formulacije procesov v cestnem prometu - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov pri načrtovanju ukrepov - Sposobnost upoštevanja dinamike prometnih procesov pri načrtovanju dejavnosti v prostoru - Sposobnost uporabe računalniških modelov v prometnem inženirstvu	from harmful effects of road traffic on the environment, - Getting familiar with numeracy planning of regulatory and mitigation measures in the transport engineering - Achieved knowledge used in the preparation of the thesis or in engineering practice - Good understanding of the legality of the traffic flow is the basis for planning and design of appropriate transport facilities and technical solutions in the transport engineering - Ability of abstract formulation processes in road traffic - Ability for critical analysis of input data and computational results obtained in the planning of measures - Ability to take into account the dynamics of transport processes in the planning of activities in space - Ability to use computer models in traffic engineering

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, terensko delo.	Lectures, tutorials and laboratory work, field work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretični izpit (ustni ali pisni)	50,00 %	Theory - oral or written exam
Zagovor vaj	50,00 %	Exercise defence

Reference nosilca/Lecturer's references:

LIPAR, Peter, ŠEMROV, Darja. Sustainable design of cycling infrastructure. ITE journal. avg. 2018, letn.

LIPAR, Peter, KOSTANJŠEK, Jure. Pedestrian crossings priority for pedestrian safety. Suvremeni promet, ISSN 0351-1898, 2005, letn. 25, št. 3-4, str. 215-220, graf. prikazi.

ŠEMROV, Darja, LIPAR, Peter, MARSETIČ, Rok. Biciklističke površine budućnosti. Put plus : regionalni almanah niskogradnje. 2018

LIPAR, Peter. Optično vodenje osi in geometrijsko oblikovanje cest = Optical leading of axis and geometrical forming of roads. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. 1995

ŽURA, Marijan, LIPAR, Peter. Presoja vplivov ceste in prometa na okolje ter izbor optimalne variante poteka trase = The road and traffic environmental impact assessment and optimal room layout selection. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. 1995

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**URBANISTIČNO NAČRTOVANJE**
Course title:	**URBAN PLANNING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code: 1397

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer: Alma Zavodnik Lamovšek

Vrsta predmeta/Course type: Izbirni strokovni /Elective professional

Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

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

Vsebina:	Content (Syllabus outline):
Predavanja Osnovni pojmi in terminologija v urejanju urbanega prostora; trajnostna načela razvoja mest, razvoj naselij, tipologija naselij, urbani sistem, urbanizacija in urbane rabe tal, urbanistična dokumentacija in upravne službe; inšpekcija, razvoj urbanih zemljišč: parcelacija v stavbne namene, pridobivanje, zemljišč. Izvajanje urbanističnih dokumentov, podatkovne osnove, mestni informacijski sistemi in njihova uporaba, urbana ekologija, presoja vplivov na okolje v mestih, mestna prenova. Predavanja o naselitveni,	Lectures Basic notions and terminology in urban spatial planning; sustainable principles of urban development, development of settlements, settlement, typology, urban system, urbanisation and urban land use, planning documentation and administrative services; inspection, development of urban areas: land allotment for building development, land acquisition, urban planning, implementation of urban planning documents, and their application, urban ecology, environmental impact assessment in urban areas, urban renovation. Lectures on housing, production and central land

proizvodni, centralni rabi tal, o zelenih, prometnih in komunalnih površinah in o infrastrukturnih sistemih	uses; green, transport and municipal areas, and infrastructure systems.
Obiski urbanističnih zavodov in mestne uprave za urejanje prostora.	Visits to urban planning institutions and the Urban Planning Department of the City Administration.
Vaje Na osnovi urbanističnega načrta ali regulacije zasnovati izvedbeni načrt (OPPN, načrt prenove) analizirati posestno stanje, parcelirati prostor in ga urbano opremiti (tekstovni in grafični elaborat). Za isti projekt obdelati strokovne podlage pridobivanje podatkov, način pridobivanja zemljišča, izvajanje plana ter trženje.	Tutorials Design of the implementation plan (municipal detailed spatial plan or renovation plan), based on the town plan or other regulations; analysis of land ownership; land allotment and urban infrastructure (textual and graphical report). To analyse and work on evidence bases for the project in question; data acquisition, land acquisition, plan implementation, and marketing.

Temeljna literatura in viri/Readings:

Pogačnik, A. 1998. Urbanistično planiranje; učbenik FGG.

Vrišer, I. 1984. Urbana geografija, UL-FGG, Ljubljana.

Taylor, N. 1998. Urban Planning Theory since 1945. Sage. Ponatisi 1999, 2001, 2003, 2004.

Crane, R., Weber, R. (ur.) 2012. The Oxford Handbook of Urban Planning. Oxford university Press.

Zavodnik Lamovšek, A. 2015. Gradiva za predmet Urbanistično načrtovanje. Spletna učilnica UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji - Podati geodetskim strokovnjakom celovita znanja o urejanju urbanih zemljišč, izgradnji naselij, varstvu okolja na urbanih območjih - Razumeti možnosti urbanizma v urejanju mest in drugih naselij - Razumeti stanje in procese razvoja zemljišč. Kompetence: - Poznavanje in razumevanje izvedbenih prostorskih dokumentov in planov razvoja stavbnih zemljišč, - Povezovanje z geoinformatiko, komunalnimi predmeti, sposobnosti teamskega in interdisciplinarnega dela. Navezava na področje upravljanja nepremičnin, razvoja zemljišč, urbanizma, rurizma.	Objectives - To provide the surveyors with comprehensive knowledge of urban planning, construction of settlements, and environmental protection in urban areas, - Understand of spatial conditions and land development processes, - Understand the options of urban design in town planning. Competences: - Knowledge and understanding of implementing spatial planning documents, and development of building plots, - Connections with geoinformation, courses on municipal management, capability of team and interdisciplinary work. Affiliation to the areas of real

	estate management, land development, urban design, rural studies.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Osnovno poznavanje vede urbanizma in obvladovanje procesov v urbanem prostoru, znanja iz načrtovanja na lokalni ravni – rabe tal, lokalne infrastrukture, izvedbenih načrtov, lokacijskih delov PGD, sodelovanje z javnostjo - V gospodarskih družbah za urbanistično načrtovanje, za pridobivanje in opremljanje zemljišč, znanja, ki so potrebna upravnim delavcem v urbanizmu., - Uporaba znanj na občinah, upravnih enotah, pri izdelavi SPRO, UN, lokacijskih načrtov in projektov - Lastno razumevanje, kritično vrednotenje procesov v urbanem prostoru, kritičnost pri prenosu vzorov urbanega razvoja iz EU in sveta. Lastna opažanja procesov v lokalnem okolju in njihovem razreševanju, kritičen odnos do nelegalnih posegov v prostor.	- Basic knowledge of urban design and understanding of processes in urban areas, know-how of planning at the local level – land use, local infrastructures, implementation plans, site-specific part of the project for acquisition of building permit (PGD), public engagement - In companies for urban planning, acquisition and development of land; know-how needed by administration staff in urban planning. Use of the knowledge in municipalities, administrative units, in elaboration of spatial development strategies, urban plans, detailed site plans and projects. - Students' own understanding, critical evaluation of processes in urban areas, critical approach to transfer of urban development models from the EU and elsewhere. Students' own observations regarding the processes in the local environment and their solving, critical approach to illegal spatial interventions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja Učenje s projektnim delom Terensko delo Seminar (Vsako temo seminarja se obrazloži, razdeli gradiva in prouči na terenu (ekskurzija). Po delu v skupinah s konzultacijami mentorjev se izdelki individualno predstavijo in zagovarjajo. V diskusiji sodelujejo vsi udeleženci seminarja.	Lectures Project based learning Field work Seminar work (Each seminar topic is explained, materials are handed out, and site visits are organised (excursion). Group work and consultations by mentors are followed by individual presentation and defence of work. All seminar participants take part in discussions.)

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Naloge in sprotno delo	50,00 %	Coursework and regular work
Pisni izpit (teoretičen del)	50,00 %	Written examination (theoretical part)

Reference nosilca/Lecturer's references:

ZAVODNIK LAMOVŠEK, Alma, DROBNE, Samo, ŽAUCER, Tadej. Small and medium-size towns as the basis of polycentric urban development = Majhna in srednje velika mesta kot ogrodje policentričnega urbanega

razvoja. Geod. vestn.. [Tiskana izd.], 2008, letn. 52, št. 2, str. 290-312, ilustr. http://www.geodetski-vestnik.com/52/2/gv52-2_290-312.pdf.

ZAVODNIK LAMOVŠEK, Alma, ČEH, Marjan, KOŠIR, Uroš. Analiza dostopnosti prebivalcev do javnih dejavnosti z medkrajevnim avtobusnim potniškim prometom. V: PERKO, Drago (ur.), ZORN, Matija (ur.). Geografski informacijski sistemi v Sloveniji 2009-2010, (GIS v Sloveniji, 10). Ljubljana: Založba ZRC, 2010, str. 251-260.

ZAVODNIK LAMOVŠEK, Alma, FOŠKI, Mojca, ČEH, Marjan. Urban Development and Planning Tools in Slovenia. V: LAMI, Isabella M. (ur.). An overview on planning systems and urban markets in Europe, (AO8, 50). Roma: Aracne editrice, 2005, str. 147-161, ilustr.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKTIRANJE IN GRADNJA JEKLENIH STAVB**
Course title:	**DESIGN AND CONSTRUCTION OF STEEL BUILDINGS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni

Koda učne enote na članici/UL Member course code:	1473

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	15	0	0	60	4

Nosilec predmeta/Lecturer:	Primož Može
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

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

Vsebina:	Content (Syllabus outline):
Predavanja Globalna analiza jeklenih konstrukcij (metode, začetne nepopolnosti, modeliranje, dimenzioniranje elementov, presoja rezultatov); osnove projektiranja potresno odpornih jeklenih konstrukcij (zasnova, duktilnost, ukrepi za zagotavljanje potresne odpornosti); korozijska zaščita jeklenih konstrukcij; požarna zaščita jeklenih konstrukcij; tolerance izdelave in montaže jeklenih; konstrukcij; tehnologija izdelave in montaže jeklenih; konstrukcij s poudarkom na stavbah; vzdrževanje jeklenih konstrukcij.	Lectures Global analysis of steel structures (methods, initial imperfections, modelling, design of the elements, and assessment of the results). Seismic design of steel structures (structural design, ductility, measures to ensure seismic resistance). Corrosion protection of steel structures Fire protection of steel structures. Manufacture and construction tolerances. Manufacture and construction technologies of steel buildings. Maintenance of steel structures. Seminar:

Seminar Izdelava projekta enostavne jeklene stavbe (statična zasnova, obtežbe, izračun notranjih sil, dimenzioniranje elementov in spojev, risanje načrta konstrukcije in podatki za izdelavo konstrukcije).	Each student has to draw a project of a simple steel building (conceptual design, definition of loads, calculation of internal forces and displacements, design of elements and joints, drawing plans by using appropriate software).

Temeljna literatura in viri/Readings:

B. Beg. 1999. Projektiranje jeklenih konstrukcij po env 1993-1-1. Ljubljana, UL FGG.

D. A. Nethercot. 1991. Limit states design of structural steelwork, chapman and hall. London.

D. Beg. 2002. Potresnoodporno projektiranje jeklenih konstrukcij - učimo se na napakah. Gradb. vestn., let. 51, str. 50-59, graf. prikazi.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Nadgraditi osnovno znanje s področja projektiranja jeklenih konstrukcij z znanjem o projektiranju stavb ter njihovi izdelavi in montaži, - Pridobiti znanja , ki bodo v pomoč pri pridobitvi licence pooblaščenega inženirja pri Inženirski zbornici Slovenije. Pridobljene kompetence: - Sposobnost projektiranja jeklenih konstrukcij na nivoju sistemov (stavb) - Sposobnost vodenja izdelave in montažejeklenih stavb.	Objectives: - To upgrade the basic knowledge on steel structures with the knowledge of design, manufacturing and construction of steel buildings - Acquire skills necessary to obtain a license for authorized engineer at the Slovenian Chamber of Engineers. Competences: - Ability to design steel structures (buildings). - Ability to manage manufacturing and construction of steel buildings.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznati in razumeti metode analize in dimenzioniranja sistemov ter - Spoznati in razumeti obnašanje jeklenih konstrukcij med potresom, - Spoznati in razumeti metode izdelave inmontaže jeklenih 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	- To know and understand the methods of analysis and the design of systems. - To know and understand the behaviour of steel structures subjected to earthquake - Student should learn to use theoretical knowledge in engineering practice. - To know and understand the manufacturing and the construction methods of steel buildings. - Student should learn to use the theoretical knowledge in engineering practice. - One of the main features of structural design is decision making. Based on acquired theoretical and practical knowledge student should be able to

posameznega problema, izločitve neustreznih rešitev in utemeljene izbire ene od ustreznih rešitev, - Sposobnost uporabe računalniških programov za analizo konstrukcij, - Sposobnost kritične presoje rezultatov računalniških analiz, - Sposobnost kritične presoje strokovnih problemov, - Pridobivanje spretnosti za uporabo literature, interneta in drugih informacijskih tehnologij.	critically judge the individual problem, to eliminate the inappropriate solutions and to justify the choice of possible solutions. - Ability to use computer programs for structural analysis. - Ability to critically judge the results of numerous numerical analyses. - 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 predavanj in seminarja.	The course will consist of lectures and seminars.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Samostojna naloga	40,00 %	Approved project work
Zagovor naloge	30,00 %	Defence of the approved project work
Ustni izpit Študenti, ki za samostojno nalogo in njen ustni zagovor dosežejo vsaj 57 točk od 70 so oproščeni ustnega izpita.	30,00 %	Oral exam If student gets more than 57 pt./70 pt. at approved project work, he can skip the oral exam

Reference nosilca/Lecturer's references:

MOŽE, Primož. Bearing strength at bolt holes in connections with large end distance and bolt pitch, Journal of Constructional Steel Research, 147 (2018) 132-144.

MOŽE, Primož, CAJOT, Luis-Guy, SINUR, Franc, REJEC, Klemen, BEG, Darko. Residual stress distribution of large steel equal leg angles. Engineering structures, ISSN 0141-0296. [Print ed.], 2014, letn. 71, št. jul., str. 35-47, ilustr.

MOŽE, Primož, BEG, Darko. A complete study of bearing stress in single bolt connections. Journal of constructional steel research, ISSN 0143-974X. [Print ed.], apr. 2014, letn. 95, str. 126-140, ilustr.

MOŽE, Primož, BEG, Darko. Investigation of high strength steel connections with several bolts in double shear. Journal of constructional steel research, ISSN 0143-974X. [Print ed.], 2011, letn. 67, št. 3, str. 333-347, ilustr., doi: 10.1016/j.jcsr.2010.10.007. [COBISS.SI-ID 5173345]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**NIZKE GRADNJE IN INFRASTRUKTURA ZA VARSTVO OKOLJA**
Course title:	**ENGINEERING WORKS AND WATER PROTECTION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer)		Letni, Zimski

Koda učne enote na članici/UL Member course code:	1775

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
15	15	0	30	0	60	4

Nosilec predmeta/Lecturer:	Mario Krzyk, Nataša Atanasova, Sabina Kolbl Repinc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Opravljeni izpiti iz predmeta Hidravlika in predmetov Osnove zdravstvene hidrotehnike ali Površinska odvodnja 1. stopnji študijskega programa BA GR-UNI ali BA VOI oz. osvojena ustrezna primerljiva znanja. Ustreznost oziroma primerljivost znanj oceni nosilec oziroma izvajalec predmeta.	Finished courses in Hydraulics and Introduction to Sanitary Engineering or Surface Drainage of the study programme BA GR-UNI or BA VOI or equivalent knowledge from other BA studies. The equvalnecy of student's prior knowledge is asses by the course lecturer.

Vsebina:	Content (Syllabus outline):
Predavanja: Gradnja inženirskih objektov se sreča tudi z infrastrukturo za varstvo okolja, zato so prikazane najnovejše okoljske tehnologije in integralne rešitve vodooskrbe, zbiranja in odvodnje odpadnih in padavinskih voda ter trendi za zapiranje snovnih tokov (ravnanje z naravnimi in sekundarnimi viri):	**Lectures:** Engineering works have environmental impacts that need to be identified and managed properly. The lectures will present the latest environmental technologies and integrated solutions for water supply, wastewater collection and treatment, drainage and reuse oriented waste management:

1. Vodna telesa in njihova (tehnična) zaščita ter varstvo voda 2. Zahteve sistemov za oskrbo z vodo in robni pogoji za druge rabe prostora 3. Objekti na vodovodnih sistemih 4. Vrste in karakterizacija odpadnih voda 5. Sistemi za zbiranje, odvodnjo in ravnanje s padavinskimi vodami – razbremenjevanje in zadrževanje 6. Objekti na kanalizacijskih sistemih 7. Ponovna in večkratna (u)poraba vode 8. Ravnanje z odpadki in pogoji za rabo sekundarnih virov **Seminar:** Študenti iz nabora področij obravnavajo povezanost izvedbe nizkih gradenj z infrastrukturo za varstvo okolja, da prikažejo pravne vidike (predpise, teh. smernice…) in tehnične rešitve pri prečkanju okoljske infrastrukture.	1. Water bodies and their protection 2. Requirements of water supply systems and their interaction with other land uses 3. Elements of water supply systems 4. Types and characterisation of wastewater 5. Wastewater collection and drainage systems. Approaches to storm water management 6. Sewage systems elements 7. Water reuse 8. Waste management and conditions for use of secondary sources. **Seminary work:** Students will work on problems where engineering works interact with infrastructure for environmental protection and present legislative aspects in this cross-sectoral area and find an optimal technical solution to avoid environmental damage.

Temeljna literatura in viri/Readings:

Knjižni viri:

Malcolm J. Brandt; K. Michael Johnson; Andrew J. Elphinston; Don D. Ratnayaka (2016) Twort's Water Supply, Seventh Edition. Butterworth-Heinemann, 2016.

Kompare, B., 2013. Vodovod in priprava pitne vode, interna skripta, slikovno gradivo.

Butler, D., Davies, J. (2011). Urban Drainage, Third Edition. London: CRC Press.

Panjan, J., (2005), Osnove zdravstveno hidrotehnične infrastrukture, UL FGG, 289 strani.

Williams, P.T. 2005. Waste treatment and disposal, 2nd edition. Wiley-Blackwell, 392 strani.

Metcalf & Eddy, Inc. Wastewater Engineering : Treatment and Reuse. Boston :McGraw-Hill, 2003. Print.

Kompare B. (1991), Modeliranje deževnega odtoka iz urbaniziranih povodij, FAGG Inštitut za zdravstveno hidrotehniki, Ljubljana, 509 strani.

Kolar, J., (1983), Odvod odpadne vode iz naselij in zaščita voda, DZS, 523 strani.

Cilji in kompetence:	**Objectives and competences:**
Cilji: Študenti naj pridobijo dodatna znanja in spretnosti za upoštevanje kompleksnih okoljskih vidikov, ki jih je treba upoštevati pri projektiranju in izvedbi nizkih gradenj. **Kompetence:** Študent pridobi širše znanje o kompleksnosti izvedbe nizkih gradenj, ki se stikajo z infrastrukturo za	**Goals:** Introduce students to additional knowledge and skills for solving complex environmental problems in planning and building infrastructural constructions. **Competences:** The student extends his/her knowledge on infrastructural civil engineering structures and their

varstvo okolja in zahtevami za trajnostno rabo naravnih virov in varstva (vodnega) okolja.	integration into the natural environment taking into account the sustainability aspects.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje kompleksnih okoljskih problemov in tehnologij, ter njihovega vpliva na pravilno zasnovo nizkih gradenj. **Prenosljive spretnosti:** Poznavanje omejitev, prepovedi in zapovedi za ustrezno delovanje infrastrukture za varstvo okolja, ki se upoštevajo pri visokih in nizkih gradnjah.	**Knowledge and understanding:** Understanding the complex environmental problems and their impact on the proper design of infrastructural civil engineering objects. **Skills:** Identifying limitations and recommendations for proper functioning of environmental protection infrastructure facilities that need to be considered when planning construction works.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in osnovni računski primeri kot podlaga za uporabo pridobljenih znanj pri izdelavi individualnega seminarskega dela.	Lectures and calculus will be used as a basis for elaboration of individual project work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
seminar	50,00 %	Project Report
izpit	50,00 %	Exam

Reference nosilca/Lecturer's references:

ATANASOVA, Nataša, DALMAU, Montserrat, COMAS, Joaquim, POCH ESPALLARGAS, Manel, RODRIGUEZ-RODA, Ignasi, BUTTIGLIERI, Gianluiggi. Optimized MBR for greywater reuse systems in hotel facilities. Journal of environmental management, ISSN 0301-4797, 2017, letn. 193, št. maj, str. 503-511, ilustr., doi: 10.1016/j.jenvman.2017.02.041. [COBISS.SI-ID 8125793]

RADINJA, Matej, BANOVEC, Primož, COMAS, Joaquim, ATANASOVA, Nataša. Modeliranje in ocena vplivov razpršenih ukrepov zadrževanja in ponikanja padavinske vode na odtok iz urbanega povodja = Modelling and evaluating impacts of distributed retention and infiltration measures on urban runoff. Acta hydrotechnica, ISSN 1581-0267. [Spletna izd.], 2017, vol. 30, no. 52, str. 51-64, ilustr. ftp://ksh.fgg.uni-lj.si/acta/a30mr.pdf. [COBISS.SI-ID 8228193]

ŠIVIC, Ana, ATANASOVA, Nataša, PUIG, Sebastià, GRIESSLER BULC, Tjaša. Ammonium removal in landfill leachate using SBR technology - dispersed versus attached biomass. Water science and technology, ISSN 0273-1223, 2017, vol. 77, iss. 1, str. 27-38, ilustr., doi: 10.2166/wst.2017.519. [COBISS.SI-ID 8181089]

ATANASOVA, Nataša, POCH ESPALLARGAS, Manel. REUCITY - Innovative technologies for resource oriented cities. Girona: Universitat de Girona, Laboratory of Chemical and Environmental Engineering, 2017. 27 str., ilustr. ISBN 978-84-9984-393-3. http://www.lequia.udg.edu/research/books/item/2514-reucity.html. [COBISS.SI-ID 8126305]

KRZYK, Mario, DREV, Darko, KOLBL, Sabina, PANJAN, Jože. Self-purification processes of Lake Cerknica as a combination of wetland and SBR reactor. Environmental science and pollution research international, ISSN 0944-1344., 2015, str. 1-9, ilustr., doi: 10.1007/s11356-015-5088-0. [COBISS.SI-ID 7133793].

KRZYK, Mario, MALUS, Davor, PANJAN, Jože. Meritve kakovostnih parametrov za modeliranje prvega vala onesnaženih voda s cestnih površin = Measurements of quality parameters for the modeling of the first flush of polluted water from roads. Gradbeni vestnik, ISSN 0017-2774, jul. 2013, letn. 62, str. 159-164, ilustr. [COBISS.SI-ID 6310497]

KRZYK, Mario, PANJAN, Jože. Občutljivostna analiza parametrov modeliranja prvega vala onesnaženih voda s cestnih površin = A sensitivity analysis modeling parameters of the first wave of polluted waterfrom road surface. Gradbeni vestnik, ISSN 0017-2774, dec. 2012, letn. 61, str. 275-283, ilustr. [COBISS.SI-ID 6129505].

KRIVOGRAD-KLEMENČIČ, Aleksandra, KRZYK, Mario, DREV, Darko, BALABANIČ, Damjan, KOMPARE, Boris. Recikliranje tekstilnih odpadnih voda očiščenih z različnimi kombinacijami naprednih oksidacijskih postopkov. Acta hydrotechnica, ISSN 0352-3551. [Tiskana izd.], 2012, letn. 25, št. 42, str. 29-36, ilustr. [COBISS.SI-ID 6056545]

KOLBL, Sabina, FORTE-TAVČER, Petra, STRES, Blaž. Potential for valorization of dehydrated paper pulp sludge for biogas production : addition of selected hydrolytic enzymes in semi-continuous anaerobic digestion assays. *Energy*, ISSN 0360-5442. [Print ed.], 2017, vol. 126, str. 326-334, ilustr. http://www.sciencedirect.com/science/article/pii/S0360544217304127, doi: 10.1016/j.energy.2017.03.050. [COBISS.SI-ID 3874696]

KOLBL, Sabina, PANJAN, Jože, STRES, Blaž. Mixture of primary and secondary municipal wastewater sludge as a short-term substrate in 2 MW agricultural biogas plant: site-specific sustainability of enzymatic and ultrasound pretreatments. *Journal of chemical technology and biotechnology*, ISSN 0268-2575. [Print ed.], 2016, vol. 91, no. 11, str. 2769-2778, ilustr. http://onlinelibrary.wiley.com/doi/10.1002/jctb.4883/abstract, doi: 10.1002/jctb.4883. [COBISS.SI-ID 7327073]

KOLBL, Sabina, STRES, Blaž. Uporaba bioloških odpadkov za pridobivanje bioplina = Usage of organic fraction of biological waste for biogas production. *Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije*, ISSN 0017-2774. [Tiskana izd.], sep. 2016, letn. 65, str. 205-211, ilustr. [COBISS.SI-ID 7654241]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**KOMUNALNO IN STANOVANJSKO GOSPODARSTVO**
Course title:	**MUNICIPAL AND HOUSING ECONOMICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Komunalno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1243

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	15	45	0	0	90	6

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač, Daniel Kozelj
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Komunalno inženirstvo.	The course is a part of the module Municipal Engineering.

Vsebina:	Content (Syllabus outline):
Predavanja: javne potrebe, javne gospodarske službe, javna infrastruktura; pojem, pomen in vloga komunalnih dejavnosti; stroškovni vidiki izvajanja komunalnih dejavnosti; organiziranost komunalnih dejavnosti; sistem javnih financ na lokalni ravni; ekonomski instrumenti varstva okolja; temeljni pojmi s področja stanovanjskega gospodarstva; lastninska in druge pravice na stanovanju; planiranje stanovanjske gradnje; trg stanovanj in stanovanjskih hiš; upravljanje države in občin z nepremičninami;	Lectures: public needs, public utility, public infrastructure; concept and role of municipal activities; cost aspects of performing municipal activities implementation; organization of public utilities; public finance system at local level; economic instruments for environmental protection; basic concepts related to housing; property and other rights to housing; housing construction within spatial planning; housing market; state and municipal real estate management; management of

upravljanje v večstanovanjskih hišah; stroški uporabe stanovanj in stanovanjskih hiš (najemnine). Seminar: Izdelava samostojnega seminarja s področja komunalnega in/ali stanovanjskega gospodarstva in predstavitev. Seminarske vaje (računske vaje)	multi-dwelling houses; costs and housing expenses (rent). Seminar: Making of individual seminar work in the field of municipal and/or housing economics. Tutorial Calculation exercises in the field of municipal and housing economics.

Temeljna literatura in viri/Readings:

Rakar, A. 2011. Komunalno gospodarstvo: študijsko gradivo, Ljubljana, UL FGG, 71. strani.

Rakar, A., Šubic Kovač M. 2010. Stanovanjsko gospodarstvo: študijsko gradivo. Ljubljana, UL FGG, 92 str.

Rakar, A. 1994. Komunalno gospodarstvo, učbenik, Ljubljana, UL, FGG, 184 strani.

Balchin P., Rhoden M. 2002. Housing policy, Routledge, London and New York, str. 99-120, 328- 338.

Aktualni predpisi: http://www.gov.si.

Cilji in kompetence:	**Objectives and competences:**
Cilji: • Predmeta je seznaniti študenta s področjem komunalnega in stanovanjskega gospodarstva, vključno z izhodišči za pripravo strokovnih podlag v pripravi prostorskega načrta. Kompetence: • Poznavanje in razumevanje strokovnega izrazoslovja s področja komunalnega in stanovanjskega gospodarstva. • Poznavanje in razumevanje bistvenih značilnosti pravnih, organizacijskih in ekonomskih vidikov na področju komunalnega in stanovanjskega gospodarstva. • Razumevanje in uporaba teoretičnih izhodišč v praksi. • Seznanjenost z zakonodajo. • Komuniciranje z drugimi strokovnjaki v praksi. • Delovanje v timu, še predvsem pri pripravi strokovnih podlag v fazi priprave prostorskih načrtov. • Kritično presojanje in prilagajanje novim situacijam.	Objectives: • To get students familiar with housing and municipal economics and their role as basis for the expert guidelines when making spatial planning documents. Competences: • To know and understand terminology in the field of housing and municipal economics. • To know and understand the key characteristics of legal, organizational and economic aspects in the field of housing and municipal economics. • Understanding and application of theoretical principles in practice. • Knowledge regarding legislation in the field of housing and municipal economics. • Ability to communicate with other experts in practice. • Ability to work in team with other experts when preparing spatial planning documents. • Ability of critical judgment and adjustment to new situations.

Predvideni študijski rezultati:	Intended learning outcomes:
• Študent spozna in razume bistvene značilnosti s področja komunalnega in stanovanjskega gospodarstva in razume specifičnosti delovanja na teh področjih. • Študent svoje znanje uporabi pri pripravi strokovnih podlag za izdelavo razvojnih programov, pri izvajanju ukrepov za njihovo realizacijo ter pri odločitvah v fazi upravljanja stanovanj in komunalne infrastrukture. Študent na osnovi sinteze pridobljenih znanj s področja prava, ekonomije in organizacije lahko kritično presoja zahteve dnevne politike glede bodočega razvoja dejavnosti, zahteve po sodelovanju kvalificirane in laične javnosti pri sprejemanju razvojnih programov, prav tako pa tudi poskuse uvajanja pogodbenih odnosov v odločanje o javno-pravnih zadevah na področju komunalnega in stanovanjskega gospodarstva.	• Student is familiar with basic characteristics in the field of housing and municipal economics. • Acquired knowledge can be used when preparing expert basis for making spatial planning documents. The knowledge should help students in the decision making process in the field of housing management and public service infrastructure management. Synthesis of knowledge in the field of law, economy and organisation allows student to critically consider housing policy and development programs in the field of public service infrastructure. Insight into contractual relationships between stakeholders in the field of housing and municipal economics is given as well

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, seminar in seminarske vaje se izdeluje s pomočjo gradiva v spletni učilnici in na spletu. Za poučevanje se uporablja IKT.	Lectures, seminar and tutorial are done using visual aids and materials/literature available through the E-classroom or using other publicly available data.

Načini ocenjevanja:	Delež/Weight	Assessment:
Dva kolokvija: teoretičen del ali Pisni izpit: teoretičen del	40,00 %	Two mid-term written exams: theoretical part or Written examination theoretical part
kolokvija-računski del ali izpit - računski del	30,00 %	Two mid-term written exams: calculation exercises or Written examination calculation exercises
Seminar Vsak del mora biti ocenjen pozitivno.	30,00 %	seminar Each part of the exam must be graded positive as well as seminar.

Reference nosilca/Lecturer's references:

ŠUBIC KOVAČ, Maruška. Analysis of expert bases for levying municipal contribution in Slovenia, taking into account fundamental principles. V: HEPPERLE, Erwin (ur.). Methods and concepts of land management : diversity, changes and new approaches, (European academy of land use and development - EALD). 1. Aufl. Zürich: Hochschulverlag. 2020, str. 293-306, ilustr. https://vdf.ch/methods-and-concepts-of-land-management.html, https://www.research-collection.ethz.ch/handle/20.500.11850/445042, doi: 10.3929/ethz-b-000445042.

ŠUBIC KOVAČ, Maruška. A causal analysis between construction, real estate, and economic growth : a case study of Slovenia. V: ABDULAI, Raymond Talinbe (ur.). *Real estate, construction and economic development*

in emerging market economies, (Routledge studies in international real estate). 1st ed. London; New York: Routledge. 2016, str. 64-87, ilustr.

ŠUBIC KOVAČ, Maruška. Acquisition of Land and Compensation in Infrastructure Projects in the Republic of Slovenia. V: HEPPERLE, Erwin (ur.), LISEC, Anka (ur.). Opportunities and Constraints of Land Management in Local and Regional Development : Integrated Knowledge, Factors and trade-offs. 1. Aufl. Zürich: Hochschulverlag. 2018, str. 187-201. https://www.research-collection.ethz.ch/handle/20.500.11850/289657.

KAFOL STOJANOVIĆ, Ajda, KOZELJ, Daniel, ŠUBIC KOVAČ, Maruška. Assessment of water distribution system capacity as settlement-development decision-making expert basis at the local level = Ocena zmogljivosti vodovodnega sistema kot strokovna podlaga za odločanje o usmerjanju razvoja naselij na lokalni ravni. Geodetski vestnik : glasilo Zveze geodetov Slovenije, ISSN 0351-0271. [Tiskana izd.], 2020, letn. 64, št. 3, str. 389-401, ilustr.

BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, Sep. 2019, vol. 27, iss. 3, str. 759-781, ilustr.

ZEVNIK, Jure, KRAMAR FIJAVŽ, Marjeta, KOZELJ, Daniel. Generalized normalized cut and spanning trees for water distribution network partitioning. Journal of water resources planning and management, ISSN 0733-9496. [Print ed.], 2019, letn. 145, št. 10, str. 1-12, ilustr.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**VODOVOD IN KANALIZACIJA**
Course title:	**WATER SUPPLY AND SEWAGE SYSTEMS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Komunalno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1627

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
60	30	0	60	0	150	10

Nosilec predmeta/Lecturer:	Franc Steinman, Mario Krzyk
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Komunalno inženirstvo. Opravljen izpit iz predmetov Hidromehanike in Inženirske hidrotehnike oziroma ustrezna primerljiva znanja.	The course is a part of the module Municipal Engineering. Passed exams in Hydromechanics and Engineering hydraulics.

Vsebina:	Content (Syllabus outline):
Predavanja Uvod in zgodovinski razvoj stroke. Hidravlično modeliranje cevovodnih sistemov (poznavanje hidravličnih lastnosti različnih elementov sistemov, običajni primeri njihove uporabe in izredni dogodki, preračun in izbira ustreznih orodij za zahtevne primere uporabe). Uporaba hidravličnih modelov	Lectures: Introduction and historical development of the profession. Hydraulic modeling of piping systems (knowledge of the hydraulic properties of the different elements of the systems, usual examples of their use and incidents, calculation and selection of appropriate tools for complex cases). The use of

(načrtovanje, preverjanje obratovanja, rehabilitacija in posodabljanje sistemov ipd.).	hydraulic models (design, verification operation, rehabilitation and modernization of systems, etc.).
Vodni viri – pojavljanje, karakteristike, izkoriščanje, zaščita. Potrebe po vodi, načrtovanje porabe in izrabe vodnih virov; vrste odpadne vode, nastanek in načini odvodnje odpadnih in padavinskih voda.	Water resources - the appearance, characteristics, utilization, protection. Water needs, consumption planning and utilization of water resources; types of waste water, the formation and methods of drainage wastewater and rainwater.
Vodne izgube – vrste, odpravljanje, rehabilitacija cevovodov. Zasnova, načrtovanje, izgradnja in obratovanje vodovodnih in kanalizacijskih sistemov. Padavine v Sloveniji in analiza nalivov.	Water loss – types, elimination, rehabilitation of pipelines. Design, planning, construction and operation of water supply and sewerage systems. Precipitation in Slovenia and rainfall analysis.
Razbremenjevanje in zadrževanje onesnaženih voda. Presoja vplivov razbremenjenih kanalskih voda na kakovost sprejemnikov razbremenjenih vod. Vpliv zalednih voda na poplavno varnost urbaniziranih površin. Statična presoja proti porušitvi cevi in vodotesnost sistema. Objekti na vodovodnih in kanalizacijskih sistemih.	Overflowing and retention of sewage water. Assessment of the effects of overflowed sewage water on recipient quality. Impact of back-water on flood security of urbanized areas. Static assessment of pipes and water tightness of the system. Facilities on water supply and sewerage systems.
Vaje:	Exercises:
Hidravlični izračun sistemov za odvod onesnaženih voda z zadrževalniki in razbremenilniki. Statična presoja cevi proti porušitvi. Dimenzioniranje črpališča. Spoznavanje z matematičnimi modeli za dimenzioniranje vodovodnih in kanalizacijskih sistemov.	Hydraulic calculation of drainage systems for sewage water with retention and overflow reservoirs Static assessment pipes burst. Dimensioning of the pumping systems. Introducing of mathematical models for designing water supply and sewerage systems.
Seminar	Seminar:
Račun hidravličnih lastnosti in značilnih obratovalnih stanj izbranega zahtevnega sistema, verifikacija-umerjanje-validacija in uporaba hidravličnih modelov v načrtovanju, obratovanju ter značilnih dogodkih tekom življenjskega cikla.	Hydraulic properties calculation and typical operating conditions of selected complex system, verification-calibration-validation and usage of hydraulic models for designing, operation and in significant events during the life cycle.

Temeljna literatura in viri/Readings:

Steinman, F. 2010. Hidravlika – učbenik. 2. ponatis, Ljubljana, UL FGG, 294 str.

Panjan, J. 2008. Odvodnjavanje onesnaženih voda – skripta. Ljubljana, UL FGG, 198 str.

Panjan, J. 2005. Osnove zdravstveno hidrotehnične infrastrukture. Ljubljana, UL FGG, 289 str.

Kompare, B. 1991. Modeliranje deževnega odtoka iz urbaniziranih povodij. Ljubljana, FAGG Inštitut za zdravstveno hidrotehniki, 509 str.

Hosang, W., Bischof, W. 1998. Abwassertechnik. B.G. Teubner Stuttgart, 724 str.

Walski, T.M. 2001. Water distribution Modeling. Haestad Press, Waterbury, ZDA, 441 str.

Viessman, W., Hammer, M.J., Chadik, P., Perez, E.M. 2008. Water Supply and Pollution Control: International Version. Pearson Education.

AWWA. 2010. Water Supply Operations: Water Treatment, 4th Ed. AWWA.

World resources institute. 2011. World resources Report 2010-2011.

e-student in spletna stran IZH.

Cilji in kompetence:	**Objectives and competences:**
- Cilj predmeta je študentom dati znanja in spretnosti za načrtovanje in izvedbo vodovodnih in kanalizacijskih sistemov. - Študent se nauči načrtovati zajem vode, pripravo pitne vode in razdelitev po naselju in odvod padavinske in odpadne vode. Razume in zna preveriti dobljene rezultate modeliranja.	- To gain knowledge and skills for designing and applying water supply and sewage systems. - Design of water catchment elements, water treatment utilities, and water distribution networks, and drain rainwater and waste water. Students are competent to understand and interpret modelling results.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Pridobljeno poglobljeno znanje za hidravlično dimenzioniranje zahtevnih primerov uporabe vodovodnih sistemov in urbani odvodnji. - Razumevanje funkcioniranja vodovodnih in kanalizacijskih sistemov. - Osvojeno znanje za dimenzioniranje in za načrtovanje sistemov. - Izdelava najzahtevnejših hidravličnih izračunov v hidrotehnični praksi ter snovanje in izgradnja vodovoda in kanalizacije. - Razumevanje fizikalnih osnov vodovodnih in kanalizacijskih sistemov, sposobnost analize variantnih rešitev in izbira optimalne. - Sposobnost upoštevanja hidravličnih lastnosti infrastrukturnih in drugih sistemov in naprav pri dimenzioniranju cevovodnih in kanalizacijskih sistemov in objektov na njih, ki jih bodo načrtovali v praksi. - Sposobnost umeščanja sistemov in naprav v urbanem okolju. - Sposobnost kritične presoje podatkov in dobljenih računskih rezultatov pri načrtovanju ukrepov.	- Obtained knowledge for the design and planning systems. - Manufacturing of complex hydraulic calculations in river engineering and design and construction of water supply and sewage systems. - Understanding the physical basis of water supply and sewerage systems, the ability to analyze alternative solutions and the optimal choice. - Ability to take into account the hydraulic characteristics of the infrastructure and other systems and installations in sizing water supply and sewage systems and buildings on them, they will be programmed into practice. - Ability positioning systems and devices in an urban environment. - The ability for critical analysis of data and computational results obtained when planning interventions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske in laboratorijske vaje, seminar.	Lectures, seminar and laboratory tutorials, seminar.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni in/ali ustni izpit	50,00 %	Written and / or oral examination

Seminarske vaje	25,00 %	Tutorials
Seminarska naloga	25,00 %	Seminar

Reference nosilca/Lecturer's references:

KOZELJ, Daniel, KAPELAN, Zoran, NOVAK, Gorazd, STEINMAN, Franci. Investigating prior parameter distributions in the inverse modelling of water distribution hydraulic models. Strojniški vestnik, ISSN 0039-2480, Nov. 2014, vol. 60, no. 11, str. 725-734.

PREŠEREN, Tanja, STEINMAN, Franci, ŠIROK, Brane, BAJCAR, Tom. The theoretical densimetric Froude number values with favourable effect on the clarifier performance. Chemical engineering and processing, ISSN 0255-2701. [Print ed.], 2013, vol. 74, str. 97-105.

BAJCAR, Tom, STEINMAN, Franci, ŠIROK, Brane, PREŠEREN, Tanja. Sedimentation efficiency of two continuously operating circular settling tanks with different inlet- and outlet arrangements. Chemical engineering journal, ISSN 1385-8947. [Print ed.], 15. Dec. 2011, vol. 178, str. 217-224.

KRZYK, Mario, DREV, Darko, KOLBL, Sabina, PANJAN, Jože. Self-purification processes of Lake Cerknica as a combination of wetland and SBR reactor. Environmental science and pollution research international, ISSN 0944-1344. [Print ed.], dec. 2015, letn. 22, št. 24, str. 20177-20185.

KRZYK, Mario, PANJAN, Jože, DREV, Darko. Postupci recikliranja tekstilnog odpada = Procedures of textile waste recycling = Recyclingverfahren von textilen Abfällen. Tekstil : časopis za tekstilnu tehnologiju i konfekciju, ISSN 0492-5882. [Print ed.], sep-okt. 2014, letn. 63, št 9-10, str. 306-313.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKT IZ KOMUNALNE INFRASTRUKTURE**
Course title:	**PROJECT FROM MUNICIPAL INFRASTRUCTURE**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Komunalno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1564

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač, Daniel Kozelj
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Komunalno inženirstvo	The course is a part of the module Municipal Engineering.

Vsebina:	Content (Syllabus outline):
Elaborat, ki ga izdela študent samostojno ali v skupini ima naslednje sestavne dele: Predstavitev obstoječega stanja in razvojnih potreb po komunalni infrastrukturi v lokalni skupnosti z opisom razlogov za obravnavano investicijo. Opredelitev razvojnih možnosti in ciljev investicije ter preveritev usklajenosti s strateškimi dokumenti. Opis in analiza variant investicije (lokacija, investicijski stroški, varstvo okolja, predvideni viri financiranja), ekonomska upravičenost projekta. Predlog najugodnejše variante s finančno konstrukcijo	Expert report by individual student or a group of students, including at least the following: analysis of existing condition and needs in the field of technical infrastructure within selected municipality; description of selected investment in technical infrastructure; definition of goals, alternatives to implement the goals, analysis of alternatives considering costs and benefits, locations, influence on environment, economic feasibility; proposal of most favourable alternative with financial structure of the project included; timeline of selected

projekta. Ugotovitev smiselnosti in možnosti nadaljnje priprave investicijske, projektne, tehnične in druge dokumentacije s časovnim načrtom. Točna vsebina oziroma obravnavana investicija se določi vsako leto posebej glede na aktualnost in v sodelovanju z ostalimi nosilci predmetov modula.	investment. The exact content (selected investment) is determined on an annual basis depending on the current relevance and in cooperation with other lecturers.

Temeljna literatura in viri/Readings:

Literatura s področja vsebine projekta (konkretne lokalne gospodarske javne infrastrukture).

Veljavni normativni akti, ki se nanašajo na:

- gospodarske javne službe
- prostorsko načrtovanje
- graditev objektov
- varstvo okolja
- sistem javnih financ na lokalni ravni
- javna naročila.

Cilji in kompetence:	**Objectives and competences:**
- Cilj je naučiti študenta povezovati tehnična, prostorska in družboslovna znanja na področju gospodarske javne infrastrukture. - Sposobnost izdelave in javne predstavitve investicijske zasnove in investicijskega programa za omrežja, objekte in naprave gospodarske javne infrastrukture.	- The goal is to teach student how to connect technical knowledge, spatial knowledge and knowledge from social sciences in the field of municipal (technical) infrastructure. - Capability to make and present in public the investment design and investment programme for the construction/renovation of municipal (technical) infrastructure.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Študent pridobi potrebno znanje za izdelavo dokumenta identifikacije investicijskega projekta za izbran del komunalne infrastrukture v smislu: potrebe – projekt– financiranje – izvedba	- Student acquires the knowledge needed to make an identification document for the investment project for a selected part of municipal (technical) infrastructure in the following sense: needs – project – financing – implementation.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Nosilec predmeta razpiše teme projektov in prijavljene kandidate pri izdelavi elaborata usmerja in vodi. Študentje (posamično ali v skupini) izdelajo elaborat s predpisano obliko in vsebino ter ga javno predstavijo in zagovarjajo.	The lecturer prepares various project tasks in advance and then guide students in the process of making a project. Students (individually or divided in several groups) make their project in the prescribed written form and make oral presentation of the project in public.

Načini ocenjevanja:	Delež/Weight	Assessment:
Projekt - pisni izdelek	70,00 %	Project - written document
ustna predstavitev projekta	30,00 %	Project - presented in public

Reference nosilca/Lecturer's references:

ŠUBIC KOVAČ, Maruška. Analysis of expert bases for levying municipal contribution in Slovenia, taking into account fundamental principles. V: HEPPERLE, Erwin (ur.). Methods and concepts of land management : diversity, changes and new approaches, (European academy of land use and development - EALD). 1. Aufl. Zürich: Hochschulverlag. 2020, str. 293-306, ilustr. https://vdf.ch/methods-and-concepts-of-land-management.html, https://www.research-collection.ethz.ch/handle/20.500.11850/445042, doi: 10.3929/ethz-b-000445042.

ŠUBIC KOVAČ, Maruška. A causal analysis between construction, real estate, and economic growth : a case study of Slovenia. V: ABDULAI, Raymond Talinbe (ur.). *Real estate, construction and economic development in emerging market economies*, (Routledge studies in international real estate). 1st ed. London; New York: Routledge. 2016, str. 64-87, ilustr.

ŠUBIC KOVAČ, Maruška. Acquisition of Land and Compensation in Infrastructure Projects in the Republic of Slovenia. V: HEPPERLE, Erwin (ur.), LISEC, Anka (ur.). Opportunities and Constraints of Land Management in Local and Regional Development : Integrated Knowledge, Factors and trade-offs. 1. Aufl. Zürich: Hochschulverlag. 2018, str. 187-201. https://www.research-collection.ethz.ch/handle/20.500.11850/289657.

KAFOL STOJANOVIĆ, Ajda, KOZELJ, Daniel, ŠUBIC KOVAČ, Maruška. Assessment of water distribution system capacity as settlement-development decision-making expert basis at the local level = Ocena zmogljivosti vodovodnega sistema kot strokovna podlaga za odločanje o usmerjanju razvoja naselij na lokalni ravni. Geodetski vestnik : glasilo Zveze geodetov Slovenije, ISSN 0351-0271. [Tiskana izd.], 2020, letn. 64, št. 3, str. 389-401, ilustr.

BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, Sep. 2019, vol. 27, iss. 3, str. 759-781, ilustr.

KOZELJ, Daniel, GORJUP, Marijan, KRAMAR FIJAVŽ, Marjeta. Uporaba teorije grafov za zasnovo merilnih območij v vodovodnem omrežju = An application of spectral graph partition for designing district metered areas in water supply networks. Acta hydrotechnica, ISSN 0352-3551. [Tiskana izd.], 2017, 30, [št.] 53, str. 81-96, ilustr.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROCESNO MODELIRANJE IN INFORMACIJSKI SISTEMI**
Course title:	**PROCESS MODELLING AND INFORMATION SYSTEMS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Organizacija - informatika (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1476

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	15	0	60	4

Nosilec predmeta/Lecturer:	Tomo Cerovšek
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Organizacija – informatika.	The course is a part of the module Organisation – Building Informatics

Vsebina:	Content (Syllabus outline):
Predavanja Osnove modeliranja procesov in njihova uporaba. Ogrodja in metode modeliranja procesov. Mikro in makro modeliranje procesov. Ponovna uporaba procesnih modelov pri sodelovanju. Prenova poslovnih procesov: posnetek, zajem, analiza. Modeliranje as-is in to-be procesnih modelov in tranzicija. Modeliranje materialov procesnih modelov na osnovi modelov. Izdelava 4D procesnih modelom pri modeliranju stavb. Izdelava in uporaba	Lectures Introduction to process modelling and its use. Tools and methods for process modelling. Micro and macro process modelling. Process model reuse in collaboration. Business process re-engineering: modelling of AS-IS and TO-BE process models; modelling of material process models based on building information models (BIM); the development of 4D process models; the development of 5D process models.

aktivnih procesnih modelov. Izdelava integriranih 5D informacijskih modelov stavb. Vaje Izdelava procesnih modelov in simulacije za optimizacijo. Izdelava 4d procesnih modelov stavbe. Seminar Model prenove poslovnih procesov.	Lab work Development of process models and simulations for business process optimization. Development of 4D process models of buildings. Seminar A model for business process re-engineering.

Temeljna literatura in viri/Readings:

ECPPM, zborniki konferenc european conference on product and process modelling in the building industry. 1998–2014. Dostopno na: http://www.ecppm.org .

MUEHLEN, M. 2003. Workflow-based Process Controlling. Foundation, Design and Application of workflowbased. Berlin, Process Information Systems. Logos.

OULD M "business process management: a rigorous approach". 2005. North america, meghan-kiffer press.

Učno gradivo v spletni učilnici UL FGG.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati osnove metod in tehnik modeliranja procesov - Podati osnove za prenovo poslovnih procesov s poudarkom na projektnih informacijskih sistemih in sistemih za sodelovanje inženirjev. Pridobljene kompetence: - Sposobnost zajema procesov v obliki procesnih modelov - Sposobnost izdelave procesnih modelov za optimizacijo in izdelavo informacijskih sistemov v gradbeništvu - Sposobnost izdelava 4D procesnih modelov stavb - Sposobnost rabe informacijskih in komunikacijskih tehnologij za upravljanje procesov in za reinženiring tehničnih procesov.	Objectives: - Students shall gain knowledge about methods and techniques of process modelling - Introduce basic concepts and methodologies for business process re-engineering with emphasis on project information systems and collaborative technologies. Competences: - Ability to capture processes in the form of process models - Ability to create process models that can be used in optimization or/and information systems for construction industry - Ability to independently create 4D process models - Ability to make use of process models for process management and re-engineering of technical processes.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Tehnike zajema, analize in modeliranjaprocesov - Uporaba procesnih modelov pri optimizaciji	- Methods of process capturing, analysis and process mapping in process modelling

- Osvojene računske spretnosti za načrtovanje - Sposobnost uvajanja prenove poslovnih procesov - Optimizacija poslovnih procesov z uporabo informacijskih tehnologij - Sposobnost modeliranja procesov je osnova za prenovo tehnologij. Izdelki študentov: - IDEF0 procesni model v okviru procesa graditve - Lokacijski terminski plan vezan na modele Seminar - Projekt prenove poslovnih procesov z uvajanjem novih informacijskih rešitev.	- Use of process models for business process optimization - Use of process models for computational and geometrical simulation in building design - Ability to introduce principles of business process re-engineering - Business process optimizuation using process oriented information systems - Ability to model business processes from relevant viewpoints Course work: - IDEF0 diagrams relevant for different project stages - Location based schedule linked to models Seminar: - Project of business process re-engineering introducing new ICT technologies into construction sector.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Podpora pri učenju z elektronskimi vsebinami o sistemih upravljanja z interaktivno vsebino. Študent dela individualno in v skupinah.	Learning is supported by online learning content management systems with interactive content. Student work is individual as well as in groups.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Kolokvij ali izpit	70,00 %	Mid term examination or exam
Samostojno izdelana naloga	20,00 %	Individual work
Projekt	10,00 %	Project

Reference nosilca/Lecturer's references:

CEROVŠEK, Tomo, KATRANUSCHKOV, Peter. Active process reuse model for collaboration. Electronic journal of information technology in construction, ISSN 1400-6529, July 2006, letn. 11, pos. št., str. 467-488, ilustr. Dostopno na: http://www.itcon.org/2006/35.

CEROVŠEK, Tomo. A framework for CPD and 5D BIM process reuse. 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. 1-10, ilustr. Dostopno na: http://itc.scix.net/data/works/att/w78-2011-Paper-157.pdf.

CEROVŠEK, Tomo, KOVAČIČ, Iztok, TURK, Žiga. Computer integrated construction at the services level – first experiences. V: TURK, Žiga (ur.), SCHERER, Raimar (ur.), Fourth European Conference on Product and Process Modelling in the Building and Related Industries, Portorož/Slovenia/, 9-11 September 2002. eWork and

eBusiness in architecture, engineering and construction : proceedings of the fourth European conference on product and process modelling in the building and related industries, Portorož/Slovenia/, 9-11 September 2002. Lisse [etc]: A.A. Balkema: Swets & Zeitlinger, cop. 2002, str. 593-602, ilustr.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**IZBRANA POGLAVJA IZ GRADBENE INFORMATIKE**
Course title:	**SELECTED CHAPTERS OF BUILDING INFORMATICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Organizacija - informatika (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1477

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45	0	0	45	0	90	6

Nosilec predmeta/Lecturer:	Žiga Turk
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Organizacija – informatika. Opravljen izpit iz predmeta Računalniško integrirana graditev.	The course is a part of the module Organisation – Building Informatics. Passed exams in Computer Integrated Construction Course.

Vsebina:	Content (Syllabus outline):
Predavanja Osnove programskega inženirstva. Metoda RUP. Management razvoja spletnih aplikacij. Infrastruktura. Omrežne topologije. Omrežni protokoli in standardi. Internet in svetovni splet (World Wide Web). Storitvene arhitekture (SOA). Objektni pristop. Relacijski pristop. Programski jeziki - osnovni pojmi. Programski jeziki za namizne	Lectures Introduction to Software Engineering. RUP method. Management of web application development. Infrastructure. Network topology. Network Protocols and Standards. Internet and World Wide Web. Service-oriented architectures (SOA). Object oriented approach. Relational approach. Programming languages - basic concepts. Programming languages for desktop applications.

aplikacije. Programski jeziki za spletne aplikacije. Programski jeziki za numerično intenzivne probleme. Programiranje mobilnih naprav. Standardi. Formati in varna izmenjava podatkov: EDI in XML, varnost. Vaje Načrtovanje programske opreme. Programiranje. Izdelava programske rešitve glede na siceršnje zanimanje študenta na eni od naslednjih osnov: zbirka podatkov, pisarniški program, spletna aplikacija, mobilna aplikacija, CAD/BIM aplikacija).	Programming Languages for Web Applications. Programming languages for numerically intensive problems. Programming mobile devices. Standards. Formats and secure data exchange: EDI and XML, Security. Tutorials Designing Software. Programming. Production of software solutions depending on the interests of student (database, Web application, mobile application, CAD/BIM/Office).

Temeljna literatura in viri/Readings:

Dough Bell, 2005, Software Engineering for Students, 4th edition, A Programming Approach, Addison-Wesley. Ivan Marsic, Software Engineering Book, Rutgers, New Jersey.

Ian Sommerville, 2007, Software Engineering, Pearson Education.

Jeff Friesen, 2014, Learn Java for Android Development, 2nd Edition, Apress.

Paul Lomax, 1999, VB & VBA in a Nutshell: The Language, O'Reilly Media.

Various Wikibooks for various languages.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Osnovni namen predmeta je usposobiti študenta za vodenje informacijskih projektov, bodisi tistih, kjer gre za izdelavo programske opreme kot tudi tistih, ki se specializirajo za izdelavo informacijske infrastrukture. Pridobljene kompetence: - Načrtovanje in izdelava programske opreme - Izdelava spletnih aplikacij. - Izdelava in vzpostavitev visokoprepustnih omrežij za računanje. - Programiranje numerično intenzivnih problemov.	Objectives: - The primary purpose of this course is to qualify student for the participation in and management of IT projects, either those where software is developed, or those which specialize in making IT infrastructure. Acquired competences: - Design and construction of software - Making Web applications - Creating and setting up networks for high throughput computing - Programming of database or numerically intensive problems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje uporabe naprednih spletnih tehnologij v gradbeništvu	- Understanding the use of advanced web technologies construction

- Razumevanje sistemov strežnik – odjemalec in aplikacije v gradbeništvu - Razumevanje programsko inženirskih pristopov. - Uporaba konceptov pri informatizaciji procesov pri strokovnem interdisciplinarnem delu - Izdelava programske opreme - Razumevanje sodobnih načinov dela gradbene informatike - Sposobnost analize uporabe IKT v gradbeništvu - Sposobnost analize komunikacijskih kanalov v okviru računalniško integrirane graditve. - Sposobnost izboljšanja komunikacije z uporabo informacijske in komunikacijske tehnologije. - Sposobnost identifikacije problemov, ki jih je mogoče avtomatizirati. - Sposobnost izdelave programske opreme, bodisi samostojne, bodisi v okviru aplikacij (Google Apps, Office, AutoCAD, Revit …).	- Understanding of client server architecture and systems in construction - Understanding of software engineering methods. - Using the concepts in the computerization of processes in expert interdisciplinary work - Software Development. - Understanding of modern methods of construction works IT. - Ability to analyse the use of ICT in construction - The ability of analysing communication channels within computer integrated construction. - Ability to improve communication with information and communication technologies. - Ability to identify problems that can be automated. - Ability to build software, either independent, or in the context of applications (Google Apps, Office, AutoCAD, Revit ...).

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. Project based leaning. Teamwork.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretično znanje na izpitu	40,00 %	Theoretical exam
Sodelovanje na vajah in predavanjih	20,00 %	Activity and collaboration
Projektni izdelek	40,00 %	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. Dostopno na: http://www.itcon.org/2009/31.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**MANAGEMENT V GRADBENIŠTVU**
Course title:	**MANAGEMENT IN CIVIL ENGINEERING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Organizacija - informatika (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1459

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	30	0	0	60	4

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Organizacija – informatika	The course is a part of the module Organisation – Building Informatics

Vsebina:	Content (Syllabus outline):
Predavanja Značilnosti gradbene industrije (kompleksnost, sestava). Opredelitev poslovnih procesov in razmejitev faz v graditvi, urejanje odnosov med udeleženci graditve. Organizacija in management organizacije (cilji in funkcije Organizacije). Upravljanje v organizacijah. Človeški viri v organizaciji (kultura v organizaciji vodenje in voditeljstvo, delo v teamu, ravnanje z ljudmi pri delu). Strateško planiranje. Merjenje in presojanje uspešnosti poslovanja organizacije. Odločanje v	Lectures Specific features of construction industry (complexity, composition). Definition of business processes, definition of phases in the construction process, stakeholders management. Organisation and management of the enterprise (goals, functions of the organisation). Governance in organisations. Human resources in organisation (organisational culture, management and leadership, team work, human resource management). Strategic planning. Assessment and measurement of business success of

organizaciji (večkriterijsko odločanje, analitično hierarhični proces, kvantitativne metode) Vaje Seminarske vaje (računske vaje), ki se navezujejo zlasti na kvantitativne metode odločanja, prognoziranja, ocene investicij in optimizacij proizvodnje. Terensko delo Študijski obisk izbranega gradbenega podjetja.	an Organisation. Decision-making in an organisation (multi-criteria decision making, analytical hierarchy process, quantitative methods) Tutorial Tutorial (seminar type) from the area of quantitative multi-criteria decision methods, prognosis, investment assessment, production optimization Field work Study visit of a selected construction company.

Temeljna literatura in viri/Readings:

Možina in soavt. 2002. Management: nova znanja za uspeh. Didakta. (izbrana poglavja)

McGeorge, D., Palmer, A. 2002. Construction management: new directions. (izbrana poglavja)

Bohanec, M. 2006. Odločanje in modeli. DMFA. (izbrana poglavja)

Katedre za operativno gradbeništvo. Dostopno na: www.fgg.uni-lj.si.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Podati osnove managementa in poslovanja organizacije ter njihovo aplikacijo v gradbenem podjetju - Podati osnove s področja operacijskih raziskav, ki se nanašajo na upravljanje gradbene proizvodnje - Spoznati študenta z osnovami modelov za odločanje Pridobljene kompetence: - Razumevanje pomena organizacije in poslovanja gradbenega podjetja - Razumevanje pomena učinkovitega sodelovanja udeležencev v procesu graditve - Sposobnost vodenja organizacijskih enot gradbenega podjetja - Sposobnost vodenja človeških virov v gradbenem podjetju - Sposobnost uporabe odločitvenih modelov	Goals: - To provide fundamentals of management and business administration in an organisation - To provide fundamentals of operational research (relevant for construction production management) - To provide fundamentals of decision making models Competences gained: - Understanding of the importance of construction company organisation and management - Understanding the importance of efficient cooperation of construction process stakeholders - Ability to manage organisational units of a construction company - Ability to lead human resources in a construction company - Ability to use the decision support models

Predvideni študijski rezultati: **Intended learning outcomes:**

- Pridobljeno temeljno znanje o organizaciji in poslovanju gradbenega podjetja - Razumevanje kompleksnosti procesa graditve - Osvojene spretnosti za uporabo formalnih modelov večkriterijskega odločanja - Razumevanje delovanja in poslovanja organizacije kot osnova za uspešno delo gradbenega podjetja - Sposobnost abstraktne formulacije vodstvenih procesov v organizaciji - Sposobnost kritične presoje podatkov, pridobljenih v poslovanju organizacije - Sposobnost uporabe računalniških programov za podporo odločanju.	- Acquired fundamental knowledge of construction company organisation and management - Understanding of construction process complexity - Acquired skills for the use of formal multicriteria decision models - Understanding of company operation, fundamental for successful operation of a construction company Transferrable skills - Ability for abstract formulation of management processes within an organisation - Ability to critically assess the data acquired in business operation - Ability to use computer aided tools for decision-making

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, sem.vaje, oboje z uporabo IKT.	Lectures, tutorial (by using ICT tools).

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Samostojna naloga in zagovor	60,00 %	Individual project work and defence
Pisni izpit	40,00 %	Written exam

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

KLINC, Robert, TURK, Žiga, DOLENC, Matevž. ICT enabled communication in construction 2.0. Pollack periodica. April 2010, letn. 5, št. 1, str. 109-120, ilustr. ISSN 1788-1994. DOI: 10.1556/Pollack.5.2010.1.8. [COBISS.SI-ID 4986465]

KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

ARČAN, Simon, ČESNIK, Jure, DOLENC, Matevž, KLINC, Robert. Hitra primerjalna analiza idejnih zasnov infrastrukturnih projektov s pomočjo orodij BIM. V: ŠEMROV, Darja (ur.). 15. slovenski kongres o prometu in prometni infrastrukturi = The 15th Slovenian Congress on Transport and Transport Infrastructure : referati = proceedings : Portorož, 26.-28. oktober 2022. Ljubljana: DRC, Združenje za promet in prometno infrastrukturo Slovenije, 2022. Str. 1-8, ilustr. ISBN 978-961-6527-32-3. https://www.drc-zdruzenje.si/kongres/. [COBISS.SI-ID 127531011], financer: ARRS, P2-0210, SI, E-gradbeništvo

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**ORGANIZACIJSKA PRIPRAVA GRADNJE**
Course title:	**ORGANISATIONAL PLANNING OF CONSTRUCTION**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Organizacija - informatika (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1628

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	30	15	15	0	90	6

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Organizacija – informatika.	The course is a part of the module Organisation – Building Informatics

Vsebina:	Content (Syllabus outline):
Priprava projekta organizacije gradnje po posameznih fazah: preverba možnih rešitev. Priprava tehnoekonomskega elaborata. Integracija terminskega plana in finančnega načrta gradnje. Priprava programa vodenja in kontrole gradnje. Vzpostavitev sistema spremljanja in kontrole izvajanja del. Priprava terminskega plana gradnje s pomočjo ustrezne programske opreme.	Preparation of construction project organisation, in separate phases: checking of possible solutions. Preparation of site documentation. Integration of time schedule and financial plan of the construction. Construction management and control programme preparation. Monitoring and control programme for the execution of works – implementation. Preparation of time schedule for the construction by using appropriate software.

Temeljna literatura in viri/Readings:

E. Rodošek. 1998. Osnove organizacije v gradbeništvu. Pšunder, Klanšek, Šuman. 2009. Organizacija grajenja.

Cilji in kompetence:	**Objectives and competences:**
- Samostojna uporaba predhodno pridobljenih teoretičnih in praktičnih znanj pri kompleksnem projektu s področja nizkih ali visokih gradenj (področje priprave gradnje) Kompetence - Sposobnost priprave projekta organizacije gradnje, tehnoekonomskega elaborata, terminskega elaborata, finančnega načrta gradnje, sistema spremljanja in kontrole izvajanja gradbenih del.	- Independent use of previously acquired theoretical and practical knowledge within a complex project (high rise or infrastructure construction) Competences - Ability to prepare the construction organisation project, technical-economic documentation, time schedule, financial plan, monitoring and control plan (execution phase).

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent spozna potek gradbenega projekta ter vsebino in pripravo spremljajoče dokumentacije.	Student gets acquainted with the content of the contraction project, as well as with the preparation and content of the accompanying documentation.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, sprotne konzultacije, vodena samostojna priprava seminarske naloge.	Lectures, tutorial, consultations, independent preparation of a seminar work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit	50,00 %	Theor. exam
Ocena oddanih vaj in sem.naloge, ustni zagovor	50,00 %	Individual seminar work and its defence

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017] KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393] KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKT IZ GRADBENE INFORMATIKE**
Course title:	**CONSTRUCTION INFORMATICS PROJECT**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Projekt (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1569

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	60	0	0	0	60	4

Nosilec predmeta/Lecturer:	Tomo Cerovšek
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Projekt.	The course is a part of the module Project.

Vsebina:	Content (Syllabus outline):
Predavanja Principi računalniško integrirane graditve. Pregled topologije projektnih informacijskih sistemov. Uporaba informacijskih modelov zgradb za projektno komunikacijo. Orodja in standardi za učinkovito projektno komunikacija. Interoperabilnost in upravljanje projektnih informacij. Vaje Vzpostavitev informacijske infrastrukture. Uporaba modelov pri projektni komunikaciji. Izdelava digitalne projektne dokumentacije	Lectures Principles of computer integrated construction. Overview of project information systems. Use of BIM for project communication. Tools & standards for project communication. Interoperability and project information mngt. Lab work: Set-up of collaborative project infrastructure. The use of models for project communication. Authoring and exchange of digital project docs Seminar work:

Seminar Vzpostavitev projektne informacijske infrastrukture. Izdelava digitalnega projektnega repozitorija. Digitalna projektna dokumentacija.	CDE (common data environment) for a specific building project. Development of digital repository. Digital project communication.

Temeljna literatura in viri/Readings:

OAKLAND, J., MAROSSZEKY, M. 2006. Total Quality in the Construction Supply Chain. Oxford, Butterworth-Heinemann, Elsevier. SOMMERVILLE, J., CRAIG, N. 2006. Implementing IT in Construction. Taylor and Francis.

Cilji in kompetence:	**Objectives and competences:**
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.	Objective: - Student shall understand the basics of collaborative project teamwork - Student shall gain the potential of construction informatics throughout building project phases - Students shall be able to model products and process in a building project Competences: - Ability to work in groups - Ability to manage project groups using information and communication technologies - Ability to author and exchange digital project documentation - Ability to make use of building information models - Ability to effectively and efficiently communicate using BIM - Ability to create digital building project manual

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Uporaba sodobnih projektnih informacijskih rešitev na konkretnem projektu - Poznavanje standardov za izmenjavo projektnih informacij - Sposobnost vzpostavitve projektnega informacijskega sistema	- The use of state-of-the-art communication channels on a building project - Standards for the exchange project information - Design and implementation principles of project information systems

Izdelki študentov: - Načrt projektnega informacijskega sistema - Infrastruktura za izmenjavo projektnih informacij - Digitalna projektna dokumentacija	Student course work: - A design of project information systems - Infrastructure for project information exchange - Digital project documentation

Metode poučevanja in učenja:	**Learning and teaching methods:**
Učenje je projektno zasnovano, tako da se del vsebin poda vnaprej, del pa v odvisnosti od izbranega projekta, oziroma evidentiranih problemov.	Learning is supported by online learning content management systems with interactive content. Student work is individual as well as in groups.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit (teoretičen del)	30,00 %	Exam
Seminarska naloga	40,00 %	Seminar work
Predstavitev naloge	30,00 %	Project report and presentation

Reference nosilca/Lecturer's references:

CEROVŠEK, Tomo. Building Collaborative Technologies : collaboration taxonomy, concurrent engineering, project information systems, collaborative BIM technologies : online lectures for Euromaster Course at UCC – University College Cork, Dublin Institute of Technology, Ireland, 19. 4. - 22. 5. 2013. Dublin, 2013: Institute of Technology. Dostopno na: http://www.dit.ie/, http://zuse.ucc.ie/pdf/Flyer_Master-ITinAEC_KMZ.pdf.

CEROVŠEK, Tomo, TURK, Žiga. Working together : ICT Infrastructures to Support Collaboration. V: BEUCKE, Karl E. (ur.). Xth International conference on Computing in civil and building engineering : proceedings : Weimar, June 02-04, 2004. Weimar: Bauhaus-Universität, cop. 2004, str. 1-12, graf. prikazi.

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.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKT IZ PROMETNE INFRASTRUKTURE**
Course title:	**PROJECT FROM TRAFFIC INFRASTRUCTURE**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Projekt (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1570

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	120	0	0	0	120	8

Nosilec predmeta/Lecturer:	Marijan Žura
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Projekt.	The course is a part of the module Project.

Vsebina:	Content (Syllabus outline):
Seminar Konceptualna zasnova cest, izbira variantnih rešitev. Napoved prometa: modeliranje in napovedi. Idejni projekt. Dimenzioniranje križišč. Dimenzioniranje voziščne konstrukcije. Presoja vplivov na okolje. Popis del in projektantski predračun. Podrobna seznanitev s projektiranjem železniške infrastrukture – spodnjega in zgornjega ustroja železniških prog (značilnosti podsistemov, komponent interoperabilnosti, elementov železniške infrastrukture, bistvenih zahtev, tehničnih specifikacij o interoperabilnosti, postopkov za	Seminar Conceptual road design: variant route selection. Traffic study: modelling and prognosis. Environmental Impact Assessment. Preliminary road design, including intersections. Flexible Pavement Design. Planimetric quantities and inventory of work, costs estimation. Detailed knowledge on the design of railway lines (calculation of all parameters of railway infrastructure, e.g. static track design, curves and gradients, tack stability…) for both conventional and

pričetek gradnje in pridobitev uporabnega dovoljenja…).	high speed lines; procedures for starting railway construction, renewal and upgrade works.

Temeljna literatura in viri/Readings:

Juvanc A. 2004. Geometrijski elementi ceste in vozišča. Ljubljana,FGG PTI. (elektronski vir).

Katanić, J., Andujs, V., Maletin, M. 1983. Projektovanje puteva. Beograd, GK.

Wright, Ashford. 1998. Transportation Engineering. New York, ZDA.

Garber, N. J., Hoel, L. A. 2009. Traffic and highway engineering. Toronto.

B. Zgonc. 1996. Železnice I. projektiranje, gradnja in vzdrževanje prog. Ljubljana, Univerza v Ljubljani FGG, 225 strani.

B. Zgonc. 2003. Železniški promet. Portorož, Univerza v Ljubljani, Fakulteta za pomorstvo in promet, str. 3-42, 105-130.

Predpisi in standardi s področja cestne in železniške infrastrukture.

Cilji in kompetence:	**Objectives and competences:**
- Samostojna izdelava projektne dokumentacije za ceste ali železnice. - Študent se usposobi za samostojno izdelavo projektne dokumentacije za ceste ali železnice.	- Student is able to prepare technical road or railway design documentation individually and/or in team - Carrying out complex tasks in organizations associated with the design and construction of roads or railways.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje voznodinamičnih zakonitosti in sistema VOZNIK-VOZILO-OKOLJE; - Poznavanje elementov ceste in način njihovega usklajevanja; metod in postopkov pri načrtovanju cest ali železnice izdelavi projektov zanje. - Samostojna izdelava idejne študije projekta ceste ali železnice - Izdelava (skrajšane verzije) idejnega projekta za cesto ali železnice– skupinsko delo (vsebine in detajli so podajani tako, da študent dobi celovito sliko o problematiki izdelave različnih projektov za ceste ali železnice, pri samostojni izdelavi kompozicije elementov ceste ali železnice študent pride do lastnih spoznanj o smotrnosti uporabe posameznih elementov); - Študent se seznani tudi s konkretnim delom v projektivni skupini; - Študenta se usposobi za samostojno odločanje pri kombiniranju elementov cest ali železnice.	- Knowledge and understanding of vehicle kinematics and dynamics and interaction Driver-Vehicle-Road; - Understanding of principles of 3D geometric road or railway design; methods and procedures for road or railway design, for identification of hazardous road locations including evaluation techniques and impact assessment - Individual elaboration of a conceptual road or railway design; Design of typical rural road or intersection using relevant road design software – teamwork (- Lectures are given in such way that student gets a comprehensive picture of the problem of road or railway design; By individual work student sees the rational use of composition of geometric road or rail elements); - Students get familiar with concrete work within a project team;

- Študent pridobi sposobnost samostojnega sprejemanja odločitev, kritične presoje variantnih rešitev.	- Student is trained for individual and independent decision-making when combining geometric and technical elements of road or railway design; - By individual work student sees the rational use of composition of geometric road or rail elements;

Metode poučevanja in učenja:	**Learning and teaching methods:**
Študentje (posamično ali v skupini) izdelajo projekt za cesto ali železnico s predpisano obliko in vsebino ter ga javno predstavijo in zagovarjajo. Nosilec predmeta pri izdelavi projekta študente usmerja in vodi, po potrebi tudi z izbrani poglavji predavanj.	Student (by himself or in a team) prepares a project of road or railway in proper form and has a presentation of his work. . Lecturer directs and guides student, if necessary, with selected sections of lectures.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit (teoretičen del)	40,00 %	Exam (theory)
Seminarska naloga	30,00 %	Seminar
Predstavitev naloge	30,00 %	Project presentation

Reference nosilca/Lecturer's references:

MAHER, Tomaž, STRNAD, Irena, ŽURA, Marijan. Estimation of EVA mode choice model parameters with diferent types of ulity functions. Promet (Zagreb), 2011, vol. 23, no. 3, str. 169-175.

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

ŽURA, Marijan, SRDIČ, Aleksander. Design and Plan of Travel Time Surveys on Slovene Road Network. WSEAS transactions on systems and control, december 2006, letn. 1, št. 2, str. 200-206

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKT IZ KOMUNALNEGA GOSPODARSTVA**
Course title:	**PROJECT FROM MUNICIPAL ECONOMICS**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Projekt (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1571

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	60	0	0	0	60	4

Nosilec predmeta/Lecturer:	Maruška Šubic-Kovač, Daniel Kozelj
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Projekt.	The course is a part of the module Project.

Vsebina:	Content (Syllabus outline):
E laborat, ki ga izdela študent samostojno ali v skupini ima naslednje sestavne dele: predstavitev obstoječega stanja in razvojnih potreb po komunalni infrastrukturi v lokalni skupnosti z opisom razlogov za obravnavano investicijo.; opredelitev razvojnih možnosti in ciljev investicije ter preveritev usklajenosti s strateškimi dokumenti; opis in analiza variant investicije (lokacija, investicijski stroški, varstvo okolja, predvideni viri financiranja), ekonomska upravičenost projekta; predlog najugodnejše variante s finančno konstrukcijo projekta; ugotovitev smiselnosti in možnosti	Expert report by individual student or a group of students, including at least the following: analysis of existing condition and needs in the field of technical infrastructure within selected municipality; description of selected investment in technical infrastructure; definition of goals, alternatives to implement the goals, analysis of alternatives considering costs and benefits, locations, influence on environment, economic feasibility; proposal of most favourable alternative with financial structure of the project included; timeline of selected investment.

nadaljnje priprave investicijske, projektne, tehnične in druge dokumentacije s časovnim načrtom. Točna vsebina oziroma obravnavana investicija se določi vsako leto posebej glede na aktualnost in v sodelovanju z ostalimi nosilci predmetov modula Magistrski modul – projekt.	The exact content (selected investment) is determined on an annual basis depending on the current relevance and in cooperation with other lecturers.

Temeljna literatura in viri/Readings:

Literatura s področja vsebine projekta (konkretne lokalne gospodarske javne infrastrukture). Veljavni normativni akti, ki se nanašajo na: gospodarske javne službe, prostorsko načrtovanje, graditev objektov, varstvo okolja, sistem javnih financ na lokalni ravni in javna naročila.

Cilji in kompetence:	**Objectives and competences:**
- Cilj je naučiti študenta povezovati tehnična, prostorska in družboslovna znanja na področju gospodarske javne infrastrukture. - Pridobljene kompetence - sposobnost izdelave in javne predstavitve investicijske zasnove in investicijskega programa za omrežja, objekte in naprave gospodarske javne infrastrukture.	- The goal is to teach student how to connect technical knowledge, spatial knowledge and knowledge from social sciences in the field of municipal (technical) infrastructure. - Competences: Capability to make and present in public the investment design and investment programme for the construction/renovation of municipal (technical) infrastructure.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent pridobi potrebno znanje za izdelavo Dokumenta identifikacije investicijskega projekta za izbran del komunalne infrastrukture v smislu: potrebe – projekt– financiranje – izvedba.	Student acquires the knowledge needed to make an identification document for the investment project for a selected part of municipal (technical) infrastructure in the following sense: needs – project – financing – implementation.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Nosilec predmeta razpiše teme projektov in prijavljene kandidate pri izdelavi elaborata usmerja in vodi. Študentje (posamično ali v skupini) izdelajo elaborat s predpisano obliko in vsebino ter ga javno predstavijo in zagovarjajo.	The lecturer prepares various project tasks in advance and then guide students in the process of making a project. Students (individually or divided in several groups) make their project in the prescribed written form and make oral presentation of the project in public.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Projekt - pisni izdelek	70,00 %	Project - written document
ustna predstavitev projekta	30,00 %	Project - presented in public

Reference nosilca/Lecturer's references:

ŠUBIC KOVAČ, Maruška. Analysis of expert bases for levying municipal contribution in Slovenia, taking into account fundamental principles. V: HEPPERLE, Erwin (ur.). Methods and concepts of land management : diversity, changes and new approaches, (European academy of land use and development - EALD). 1. Aufl. Zürich: Hochschulverlag. 2020, str. 293-306, ilustr. https://vdf.ch/methods-and-concepts-of-land-management.html, https://www.research-collection.ethz.ch/handle/20.500.11850/445042, doi: 10.3929/ethz-b-000445042.

ŠUBIC KOVAČ, Maruška. A causal analysis between construction, real estate, and economic growth : a case study of Slovenia. V: ABDULAI, Raymond Talinbe (ur.). *Real estate, construction and economic development in emerging market economies*, (Routledge studies in international real estate). 1st ed. London; New York: Routledge. 2016, str. 64-87, ilustr.

ŠUBIC KOVAČ, Maruška. Acquisition of Land and Compensation in Infrastructure Projects in the Republic of Slovenia. V: HEPPERLE, Erwin (ur.), LISEC, Anka (ur.). Opportunities and Constraints of Land Management in Local and Regional Development : Integrated Knowledge, Factors and trade-offs. 1. Aufl. Zürich: Hochschulverlag. 2018, str. 187-201. https://www.research-collection.ethz.ch/handle/20.500.11850/289657.

KAFOL STOJANOVIĆ, Ajda, KOZELJ, Daniel, ŠUBIC KOVAČ, Maruška. Assessment of water distribution system capacity as settlement-development decision-making expert basis at the local level = Ocena zmogljivosti vodovodnega sistema kot strokovna podlaga za odločanje o usmerjanju razvoja naselij na lokalni ravni. Geodetski vestnik : glasilo Zveze geodetov Slovenije, ISSN 0351-0271. [Tiskana izd.], 2020, letn. 64, št. 3, str. 389-401, ilustr.

ZEVNIK, Jure, KRAMAR FIJAVŽ, Marjeta, KOZELJ, Daniel. Generalized normalized cut and spanning trees for water distribution network partitioning. Journal of water resources planning and management, ISSN 0733-9496. [Print ed.], 2019, letn. 145, št. 10, str. 1-12, ilustr.

BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, Sep. 2019, vol. 27, iss. 3, str. 759-781, ilustr.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKT IZ ORGANIZACIJSKE PRIPRAVE GRADNJE**
Course title:	**PROJECT FROM CONSTRUCTION ORGANISATION AND CONTRACTING**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Projekt (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1631

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	30	0	0	0	60	4

Nosilec predmeta/Lecturer:	Robert Klinc
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Projekt.	The course is a part of the module Project.

Vsebina:	Content (Syllabus outline):
Predavanja Prikazi in analiza primerov iz prakse; sodelujejo tudi predavatelji iz prakse (izkušnje pri organizaciji gradbišča, spremljanju in usklajevanju gradnje, variantni načini proizvodnje). Seminar Vsak študent na osnovi projektantskega popisa del izdela tehnoekonomski elaborat oz. projekt organizacije gradnje - vsebina vsakega od projektov: študija različnih variantnih izvedb, gradbena kalkulacija, terminski plan izvedbe, plan porabe	Lectures Presentation and analysis of case studies; also by invited lecturers form the industry (experience with site organisation, monitoring and coordination of construction, alternative ways of production). Seminar Each student prepares, on the basis of a bill of quantities (prepared by the design engineer), a techno-economic project: study of various alternative execution ways, calculation of unit prices, time schedule, resources plan, material consumption

virov, plan porabe in dobave materiala plan ter shema ureditve gradbišča. Strokovne ekskurzija (zanimiva gradbišča, oddelki za planiranje v večjih podjetjih).	and supply plan, site organisation scheme. Site visit (representative construction sites, planning departments in large companies)

Temeljna literatura in viri/Readings:

Pšunder M. 2008. Ekonomika grajenja. Maribor.

Žemva Š. 2006. Gradbene kalkulacije in obračun gradbenih objektov.

Hegazy, T. 2002. Computer-based construction project management.

Trbojević B. 1981. Organizacija gradjevinskih radova. Beograd.

Project management for construction. Dostopno na: http://www.ce.cmu.edu/pmbook/index.html.

Spletna stran katedre za operativno gradbeništvo

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Sinteza znanja, pridobljenega med študijem in uporaba tega znanja na praktičnih primerih - Pridobiti znanja, ki bodo v pomoč pri pridobitvi licence pooblaščenega inženirja pri Inženirski Zbornici Slovenije. Pridobljene kompetence: - Sposobnost celovitega pristopa k pripravi dokumentacije, potrebne za pripravo gradnje - Razumevanje procesa priprave projekta organizacije gradnje in njegovega vpliva na uspešnost izvedbe in kakovost objekta - Pridobitev posameznih funkcionalnih inženirskih znanj (npr. o izdelavi sheme ureditve gradbišča).	Goals: - Synthesis of knowledge acquired during studies, application of this knowledge for solving practical case studies - To acquire knowledge to be used when professional licence of the Slov. Chamber of Engineers is sought. Acquired competencies: - Ability to approach in a comprehensive way to the documentation preparation (required for the preparation of construction) - Understanding the process of the preparation of project organisation and its influence upon success of the execution, and quality of the structure - Acquisition of certain functional engineering skills (e.g. how to prepare the construction site layout).

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Spoznati in razumeti proces priprave projekta organizacije gradnje in njegovega vpliva na uspešnost izvedbe in kakovost objekta. - Pridobiti posamezna funkcionalna inženirska znanja (npr. o izdelavi sheme ureditve gradbišča). - Študent se bo naučil teoretična znanja, pridobljena med študijem, uporabiti v inženirski praksi.	- To get acquainted and understand the process of the construction project organisation and its influence upon success of the execution and quality of the structure - To acquire functional engineering skills (e.g. how to prepare the construction site layout)

- V fazi priprave na gradnjo in pri kasnejši izvedbi se sprejema veliko število odločitev. 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 analitične obravnave problema in sintezne obdelave rešitev. - Sposobnost uporabe računalniškega programa za simulacijo.	- Student will learn how to use theoretical knowledge gained during the studies in engineering practice - In the stage of site preparation and consequent execution, many decisions have to be taken. On the basis of the acquired theoretical and applied knowledge, student will be able to critically assess individual problem, eliminate non- adequate solutions and justify the selection of the alternative - Ability to analytically solve problems, synthesis of the solutions - Ability to use computer simulation tools.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar.	Lectures, seminar.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Samostojna seminarska naloga	100,00 %	Individual seminar work

Reference nosilca/Lecturer's references:

KLINC, Robert, TURK, Žiga. Construction 4.0 - digital transformation of one of the oldest industries. Economic and business review. 2019, vol. 21, no. 3, str. 393-410, ilustr. ISSN 1580-0466. http://ojs.ebrjournal.net/ojs/index.php/ebr/article/view/786/pdf_163, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=114085&lang=slv, DOI: 10.15458/ebr.92. [COBISS.SI-ID 9010017]

KLINC, Robert, DOLENC, Matevž, TURK, Žiga. Novi trendi na področju sodelovalnega inženirstva = New trends in collaborative engineering. Gradbeni vestnik : glasilo Zveze društev gradbenih inženirjev in tehnikov Slovenije. [Tiskana izd.]. nov. 2011, letn. 60, št. 11, str. 300-309, ilustr. ISSN 0017-2774. [COBISS.SI-ID 5623393]

KLINC, Robert, DOLENC, Matevž. Vpliv IT na produktivnost. Sistem : nove tehnologije za poslovni svet. [Tiskana izd.]. 2007, december, str. 12-14, barvne ilustr. ISSN 1318-9077. [COBISS.SI-ID 3786849]

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKTIRANJE CEST**
Course title:	**ROAD DESIGN**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Prometno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1577

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	0	0	45	3

Nosilec predmeta/Lecturer:	Peter Lipar, Robert Rijavec
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional
Jeziki/Languages:	Predavanja/Lectures: Slovenščina Vaje/Tutorial: Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Prometno inženirstvo.	The course is a part of the module Traffic Engineering.

Vsebina:	Content (Syllabus outline):
Predavanja Vrste gradbenih posegov na cestah in njihove značilnosti; vrste projektne in tehnične dokumentacije (PD in TD); obvezni in potrebni sestavni deli posamezne vrste PD in TD; tipologija označevanja posamezne vrste projektov in njegovih prilog; načini določanja prometnih obremenitev in definiranje TPP (tipskega prečnega profila); geometrijski in tehnični elementi ceste (povzetek), elementi odvodnjavanja, elementi podpornih in premostitvenih konstrukcij, elementi prometne signalizacije in opreme ter predizmere in predračun (vsebine, detajli, izračuni) v projektu; prometna varnost v projektih za ceste ugotavljanje, ocene,	Lectures Road construction and its characteristics; sub-disciplines: road planning, road design, road building and operations; road design procedures: process and documentation; contents of project and technical design documentation; spatial and structural road characteristics: classification of roads, traffic loads, factors and principles for Typical Cross Section (TCS) definition; geometrical and technical elements of the road: speed terminology, sight distances and alignment (summary), elements of roadway drainage, bridges, retaining walls and other structures, traffic signalisation and equipment, planimetric quantities and calculation support; road

sanacije nevarnih mest); okoljska problematika v projektih za ceste (ukrepi, ureditve); zasnova in idejna študija variant (tehnologija in postopek primerjave); tehnologija izdelave projektne dokumentacije za novogradnje (zasnova, idejna študija, idejni projekt, PGD/PZI); tehnologija izdelave projektne dokumentacije za rekonstrukcije in obnove cest; večnivojska križišča (zasnova, kriteriji, pogoji, signalizacija in oprema); prenos trase na teren in katastrski elaborat. Vaje Seminarske vaje: primeri reševanja problemov iz vsakodnevne prakse.	safety (impact assessment and audit) and road safety measures; environmental issues in road design (measures, arrangements); comparative and pre-investment studies of road infrastructure investments (principles and process of comparison); technical design documentation for new road construction (conceptual design, preliminary design, building permit documentation, documentation for execution); technical design documentation for reconstruction and renovation of roads; at-grade intersections and graded interchanges (design, criteria, conditions, signs and equipment); from roadway design to terrain and cadastral study. Tutorial Practical examples of road design (using appropriate computer software).

Temeljna literatura in viri/Readings:

Juvanc A. 2004. Geometrijski elementi ceste in vozišča, FGG-PTI, 2004 (elektronski vir).

Katanić, J., Andujs, V., Maletin, M. 1983. Projektovanje puteva, Beograd, GK.

Wright, Ashford. 1998. Transportation Engineering. New York, ZDA.

Garber, N. J., Hoel, L. A. 2009. Traffic and highway engineering. Toronto.

Tehnični predpisi za projektiranje cest: domači in tuji (dosegljivi na svetovnem spletu).

Različni viri na svetovnem spletu (študent išče sam po potrebi).

Gradiva za razne posamične rešitve, ureditve in detajle (sproti pripravi predavatelj).

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Usposobiti se za samostojno in skupinsko izdelavo projektne in tehnične dokumentacije za ceste. Pridobljene kompetence: - Opravljanje zahtevnejših delovnih nalog v organizacijah povezanih s projektiranjem in gradnjo cest; - Reševanje tekočih tehničnih, tehnoloških, organizacijskih in drugih problemov v procesih povezanih s cestno infrastrukturo; - Obvladovanje specifičnih postopkov v tehnologiji projektiranja, gradnje in vzdrževanja cestne infrastrukture.	Objectives: - Student is able to prepare technical road design documentation individually and/or in team Acquired competences: - Carrying out complex tasks in organizations associated with the design and construction of roads; - Solving of current technical, technological, organizational and other problems in the processes related to road infrastructure; - Managing of specific procedures in the road design process: planning, design, construction and maintenance of road infrastructure.

Predvideni študijski rezultati:	Intended learning outcomes:
- Poznavanje voznodinamičnih zakonitosti in sistema VOZNIK-VOZILO-OKOLJE; - Elementov ceste in način njihovega usklajevanja; - Metod in postopkov pri načrtovanju cest, izdelavi projektov zanje. - Samostojna izdelava idejne študije projekta ceste; - Izdelava (skrajšane verzije) idejnega projekta za cesto – skupinsko delo. - Vsebine in detajli so podajani tako, da študent dobi celovito sliko o problematiki izdelave različnih projektov za ceste; - Pri samostojni izdelavi kompozicije elementov ceste študent pride do lastnih spoznanj o smotrnosti uporabe posameznih elementov; - Študent se seznani tudi s konkretnim delom v projektivni skupini; - Študenta se usposobi za samostojno odločanje pri kombiniranju elementov cest. - Študent pridobi sposobnost samostojnega sprejemanja odločitev, kritične presoje variantnih rešitev.	- Knowledge and understanding of vehicle kinematics and dynamics and interaction Driver-Vehicle-Road; - Principles of 3D geometric road design; - Methods and procedures for road design, for identification of hazardous road locations including evaluation techniques and impact assessment. - Individual elaboration of conceptual road design; - Design of typical rural road or intersection using relevant road design software - teamwork. - Lectures are given in such way that student gets a comprehensive picture of the problem of road design; - With individual work student sees the rationality of using individual geometric road elements; - Students get familiar with concrete work within project team; - Student is trained for individual and independent decision-making when combining geometric and technical elements of roads. - Student acquires the ability of independent decision-making and critical assessment of different solutions in road design.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja in vaje.	Lectures and Tutorial.

Načini ocenjevanja:	Delež/Weight	Assessment:
Izpit (teoretičen del)	70,00 %	Theory exam
Seminarske vaje (samostojno delo)	30,00 %	Tutorial: practical exams

Reference nosilca/Lecturer's references:

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

LIPAR, Peter. Optično vodenje osi in geometrijsko oblikovanje cest = Optical leading of axis and geometrical forming of roads. Gradbeni vestnik, ISSN 0017-2774, 1995, 44, št. 11/12, str. 263-275, ilustr.

LIPAR, Peter, KOSTANJŠEK, Jure. Pedestrian crossings priority for pedestrian safety. Suvremeni promet, ISSN 0351-1898, 2005, letn. 25, št. 3-4, str. 215-220, graf. prikazi.

RIJAVEC, Robert, SRDIĆ, Aleksander, JUVANC, Alojzij. The level of potential risk on motorway sections as a part of decision-making for the future traffic management system. V: ITS for livable society : proceedings. Nagoya: ITS Japan, 2004.

KOKOT, Darko, RIJAVEC, Robert, AMBROŽ, Miha. Determination of correlation between road pavement skid resistance and braking deceleration. V: 7th Symposium on Pavement Surface Characteristics : SURF 2012, Norfolk, VA, September 19 - 22, 2012. Norfolk, VA: VTTI, 2012.

RIJAVEC, Robert, DADASHZADEH, Nima, ŽURA, Marijan, MARSETIČ, Rok. Park and pool lots' impact on promoting shared mobility and carpooling on highways - the case of Slovenia : 3188 - OA article. Sustainability. 2020, letn. 12, št. 8, str. 1-19.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**SEMINAR IZ CEST**
Course title:	**ROAD SEMINAR**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Prometno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1566

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	60	0	45	0	105	7

Nosilec predmeta/Lecturer:	Peter Lipar, Robert Rijavec
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Prometno inženirstvo.	The course is a part of the module Traffic Engineering.

Vsebina:	Content (Syllabus outline):
Seminar Konceptualna zasnova cest, izbira variantnih rešitev. Napoved prometa: modeliranje in napovedi. Idejni projekt. Dimenzioniranje križišč. Dimenzioniranje vozišče konstrukcije. Presoja vplivov na okolje. Popis del in projektantski predračun. Vaje Izdelava projekta ceste značilne podeželske ceste z uporabo računalniške podpore, študija variant. Vpliv	Seminar Conceptual road design: variant route selection. Traffic study: modelling and prognosis. Environmental Impact Assessment. Preliminary road design, including intersections. Flexible Pavement Design. Planimetric quantities and inventory of work, costs estimation. Tutorial Design of typical rural road using relevant highway design software - study of variant level. Traffic

prometa in mere prometne ga upravljanja. Predstavitev projekta.	impact analysis and traffic management measures. Project presentation.

Temeljna literatura in viri/Readings:

Juvanc A. 2004. Geometrijski elementi ceste in vozišča. Ljubljana, FGG PTI. (elektronski vir)

Katanić, J., Andujs, V., Maletin, M. 1983. Projektovanje puteva. Beograd, GK.

Wright, Ashford. 1998. Transportation Engineering. New York, ZDA.

Garber, N. J., Hoel, L. A. 2009. Traffic and highway engineering. Toronto.

Tehnični predpisi za projektiranje cest: domači in tuji.

Priročniki programske opreme za načrtovanje in modeliranje cest in cestnega prometa.

Cilji in kompetence:	**Objectives and competences:**
Cilji: - Samostojno je sposoben priprave tehnične dokumentacije načrtovanja ceste in izdelava projektne dokumentacije za ceste. Pridobljene kompetence: - Študent se usposobi za samostojno izdelavo projektne dokumentacije za ceste. - Reševanje trenutnih tehničnih, tehnoloških in organizacijskih izzivov v postopku vzpostavitve cestne infrastrukture. - Vodenje posebnih postopkov v postopku načrtovanja ceste: umestitev, izgled, izgradnja in vzdrževanje.	Objectives: - Student is able to prepare technical road design documentation individually and/or in team. Acquired competences: - Carrying out complex tasks in organizations associated with the design and construction of roads; - Solving of current technical, technological, organizational and other problems in the processes related to road infrastructure; - Managing of specific procedures in the road design process: planning, design, construction and maintenance of road infrastructure.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje voznodinamičnih zakonitosti in sistema VOZNIK-VOZILO-OKOLJE; - Elementov ceste in način njihovega usklajevanja; - Metod in postopkov pri načrtovanju cest, izdelavi projektov zanje. - Samostojna izdelava idejne študije projekta ceste; - Izdelava (skrajšane verzije) idejnega projekta za cesto – skupinsko delo. - Vsebine in detajli so podajani tako, da študent dobi celovito sliko o problematiki izdelave različnih projektov za ceste;	- Knowledge and understanding vehicle kinematics and dynamics and interaction Driver-Vehicle-Road; - Principles of 3D geometric road design; - Methods and procedures for road design, for identification of hazardous road locations evaluation techniques and impact assessment. - Individual elaboration of the conceptual road design; - Design of typical rural road or intersection using relevant road design software - teamwork. - Lectures are given in such way that student gets a comprehensive picture of the problem of road design;

- Pri samostojni izdelavi kompozicije elementov ceste študent pride do lastnih spoznanj o smotrnosti uporabe posameznih elementov; - Študent se seznani tudi s konkretnim delom v projektivni skupini; - Študenta se usposobi za samostojno odločanje pri kombiniranju elementov cest. - Študent pridobi sposobnost samostojnega sprejemanja odločitev, kritične presoje variantnih rešitev.	- With individual work student sees the rationality of using of geometric road elements; - Students get familiar with concrete work within the project team; - Student is trained for individual and independent decision-making when combining geometric and technical elements of roads; - Student acquires the ability of independent decision-making and critical assessment of different solutions in road design.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Študentje (posamično ali v skupini) izdelajo projekt za cesto s predpisano obliko in vsebino ter ga javno predstavijo in zagovarjajo. Nosilec predmeta pri izdelavi projekta študente usmerja in vodi, po potrebi tudi z izbrani poglavji predavanj.	Individual or team project, guided by lecturer. Final presentation of project.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Izpit (teoretičen del)	30,00 %	Theory exam
Seminarska naloga	40,00 %	Seminarska naloga
Predstavitev naloge	30,00 %	Presentation of seminar

Reference nosilca/Lecturer's references:

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

LIPAR, Peter. Optično vodenje osi in geometrijsko oblikovanje cest = Optical leading of axis and geometrical forming of roads. Gradbeni vestnik, ISSN 0017-2774, 1995, 44, št. 11/12, str. 263-275, ilustr.

LIPAR, Peter, KOSTANJŠEK, Jure. Pedestrian crossings priority for pedestrian safety. Suvremeni promet, ISSN 0351-1898, 2005, letn. 25, št. 3-4, str. 215-220, graf. prikazi.

RIJAVEC, Robert, SRDIĆ, Aleksander, JUVANC, Alojzij. The level of potential risk on motorway sections as a part of decision-making for the future traffic management system. V: ITS for livable society : proceedings. Nagoya: ITS Japan, 2004.

KOKOT, Darko, RIJAVEC, Robert, AMBROŽ, Miha. Determination of correlation between road pavement skid resistance and braking deceleration. V: 7th Symposium on Pavement Surface Characteristics : SURF 2012, Norfolk, VA, September 19 - 22, 2012. Norfolk, VA: VTTI, 2012.

RIJAVEC, Robert, DADASHZADEH, Nima, ŽURA, Marijan, MARSETIČ, Rok. Park and pool lots' impact on promoting shared mobility and carpooling on highways - the case of Slovenia : 3188 - OA article. Sustainability. 2020, letn. 12, št. 8, str. 1-19.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**PROJEKTIRANJE ŽELEZNIC**
Course title:	**RAILWAY DESIGN**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Prometno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1567

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
30	0	15	0	0	45	3

Nosilec predmeta/Lecturer:	Marijan Žura, Peter Lipar, Robert Rijavec
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Prometno inženirstvo.	The course is a part of the module Traffic Engineering.

Vsebina:	Content (Syllabus outline):
Predavanja Podrobna seznanitev z elementi železniške infrastrukture (zgornju ustroj, spodnju ustroj, odvodnjavanje, kretnice …), seznanitev z načeli projektiranja železniške infrastrukture ob upoštevanju tehničnih specifikacij o interoperabilnosti železniškega sistema (značilnosti podsistemov, komponente interoperabilnosti, bistvene zahteve …), podrobno poznavanje nacionalne in EU zakonodaje.	Lectures Thorough knowledge on the railway infrastructure elements (upper structure, substructure, switches …), principles of railway infrastructure designing considering technical specifications for interoperability (railway interoperability subsystems, interoperability constituents, essential requirements …), comprehensive knowledge on national and EU legislation. Individual work

Samostojno delo Izdelava projekta železniške proge ali železniškega prometnega mesta ali vozlišča (reševanje problemov iz vsakodnevne projektantske prakse).	Design of railway line; computer-aided track design of railway line or railway station or marshalling yard (real-life problems).

Temeljna literatura in viri/Readings:

Zgonc, B. 1996. Železnice I. projektiranje, gradnja in vzdrževanje prog,. Ljubljana, Univerza v Ljubljani FGG, 225 str.

Zgonc, B. 2003. Železniški promet. Portorož, Univerza v Ljubljani, Fakulteta za pomorstvo in promet, str. 342, 105-130.

Zgonc, B., Verlič, P., Šemrov, D. 2022. Železniški tir: zgornji ustroj in elementi trase. Portorož, Univerza v Ljubljani, Fakulteta za pomorstvo in promet.

Predpisi in standardi s področja železniške infrastrukture.

Cilji in kompetence:	**Objectives and competences:**
- Poglobljeno poznavanje nacionalne in evropske tehnične zakonodaje, evropskih tehničnih specifikacij za interoperabilnost ter standardov. - Opravljanje zahtevnejših delovnih nalog v projektantskih organizacijah.	- Thorough knowledge on national end European technical legislation, European technical specifications for interoperability and related standards. - Qualified for more complex tasks in railway infrastructure designing.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Sposobnost izdelave projektne dokumentacije in reševanje problemov projektiranja (za novogradnje, nadgradnje oz. vzdrževanje) železniške infrastrukture. - Razumevanje značilnosti železniške infrastrukture, njenih podsistemov in komponent - Poglobljena znanja o projektiranju železniške infrastrukture.	- Ability to prepare design documentation and to solve railway infrastructure designing problems (for new railway infrastructure, for upgrade and renewal). - Understanding of the railway infrastructure characteristics, its subsystems and components. - Thorough knowledge on designing railway infrastructure.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarske vaje.	Lectures and individual work.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Predavanja	60,00 %	Theory
Vaje	40,00 %	Tutorial

Reference nosilca/Lecturer's references:

KASTELIC, Tomaž, VERLIČ, Peter, ŽURA, Marijan, FAJFAR, Dušan, STRAH, Bojan, RIJAVEC, Robert, KOSTANJŠEK, Jure, VELKAVRH, Jurij, REJC, Dario, ŠTURM, Janez, REPAR, Miroslav. *Vzpostavitev informacijskega sistema slovenske železniške infrastrukture : končno poročilo*. Ljubljana: Prometni inštitut, 1997.

ŠEMROV, Darja, MARSETIČ, Rok, ŽURA, Marijan, TODOROVSKI, Ljupčo, SRDIČ, Aleksander. Reinforcement learning approach for train rescheduling on a single-track railway. *Transportation research. Part B, Methodological*, ISSN 0191-2615. [Print ed.], 2016, letn. 86, št. apr., str. 250-267.

LOKAN, Iztok (avtor, fotograf). Nizke zgradbe, Ceste in železnice : učbenik za predmet Nizke zgradbe za 4. letnik srednjega strokovnega izobraževalnega programa Gradbeni tehnik ter za 2. letnik poklicno-tehniškega izobraževalnega programa Gradbeni tehnik. 1. natis. Ljubljana: Tehniška založba Slovenije, 2005. (recenzent: LIPAR, Peter).

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.

ŽURA, Marijan, RIJAVEC, Robert, ŠEMROV, Darja. Consultations for the project "Technical, economic and environmental prefeasibility study on the economic and transport axis Villese - Ljubljana". Ljubljana: University of Ljubljana, Faculty of Civil and Geodetic Engineering, Traffic Technical Institute, 2009.

IORDANOPOULOS, Panagiotis, MITSAKIS, Evangelos, RIJAVEC, Robert, HAUSMANN, Alexander, KERNSTOCK, Wolfgang. Requirements for interoperable intelligent transport system deployment in South East Europe - SEE. V: RIJAVEC, Robert (ur.), et al. ITS for seamless and energy smart transport : proceedings. Ljubljana: Electrotechnical Association of Slovenia: ITS Slovenia, 2014.

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	**SEMINAR IZ ŽELEZNIC**
Course title:	**RAILWAY SEMINAR**

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Gradbeništvo, druga stopnja, magistrski	Nizke gradnje (smer), Prometno inženirstvo (modul)	2. letnik	Letni

Koda učne enote na članici/UL Member course code:	1568

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
0	45	0	60	0	105	7

Nosilec predmeta/Lecturer:	Peter Lipar, Robert Rijavec
Vrsta predmeta/Course type:	Izbirni strokovni /Elective professional

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Predmet je del modula Prometno inženirstvo.	The course is a part of the module Traffic Engineering.

Vsebina:	Content (Syllabus outline):
Seminar Podrobna seznanitev z naslednjimi tematikami: tehnologija železniškega prometa, propustnost železniških prog, vozni red, tehnologija dela vmesnih in ranžirnih postaj, vlečne sile lokomotiv, odpori vlakov in proge, spoznavanje postopkov za pričetek gradnje/nadgradnje ter obnove železniške infrastrukture in pridobitev uporabnega dovoljenja. Samostojno delo	Seminar Detailed knowledge on railway topics as: transport management and technology, railway capacity utilization, railway timetable, train scheduling at stations and shunting stations, locomotive traction, resistance of trains and railway infrastructure, knowledge on procedures for starting railway construction/upgrade and renewal, renewal of railway infrastructure. Individual work

Reševanje praktičnih problemov iz vsakodnevne prakse (izdelava voznega reda, izračun kapacitete postaje ali odseka, priprava terminskega plana izvedbe del …).	Solving of railway infrastructure related problems (timetable construction, calculation of railway infrastructure capacity utilization, construction scheduling …).

Temeljna literatura in viri/Readings:

Zgonc, B. 1996. Železnice I. projektiranje, gradnja in vzdrževanje prog,. Ljubljana, Univerza v Ljubljani FGG, 225 str.

Zgonc, B. 2003. Železniški promet. Portorož, Univerza v Ljubljani, Fakulteta za pomorstvo in promet, str. 342, 105-130.

Zgonc, B., Verlič, P., Šemrov, D. 2022. Železniški tir: zgornji ustroj in elementi trase. Portorož, Univerza v Ljubljani, Fakulteta za pomorstvo in promet.

Predpisi in standardi s področja železniške infrastrukture.

Cilji in kompetence:	**Objectives and competences:**
- Opravljanje zahtevnejših delovnih nalog v ministrstvu pristojnem za promet, Javni agenciji za železniški promet RS, v družbah železniške dejavnosti (pri nadzoru, pri izvajalcih gradbenih del ter pri upravljavcu železniške infrastrukture itd.). - Reševanje zahtevnejših problemov povezanih z železniško infrastrukturo. - Obvladovanje specifičnih postopkov, tehnologij in organizacije del pri gradnji in vzdrževanju železniške infrastrukture.	- Qualified for more complex tasks in bodies affiliated to the Ministry of infrastructure, Railway agency and other institutions engaged in railway infrastructure (as supervisor, constructor or railway traffic manager etc.). - Qualified for solving tasks related with railway infrastructure. - Qualified for solving technical, technological, organizational problems related to railway infrastructure construction and maintenance.

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Razumevanje karakteristik železniške infrastrukture. - Sposobnost izdelave zahtevnejših projektov na področju železniške infrastrukture. - Sposobnost prepoznavanja različnih problemov in vplivov pri projektiranju železniških prometnic v naravnem, gospodarskem in družbenopolitičnem okolju.	- Understanding the characteristics of the railway infrastructure. - Ability to solve comprehensive problems related to railway infrastructure. - Ability to recognize different problems related to railway infrastructureinflunece on environment, economy and socio-political objectives.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Seminar, vaje v laboratoriju.	Seminar, exercises in laboratory.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Seminar	60,00 %	Seminar

Izdelek pri vajah	40,00 %	Excercise work

Reference nosilca/Lecturer's references:

LOKAN, Iztok (avtor, fotograf). Nizke zgradbe, Ceste in železnice : učbenik za predmet Nizke zgradbe za 4. letnik srednjega strokovnega izobraževalnega programa Gradbeni tehnik ter za 2. letnik poklicno-tehniškega izobraževalnega programa Gradbeni tehnik. 1. natis. Ljubljana: Tehniška založba Slovenije, 2005 (recenzent: LIPAR, Peter).

LIPAR, Peter, KOSTANJŠEK, Jure. Pedestrian crossings priority for pedestrian safety. Suvremeni promet, ISSN 0351-1898, 2005, letn. 25, št. 3-4, str. 215-220, graf. prikazi.

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.

KASTELIC, Tomaž, VERLIČ, Peter, ŽURA, Marijan, FAJFAR, Dušan, STRAH, Bojan, RIJAVEC, Robert, KOSTANJŠEK, Jure, VELKAVRH, Jurij, REJC, Dario, ŠTURM, Janez, REPAR, Miroslav. Vzpostavitev informacijskega sistema slovenske železniške infrastrukture : končno poročilo. Ljubljana: Prometni inštitut, 1997.

ŽURA, Marijan, RIJAVEC, Robert, ŠEMROV, Darja. Consultations for the project "Technical, economic and environmental prefeasibility study on the economic and transport axis Villese - Ljubljana". Ljubljana: University of Ljubljana, Faculty of Civil and Geodetic Engineering, Traffic Technical Institute, 2009.

IORDANOPOULOS, Panagiotis, MITSAKIS, Evangelos, RIJAVEC, Robert, HAUSMANN, Alexander, KERNSTOCK, Wolfgang. Requirements for interoperable intelligent transport system deployment in South East Europe - SEE. V: RIJAVEC, Robert (ur.), et al. ITS for seamless and energy smart transport : proceedings. Ljubljana: Electrotechnical Association of Slovenia: ITS Slovenia, 2014.