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

Učni načrti

Magistrski študijski program druge stopnje

GRADBENIŠTVO (MA)
Geotehnika-hidrotehnika

Course Syllabi

2nd cycle master study

CIVIL ENGINEERING (MA)
Geotechnics-Hydrotechnics

KAZALO / TABLE OF CONTENTS

1. LETNIK / 1st YEAR
Matematika 3 / Mathematics 3 ... 3
Numerične metode / Numerical methods ... 6
Geotehnika nizkih gradenj / Geotechnics of infrastructural facilities ... 9
Hidravlično modeliranje / Hydraulic modelling ... 12
Hidrološko modeliranje / Hydrological modelling ... 17
Potresno inženirstvo / Earthquake engineering ... 20
Modeliranje geotehničnih konstrukcij / Numerical modelling of geotechnical structures ... 23
Numerično modeliranje trdnin / Numerical modelling of solids ... 26
Projektiranje gradbenih konstrukcij / Design of building structures ... 29
Verjetnostni račun in statistika/ Probability theory and statistics ... 32
2. LETNIK / 2nd YEAR
Vodenje projektov / Project management ... 35
Urejanje vodotokov / River engineering ... 37
Hidrotehnični objekti / Hydraulic structures ... 40
Eksperimentalne metode v geotehniki / Experimental methods in geotechnical engineering ... 43
Hudourništvo / Torrent, erosion, rockfall and avalanche control ... 46
Pobočni procesi / Slope processes ... 49
Mehanika kamnin in podzemni objekti / Rock mechanics and underground structures ... 52
Magistrsko delo / Master thesis ... 55
Praktično usposabljanje / Practical training ... 58
STROKOVNI IZBIRNI PREDMETI / PROFESSIONAL ELECTIVE COURSES
Hidravlični stroji in naprave / Hydraulic machines and devices ... 61
Vodne moči / Hydroelectric power ... 64
Numerične metode v dinamiki tekočin / Numerical methods in fluid dynamics ... 67
Geotehnika okolja / Environmental geotechnics ... 70

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	1
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	1

Vrsta predmeta / Course type: Obvezni splošni / Obligatory general

Univerzitetna koda predmeta / University course code:

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

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

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

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

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

Prerequisites:

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

Vsebina:

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

Content (Syllabus outline):

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

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

Temeljni literatura in viri / Readings:

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

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

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

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

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

Reference nosilca / Lecturer's references:

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.
http://springerlink.metapress.com/app/home/issue.asp?wasp=9ed0dca63b2b46c3ad74b3d0e2855bcc&referrer=parent&backto=journal,5, 116;linkingpublicationresults,1:100443,1.

LIPAR, Peter, LAKNER, Mitja, MAHER, Tomaž, ŽURA, Marijan. Estimation of road centerline curvature from raw GPS data. The Balt. j. road bridge eng., 2011, letn. 6, št. 3, str. 163-168, ilustr., doi: 10.3846/bjrbe.2011.21.
KRAMAR FIJAVŽ, Marjeta, LAKNER, Mitja, ŠKAPIN-RUGELJ, Marjeta. An equal-area method for scalar conservation laws. The Anziam journal, 2012, vol. 53, iss. 2, str. 156-170.
http://dx.doi.org/10.1017/S1446181112000065.
SKUBIC, Blaž, LAKNER, Mitja, PLAZL, Igor. Sintering behavior of expanded perlite thermal insulation board : modeling and experiments. Ind. eng. chem. res.. [Print ed.], 9. jul. 2013, vol. 52, no. 30, str. 10244-10249, ilustr. http://pubs.acs.org/doi/ipdf/10.1021/ie400196z, doi: 10.1021/ie400196z.

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	1
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: prof. dr. Boštjan Brank

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

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

Prerequisites:

Vsebina:

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

Content (Syllabus outline):

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

Temeljni literatura in viri / Readings:

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

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

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

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

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

Reference nosilca / Lecturer's references:

JUKIĆ, Miha, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Embedded discontinuity finite element formulation for failure analysis of planar reinforced concrete beams and frames. Engineering structures, ISSN 0141-0296. [Print ed.], maj 2013, letn. 50, št. 5, str. 115-125, ilustr., doi: 10.1016/j.engstruct.2012.07.028.
DUJC, Jaka, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Stress-hybrid quadrilateral finite element with embedded strong discontinuity for failure analysis of plane stress solids. International journal for

numerical methods in engineering, ISSN 0029-5981, jun. 2013, letn. 94, št. 12, str. 1075-1098, ilustr., doi: 10.1002/nme.4475.
BOHINC, Uroš, BRANK, Boštjan, IBRAHIMBEGOVIĆ, Adnan. Discretization error for the Discrete Kirchoff plate finite element approximation. Computer Methods in Applied Mechanics and Engineering, ISSN 0045- 7825. [Print ed.], feb. 2014, letn. 269, str. 415-436, ilustr., doi: 10.1016/j.cma.2013.11.011.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Geotehnika nizkih gradenj
Course title:	Geotechnics of infrastructural facilities

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	1
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	1

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

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

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

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

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

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.	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.

Temeljni 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.
Vaniček I, Vaniček 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) - Predstaviti možnost uporabe geosintetičnih materialov v geotehničnem inženirstvu - Predstaviti geotehnično pogojena tveganja in preproste možnosti analize in upravljanja s tveganji	- 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) - 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	- 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)

filtracije, separacije, tesnenja in armiranja - Razume geotehnično pogojena tveganja in jih zna analizirati.	- 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 (v %) / Weight (in %)	**Assessment:**
Računski izpit ali 2 kolokvija	**50 %**	Written exam or 2 midterm tests
Samostojno delo	**15 %**	Individual work (Seminar)
Teoretični izpit	**35 %**	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:	Hidravlično modeliranje
Course title:	Hydraulic modelling

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	1
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	1

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45	15		45		105	7

Nosilec predmeta / Lecturer: prof. dr. Franci Steinman, prof. dr. Matjaž Četina

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

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 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	a. The "Hydraulics of unsteady flow" Lectures: Unsteady free surface flow (types of waves, basic Saint Venant equation, 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). 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,

– delo v računalniški učilnici). b. “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 stalnega odprtem modeliranje zahtevnejšega cevovodnega sistema ali hidravlično modeliranje zahtevnejšega hidrotehničnega objekta.	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.

Temeljni 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 4.0.
Dostopno na: http://www.hec.usace.army.mil/software/hec-ras .
US Environmental Protection Agency: EPANET 2.0.
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 računalniškim 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” - 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.	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. 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 (v %) / Weight (in %)	**Assessment:**
Domače naloge (pisno, oddaja vaj sklopa a.)	**25 %**	Home practicals (written, submission of practicals part a.)
Seminarska naloga (pisno, oddaja seminarja sklopa b.)	**25 %**	Seminar work (written, submission of part b.)
Pisni izpit (izpit iz teorije sklopov a. in b.)	**50 %**	Written exam (theory of part a. and b.)

Reference nosilca / Lecturer's references:

NOVAK, Gorazd, KOZELJ, Daniel, STEINMAN, Franci, BAJCAR, Tom. Study of flow at side weir in narrow flume using visualization techniques. Flow meas. instrum. [Print ed.], mar. 2013, letn. 29, str. 45-51.
ENGI, Zsuzsanna, TOTH, Gabor, STEINMAN, Franci, BRAUN, Mihaly. Historical morphological reconstruction of the Mura River (SW of the Carpathian Basin) by using GIS methods. Z. Geomorphol., 2012, letn. 56, št. 2, str. 63-77.
BAJCAR, Tom, STEINMAN, Franci, ŠIROK, Brane, PREŠEREN, Tanja. Sedimentation efficiency of two continuously operating circular settling tanks with different inlet- and outlet arrangements. Chem. eng. j. 1996. [Print ed.], 15. Dec. 2011, vol. 178, str. 217-224.

ČETINA, Matjaž, RAJAR, Rudolf, HATIĆ, Vanja, ŠIRCA, Andrej. Matematično modeliranje toplotne obremenitve spodnje Save pri nuklearni elektrarni Krško = Mathematical modeling of thermal pollution of lower Sava river at the nuclear power plant Krško. Gradb. vestn., jun. 2013, letn. 62, str. 131-139.
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.
ČETINA, Matjaž, RAJAR, Rudolf, HOJNIK, Tomaž, ZAKRAJŠEK, Majda, KRZYK, Mario, MIKOŠ, Matjaž. Case study: Numerical simulations of debris flow below Stože, Slovenia. J. hydraul. eng. (New York, N.Y.), 2006, vol. 132, iss. 2, str. 121-130.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Hidrološko modeliranje
Course title:	Hydrological modelling

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	1
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	1

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

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

Nosilec predmeta / Lecturer:	doc. dr. Mojca Šraj, prof. dr. Mitja Brilly

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

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 modelov podtalnice (MODFLOW, PESTAN – avtomatska kalibracija) v kombinaciji z osnovnimi GIS orodji za določitev vhodnih podatkov v modele.	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 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.

Temeljni 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:

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 and competences:

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 management.

Predvideni študijski rezultati:

- Pridobljeno poglobljeno znanje iz hidrološkega modeliranja.
- Osvojene računske spretnosti za pripravo podatkov, umerjanje hidroloških modelov in analizo rezultatov.
- 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.

Intended learning outcomes:

- 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. 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 (v %) / Weight (in %)	**Assessment:**
Oddane vaje	**40 %**	Coursework/lab exercises
2 kolokvija ali izpit:		two mid-term exams or final exam:
računski del	**40 %**	practical part
teoretični del	**20 %**	theoretical part

Reference nosilca / Lecturer's references:

ŠRAJ, Mojca, DIRNBEK, Luka, BRILLY, Mitja. The influence of effective rainfall on modeled runoff hydrograph. Journal of Hydrology and Hydromechanics, 2010, letn. 58, št. 1, str. 3-14, doi: DOI: 10_2478/v10098-010-0001-5.
BEZAK, Nejc, BRILLY, Mitja, ŠRAJ, Mojca. Comparison between the peaks over treshold method and the annual maximum method for flood frequency analyses. Hydrol. sci. j. [Print ed.], [v tisku] 2013, str. 1-29. doi: 10.1080/02626667.2013.831174.
ŠRAJ, Mojca, BRILLY, Mitja, MIKOŠ, Matjaž. Rainfall interception by two deciduous Mediterranean forests of contrasting stature in Slovenia. Agric. for. meteorol.. [Print ed.], 2008, letn. 148, št. 1, str. 121-134, ilustr.

ŠRAJ, Mojca, RUSJAN, Simon, PETAN, Sašo, VIDMAR, Andrej, MIKOŠ, Matjaž, GLOBEVNIK, Lidija, BRILLY, Mitja. The experimental watersheds in Slovenia. V: BRILLY, Mitja (ur.). XXIVth Conference of the Danubian Countries on the Hydrological Forecasting and Hydrological Bases of Water Management, IOP Conference Series, vol. 4. London: Institute of Physics, 2008, str. 1- 13. doi: 10.1088/1755-1307/4/1/012051. Dostopno na: http://iopscience.iop.org/1755-1315/4/1/012051/pdf?ejredirect=.iopscience .
ŠTRAVS, Luka, BRILLY, Mitja, ŠRAJ, Mojca. Precipitation interception modelling using machine learning methods - the Dragonja river basin case study. V: ABRAHART, Robert J. (ur.), SEE, Linda M. (ur.), SOLOMATINE, Dimitri P. (ur.). Practical hydroinformatics : computational intelligence and technological developments in water applications, (Water science and technology library, 68). Berlin; London: Springer, 2008, str. 347-358.
BRILLY, Mitja. Danube river basin coding : Chapter 4. V: BRILLY, Mitja (ur.). Hydrological processes of the Danube river basin : perspectives from the Danubian countries. Dordrecht [etc.]: Springer, cop. 2010, str. 125-141.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Potresno inženirstvo
Course title:	Earthquake engineering

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	2
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	2

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

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

Nosilec predmeta / Lecturer:	prof. dr. Peter Fajfar, izr. prof. dr. Matjaž Dolšek

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

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

Temeljni 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:

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 and competences:

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:

- 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

Intended learning outcomes:

- 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.

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.	- 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 (v %) / Weight (in %)	**Assessment:**
Vaje	**30 %**	Exercises during year Written exam:
Računski del izpita	**30 %**	Practical part
Teoretičen del izpita	**40 %**	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:	Numerical modelling of geotechnical structures

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	2
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

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

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

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

Opravljen izpit iz predmetov Mehanika tal in inženirska geologija ter Geotehnika oziroma usvojena enakovredna znanja, hkratni vpis predmeta Numerične metode.

Prerequisites:

Passed exams in Soil Mechanics and Engineering Geology, Geotechnics and simultaneous enrolment in the course Numerical methods.

Vsebina:

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

Content (Syllabus outline):

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

geotehničnih objektov (plitvi in globoki temelji, varovanje gradbene jame, posedanje tal pod nasipom, zemeljska pregrada, predor).	deep foundations, protection of the excavation, settlements beneath the embankment, earth dam, tunnel).

Temeljni literatura in viri / Readings:

Atkinson, J. 2007. The mechanics of soils and foundations, second edition, Taylor & Francis, 442 p.
Schweiger, H.F., Logar, J., Pulko, B. 2004. Seminar iz uporabe programa Plaxis, 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 - Razumevanje reševanja problema konsolidacije - Poznavanje načel dinamičnih analiz tal - Obvladovanje uporabe nelinearnih numeričnih orodij za geotehnične analize. - Vzpostavitev odnosa do numeričnega modela kot zgolj poenostavljene slike realne konstrukcije. - Videti kako se matematična formulacija modela reflektira v rezultatih analize. - Sposobnost uporabe nelinearnih numeričnih orodij za geotehnične analize - Sposobnost kritične presoje vhodnih podatkov in dobljenih računskih rezultatov - Sposobnost določanja materialnih parametrov za izbrane materialne modele.	- Understanding of the critical state soil mechanics - Knowledge of the basic principles of elasto- plastic models and concrete material models - Understanding of the principles of the numerical solution of nonlinear problems - Understanding of solving the problem of consolidation - Knowledge of the principles of dynamic analysis of soil - Use of non-linear numerical tools in geotechnical engineering. - Establishing a relation to the numerical model as simplified picture of real behaviour. - To see how the mathematical formulation of the model reflects the results of the analysis. - Ability to use non-linear numerical tools in geotechnical analysis - Ability of critical analysis of the input data and obtained computational results - Ability to determine material parameters for the selected material models.

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

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

Reference nosilca / Lecturer's references:

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

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

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

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

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

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

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	2
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: prof. dr. Jože Korelc

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

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

Prerequisites:

Vsebina:

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

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

Content (Syllabus outline):

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

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

Temeljni literatura in viri / Readings:

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

Cilji in kompetence:

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

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

Objectives and competences:

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

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

Predvideni študijski rezultati:

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

Intended learning outcomes:

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

Metode poučevanja in učenja:

Predavanja se izvajajo v učilnici z različnimi učnimi pripomočki. Vse vaje se izvajajo v računalniškem laboratoriju, kjer se uporabljajo komercialni in

Learning and teaching methods:

Lectures, exercises, attendance of International Short Course on Experimental and Numerical Modelling of M5 Problems in Engineering.

raziskovani računalniški programi po metodi končnih elementov. Študentje jih izvajajo deloma individualno, deloma skupinsko.	

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

Reference nosilca / Lecturer's references:

KORELC, Jože. 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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	2
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	2

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

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

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

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

Prerequisites:

Vsebina:

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 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).

Content (Syllabus outline):

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 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)

Temeljni 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).
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:

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 and competences:

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:

- 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.

Intended learning outcomes:

- 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:

Predavanja in večji del vaj v klasični učilnici, manjši del vaj pa tudi v računalniški učilnici.

Learning and teaching methods:

Lectures and large part of tutorials in classical classroom, small part of tutorials in computer classroom.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Vaje	**30 %**	Tutorials
Računski del izpita	**30 %**	Computational part of exam
Teoretični del izpita	**40 %**	Theoretical part of exam

Reference nosilca / Lecturer's references:

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

S. BRATINA, Kontrola napetostnega in deformacijskega stanja lesenega lameliranega lepljenega nosilca nadstrešnice CP Brezje - strokovno mnenje, Ljubljana: UL FGG, 2006, 13 str.
S. BRATINA, T. HOZJAN, 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.
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.

ILC, Anka, TURK, Goran, KAVČIČ, Franci, TRTNIK, Gregor. New numerical procedure for the prediction of temperature development in early age concrete structures. Automation in construction, ISSN 0926-5805. [Print ed.], 2009, letn. 18, št. 6, str. 849-855.
ILC, Anka, TRTNIK, Gregor, PLANINC, Igor, TURK, Goran. Temperaturna analiza postopne gradnje masivnih betonskih konstrukcij = Thermal analysis of successive construction of mass concrete. Gradbeni vestnik, ISSN 0017- 2774, marec 2009, letn. 58, št. 3, str. 54-61.
ILC, Anka, TURK, Goran, TRTNIK, Gregor. Numerično modeliranje poladiabatnega poskusa = Numerical modelling of semi-adiabatic test. V: EBERLINC, Matjaž (ur.), ŠIROK, Brane (ur.), Kuhljevi dnevi, 22. september 2011, Mengeš. Zbornik del. Ljubljana: SDM - Slovensko društvo za mehaniko, 2011, str. 75-82.

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1	2
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1	2

Vrsta predmeta / Course type: Obvezni splošni / Obligatory general

Univerzitetna koda predmeta / University course code:

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

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

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

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

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

Prerequisites:

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

Vsebina:

Računanje z dogodki, neodvisni in nezdružljivi dogodki.
Definicije verjetnosti, pogojna verjetnost, formula o popolni verjetnosti, Bayesova formula.
Slučajne spremenljivke: diskretne in zvezne, porazdelitvena funkcija, gostota verjetnosti, matematično upanje, disperzija, posebne porazdelitve: Bernoullijeva, binomska, geometrijska, Poissonova, eksponentna, enakomerna, normalna.
Slučajni vektorji: diskretni in zvezni; robne in pogojne porazdelitve, neodvisnost, koreliranost, kovarianca, dvorazsežna normalna porazdelitev, funkcije slučajnega vektorja.
Osnove stohastičnih procesov.
Limitni izreki: neenakosti Markova in Čebiševa, centralni limitni izrek.
Osnove statistike: vzorčenje, ocenjevanje parametrov, metoda momentov, metoda največjega verjetja, intervali zaupanja, preskušanje domnev.

Content (Syllabus outline):

Algebra of events, independent and exclusive events.
Definitions of probability, conditional probability, total probability, Bayes' Theorem.
Random variables: discrete and continuous, cumulative distribution function, probability density function, mathematical expectation, variance, special distributions: Bernoulli, binomial, geometric, Poisson, exponential, uniform, normal.
Random vectors: discrete and continuous, marginal and conditional distributions, independence, correlation, covariance, bivariate normal distribution, functions of random vectors.
Basics in stochastic processes.
Limit theorems: Markov and Chebyshev's inequality, the central limit theorem.
Basics in statistics: sampling, estimation of parameters, the method of moments, the method of maximum likelihood, confidence intervals, hypothesis testing.

Temeljni literatura in viri / Readings:

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

Cilji in kompetence:

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 and competences:

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:

- Formulacija konkretnih problemov v matematičnem jeziku
- Identifikacija ustreznega matematičnega modela
- Poznavanje teoretičnih osnov za praktično iskanje rešitev
- Doseženo matematično znanje uporabljajo strokovni predmeti
- Statistika je glavno orodje za analizo kvantitativnih podatkov
- Spretnost uporabe literature in modernih tehnologij,
- Poznavanje računalniških orodij (Mathematica, Matlab)

Intended learning outcomes:

- Formulation of practical problems in mathematical language
- Identification of the appropriate mathematical model
- Basic theoretical knowledge for using in practical problems
- Statistics is the main tool for quantitative data analysis
- Skills in using literature and modern technologies
- Ability to use computational tools (Mathematica, Matlab)

Metode poučevanja in učenja:

Predavanja, seminarske vaje

Learning and teaching methods:

Lectures, tutorials, consultations

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

Reference nosilca / Lecturer's references:

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

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

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	3
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: izr. prof. dr. Jana Šelih

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

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

Vsebina:	**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.

Temeljni literatura in viri / Readings:

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

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

Reference nosilca / Lecturer's references:

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

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Urejanje vodotokov
Course title:	River engineering

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	3
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60	30	15		15	120	8

Nosilec predmeta / Lecturer: prof. dr. Matjaž Mikoš

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

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 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	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 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

uporabo najnovejše različice programa HEC-RAS. Terensko delo Zasnova in izvedba tehničnih ureditev na rekah (gradbišča). Analiza zrnavosti rečnih sedimentov.	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.

Temeljni 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: - Sposobnost terenskega prepoznavanja razmer na vodotoku. - Sposobnost izdelave ureditvenih načrtov odsekov vodotokov.	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: - 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 (v %) / Weight (in %)	Assessment:
Seminarske vaje	**10 %**	Seminar tutorials
Seminar	**40 %**	Seminar coursework
Terensko delo	**10 %**	Field work report
Pisni in/ali ustni izpit	**40 %**	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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	3
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
60		60			120	8

Nosilec predmeta / Lecturer: doc. dr. Andrej Kryžanowski

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

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

Prerequisites:

Vsebina:

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 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

Content (Syllabus outline):

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 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.

programom DIANA.	

Temeljni 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. - 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.	- In-depth knowledge for design and planning of dams and hydraulic structures in water works. - 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 (v %) / Weight (in %)	Assessment:
Vaje	**50 %**	Tutorials
Pisni izpit	**50 %**	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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	3
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	3

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45	10		30	5	90	6

Nosilec predmeta / Lecturer: doc. dr. Ana Petkovšek, izr. prof. dr. Janko Logar

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

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

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

Prerequisites:

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

Vsebina:

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 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,

Content (Syllabus outline):

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 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

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.	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.

Temeljni 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 - 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 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 - 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	- 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

- 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 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 (v %) / Weight (in %)	**Assessment:**
Laboratorijske in terenske vaje	**50 %**	Laboratory and field work
Izpit	**50 %**	Exam

Reference nosilca / Lecturer's references:

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:	Hudourništvo
Course title:	Torrent, erosion, rockfall and avalanche control

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	4

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: prof. dr. Matjaž Mikoš

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

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

Opravljen izpit iz predmetov Hidravlično modeliranje, Hidrološko modeliranje ali pridobljena primerljiva znanja.

Prerequisites:

Passed exams in Hydraulic modelling and Hydrological modelling or acquired comparable knowledge.

Vsebina:

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. 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,

Content (Syllabus outline):

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), 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

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.	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.

Temeljni 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. - 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.	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. - 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	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

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.	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 (v %) / Weight (in %)	**Assessment:**
Seminarske vaje	**40 %**	Seminar tutorials
Terensko delo	**10 %**	Field work report
Pisni in/ali ustni izpit	**50 %**	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:	Pobočni procesi
Course title:	Slope processes

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	4

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
20	5		30	5	60	4

Nosilec predmeta / Lecturer: prof. dr. Matjaž Mikoš, doc. dr. Ana Petkovšek

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

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 Sanacija zemeljskih plazov v Sloveniji kot študijski primeri izvedenih sanacijskih ukrepov. Terensko delo Prepoznavanje ogroženih pobočij, koncepti sanacije aktivnih zemeljskih plazov in podorov.	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 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.

Temeljni 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 spletne strani Katedre za mehaniko tal. Dostopno na: http://www.fgg.uni-lj.si/KMTal/index.htm.

Cilji in kompetence:

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 and competences:

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:

- Poglobljeno razumevanje procesov v naravi.
- Poglobljeno znanje iz dinamike masnih gibanj in njihove sanacije.
- 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.

Intended learning outcomes:

- Acquired in-depth knowledge of processes in nature.
- Acquired in-depth knowledge of dynamics of mass movements and their mitigation.
- 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 activities.

Metode poučevanja in učenja:

Predavanja, seminarske vaje, terensko delo.

Learning and teaching methods:

Lectures, seminar tutorials, field work.

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

Reference nosilca / Lecturer's references:

LOGAR, J., FIFER BIZJAK, K., KOČEVAR, M., MIKOŠ, M., RIBIČIČ, M., MAJES, B. (2005). History and present state of the Slano Blato landslide. Natural hazards and earth system sciences 5, 447-457.
MIKOŠ, M., FAZARINC, R., PULKO, B., PETKOVŠEK, A., MAJES, B. (2005). Stepwise mitigation of the Macesnik landslide, N Slovenia. Natural hazards and earth system sciences 5, 948-958.
ĐUROVIĆ, B., MIKOŠ, M. (2004). Preventivno obvladovanje tveganj zaradi naravnih nevarnosti: postopki v alpskih državah in Sloveniji. Acta hydrotechnica 22/36, 17-35.

MAJES, B., PETKOVŠEK, A., LOGAR, J. (2002). Primerjava materialnih lastnosti drobirskih tokov iz plazov Stože, Slano blato in Strug. Geologija 45/2, 457-463.
PETKOVŠEK, A., FAZARINC, R., KOČEVAR, M., MAČEK, M., MAJES, B., MIKOŠ, M. (2011). The Stogovce landslide in SW Slovenia triggered during the September 2010 extreme rainfall event. Landslides 8(4), 499-506.
PETKOVŠEK, A., MAČEK, M., MIKOŠ, M., MAJES, B. (2013). Mechanisms of Active Landslides in Flysch. V: SASSA, Kyoji (ur.), BRICEÑO, Sálvano (ur.), MCSAVENEY, Mauri (ur.), HE, Bin (ur.), ROUHBAN, Badaoui. Landslides : Global Risk Preparedness. Berlin: Springer Verlag, 149-164.

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	4

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: izr. prof. dr. Janko Logar, izr. prof. dr. Vojkan Jovičić

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

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

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

Prerequisites:

Passed exams in Soil mechanics and engineering geology, Geotechnical Engineering

Vsebina:

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

Content (Syllabus outline):

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

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

Temeljni literatura in viri / Readings:

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

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

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

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

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

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

Reference nosilca / Lecturer's references:

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

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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	4

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

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

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

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

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

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

Temeljni literatura in viri / Readings:

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

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

Cilji in kompetence:

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

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

Objectives and competences:

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

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

Predvideni študijski rezultati:

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

Intended learning outcomes:

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

Metode poučevanja in učenja:

Mentorsko vodeno samostojno delo.

Learning and teaching methods:

Independent work under supervision.

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

Reference nosilca / Lecturer's references:

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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	2	4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	2	4

Vrsta predmeta / Course type: Obvezni strokovni / Obligatory professional

Univerzitetna koda predmeta / University course code:

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

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

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

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

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

Temeljni literatura in viri / Readings:

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

Cilji in kompetence:

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

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

Objectives and competences:

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

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

Predvideni študijski rezultati:

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

Intended learning outcomes:

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

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

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

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

Reference nosilca / Lecturer's references:

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

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Hidravlični stroji in naprave
Course title:	Hydraulic machines and devices

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1, 2	1–4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1, 2	1–4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: prof. dr. Franci Steinman

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

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

Opravljen izpit iz predmetov Hidromehanika in Hidravlika oz. osvojena ustrezna primerljiva znanja.

Prerequisites:

Passed exams in Fluid mechanics and Hydraulics.

Vsebina:

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
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

Content (Syllabus outline):

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.

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

praksi.	operations.

Temeljni 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 (v %) / Weight (in %)	Assessment:
Vaje	**50 %**	Coursework/exercises
Pisni in/ali ustni izpit	**50 %**	Written and/or oral examination

Reference nosilca / Lecturer's references:

KLASINC, Roman, LARCHER, Markus, STEINMAN, Franci, KOZELJ, Daniel. Fast pumped - storage schemes analysis by means of the hydraulic model : paper no. 49. V: Waterpower XV : Advancing Technology for Sustainable Energy : July 23.-26., 2007, Chattanooga, Tennessee USA. S.l.: Technical Papers, HCI Publications, 2007, str. 1-13, graf. prikazi.

BAJCAR, Tom, STEINMAN, Franci, ŠIROK, Brane, PREŠEREN, Tanja. Sedimentation efficiency of two ontinuously operating circular settling tanks with different inlet- and outlet arrangements. Chem. eng. j. 1996. [Print ed.], 15. Dec. 2011, vol. 178, str. 217-224.

NOVAK, Gorazd, KOZELJ, Daniel, STEINMAN, Franci, BAJCAR, Tom. Study of flow at side weir in narrow flume using visualization techniques. Flow meas. instrum.. [Print ed.], mar. 2013, letn. 29, str. 45-51.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Vodne moči
Course title:	Hydroelectric power

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1, 2	1–4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1, 2	1–4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: doc. dr. Andrej Kryžanowski

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

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

Prerequisites:

Vsebina:

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 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.

Content (Syllabus outline):

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). 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.

Temeljni 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:

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 and competences:

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:

- 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.
- 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.

Intended learning outcomes:

- 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.
- 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:

Predavanja in seminarske vaje.

Learning and teaching methods:

Lectures and tutorials.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Vaje	**50 %**	Coursework/exercises
Pisni izpit	**50 %**	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 program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1, 2	1–4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1, 2	1–4

Vrsta predmeta / Course type: Izbirni strokovni / Elective professional

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: prof. dr. Matjaž Četina

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

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

Prerequisites:

Vsebina:

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

Laboratorijske vaje
Meritve vodnega skoka v šolskem žlebu ter masnih nihanj na fizičnem modelu vodostana.

Content (Syllabus outline):

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

Laboratory tutorials
Measurements of hydraulic jump and mass oscillations in surge tank in hydraulic laboratory.

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

Temeljni literatura in viri / Readings:

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

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

Predvideni študijski rezultati:	**Intended learning outcomes:**
- Poznavanje lastnosti nestalnega toka v odprtih koritih (valovi) in ceveh pod tlakom (vodni udar). - Razumevanje procesov kakovostnih sprememb v vodnih telesih in sposobnost njihovih kvantitativnih napovedi z numeričnimi modeli. - Doseženo znanje uporabljajo pri izdelavi 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 (v %) / Weight (in %)	**Assessment:**
Način(pisni izpit, ustno izpraševanje, naloge, projekti)		Type (examination, oral, coursework, project)
Domače naloge (pisno, oddaja več vaj)	**50 %**	Homework (written, several exercises)
Pisni izpit (izpit iz teorije)	**50 %**	Written exam (theory)

Reference nosilca / Lecturer's references:

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

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Geotehnika okolja
Course title:	Environmental geotechnics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Gradbeništvo - druga stopnja MA	Geotehnika-hidrotehnika	1, 2	1–4
Civil Engineering - second cycle MA	Geotechnics-Hydrotechnics	1, 2	1–4

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

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

Nosilec predmeta / Lecturer:	doc. dr. Ana Petkovšek

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

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 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	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 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

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.	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.

Temeljni 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 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.	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 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

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.	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. - 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.	- 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 - 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 (v %) / Weight (in %)	**Assessment:**
Pisni izpit	**70 %**	Written exam
Vaje in individualne naloge	**30 %**	Tutorials and individual work

Reference nosilca / Lecturer's references:

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.

MLADENOVIČ, Ana, POGAČNIK, Željko, MILAČIČ, Radmila, PETKOVŠEK, Ana, CEPAK, Franka. Dredged mud from the Port of Koper - civil engineering applications = Mulj iz Luke Koper - uporabnost v gradbeništvu. Mater.tehnol., 2013, letn. 47, št. 3, str. 353-356.

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.