



1. GENERAL INFORMATION					
<b>Study programme title</b>	University graduate study programme in mining engineering Subprogramme waste treatment and disposal				
<b>Course title</b>	Landfills		<b>Semester</b>	3	
<b>Teacher</b>	PhD. Želimir Veinović, Assistant professor		<b>Course code</b>	27123	
<b>Course type</b>	<input checked="" type="checkbox"/> obligatory <input type="checkbox"/> elective		<b>ECTS</b>	5,5	
<b>Location</b>					
<b>Language</b>	<input checked="" type="checkbox"/> Croatian <input checked="" type="checkbox"/> English				
<b>Class type</b>	<b>Weekly hours</b>	<b>Teaching staff</b>	<b>Office hours</b>	<b>Room</b>	<b>E-mail</b>
<b>Class</b>	30	Želimir Veinović, PhD, Assistant professor	10,00-12,00	V504	zelimir.veinovic@rgn.hr
<b>Practice</b>	30	Želimir Veinović, PhD, Assistant professor	10,00-12,00	V504	zelimir.veinovic@rgn.hr
<b>Field lecture</b>	7,5	Želimir Veinović, PhD, Assistant professor	10,00-12,00	V504	zelimir.veinovic@rgn.hr
<b>E-learning level</b>	2		<b>Percentage of on-line class (max. 20%)</b>		5%
2. COURSE DESCRIPTION					
<b>Course aims</b>	<p>In the course, focus will be placed on the evaluation of waste containment facilities. The objective of this course is to provide an understanding of the use of geotechnical concepts in the analysis and design of landfills. Specific topics to be covered include the environmental geotechnics field and regulatory framework. Analyzed will be soils in waste containment: relevant soil properties, compaction and compacted clay properties, drainage material, slurry walls. Described will be solid waste by its characterization and engineering properties. Special attention will be given to use of geosynthetics in waste containment (types, functions, mechanical and hydraulic properties). An introduction will be given to waste containment systems: base lining systems, leachate collection and removal systems, cover systems, alternative cover systems, development over closed landfills. In addition, discussed will be: contaminant transport through barrier systems (advection, dispersion, and diffusion mechanisms) and water balance for landfills. Discussed is: permeability analysis and use of</p>				



	<p>composite clay and liner systems. In the stability of landfills treated will be failure modes, analysis and design considerations, seismic considerations.</p> <p>Other subjects that will be considered are strategy of waste management in the Republic of Croatia and European Union (EU). action plan of waste management in the Republic of Croatia and EU, integrated system of waste management, case studies of landfill rehabilitation, nonstandard methods of waste disposal and EU Directives.</p>
<b>Requirements for applicants</b>	<p>Conditions:</p> <p>Bachelor of science of technical sciences (mining, geotechnics, geology, civil engineering, mechanical engineering, etc.) or natural sciences (physics, chemistry, geology, etc.) or in environmental engineering.</p>
<b>Programme level learning outcomes with course contribution</b>	<p>Landfill analysis as part of the waste management system and environmental protection system. Evaluation of the impacts of landfills, applied technologies and materials on the environment.</p>
<b>Expected course level learning outcomes (4-10 outcomes)</b>	<p>Ability to analyze waste management system at local or regional level. Ability to evaluate the design and quality of the landfill project. Possibility of selecting the location and choice of individual systems / elements on the landfill. Quality assessment of the performance of individual parts of the landfill and landfill as a whole system.</p>
<b>Course contents by individual lessons</b>	
<b>Class</b>	<b>Practice</b>
L01 - Geotechnical particularities of the landfill	<p>P01 - Analysis of the site of emergence and composition of municipal waste</p> <p>Project theme selection.</p>
L02 - Types and properties of waste materials	<p>P02 – Organisation of a sanitary landfill of the slid municipal waste</p>
L03 - Quantitative characteristics of waste materials	<p>P03 - Analysis of the example of determining the quantity and speed of municipal waste generation</p>
L04 - Qualitative characteristics of waste materials - chemical and biological properties	<p>P04 - Chemical and biological properties of waste - analysis of examples</p>
L05 - Qualitative characteristics of waste materials - physical and geomechanical properties	<p>P05 - Physical and geomechanical properties of waste - analysis of examples</p>
L06 - Stability of landfill	<p>P06 - Stability of landfill - example analysis</p>



L07 - Aging of waste	P07 - Changes in the characteristics of waste materials over time			
L08 - Selection of landfill locations	P08 - Selection of landfill sites Blitz test.			
L09 - Landfill types with respect to waste disposal technology	P09 - Types and types of landfills - example analysis			
L10 - Base layer protection system	P10 – Base Layer Protection System - Example Analysis - Materials			
L11 - Surface protection layer system	P11 - Surface Layer Protection System - Example Analysis - Materials			
L12 - Waste Disposal	P12 - Placement of waste materials			
L13 - Evaluation of landfill safety and subsequent measurements	P13 – Landfills - Example Analysis			
L14 - Croatian and foreign legislative	P14 - Landfills - Example Analysis Blitz test.			
L15 – Special cases.	Project presentation and defence.			
<b>Students' obligations</b>	Regular presence at the class (maximum absence 3 times), two blitz tests, written (accepted by the teacher) and defended project.			
<b>Students' work track</b> <i>(indicate share in ECTS points for each activity so that overall ECTS number corresponds to class credits score):</i>	Class attendance	1	Research	
	Project	2	Report	
	Colloquium	1	Seminar paper	
	Practical work		Oral exam	1
	Written exam		(Extra)	
<b>Type of exam, grades and evaluation of students work</b> during class and on final exam	Attending classes, active participation in lectures, writing, presenting and defending Project.			
<b>Mandatory literature</b> (available in the Library and via other media)	German Geotechnical Society of Soil Mechanics and Foundation Engineering (1993) Technical Recommendations - GLR, Geotechnical of Landfill Design and Remedial Works Chapman & Hall, London. Croatian and European legislation concerning municipal solid waste management/disposal.			
<b>Additional literature</b> (at the moment of study program proposition application)	Tchobanoglous, G., Kreith, F. (2002): HANDBOOK OF SOLID WASTE MANAGEMENT, McGRAW-HILL, New York. Pichtel, J. (2014): Waste Management Practices: Municipal, Hazardous, and Industrial, Second Edition, CRC Press. Ludwig, C, Hellweg, S., Stucki, S. (2003): Municipal Solid Waste Management: Strategies and Technologies for Sustainable Solutions. Springer, Berlin. Unnisa, S.A., Rav, S.B. (2012): Sustainable Solid Waste Management. CRC Press.			



	Chandra, R. (2015): Environmental Waste Management. CRC Press. Letcher, T., Vallerio. D. (2011): Waste - A Handbook for Management. Academic Press. Pires, A., Martinho, G., Rodrigues, S., Gomes, M.I. (2019): Sustainable Solid Waste Collection and Management. Springer, Berlin.
<b>Examination terms</b>	Every Thursday within exam-terms (at 10:00).
<b>Other</b>	

Course Teacher:

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Asst. Prof. Želimir Veinović Ph.D.