



1. GENERAL INFORMATION				
1.1 Course teacher	Assoc. Prof. Hrvoje Kušić, PhD Prof. Zlata Hrnjak-Murčić, PhD		1.6 Year of the study	2 (3 rd semester)
1.2 Name of the course	Solid Waste Recycling and Treatment		1.7 ECTS credits	5
1.3 Associate teachers	Josipa Papac, mag. ing. oecoinq. Zvonimir Katančić, PhD		1.8 Type of instruction (number of hours L + E + S + e-learning)	Total: 60 (30L+15E+15S)
1.4 Study programme (undergraduate, graduate, integrated)	Graduate		1.9 Expected enrolment in the course	10
1.5. Status of the course	<input type="checkbox"/> mandatory	<input checked="" type="checkbox"/> elective	1.10 Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2
2. COUSE DESCRIPTION				
2.1. Course objectives	Introducing students; with the sources of municipal/solid waste generation, with the application of "green engineering" approach in production, life cycle analysis, characterization, recycling and treatment of solid municipal waste, as well as the organization and establishment of system of solid waste management			
2.2. Enrolment requirements and/or entry competences required for the course	Environmental Engineering, Remediation Technologies			
2.3. Learning outcomes at the level of the programme to which the course contributes	<ul style="list-style-type: none"> • Compile and apply advanced knowledge of natural and technical sciences, particularly chemical engineering and environmental engineering in solving scientific, professional and general social problems. • Solve engineering problems using the scientific method combining expert knowledge from chemistry, environmental, and chemical engineering as well as material science and engineering. • Correlate expert knowledge from chemistry, chemical engineering and material engineering with awareness of influence on society, economy and environment. • Plan and independently perform experiments in order to confirm a hypothesis to estimate economic and ecological efficiency of processes. • Utilise advanced laboratory procedures and instruments for synthesis of new products, create sustainable processes, and solve problems of water, air and soil pollution. • Apply different analytical techniques, analytical and numerical methods, as well as software tools in creative problem solving of engineering challenges, proposing sustainable technological solutions. • Identify and analyse complex problems in technological processes of chemical and related industries. • Apply tools, methods and standards for monitoring and assessing the quality of processes and products, as well as their environmental impact, and to predict potential risks in working with technological processes and developing products. 			



	<ul style="list-style-type: none"> • Identify and discuss advantages, disadvantages and limitations of certain methods for preparation, synthesis, analysis and processing of samples in accordance with sustainable development and life cycle of products and processes. • Independently organise and plan timelines, apply a general methodology for project planning and management in a business environment • Evaluate technological processes and products from the perspective of high functionality in different conditions and environmental effects. • Create a critical analysis, evaluation and interpretation of personal results, and compare them with existing data in scientific and expert literature • Demonstrate independence and reliability in independent work, as well as effectiveness, reliability and adaptability in team work • Outline results of independent and teamwork in a written and oral form to non-experts and experts in a clear and coherent way. • Communicate with the scientific and professional community, as well as society in general in local and international surroundings • Develop work ethic, personal responsibility and tendency for further skill and knowledge acquisition, according to standards of engineering practice
<p>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</p>	<ol style="list-style-type: none"> 1. Define terms: environment pollution, pollution sources, sustainable development 2. Explain solid waste legislation valid for EU and Republic of Croatia 3. Apply assessment methods and pollution monitoring in the implementation of Life Cycle Analysis (LCA, LCC) for solid waste 4. Apply characterization methods for solid waste regarding overall amount, source type and amount of particular fraction materials 5. Apply assessment methods for the determination of material properties from solid waste; energy content (caloric value), chemical (organic, inorganic, hazardous) and physical (density, moisture) properties 6. Apply assessment methods for establishing and organizing a waste management system with separate phases 7. Apply technologies for waste recycling and treatment and analyse the secondary products
<p>2.5. Course content (syllabus)</p>	<p>WEEK 1. Pollution sources, Green Engineering approach, Sustainable development</p> <p>WEEK 2. Definition of waste; generation sources (municipal, industrial) and properties (hazardous, non-hazardous, inert)</p> <p>WEEK 3. EU and Republic of Croatia legislation for waste management; strategies and action plans</p> <p>WEEK 4. Waste management hierarchy, prevention strategies, circular economy</p> <p>WEEK 5. Life cycle assessment (LCA, LCC), monitoring methods and pollution measurement units</p> <p>WEEK 6. Classification, characterization, composition and properties of solid waste</p> <p>WEEK 7. Municipal waste; organization of waste management system with separate phases – collection, storage, separation/sorting, transport</p> <p>WEEK 8. Partial exam</p> <p>WEEK 9. Recycling of materials from waste; plastics, glass, paper, metal</p> <p>WEEK 10. Special waste categories; packaging waste, e-waste, waste oils, waste vehicles, waste tires, waste batteries and accumulators</p> <p>WEEK 11. Municipal waste landfills, Waste management centres</p> <p>WEEK 12. Landfill leachate; characteristics and treatment</p> <p>WEEK 13. Composting and mechanical-biological treatment; demands, technologies, products</p>



	WEEK 14. Thermal waste treatment; demands, technologies, energy, products								
	WEEK 15. Partial exam								
2.6. Format of instruction:	<input checked="" type="checkbox"/> lectures <input checked="" type="checkbox"/> seminars and workshops <input checked="" type="checkbox"/> exercises <input type="checkbox"/> online in entirety <input type="checkbox"/> partial e-learning <input checked="" type="checkbox"/> field work			<input checked="" type="checkbox"/> independent assignments <input type="checkbox"/> multimedia and the internet <input checked="" type="checkbox"/> laboratory <input type="checkbox"/> work with mentor <input type="checkbox"/> (other)			2.7. Comments:		
2.8. Student responsibilities	A minimum of 75% of attendance of all classes is mandatory. Absence from the seminars and lab exercise must be compensated. Before taking the exam, the student is required to submit the written seminar report, complete all exercises and to submit all written reports. Oral exam is possible only at a personal request and/or in special circumstances.								
2.9. Monitoring student work	Class attendance	YES		Research		NO	Oral exam		NO
	Experimental work	YES		Report	YES		(other)		
	Essay		NO	Seminar paper	YES		(other)		
	Preliminary exam	YES		Practical work	YES		(other)		
	Project		NO	Written exam	YES		ECTS credits (total)	5	
2.10. Required literature (available in the library and/or via other media)	Title						Number of copies in the library	Availability via other media	
	Teaching materials prepared by the course teachers for lectures, seminars and laboratory exercise, available through the course website							www.fkit.unizg.hr	
	J. R. Mihelcic, J. B. Zimmerman, Environmental Engineering: Fundamentals, Sustainability, Design, John Wiley & Sons, 2009, New Jersey.						1		
	N. L. Nemerow, F. J. Agardy, P. Sullivan, J. A. Salvato, Environmental Engineering; Environmental health and Safty for Municipal Infrastructure, Land Use and Planning and Industry, 6th edition, John Wiley & Sons, 2009. New Jersey.						1		
2.11. Optional literature	P. T. Williams, Waste Treatment and Disposal, 2nd edition, John Wiley & Sons, 2005. New Jersey.						1		
	W. J. Lacy, H. E., Allen, I. Twardowska, A. A. F. Kettrup, Solid Waste: Assessment, Monitoring and Remediation, Elsevier, 2004, Amsterdam-Boston								
	A. Azapagic, A. Emsley, I. Hamerton "Polymers, the Enviromental and Sustanible Development" J. Wiley & Sons, N.Y. 2003.								
2.12. Other (as the proposer wishes to add)	J. Scheirs, Polymer Recycling: Science, Technology and Applications, J.Wiley & Sons, Brisbane, 1998								