2.9. Monitoring student work	Class attendance	YES		Research		NO	Oral exam		NO
	Experimental work	YES		Report		NO	Independent and joint assignments	YES	
	Essay		**NO**	Seminar paper		NO	(other)		
	Preliminary exam	YES		Practical work	YES		(other)		
	Project		NO	Written exam	YES		ECTS credits (total)	5	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	P. Wyatt, S. Warren, ORGANIC SYNTHESIS: STRATEGY AND CONTROL, John Willey & Sons, New York, 2007.	1	YES
	R. P. Irwin, ORGANOMETALLIC CHEMISTRY-RESEARCH PERSPECTIVES, Nova Science Publishing. Inc., New York, 2007.	1	YES
	T. W. Graham Solomons, ORGANIC CHEMISTRY, John Willey & Sons, New York, 2104.	2	YES
	l.G. Wade Jr, ORGANIC CHEMISTRY, Pearson, 8th Ed, 2013.	2	YES
2.11. Optional literature	L. F. Tietze, G. Brasche, K. M. Gericke, DOMINO REACTIONS IN ORGANIC SYNTHESIS, Willey VCH-Verlag, Weinheim, 2006.		
	C. O. Kappe, D. Dallinger, S. S. Murphree, PRACTICAL MICROWAVE SYNTHESIS FOR ORGANIC CHEMISTS, Wiley-WCH, Weinheim, 2009.		
2.12. Other (as the proposer wishes to add)			

University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Assoc. Prof. Hrvoje Kušić, PhD Prof. Zlata Hrnjak-Murgić, PhD		1.6 Year of the study	2 (3rd 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. oecoing. 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	☐ mandatory	☒ 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	• 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.

	• 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
2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	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
2.5. Course content (syllabus)	**WEEK 1.** Pollution sources, Green Engineering approach, Sustainable development **WEEK 2.** Definition of waste; generation sources (municipal, industrial) and properties (hazardous, non-hazardous, inert) **WEEK 3.** EU and Republic of Croatia legislation for waste management; strategies and action plans **WEEK 4.** Waste management hierarchy, prevention strategies, circular economy **WEEK 5.** Life cycle assessment (LCA, LCC), monitoring methods and pollution measurement units **WEEK 6.** Classification, characterization, composition and properties of solid waste **WEEK 7.** Municipal waste; organization of waste management system with separate phases – collection, storage, separation/sorting, transport **WEEK 8.** Partial exam **WEEK 9.** Recycling of materials from waste; plastics, glass, paper, metal **WEEK 10.** Special waste categories; packaging waste, e-waste, waste oils, waste vehicles, waste tires, waste batteries and accumulators **WEEK 11.** Municipal waste landfills, Waste management centres **WEEK 12.** Landfill leachate; characteristics and treatment **WEEK 13.** Composting and mechanical-biological treatment; demands, technologies, products

	WEEK 14. Thermal waste treatment; demands, technologies, energy, products **WEEK 15.** Partial exam

2.6. Format of instruction:			2.7. Comments:
	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ partial e-learning ☒ field work	☒ independent assignments ☐ multimedia and the internet ☒ laboratory ☐ work with mentor ☐ (other)	

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, Sustainablity, Design, John Wiley& Sons, 2009, New Yersey.	1	
	N. L. Nemerow, F. J. Agardy, P. Sullivan, J. A. Salvato, Environmental Engineering; Environmental helth and Safty for Municipal Infrastructure, Land Use and Planning and Industry, 6th edition, John Wiley & Sons, 2009. New Jersey.	1	
	P. T. Williams, Waste Treatment and Disposal, 2nd edition, John Wiley & Sons, 2005. New Jersey.	1	

2.11. Optional literature	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.
	J. Scheirs, Polymer Recycling: Science, Technology and Applications, J.Wiley & Sons, Brisbane, 1998
2.12. Other (as the proposer wishes to add)	