University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Prof. Ana Lončarić Božić, PhD Assist. Prof. Davor Dolar, PhD		1.6 Year of the study	2 (3rd semester)
1.2 Name of the course	Advanced Water Treatment Technologies		1.7 ECTS credits	5
1.3 Associate teachers	Josipa Papac, mag. ing. oecoing. Marko Racar, mag. ing. cheming.		1.8 Type of instruction (number of hours L + E + S + e-learning)	Total: 60 (L:30, E:30, S:0)
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	To introduce students to advanced technologies for water purification and wastewater treatment, and to develop understanding of related challenges and opportunities. To adopt specific theoretical knowledge and practical skills related to the characteristic radical reactions and mechanisms, reactor systems and operating process parameters.
2.2. Enrolment requirements and/or entry competences required for the course	Environmental engineering, Remediation technology
2.3. Learning outcomes at the level of the programme to which the course contributes	• 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. • Optimise complete and sustainable technological processes using analysis and modelling aimed at waste minimization utilising the strategy of the closed cycle manufacturing. • Independently organise and plan timelines, apply a general methodology for project planning and management in a business environment • Create a critical analysis, evaluation and interpretation of personal results, and compare them with existing data in scientific and expert literature • 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

2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	• Explain means and materials for membrane preparation, and how to to characterize membranes • Define types of membrane operations and design membrane systems • Explain the principles of pressure membrane processes • Select membranes for specific purposes and to test their main characteristics • Discuss characteristics of different types of advanced oxidation processes • analyse influence of process parameters on efficiency of water treatment by advanced oxidation processes • correlate degradation mechanisms of water pollutants with biodegradability and toxicity changes • Assess inhibitory effect of water matrix in practical application of advanced oxidation processes.		
2.5. Course content (syllabus)	**WEEK 1.** introductory lecture: water in general; membrane processes in general **WEEK 2.** classification of membranes; characterization of membranes **WEEK 3.** pressure membrane processes; membrane modules **WEEK 4.** design of membrane processes; seminar tasks **WEEK 5.** examples of membrane systems design; desalination **WEEK 6.** fouling; electrochemical membrane processes; membrane bioreactor **WEEK 7.** Partial exam **WEEK 8.** classification and main characteristics of advanced oxidation processes; degradation of water pollutants by OH radical mechanism **WEEK 9.** homogeneous and heterogeneous Fenton type processes, UV/Fenton **WEEK 10.** ozonation **WEEK 11.** catalytic ozonation, peroxone process **WEEK 12.** photolysis, photooxidation processes **WEEK 13.** photocatalytic processes **WEEK 14.** hybride processes **WEEK 15.** Partial exam		
2.6. Format of instruction:	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia and the internet ☒ laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attendance and participation in lectures (75% min) and lab (100%). Written laboratory reports.		

2.9. Monitoring student work	Class attendance	YES		Research		NO	Oral exam	YES		
	Experimental work	YES		Report	YES		(other)			
	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)	Course materials prepared by the course teacher, available through the course website.		www.fkit.unizg.hr
	M. Mulder, Basic principles of membrane technology, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1996	1	
	A.I. Schäfer, A.G. Fane, T.D. Waite (Eds.) Nanofiltration – principles and applications, Elsevier, Oxford, 2005	1	
2.11. Optional literature	Wilf M., The Guidebook to membrane desalination technology – reverse osmosis, nanofiltration and hybrid system process, applications and economics, Balaban Desalination Publications, L'Aquila, Italy, 2007.		
	J. Mallevialle, P.E. Odendaal, M.R. Wiesner (edts.), Water treatment membrane processes, McGraw-Hill, New York, 1996		
	S. Parsons, Advanced Oxidation Processes for Water and Wastewater Treatment, IWA Publishing, London, 2004		
2.12. Other (as the proposer wishes to add)			