University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Prof. Zoran Mandić, PhD Prof. Ante Jukić, PhD		1.6 Year of the study	1
1.2 Name of the course	Renewable Energy Sources		1.7 ECTS credits	5
1.3 Associate teachers	Roko Blažic, mag. ing. cheming.		1.8 Type of instruction (number of hours L + E + S + e-learning)	Total: 60 (L:30, E:15, S:15)
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	The aim of the course is to give an overview of scientific and technological principles underlying the operation of renewable energy sources and their application.			
2.2. Enrolment requirements and/or entry competences required for the course				
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 • 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. • Demonstrate independence and reliability in independent work, as well as effectiveness, reliability and adaptability in teamwork. • Communicate with the scientific and professional community, as well as society in general in local and international surroundings.			

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2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	1. Define the field and the scope of renewable energy sources 2.Outline environmental, geopolitical and commercial requirements for renewable energy systems and for sustainable development of the society 3. Analyse the advantages and disadvantages of different types of renewable energy systems 4. Design and setting up of the systems for the application of renewable energy systems 5. Suggest different options and possibilities for solving the present energy and ecological problems 6. Apply acquired knowledge in practice
2.5. Course content (syllabus)	**WEEK 1.** Introduction to renewable energy sources, historical review, and their role in solving energy and ecological problems **WEEK 2.** Different types of renewable energy sources **WEEK 3.** Energy conversion thermodynamics **WEEK 4.** Biomass: its role and application **WEEK 5.** Manufacturing and use of biofuels **WEEK 6.** Hydrogen as an emerging fuel **WEEK 7.** Production processes, storage, transport and use of hydrogen **WEEK 8.** Evaluation of knowledge and preliminary exam **WEEK 9.** Partial exam **WEEK 10.** Wind power generation **WEEK 11.** Solar energy and photovoltaics **WEEK 12.** Geothermal energy **WEEK 13.** Grid integration of renewable energy sources **WEEK 14.** Energy storage technologies, Evaluation of knowledge and preliminary exam. **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% attendance of all classes is mandatory. Absence from the seminars and lab exercise must be compensated. Before passing the exam, the student is required to submit the written seminar report, complete all exercises and submit all written reports.

2.9. Monitoring student work									
	Class attendance	YES		Research	YES		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	

	Title	Number of copies in the library	Availability via other media
2.10. Required literature (available in the library and/or via other media)	Lecture handouts prepared by the course teachers for lectures, seminars and laboratory exercise.		www.fkit.unizg.hr
	Twidell J., Weir T., Renewable Energy Resources, Routledge Taylor & Francis, London and New York, 2015.	1	
	Letcher T. M., Future Energy: Improved, Sustainable and Clean Options for our Planet, Elsevier, Oxford, 2008.	1	
2.11. Optional literature			
2.12. Other (as the proposer wishes to add)			