University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Prof. Ante Jukić, PhD Assist. Prof. Fabio Faraguna, PhD		1.6 Year of the study	2nd year, 3rd semester
1.2 Name of the course	BAT in Chemical Industry		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	20
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	Students will learn the application of the Best Available Techniques (BAT) concept in environmental engineering and reduction of air, water and soil emissions in major chemical industry facilities such as petroleum and natural gas refineries, cement and petrochemical plants.
2.2. Enrolment requirements and/or entry competences required for the course	Applied Catalysis, Process Design and Economic, Sustainable Technologies and Development
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. • Optimise complete and sustainable technological processes using analysis and modelling aimed at waste minimization utilising the strategy of the closed cycle manufacturing. • Plan, document and monitor developmental activities of complex sustainable technological systems and processes. • 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. • 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.

	• Investigate and analyse implementation of innovative and incoming chemical technologies in multidisciplinary environment. • 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. Collect, evaluate and process information from various sources 2. Describe the technological processes in the chemical industry 3. Determine influence points and main sources of emissions in environment of certain chemical processes in the chemical industry 4. To apply the concept of the best available technology to the target process of the chemical industry and assess the reduction of environmental impact 5. Analyze and evaluate new, transformed and evolving technological processes		
2.5. Course content (syllabus)	**WEEK 1.** Introduction to a holistic approach to environmental engineering and related legislations **WEEK 2.** Description of the best available technology (BAT) concept for reduction and control of environmental impact. Reference Documents (BREFs). **WEEK 3.** BAT in the treatment of waste water and gases in the chemical industry **WEEK 4.** Technological processes, environmental impact and BAT for petroleum and natural gas refineries (Part 1) **WEEK 5.** Technological processes, environmental impact and BAT for oil and natural gas refineries (Part 2) **WEEK 6.** Technological processes, environmental impact and BAT for ammonia production plants (Part 1) **WEEK 7.** Technological processes, environmental impact and BAT for ammonia production plants (Part 2) **WEEK 8.** Technological processes, environmental impact and BAT for the selected example of the organic chemical industry **WEEK 9.** Partial exam **WEEK 10.** Technological processes, environmental impact and BAT for the selected example of the polymer industry **WEEK 11.** Technological processes, environmental impact and BAT for cement production **WEEK 12.** Technological processes, environmental impact and BAT for steelwork production **WEEK 13.** BAT in the production of heat and electricity by combustion of fuels (Part 1) **WEEK 14.** BAT in the production of heat and electricity by combustion of fuels (Part 2) **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: Field work: industrial visit.

2.8. Student responsibilities	Attendance of a minimum of 75% of classes is mandatory. Missed seminars and lab exercises must be made-up. Before passing the exam, the student is required to submit written seminar reports, as well as complete all exercises and submit all written reports.								
2.9. Monitoring student work	Class attendance	YES		Research		NO	Oral exam		NO
	Experimental work	YES		Report	YES		(other)		NO
	Essay		NO	Seminar paper	YES		(other)		NO
	Preliminary exam	YES		Practical work		NO	(other)		NO
	Project		NO	Written exam	YES		ECTS credits (total)		

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
	Thomas Brinkmann, Germán Giner Santonja, Hande Yükseler, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector, EUR 28112 EN, European Comission, 2016.	2	Yes (https://ec.europa.eu/jrc)
	Pascal Barthe, Michel Chaugny, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas, EUR 27140 EN, European Comission, 2015.	1	Yes (https://ec.europa.eu/jrc)
	Heino Falcke, Simon Holbrook, Iain Clenahan, Alfredo Lopez Carretero, Teoman Sanalan, Thomas Brinkmann, Joze Roth, Benoit Zerger, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for the Production of Large Volume Organic Chemicals, EUR 28882 EN, European Comission, 2017.	1	Yes (https://ec.europa.eu/jrc)

2.11. Optional literature	Frauke Schorcht, Ioanna Kourti, Bianca Maria Scalet, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide, EUR 26129 EN, European Comission, 2013.
	Rainer Remus, Miguel A. Aguado-Monsonet, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for Iron and Steel Production, EUR 25521 EN, European Comission, 2013.

	Thierry Lecomte, José Félix Ferrería de la Fuente, Frederik Neuwahl, Michele Canova, Antoine Pinasseau, Ivan Jankov, Thomas Brinkmann, Serge Roudier, Luis Delgado Sancho: Best Available Techniques (BAT) Reference Document for Large Combustion Plants, EUR 28836 EN, European Comission, 2017.
2.12. Other (as the proposer wishes to add)	