University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Assist. Prof. Igor Dejanović, PhD		1.6 Year of the study	1st (1st semester)
1.2 Name of the course	Process Design and Economics		1.7 ECTS credits	5
1.3 Associate teachers	Goran Lukač, mag. ing. cheming.		1.8 Type of instruction (number of hours L + E + S + e-learning)	Total 60 (L: 30, E: 0, S: 30)
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	To master basic steps of chemical process design using knowledge acquired during undergraduate study. To acquire knowledge needed to perform basic economic analysis of a project.			
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	• Solve engineering problems using the scientific method combining expert knowledge from chemistry, environmental, and chemical engineering as well as material science and engineering. • 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. • Demonstrate independence and reliability in independent work, as well as effectiveness, reliability and adaptability in teamwork. • Outline results of independent and teamwork in a written and oral form to non-experts and experts in a clear and coherent way.			
2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	1. Synthesise process diagram for a specified task and model it using process simulators. 2. To create documentation comprising basic engineering design for a specified design task. 3. Synthesise heat exchanger network. 4. Synthesise basic mass exchange network 5. Estimate capital and operating expenses of a process. 6. Devise cash flow diagram and use it to calculate profitability criteria of a project.			

2.5. Course content (syllabus)	**WEEK 1.** Introduction. Project documentation. Standards, codes and recommendations. Organization of a chemical engineering project; requested accuracy and project security factors. Contents of a project assignment. **WEEK 2.** Basic process diagrams (BFD, PFD, P&ID). Synthesis of process diagrams.. Process simulators. **WEEK 3.** Reaction systems selection and design. Separation systems selection and design. **WEEK 4.** Distillation system design. Distillation sequence synthesis. Azeotropic distillation **WEEK 5.** Heat transfer equipment. Heat exchanger network synthesis. Basics of pinch method. **WEEK 6.** Determining process energy targets – graphical and algebraic method. Composite curves and cascade diagrams. **WEEK 7.** Designing heat exchanger network to fulfil determined targets. Threshold problems. Multiple pinches. Data extraction. Integration of reactors, distillation columns, evaporators, dryers, cooling systems, steam and cogeneration systems into the background process. **WEEK 8.** Partial exam **WEEK 9.** Mass exchanger network synthesis. Mass exchangers – simplified models. Pinch method. **WEEK 10.** Algebraic method for mass integration – interval and cascade diagram. Water reduction through superstructure optimization. **WEEK 11.** Methods for estimation of investments. Use of cost indices. **WEEK 12.** Engineering economic analysis. Time value of money and cash flow diagrams **WEEK 13.** Calculating performance indicators from cash flow diagram. **WEEK 14.** Profitability analysis – discounted and non-discounted criteria. Accounting for uncertainties in profitability analysis. **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			

2.9. Monitoring student work

Class attendance	YES		Research		NO	Oral exam		NO
Experimental work		NO	Report		NO	(other)		
Essay		NO	Seminar paper		NO	(other)		
Preliminary exam	YES		Practical work		NO	(other)		
Project	YES		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
L.T.Biegler, I.E.Grosmann, A.W.Westerberg, SYSTEMATIC METHODS OF CHEMICAL PROCESS DESIGN, Prentice Hall International, University Huston, 1999.	2	
R. Smith, CHEMICAL PROCESS, Design and integration, John Wiley & Sons, 2005.	1	

	W.D.Seider, J.D.Seader, D.R.Lewin, S.Widagdo, PRODUCT AND PROCESS DESIGN PRINCIPLES, Synthesis,Analysis and Evaluation, John Wiley & Sons, 2010.	2	
2.11. Optional literature	R.Turton, R.C. Bailie, W.B.Whiting, J.A.Shaeiwitz, ANALYSIS, SYNTHESIS and DESIGN OF CHEMICAL PROCESSES, Prentice Hall International, University Huston		
	T.G. Eschenbach, ENGINEERING ECONOMY, Applying theory to practice, Oxford University Press, Oxford, 2003		
2.12. Other (as the proposer wishes to add)			