University of Zagreb

1. GENERAL INFORMATION				
1.1 Course teacher	Assoc. Prof. Ivana Steinberg, PhD		1.6 Year of the study	2. (3rd semester)
1.2 Name of the course	Integrated Chemical Systems		1.7 ECTS credits	5
1.3 Associate teachers	Petar Kassal, PhD		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%)	2nd
2. COUSE DESCRIPTION				
2.1. Course objectives	Adopting fundamental concepts of *nano* and *micro*-integrated chemical systems (ICS) and their function, form and application in the context of multidisciplinary fields of modern science and technology. Enabling students to understand and apply systematic approach in analysis and synthesis of ICSs, using previously adopted knowledge in related fields of chemistry and engineering. Becoming familiar with real examples of high-tech integrated chemical systems including DNA chips, organic solar cells, microfluidic diagnostic chips.			
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. • Utilise advanced laboratory procedures and instruments for synthesis of new products, create sustainable processes, and solve problems of water, air and soil pollution. • Identify and analyse complex problems in technological processes of chemical and related industries. • 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. • Evaluate technological processes and products from the perspective of high functionality in different conditions and environmental effects.			

<table>
<tr><td></td><td colspan="3">• 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</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td colspan="3">• Define function, forms and applications of nano- and micro-integrated chemical systems (ICS) in the context of modern science and technology
• Identify main parts of real integrated chemical systems using hierarchical approach and analyse their chemical function
• Recognise the role of miniaturisation concepts and define the consequences of miniaturisation on the function and application of an ICS
• Create a virtual ICS with proposed function using predetermined building blocks
• Evaluate the potential of proposed ICS for real application in the context of existing scientific knowledge</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td colspan="3">WEEK 1. Introduction to the course, concepts of Integrated Chemical Systems
WEEK 2. Examples of ICSs: glucose biosensor, organic solar cells, organic light emitting diode, Lab-on-a-chip systems: chemical function, form, application
WEEK 3. Integrated chemical analytical systems (ICAS): examples of chemical sensors and biosensors
WEEK 4. Building blocks and ICS fabrication techniques I Functional materials – examples
WEEK 5. Building blocks and ICS fabrication techniques II Self-assembly of molecules and materials
WEEK 6. Building blocks and ICS fabrication techniques III Microsystem Technologies
WEEK 7. Building blocks and ICS fabrication techniques IV Chemical methods of nano- and micro-functionalisation of ICSs
WEEK 8. Partial exam
WEEK 9. Introduction to microfluidics as enabling technology for ICAS; Miniaturisation of analytical systems: Lab-on-a-chip
WEEK 10. Integrated chemical analytical systems (ICAS)
WEEK 11. Integrated chemical synthetic systems (microreactors)Microfluidic chemical synthesis (Plant-on-a-chip)
WEEK 12. Students' presentations
WEEK 13. Students' presentations
WEEK 14. Final revision and summary of the course
WEEK 15. Partial Exam</td></tr>
<tr><td>2.6. Format of instruction:</td><td>☒ lectures
☒ seminars and workshops
☐ exercises
☐ online in entirety
☒ partial e-learning
☐ field work</td><td>☒ independent assignments
☒ multimedia and the internet
☒ laboratory
☐ work with mentor
☐ (other)</td><td>2.7. Comments:</td></tr>
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2.8. Student responsibilities	Lectures, seminars and laboratory work – attendance is mandatory; regular homework assignments and problem solving exercises, written and oral presentations; mandatory reading for seminar discussions; presentation of final assignment, final written exam

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	NO	(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
1. Allen J. Bard, *Integrated Chemical Systems: A Chemical Approach to Nanotechnology*, John Wiley & Sons Ltd., New York, 1994.	2	YES
2. G. A. Ozin, A. C. Arsenault, *Nanochemistry: A Chemical Approach to Nanomaterials,* RSC, Cambridge, 2005.	1	YES
3. A. Rios, A. Escarpa, B. Simonet, *Miniaturization of Analytical Systems: Principles, Design and Applications*, Wiley, Chichester, 2009.	1	YES
4. P. Ball, *Made to Measure: New Materials for the 21st Century*, Princeton University Press, Princeton, New Jersey, 1997.	1	YES

2.11. Optional literature	1. M. Wilson, K. Kannangara, G. Smith, M. Simmons, B. Raguse, *Nanotechnology: Basic Science and Emerging Technologies*, Chapman & Hall, CRC, Boca Raton, 2002. 2. N. Hall (Editor), *The New Chemistry*, Cambridge University Press, Cambridge, 2000. 3. F. A. Gomez (Editor*), Biological Applications of Microfluidics*, John Wiley & Sons, New Jersey, 2008. 4. M. Miodownik, *Stuff Matters*, Mariner Books, Houghton Mifflin Harcourt, New York, 2015.
2.12. Other (as the proposer wishes to add)	