

STUDY COURSE DESCRIPTION FORM		
Name of the course		Code
Trends in the development of chemical technology and separation techniques for sustainable development – case studies		
Name of the doctoral school		Year /Semester
Poznan University of Technology Doctoral School	
Specialty/Discipline		Type (obligatory, elective):
Chemical sciences		elective
No. of hours		No. of credits
Lectures: 4 Classes: - Laboratories: - Seminars: -		1
Cycle of study: Third-cycle studies (Polish Qualifications Framework level eight)	Form of study: Full-time	Assessment: (written exam, presentation, etc.) exam
Responsible for the course/lecturer:		
<p style="text-align: center;">prof. dr hab. inż. Krystyna Prochaska e-mail: krystyna.prochaska@put.poznan.pl phone : +48 61 665 3601 Faculty of Chemical Technology Berdychowo street 4, 60-965 Poznan, Poland</p> <p style="text-align: center;">dr hab. inż. Magdalena Regel-Rosocka, prof. PP e-mail: Magdalena.Regel-Rosocka@put.poznan.pl phone : +48 61 665 3667 Faculty of Chemical Technology Berdychowo street 4, 60-965 Poznan, Poland</p>		
Prerequisites in terms of knowledge, skills and social competencies:		
1	Knowledge: A PhD student knows the principles of environmental protection related to chemical production and waste management.	
2	Skills: A PhD student can obtain information from literature, databases and other sources of chemical and environmental sciences, he/she can interpret them, draw conclusions, and formulate opinions.	
3	Social competencies: A PhD student understands the need for further education and improvement of his/her professional and personal competences.	
Objectives of the course:		
Extending knowledge of separation techniques application on industrial scale for sustainable development in chemical technology.		
Educational results (Study outcomes)		
Knowledge: – a person who graduated from doctoral school knows and understands:		
P8S_WG	to the extent that enables revision of existing paradigms - global achievements, covering theoretical basis as well as general and selected specific issues, that are specific to scientific disciplines studied at the doctoral school,	SzD_W01
P8S_WG	key developmental trends of science disciplines in which education takes place at the doctoral school,	SzD_W02
P8S_WK	fundamental dilemmas of the contemporary civilization,	SzD_W05
P8S_WK	economic, legal, ethical and other vital conditions related to scientific activity	SzD_W06

Skills: a person who graduated from doctoral school can:			
P8S_UW	critically analyze and asses scientific research results, work of experts and other creative activities together with their contribution into knowledge development	SzD_U02	
P8S_UK	take part in scientific discourse	SzD_U07	
Social competencies: a person who graduated from the doctoral school is ready to:			
P8S_KK	critically assess the achievements within a given scientific discipline	SzD_K01	
Compulsory literature:			
<ol style="list-style-type: none"> 1. C.A.M. Afonso, J.P. Crespo, P.T. Anastas, <i>Green Separation Processes: Fundamentals and Applications</i>, Wiley, Weinheim 2005 (e-book). 2. C.K. Gupta, <i>Chemical Metallurgy: Principles and Practice</i>, Wiley, Weinheim 2003 (e-book). 3. E. Drioli, A. Criscuoli, E. Curcio, E. Curcio, <i>Membrane Contactors : Fundamentals, Applications and Potentialities</i>, Elsevier, Amsterdam 2006. 			
Additional literature:			
<ol style="list-style-type: none"> 1. J. Szymanowski, <i>Hydroxyoximes and Copper Hydrometallurgy</i>, 1st Ed., CRC Press, Boca Raton 1993. 2. K. Wieszczycka, B. Tylkowski, K. Staszak (Eds.), <i>Metals in Wastes</i>, DE GRUYTER, Berlin 2018. 3. Z. F. Cui, H. S. Muralidhara, <i>Membrane Technology, A Practical Guide to Membrane Technology and Applications in Food and Bioprocessing</i>, 1st Edition, Butterworth-Heinemann 2010, Hardcover ISBN: 9781856176323; eBook ISBN: 9780080951348 			
COURSE DESCRIPTION			
	General issues	Specific issues	No. of hours
1	Recovery of metals from primary (e.g. copper ores) and secondary (e.g. spent automotive catalysts, spent batteries) resources	<ul style="list-style-type: none"> • Significance of metals (copper, cobalt, nickel, platinum group metals, rare earth elements) for high-tech production and economy • Pyro-, hydro- and electrometallurgy in metal recovery – advantages and disadvantages • Primary resources – copper recovery from Polish (pyrometallurgical process, KGHM Polska Miedź) and Chilean copper ores (hydrometallurgical process) • Secondary resources <ul style="list-style-type: none"> – pyrometallurgy for recovery of Platinum Group Metals from spent automotive catalysts – hydrometallurgy for cobalt, nickel and REE recovery from spent NiMH and Li-ion batteries 	2
2	Membrane separation as <i>green technologies</i> for water, soil and air purification	<ul style="list-style-type: none"> • Classification of membrane techniques; Characteristic of membranes; Multistage Membrane Separations • Desalination of seawater for potable and technological water • Membrane separation of organic compounds obtained by biosynthesis (e.g. production of carboxylic acids) • Current Technical Trends in the Gas Separation(removal of CO₂) 	2
Assessment methods of educational results			
oral or written exam			

STUDENT'S WORKLOAD	
Activity	Hours
Participation in lectures, classes, seminars and laboratories	4
Contact hours with lecturers	2
Self-study	16
Exam	2
TOTAL	24
TOTAL NUMBER OF ECTS POINTS FOR THE COURSE	1