Faculty of Chemical Technology and Engineering

WEST POMERANIAN UNIVERSITY OF TECHNOLOGY
IN SZCZECIN, POLAND

THE OFFER FOR INTERNATIONAL STUDENTS FOR THE YEAR 2023/2024 FIRST DEGREE

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
1	ANALYSIS OF WATER AND EFFLUENTS	Sylwia Mozia	winter	10	105
2	BASIC OPERATIONS IN CHEMICAL ENGINEERING	Anna Story	winter/summer	6	60
3	BASICS OF OLEOCHEMISTRY	Ewa Janus	winter/summer	5	45
4	BIOMATERIALS	Piotr Sobolewski	winter	2	30
5	BIOPOLYMERS	Piotr Sobolewski	winter	2	30
6	CHARACTERIZATION METHODS AND PROPERTIES OF POLYMERIC MATERIALS	Agnieszka Piegat	winter/summer	4	45
7	CHEMICAL AND PROCESS ENGINEERING	Halina Murasiewicz	winter/summer	9	75
8	CHEMICAL ENGINEERING DESIGN	Halina Murasiewicz	winter/summer	5	60
9	CHEMICAL ENGINEERING PROCESS SIMULATION USING ASPEN PLUS	Halina Murasiewicz	winter/summer	5	60
10	CHEMICAL ENGINEERING THERMODYNAMICS	Konrad Witkiewicz	summer	7	90
11	CHEMICAL PROCESS EQUIPMENT	Halina Murasiewicz	winter/summer	4	60
12	CHEMICAL PROCESSES IN INORGANIC INDUSTRY AND ENVIRONMENTAL ENGINEERING	Sylwia Mozia	winter/summer	3	45
13	CHEMICAL REACTION ENGINEERING	Halina Murasiewicz	winter	4	60
14	CHEMICAL REACTOR ENGINEERING	Halina Murasiewicz	summer	5	75
15	CHEMISTRY	Zbigniew Rozwadowski	summer	9	135
16	CHEMISTRY AND TECHNOLOGY OF SURFACTANTS	Paula Ossowicz-Rupniewska	winter/summer	5	45
17	CHEMISTRY OF BUILDING MATERIALS	Katarzyna Wilpiszewska	winter/summer	5	60
18	COLLOID AND SURFACTANT SCIENCE	Ewa Janus	summer	5	60
19	CONCEPTS IN MODERN HOMOGENEOUS AND HETEROGENEOUS CATALYSIS	Dariusz Moszyński	summer	4	60
20	COSMETIC AND PHARMACEUTICAL RAW MATERIALS	Paula Ossowicz-Rupniewska	winter/summer	5	45
21	COSMETIC FORMULATION	Paula Ossowicz-Rupniewska	winter/summer	5	45
22	ENGINEERING GRAPHICS AND DESIGN	Grzegorz Story	summer	5	45
23	ENGINEERING NANOSCIENCE AND NANOTECHNOLOGY	Agnieszka Piegat	winter	5	60
24	ENVIRONMENTAL ENGINEERING	Agata Markowska-Szczupak	winter	5	75
25	ENVIRONMENTALLY FRIENDLY POLYMERS AND POLYMER COMPOSITES	Agnieszka Piegat	winter/summer	4	45
26	ENVIRONMENTAL POLLUTION CONTROL	Halina Murasiewicz	summer	4	60
27	FLUID MECHANICS	Anna Story	summer	8	90

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
28	FLUID MECHANICS	Maciej Konopacki	winter	7	90
29	FOOD PACKAGING AND RECYCLING	Katarzyna Wilpiszewska	winter/summer	5	60
30	FUNDAMENTALS OF PHYSICAL CHEMISTRY	Krzysztof Lubkowski	winter	8	75
31	GRAPHICAL ENGINEERING	Anna Kiełbus-Rąpała	summer	3	60
32	GREEN POLYMERS FOR CIRCULAR ECONOMY	Mirosława El Fray	winter/summer	2	30
33	HEAT TRANSFER PROCESS	Halina Murasiewicz	winter/summer	4	60
34	INDUSTRIAL CHEMISTRY AND CHEMICAL PROCESS PATHWAYS	Ewa Janus	summer	5	60
35	INSTRUMENTAL ANALYSIS	Elwira Wróblewska	winter/summer	8	75
36	INTERFACIAL PHENOMENA	Dariusz Moszyński	winter	4	60
37	INTRODUCTION TO COSMETIC CHEMISTRY	Edyta Kucharska	winter	4	30
38	INTRODUCTION TO RHEOLOGY	Anna Story	winter/summer	5	45
39	INTRODUCTION TO SEPARATION PROCESSES	Halina Murasiewicz	winter/summer	4	60
40	KINETICS AND CATALYSIS OF CHEMICAL REACTIONS	Rafał Wróbel	winter	5	60
41	MATERIAL SCIENCE AND TECHNOLOGY	Mirosława El Fray	summer	6	75
42	MEMBRANE PROCESSES	Sylwia Mozia	winter/summer	1	15
43	METHODS OF ORGANIC COMPOUNDS IDENTIFICATION	Elwira Wróblewska	summer	5	45
44	MODELING AND SIMULATION IN CHEMICAL ENGINEERING	Anna Story	winter	7	75
45	PARTICULATE TECHNOLOGY	Anna Story	winter/summer	3	45
46	PHARMACEUTICAL CHEMISTRY	Paula Ossowicz-Rupniewska	winter/summer	6	60
47	POLYMER CHEMISTRY	Mirosława El Fray	winter/summer	2	30
48	POLYMER DEGRADATION AND STABILITY	Joanna Rokicka	summer	8	75
49	PRINCIPLES OF ANALYTICAL CHEMISTRY	Zbigniew Rozwadowski	winter/summer	5	45
50	PROCESS DYNAMICS, OPERATIONS AND CONTROL	Rafał Rakoczy	summer	4	60
51	PROCESS SAFETY ENGINEERING	Halina Murasiewicz	winter/summer	5	60
52	RENEWABLE ENERGY SOURCES	Halina Murasiewicz	winter/summer	4	60
53	RESEARCH PROJECT IN CARBON MATERIALS PRODUCTION AND MODIFICATION	Iwona Pełech	winter/summer	15	120
54	RESEARCH PROJECT IN CHEMICAL ENGINEERING	Halina Murasiewicz	winter/summer	15	120
55	RESEARCH PROJECT IN COSMETIC PRODUCTIONS	Ewa Janus	winter/summer	15	120
56	RESEARCH PROJECT ON PHOTOCATALYTIC SORBENTS	Ewelina Kusiak-Nejman	winter/summer	15	120

	Course title	Person responsible for the course	Semester (winter/summer)	ECTS points	Hours
	PRODUCTION				
57	SPECTROSCOPIC METHODS	Elwira Wróblewska	summer	8	75
58	STATISTICAL METHODS IN ENGINEERING	Anna Story	winter/summer	3	45
59	SYSTEMS ENGINEERING	Grzegorz Story	winter	5	60
60	TECHNOLOGY, LAW, AND THE WORKING ENVIRONMENT	Beata Tryba	summer	2	30
61	TECHNOLOGY OF RESOURCES	Agnieszka Kowalczyk	winter	5	60
62	TRANSPORT AND SEPARATION PROCESSES	Maciej Konopacki	winter/summer	4	60
63	TRANSPORT PHENOMENA	Halina Murasiewicz	summer	4	60
64	WASTEWATER MANAGMENT	Ewelina Kusiak-Nejman	winter/summer	15	150
65	WATER TECHNOLOGY AND RECLAMATION	Ewelina Kusiak-Nejman	summer	6	60

Course title	ANALYSIS OF WATER AND EFFLUENTS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Sylwia Mozia	**E-mail address to the person**	Sylwia.Mozia@zut.edu.pl
Course code (if applicable)	WTiICh-1-01	**ECTS points**	10
Semester	winter	**Language of instruction**	english
Hours per week	7	**Hours per semester**	105
Objectives of the course	Student will get theoretical knowledge on chemical composition of natural waters, water and wastewater treatment processes, drinking water quality standards and wastewater quality standards, methods of preservation and analysis of water and wastewater samples. Student will get practical skills in the area of analysis of water and wastewater parameters.		
Entry requirements	Water and wastewater treatment, analytical chemistry		
Course contents	Calculation of solutions concentrations, pH, hardness, alkalinity and acidity of natural waters, corrosivity, BOD. Regulations concerning drinking water quality. Determination of PO43-, N-NO3-, N-NH4+ and dissolved oxygen concentrations, determination of COD-Cr, COD-Mn, TOC, alkalinity, acidity, hardness, color, turbidity and pH of water, evaluation of water corrosivity. Characteristics of surface water and groundwater. Classification of waters. Regulations concerning drinking water quality. Characteristics of municipal wastewater and selected industrial effluents. Wastewater quality standards. Aims and ranges of water and wastewater analysis. Fundamentals of analysis of water and wastewater. Background of sampling. Sample stabilization and safe keeping. Physical and chemical indicators of water and wastewater contamination. Indicators of bacteriological contamination of water. Methods of analysis of water and wastewater.		
Assessment methods	lecture workshop laboratory Lecture: written exam Workshop: class test/grade Laboratory: report, class test/grade		
Recommended readings	1. Ed. Leo M.L. Nollet, Handbook of Water Analysis, CRC Press LLC, USA, 2007, Second Edition 2. K. Kaur, Handbook of water and wastewater analysis, Atlantic Publishers & Distributors (P) Ltd., 2007 3. irk-Othmer, Chemical Technology and the Environment, Vol. 1 and 2, 2007 4. ed. O. Hutzinger, Handbook of Environmental Chemistry, Vol.5, part A, Water Pollution, Springer-Verlag, 1991 5. B.J. Alloway, D.C. Ayres, Chemical Principles of Environmental pollution, Blackie Academic & Professional, 1993 6. Water treatment, Plant Design, American Water Works Association, McGraw, 1998, 3th Edition 7. W.J. Masschelein, Unit Processes in Drinking Water Treatment, Marcel Dekker Inc., 1992		
Knowledge	At the completion of this course, students will be able to: - Understand fundamental water chemistry. - Learn the parameters that characterize the constituents found in potable water and wastewater. - Comprehend water/wastewater quality data. - Characterize water and wastewater.		
Skills	At the completion of this course, students will be able to plan and carry out experiments for analysis of water and wastewater quality, collect experimental data, analyze and interpret results, write technical reports and give presentations.		
Other social competences	Student understands the needs of continuous training and development in the field of analysis of water and effluents		

Course title	BASIC OPERATIONS IN CHEMICAL ENGINEERING		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-02	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Understanding the basics of basic operations in the area of fluid mechanics and their importance in constructing various industrial processes. Distinguishing various basic operations and understanding the basics of their classification. Theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses.		
Entry requirements	Chemical engineering fundamentals Applied Mathematics		
Course contents	Solving exercises related to the content of the lecture. Written test. Laboratory exercises will be carried out with a total teaching load of 30 hours. Possible laboratory: determination of particle size by sieving, determination of the operating parameters of a stirring and mixing system: power characteristic and mixing time, sedimentation, clarification of liquids, pneumatic transport and gas cleaning. Unit operations with fluids (fluid transport, energy relations, measures of fluid flow) Unit operations with solids (storage and mechanical transportation of solids, reduction of size, the sieving operation, ideal sieves and real sieves) Mixing and mixing tanks (mixing equipment, calculation of the required power, evaluation of the power of different agitation systems, mixing time determination, mixing of liquids, mixing of multiphase systems) Displacement of solids in fluids (movement of particles in a fluid, definition of sedimentation and its characteristics, flocculation and coagulation, sedimentation equipment, hydraulic classification, wet classification and screening, types of classifiers) Movement of fluids between solids (circulation of fluids through porous beds, pneumatic and hydraulic transport, filtration) Unit membrane separation operations (microfiltration, ultrafiltration, reverse osmosis, electrodialysis) Unit operations with heat transfer (heat transfer fundamentals, heat exchangers, operations with vapor-liquid transfer, types of evaporators, single acting evaporators, multiple effect evaporators) Unit operations with mass transfer (general aspects of mass transfer, basis of unit mass transfer operations, solid-liquid extraction, liquid-liquid extraction) Written final test		
Assessment methods	Activating methods: lecture illustrated by multimedia presentation and didactic discussion Practical methods: laboratory exercises Practical methods: calculation of exercises Lectures - written final test Laboratory - individual report after each laboratory Classes - two written tests		
Recommended readings	1. John J. McKetta Jr, Unit Operations Handbook: Volume 1, CRC Press, New York, 1993, ISBN 9780824786694 2. John J. McKetta Jr, Unit Operations Handbook: Volume 2, CRC Press, New York, 1993, ISBN 9780824786700 3. McCabe Warren L., Unit Operations of Chemical Engineering, McGraw-Hill, 2005, ISBN 9780071247108 4. Geankoplis Christie John, Transport Processes and Separation Process Principles (Includes Unit Operations), Pearson Education Limited, 2013, 4th Edition, ISBN 9781292026022		
Knowledge	Students will acquire detailed theoretical knowledge on many aspects within the framework of the basic operations in chemical engineering		
Skills	Students will acquire practical knowledge on many aspects within the framework of the basic operations in chemical engineering		
Other social competences	Students have the ability to solving and analyzing processes in the field of basic operations in chemical engineering. Students understand the needs of continuous training and development in the field of basic operations in chemical engineering		

Course title	BASICS OF OLEOCHEMISTRY		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Ewa Janus	**E-mail address to the person**	Ewa.Janus@zut.edu.pl
Course code (if applicable)	WTiICh-1-03	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	understanding general aspects of industry and technology of oleochemicals, used raw materials and the most important categories of oleochemicals, technology and terminology of oleochemicals production; forming student's skills in analysis and characteristic of oils and synthesis of chosen oleochemicals		
Entry requirements	fundamentals of organic chemistry		
Course contents	Oils from oily fruits and seeds - maceration and extraction process Chromatographic and spectroscopic analyses for identification of oils and fatty acids Transesterification process of oils with methyl alcohol Preparation of soaps Epoxidation of oils and fatty acids Natural oils and fats, nomenclature and molecular structure of fatty acids; global production of vegetable oils; characteristcs of the oils produced in the greatest quantities Technology of crude oils production - from plantation to crude oil; specific examples of processing for different plants (palm fruits, soybeans) Pre-treatment processes of crude plant oils in oleachemicals production - refining processes, degumming, bleaching, deodorising Fractionation, winterization, interesterification and hydrogenation as modification processes of oils Splitting of oils to glycerol and fatty acids - batchwise and continuously conducted processes; Plants for distillation and fractionation of fatty acids Fatty acids methyl esters and fatty alcohols production Fatty acids and alcohols - based surfactants and their use		
Assessment methods	Lecture with multimedia presentation Laboratory excercises final written test laboratory report Continous assesment		
Recommended readings	1. Edited by Moghis U.Ahmad, Fatty acids - Chemistry, Synthesis and Appllications, AOCS Press, Elsevier Inc., 2017, ISBN: 978-0-12-809521-8 2. Editors: J.A. Kent, T.V. Bommaraju, S.D. Barnicki, Handbook of industrial chemistry and biotechnology, Springer International Publishing, 2017, 13th, pages 823-932, 979-1032 3. Kirk-Othmer Chemical Technology of cosmetics, John Wiley&Sons, Inc., New Jersey, 2013, pages 445-482		
Knowledge	Students is able to name and characterize the raw materials used in the oleochemicals production, describe main proceeses of oil production, pre-treatment, purification and modification; Student is able to describe the condition and main unit operation of oleochemicals production processes		
Skills	Student is able to: analyze the oils and interpret the analysis results, extract oils from plant with various methods, to synthesize the chosen oleochemicals using different chemical methods		
Other social competences	student is aware of the importance of technological and environmetal aspects of oleochemicals production and usefulness		

Course title	BIOMATERIALS		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Piotr Sobolewski	**E-mail address to the person**	psobolewski@zut.edu.pl
Course code (if applicable)	WTIiCH-1-04	**ECTS points**	2
Semester	winter	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Define important keywords and concepts relating to biomaterials Describe the interactions between (bio)materials and blood. Describe the host response to a (bio)material. Discuss material-related design considerations for a medical device/implant.		
Entry requirements	None		
Course contents	Introduction and definitions Biocompatibility: concept Soft tissues Hard tissues Blood-biomaterial contact Host response Surface modification of biomaterials Case study: intraocular lens Biomaterials for drug delivery Degradable biomaterials and mechanisms of degradation		
Assessment methods	Multimedia presentations Student presentation on a biomaterial topic		
Recommended readings	1. Ratner, Hoffman, Schoen, Lemons, Biomaterials Science An Introduction to Materials in Medicine, Elsevier Academic Press, 2013, https://www.sciencedirect.com/book/9780123746269/biomaterials-science		
Knowledge	Define important keywords and concepts		
Skills	Discuss material-related design considerations for a medical device/implant.		
Other social competences	Will be capable of independent study and presenting a biomaterial system.		

Course title	BIOPOLYMERS		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Piotr Sobolewski	**E-mail address to the person**	psobolewski@zut.edu.pl
Course code (if applicable)	WTIiCH-1-05	**ECTS points**	2
Semester	winter	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Define important keywords and concepts Explain the difference between biopolymers and bio-based polymers Describe the main classes of biopolymers, including key structural and chemical features Discuss potential applications of biopolymers, including key features		
Entry requirements	None		
Course contents	Introduction and definitions Nucleic acids Proteins Polysacchrides Extracellular matrix Aliphatic polyesters Latex and natural rubber Bio-based polymers Degradation and biodegradation Select topics and case studies		
Assessment methods	Multimedia presentations Student presentation		
Recommended readings	1. Kaplan, Biopolymers from Renewable Resources, Springer, 1998, https://link.springer.com/book/10.1007/978-3-662-03680-8		
Knowledge	Define important keywords and concepts		
Skills	Describe the main classes of biopolymers, including key chemical and structural features		
Other social competences	Will be capable of independent study and presenting a biopolymer system.		

Course title	CHARACTERIZATION METHODS AND PROPERTIES OF POLYMERIC MATERIALS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Agnieszka Piegat	**E-mail address to the person**	Agnieszka.Piegat@zut.edu.pl
Course code (if applicable)	WTIiCH-1-06	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Students will be able to develop a knowledge about the techniques used for polymers characterization. Students will be able to use presented techniques effectively in the delivery of instruction, assessment, and professional development. Students will be able to use to identify, formulate, and solve problems at the area of polymer characterization.		
Entry requirements	no prerequisites		
Course contents	Identification of polymers. Analysis of chemical structure of polymers by ATR-FTIR spectroscopy. Analysis of thermal properties of polymers by DSC method. Mechanical properties of polymers. Viscosity measurments. Classification of polymers according to their properties. Physical and phase states of polymers. Temperatures of phase and physical transitions. Microscopic techniques in evaluation of polymers morphology (transmission electron microscopy, scanning electron microscopy, light microscopy, atomic force microscopy) Spectroscopic methods for chemical structure evaluation (FTIR, Raman spectroscopy, UV-Vis) Thermal analysis of polymeric materials Mechanical properties of materials: modulus of elasticity, bending, tensile, compressive and shear strength. Fatigue strength. Creep resistance. Investigations of properties by static and dynamic methods. Degradation and biodegradation of polymers. Biological resistance of plastics, its dependence on the composition of the material. Impact of plastics on the environment: emission and fogging. Written test.		
Assessment methods	Lecture laboratories written test colloquium in laboratory classes report from the laboratories observation of activity during lectures and laboratories		
Recommended readings	1. Arza Seidel [et al.]., Properties and behavior of polymers. Vol. 1, 2011 2. Arza Seidel [et al.]., Properties and behavior of polymers. Vol.2, 2011 3. Raja Shunmugam, Functional polymers : design, synthesis and applications, 2017		
Knowledge	The student, due to his knowlage is able to describe and explain the relationship between the structure of polymers and their properties, and to indicate processing methods and areas of application.		
Skills	The student is able to interpret and describe the properties physicochemical properties of polymers depending on their chemical and molecular structure. The student is able to supplement the information obtained in the lectures with the content contained in the literature of the subject.		
Other social competences	The student shows an active attitude during lectures and laboratory exercises and cares about the linguistic correctness related to the terminology of the subject.		

Course title	CHEMICAL AND PROCESS ENGINEERING		
Level of course	first cycle		
Teaching method	laboratory class		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-07	**ECTS points**	9
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Apply process principles learnt in other chemical engineering courses to practical situations Identify and analyse the fundamental physical parameters of an experimental system Write technical reports Perform statistical analysis on data and conduct statistically designed experiments Demonstrate laboratory and analytical skills, safety awareness and organisational skills Demonstrate skills with numerical methods and computing applications		
Entry requirements	Fundamentals of mathematics. Fundamentals of chemical engineering		
Course contents	Comprises experiments related to various aspects reletaing with chemical engineering: measurment of density, viscosity (rhelogy), ph, reflacting index, interfacial tension, mixing process, formulating of two phase system, sedimentation process, measurment techniques used in flow, numerical simulation of flow and process. After successfully conducting an experiment, the students need to write a well formatted technical report. In addition, the course will introduce students to numerical methods for solving typical chemical engineering problems. It also introduces the students to the use of spreadsheets to solve chemical engineering design and process problems.		
Assessment methods	activating methods: didactic discussion practical methods - calculation, design, numerical/simulation study Lab Report (Individual) after each labratory written final test		
Recommended readings	1. Thomas Ch. E., Process technology equipment and systems, Cengage Learning, Stamford, 2015 2. K. Walters, An Introduction to Rheology, Elsevier Science, 1989 3. Howard A. Barnes, A Handbook of Elementary Rheology, University of Wales, Institute of Non-Newtonian Fluid Mechanics, 2000 4. McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, McGraw-Hill, New York, 2005		
Knowledge	The student will be able to measure a physcial properties of liquid, solid and gas, identify the various types of measurment equipments used in the chemical engineering and use commercial software to analyze data and simulate the process.		
Skills	The student will be able to apply knowledge of measurement techniques to identify physical properties and solve chemical engineering problems.		
Other social competences	Student will be began to prepare for a role as a professional chemical engineer in industry or academia		

Course title	CHEMICAL ENGINEERING DESIGN		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-08	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1.Apply knowledge of chemical engineering fundamentals to identify and solve chemical engineering design problems. 2.Perform step-by-step design of chemical engineering processes. 3.Use of Aspen Plus for chemical engineering design.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Project of the selected equipment in ASPEN Plus Introduction to design. Design information. Physical properties of chemical compounds. Materials of Construction. Costing. Mechanical design of process equipment. Flow-sheeting. Material and energy balances. Energy utilization. Piping and instrumentation. Equipment selection, specification and design: separation columns, heat-transfer equipment. Aspen simulation. Plant location and site selection. Environmental considerations. Safety and loss prevention.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Project Periodic assessment of student achievement Lecture: exam at the end of the semester Project: assessment of project		
Recommended readings	1. Sinnott R.K., Coulson & Richardson's Chemical Engineering, Vol. 6: Chemical Engineering Design, Butterworth-Heinemann, Oxford, 2003 2. Luyben W.L., Distillation design and control using Aspen simulation, Wiley, New York, 2006		
Knowledge	The student will be able to demonstrate basic knowledge of chemical engineering design problems.		
Skills	The student will be able to apply knowledge of chemical engineering fundamentals to identify and solve chemical engineering design problems.		
Other social competences	The student will be able to use of Aspen Plus for chemical engineering design.		

Course title	CHEMICAL ENGINEERING PROCESS SIMULATION USING ASPEN PLUS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-09	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1. Develop the process models based on conservation principles. 2. Use Aspen Plus to model chemical engineering processes.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Selected process simulation in Aspen Plus. Introduction to chemical engineering process simulation. Introduction to the Aspen Plus interface. Simulation file creation. Basic process options and simulation tools in Aspen Plus. Selecting physical property models. The data regression system. Unit operation models. Reaction and reactors. Separation columns. Processes with recycle. Sensitivity analysis. Optimization.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation in ASPEN Laboratory Periodic assessment of student achievement Lecture: exam at the end of the semester Laboratory: assessment of reports		
Recommended readings	1. Hangos K.M., Cameron L.T., Process modelling and model analysis, Academic Press, 2001 2. Dhurjati P., Shiflett M., Modeling and simulation in chemical engineering using Aspen and Matlab, CRC Press, 2014 3. Rice R.G., Do D.D., Applied mathematics and modeling for chemical engineers, Wiley, New York, 2012 4. Finlayson B.A., Introduction to chemical engineering computing, Wiley, New York, 2005 5. Schefflan R., Teach Yourself the Basics of Aspen Plus, Wiley, New York, 2011 6. Luyben W.L., Chemical Reactor Design and Control, Wiley, New York, 2007		
Knowledge	The student will be able to develop the process models based on conservation principles.		
Skills	The student will be able to use Aspen Plus to model chemical engineering processes.		
Other social competences	The student will be able to model chemical engineering processes.		

Course title	CHEMICAL ENGINEERING THERMODYNAMICS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Konrad Witkiewicz	**E-mail address to the person**	Konrad.Witkiewicz@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C11	**ECTS points**	7
Semester	summer	**Language of instruction**	english
Hours per week	6	**Hours per semester**	90
Objectives of the course	To acquaint students with the basic concepts of process thermodynamics. Developing the ability to solve tasks in the field of process thermodynamics. The formation of an open attitude to the joint search for solutions to problems in the field of process thermodynamics.		
Entry requirements	Basic knowledge of mathematics.		
Course contents	Calculation of thermodynamic properties of fluids. Analysis of flow processes. Energy, exergy and entropy balances of processes. Calculation of phase equilibria. Analysis of thermodynamic cycles and processes. Written test Parameters of moist air. Heat of solids combustion. Gas-solid equilibirum. Isosteric heat of adsorption. Crystallization equilibrium. Written tests The first law of thermodynamics, entropy and the second law of thermodynamics, equations of state and intermolecular forces, thermodynamic properties of fluids, thermodynamic analysis of flow processes, exergy, thermodynamic cycles, solution thermodynamics, phase equilibria, chemical reaction equilibria, thermodynamic analysis of processes.		
Assessment methods	Lecture Classes Laboratories Lecture - written exam Classes - written test Laboratories - written reports Laboratories - written tests		
Recommended readings	1. M.D. Koretsky, Engineering and Chemical Thermodynamics, John Wiley & Sons, Hoboken, NJ, 2004 2. H.S. Fogler, Elements of chemical reaction engineering, Prentice Hall International Series in the Physical and Chemical Engineering Sciences, New Jersey, 2006, 4th ed. 3. D. Kondepudi, Introduction to modern thermodynamics, John Wiley & Sons Inc., Chichester, UK, 2008		
Knowledge	Student demonstrates knowledge of chemical and process thermodynamics		
Skills	Student can solve problems associated with thermodynamic systems.		
Other social competences	Student understands the need for continuous training and development in the field of chemical and process thermodynamics.		

Course title	CHEMICAL PROCESS EQUIPMENT		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-10	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1.Identify the various types of equipment used in the chemical-processing industry. 2.Explain the basic elements of chemical process equipment. 3.Describe the scientific principles associated with chemical process equipment. 4.Describe the operation and maintenance of chemical process equipment. 5.Troubleshoot typical problems associated with the operation of chemical process equipment. 6.Describe the basic instruments used in the process industry. 7.Identify and draw standard instrument symbols. 8.Describe temperature, pressure, flow, and level-measurement techniques. 9.Identify the elements of a control loop. 10.Describe the various concepts associated with utility systems		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Flowsheets. Calculation of flow of fluids and fluid transport equipment. Calculation of heat transfer and heat exchangers. Calculation of dryers and cooling towers. Calculation of separation equipment (distillation, absorption, adsorption and ion exchange). Process equipment cost estimation. Basic terms. Introduction to process equipment. Flowsheets. Drivers for moving equipment. Flow of fluids. Fluid transport equipment. Pumps, compressors, turbines and motors. Valves: applications and theory of operation. Tanks, piping, and vessels. Heat transfer and heat exchangers. Dryers and cooling towers. Mixing and agitation. Boilers. Furnaces. Instruments. Process control diagrams. Utility systems. Reactor Systems. Distillation and absorption systems. Adsorption and ion exchange. Crystallization from solutions and melts. Extraction. Other separation systems. Plastics Systems. Costs of individual equipment.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Thomas Ch. E., Process technology equipment and systems, Cengage Learning, Stamford, 2015 2. Walas S. M., Chemical Process Equipment, Butterworth-Heinemann, Newton, 1990 3. Cheremisinoff N. P., Handbook of Chemical Processing Equipment, Butterworth-Heinemann, Boston, 2000 4. Elizabeth T. Lieberman E. T., Norman P., Lieberman N., A Working Guide to Process Equipment, McGraw-Hill, New York, 2008		
Knowledge	The student will be able to Identify the various types of equipment used in the chemical-processing industry.		
Skills	The student will be able to describe the operation and maintenance of chemical process equipment.		
Other social competences	The student will be able to describe the scientific principles associated with chemical process equipment.		

Course title	CHEMICAL PROCESSES IN INORGANIC INDUSTRY AND ENVIRONMENTAL ENGINEERING		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Sylwia Mozia	**E-mail address to the person**	Sylwia.Mozia@zut.edu.pl
Course code (if applicable)	WTiICh-1-11	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Student will get theoretical knowledge on chemical processes in inorganic industry and environmental engineering, including technologies of flue gas desulfurization and NOx removal, purification of air, production of building and construction materials, as well as electrochemical methods of synthesis of inorganic compounds and treatment of metal surfaces.		
Entry requirements	Fundamentals of chemistry and chemical technology		
Course contents	Part I: Technologies of flue gas desulfurization and NOx removal, purification of air: general information concerning pollution with SOx and NOx, EU regulations, sources of sulfur and formation of SOx, wet and dry methods applied for desulfurization of flue gases, modern regenerative methods, formation of NOx during combustion of fuels, removal of NOx from flue gases including catalytic methods, preparation of pure air. Part II: Building materials. Lime, gypsum, cement, concrete, prefabricated products. Ceramics: ceramic building materials, electroceramics, metal ceramics, ceramic whiteware. Glass and glassware. Different sorts of glass, glass wool, ceramic and glass fibres, frits. Part III: Industrial electrochemistry: electrolysis of aqueous solutions; electrolysers; factors influencing electrolysis; electrolysis of aqueous solutions of NaCl; electrolysis of spent HCl; electrochemical treatment of metal surfaces – electroplating; hydroelectrometallurgy; electrochemical synthesis of inorganic compounds		
Assessment methods	lecture class test/grade		
Recommended readings	1. Ron Zevenhoven, Pia Kilpinen, Control of pollutants in flue gases and fuel gases, ISBN 951-22-5527-8 (available online) 2. Boynton R.S., Chemistry and technology of lime and limestone, John Wiley, New York 1980 3. ed. R.D. Hooton, Cement, Concrete, and Aggregates, ASTM International, West Consh., PA 2003 4. Hocking M.B., Modern Chemical Technology and Emission Control, Springer-Verlag, Berlin 1985 5. Volf M.B., Chemical approach to glass, Elsevier, Amsterdam 1984 6. Pletcher D., Walsh F. C., Industrial Electrochemistry, Springer-Verlag GmbH, 2007 7. Wendt H., Kreysa G., Electrochemical Engineering: Science and Technology in Chemical and Other Industries, Springer Science & Business Media, 1999		
Knowledge	At the completion of this course, students will be able to: - Explain fundamentals of chemical processes applied in industry, including processes of flue gas desulfurization, NOx removal, and purification of air, processes and methods applied in building and construction industry and well as electrochemical processes utilized for production of organic and inorganic compounds, in electroplating and hydroelectrometallurgy. - Describe the properties of materials and the engineering aspects for various chemical processes applied in inorganic industry.		
Skills	At the completion of this course, students will be able to: - Analyze and propose methods of manufacturing of numerous products using chemical processes. - Analyze and propose methods of purification of flue gases emitted by chemical industry.		
Other social competences	Student understands the needs of continuous training and development in the field of chemical processes in inorganic industry		

Course title	CHEMICAL REACTION ENGINEERING		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-12	**ECTS points**	4
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1.Describe and define the rate of reaction. 2.Derive the mass balance equation. 3.Apply the mass balance equation to the most common types of industrial reactors. 4.Write the rate law in terms of concentrations, and temperature. 5.Use nonlinear regression to determine the rate law parameters. 6.Apply the differential and integral methods for analysis of reactor data. 7.Define a catalyst and describe its properties. 8.Describe the steps in a catalytic reaction. 9.Suggest a mechanism and apply the concept of a rate-limiting step to derive a rate law.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Derivation of general mass balance equations. Reactor sizing. Analysis of stoichiometry. Analysis of rate data. Analysis of catalytic reactors . Analysis of three-phase reactors. Analysis of isothermal and nonisothermal reactors. Analysis of biochemical reactors. Chemical reactor Design using ASPEN Plus. Introduction. Fundamental concepts. The General Mass Balance Equation. Reactor sizing. Stoichiometry. Conversion. The Reaction Order. The Rate Law. Collection and analysis of rate data. Multiple reactions. Reaction mechanisms. Catalytic reactors. Three-phase reactors. Isothermal and nonisothermal reactor design. Biochemical reactors.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Fogler H.S., Elements of chemical reaction engineering, Prentice-Hall, New Jersey, 2009 2. Levenspiel O., Chemical reaction engineering, Wiley, New York, 1999 3. Luyben W.L., Chemical reactor design and control, Wiley, New York, 2007		
Knowledge	The student will be able to: 1.Describe and define the rate of reaction. 2.Derive the mass balance equation. 3.Write the rate law in terms of concentrations, and temperature. 4.Define a catalyst and describe its properties. 5.Describe the steps in a catalytic reaction.		
Skills	The student will be able to: 1.Apply the mass balance equation to the most common types of industrial reactors. 2.Use nonlinear regression to determine the rate law parameters. 3.Apply the differential and integral methods for analysis of reactor data.		
Other social competences	The student will be able to suggest a mechanism and apply the concept of a rate-limiting step to derive a rate law.		

Course title	CHEMICAL REACTOR ENGINEERING		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C11	**ECTS points**	5
Semester	summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Fundamentals of chemical reaction engineering. Rate laws, kinetics, and mechanisms of homogeneous and heterogeneous reactions. Analysis of rate data, multiple reactions, heat effects, bioreactors. Design of industrial reactors. Chemical Reaction Engineering (CRE) is the core subject in the specialties of Chemical Engineering and Technology. It mainly involves the study on industrial-scale chemical processes including chemical reaction rate, materials balance, and influences of macro-engineering factors. The objectives are to achieve the optimization control on industrial reaction process, and reactor development, design and scaling-up. Chemical reaction engineering is also concerned with the exploitation of chemical reactions on a commercial scale. Its tasks are to make students grasp the knowledge as follows: (i) thermodynamics, (ii) kinetics, (iii) transport processes, (iv) types of reactors, (v) operation mode and contacting, (vi) modeling and optimization, and (vii) control.		
Entry requirements	Mathematics Physics Thermodynamics		
Course contents	Practical study of batch reactor Practical study of continous reactor Calculation of chosen type of reactor - part 1 (HM). Calculation of bioreactor - part 2 (MK). Stoichiometry of elementary and complex reactions. Mole balances, conversions and desig equation. Kinetic rate laws. Single chemical reaction and multiple reactions (reversible, consecutive, parallel).Types of reactor: Batch Reactor, RB, Continuous Stirred-Tank Reactor, CSTR, continuous Plug-Flow Reactor, PFR. Multiple reactions, yield and selectivity. Analysis of reactor performance data. (PPO, HM)		
Assessment methods	Preparation of a multimedia for of lecture presentation Project method. Demonstration of the chosen type of reactor. Written final exam based on the lecture contents. Project report - part 1. Project report - part 2. Active participation in laboratory classes.		
Recommended readings	1. Fogler, H. S., Elements of Chemical Reaction Engineering, Prentice-Hall PTR, 2006, 9780130473943, Upper Saddle River 2. Levenspiel O., Chemical Reaction Engineering, Wiley,, New York, 1999, 9780471254249 3. Steinfeld, J. I., J. S. Francisco, and W. L. Hase., Chemical Kinetics and Dynamics, Prentice Hall, 1999, 9780137371235		
Knowledge	Student is able to define fundamentals of chemical reactions. Student can analyze models of reactors and is able to explain the used chemical reactors construction and select an appropriate type of reactor for specific needs.		
Skills	Student can propose and calculte chemical reaction kinetics. Student is able to perform calculations for chosen types of reactors: Batch Reactor, Continuous Stirred Tank Reactor, Plug Flow Reactor.		
Other social competences	Student can present and defence the role of chosen chemical reactor design. Student can demonstrate ability to take responsibility and collaborate with others when working in a team during the labs.		

Course title	CHEMISTRY		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Zbigniew Rozwadowski	**E-mail address to the person**	Zbigniew.Rozwadowski@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_B03	**ECTS points**	9
Semester	summer	**Language of instruction**	english
Hours per week	9	**Hours per semester**	135
Objectives of the course	Knowledge and understandig the basic concepts and laws of inorganic and organic chemistry: type of chemical bonds, chemical reactions, classification and characterisation of inorganic and organic compounds as well as their structure. Knowledge of relationships between physico-chemical properties of the various classes of compounds and their structure		
Entry requirements	The basic knowledge of fundamental and inorganic chemistry as well as basic safety rules		
Course contents	Arrhenius and Brønsted-Lowry concept of acids and bases Autoionization of water and pH scale (pH, pOH, pKw) Buffers: The control of pH Equilibrium constant for acids and bases. Degree of dissociation Properties of salts in solution. Solubility and solubility product Organic nomenclature, recognition and classification of organic compounds and their stucture Organic reaction equations and reaction mechanisms Funcional group transformations. Project of synthetic paths Kinetic of polymerization. Crosslink density calculations in polymer gels and networks. Polymer crystallinity and phase transitions. Polymer modulus and toughness. Miscibility of polymer blends Occupational health and safety in the laboratory. Calibration of volumetric glassware: calibration of a buret. Acid-base titrimetry. Titration of HCl solution. Reduction-Oxidation Titrations. Complexometric methods. Determination of total hardness of water Qualitative analysis of cations of groups I, II and III Qualitative analysis of cations of groups IV and V Qualitative analysis of anions and salts Safety rules and basic techniques of preparative chemistry (distillation, crystallization, extraction) Preparation and purification of simple organic molecules (aspirin, acetanilide, p-bromoacetanilide) Stucture and purity determination of obtained compounds by selected spectroscopic methods UV-Vis spectroscopy Melt polycondensation of poly(ethylene terephthalate)(PET) Chemical reactions Quantum theory States of matter Equilibrium Acid-base equilibria in aqueous solutions The periodic table and periodic low (periods and groups) Transition elements and coordination compounds Physical Properties of Solutions Solid state structure and the properties of solid substance Alkanes, alkenes, alkynes, alkyl halides, their nomenclature, structure, rectivity and reaction mechanisms. Alcohols, amines, methods of their preparations and reactivity. Examples of the functional groups transformations. Carbonyl compounds. Structure, properties and reactivities. Characteristic reactions and their mechanisms. Aromatic compounds. Types of polymers and polymerizations, polymers nomenclature.Molecular weight of polymers. Mechanisms of polymerization. Stereochemistry of polymers. Physical state of polymers and their properties Basics of analytical chemistry. Analytical methods (accuracy, selectivity, sensitivity, experimental errors, statistical analysis of data). Titrametic methods (acid-base, complexation, redox, precipitation). Gravimetric methods. Overwiew of instrumental methods (UV-Vis, IR, NMR, GC, MS, etc.).		
Assessment methods	Lecture		

	Discussion Labs Exercise Written exam (lecture) Continuous assessment: lab reports and activity (labs) Test (exercise)
Recommended readings	1. Harvey D., Modern analytical chemistry, McGraw-Hill Companies Inc., 2000, open access 2. Curreli, G., Analytical instrumentation, Wiley, Chichester, 2000 3. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, Edinburgh, UK, 2001, ISBN 0582-31080-6 4. P. W. Atkins, M. J. Clugston, M. J. Frazer, R. A. Y. Jones, Chemistry. Principles and applications, Longman Group UK Limited, New York, 1990, ISBN 0582-35590-7 5. J. E. Brady, General Chemistry. Principles and Structure, John Wiley & Sons, New York, 1990, ISBN 0-471-62131-5 6. W. W. Porterfield, Inorganic Chemistry. A Unified Approach, Academic Press Inc., London, 1993, ISBN 0-12-562981-8 7. F.J. Davis, Polymer Chemistry, Exford University Press, New York, 2004 8. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, Pearson Education Inc., New Jersey, 2004, ISBN 0-13-120198-0 9. G. Odian, Princliples of Polymerization, John Wiley&Sons, Inc., Hoboken, NJ, 2004 10. G. C. Hill, J. S. Holman, Chemistry in Context, Thomson Nelson and Sons Ltd, Edinburgh, UK, 1989, ISBN 0-17-438401-7 11. G. Marc Laudon, Organic Chemistry, Oxford, New York, 2002, (4th edition) 12. T.W. Graham Solomons, Craig B. Fryhle, Organic chemistry, Hoboken: John Wiley and Sons, 2006
Knowledge	Students has knowledge and understanding of basic concepts and laws of chemistry: type of reactions, characterisation of organic and inorganic compounds, kinetics, chemical equilibrium, analytical methods.
Skills	Students are able to plan and conduct experiments, measurements or computer simulations, as well as to interpret the obtained results and draw conclusions
Other social competences	Students are able to cooperate and work in a group also as a team leader and have understanding the need of learning

Course title	CHEMISTRY AND TECHNOLOGY OF SURFACTANTS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paula Ossowicz-Rupniewska	**E-mail address to the person**	Paula.Ossowicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-13	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Student has knowledge about physical properties of surfactants and their solutions (solubility, Kraft point, cloud point, adsorption at interfacial surface, interfacial tension) Student has knowledge about colloids with surfactants - micelles, emulsions and microemulsions, liquid crystals Student has knowledge about effects delivered by surfactants - including wetting, foaming, detergency, emulsification, solubilisation Student has skills of determination of surfactants and their properties in different commercial products		
Entry requirements	organic chemistry inorganic chemistry		
Course contents	Determination of cloud points of nonionic surfactants. Effect of chemical structure on the cloud point. Determination of the surface tension of surfactant solutions-effect of surfactants structure and additives. Critical micelle concentration - methods of determination Determination of Krafft point and solubility of surfactants Analysis of anionic and cationic surfactants in different commercial products Chemical and thermal stability of surfactants Structure of Surfactants and their classification Different types of surfactants Adsorption of surfactants at interfaces - surface tension, surface excess; interfacial tension, contact angle, wetting of surfaces, and methods of measurements Surfactant solubility; self-assembled surfactants aggregates - micelles and critical micelle concentration, factors affecting the CMC, the structure of micelle and molecular packing; liquid crystalline mesophases; Detergency: Theory and Test Methods Emulsions and Emulsion Technology Applications of surfactants		
Assessment methods	Lectures Laboratory final written test - lectures project work continuous assessment		
Recommended readings	1. R. J. Farn (Ed.), Chemistry and Technology of Surfactants, Blackwell Publishing, 2006 2. M. R. Potter, Handbook of surfactants, Springer Science + Business Media, 1993, Chapter 4 3. European standards		
Knowledge	Student will have knowledge of surfactant properties, their interaction with substrates and analysis methods		
Skills	Uses knowledge to characterize the basic physicochemical properties of surfactants and their solutions as well as colloidal systems created with their participation.		
Other social competences	Student is able to indicate by-products and waste substances arising in the production process of selected groups of surfactants and their impact on the quality of surfactants and the ways of their elimination.		

Course title	CHEMISTRY OF BUILDING MATERIALS		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Katarzyna Wilpiszewska	**E-mail address to the person**	Katarzyna.Wilpiszewska@zut.edu.pl
Course code (if applicable)	WTiICh-1-14	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To familiarize the student with the cement and concrete chemistry, and the use of polymeric materials in construction and the properties of such materials		
Entry requirements	inorganic chemistry		
Course contents	preparation of WRA Cement paste properties polymer concrete films for building industry Mineral and polymer construction binders - composition, types and basic properties. Additives to construction binders (including polymeric additives for improving workability, spreading, stability of the mixture, preventing dilatation). Polymeric materials as construction stabilizing, reinforcing/reinforcing, barrier and protective (including anticorrosion) materials. Geopolymers, geopolymer concrete test		
Assessment methods	informative lecture quizz practical classes lab reports quizzes test		
Recommended readings	1. F.M. Lea., The chemistry of cement and concrete, Edward Arnold,, London 2. Lee, Kwang-Sup. - ed, Polymer materials : block-copolymers, nanocomposites, organic/inorganic hybrids, polymethylenes, Heidelberg : Springer-Verlag, Berlin, 2010		
Knowledge	Student is familiar with cement and concrete chemistry, polymer materials in building industry		
Skills	Student knows hot to evaluate the properties of cement paste		
Other social competences	Student knows how to study the problem		

Course title	COLLOID AND SURFACTANT SCIENCE		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Ewa Janus	**E-mail address to the person**	Ewa.Janus@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C20	**ECTS points**	5
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student has knowledge of the structure, characteristic features of surfactants and amphiphilic molecules, their properties, interfacial phenomena and colloidal systems with their participation Student can determine the properties of surfactants and amphiphilic molecules; can characterize and measure the properties of colloids; can define and explain the observed phenomena		
Entry requirements	Chemistry		
Course contents	Determination of cloud points of nonionic surfactants. Effect of chemical structure on the cloud point. Determination of the surface tension of surfactant solutions-effect of surfactants structure and additives. Critical micelle concentration of surfactants - determination by surface tension and conductivity measurements Determination of Krafft point and solubility of surfactants Determination of required HLB for oil components and oil phase Formation of emulsions and determination of their stability Self assembly properties of polymeric materials. Determination of hydrodynamic radius of polymeric micelles. Self assembly properties of polymeric materials. Determination of Zeta-potential of polymeric micelles. Self assembly properties of polymeric materials. Determination of critical micelles concentration. Characteristic features of surfactans, classification and chemical structures of surfactants; criteria of application Adsorption of surfactans at interfaces - surface tension, surface excess; interfacial tension, contact angle, wetting of surfaces and methods of measurements Surfactant solubility; self-assembled surfactants aggregates - micelles and critical micelle concentration, factors affecting the CMC, structure of micelle and molecular packing; liquid crystalline mesophases; Polymeric materials with self-assembly properties; amphiphilic polymers Formation and stabilization of colloids: emulsions, microemulsions, foams, solid/liquid disperions; colloid stability, forms of instability, effect of surfactants and polymers on colloid stability Colloids in products and processes		
Assessment methods	Laboratory Lectures Discussion lab report continuous assessment Written exam		
Recommended readings	1. R. J. Farn (Ed.), Chemistry and Technology of Surfactants, Blackwell Publishing, 2006 2. M. R. Potter, Handbook of surfactants, Springer Science + Business Media, 1993, Chapter 4 3. European standards 4. Milton J. Rosen, Joy T. Kunjappu, Surfactants and Interfacial Phenomena, WILEY, 2012, 4th Edition 5. Krister Holmberg, Bo Jonsson, Bengt Kronberg and Bjorn Lindman, Surfactants and Polymers in Aqueous Solution, John Wiley & Sons, Ltd., 2002, 2nd ed. 6. Terence Cosgrove, Colloid Science Principles, methods and applications, WILEY, 2010, 2nd ed.		
Knowledge	Student can: describe structure and properties of surfactants and amphiphilic polymers; define and explain surface and interfacial phenomena and different types of colloidal systems; describe interactions between colloidal particles and explain colloidal stability and instability		
Skills	Student can perform numeric calculations of physical-chemical quantities; provide a graphical representation of experimental data; evaluate experimental data in relation to relevant theory; use releveant theory to analyze practical problems		
Other social competences	Student can cooperate in a group to perform experiments in lab at the alloted time; can reflect on the different solutions for a specific problem; express oneself in scientifically correct manner		

Course title	CONCEPTS IN MODERN HOMOGENEOUS AND HETEROGENEOUS CATALYSIS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Dariusz Moszyński	**E-mail address to the person**	Dariusz.Moszynski@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C23	**ECTS points**	4
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student knows the composition and structure of moder homo- and heterogeneous catalysts Student knows the contemporary experimental methods applied to evaluate the properties of catalysts Student is able to select a proper catalyst in regard to the chemical reaction		
Entry requirements	No requirements		
Course contents	Formation of catalytic systems using ionic liquids and application in chosen process Application of phase transfer catalysis in the chosen compounds synthesis Homogeneous catalysis - The isomerisation of allyl ethers catalyzed by ruthenium complexes Synthesis and characterization of Ti-MCM-41 catalyst Cobalt molybdenum nitrides as a modern catalysts for ammonia synthesis Surface reactions by electron spectroscopy Photocatalysis on modified TiO2 Active removal of air polutions Advanced Aspects of Mechanisms in Heterogeneous Catalysis Modern Synthesis in Inorganic Reactions Environmental Catalysis Phase transfer catalysis – fundamentals and application in organic industrial processes Strategies of Ionic liquids application in catalysis Homogeneous transition metal complexes catalysis - aspects of fundamentals and application in organic synthesis Zeolites and zeolite-like materials as the heterogeneous catalysts – structures, properties, synthesis and applications in organic synthesis Activity Loss		
Assessment methods	lecture case studies laboratory classes colloqium exam		
Recommended readings	1. G. Ertl, H. Knozinger, F. Schuth, J. Weikamp, Handbook of Heterogeneous Catalysis, Wiley-VCH, Weinheim, 2008 2. A. Behr, P. Neubert, Applied Homogeneous Catalysis, Wiley-VCH, 2012 3. R.H. Crabtree, The organometallic chemistry of the transition metals, John Wiley&Sons, 2005 4. S. Bhaduri, D. Mukesh, Homogeneous calalysis. Mechanisms and Iindustrial Applications, John Wiley & Sons, 2000 5. Jiri Cejka, Avelino Corma, Stacey Zones, Zeolites and Catalysis: Synthesis, Reactions and Applications, WILEY-VCH, 2010 6. Santi Kulprathipanja, Zeolites in Industrial Separation and Catalysis, WILEY-VCH, 2010 7. Edited by P. Wasserscheid, T. Welton, Ionic Liquids in Synthesis t.1 and t.2, Wiley-VCH, Weiheim, 2008, 2 8. C.M. Starks, C.L. Liotta, M.E.Halpern, Phase-Transfer Catalysis, Chapmann & Hall, New York, 1994 9. Ed.: I.T. Horvath, Encyclopedia of Catalysis Vol. 5 (p. 511-564), Wiley-Interscience, Hoboken, NJ, 2003 10. Ed.: K. Maruoka, Asymmetric Phase-Transfer Catalysis, Wiley-VCH, Weinheim, Germany, 2008		
Knowledge	Has a basic and advanced knowledge about homo- and heterogenous catalysis		
Skills	Is able to choose, prepare and applicate the proper catalyst for a given chemical process.		
Other social competences	Is able to manage an analysis of catalytic process.		

Course title	COSMETIC AND PHARMACEUTICAL RAW MATERIALS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paula Ossowicz-Rupniewska	**E-mail address to the person**	Paula.Ossowicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-15	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Student has knowledge about synthesis and isolations of organic compounds, their identifications by instruments methods		
Entry requirements	organic chemistry inorganic chemistry		
Course contents	Synthesis of cosmetic products Isolation of products from natural sources Identifications and properties of cosmetic compounds Oily materials – oils and fats, hydrocarbons, higher fatty acids, higher alcohols, esters, silicones, others Surface active agents (anionic surfactants, cationic surfactants, non-ionic surfactants, other surfactants) Raw materials for API synthesis Excipients for pharmaceutical formulations Functional additives		
Assessment methods	laboratory written reports, grade final written test - lectures		
Recommended readings	1. Cannell R.J.P., Natural Products Isolation, Humana Press lnc, Totowa, 1998, 4th edition 2. Baki G., Kenneth S.A., Introduction to Cosmetic Formulation and Technology, John Wiley & Sons, Inc, Hoboken, 2015, 1st edition		
Knowledge	Student will have knowledge on the methods of: synthesis of cosmetic products, identifying cosmetic products and determining the biological activity of cosmetic products. Student will have knowledge how to isolate cosmetic products from post-reaction mixtures.		
Skills	Student will be able to synthesis of other cosmetic products. Student will be able to evaluation of antioxidant activity of cosmetic products obtained. Student can determine physicochemical properties of cosmetic products obtained.		
Other social competences	Student can characterize other products of natural origin. Student is able to extract natural raw materials from plant materials.		

Course title	COSMETIC FORMULATION		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paula Ossowicz-Rupniewska	**E-mail address to the person**	Paula.Ossowicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-16	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Student has knowledge of typical group of cosmetic raw materials - their chemical structure, the most important properties and functions in cosmetics. Student can recognize relationship between structure and properties and applications of raw materials. Student can name and describe steps in the production of cosmetics. Student can prepare different cosmetic formulations (solutions, emulsions, gels, suspensions), using the knowledge of raw materials and their impact on the physicochemical form of the cosmetic and its application. Student can assess and control the quality of the cosmetic formulation.		
Entry requirements	fundamentals of chemistry		
Course contents	Shampoos and liquids soaps formulation quantity analysis of the anionic surfactant. Hard soaps – obtaining and analyses of properties Formulation of lotions – micellar lotion, tonic, hair lotion Creams – obtaining and characteristic Washing and antibacterial gels Analysis of the cosmetic raw materials – quality and quantity analysis Type of cosmetic ingredients in terms of chemical structure and functionality Common cosmetic ingredients (chemistry and function): solvents, petrolatum and mineral oils, polybutenes, lipids, surfactants, colorants, preservatives, antioxidants Cosmetic formulation: oily products, emulsions/microemulsions, foams, gels, powder, sticks Segmentation of cosmetics depending on the intended use - cleansing preparations, hair products, shaving products, nail-care products, deodorants/antiperspirants, sun-protection products, oral and denal cara products, decorative cosmetics		
Assessment methods	lectures laboratory final written test - lectures project work continuous assesment		
Recommended readings	1. H. Mollet, A. Grubenmann, Formulation Technology. Emulsions, suspensions, solid forms, Wiley-VCH, Weinheim, 2001 2. I. D. Morrison, S. Ross, Colloidal dispersions, Suspensions, Emulsions and Foams, Wiley-Interscience, New York, 2002 3. A. O. Barel, M. Paye, H. I. Maibach (Eds.), Handbook of Cosmetic Science and Technology, Informa Healthcare, 2009, third		
Knowledge	Student will have knowledge of production of different cosmetic formulation, effect of cosmetic ingredients on application and quality of formulation		
Skills	Student prepares various cosmetic formulations (solutions, emulsions, gels, suspensions) using the knowledge about raw materials and their impact on the physicochemical form of the cosmetic; the student is able to assess and control the quality of the cosmetic formulation; the student uses the rules and requirements set out in the cosmetics law		
Other social competences	Student is aware of the importance of legal and health aspects related to the formulation of cosmetic products and the need to expand knowledge in this field		

Course title	ENGINEERING GRAPHICS AND DESIGN		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Grzegorz Story	**E-mail address to the person**	Grzegorz.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-17	**ECTS points**	5
Semester	summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Mastering the ability to read and perform technical drawings, machine diagrams, installation diagrams, devices, technical systems in accordance with the principles of technical drawing. Mastering the computer technique of creating and modifying drawings based on AutoCAD.		
Entry requirements	None		
Course contents	Introduction to AutoCAD. Prepare technical drawings with AutoCAD requiring students to set units, limits, layers, and utilize the tools of AutoCAD's Draw, Modify, and Dimension toolbars. Create AutoCAD dimension styles. Draw section views of machine parts. Prepare auxiliary views of machine parts. Create 3D models of machine parts. Introduction to Drawing. Lines and Conventional Breaks. Lettering Techniques and Dimensioning with Tolerances. Geometrical Construction. Scales.Theory of Projection. Projection of Solid. Orthographic Projection. Sectional Views. Isometric Projection. Development of Surfaces. Screw Threads and Fasteners. Rivets and Riveted Joints. Welded Joint. Floor Plan. Written test		
Assessment methods	Activating methods: lecture illustrated by multimedia presentation and didactic discussion Practical methods: computer exercises written test Execution of technical drawings of the selected object.		
Recommended readings	1. Mohd Parvez; Osama Khan, Engineering Graphics and Design, Bhavya Books, New Delhi, 2019, 1		
Knowledge	Students will acquire detailed theoretical knowledge on many aspects within the framework of the graphics engineering		
Skills	Students will acquire practical knowledge on many aspects within the framework of the graphics engineering		
Other social competences	Students understand the needs of continuous training and development in the field of graphics engineering		

Course title	ENGINEERING NANOSCIENCE AND NANOTECHNOLOGY		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Agnieszka Piegat	**E-mail address to the person**	Agnieszka.Piegat@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C06	**ECTS points**	5
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	To know about the fundamental knowlege abouth nanoscience and nanotechnology. Education of the ability to use knowledge in the field of basic and specific issues of engineering nanoscince and nanotechnology. The development of the ability to describe and analyze phenomena occured in nanomaterials		
Entry requirements	Fundamentals of chemical engineering Chacterization techniques of materials		
Course contents	Ethical issues in nanotechnology Nanotechnology in enivornmental protecting Biomimetic approach in nanotechnology Nanotechnology: The Science of Miniaturization Nanotechnology: science or fiction Synthesis of nanosilver particles Electrospinning of polymeric nanofibers Synthesis of nanocomposites by polycondensation method Synthesis of nanoparticles of specified sizes Determination of the properties of nanomaterials using Chemical Potential Programmed Method Synthesis of inorganic nanomaterials Introduction to nanotechnology- definitions; examples of nanomaterials - inorganic, organic, polymeric materials Morphology of different nanostructures Preparation techniques of nano-sized materials. Size effect in properties of materials. Characterization of nanomaterials Polymeric nanocomposites- fabriaction methods, nanofillers. Examples of application of nanomaterials in industry		
Assessment methods	Lecture - multimedia presentation Class exercises Laboratories writing exam Test Activity Observation during group classes		
Recommended readings	1. Gabor L. Hornyak, Fundamentals of nanotechnology, 2009 2. Günter Schmid ; G. Schmid [et al.], Nanotechnology. Vol. 1, Principles and fundamentals, 2008 3. Bharat Bhushan (ed.), Springer handbook of nanotechnology, 2004		
Knowledge	To give a general introduction to different classes of nanomaterials and educate scientifically the new developments in engineering nanoscience and nanotechnology.		
Skills	Student knows how to integrated the obtained information about the nanomaterials and their characterization and industrial applications.		
Other social competences	Student understands the need of learning, easly cooperate in a group, is able to reach own and group goals.		

Course title	ENVIRONMENTAL ENGINEERING		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Agata Markowska-Szczupak	**E-mail address to the person**	Agata.Markowska@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C26	**ECTS points**	5
Semester	winter	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Student will be able to: characterize popular environmental pollutants and indicate sources of its emission; explain principles of operation of devices and technologies used in environment protection; collect, organize and present data from literature; Student will be aware of the harmful influence of pollution on the environment. Students will obtain knowledges on basic principles on technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of the biological approaches using degradation ability of microorganisms, fungi, and plants, i.e. using bioremediation, mycoremediation, and phytoremediation technologies, as well as physico-chemical technologies, nanotechnologies, and other innovative technologies. Knowledges on basic principles of bioremediation technologies as the alternative of physico-chemical methods are being emphasized. Knowledge and skills associated with the technology used in contaminants removal from air, water and wastewater.		
Entry requirements	Background in chemical engineering at university level is required. Principles of microbiology applied to the design and operation of engineered environmental systems: treatment of wastewater, bioremediation, energy conversion. Actively engaging in classroom discussions, classroom activities, and laboratory investigations.		
Course contents	Methods of emission control. Methods of clean-up of municipal and industrial effluents. Determination of odour emission rate. Determination of odour abatement efficiency. Determination od precision and accuracy using reference material. Relationship between odour concentration and odour intensity. Odour dispersion modeling in the atmosphere. Assessing the impact of odour nuisance of installations on the environment. Elimination of iron from water. The use of activated carbon for the removal of oxidizable compounds from water. Elimination of phosphorus from water by precipitation method. Determination of nitrogen dioxide in air by spectrophotometric method. Determination of odour concentration by dynamic olfactometry: yes/no method and forced choice method. Determination of individual odour threshold. Odour panel selection and panel screening.Determination of odour intensity and hedonic tone. Olfactometry field. Biodegradability evaluation of polymers Microbial contamination detection in water. Air pollutants. Sources of emission. Global problems of air protection. Monitoring of air pollutants. Strategies to reduce the environmental impact.Methods of gas emission control (absorption, adsorption, thermal and catalytic combustion, condensation). Methods of particulate matter removal. Types of dust collectors (settling chambers, inertial dust collectors, wet scrubbers, fabric filters, electrostatic precipitators). Sources of water contaminants. Characteristic, classification and composition of effluents. Technologies for removal of contaminants from water (conventional treatment systems: primary and secondary treatment, advanced treatment processes) Replacement of chemicals & chemical processes conversion of plant biomass to fermentable sugars, conversion of sugars to biotechnological products eg ethanol, biopolymers etc. Biomining and acid mine drainage. Principles, methods, advantages, and limitations of bioremediation processes. Bioremediation of heavy and toxic metals. Nanotechnologies used for removal of contaminants. Requirements to the microorganisms used in decontamination processes. Isolation and adaptation of microorganisms with degradation ability. Biological wastewater processing. Biological processes for nitrogen and phosphorus removal. Odour nuisance of emission sources. Odour abatement of industrial gases. Methods of odour emission and odour concentratin measurement. Pollution dispersion modeling in the atmosphere. Odour air quality forecasting. Standards of odour air quality. Odour sampling methods. Determination of odour in ambient air. Odour sampling methods. Determination of odour in ambient air.		
Assessment methods	lectures with presentations discussion during lectures and seminar laboratory classes seminar		

	private study, working through the course as presented in lectures, tutorials and learning materials evaluation of attendence at laboratory classes and working in the laboratory evaluation of knowledge and engagement in discussion during seminar written test - grade from lectures evaluation of written reports from laboratory evaluation of presentations during seminar
Recommended readings	1. Evans G. M., Furlong J.Cans G. M., Furlong J.C, Environmental Biotechnology.Theory and Application, Wiley,, 2003, 2nd 2. Scrag A., Environmental Biotechnology, Oxford: Oxford University Press, Oxford, 2005, 2nd, 447 p. ISBN 0-19-926867-3 3. Basak N.N., Environmental Engineering, Tata McGraw-Hill Education, 2003, pp.295 4. Manahan S.E., Environmental Science and Technology, CRC Taylor & Francis, Boca Raton, London, New York, 2007
Knowledge	Student has knowledge about environmental pollutants, processes, devices and technologies used in environmental protection.
Skills	Student is able to collect and interpret data from laboratory experiments and literature, prepare written experimental reports and present results of literature study using audiovisual ways.
Other social competences	Student is able to perform all tasks on time, cooperate and work in group.

Course title	ENVIRONMENTALLY FRIENDLY POLYMERS AND POLYMER COMPOSITES		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Agnieszka Piegat	**E-mail address to the person**	Agnieszka.Piegat@zut.edu.pl
Course code (if applicable)	WTiICh-1-18	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Familiarizing students with definitions and concepts related to the subject of circular economy concept. Developing the ability to use knowledge in the field of biodegradable polymers of natural and synthetic origin		
Entry requirements	no prerequisites		
Course contents	Synthesis of biodegradable polyester. Preparation of composite and its characterization. Enzymatic degradation of biopolymers. Introduction to the circular economy concept. Definitions. Biopolymers - examples, sources, properties and applications. Polymers from renewable sources - synthesis, properties, applications. Bio-based matrixes and fillers for composites. New trends in polymers recykling. Biodegradation and composting. Green composites, wood plastic composites. Composites characterization, bioplastics manufacturing written test		
Assessment methods	lecture laboratories colloquium in laboratory classes written test - lectures observation of avtivity during lectures and laboratories report from the laboratories		
Recommended readings	1. Richard P. Wool, Xiuzhi Susan Sun., Bio-based polymers and composites, 2005 2. Maria Laura Di Lorenzo, René Androsch, Thermal properties of bio-based polymers, 2019 3. Alain Dufresne, Biopolymer nanocomposites : processing, properties and applications, 2013		
Knowledge	The student defines, explains and translates the concepts of environmentally friendly polymers and composites. He can discuss the characteristics of this group of materials		
Skills	The student is able to interpret and describe the properties environmentally friendly polymers and their composites. The student is able to supplement the information obtained in the lectures with the content contained in the literature of the subject.		
Other social competences	The student shows an active attitude during lectures and laboratory exercises and cares about the linguistic correctness related to the terminology of the subject.		

Course title	ENVIRONMENTAL POLLUTION CONTROL		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-19	**ECTS points**	4
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1. Identify the various types of air, water, and soil pollutants. 2. Explain the effects of pollutants on human beings and environment. 3. Describe the sources of air, water, and soil pollutants. 4. Demonstrate basic knowledge of control technologies preventing air, water, and soil pollution.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Analysis of methods used for air pollution control: absorption, adsorption, biofiltration, catalytic destruction, particles capture. Analysis of methods used for waste water treatment: aerobic and anerobic digesters, activated sludge process. Analysis of methods used for monitoring and control of soil pollution. Introduction. Basic concepts. Air pollution. Smog in troposphere. Ozone depletion in stratosphere. Acid Rain. Aerosols: deposition and nucleation. Control of air pollution: absorption; adsorption, biofiltration, catalytic destruction. Particles capture. Water pollution: organic, inorganic, biological. Waste water treatment: aerobic and anerobic digesters, activated sludge process. Soil pollution: types of soil pollution, sources of soil pollution, effects of soil pollution. Monitoring and control of soil pollution.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Peirce J.J., Vesilind P.A., Weiner R.F., Environmental Pollution and Control, Elsevier, Amsterdam, 1997 2. Flagan R.C.,, Fundamentals of air pollution engineering, Prentice-Hall, New Jersey, 1988 3. Hill M.K., Understanding Environmental Pollution. A Primer, Cambridge University Press, Cambridge, 2004 4. Mirsal I.A., Soil Pollution: Origin, Monitoring and Remediation, Springer, Berlin, 2004		
Knowledge	The student will be able to identify the various types of air, water, and soil pollutants.		
Skills	The student will be able to explain the effects of pollutants on human beings and environment.		
Other social competences	The student will be able to demonstrate basic knowledge of control technologies preventing air, water, and soil pollution.		

Course title	FLUID MECHANICS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-20	**ECTS points**	8
Semester	summer	**Language of instruction**	english
Hours per week	6	**Hours per semester**	90
Objectives of the course	Understanding basic laws, principles and phenomena in the area of fluid mechanics Theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses		
Entry requirements	Chemical engineering fundamentals Applied Mathematics		
Course contents	Solving exercises related to the content of the lecture. Written test. Laboratories include experiments related to the determination of liquids properties and their flow in process equipment, for example, determination of the viscosity and density of liquids, determination of the Reynolds number, characterization of the mixing time in a mechanical mixer, liquid outflow from the tank, analysis of liquid velocity using LDA method, visualization of fluid flow. Introduction. The concept of the continuum and kinematics (properties of fluids, continuum hypothesis, kinematics) Fundamental laws of continuum mechanics (conservation of mass, equation of continuity, balances of momentum, angular momentum, energy, entropy, thermodynamic equations of state) Constitutive relations for fluids Equations of motion for particular fluids (Newtonian fluids, inviscid fluids, initial and boundary conditions, simplification of the equations of motion) Hydrostatics Laminar unidirectional flows (steady unidirectional flows, unsteady unidirectional flows, unidirectional flows of non-Newtonian fluids, Bingham material) Fundamentals of turbulent flow (stability and the onset of turbulence, Reynolds' equations, turbulent shear flow near a wall, turbulent flow in smooth pipes and channels, turbulent flow in rough pipes) Hydrodynamic lubrication (Reynolds' equation of lubrication theory, statically and dynamically loaded bearing, thin-film flow on a semi-infinite wall, flow through particle filters, flow through a porous medium, Hele-Shaw flows) Stream filament theory (incompressible flow, steady compressible flow, unsteady compressible flow) Potential flows (one-dimensional propagation of sound, steady compressible potential flow, incompressible potential flow, plane potential flow) Boundary layer theory Written test		
Assessment methods	Activating methods: lecture illustrated by multimedia presentation and didactic discussion Practical methods: calculation of exercises Practical methods: laboratory exercises Lectures - written final test Classes - two written tests Laboratory - individual report after each laboratory		
Recommended readings	1. Joseph H. Spurk, Nuri Aksel, Fluid Mechanics, Springer-Verlag Berlin Heidelberg, Leipzig, Germany, 2008, 2nd Edition, ISBN 978-3-540-73536-6 2. Frank M. White, Fluid Mechanics, McGraw-Hill, New York, 2011, 7th Edition, ISBN 978-0-07-352934-9		
Knowledge	Students will acquire detailed theoretical knowledge on many aspects within the framework of the fluid mechanics		
Skills	Students will acquire practical knowledge on many aspects within the framework of the fluid mechanics		
Other social competences	Students have the ability to solving and analyzing processes in the field of fluid mechanics. Students understand the needs of continuous training and development in the field of fluid mechanics		

Course title	FLUID MECHANICS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Maciej Konopacki	**E-mail address to the person**	mkonopacki@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C05	**ECTS points**	7
Semester	winter	**Language of instruction**	english
Hours per week	6	**Hours per semester**	90
Objectives of the course	The course is aimed at giving an introduction to fluid mechanics. Student will be able to define fluid flow in chemical engineering by means of the mathematical relations; explain the physical properties of a fluid and the consequence of such properties on fluid flow; state the conservation principles of mass, momentum and energy for fluid flow; apply the basic applied-mathematical tools that support fluid mechanics; create mathematical descriptions of fluid flow with the application of the mathematical description.; determine the basic forces acting on fluid flow.		
Entry requirements	Bacic knowledge in mathematics and engineering.		
Course contents	fluid properties; fluid static; fluid kinematics; laminar flow; turbulent flow; steady flow; unsteady flow; internal flow Final test Practical studies of fluid flow in chemical engineering systems. introduction to fluid mechanic; fundamentals; phenomenological rate and transport laws; differential equations of fluid mechanics dimensional analysis and similarity; scale-up; fluid properties; fluid statics; conservation principles; flow; internal flow applications; technical aspects of fluid mechanics; compressible flows; flow measurement and control; external flows; turbulent flow;		
Assessment methods	Information lecture with the use of a multimedia projector Discussion Classes Laboratory Written test Written pass Reports Active participation in auditory classes		
Recommended readings	1. Borghi, Roland; Anselmet, Fabien, Turbulent multiphase flows with heat and mass transfer, ISTE Ltd ; Hoboken : John Wiley & Sons, Inc.,, London, 2014 2. Andrzej T. Gierczycki, Robert Kubica, Basic course on technical and fluid mechanics, Wydawnictwo Politechniki Śląskiej, 2012., Gliwice, 2012 3. Clement Kleinstreuer, Modern fluid dynamics : basic theory and selected applications in macro- and micro-fluidics, New York : Springer, London, 2010 4. Yunus A. Çengel, John M. Cimbala., Fluid mechanics : fundamentals and applications, McGraw Hill, 2006., Boston, 2006		
Knowledge	Student has knowledge in fluid mechanics, including mathematical calculation useful for solving tasks connected with the scope of chemical engineering.		
Skills	Student is able to plan and conduct process experiments, including measurements and operations, as well as to interpret the obtained results and draw the conclusions		
Other social competences	Student is able to work in a group and perform as a group leader; he/she is able to estimate the time necessary to accomplish the assigned tasks.		

Course title	FOOD PACKAGING AND RECYCLING		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Katarzyna Wilpiszewska	**E-mail address to the person**	Katarzyna.Wilpiszewska@zut.edu.pl
Course code (if applicable)	WTiICh-1-21	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	to learn about the foog packaging technology, materials, functions and recycling		
Entry requirements	basing polymer science		
Course contents	polymer films barrier properties surface properties edible film recycling fundamentals in packaging Packaging materials and components Application and processing edible films Active and intelligent packaging Biopolymer packaging recycling test		
Assessment methods	lecture practical classes quizz quizz report test		
Recommended readings	1. M. L. Rooney., Active food packaging, Blackie Academic & Professional, London 2. Han, Jung H., Innovations in Food Packaging, Elsevier, 2011		
Knowledge	Student is familiar with the foog packaging technology, materials, functions and recycling		
Skills	Student knows the properties of packaging materials		
Other social competences	student knows how to study the problem		

Course title	FUNDAMENTALS OF PHYSICAL CHEMISTRY		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Krzysztof Lubkowski	**E-mail address to the person**	Krzysztof.Lubkowski@zut.edu.pl
Course code (if applicable)	WTiICh-1-22	**ECTS points**	8
Semester	winter	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Understanding of real fenomena in physical chemistry. Ability of prediction of physicochemical properties of materials.		
Entry requirements	Basis of inorganic and organic chemistry		
Course contents	Physicochemical calculations related to thermodynamics, thermochemistry and solutions and phase equilibria Laboratory units related to physicochemical properties of materials, thermodynamics, thermochemmistry, solutions and phase equilibria Characteristics of individual states of aggregation, Clapeyron and van der Waals equations, kinetic theory of gases Phenomenological thermodynamics. Gibbs-Helmholtz equation, reversible and irreversible processes, spontaneity of processes, termochemistry, heat of reaction, Hess law, heat capacity, Kirchoff's law, Phase equilibria, Gibbs phase rules, lever rule, Claussius-Clapeyron equation, Solutions, classification of solutions, Raoult and Henry equation, thermodynamics of mixing, Activity, mixing functions, Gibbs-Duhem equation. Chemical statics		
Assessment methods	Lectures with discussion Classes Laboratory units written exam and/or oral discussion assessment of laboratory report		
Recommended readings	1. Sun, Siao F., Physical chemistry of macromolecules : basic principles and issues, Hoboken : John Wiley & Sons, 2004 2. Uziel Zbigniew, Żak Jerzy, asic calculations in physical chemistry. Pt. 1, . The properties of gases, thermodynamics, chemical equilibrium, Gliwice : Silesian University of Technology, 2004 3. Raff, Lionel M, Principles of physical chemistry, Upper Saddle River : Prentice Hall, 2001		
Knowledge	student knows the phenomena of physical chemistry		
Skills	student is able to plan and carry out the experiment with the interpretation of obtained results		
Other social competences	student is able to choose the appropriate method in order to solve the problem related to physical chemistry		

Course title	GRAPHICAL ENGINEERING		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Anna Kiełbus-Rąpała	**E-mail address to the person**	Anna.Kielbus-Rapala@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C02	**ECTS points**	3
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Familiarize students with the principles of technical drawing Familiarize students with the AutoCAD program Forming students' skills in reading technical drawings, machine diagrams, installations, devices Forming students' skills in making technical drawings Shaping the students' ability to use AutoCAD to perform technical drawings		
Entry requirements	Basics of mathematics and drawing at the high school level Basic computer skills, basics of IT		
Course contents	Rectangular projection (European or American method) Axonometric projection Cross sections Dimensioning of simple details Drawing objects Drawing in the AutoCAD program Passing: preparation of a technical drawing using the AutoCAD program Basics of technical drawing: drawing formats, scales, types of lines and their application Rectangular and axonometric projection (European and American method), cross sections Dimensioning, drawing norms Assembly drawings, diagrams of technical systems, machines and devices AutoCAD: basics, commands, drawing in a CAD program Written exam		
Assessment methods	Lecture illustrated by Power Point presentation Practical exercises: manual drawing Programmed methods: drawing with the use of a computer Lecture: written test Practical exercises: positive grade from each drawing made Programmed methods: positive grade from drawing made using computer Exercises: average grade resulting from practical exercises and programmed methods		
Recommended readings	1. CADFolks, AutoCAD 2017 For Beginners, 2016 2. Cheryl R. Shrock,Steve Heather, Beginning AutoCAD 2017: Exercise Workbook, 2016 3. George Omura,Brian C. Benton, Mastering AutoCAD 2018 and AutoCAD LT 2018, 2017 4. W. Abbott, Technical drawing, Blackie & Son Limited, London, 1976, Fourth edition 5. R.S.RHODES, L.B.COOK, Basic Engineering Drawing, Pitman Publishing, Londyn, 1978		
Knowledge	Student knows the appropriate methods, techniques and tools used to perform tasks in the field of engineering graphics Student has knowledge of the principles of creating a technical drawing		
Skills	Student has ability to perform technical drawings using AutoCAD program Student has the skill to read technical drawings Student has the ability to perform technical drawings		
Other social competences	Student understands the need for continuous vocational education and training in the field of graphical engineering		

Course title	GREEN POLYMERS FOR CIRCULAR ECONOMY		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Mirosława El Fray	**E-mail address to the person**	Miroslawa.ElFray@zut.edu.pl
Course code (if applicable)	WTiICh-1-23	**ECTS points**	2
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The course is aimed at giving an introduction to "green" polymers for circular economy. Student will be able to define basic terms related to circular economy, waste (mainly plastics) management and recycling. Student will be able to work in a group and will be able to broaden her/his knowledge in the field.		
Entry requirements	none		
Course contents	Introduction to circular economy Sustainable production Methods of recycling Platics used in packaging sector Biomass and bio-based products Biodegradable polymers - present, future and opportunities (Bio)waste management and production of new products Introduction to Life Cycle Assessment (LCA)		
Assessment methods	lecture examination/presentation of a topic formulated by the supervisor presentation		
Recommended readings	1. S. Dake, R.S. Shinde, S.C. Ameta, Green Chemistry and Sustainable Technology, CRC Press, London, 2002 2. N.K. Rawat, I. Stoica, A.K. Haghi, Green polymers and composites, CRC Press, London, 2021 3. P. Lacy, J. Rutqvist, Waste to Wealth: The Circular Economy Advantage, Springer, 2015		
Knowledge	To provide a detailed theoretical knowledge in the field of green, environment friendly polymers		
Skills	To provide a practical knowledge within the framework of green polymers for circular economy		
Other social competences	To provide basic competences in knowledge on green polymers, recycling of plastics and bio-waste management		

Course title	HEAT TRANSFER PROCESS		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-24	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1.Identify the different modes of heat transfer. 2.Formulate basic equation for heat transfer problems. 3.Solve differential and algebraic equations associated with heat transfer using analytical and numerical methods. 4.Apply heat transfer principles to design heat exchanger. 5.Apply Aspen Plus to design of heat exchanger.		
Entry requirements	Fundamentals of chemical engineering Physics Mathematics		
Course contents	Analysis of heat conduction Analysis of convective heat transfer: laminar and turbulent. Analysis of simultaneous heat and mass transfer Analysis of boiling and condensation Heat exchanger calculations Introduction to heat transfer Conduction Heat Transfer Convective heat transfer: laminar and turbulent flow Simultaneous heat and mass transfer Boiling and Condensation Radiation Types Of Heat Exchangers Calculations method for heat exchangers. Basic Design Methods of Heat Exchange		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: written test at the end of the semester Classis: written test		
Recommended readings	1. Incropera F.P., Lavine A.S., DeWitt D.P., Fundamentals of Heat and Mass Transfer, Wiley, New York, 2011 2. Rathore M.M., Kapuno R.R., Engineering Heat Transfer, Jones & Bartlett Learning, Sudbury, 2011		
Knowledge	The student will be able to: 1.Identify the different modes of heat transfer. 2.Formulate basic equation for heat transfer problems.		
Skills	The student will be able to: 1.Solve differential and algebraic equations associated with heat transfer using analytical and numerical methods. 2.Apply Aspen Plus to design of heat exchanger.		
Other social competences	The student will be able to apply heat transfer principles to design heat exchanger.		

Course title	INDUSTRIAL CHEMISTRY AND CHEMICAL PROCESS PATHWAYS		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Ewa Janus	**E-mail address to the person**	Ewa.Janus@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C21	**ECTS points**	5
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student is well-grouded in principles, knowledge of scientific and techniques of industrial chemistry student has a meaningful knowledge of chemical industries student is prepared for professional participation in chemical industries and to use and adapt his knowledge to solve of problems		
Entry requirements	Chemistry Introduction to Chemical Technology Fundamentals of Polymer Technology		
Course contents	Technological project for selected industrial inorganic processes (mass and energy balances) Technological project for selected industrial processes of polymeric materials synthesis and modification Detailed technological consideration of chosen industrial processes of organic compound production Industrial methods of the synthesis gas production Technologies for the production of nitrogen compounds (e.g. ammonia, nitric acid) Technologies of the phosphoric acid production (physicochemical basis of the process, operations and unit processes, process kinetics, waste and air pollution) Technology of the sulfuric acid production (physicochemical basis of the process, operations and unit processes, process kinetics, waste and air pollution) Soda production (physicochemical basis of the process, operations and unit processes, process kinetics, waste and air pollution) Technology of alkyd resins and oil-modified alkyd resins (technology fundamentals, products characterisation, modifications and applications) Liquid and solid epoxy resins technology (technology fundamentals, products characterisation, modifications and application) Technology of isocyanates and polyurethanes (technology fundamentals, products characterisation and modifications) Technology of selected thermoplastics (polyolefines, PMMA, PS, PVAl) Industrial processes of olefins (ethylene, propylene) production - pyrolysis and steam cracking, catalytic cracking, propane dehydrogenation, metathesis, MTO, MTP processes Industrial processes of methanol and formaldehyde production Industrial processes of ethylene and propylene oxides production Industrial processes of fatty acids, methyl esters of fatty acids and fatty alcohols production Technologies of soaps and chosen surfactants and detergents production		
Assessment methods	Information lecture with multimedial presentation Discussion during lectures Preparing of the project Consultation Written exam Evaluation of the prepared project Evaluation of participation in discussion evaluation of the subsequent stages of the project preparation		
Recommended readings	1. Kemeth A. Kobe, Inorganic process industries 2. James A. Kent, Industrial Chemistry 3. R. J. Jennings, Catalytic ammonia synthesis, Fundamentals and Practice 4. Pierre Becker, Phosphates and phosphoric acid, Raw Materials, Technology and Economics of the wet process 5. Werner W. Duecker, James R. West, The manufacture of sulfuric acid 6. Wicks Z., Jones F. et al, Organic coatings, Wiley, Hoboken, 2007 7. Manea M., High solids binders, Vincentz, Hannover, 2008		
Knowledge	Student can describe technologies of industrial production in the field of chemistry (inorganic, organic and polymer chemistry); has the advanced knowledge of the fundamentals of industrial chemistry		
Skills	Student can use literature sources and other tools to find information on the industrial chemical processes and can in- depth examinate of operational consideration of processes such as connection between products and process, theoretical and practical aspects of chemical processes.		

Other social competences	Student can reflect on the different (fundamentals, technological, engineering, environmental) aspects of industrial chemical production and understands the linkages between these different aspects of industrial chemical production

Course title	INSTRUMENTAL ANALYSIS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Elwira Wróblewska	**E-mail address to the person**	Elwira.Wroblewska@zut.edu.pl
Course code (if applicable)	WTiICh-1-25	**ECTS points**	8
Semester	winter/summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	Theoretical and practical learning about instrumental methods applied in quantitative and qualitative analysis; Theoretical studies about the phenomena used in the particular method as well as practical interpretation of the results given.		
Entry requirements	Basis of physical chemistry, organic chemistry, general chemistry, analytical methods.		
Course contents	The ways of preparing of the solution with a given concentration. The ways of expression of the content od some components of the solution. Units usually used in absorption spectra. The application of Lambert-Beer's low in quantitative analysis of single and multicomponent mixtures. Calibration curve and their application in quantitative analysis. The characteristic of the analytical method (limit of detection, method sensitivity and precision). The use of NMR spectroscopy in qualitative and quantitative analysis of organic compounds. The use of some information which are read off from chromatogram into qualitative and quantitative analysis of organic compounds Measurements of UV-vis spectra and their application in the studies of solute-solvent intermolecular interaction , as well as in quantitative analysis. The interpretation of HNMR spectra as a key to the determination of the structure of organic compounds. The application of IR method in qualitative and quantitative analysis of organic compounds. The application of chromatographic method in qualitative and quantitative analysis of multicomponent mixtures. The determination of some metals with the use of ASA method. The fundamental definitions concerning analytical process, the kind of analytical method with respect to instrumental method analysis. Classification of the methods of instrumental analysis, particularly spectroscopic and chromatographic ones. Explanation of wave-particle duality of electromagnetic radiation and influence of its absorption/emission by atom or molecule on their properties. Theoretical studies of phenomena proceeding in the molecule/atom under the irradiation and their application in particular methods i.e. ultraviolet-visual spectroscopy (UV-VIS), infrared spectroscopy (IR), nuclear magnetic resonance spectroscopy (NMR), mass spectroscopy (MS), atomic absorption spectroscopy (AAS), X-ray absorption, atomic emission spectroscopy (AES), flame photometry, inductively coupled plasma spectrometry (ICP), X-ray fluorescence (XRF), atomic fluorescence. Explanation of phenomena, concepts, and definitions used in chromatographic methods. The ways of separation of a mixture components.		
Assessment methods	The lectures with the discussion. Classes Laboratory Written exam and/or oral discussion. Assessment of laboratory written report. Assessment of homework assignments. Evaluation of the student’s work based on the student activity during the course.		
Recommended readings	1. J. M. Hollas, Modern spectroscopy, John Wiley, 2004 2. L.D. Field, S. Sternhall, J.R. Kalman, Organic structures from spectra, 3rd ed., Chichester, John Wiley and Son, 2002 3. J.R. Chapman, Practical Organic Mass Spectrometry, 2nd ed., Chichester, John Wiley and Son, 1993 4. Ira N. Levin, Molecular spectroscopy, Wiley-Interscience, New York, 1975 5. C. N. R. Rao, Ultra-violet and visible spectroscopy: chemical applications, 3rd ed., Butterworths, London, 1975 6. ed. D. A. Ramsay, Spectroscopy, University Park Press, London: Butterworths; Baltimore, 1976 7. Stefan Hüfner, Photoelectron spectroscopy: principles and applications, 2nd ed., Springer, Berlin, 1996		
Knowledge	Student knows the phenomena applied in the instrumental analysis. He has a knowledge about the fundamentals of the selected spectroscopic and chromatographic methods.		
Skills	Student is able to plan and carry out the experiment with the interpretation of obtained results.		

Other social competences	Student is able to choose the appropriate method in order to solve particular problem concerning qualitative and/or quantitative analysis

Course title	INTERFACIAL PHENOMENA		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Dariusz Moszyński	**E-mail address to the person**	Dariusz.Moszynski@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C07	**ECTS points**	4
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student knows the structure of surfaces and interfaces. Student knows fundamental laws applicable to the processes performed on interfaces Student knows the basic experimental methods applied to evaluate the properties of interfaces and is able to perform respective experiments.		
Entry requirements	no requirements		
Course contents	Physics of Surfaces - calculations Adsorption at Interfaces - calculations Simulation of Reactions at Liquid Surfaces Monolayers observed by electron spectroscopy Adsorption/desorption phanomena as a tool for surface evaluation Segregation to gas-solid interface Study on synthesis of ordered and disordered mesoporous silica Study on adsorption of organic dyes on activated carbons Measurement of the surface tension of a liquid by a stalagmometric method The Physics of Surfaces Electrostatic Phenomena, Interfacial and Surface Potentials Electrokinetic Phenomena Adsorption at Interfaces Properties of Monolayers Reactions at Liquid Surfaces Disperse Systems and Adhesion		
Assessment methods	Lecture Case studies Seminar Laboratory classes Exam Reports		
Recommended readings	1. G.A. Somorjai, Introduction to surface chemistry and catalysis, Wiley, 1994 2. John C. Vickerman, Ian S. Gilmore, Surface analysis: the principal techniques, Wiley, 2009 3. Dongyuan Zhao, Ying Wan, Wuzong Zhou, Ordered Mesoporous Materials, Wiley-VCH, 2013		
Knowledge	Student knows the basic phenomena on interfaces		
Skills	Is able to distinguish between interfacial phenomena and to find a proper tools to analyse them		
Other social competences	Is able to use tools and methods for phenomena analysis		

Course title	INTRODUCTION TO COSMETIC CHEMISTRY		
Level of course	first cycle		
Teaching method	laboratory class		
Person responsible for the course	Edyta Kucharska	**E-mail address to the person**	edyta.makuch@zut.edu.pl
Course code (if applicable)	WTiICh-1-26	**ECTS points**	4
Semester	winter	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	Student has knowledge about synthesis, evaluating antioxidant activity and physicochemical properties of cosmetic products.		
Entry requirements	organic chemistry		
Course contents	Methods of the synthesis of cosmetic products Methods of evaluating antioxidant activity of cosmetic products Analysis of physicochemical properties of cosmetic products		
Assessment methods	laboratory written reports, grade		
Recommended readings	1. B. Tal-Figiel, THE FORMATION OF STABLE W/O, O/W, W/O/W COSMETIC EMULSIONS IN AN ULTRASONIC FIELD, Chemical Engineering Research and Design, Institution of Chemical Engineers, 2007, Vol 85 (A5), Part A 2. Salvador A, March JG, Vidal MT, Chisvert A, Balaguer A, Analysis of Cosmetic Products, Elsevier, Amsterdam, 2007, Edited by Amparo Salvador Department of Analytical Chemistry Faculty of Chemistry University of Valencia Valencia, Spain and Alberto Chisvert Department of Analytical Chemistry, Nutrition and Bromatology Faculty of Sciences University of Alicante		
Knowledge	Student will have knowledge on the methods of synthesis of cosmetic products, on the methods of evaluation of antioxidative activity of cosmetic products and determining of physicochemical properties of cosmetic products		
Skills	Student will be able to synthesis of other cosmetic products. Student will be able to evaluation of antioxidant activity of cosmetic products obtained. Student can determine physicochemical properties of cosmetic products obtained.		
Other social competences	Student has knowledge about synthesis of other cosmetic products. Student will be able to evaluation of antioxidant activity of other cosmetic products. Student is able to determine physicochemical properties of other cosmetic products.		

Course title	INTRODUCTION TO RHEOLOGY		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-27	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course aims to give a general introduction to the theory and practice of rheology		
Entry requirements	Chemical engineering fundamentals Applied Mathematics		
Course contents	Laboratories include experiments related to rheometric measurements of selected Newtonian and non-Newtonian systems at room temperature and high temperature, as well as descriptions of the results of rheometric measurements using mathematical models Introduction. Rheology and rheometry. Viscosity. Practical ranges of variables which affect viscosity. The shear-dependent viscosity of non-Newtonian liquids. Viscometers for measuring shear viscosity. Linear viscoelasticity. Normal stresses. Extensional viscosity. Rheology of polymeric liquids. Rheology of suspensions. Theoretical rheology. Written test.		
Assessment methods	Activating methods: lecture illustrated by multimedia presentation and didactic discussion Practical methods: laboratory exercises Lectures - written final test Laboratory - individual report after each laboratory		
Recommended readings	1. H.A. Barnes, J.F. Hutton, K. Walters, An Introduction to Rheology, Howard A. Barnes, John Fletcher Hutton, Kenneth Walters, Amsterdam, 1989, ISBN 0 444 87140 3 2. Thomas G. Mezger, The Rheology Handbook, Vincentz Network, 2011, 4th Edition, ISBN 978-3866308428		
Knowledge	Students will acquire detailed theoretical knowledge on many aspects within the framework of the rheology and rheometry		
Skills	Students will acquire practical knowledge on many aspects within the framework of the rheology and rheometry		
Other social competences	Students have the ability to solving and analyzing processes in the field of the rheology and rheometry. Students understand the needs of continuous training and development in the field of the rheology and rheometry		

Course title	INTRODUCTION TO SEPARATION PROCESSES		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-28	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1. Demonstrate basic knowledge of separation of chemical mixtures by industrial processes, including bioprocesses. 2. Describe the scientific principles associated with separation equipments. 3. Demonstrate basic knowledge of making mass balances and specifying component recovery and product purity. 4. Demonstrate basic knowledge of modeling and simulation of separation processes using POLYMATH, ASPEN PLUS and HYSYS.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Thermodynamic analysis of selected separation processes. Single equilibrium stages calculations. Flash calculations. Calculation of selected separation processes: distillation, liquid–liquid extraction, supercritical extraction, membrane separations, adsorption, ion exchange, chromatography, electrophoresis, mechanical phase separations. Modeling and simulation of separation processes using POLYMATH, ASPEN PLUS and HYSYS. Introduction to separation processes Fundamental concepts. Thermodynamics of separation processes. Mass transfer and diffusion. Flash calculations. Absorption. Stripping of dilute mixtures. Distillation. Liquid–liquid Extraction. Membrane separations. Adsorption. Ion exchange. Chromatography. Modeling and simulation of separation processes using POLYMATH, ASPEN PLUS and HYSYS.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Seader J.D., Henley E.J., Separation process principles, Wiley, New York, 2006 2. Seader J. D., Henley E.J., Roper D.K., Martin R.E., Separation process principles. Chemical and biochemical operations, Wiley, New York, 2011 3. Wankat P.C., Separation Process Engineering, Prentice Hall, New Jersey, 2012 4. Noble R.D., Terry P.A., Principles of chemical separations with environmental applications, Cambridge University Press, New York, 2004		
Knowledge	The student will be able to demonstrate basic knowledge of separation of chemical mixtures by industrial processes, including bioprocesses.		
Skills	The student will be able to describe the scientific principles associated with separation equipments.		
Other social competences	The student will be able to demonstrate basic knowledge of modeling and simulation of separation processes using POLYMATH, ASPEN PLUS and HYSYS.		

Course title	KINETICS AND CATALYSIS OF CHEMICAL REACTIONS		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Rafał Wróbel	**E-mail address to the person**	Rafal.Wrobel@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C08	**ECTS points**	5
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Getting knowledge about kinetics of chemical reactions, catalysis and related calculations		
Entry requirements	Basic chemistry and advanced mathematics		
Course contents	Hydrothermal synthesis of TS-1 zeolite, its activation and acidity studies Epoxidation of allyl alcohol over the TS-1 zeolite catalyst Impact of poisoning of catalyst on reaction kinetic. Catalytic carbon monoxide oxidation Catalytic ammonia decomposition Determination of the ion-exchange capacity of porous materials Definitions and Concepts - Rate of Reaction; Turnover Frequency; Selectivity; Elementary Step and Rate Determining Step (RDS); Reaction Rates in Reactors; Metal Dispersion; Metal-Support Interactions (MSI) Catalyst Characterization Acquisition and Evaluation of Reaction Rate Data - Types of Reactors; Heat and Mass Transfer Effects; Intraphase Gradients; Criteria to Verify the Absence of Mass and Heat Transfer Limitations Adsorption and Desorption Processes - Adsorption Rate; Desorption Rate; Adsorption Equilibrium on Uniform Surfaces-Langmuir Isotherms; Adsorption Equilibrium on Nonuniform (Nonideal) Surfaces; Activated Adsorption Kinetic Data Analysis - Transition-State Theory (TST) or Absolute Rate Theory; The Steady-State Approximation (SSA); Heats of Adsorption and Activation Barriers on; Use of a Rate Determining Step (RDS) and/or a Most Abundant Reaction Intermediate (MARI) . Modeling Reactions on Uniform (Ideal) Surfaces - Reaction Models with a RDS – Unimolecular Surface Reactions; Reaction Models with a RDS – Bimolecular Surface Reactions; Reaction Models with a RDS – Reactions between an Adsorbed Species and a Gas-Phase Species; Reaction Models with no RDS; A Series of Irreversible Steps – General; Data Analysis with an Integral Reactor; Modeling Reactions on Nonuniform (Nonideal) Surfaces - Initial Models of a Nonuniform Surface; Correlations in Kinetics; Formalism of a Temkin Surface; Consequences of Temkin’s Model; Kinetics of Enzyme-Catalyzed Reactions Selection of heterogeneous catalyst for the reactions in organic technology.		
Assessment methods	Lecture project laboratory Written exam raport activity		
Recommended readings	1. M. Albert Vannice, Kinetics of Catalytic Reactions, Springer, 2005		
Knowledge	Student knows the theorem of catalysis and its applications in chemical engineering. He or she also knows typical catalytic chemical industrial processes.		
Skills	Student is able to find literature data required for evaluation of catalytic processes with modern data bases and search engines. He or she is also able to plan experiments with catalytic reaction and choose the appropriate control techniques.		
Other social competences	Student is able to teamwork focused on solving catalytically problems. He or she is understand the requirement of self-development in mastering the skills of catalytical processes in chemical engineering.		

Course title	MATERIAL SCIENCE AND TECHNOLOGY		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Mirosława El Fray	**E-mail address to the person**	Miroslawa.ElFray@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C18	**ECTS points**	6
Semester	summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	The course is aimed at giving an introduction to materials science and technology. Student will be able to define basic groups of materisl, their manufacturing methods, chatacterized their basic properties and find the relationship between their structure and properties, and applications		
Entry requirements	Bacic knowledge in materials science and engineering as well as basic safety rules		
Course contents	Ceramics technology Silicone technology Carbonaceuous materials technology High performance polymers Natural polymers Polymer nanocomposites Evaluation of necessary UV-dose for crosslinking of diverse adhasives Kinetics of UV crosslinking process Basic definitions in crystallography. Properties of solids affecting their practical applications. Crystal systems. Indexation of directions and planes in crystals. Anisotrophy of thermal expansion. Polymorphic phase transitions. Application of XRD, DTA-TGA, IR, UV-Vis and XRD measuring techniques for investigation of properties of molecular sieves. Synthesis of polyurethane elastomer Synthesis of polymer nanocomposite Synthesis of diverse photoreactive polymers and UV-initiated crosslinking (PSA) or curing (lacquers) Identification of samples of selected minerals and rocks. Properties and application of these minerals and rocks. X-ray phase analysis of metals, minerals, rocks, drugs and cosmetics. Indexation of powder diffraction patterns and determination of unit cell parameters. Quantitative X-ray phase analysis. Dillatometric measurement of coefficients of thermal expansion. Application of XRD, IR, UV-Vis-NIR measuring methods as well as measurement of density for identification and investigations of properties of precious stones and their simulants, gold and silver coins and their counterfeits. Common ceramic materials - synthesis and manufacture of ceramic elements Silicone technology Carbonaceous materials (diamond, graphite, activated carbon, soot) Rubbers and elastomers Thermoplasts and duroplasts technology Composite materials Application of UV-technology by photoreactive materials - photoreactivity of polymers, adjusting of photoreactivity Photoinitiators - unsaturated copolymerizable photoinitiators UV-radiation, excimer lasers, technological use Basic definitions in crystallography. X-rays and their properties. X-ray diffraction (XRD) techniques for materials characterization. Phase transitions. Properies and investigation of crystalline, nanocrystalline, semicrystalline and amorphous materials.		
Assessment methods	Lecture Discussion Laboratory exercises Auditory classes Written exam (lecture) Continuous assessment: lab reports and activity (labs) Assessment of activity during auditory classes		
Recommended	1. I.M. Ward, J. Sweeney, An introduction to the mechanical properties of solid polymers, Wiley & Sons Ltd, Chichester, 2004		

readings	2. J.H. Koo, Polymer nanocomposites, McGraw-Hill Comp., Toronto, 2006 3. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH @Co. KGaA, 2002 4. C. Giacovazzo, H.Z. Monaco, D. Biterbo, F. Scordari, G. Gilli, G. Zanotti, M. Catti, Fundamentals of Crystallography, IURC, Oxford University Press, 2000 5. A. Gaunier, X-ray differaction in crystals, imperfect crystals, and amorphous bodies, Courier Corporation, New York, 1994
Knowledge	Student has knowledge in basic properties and technologies of different materials, including ceramics, polymers, composites and metals, useful for solving basic tasks within the scope of chemical engineering
Skills	Student is able to plan and conduct process experiments, including measurements and operations, as well as to interpret the obtained results and draw the conclusions
Other social competences	Student is able to work in a group and perform as a group leader; he/she is able to estimate the time necessary to acomplish the assigned tasks.

Course title	MEMBRANE PROCESSES		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Sylwia Mozia	**E-mail address to the person**	Sylwia.Mozia@zut.edu.pl
Course code (if applicable)	WTiICh-1-29	**ECTS points**	1
Semester	winter/summer	**Language of instruction**	english
Hours per week	1	**Hours per semester**	15
Objectives of the course	Student will get theoretical knowledge on membranes and membrane processes and their applications. The main issues to be discussed during the lectures include (i) polymeric and ceramic membranes: properties and preparation, (ii) basics of pressure driven, concentration driven and electrically driven techniques, and (iii) examples of applications of membrane technology in industry and environment.		
Entry requirements	Fundamentals of chemistry and chemical technology/engineering.		
Course contents	Introduction to membrane processes. Definitions. Membranes and membrane modules: definitions, division, preparation, properties. Pressure driven membrane techniques (microfiltration, ultrafiltration, nanofiltration, reverse osmosis) Concentration driven membrane processes (dialysis, pervaporation, membrane distillation) Electrically driven membrane processes (electrodialysis, electrodialysis reversal) Membrane reactors		
Assessment methods	lecture class test/grade		
Recommended readings	1. Heinrich Strathmann, Introduction to Membrane Science and Technology, John Wiley & Sons, 2011 2. Marcel Mulder, Basic Principles of Membrane Technology, Springer Science & Business Media, 2013 3. Richard W. Baker, Membrane Technology and Applications, John Wiley & Sons, 2004 4. Norman N Li, Anthony G. Fane, W. S. Winston Ho, Takeshi Matsuura, Advanced Membrane Technology and Applications, John Wiley & Sons, 2011		
Knowledge	At the completion of this course, students will be able to: - Present definisions and bascis laws related to membranes and membrane processes. - Explain differences between membrane processes operated under various driving forces. - Describe industrial and environmental applications of membrane technology.		
Skills	At the completion of this course, students will be able to: - Analyze and propose membranes for process design. - Analyze and propose membrane technology for environmental and industrial applications.		
Other social competences	Student understands the needs of continuous training and development in the field of membranes and membrane processes.		

Course title	METHODS OF ORGANIC COMPOUNDS IDENTIFICATION		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Elwira Wróblewska	**E-mail address to the person**	Elwira.Wroblewska@zut.edu.pl
Course code (if applicable)	WTiICh-1-30	**ECTS points**	5
Semester	summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	To gain the knowledge about the methods of organic compounds identification.		
Entry requirements	Fundamentals of physical chemistry. Fundamentals of organic chemistry		
Course contents	The recording and interpretation of IR spectra od various organic compounds. The analysis of NMR spectra of organic compounds. The analysis of MS spectra of various group of organic compounds. The application of the chromatographic method in qualitative analysis of various compounds. Classification of the methods of qualitative analysis of organic compounds, especially spectroscopic and chromatographic ones. Explanation of theoretical fundamentals of the interaction of electromagnetic radiation with an atom or molecule. Application of selected methods i.e. ultraviolet-visual spectroscopy (UV-VIS), infrared spectroscopy (IR), nuclear magnetic resonance spectroscopy (NMR), mass spectroscopy (MS), atomic absorption in qualitative analysis of various compounds. Explanation of phenomena, concepts, and definitions used in chromatographic methods. Application of chromatographic methods in qualitative analysis of organic compounds.		
Assessment methods	The lectures with the discussion. Laboratory Written exam and/or oral discussion Assessment of laboratory written report Evaluation of the student’s work based on the student activity during the course.		
Recommended readings	1. Field, L. D, Strnhell, S, Kalman, J.R., Organic structures from spectra, Chichester : John Wiley and Sons, 2002 2. Láng, L., Holly, S, Sohár, P., Absorption spectra in the infrared region., Akadémiai Kiadó,, Budapest, 1980 3. Perkampus, Heinz-Helmut., Encyclopedia of spectroscopy, Weinheim : VCH, 1995 4. Rahman, Atta-ur, One and two dimensional NMR spectroscopy, Elsevier, Amsterdam, 1989 5. J.R. Chapman, Practical Organic Mass Spectrometry, 2nd ed., Chichester: John Wiley and Son, 1993 6. Sliwiok, Józef,, Chromatography in physico-chemical investigations of organic compounds, Uniwersytet Slaski,, Katowice, 1985 7. ed. F. A. A. Dallas, Thin-layer chromatography-recent advances., Chromatographic Society;, London : Plenum, New York, 1988		
Knowledge	Student has a knowledge about the selected method of organic compounds identyfication.		
Skills	Student is able to plane and carry the experiment with the interpretation of obtained results.		
Other social competences	Student is able to choose the appropriate method in order to solve particular problem concerning quantitative analysis.		

Course title	MODELING AND SIMULATION IN CHEMICAL ENGINEERING		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-31	**ECTS points**	7
Semester	winter	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	The student will be able to: 1. Develop of process models based on conservation laws and process data. 2. Use computational techniques to solve the process models. 3. Use simulation tools such as MATLAB, POLYMATH, and ASPEN PLUS.		
Entry requirements	Mathematics. Fundamentals of chemical engineering.		
Course contents	MATLAB Basics Curve-Fitting Numerical Integration A System of Algebraic Equations Solving Differential Equations Solving selected problems from chemical engineering in Matlab Introducing Aspen Plus Aspen Plus Flowsheet Features Simulation of selected problems from chemical engineering in Aspen Plus Formulation of physicochemical problems Development of exemplary mathematical models Classification of mathematical models Reducing mathematical models Error estimations Numerical methods for ordinary differential equations, ODEs Methods for boundary value problems Numerical methods for partial differential equations, PDEs Statistical analysis of mathematical models Written test		
Assessment methods	Lecture illustrated by Power Point presentation Numerical analysis by solving chemical engineering problems using MATLAB. Numerical analysis by solving chemical engineering problems using Aspen TECH. Written final exam based on the lecture contents. Mid-term exam 1 - MATLAB. Mid-term exam 2 - Aspen TECH		
Recommended readings	1. Hangos K.M., Cameron L.T., Process modelling and model analysis, Academic Press, San Diego, 2001 2. Rice R.G., Do D.D., Applied mathematics and modeling for chemical engineers, Wiley, New York, 2011 3. Finlayson B.A., Introduction to chemical engineering computing, Wiley, New York, 2005		
Knowledge	The student will be able to develop of process models based on conservation laws and process data.		
Skills	The student will be able to use computational techniques to solve the process models.		
Other social competences	The student will be able to use simulation tools such as MATLAB, POLYMATH, and ASPEN PLUS.		

Course title	PARTICULATE TECHNOLOGY		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-32	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The student will be able to: 1. Understand and apply the theoretical fundamentals of particle technology in chemical engineering. 2. Understand the experimental methods necessary to characterize the properties of particles and powders. 3. Understand the hydrodynamics of gas-solid systems.		
Entry requirements	Fundamentals of chemical engineering Physics		
Course contents	Particle size analysis. Motion of solid particles in a fluid. Fluid flow through a packed bed. Filtration. Fluidization. Separation of particles from a gas. Mixing and segregation of particles. Particle characterization. Particle size analysis. Motion of solid particles in a fluid. Multiple particle systems. Colloids and fine particles. Fluid flow through a packed bed. Filtration. Fluidization. Pneumatic transport. Separation of particles from a gas. Mixing and segregation of particles. Particles size reduction. Particles mechanics. Discharge of particulate bulk solids. Storage and flow of powders.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classes illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Rhodes M., Introduction to Particle Technology, Wiley, Chichester, 2008 2. Aste T., Tordesillas A., Di Matteo T. (Editors), Granular and complex materials, World Scientific Publishing, London, 2007 3. Particles, bubbles and drops-their motion, heat and mass transfer, World Scientific Publishing, London, 2006		
Knowledge	The student will be able to understand the theoretical fundamentals of particle technology.		
Skills	The student will be able to apply the particle technology in chemical engineering.		
Other social competences	The student will be able to understand the hydrodynamics of gas-solid systems.		

Course title	PHARMACEUTICAL CHEMISTRY		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Paula Ossowicz-Rupniewska	**E-mail address to the person**	Paula.Ossowicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-33	**ECTS points**	6
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student has knowledge about drug discover, sources of drugs and lead compounds, classification of drugs and drug action. Student can synthesis different active substances (drugs).		
Entry requirements	Basics of organic compound and biochemistry.		
Course contents	Paracetamol synthesis and analysis Barbituric acid synthesis and analysis Phenytoin synthesis and analysis Lidocaine synthesis and analysis Extraction of piperine from black pepper and analysis Isolation of citral from lemongrass using steam distillation and analysis A brief history of drugs: from plants extracts to DNA technology Sources of drugs and lead compounds Classification of drugs Introduction to drug action Drug Development and Production		
Assessment methods	lectures laboratory wtritten exam written report, grade		
Recommended readings	1. Gareth Thomas, Medicinal Chemistry An Introduction, John Wiley & Sons Ltd,, Chichester, England, 2007, Second Edition 2. Camille Georges Wermuth, The Practice of Medicinal Chemistry, Elsevier, Oxford, England, 2003, Second Edition 3. Pharmaceutical Chemistry, David G. Watson, Elsevier, 2011 4. Gareth Thomas, Fundamentals of Medicinal Chemistry, John Wiley & Sons Ltd,, Chichester, England, 2003		
Knowledge	Student will have knowledge about drugs, their classification, types of drugs, sources and drug action.		
Skills	The student will be able to obtain simple compounds with pharmaceutical activity.		
Other social competences	Student is able to indicate by-products and waste substances arising in the production process of selected groups of drugs and their impact on the quality of drugsand the ways of their elimination.		

Course title	POLYMER CHEMISTRY		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Mirosława El Fray	**E-mail address to the person**	Miroslawa.ElFray@zut.edu.pl
Course code (if applicable)	WTiICh-1-34	**ECTS points**	2
Semester	winter/summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The course is aimed at giving an introduction to polymer chemistry. Student will be able to define basic terms related to polymer synthesis and properties, will be able to select materials for particular applications according the applications requirements. Student will be able to work in a group and will be able to broaden her/his knowledge in the field.		
Entry requirements	none		
Course contents	Basic definitions in polymer chemistry Molecular masses and macromolecular architectures Basic mechanisms in polymer reactions Synthesis methods in polymer chemistry Synthesis and applications of polyolefines: polyethylene and polypropylene Synthesis and applications of polyesters: PET, PBT Synthesis and applications of polyamides: PA6 and PA6,6 Synthesis and applications of polyurethanes Synthesia dn applications of high performance polymers: PEEK, PES Synthesis and applications of thermoplastic elastomers		
Assessment methods	lecture examination/presentation of a topic formulated by the supervisor		
Recommended readings	1. Davis F.J., Polymer chemistry, Oxford University Press, Oxford, 2004 2. Cheremisinoff N.P., Polymer characterization, Noves Pub., New York, 1996		
Knowledge	To provide a detailed theoretical knowledge within the field of polymer chemistry		
Skills	To provide a practical knowledge within the framework of polymer chemistry		
Other social competences	To provide basic competences in knowledge on polymer praparation, characterization and applications		

Course title	POLYMER DEGRADATION AND STABILITY		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Joanna Rokicka	**E-mail address to the person**	Joanna.Rokicka@zut.edu.pl
Course code (if applicable)	WTiICh-1-35	**ECTS points**	8
Semester	summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To provide a general understanding of polymer degradation and stability. Understand the structure relationship with degradation processes.		
Entry requirements	Basic polymer science		
Course contents	Synthesis of the base material for degradation: polytrimethylene terephthalate. Synthesis of modified polytrimethylene terephthalate with increased susceptibility to degradation. Part 1. Synthesis of modified polytrimethylene terephthalate with increased susceptibility to degradation. Part 2. Examination of the basic physicochemical properties of the obtained materials. Preparation of polymer samples for degradation. (Bio)degradation tests in laboratory and environmental conditions. Part 1. (Bio)degradation tests in laboratory and environmental conditions. Part 2. Examination of basic physicochemical properties of materials after completion of degradation tests. Literature review of the subject of a research project. Preparation of the appropriate content of the project (measurements, calculations, simulations, design). Preparation final research project. Presentation of the results of the prepared project. General aspects of polymer degradation and stability. General factors of polymer degradation. Thermal degradation. Mechanical degradation. Ultrasonic and photo degradation. Degradation by high energy radiation. Chemical degradation. Biodegradation.		
Assessment methods	Class lecture Laboratory work Seminars Report Project work Final written test		
Recommended readings	1. Norman Grassie, Gerald Scot, Polymer Degradation and Stabilization, Cambridge University Press, New York, 1988 2. W. Lincolin Hawains, Polymer Stabilization, Wiley-Interscience, New York, 1971 3. N.S. Allen, M. Edge, Fundamentals of Polymer Degradation and Stabilization, Springer Dordrecht, 1993		
Knowledge	Student is able to understand the fundamentals of polymer degradation and stability.		
Skills	Student is able to explain the degradation mechanisms in different scenarios due to heat, atmosphere, fire, UV-light, ionizing radiations, and mechanical stress, and indispensable stabilization processes.		
Other social competences	Student knows how to study the problem.		

Course title	PRINCIPLES OF ANALYTICAL CHEMISTRY		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Zbigniew Rozwadowski	**E-mail address to the person**	Zbigniew.Rozwadowski@zut.edu.pl
Course code (if applicable)	WTiICh-1-36	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	Application of an appropriate analytical techniques depending on the sample type and matrix. Explanation of the construction of analytical instrumentation and indications the possibility of its application. Correct interpretation of the results of analytical determinations. Writing of reports on the analytical results.		
Entry requirements	The basic knowledge of fundamental and inorganic chemistry as well as basic safety rules		
Course contents	Occupational health and safety in the laboratory. Calibration of volumetric glassware: calibration of a buret Acid-base titrimetry. Preparation of 0.1 M HCl solution Standardization of 0.1 HCl solution with sodium carbonate. Acid-base titrimetry. Preparation of 0.1 M NaOH solution. Standardization of 0.1 NaOH solution. Titration of HCl solution Conductometry. Conductometric titratiof of HCl Reduction-Oxidation Titrations. Preparation of 0.1 M potassium permanganate solution Standardization of a 0.1 M potassium permanganate solution solution with sodium oxalate. Determination of Fe in sample. Complexometric methods. Determination of total hardness of water Gravimetric methods. Determination of chlorides (Mohr method) Basic tool in analytical chemistry (measurements, concentration, stock solution, basic equippment, etc.). Analytical methods (accuracy, selectivity, sensitivity, experimental errors, statistical analysis of data). Standarizing analytical methods. Preparation of samples. Titrametic methods (acid-base, complexation, redox, precipitation). Gravimetric methods. Spectroscopic methods (UV-Vis, IR, NMR, etc.). Chromatographic methods (GC, HPLC). Electrochemical methods: introduction to electrochemistry, conductometry, potentiometry, amperometry and voltametry.		
Assessment methods	Lecture Discussion Labs Written exam (lecture) Continuous assessment: lab reports and activity (labs)		
Recommended readings	1. Harvey D., Modern analytical chemistry, McGraw-Hill Companies Inc., 2000, open access 2. Curreli, G., Analytical instrumentation, Wiley, Chichester, 2000		
Knowledge	Knowledge of the analytical techniques and analytical procedures		
Skills	Explanation of the construction of analytical instrumentation and indications the possibility of its application.		
Other social competences	Correct interpretation of the results		

Course title	PROCESS DYNAMICS, OPERATIONS AND CONTROL		
Level of course	first cycle		
Teaching method	laboratory class / project / lecture		
Person responsible for the course	Rafał Rakoczy	**E-mail address to the person**	Rafal.Rakoczy@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C12	**ECTS points**	4
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	This course will present an introduction to process dynamics and control. Students will learn how to construct dynamic models of process systems, how to analyze process dynamics using Laplace transforms and transfer functions, the characteristic responses of dynamic processes, and the design and implementation of feedback control. Students will also learn to use computer software to model process dynamics and control.		
Entry requirements	Mathematics Industrial Automation Bacic knowledge in chemical engineering.		
Course contents	Practical studies of dynamics of chemical engineering systems Poject of chemical engienering systems with the application of Matlab software. basic concepts; process dynamics fundamentals; dynamic behavior of processes; modelling of stagewise process; differential flow and reaction applications; simulation tools; examples of chemical engineering processes; process control; feedback and feedforward control;		
Assessment methods	Information lecture with the use of a multimedia projector Discussion Laboratory Project Written test Written pass Reports Active participation in auditory classes		
Recommended readings	1. Roffel, Brian, LinkProcess dynamics and control : modeling for control and prediction, John Wiley & Sons, cop., Chichester, 2006 2. J. Ingham, I. J. Dunn, E. Heinzle, J. E. Prenosil, J. B. Snape, Chemical Engineering Dynamics, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007		
Knowledge	Student has knowledge in process dynamics, operations and control, including calculation useful for solving tasks connected with the dynamic models of chemical engineering systems and the control of chemical engineering processes and systems.		
Skills	Student will be able to: construct dynamic models of chemical processes; solve differential equations using Laplace transforms; build and analyze transfer function and state-space models; understand the dynamic response of representative processes; develop empirical dynamic process models; implement and tune PID controllers; use frequency response methods to analyze processes and design controllers; understand and implement feed-forward, ratio, cascade and multi-variable control.		
Other social competences	Student is able to work in a group and perform as a group leader; he/she is able to estimate the time necessary to accomplish the assigned tasks.		

Course title	PROCESS SAFETY ENGINEERING		
Level of course	first cycle		
Teaching method	project / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-37	**ECTS points**	5
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Students in this course will learn how to apply basic chemical engineering fundamentals involving energy and mass balances, fluid mechanics, heat and mass transfer, thermodynamics, etc. to the analysis and design of elements of processes and process equipment associated with loss prevention and safe operations involving hazardous materials and/or conditions. Techniques for process hazard analysis, risk assessment, and accident investigations are also covered. A case study approach will allow demonstrating the potential risks involved in many process operations in chemical or similar plants.		
Entry requirements	Fundamentals of mass and energy balances Thermodynamics		
Course contents	Students will analyse a case study in process safety for the selected chemical process or storage of hazardous chemicals by using ALOHA programme and relevant methods applicable to process safety engineering. Process Safety Management; Responsibility; OSHA and EPA Regulations Properties of Toxic Materials; Industrial Hygiene Vaporization Rates; Dilution; Ventilation; Toxic and Flammable Release and Dispersion Modeling Fires and Explosions; Flammability, MOC; Explosions, Detonations, Blast Damage Fire and Explosion Protection and Prevention; Inerting and Purging; Static Electricity; Ventilation Hazard Identification; DOW F&EI, HAZOP, Safety Reviews Risk Assessment; Probability Theory; Event Tree; Fault Tree Accident Investigations- ALOHA programme		
Assessment methods	activating methods: lecture and didactic discussion practical methods - case study/project assessment of progress of the work - monthly written final test/report		
Recommended readings	1. D.A. Crowl, J.A. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall PTR, 2002 2. R. E. Sanders, Chemical Process Safety, Elsevier, 2011 3. D.P. Nolan, Safety and Security Review for the Process Industries: Application of HAZOP, PHA, What-IF and SVA Reviews, Elsevier, 2014		
Knowledge	Student knows how to apply basic chemical engineering fundamentals involving energy and mass balances, fluid mechanics, heat and mass transfer, thermodynamics, etc. to the analysis and design of elements of processes and process equipment associated with loss prevention and safe operations involving hazardous materials and/or conditions. Techniques for process hazard analysis, risk assessment, and accident investigations are also covered. A case study approach will allow demonstrating the potential risks involved in many process operations in chemical or similar plants.		
Skills	Student will have the following skills in the field of: - calculating the extent of danger zones in natural and turbulent dispersion. - calculation of the extent of hazard zones in the flow scattering. - determination and design of natural ventilation. - determination of explosion hazard zones for industrial and storage facilities.		
Other social competences	Student will be aware of the responsibility for safety in the workplace and in chemical industry and also will know how to eliminate risk of occurrence of potential major industrial accident		

Course title	RENEWABLE ENERGY SOURCES		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-38	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student is expected to be able to: • List and generally explain the main sources of energy and their primary applications in the world. • Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, about future supply and the environment. • Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources. • List and describe the primary renewable energy resources and technologies. • Describe/illustrate basic electrical concepts and system components. • Make quantity/quality comparisons among energy uses, resources, and technologies.		
Entry requirements	Fundamentals of mass and energy balances Thermodynamics Heat transfer		
Course contents	Students will analyse/calculate many examples of the application of renewable energy resources to identify the optimal solutions: PV panel, solar panel, wind turbine, heat pumps Introduction to renewable energy sources Energy from the physical view Renewable energy - hydropower, wind energy, solar energy, geothermal energy and energy of biomass Fossil fuels and nuclear energy Transmission and energy storage World energy balance Environmental aspects of energy consumption Economic aspects of energy production and consumption Emerging technologies		
Assessment methods	activating methods: lecture and didactic discussion practical methods - tutorials assessment of progress of the work - monthly written final test/report		
Recommended readings	1. B. Godfrey, Renewable Energy: Power for a Sustainable Future, Oxford Univ. Press, 2004 2. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind energy explained, theory, design and application, Wiley and sons LTD, 2005 3. Taylor, F. W., Elementary climate physics, Oxford University Press, 2005		
Knowledge	Student is expected to be able to list and generally explain the main sources of energy and their primary applications in the world. Student is expected to be able to describe the challenges and problems associated with the use of various energy sources, including fossil fuels, about future supply and the environment. Student is expected to be able to discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources. Student is expected to be able to list and describe the primary renewable energy resources and technologies. Student is expected to be able to describe/illustrate basic electrical concepts and system components. Student is expected to be able to make quantity/quality comparisons among energy uses, resources, and technologies.		
Skills	Student can ensure adequate protection of his/her own workplace and assess the risks during testing, measurements and experiments Student is able to acquire, critically evaluate and creatively process information from the scientific literature databases, and other properly chosen sources		
Other social competences	Student is able to define the social role of the graduate of technical university, particularly in the dissemination of technical culture in society and communicating in a meaningful and attractive way information on the achievements of applied energetics and its effects on development of modern technologies, especially in the renewable energy sector Student is able to work as individual or in group		

Course title	RESEARCH PROJECT IN CARBON MATERIALS PRODUCTION AND MODIFICATION		
Level of course	first cycle		
Teaching method	project / seminar		
Person responsible for the course	Iwona Pełech	**E-mail address to the person**	Iwona.Pelech@zut.edu.pl
Course code (if applicable)	WTiICh-1-39	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	8	**Hours per semester**	120
Objectives of the course	Applying of knowledge and skills learned during studies to solving a practical research problems.		
Entry requirements	Fundamentals of chemical engineering Fundamentals of chemistry Fundamentals of analytical chemistry		
Course contents	The students perform the research project concerning production and modification of carbon spheres. The students examine the influence of experimental conditions and/or modification using metal oxides and/or functional group surface modification on the physicochemical properties of the obtained materials. It consist of literature studies, concept of project realization, selection of used materials, performing the selected process, characteristic of obtained products, control measurements using proper methods and instruments, calculations, discussion of the results, conclusions. Description of all this aspects should be given in the written project report. The students present results of literature studies, concept and progress of project realization.		
Assessment methods	discussion demonstrating measurements laboratory seminar activity assessment assessment of progress of the work discussion evaluation of presentation written final project report		
Recommended readings	1. Michio Inagaki, Feiyu Kang, Hidetaka Konno, Advanced Materials Science and Engineering of Carbon Book, Springer, 2014 2. Carlos P. Bergmann, Fernando Machado Machado, Carbon Nanomaterials as Adsorbents for Environmental and Biological Applications, Springer, 2015 3. Sergey P. Gubin, Magnetic Nanoparticles, Viley, 2009 4. C. N. R. Rao, P. J. Thomas, G. U. Kulkarni, Nanocrystals: Synthesis, Properties and Applications, Springer, 2007		
Knowledge	Student knows how to apply chemical engineering fundamentals and instrumental analysis to the preparation and chcaracterization of carbon materials. Student has an extended knowledge about the issues related to the project.		
Skills	Student will be able to obtain information from library, online and literature resources that will support the solving of research problems. Student will be able to plan and carry out experiments, collect experimental data, analyze and interpret results, write technical reports and give presentations.		
Other social competences	Student understands the needs of continuous training and development in the field of carbon materials. Student knows how to individually study the problem: from it formulate to the solution and also propose possible solutions. Student is able to work in an international team.		

Course title	RESEARCH PROJECT IN CHEMICAL ENGINEERING		
Level of course	first cycle		
Teaching method	project		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-40	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	8	**Hours per semester**	120
Objectives of the course	Learn how to conduct the case study based on literature Learn how to present complex data or situations clearly Learn how to review and analyze research findings that affect the process Learn how to prepare a preliminary research design for projects in their subject matter areas		
Entry requirements	Fundamentals of Chemical Engineering Chemical engineering reaction Physics, mathematics Numerical or process simulation tools: CFD, Aspen Plus, Matlab		
Course contents	Literature review of the subject of a research project Identify an appropriate research design Conduct the appropriate research activities: measurements, numerical simulation, design or calculation Data analysis Write the final research paper according to identified guidelines Meeting with the instructor to discuss research and writing methods and to review progress on his/her research paper		
Assessment methods	activating methods: didactic discussion practical methods - numerical/simulation study assessment of progress of the work - monthly written reports written final project report		
Recommended readings	1. McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, McGraw-Hill, New York, 2005 2. Sinnott R.K., Coulson & Richardson's Chemical Engineering, Vol. 6: Chemical Engineering Design, Butterworth-Heinemann, Oxford, 2003 3. Moin, P., Fundamentals of Engineering Numerical Analysis, Cambridge University Press, Cambridge, 2010		
Knowledge	Student knows how to apply basic chemical engineering fundamentals involving energy and mass balances, fluid mechanics, heat and mass transfer, thermodynamics, etc. to the analysis and design processes, part of process and process equipment.		
Skills	Student will have the following skills in the field of: - design experiments to obtain relevant data -utilize numerical software packages to simulate transport phenomena and thermodynamics -analyze data appropriately to extract parameters of interest -characterize, quantify, and report error in results and calculations -present technical information effectively in written and verbal form		
Other social competences	Student knows how to individually study the problem: from it formulate to the solution and also propose possible solutions.		

Course title	RESEARCH PROJECT IN COSMETIC PRODUCTIONS		
Level of course	first cycle		
Teaching method	laboratory class		
Person responsible for the course	Ewa Janus	**E-mail address to the person**	Ewa.Janus@zut.edu.pl
Course code (if applicable)	WTiICh-1-41	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	8	**Hours per semester**	120
Objectives of the course	Applying of knowledge and skills learned during studies to solving a practical research problem related to cosmetic ingredients and cosmetic formulation		
Entry requirements	Fundamentals of chemistry, mathematics and analytical methods		
Course contents	The students accomplish the research project concerning the chemical and/or physical modifications of cosmetic ingredients, identification and measurements of properties of obtained products, and preparation of final cosmetic formulations. It consists of literature studies, the concept of project realization, selection of used materials, performing the selected processess, characteristic of obtained products, control measurements using proper methods and instruments, calculations, discussion of the results, conclusions. Description of all these aspects should be given in the written project report.		
Assessment methods	laboratory project assessment of progress in the laboratory experiments assessment of the quality of written project report		
Recommended readings	1. Literature connected with the research subject, including books, articles, and patents, 2011		
Knowledge	The student has comprehensive knowledge about the issues related to the project.		
Skills	The student will be able to analyze new research problems and propose strategies to solve them. The student will be able to execute a research project under the supervision of the tutor. The student will perform evaluation and interpretation of data from the literature and the experimental work. The student will be able to prepare the written scientific report.		
Other social competences	The student is aware of the responsibility for the results of studies. The student can work in an international team.		

Course title	RESEARCH PROJECT ON PHOTOCATALYTIC SORBENTS PRODUCTION		
Level of course	first cycle		
Teaching method	project / seminar		
Person responsible for the course	Ewelina Kusiak-Nejman	**E-mail address to the person**	Ewelina.Kusiak@zut.edu.pl
Course code (if applicable)	WTiICh-1-42	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	8	**Hours per semester**	120
Objectives of the course	To familiarise the student with the mechanisms of sorption processes. To familiarise the student with the sorbents preparation methods Teaching the student how to design photoactive sorption materials.		
Entry requirements	English language skills at B2 level		
Course contents	Introduction to laboratory classes: safety training, presentng of rules for working in laboratory, safety data sheets presentation. Practical familiarisation of the student with the apparatus used in the preparation of photoactive sorbents. Preparation of photoactive sorbents. Physicochemical characterisation of photoacive sorbents. Photosorption studies. Introduction to photocatalytic sorbents production Adsorption mechanisms Sorbents for air pollution Sorbents for water and wastewater treatment Photocatalytic sorbents preparation methods Final assessment		
Assessment methods	Clarification or explanation Practical methods: seminars with multimedial presentations Activating methods: discussion Formative evaluation: evaluation of the student's preparation for classes, student attendance, active participation of the student in classes, preparation and delivery of a presentation on a given topic. Final evaluation: average note of activities indicated in the formative evaluation.		
Recommended readings	1. Lauren N. PincusLauren N. Pincus School of Forestry and Environmental Studies, Yale University, 195 Prospect Street, New Haven, Connecticut 06511, United States Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment (NEWT), Yale University, New Haven, Connecticut 06511, United States More by Lauren N. Pincus View Biography , Amanda W. Lounsbury, Julie B. Zimmerman, Toward Realizing Multifunctionality: Photoactive and Selective Adsorbents for the Removal of Inorganics in Water Treatment, Acc. Chem. Res., 2019, 52(5), pp. 1206–1214 2. Iwona Pełech, Ewelina Kusiak-Nejman, Piotr Staciwa, Daniel Sibera, Joanna Kapica-Kozar, Agnieszka Wanag, Filip Latzke, Karolina Pawłowska, Adrianna Michalska, Urszula Narkiewicz, Antoni W. Morawski, CO2 Sorbents Based on Spherical Carbon and Photoactive Metal Oxides: Insight into Adsorption Capacity, Selectivity and Regenerability, Molecules 2022, 2022, 27(20), 6802. https://doi.org/10.3390/molecules27206802 3. K. Aboo Shuhailath, Vazhayal Linsha, Sasidharan Nishanth Kumar, K. Babu Babitha, Abdul Azeez Peer Mohamed, Solaiappan Ananthakumar, Photoactive, antimicrobial CeO2 decorated AlOOH/PEI hybrid nanocomposite: a multifunctional catalytic-sorbent for lignin and organic dye, RSC Advance, 2016, 6, pp. 54357-54370. https://doi.org/10.1039/C6RA07836B		
Knowledge	The student has assimilated the knowledge in the subject of the implemented project		
Skills	Student will be able to find information from the literature that will support the solving of scientific problems. Student will be able to plan and carry out experiments, collect experimental data, analyse and interpret results, write laboratory reports and present the obtained results.		
Other social competences	Student understands the needs of continuous training and development in the field of photosorbents.		

Course title	SPECTROSCOPIC METHODS		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Elwira Wróblewska	**E-mail address to the person**	Elwira.Wroblewska@zut.edu.pl
Course code (if applicable)	WTiICh-1-43	**ECTS points**	8
Semester	summer	**Language of instruction**	english
Hours per week	5	**Hours per semester**	75
Objectives of the course	To gain the knowledge about the theory of spectroscopic methods and their application in qualitative and quantitative analysis.		
Entry requirements	Fundamentals of physical chemistry. Fundamentals of organic chemistry.		
Course contents	Calculation of a compound concentration expressed in various concentration units. Calculation the concentration of a solution after dillution. Solving some excercisses concerning the interaction of the matter with light (absorbance, transmitance). Determination of compounds based on Lambert-Beer's low in single and multicomponent mixtures. The application of calibration curve in quantitative analysis of componds. Limit of detection, method sensitivity and precision - calculation. The application of NMR spectroscopy in qualitative and quantitative analysis of organic compounds (the calculation of the position of the band corresponding to particular proton on the basis on empirical equations, determination of a compound purity). Application of MS spectra in determination of organic compounds composition (Beynon table). The measurements of UV-vis spectra and their application in qualitative and quantitative analysis of various compounds. The recording and interpretation of IR spectra. Analysis of multicomponent mixtures by spectroscopic methods supported by computer programs. Precise analysis of NMR spectra with the use of technical software. The interpretation of MS spectra of various group of organic compounds. Explanation of wave-particle duality of electromagnetic radiation and influence of its absorption/emission by atom or molecule on their properties. Theoretical studies of phenomena proceeding in the molecule/atom under the irradiation. The theory of ultraviolet-visual spectroscopy (UV-VIS); the Lambert-Beer's low and the reason of the departure from this low: association, solvatochromism, thermochromism, photochromism, halochromism. The application of UV-vis spectrophotometry to the analysis of multicomponent mixtures (theory, mathematics and software). The use of UV-vis spectrophotometers into the studies of luminescent materials. Infrared spectroscopy (IR) and its application to qualitative analysis of solids and liquids. The application of IR spectroscopy to quantitative analysis of compounds (methods, their possibilities and limitations). The theory of NMR spectrometry. The analysis of the spectra of various compounds. MS spectrometry: types of MS spectrometers, the methods of ionisation.		
Assessment methods	The lectures with the discussion. Classes Laboratory Written exam and/or oral discussion Assessment of laboratory written report Assessment of homework assignments. Evaluation of the student’s work based on the student activity during the course.		
Recommended readings	1. Field, L. D, Strnhell, S, Kalman, J.R., Organic structures from spectra, Chichester: John Wiley and Sons, 2002 2. Bartecki, A. , Lang, L., Absorption spectra in the ultraviolet and visible region., House of the Hungarian. Academy of Sciences, Budapest, 1982 3. Láng, L., Holly, S, Sohár, P., Absorption spectra in the infrared region, Akadémiai Kiadó, Budapest, 1980 4. Rahman, Atta-ur, One and two dimensional NMR spectroscopy,, Elsevier, Amsterdam, 2011 5. Perkampus, Heinz-Helmut, Encyclopedia of spectroscopy, Weinheim : VCH, 1995		
Knowledge	He has a knowledge about the fundamentals of the selected spectroscopic method and their application in qualitative and quantitative analysis.		
Skills			

	Student is able to make some calculation concerning the analysis with the interpretation of obtained results. Student can plane and carry the experiment with the interpretation of obtained results.
Other social competences	Student is able to choose the appropriate method in order to solve particular problem.

Course title	STATISTICAL METHODS IN ENGINEERING		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Anna Story	**E-mail address to the person**	Anna.Story@zut.edu.pl
Course code (if applicable)	WTiICh-1-44	**ECTS points**	3
Semester	winter/summer	**Language of instruction**	english
Hours per week	3	**Hours per semester**	45
Objectives of the course	The course aims to give a general introduction to the theory and practice of statistical methods in engineering		
Entry requirements	Applied Mathematics		
Course contents	Calculations of exercises connected with application of statistical techniques which are included to lectures content. Practical using of software (Excel, MATLAB) for statistical analysis. Introduction to statistics and data visualisation. Theoretical foundation for statistical analysis. Regression. Design of experiments. Modelling stochastic processes with time Ssries aalysis. Modelling dynamic processes using system identification methods. Using Excel to do statistical analysis. Using MATLAB for statisitical analysis. Written test.		
Assessment methods	Activating methods: lecture illustrated by multimedia presentation and didactic discussion Practical methods: execution of exercises Lectures and classes - written final test Written report after computer exercises		
Recommended readings	1. Yuri A.W. Shardt, Statistics for chemical and process engineers : a modern approach, Springer, 2015, ISBN: 9783319215082		
Knowledge	Students will acquire detailed theoretical knowledge on many aspects within the framework of the statistical methods in engineering		
Skills	Students will acquire practical knowledge on many aspects within the framework of the statistical methods in engineering		
Other social competences	Students have the ability to solving and analyzing processes with using the statistical methods in engineering. Students understand the needs of continuous training and development in the field of statistical methods		

Course title	SYSTEMS ENGINEERING		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Grzegorz Story	**E-mail address to the person**	Grzegorz.Story@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C14x	**ECTS points**	5
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Student will become familiar with the basics of processes system designing, including elements of the process design and design strategy. Student learns the principles of selecting processes and parameters of their work, design heuristics and simulation software. Preparing the student to elaboration of the process systems project. Student is able to assess the conditions that have to be met for the implementation of a project, involving the construction or modernization of the installation. Student possesses ability to design the process.		
Entry requirements	Basic knowledge of mathematics.		
Course contents	Calculations leading to the development of a comprehensive project of a selected industrial installation in the field of chemical engineering. During design a number of issues will be taking into account, i.e. safety, functionality, innovative solutions, iso-performance, economic and environmental conditions - lifecycle. Selected stages of the desing will be realized with a modern computers software. Introduction to the Engineering Systems: subject and scope of process design, concepts of the process design, technological design and system. Connection between research, design and implementation of the system. Stakeholders and requirements of the system. Elements of the process design: research and industrial assumptions, choice and description of the technological method, process diagram, mass and heat balance, selection of technological apparatus, technological scheme, apparatus work schedule, selection of materials and corrosion issues, measurements and processes automation, sewage and waste, safety issues. Hierarchical and simultaneous strategies of the technological systems design with several examples. Basic principles of processes selection and setting of operating parameters. Design heuristics.		
Assessment methods	Lecture Laboratory classes Written final exam based on the lecture contents Project report Active participation in laboratory classes.		
Recommended readings	1. A.M.Kutepov; T.I.Bondareva; M.G.Berengarten, Basic Chemical Engineering with Practical Applications, Mir Publishers, Moscow, 1988, 1 2. M.D. Himmelblau, Basic Principles and Calculations in Chemical, Prentice Hall PTR, New Jersey, 1996, 6		
Knowledge	Student has a structured, theoretical and practical knowledge about the processes system designing, including elements of the process design and design strategy. Student has knowledge about selecting processes and parameters of their work, design heuristics and simulation software.		
Skills	Student possesses an ability to assess the conditions that have to be met for the implementation of a project, involving the construction or modernization of the installation. Student possesses an ability to design the process.		
Other social competences	Student understands the need to train and improve his/her professional and personal competences. Student is able to teamwork and to properly define the priorities for the implementation of the task - a process project.		

Course title	TECHNOLOGY, LAW, AND THE WORKING ENVIRONMENT		
Level of course	first cycle		
Teaching method	lecture		
Person responsible for the course	Beata Tryba	**E-mail address to the person**	Beata.Tryba@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_A12	**ECTS points**	2
Semester	summer	**Language of instruction**	english
Hours per week	2	**Hours per semester**	30
Objectives of the course	The aim of this course is focused on the general orientation about existed regulations in a working environment related to the technology, safety and man; the student will be aware responsibility for the work and some legal consequences in the case of incompatibility of the work in the industrial systems Student will be aware of the possible occurence of the risk at the working environment, especially in the industry Student will get knowledge about risk assesments during working with the toxic or dangerous substances and will be familiar with the good laboratory practise and the guidance for the safety work		
Entry requirements	Basic knowledge about regulations and existing law in the European Union and all over the world related to the environment, chemical technology and safety in the working place		
Course contents	REACH regulation Certification of products for safety WHO Guidelines on Protecting Workers from Potential Risks of Manufactured Nanomaterials Risk assesment of nanomaterials FDA regulation The toxic substances control act The Occupational Safety and Health Act Employment law in a working environment Health and safety at work European Union directives Risk and mechanisms of crashes in the industrial installations Reliability in the system of man-technics-environment		
Assessment methods	Lecture Discussion Written exam (in the form of test)		
Recommended readings	1. Nicholas A. Ashford, Charles C. Caldart, Technology, Law, and the Working Environment, Island Press, Island, 1996 2. Steven Vaughan, EU Chemicals Regulation, New Governance, Hybridity and REACH, Faculty of Laws, University College London, UK, 2015 3. J. C. Miller, R. Serrato, J. M. Represas-Cardenas, G. Kundahl, The Handbook of Nanotechnology. Business, Policy, and Intellectual Property Law, John Wiley & Sons, Inc., 2005		
Knowledge	has knowledge about law and regulations at the working environment and other regulations such as REACH, directives of EU, OSH and FDA acts		
Skills	knows and understand regulations and OHS rules applicable in industry and can apply it; can predict and asses the danger in the working place		
Other social competences	Is aware of responsibility for the taken decisions during work and their effect on the surrounded environment		

Course title	TECHNOLOGY OF RESOURCES		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Agnieszka Kowalczyk	**E-mail address to the person**	Agnieszka.Kowalczyk@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C14	**ECTS points**	5
Semester	winter	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The course is aimed at giving an intoduction to technology of recourses in the chemical enginering processes. Student will be able to difine basic groups of recourses and their matufacturing methods and applications for chemical technology.		
Entry requirements	Basic knowledge in chemical technology and chemical processes.		
Course contents	Pertoleum- visit PCK Raffinerie GmbH Polysaccharides - importance, isolation, characterization and ways of application Determination of fatty acids profile and specifis numbers for fats and oils from different sources Titania production – visit of Police S.A. factory Phospates in fertilizers production - visit of Police S.A. factory Natural gas - fundamentals, evolution of the natural gas industry, preparing natural gas for transmission, new potential source for natural gas Petroleum and its products- fundamentals, economics and politics, exploration and production, transportation and storage, refining, products: fuels and chemicals, safety and the environment, the future of petroleum Coal- origin and classification of coal, structure, coal technology for chemicals Biomass- fundamentals and converting biomas to chemical products Fats and oils sources and their characterisic; Processes in fats and oil production (pressing, extraction, refining); Modification of fats and oils - hydrogenation, interesterification, splitting, fractionation Inorganic resources - sulphur, sodium, phosphates, titania, metals, building materials Energy resources – coal, lignite, crude oil, natural gas, uranium		
Assessment methods	Information lecture Laboratory excercisies Written exam Activity on the lectures and laboratory Laboratory - report and test		
Recommended readings	1. John Tabak, Coal and Oil, Facts on file Inc., New York, 2009 2. H. Wittcoff, B. Reuben, J. Plotkin, Industrial Organic Chemicals, Wiley-Interscience, 2004 3. H. Weissermrl, H.J. Arpe, Industrial Organic Chemistry, Wiley-VCH GmbH, 2003 4. James G. Speight, The chemistry and technology of petroleum, Taylor and Francis Gropu, 2006		
Knowledge	Student knows the basic knowledge of recourses used in chemical technology and thier manufacturing methods and application.		
Skills	Student in able to select basic recourses for chemical processes andto practical using of knowledge in chemical technology.		
Other social competences	Student understands the need of train and improve his/her professional and personal competences, especially for the teamwork.		

Course title	TRANSPORT AND SEPARATION PROCESSES		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Maciej Konopacki	**E-mail address to the person**	mkonopacki@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C06	**ECTS points**	4
Semester	winter/summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1. Formulate governing equation for momentum, mass, and heat transfer. 2. Identify the terms describing storage, convection, diffusion, dispersion, and generation in the general governing equation for momentum, mass, and heat transfer. 3. Understand the various components needed for setting up conservation equations. 4. Utilize information obtained from solutions of the balance equations to solve chemical engineering problems. 5. Appreciate relevance of transport phenomena in chemical engineering. 6. Demonstrate basic knowledge of separation of chemical mixtures by industrial processes, including bioprocesses. 7. Describe the scientific principles associated with separation equipments. 8. Demonstrate basic knowledge of making mass balances and specifying component recovery and product purity. 9. Demonstrate basic knowledge of modeling and simulation of separation processes using POLYMATH, ASPEN PLUS and HYSYS.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Derivation of momentum conservation equations. Solving selected problems related to momentum transfer. Derivation of energy conservation equations. Solving selected problems related to energy transfer. Derivation of mass conservation equations. Solving selected problems related to mass transfer. Thermodynamic analysis of selected separation processes. Single equilibrium stages calculations. Flash calculations. Calculation of selected separation processes: distillation, liquid–liquid extraction, supercritical extraction, membrane separations, adsorption, ion exchange, chromatography, electrophoresis, mechanical phase separations. Mechanical phase separation. Membrane separations. Liquid–liquid Extraction. Adsorption separation of gas mixtures. Modeling and simulation of separation processes using ASPEN PLUS and HYSYS. Momentum transport: Viscosity; Mechanisms of momentum transport; Momentum balances; Velocity distributions in laminar and turbulent flow; Interphase transport of momentum in isothermal systems; Macroscopic balances for isothermal flow systems. Mass transport: Mechanisms of mass transport; Diffusivity; Mass balances; Concentration distributions in solids. Equations of change for multicomponent systems; Concentration distributions in turbulent flow, Interphase transport; Macroscopic mass balances for multicomponent systems. Energy Transport: Mechanisms of energy transport; Thermal conductivity; Energy balances; Temperature distributions in solids; The equations of change for nonisothermal systems; Temperature distributions in turbulent flow; Interphase transport in nonisothermal systems; Macroscopic balances for nonisothermal systems. Thermodynamics of separation processes. Single equilibrium stages calculations. Flash calculations. Cascades systems. Hybrid systems. Absorption. Stripping of dilute mixtures. Distillation. Liquid–liquid Extraction. Multicomponent, multistage separations. Supercritical extraction. Adsorption. Ion exchange. Chromatography. Electrophoresis. Mechanical phase separations. The basic information about microfiltration, ultra- and nanofiltration, reverse osmosis and membrane distillation processes. The application of membrane processes for separation, concentration and purification of solutions.		
Assessment methods	information method: lecture practical method: classes practical method: laboratories evaluation of periodic student achievements evaluation at the end of the course		
Recommended readings	1. Bird R.B., Stewart W.E., Lightfoot E.N., Transport Phenomena, Wiley, New York, 2007 2. Welty J.R., Wicks Ch.E., Wilson R.E., Rorrer G.L., Fundamentals of Momentum, Heat, and Mass Transfer, Wiley, New York, 2008 3. Seader J.D., Henley E.J., Separation Process Principles, Wiley, New York, 2006 4. Wankat P.C., Separation Process Engineering, Prentice Hall, New Jersey, 2012		
Knowledge			

	The student will be able to understand the various components needed for setting up conservation equations. The student will be able to demonstrate basic knowledge of separation of chemical mixtures by industrial processes, including bioprocesses.
Skills	The student will be able to utilize information obtained from solutions of the balance equations to solve chemical engineering problems. The student will be able to describe the scientific principles associated with separation equipments.
Other social competences	The student will be able to appreciate relevance of transport phenomena in chemical engineering. The student will be able to demonstrate basic knowledge of modeling and simulation of separation processes using ASPEN PLUS and HYSYS.

Course title	TRANSPORT PHENOMENA		
Level of course	first cycle		
Teaching method	auditory class / lecture		
Person responsible for the course	Halina Murasiewicz	**E-mail address to the person**	Halina.Murasiewicz@zut.edu.pl
Course code (if applicable)	WTiICh-1-45	**ECTS points**	4
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	The student will be able to: 1. Formulate governing equation for momentum, mass, and heat transfer. 2. Identify the terms describing storage, convection, diffusion, dispersion, and generation in the general governing equation for momentum, mass, and heat transfer. 3. Understand the various components needed for setting up conservation equations. 4. Utilize information obtained from solutions of the balance equations to solve chemical engineering problems. 5. Appreciate relevance of transport phenomena in chemical engineering.		
Entry requirements	Fundamentals of chemical engineering		
Course contents	Derivation of momentum conservation equations. Solving selected problems related to momentum transfer. Derivation of energy conservation equations. Solving selected problems related to energy transfer. Derivation of mass conservation equations. Solving selected problems related to mass transfer. Momentum transport: Viscosity; Mechanisms of momentum transport; Momentum balances; Velocity distributions in laminar and turbulent flow; Interphase transport of momentum in isothermal systems; Macroscopic balances for isothermal flow systems. Energy Transport: Mechanisms of energy transport; Thermal conductivity; Energy balances; Temperature distributions in solids; The equations of change for nonisothermal systems; Temperature distributions in turbulent flow; Interphase transport in nonisothermal systems; Macroscopic balances for nonisothermal systems. Mass transport: Mechanisms of mass transport; Diffusivity; Mass balances; Concentration distributions in solids. Equations of change for multicomponent systems; Concentration distributions in turbulent flow, Interphase transport; Macroscopic mass balances for multicomponent systems.		
Assessment methods	Lecture illustrated by Power Point presentation and computer simulation Classis illustrated by computer and manual calculations Periodic assessment of student achievement Lecture: exam at the end of the semester Classis: written test		
Recommended readings	1. Bird R.B., Stewart W.E., Lightfoot E.N., Transport Phenomena, Wiley, New York, 2007 2. Brodkey R.S., Hershey H.C., Transport phenomena. A unified approach, McGraw-Hill, New York, 1988 3. Kessler, David P. Greenkorn. Kessler D.P., Greenkorn R.A., Momentum, heat, and mass transfer fundamentals, Marcel Dekker, Basel, 1999		
Knowledge	The student will be able to understand the various components needed for setting up conservation equations.		
Skills	The student will be able to utilize information obtained from solutions of the balance equations to solve chemical engineering problems.		
Other social competences	The student will be able to appreciate relevance of transport phenomena in chemical engineering.		

Course title	WASTEWATER MANAGMENT		
Level of course	first cycle		
Teaching method	auditory class / laboratory class / lecture		
Person responsible for the course	Ewelina Kusiak-Nejman	**E-mail address to the person**	Ewelina.Kusiak@zut.edu.pl
Course code (if applicable)	WTiICh-1-46	**ECTS points**	15
Semester	winter/summer	**Language of instruction**	english
Hours per week	10	**Hours per semester**	150
Objectives of the course	Student will get theoretical knowledge on the wastewater treatment and management Student will get practical skills in the area of treatment of wastewater and recycling methods		
Entry requirements	English language skills at B2 level		
Course contents	Introduction to auditory classes Characteristic effluent quantity, loads and concentrations of discharged pollutants Principles for the calculation and selection of equipment - gratings Principles for the calculation and selection of equipment - sand traps Principles for the calculation and selection of equipment - settling tanks Principles for the calculation and selection of equipment - mechanical mixers and flotation and coagulation chambers Principles for the calculation and selection of equipment - biological tanks Calculation of activated sludge equipment Sludge balancing calculations Final test Introduction to laboratory classes: safety training, presentng of rules for working in laboratory, safety data sheets presentation. Determination of selected physicochemical parameters in wastewater. Wastewater plant visiting Solid-phase separation utilizing coagulation Membarne processes for wastewater treatment Adsorption for wastewater treatment Heterogeneous photocatalysis for wastewater treatment Final test Introduction to wastewater management Definition and classification of wastewater Chemical composition and properties of wastewater Hygienic and sanitary characteristics of wastewater Wastewater treatment- mechanical, physical, chemical and biological methods Removal of nutrients from waste water Natural management of wastewater and wastewater from industry and municipalities Natural management of wastewater from agricultural production Management of wastewater from selected industries Final test		
Assessment methods	Informative lecture Clarification or explanation Practical methods - auditory classes Practical methods - laboratory classes Participation in classes Preparation of laboratory reports Achieving a passing grade in the final tests		
Recommended readings			

	1. Carsten Hollænder Laugesen and Ole Fryd with Thammarat Koottatep and Hans Brit, Sustainable Wastewater Management in Developing Countries - New Paradigms and Case Studies from the Field: New Paradigms and Case Studies from the Fiel, American Society of Civil Engineers, Reston (US), 2009, https://app.knovel.com/web/view/khtml/show.v/rcid:kpSWMDCNPR/cid:kt00BT4CG3/viewerType:khtml//root_slug:title-page/url_slug:front-matter?b-q=wastewater%20management&b-toc-cid=kpSWMDCNPR&b-toc-title=Sustainable%20Wastewater%20Management%20in%20Developing%20Countries%20-%20New%20Paradigms%20and%20Case%20Studies%20from%20the%20Field&b-toc-url-slug=front-matter&hierarchy=toggle-content&include_synonyms=no&page=last&view=collapsed&zoom=1&q=wastewater%20management 2. Linda Strande, Mariska Ronteltap, Damir Brdjanovic (Eds.), Faecal Sludge Management - Systems Approach for Implementation and Operation, IWA Publishing, London (UK), 2014, https://app.knovel.com/web/view/khtml/show.v/rcid:kpCFRTTV0B/cid:kt010X3Y65/viewerType:khtml//root_slug:title-page/url_slug:front-matter?cid=kt010X3Y65&b-q=wastewater%20management&b-toc-cid=kpCFRTTV0B&b-toc-title=Faecal%20Sludge%20Management%20-%20Systems%20Approach%20for%20Implementation%20and%20Operation&b-toc-url-slug=front-matter&hierarchy=toggle- 3. Prepared by Industrial Wastewater Management, Treatment, and Disposal Task Force of the Water Environment Federation, Industrial Wastewater Management, Treatment, and Disposal, WEF Manual of Practice No. FD-3, Water Environment Federation, US, 2008, 3rd edition, https://app.knovel.com/kn/resources/kpIWMTDWE1/toc?b-q=wastewater%20management&include_synonyms=no&q=wastewater%20management&sort_on=default 4. Water Environment Federation, Wastewater Treatment Fundamentals I - Liquid Treatment, Water Environment Federation, Alexandia (US), 2018, https://app.knovel.com/kn/resources/kpWTFILT02/toc?b-q=wastewater%20treatment&include_synonyms=no&q=wastewater%20treatment&sort_on=default 5. Maulin P. Shah, Susana Rodriguez-Cout (Eds.), Microbial Wastewater Treatment, Elsevier Inc., Amsterdam (Netherlands), 2019, https://app.knovel.com/kn/resources/kpMWT0000D/toc?b-q=wastewater%20treatment&include_synonyms=no&q=wastewater%20treatment&sort_on=default 6. Giorgio Mannina, George Ekama, Hallvard Ødegaard and Gustaf Olsson, Advances in Wastewater Treatment, IWA Publishing, London (UK), 2018, https://app.knovel.com/kn/resources/kpAWT00006/toc?b-q=wastewater%20treatment&include_synonyms=no&q=wastewater%20treatment&sort_on=default
Knowledge	The student has knowledge of wastewater classification and the basics of wastewater treatment methods The student has knowledge of natural ways to manage industrial, agricultural and municipal wastewater
Skills	Students will be able to correctly select and calculate the parameters of equipment used in wastewater treatment processes Students will be able to identify the basic methods of investigating the physicochemical properties of wastewater and be able to carry out experiments to determine these parameters
Other social competences	The student is aware of the global trend in wastewater loads hazardous to humans and the environment, and the need to counteract these changes

Course title	WATER TECHNOLOGY AND RECLAMATION		
Level of course	first cycle		
Teaching method	laboratory class / lecture		
Person responsible for the course	Ewelina Kusiak-Nejman	**E-mail address to the person**	Ewelina.Kusiak@zut.edu.pl
Course code (if applicable)	ChEn_1A_S_C23	**ECTS points**	6
Semester	summer	**Language of instruction**	english
Hours per week	4	**Hours per semester**	60
Objectives of the course	Knowledge of technology of water production and wastewater purification		
Entry requirements	Knowledge of water chemistry. Knowledge of basis for ech processes and oparation unit.		
Course contents	Chemical and instrumental water and waste water analysis. Water and wastewater treatment by coagulation and sedimentation. Desalination of water by membranes (Reverse osmosis,Nanofiltration, ultrafiltration) Clarification of water by membranes (Ultrafiltration, Microfiltration). Advanced oxidation treatment of water (photocatalysis). Natural Water (groudwater and surface water) Industrial water. Urban effluent. Industrial effluent. Coagulation-flocculation. Chemical precipitation. Sedimentation. Flotation. Filtration. Membrane separation. Adsorpton. Water analysis and treatability. Aquatic organisms and biological processes. Methane fermentation. Corrosion in metal and concrete. Apparatus for water and wastewater tretment. Sludge treatment. Reagent storage and feeding Intrumentation, control and regulation in water and wastewater treatment. Oxidation and desinfection		
Assessment methods	Lectures Laboratories (practical exercises) Written exam Final test/report from laboratory		
Recommended readings	1. team of authors, Water Treatment Handbook, Vol. 1 and Vol.2, Degrement SUEZ, Lavoisier SAS, 94236 Cachan Cedex, France; www.lavoisier.fr, 2011, Seventh edition, ISBN 978-2-7430-0970-0		
Knowledge	Student knows the principles for each steps of water production as well as wastewater purification and menagement. Student knows the functionning of typical processes in water and wastwater technology.		
Skills	Ability to study of literature on water technology and drawing proper conlusions. Ability to preparing suitable report with focus on each steps of water and wastewater treatment. Ability of knwoledge to enhance competences. Ability to planne suitable operation steps with making conclusions from obtained results. Ability to select methods and tools for technology of water and wastewater treatment.		
Other social competences	Ability to be the lider of team for developing of water reclamation technology. Ability to cooperate within project group as well as to be the leader of group. Ability to creation of future tasks for team members. On the base of own professional development student will be able to solve each group of problems.		