Zachodniopomorski Uniwersytet Technologiczny w Szczecinie

Faculty of Chemical Technology and Engineering

Field of study	Chemical Engineering		
Mode of study	stationary	*Level*	first cycle
Graduate's qualification	inżynier		
Area(s) of study	nauki techniczne		
Educational profile	general academic		
Module			
Course unit	**Transport and Separation Processes**		
Code	ChEn_1A_S_C04		
Field of specialisation			
Administering faculty	Institute of Chemical Engineering and Environmental Protection Processes		
ECTS	5,0	*ECTS (forms)*	5,0
Form of course credit	credits	*Language*	english
Electives		*Elective group*	

Form of instruction	*Code*	*Semester*	*Hours*	*ECTS*	*Weight*	*Credit*
lecture	W	3	30	2,0	0,30	credits
lecturing course	A	3	15	1,5	0,30	credits
laboratory course	L	3	15	1,5	0,40	credits

Leading teacher	Ambrożek Bogdan (Bogdan.Ambrozek@zut.edu.pl)
Other teachers	Ambrożek Bogdan (Bogdan.Ambrozek@zut.edu.pl), Gryta Marek (Marek.Gryta@zut.edu.pl), Konopacki Maciej (Maciej.Konopacki@zut.edu.pl), Ziętarska Katarzyna (kzietarska@zut.edu.pl)

Prerequisites

W-1	Fundamentals of chemical engineering

Module/course unit objectives

C-1	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.

Course content divided into various forms of instruction		*Number of hours*
T-W-1	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.	5
T-W-2	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.	5
T-W-3	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.	5
T-W-4	Thermodynamics of separation processes. Single equilibrium stages calculations. Flash calculations. Cascades systems.	3
T-W-5	Hybrid systems. Absorption. Stripping of dilute mixtures. Distillation. Liquid–liquid Extraction.	3
T-W-6	Multicomponent, multistage separations. Supercritical extraction. Adsorption. Ion exchange. Chromatography. Electrophoresis. Mechanical phase separations.	5
T-W-7	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.	4
T-A-1	Derivation of momentum conservation equations. Solving selected problems related to momentum transfer.	2
T-A-2	Derivation of energy conservation equations. Solving selected problems related to energy transfer.	2
T-A-3	Derivation of mass conservation equations. Solving selected problems related to mass transfer.	3

Course content divided into various forms of instruction		*Number of hours*
T-A-4	Thermodynamic analysis of selected separation processes. Single equilibrium stages calculations. Flash calculations.	3
T-A-5	Calculation of selected separation processes: distillation, liquid–liquid extraction, supercritical extraction, membrane separations, adsorption, ion exchange, chromatography, electrophoresis, mechanical phase separations.	5
T-L-1	Mechanical phase separation.	2
T-L-2	Membrane separations.	2
T-L-3	Liquid–liquid Extraction.	2
T-L-4	Adsorption separation of gas mixtures.	2
T-L-5	Modeling and simulation of separation processes using ASPEN PLUS and HYSYS.	7

Student workload - forms of activity		*Number of hours*
A-W-1	Class participation	30
A-W-2	Tutorial	10
A-W-3	Individual work	20
A-A-1	Class participation	15
A-A-2	Tutorial	5
A-A-3	Solving computational problems.	25
A-L-1	Class participation	15
A-L-2	Tutorial	5
A-L-3	Preparation of reports	25

Teaching methods / tools	
M-1	metoda podająca: wykład
M-2	metoda praktyczna: ćwiczenia przedmiotowe
M-3	metoda praktyczna: ćwiczenia laboratoryjne

Evaluation methods (F - progressive, P - final)		
S-1	F	ocena okresowych osiągnięć studenta
S-2	F	ocena pod koniec przedmiotu

Designed learning outcomes	Reference to the learning outcomes designed for the fields of study	Reference to the learning outcomes defined for the particular areas of education	Reference to learning outcomes leading to the degree of "inżynier"	Course objectives	Course content	Teaching methods	Evaluation methods
Knowledge							
ChEn_1A_C04_W01 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.	ChEn_1A_W15 ChEn_1A_W20	P6S_WG_TA11	P6S_WG_IA11	C-1	T-W-1 T-W-5 T-W-2 T-W-6 T-W-3 T-W-7	M-1 M-2 M-3	S-1 S-2
Skills							
ChEn_1A_C04_U01 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.	ChEn_1A_U01 ChEn_1A_U03 ChEn_1A_U05 ChEn_1A_U07 ChEn_1A_U08 ChEn_1A_U16	P6S_UO P6S_UU P6S_UW_TA11 P6S_UW_TA14	P6S_UW_IA11 P6S_UW_IA14	C-1	T-A-1 T-A-3 T-A-2 T-A-5	M-1 M-2 M-3	S-1 S-2
Other social / personal competences							
ChEn_1A_C04_K01 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.	ChEn_1A_K01 ChEn_1A_K03 ChEn_1A_K04 ChEn_1A_K05	P6S_KK P6S_KO P6S_KR		C-1	T-A-1 T-A-3 T-A-2	M-1 M-2 M-3	S-1 S-2

Required reading
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

Supplementary reading
1. Brodkey R.S., Hershey H.C., Transport Phenomena. A Unified Approach., McGraw-Hill, New York, 1998
2. Kessler D.P., Greenkorn R.A., Momentum, Heat, and Mass Transfer Fundamentals, Marcel Dekker, Basel, 1999
3. Noble R.D., Terry P.A., Principles of Chemical Separations with Environmental Applications, Cambridge University Press, New York, 2004
4. Seader J. D., Henley E.J., Roper D.K., Martin R.E., Separation Process Principles. Chemical and Biochemical Operations, Wiley, New York, 2011