Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Zaawansowana grafika inżynierska**
Name in English	**Advanced engineering graphics**
Main field of study (if applicable)	**Chemical engineering**
Specialization (if applicable)	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**GFC024003**
Group of courses	**NO**

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			30		
Number of hours of total student workload (CNPS)			90		
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points			3		
including number of ECTS points for practical (P) classes			3		
including number of ECTS points for direct teacher-student contact (BK) classes			3		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Technical drawing conventions knowledge and basic working knowledge of using AutoCAD.

SUBJECT OBJECTIVES	
C1	Familiarisation with terminology and principles of Computer Aided Design.
C2	Possessing of practical skill at using CAD in modelling and visualization of technical objects and assemblies interactions.
C3	Working knowledge of using the computer aided design software in making a graphical documentation of equipment set-up.

SUBJECT EDUCATIONAL EFFECTS

Relating to skills:

PEK_U01 – understands terminology and principles of Computer Aided Design.
PEK_U02 – possesses skills at using CAD in engineering design of technical objects.
PEK_U03 – can realize modelling and visualization of technical assemblies.
PEK_U04 – is able to perform an assembly motion analysis and simulation of components interactions.
PEK_U05 – has the working knowledge of using the computer aided design applications in creation of the graphical documentation of equipment set-up.

PROGRAMME CONTENT		
Form of classes - laboratory		Number of hours
Lab 1	Organising class. Familiarisation with the safety rules in the computer room. Teaching tools and conditions of course credition. Computer Aided Design. CAD terminology. Formulation and analysis of the problem, exemplary solutions, additional methods and techniques.	2
Lab 2	Principles of using Autodesk Inventor. Types and formats of files created (part, assembly, presentation, drawing files) and the user interfaces. Browser of objects. Project file and managing of the project.	2
Lab 3	2D sketch. Sketch mode. Drawing and editing of objects. Parametric design. Sketch constrains and degrees of freedom. Sketch dimensioning.	2
Lab 4	3D objects creation upon sketch. Orientation and observation in space. Part creation and modification tools. Work features creation and editing. Solid and surface bodies. Drawing propertities and their modification.	2
Lab 5	2d to 3D. Methods of using .dwg format files for creation of 3D objects. Import and export to and from Autodesk Inventor software.	2
Lab 6	Creation and printing of technical documentation of single 3D objects. Using and modification of drawing resources. Dimensioning, center lines and marks and annotations.	2
Lab 7	Repetition and test I.	2
Lab 8	3D sketches and using of them in creation of technical objects. Creation, modification and using of surface bodies. Sheet metal design.	2
Lab 9	Assembly interface. Using of existing parts and creation of new parts in assembly environment. Inserting, moving and constraining of components. Adaptive parts. Analysis of assembly correctness.	2
Lab 10	Using of Content Center components. Insering of standarised parts. Design Accelerator (frame generator, bolted connection component generator, weldments).	2
Lab 11	Creation and analysis of assembly movement, simulations of components movement. Collision analysis. Part representations in assembly. Presentation of assembly, presentation mode, exploded views animations.	2

Lab 12	2D technical documentation of assembly. Creation of sections, details, item numbers balloons and parts list.	2
Lab 13	Visual presentations of 3D objects (rendering, surface texture, materials).	2
Lab 14	Repetition and test II.	2
Lab 15	Presentation and submission of technical documentation of the final project. Course acceptance.	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Multimedia presentations
N2	Using of AutoCAD and Autodesk Inventor software

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01- PEK_U02	test I
F2	PEK_U03- PEK_U05	test II
F3-F8	PEK_U01- PEK_U05	drawings made in AutoCAD and Autodesk Inventor

C=[(F1+F2)/2+(F3+F4+...+F8)/6]/2

3,0 if 3,25 < C

3,5 if 3,25 ≤ **C**< 3,75

4,0 if 3,75 ≤ **C** < 4,25

4,5 if 4,25 ≤ **C** < 4,75

5,0 if 4,75 ≤ **C**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Noga B.: Inventor: podstawy projektowania, Gliwice, Helion, 2011.
[2] Sydor M.: Wstęp do CAD, Warszawa, PWN, 2009 (PWr on-line library).

SECONDARY LITERATURE:

[1] Jaskulski A.: Autodesk Inventor Professional/Fusion 2013pl/2013+ :metodyka projektowania, Warszawa, PWN, 2012 (PWr on-line library).
[2] Stasiak F.: Zbiór ćwiczeń: Autodesk Inventor 2012, Łódź, ExpertBooks, 2011.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Izabela Polowczyk, izabela.polowczyk@pwr.wroc.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Advanced technical drawing

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

(Chemical Engineering)

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(competences)\ PEK_U01	K2Aic_U02	C1	La1	N1
PEK_U02	K2Aic_U02	C2	La2-La7	N1, N2
PEK_U03	K2Aic_U02	C2	La8-La10	N1, N2
PEK_U04	K2Aic_U02	C3	La11-La15	N1, N2
PEK_U05	K2Aic_U02	C3	La1-La15	N1, N2

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED	
SUBJECT CARD	
Name in Polish	**Inżynieria procesów biotechnologicznych**
Name in English	**Biotechnology process engineering**
Main field of study (if applicable):	**Chemical and process engineering**
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**ICC024016**
Group of courses	**NO**

*niepotrzebne usunąć

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	120		60		
Form of crediting	Exam		Credited with grade		
For group of courses mark (X) final course					
Number of ECTS points	4		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		1		

*delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Completed course “Chemical Reactors”

SUBJECT OBJECTIVES	
C1	Understanding the concepts of the enzymatic reaction and microbial metabolism. To obtain knowledge of the types of enzymes' classes and microorganism's systematics.
C2	To obtain knowledge of the description of the kinetics of enzymatic reactions and

	microbiological changes.
C3	To obtain knowledge of the balancing microbiological and enzymatic transformations.
C4	To obtain knowledge of the use of selected classes of enzymes, strains of bacteria and fungi.
C5	Presentation of the mathematical description of the various types of bioreactors. Understanding the principles of the selection.

SUBJECT EDUCATIONAL EFFECTS

Related to knowledge:
The person who completed the course:
PEK_W01 – to know the basic concepts of micro-organisms, their structure, function
PEK_W02 – to know the basic concepts of enzymes and enzymatic catalysis
PEK_W03 – to know experimental methods to determine the kinetic equation
PEK_W04 – to know the basic types of bioreactors, their description and properties
PEK_W05 – to know the basic technologies based on enzymatic catalysis and microbial metabolism

Related to skills:
The person who completed the course:
PEK_U01 - is able to carry out a pure culture of bacteria and fungi in liquid and on solid state
PEK_U02 - is able to carry out experiments in order to obtain data to determine the kinetic equation, stoichiometric coefficients
PEK_U03 – is able to, using computer, compile results obtained in the course of cultivation of microorganisms
PEK_U04 – is able to perform immobilization of enzymes in alginate gel
PEK_U05 – is able to perform experiments to determine the kinetic constants of the equation and the equation enzymatic inactivation
PEK_U06 - is able to, using computer, compile results obtained in the course of enzymatic catalysis
PEK_U07 – is able to design a continuous process in a bioreactor

The person who completed the course:
PEK_K01 - is able to work in a group consisting of several people performing experiments as well as analysing data using computer

PROGRAMME CONTENT		
Form of classes - project		**Number of hours**
Lec1	Introduction to microbiology. Introduction to the basic concepts, systematics of microorganisms, the elements of the microbial cell.	2
Lec2	Methods for cultivation of microorganisms on solid state and in liquid medium. Batch culture. Growth phase.	2
Lec3	The kinetics of microbial growth. Monod's equation, the equation of inhibition. Methods for determining the constants.	2
Lec4	Batch and continuous reactors for the cultivation of microorganisms.	2

Lec5	Microbial membrane bioreactor.	2
Lec6	The basic technologies using microorganisms.	2
Lec7	Introduction to the enzymatic catalysis. Class of enzymes.	2
Lec8	Michaelis-Menten's equation, the method of determining the constants. Equations of substrate and product inhibition.	2
Lec9	Inactivation of the enzyme. The equations describing this phenomenon.	2
Lec10	Immobilization of enzymes - methods, properties derived preparations.	2
Lec11	Batch and continuous reactors with enzymes in native form and mobilized them.	2
Lec12	Catalytic membrane reactors with convective flow.	2
Lec13	Catalytic membrane reactors with diffusive flow .	2
Lec14	Fundamental enzymatic technologies.	2
Lec15	Principles of design of biotechnological processes.	2
	Total hours	**30**

Form of classes - laboratory		**Number of hours**
L1	Introduction to the course. Familiarization with the terms of the sterile working with microorganisms.	2
L2	Bacterial and fungal cultures on solid media. Determining the amount of cell dilution. Preparation curve measuring the concentration of cells.	4
L3	Batch culture in a microbial bioreactor.	4
L4	Determination of kinetic constants of the equation of microbiological metabolism, stechiometric coefficients (computer classes).	4
L5	Enzymatic reactor. Determination of the reaction rate.	4
L6	Immobilization of the enzyme in alginate gel. Determination of the reaction rate.	4
L7	Determination of the kinetics of inactivation of the native and immobilized enzyme.	4
L8		4
	Total hours	30

TEACHING TOOLS USED	
N1	Lecture
N2	Experiment and preparation of the results
N3	Consultation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1 (lecture)	PEK_W01-W05	exam
P2 (laboratory)	PEK_U01-U07	Test (50%) + laboratory (25%) + report (25%)
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 21,5 pnt. **4,0** if P = 20 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Aiba: Inżynieria biochemiczna, WNT 1977

[2] A. Trusek-Hołownia: Membrane Bioreactors - Models for Bioprocess Design, Desalination Publications, 2011

[3] J. Bałdyga: Obliczenia w inżynierii bioreaktorów, Oficyna Wydawnicza Pol. Warszawskiej, 1996

SECONDARY LITERATURE:

[3] J.E. Bailey, D.F/ Ollis: Biochemical Engineering Fundamentals, McGraw-Hill, 1986

[4] S. Ledakowicz: Inżynieria biochemiczna, WNT, Warszawa 2011

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
dr hab. inż. Anna Trusek-Hołownia, Prof. PWr. **anna.trusek-holownia@pwr.wroc.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **BIOTECHNOLOGICAL ENGINEERING** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **BIOTECHNOLOGY**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	S2Aic1_W01	C1,C2	Lec1-Lec2	N1, N3
PEK_W02	S2Aic1_W01	C1,C2	Lec7, Lec8, Lec10	N1, N3
PEK_W03	S2Aic1_W01	C2	Lec3, Lec8, Lec9,	N1, N3
PEK_W04	S2Aic1_W01	C5	Lec4, Lec5, Lec11, Lec12, Lec13	N1, N3
PEK_W05	S2Aic1_W01	C4	Lec6, Lec14, Lec15	N1, N3
PEK_W06	S2Aic1_W01			
PEK_W07	S2Aic1_W01			
(skills) PEK_U01	S2Aic1_U01	C1	L1	N2
PEK_U02	S2Aic1_U01	C1	L2, L4	N2
PEK_U03	S2Aic1_U01	C2	L3	N2
PEK_U04	S2Aic1_U01	C3	L6	N2
PEK_U05	S2Aic1_U01	C2	L5, L7, L8	N2
PEK_U06	S2Aic1_U01	C2	L5, L7, L8	N2
PEK_U07	S2Aic1_U01	C5	L1-L8	N2
(social skills) PEK_K01				
PEK_K02				
…				

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**CFD – komputerowe modelowanie procesów**
Name in English	**CFD – computer modeling of processes**
Main field of study (if applicable)	**Chemical Engineering and Processing**
Specialization (if applicable)	**Applied Chemical Engineering**
Level and form of studies:	**~~1st~~/ 2nd* level, full-time / ~~part-time~~***
Kind of subject	**obligatory / ~~optional~~ / ~~university-wide~~***
Subject code	**ICC024013**
Group of courses	**~~YES~~ / NO***

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*	~~Examination~~ / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	0.5		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

2. Knowledge of mathematics at the level, that allows the understanding of the equation of momentum, heat and mass transfer for one and multiphase systems during laminar and turbulent flow
3. Knowledge of basics of the momentum, heat and mass transfer in chemical processes

SUBJECT OBJECTIVES	
C1	Introducing students to the basics of CFD methods and their application areas
C2	Gain basic knowledge about the equations describing momentum, heat and mass transfer during the laminar flow
C3	Introducing students to the basic models of the turbulent flow
C4	Introducing students to the basic models of the multiphase flow

C5	Gain basic knowledge about the equations describing momentum, heat and mass transfer in transient processes
C6	Introducing students to the basic numerical methods used for solving of the momentum, heat and mass transfer equations
C7	Gain basic skills used for CFD calculations of laminar and turbulent flow, in steady and unsteady, one and multiphase systems with the use of a selected software package

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

The person who has passed this subject:

PEK_W01 - has the knowledge about application areas, advantages and disadvantages of CFD methods,

PEK_W02 - has the basic knowledge about equations describing momentum, heat and mass transfer during the laminar flow,

PEK_W03 – has the basic knowledge about equations describing momentum, heat and mass transfer during the turbulent flow,

PEK_W04 - has the basic knowledge about equations describing momentum, heat and mass transfer in multiphase systems,

PEK_W05 - has the basic knowledge about equations describing momentum, heat and mass transfer in steady and unsteady systems,

PEK_W06 - has the basic knowledge about numerical methods used for solving of the momentum, heat and mass transfer equations.

Relating to skills:

The person who has passed this subject:

PEK_U01 – can use the selected CFD software package for calculations of momentum, heat and mass transfer during the laminar flow in chemical devices,

PEK_U02 - can use the selected CFD software package for calculations of momentum, heat and mass transfer during the turbulent flow in chemical devices,

PEK_U03 - can use the selected CFD software package for calculations of momentum, heat and mass transfer in multiphase systems,

PEK_U04 - can use the selected CFD software package for calculations of momentum, heat and mass transfer in unsteady chemical processes.

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	Introducing to CFD methods, areas of their application, their advantages and disadvantages	1
Lec 2	Derivation of the equation of the momentum transport during laminar, one phase flow of Newtonian liquid	1
Lec 3	Derivation of the equation of the heat transport by conduction and convection during one phase flow	1

Lec 4	Derivation of the equation of the mass transport by diffusion and convection during one phase flow	1
Lec 5	Turbulence definition, different ways of describing of turbulent flows	1
Lec 6	Turbulence models	1
Lec 7	Models of multiphase flow	1
Lec 8	VOF and Level Set models	1
Lec 9	Euler-Lagrange models	1
Lec 10	Euler-Euler models	1
Lec 11	Multiphase model selection	1
Lec 12	Basics of numerical methods used for solving of the momentum, heat and mass transfer equations.	1
Lec 13	Numerical mesh	1
Lec 14	Basics of Boltzmann's method	1
Lec 15	CFD software	1
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab 1	Basic information about user interface of the selected software package, first simulation of a simple, laminar flow in a pipe, creation of geometry and mesh, boundary conditions	2
Lab 2	Computer simulation of a laminar, one phase flow in different chemical devices in 2D, 2D axisymmetric, 3D geometries, results comparison	2
Lab 3	Computer simulation of a turbulent, one phase flow in different chemical devices in 2D, 2D axisymmetric, 3D geometries, results comparison	2
Lab 4	Computer simulation of heat conduction	2
Lab 5	Computer simulation of heat conduction with convection and radiation	2
Lab 6	Computer simulation of the one phase flow with the heat transfer in unsteady system	2
Lab 7	Computer simulation of the flow with diffusion and chemical reaction	2
Lab 8	Test 1	2
Lab 9	Computer simulation of the multiphase flow with the use of VOF and Level Set models	2
Lab 10	Determination of the trajectories of the particles with the use of Euler-Lagrange model	2
Lab 11	Computer simulation of the steady gas-solid multiphase flow with the use of Euler-Euler model	2
Lab 12	Computer simulation of the steady liquid-liquid multiphase flow with the use of Euler-Euler model	2
Lab 13	Computer simulation of the unsteady gas-solids multiphase flow with the use of Euler-Euler model	2
Lab 14	Computer simulation of the unsteady liquid-liquid multiphase	2

	flow with the use of Euler-Euler model	
Lab 15	Test 2	
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture with multimedia presentation
N2	Computer simulation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C (Lecture)	PEK_W01 – PEK_W06	Final Exam
F1 (laboratory)	PEK_U01, PEK_U02, PEK_U04	Test 1
F2 (laboratory)	PEK_U03, PEK_U04	Test 2
C (laboratory) = (F1+F2)/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] J. D. Anderson, Computational Fluid Dynamics: The Basics with Application, McGraw-Hill, New York 1995
[2] T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, Cambridge 2002

SECONDARY LITERATURE:

[1] Ansys Fluent Help
[2] Comsol Multiphysics Help

SUBJECT SUPERVISOR
(NAME AND SURNAME, E-MAIL ADDRESS)

Wojciech Ludwig, wojciech.ludwig@pwr.wroc.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

CFD – computer modeling of processes

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Engineering and Processing

SPECIALIZATION

Applied Chemical Engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic3_W03	C1	Lec1	N1
PEK_W02	K2Aic3_W03	C2	Lec2-Lec4	N1
PEK_W03	K2Aic3_W03	C3	Lec5, Lec6	N1
PEK_W04	K2Aic3_W03	C4	Lec7-Lec11	N1
PEK_W05	K2Aic3_W03	C5	Lec2-Lec4 Lec8-Lec10	N1
PEK_W06	K2Aic3_W03	C6	Lec12-Lec15	
(skills) PEK_U01	K2Aic3_U04	C6, C7	Lab1, Lab2	N2
PEK_U02	K2Aic3_U04	C6, C7	Lab3	N2
PEK_U03	K2Aic3_U04	C6, C7	Lab9-Lab12	N2
PEK_U04	K2Aic3_U04	C6, C7	Lab4-Lab7 Lab13-Lab14	N2

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED

SUBJECT CARD

Name in Polish:	**Nanoinżynieria chemiczna**
Name in English	**Chemical nanoengineering**
Main field of study (if applicable):	**Chemical engineering**
Specialization (if applicable):	**Projektowanie procesów chemicznych**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ICC024009**
Group of courses:	**No**

*delete if not related

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				15
Number of hours of total student workload (CNPS)	90				30
Form of crediting	Exam				Credited with grade
For group of courses mark (X) final course					
Number of ECTS points	3				1
including number of ECTS points for practical (P) classes					1
including number of ECTS points for direct teacher-student contact (BK) classes	0,75				0,25

* delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of such courses as physics, chemistry, chemical engineering.
2. Ability to understand numerical algorithms.
3. Understanding of basic of chemical thermodynamics (first principle, heat of reaction) and theory of interaction.

SUBJECT OBJECTIVES	
C1	To understand the current state of nano-science.
C2	To understand the possible application of nano-materials in chemical engineering.
C3	To understand specific properties of materials in nano-scale
C4	To obtain knowledge of the basic techniques used in production of nano-materials
C5	To understand the principles of numerical modeling of nano-objects.

SUBJECT EDUCATIONAL EFFECTS

The scope of knowledge:
The person who completed the course:
PEK_W01 – is familiar with the term "nano-engineering" and understands its role in technology,
PEK_W02 – is familiar with the current trends of developments in the nanoscale,
PEK_W03 – knows the types of materials used in nano-engineering and their properties,
PEK_W04 – knows the basic methodology of design of nano-systems,
PEK_W05 – understands the physics and chemistry of phenomena observed in nano-scale,
PEK_W06 – is able to model mathematically and numerically the properties of nano-objects.

The range of skills:
The person who completed the course:
PEK_U01 – is able to find in literature information related to applications in nano-chemistry,
PEK_U02 - is able to present and evaluate applications of designed nano-materials in industrial environment,
PEK_U03 - is able to present and discuss the current trends in nanotechnology and their applicability for industrial purpose,
PEK_U04 – is able to analyze numerically the properties of nano-materials.

With a range of social skills:
The person who completed the course:
PEK_K01 - is able to work in a group consisting of several people performing analysis as well as modeling using computer.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Le1	Experimental techniques in nano-characterization.	4
Le2	Nano-design using “bottom-up” and „top-down” approach.	4
Le3	Application of numerical design of nano-systems. Multiscale approach.	4
Le4	Role of surface and deformation in nanoscale: metal organic frameworks. Nano-mechanics. Nanoporous materials	4
Le5	Functionalization of graphene and other carbon systems.	4

Le6	Mechanics of liquids in nanoscale.Adsorption	4
Le7	Nanotechnology in renewable energy.	2
Le8	Detection with a help of nanoparticles.	4
	Total hours	**30**

Form of classes - seminar		**Number of hours**
Sem1	Social impact. Nanofabrication and Moore's law.	2
Sem2	Nano materials: review of existing and potential ideas.	2
Sem3	Role of quantum effects.	2
Sem4	Modeling of interatomic interactions.	2
Sem5	Bottom-up versus bottom-down approach.	2
Sem6	Transport in nanostructures.	2
Sem7	Adsorption in nano-porous materials.	2
Sem8	Historical perspective on nano-engineering.	1
	Total hours	15

TEACHING TOOLS USED	
N1	Lecture.
N2	Discussion.
N3	Internet search.
N4	Consultation.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1 (lecture)	PEK_W01-W07	Written evaluation
P2 (seminar)	PEK_U01-U05	Evaluation of oral presentation of different topics
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 20 pnt. **4,0** if P = 20,5 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE [1] Akhlesh Lakhtakia, Nanometer structures: Theory, modelling and simulation, SPIE Press 2004 **SECONDARY LITERATURE:** Internet sources.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Bogdan Kuchta **bogdan.kuchta@univ-amu.fr**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **Chemical nanoengineering** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Chemical engineering**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic3_W07	C1-C3	Le1	N1
PEK_W02	K2Aic3_W07	C1,C2	L2, Le5-Le8	N1
PEK_W03	K2Aic3_W07	C2,C3	L4, Le5-Le8	N1
PEK_W04	K2Aic3_W07	C4	L4, Le5-Le8	N1
PEK_W05	K2Aic3_W07	C3,C5	L2, Le5-Le8	N1
PEK_W06	K2Aic3_W07	C5	Le3	N1
(skills) PEK_U01	K2Aic3_W07	C1, C2	La1, L5-La8	N2-N4
PEK_U02	K2Aic3_W07	C3, C4	La2, L5-La8	N2-N4
PEK_U03	K2Aic3_W07	C3, C4	La1, L4-La8	N2-N4
PEK_U04	K2Aic3_W07	C5	La3	N2-N4
(social skills) PEK_K01	K2Aic3_W07			

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED

SUBJECT CARD

Name in Polish:	**Symulacje komputerowe w projektowaniu materiałów do procesów chemicznych**
Name in English	**Computer simulations in designing materials for chemical processes**
Main field of study (if applicable):	**Chemical and processing engineering**
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ICC024012**
Group of courses:	**No**

*delete if not related

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	Exam		Credited with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	0,25		0,75		

* delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of such courses as physics, chemistry, chemical engineering.
2. Ability to understand numerical algorithms.
3. Understanding of basic of chemical thermodynamics (first principle, heat of reaction) and theory of interaction.

SUBJECT OBJECTIVES	
C1	To understand current capabilities of computer simulations in materials design.
C2	To understand the possible application of computer simulations in chemical engineering.
C3	To understand mathematical apparatus of various numerical techniques.
C4	To understand and apply computational apparatus of various numerical techniques.
C5	To understand the principles of numerical modelling in various scale.
C6	To understand the relation between numerical modelling and experimental results.

SUBJECT EDUCATIONAL EFFECTS

The scope of knowledge:
The person who completed the course:
P2K_W01 – is familiar with the "multiscale modelling" term and understands its role in the industry,
P2K_W02 – is familiar with current computational techniques used in designing materials for chemical engineering,
P2K_W03 – knows the basic types of materials used in various scales of technological design, their properties and applications ,
P2K_W04 – knows the basic methodology of computational design and prediction of properties of systems in various scales ,
P2K_W05 – understands the physics and chemistry of phenomena observed in a nano-scale
P2K_W06 – is able to apply appropriate mathematical and numerical model for a given system in a given scale.

The range of skills:
The person who completed the course:
P2K_U01 – is able to find in literature information related to applications multi-scale modelling in chemical engineering,
P2K_U02 - is able to present and evaluate applications of designed nano-materials in industrial environment,
P2K_U03 - is able to present and discuss the current trends in computational design and their applicability for industrial purpose,
P2K_U04 – is able to numerically analyze properties of nano-materials,
P2K_U05 – is able to choose and implement appropriate numerical method according to the scale of investigated system.

With a range of social skills:
The person who completed the course:
P2K_K01 - is able to work in a group consisting of several people performing analysis as well as modelling using computer.

PROGRAMME CONTENT		
Form of classes – lecture		**Number of hours**
Le1	Introduction to computing simulations: multi-scale modelling, parallel computations.	2
Le2	Quantum level computational techniques: tight-binding methods, ab initio methods.	2
Le3	Nano-scale computational techniques I: molecular dynamics method.	2
Le4	Nano-scale computational techniques II: thermostats and solvation.	2
Le5	Nano-scale computational techniques III: advanced Monte Carlo methods.	2
Le6	Mezo-scale computational techniques: coarse graining method.	2
Le7	Real-world computational techniques: finite difference method.	2
Le8	Current challenges in molecular modelling.	1
	Total hours	**15**

Form of classes - laboratory		**Number of hours**
Lab1	Introduction to programming and data analysis: Matlab.	2
Lab2	Ab initio methods I: introduction.	2
Lab2	Ab initio methods II: molecule geometry optimization.	2
Lab4	Ab initio methods III: path of reaction.	2
Lab5	Molecular Dynamics I: introduction.	2
Lab6	Molecular Dynamics II: large scale geometry optimization, cohesive energy.	2
Lab7	Molecular Dynamics III: thermostats.	2
Lab8	Molecular Dynamics IV: transport in nanostructures.	2
Lab9	Advanced Monte Carlo techniques I: introduction.	2
Lab10	Advanced Monte Carlo techniques II: adsorption in nano-materials.	2
Lab11	Advanced Monte Carlo techniques III: polymers.	2

Lab12	Coarse-graining methods.	2
Lab13	Finite difference method: diffusion.	2
Lab14	Finite difference method: continuous models.	2
Lab15	Introduction to conformational analysis.	2
	Total hours	30

TEACHING TOOLS USED	
N1	Lecture.
N2	Laboratory.
N3	Internet search.
N4	Consultation.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1 (lecture)	P2K_W01-W06	Written evaluation
F1-F5 (laboratory)	P2K_U01-U05	Evaluation of projects of specific topics
P = P1*0.25+(F1+F2+F3+F4+F5)*0.75 grade **2,0** if P < 25 pnt. **3,0** if P= 25,5– 28 pnt. **3,5** if P = 28,5 – 31 pnt. **4,0** if P = 31,5 – 34 pnt. **4,5** if P = 34,5- 37 pnt. **5,0** if P = 40 - 45 pnt. **5,5** if P = 45,5- 50 pnt.		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Akhlesh Lakhtakia, Nanometer structures: Theory, modelling and simulation, SPIE Press 2004

[2] Andrew R. Leach, Molecular Modelling: Principles and Applications, Pearson Education Limited, 2001.

SECONDARY LITERATURE:

Internet sources.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Łukasz Radosiński
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Computer simulations in designing materials for chemical processes
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical and processing engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) P2K_W01	K2Aic3_W07	C1,C2	Le1	Le1
P2K_W02	K2Aic3_W07	C1,C2,C3	Le2, Le8	Le2, Le8
P2K_W03	K2Aic3_W07	C1, C6	Le1, Le2, Le4, Le6, Le7	Le1, Le2, Le4, Le6, Le7
P2K_W04	K2Aic3_W07	C3, C4, C5	Le2-Le8	Le2-Le8
P2K_W05	K2Aic3_W07	C1, C2, C6	Le2, Le3, Le5, Le8	Le2, Le3, Le5, Le8
P2K_W06	K2Aic3_W07	C2-C4	Le2,Le3,Le5-Le7	Le2,Le3,Le5-Le7
(skills) P2K_U01	K2Aic3_W07	C1	Lab1	Lab1
P2K_U02	K2Aic3_W07	C1	Lab1, Lab4	Lab1, Lab4
P2K_U03	K2Aic3_W07	C2	Lab1, Lab2, Lab5, Lab9, Lab12	Lab1, Lab2, Lab5, Lab9, Lab12
P2K_U04	K2Aic3_W07	C3, C4, C5	Lab1, Lab2, Lab5, Lab9, Lab12	Lab1, Lab2, Lab5, L9, L12
P2K_U05	K2Aic3_W07	C3, C4, C5	Lab1-Lab15	L1-L15
(social skills) P2K_K01	K2Aic3_W07	C1-C6	Lab1-Lab15	L1-L15

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	Ekonomika procesów produkcyjnych
Name in English	**Economics of production processes**
Main field of study (if applicable)	Inżynieria chemiczna i procesowa
Specialization (if applicable)	Applied chemical engineering
Level and form of studies:	II stopień, stacjonarna
Kind of subject	obowiązkowy
Subject code	**ICC024017**
Group of courses	NIE

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	crediting with grade		crediting with grade *		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes			2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

4. Software for simulation and design of chemical systems Physics
5. Process modeling in chemical engineering

SUBJECT OBJECTIVES	
C1	Familiarization with the concepts of production economics
C2	Understanding and practical application of knowledge of modelling chemical and biotechnological processes
C3	Familiarization with selected examples of modelling, calculation and optimization of chemical and biotechnological processes
C4	Working knowledge of using a professional software for calculation of optimal process parameters, energy consumption, and costs of processing.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_W01 – Knows how to perform economic analysis of industrial installation, able to produce required product.

PEK_W02 – Knows methods of optimization of unit operations and complete process lines

PEK_W03 – Knows methods to estimate costs of apparatus, operating cost and fixed capital.

Relating to skills:

PEK_U01 – Can perform economic analysis of chemical and biotechnological installation.

PEK_U02 – Can perform economical optimization of unit operation and complete installation.

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Wy1	concept of production. Factors of production.	2
Wy2	Theory of production.	1
Wy3	Short-run production costs.	1
Wy4	Long-run production costs.	1
Wy5	Reserach-project-implementation cycle.	1
Wy6	Design of installation.	1
Wy7	Cost of scale-up.	1
Wy8	Selection of optimal production method.	1
Wy9	Bottlenecks.	1
Wy10	Payback time. Product lifetime.	1
Wy11	Analysis of selected processes.	4
	Total hours	**15**

PROGRAMME CONTENT		
Form of classes - project		Number of hours
Lab 1	Organising class. Familiarisation with the safety rules in the computer room. Software for computer aided design and modeling of bioprocesses.	2
Lab 2	Intoduction to Aspen Economic Evaluation. Application of software. User interface.	2
Lab 3	Intoduction to SuperPro Designer. Application of software. User interface. Databases. Material and energy balances of chemical processes and bioprocesses..	2
Lab 4	Optimal parameters of bioprocess. Design optimization.	2
Lab 5	Schedule of process. Gantt charts. Resource management.	2
Lab 6	Selection and scheduling of purification methods. Upstream and downstream processing.	2
Lab 7	Design of pharmaceutical bioprocesses.	2

Lab 8	Membrane processes for recovery, purification and concentration of bioproducts. Cost of consumables.	2
Lab 9	Diffusion-driven separation processes: distillation, extraction, absorption, adsorption, crystallization and drying. Cost of energy.	2
Lab 10	Equipment and resources bottlenecks.	2
Lab 11	Consumption of energy. Sizing of the devices. Scaling-up of the biotechnological process. Cost of process.	2
Lab 12	Environmental impact of production. Costs of wastewater treatment and gaseous emissions.	2
Lab 13	Waste treatment, sewage treatment, purification of water.	2
Lab 14	Presentation of the final projects.	2
Lab 15	Presentation of the final projects. Course acceptance.	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Multimedia presentations
N2	Solving the exemplary issues during the classes
N3	Using of the commercial software

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C (lecture)	PEK_W01-PEK_W03	crediting with grade *
F1-F3 (lab)	PEK_U01-PEK_U05	partial projects made in a professional software
F4(lab)	PEK_U01-PEK_U05	final project made in a professional software
C (lab)=0,4(F1+F2+F3)/3+0,6F4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[5] F.N. Fraser, Global engineering economics, Financial decision making for engineers, 4th Ed., Prentice Hall, Toronto, 2009.

[6] E. Heinzle, A.P. Biwer, C.L. Cooney - Development of Sustainable Bioprocesses: Modeling and Assessment, Viley 2006 (PWr. On-line library).

[7] L.T. Blank, A. Tarquin, Engineering Economy, 6th Ed., McGraw-Hill, Boston, 2005.

SECONDARY LITERATURE:

[1] R.G. Harrison, P. Todd, S.R. Rudge, D.P. Petrides - Bioseparations Science and Engineering, Oxford 2002.

[2] Manuals of SuperPro Designer and Aspen Economic Evaluation.

SUBJECT SUPERVISOR

(NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Economics of production processes

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and Process Engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic_W05	C1	Wy1-Wy2 Wy10	N1
PEK_W02	K2Aic_W05	C2	Wy5, Wy6, Wy8, Wy9, Wy11	N1
PEK_W03	K2Aic_W05	C1, C2	Wy3, Wy4, Wy7	N1
(skills) PEK_U01	K2Aic_U05	C2, C3, C4	La1-La4	N2, N3
PEK_U02	K2Aic_U05	C3, C3,C4	La5-La15	N2, N3

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Metody matematyczne i statystyczne w inżynierii chemicznej**
Name in English	**Mathematical and statistical methods in chemical engineering**
Main field of study (if applicable)	**Chemical and process engineering**
Specialization (if applicable)	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**ICC024008**
Group of courses	**NO**

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	**crediting with grade**		**crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge of mathematics in algebra and differation as well as integration calculus

SUBJECT OBJECTIVES	
C1	Teaching students the mathematical and statistical methods used in design of physical and chemical processes
C2	Teaching students ability of solving of various problems connected in chemical engineering

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_W01 – knows analytical and numerical methods of algebraic equations solving
PEK_W02 – knows elements of scalar and vector fields analysis
PEK_W03 – knows and understand mathematical methods of working out experiments, in particular method of the least squares
PEK_W04 – knows ways of experimental results description with the aid of mathematical formulas

Relating to skills:

PEK_U01 – can solve equations and systems of equations by analytical and numerical methods
PEK_U02 – can use various coordinate systems (Cartesian, spherical and cylindrical) in problems connected with scalar and vector fields
PEK_U03 – can calculate the model parameters on the base of experimental data with the aid of the least squares method
PEK_U04 – can calculate uncertainty parameters of mathematical models

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	The base mathematical ideas - reminding	1
Lec 2	Analytical methods of algebraic equations solving	2
Lec 3	Numerical methods of algebraic equations solving	2
Lec 4	Numerical methods of algebraic systems of equations solving	2
Lec 5	Elements of scalar and vector fields	2
Lec 6	Mathematical methods of working out experimental data. The least squares method.	4
Lec 7	Statistical analysis of experimental data.	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab 1	Method of conducting and completing the classes. Tool used.	2
Lab 2	Solving the equations of 2th, 3th and 4th degree.	4
Lab 3	Numerical solving of equations and systems of equations.	6
Lab 4	Calculating of the model parameters with the aid of the least squares method.	6
Lab 5	Calculating the coefficients and their uncertainties in mathematical formulas describing of experimental data.	6
Lab 6	Recalculating coordinate systems. Calculating the base operators of scalar and vector fields.	4
Lab 7	Completing test	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture with multimedia presentation
N2	Solving of calculate problems with the aid of computer techniques

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C (Lecture)	PEK_W01 – PEK_W04	Final exam
F1 (laboratory)	PEK_U01 – PEK_U04	Notes completing every problem. For one problem one can obtain from 0 to 20 points. Exeptionally for perfect execution one can obtain over 20 points but not more than 24 points.
F2 (laboratory)	PEK_U01 – PEK_U04	Final test (0 to 100 points)
C (laboratory)		
C (laboratory) = 3.0 if (F1+F2) = 100 – 120 points 3.5 if (F1+F2) = 121 – 120 points 4.0 if (F1+F2) = 141 – 160 points 4.5 if (F1+F2) = 161 – 180 points 5.0 if (F1+F2) = 181 – 200 points 5.5 if (F1+F2) = 201 – points		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[4] A. Kozioł, materiały wykładowe, Internet (adres podany na wykładzie)

[5] Praca zbiorowa, Chemia fizyczna. Laboratorium fizykochemiczne. Tom 4, Str. 66 – 80, Wydawnictwo naukowe PWN, Warszawa 2013

[6] T. Traczyk, M. Mączyński, Matematyka stosowana w inżynierii chemicznej, WNT, Warszawa, 1970

[7] E. Kreyszig, Advanced Engineering Mathematics, J. Wiley & Sons, New York 1993.

SECONDARY LITERATURE:

[8] T. Zalewski, Metody algebry liniowej w inżynierii procesowej, WNT, Warszawa, 1991.

[2] K. A. Stroud, Advanced Engineering Mathematics, Industrial Press, New York 2003.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Mathematical and statistical methods in chemical engineering

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and process engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic_W01	C1	Lec 1 – Lec 4	N1
PEK_W02	K2Aic_W01	C1	Lec 5	N1
PEK_W03	K2Aic_W01	C1	Lec 6	N1
PEK_W04	K2Aic_W01	C1	Lec 7	N1
(skills) PEK_U01	K2Aic_U01	C2	Lab 1 – Lab 3	N2
PEK_U02	K2Aic_U01	C2	Lab 6	N2
PEK_U03	K2Aic_U01	C2	Lab 5	N2
PEK_U04	K2Aic_U01	C2	Lab 4	N2

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish **Nowoczesne metody rozdzielania roztworów**

Name in English **Modern methods of liquid separation**

Main field of study (if applicable): Chemical and process engineering
Specialization (if applicable): Applied chemical engineering
Level and form of studies: ~~1st/~~ 2nd* level, full-time / ~~part-time~~*
Kind of subject: obligatory ~~/ optional / university-wide~~*
Subject code ICC024010
Group of courses ~~YES~~ / NO*

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	~~Examination /~~ crediting with grade*	Examination / crediting with grade*	~~Examination /~~ crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Chemical engineering
2. Physical chemistry
3.

SUBJECT OBJECTIVES

C1 Introduction with an understanding of the basics of membrane processes
C2 Introduction with membrane processes application
C3 To familiarize students with mathematical description of mass transfer through the membranę
C4 To familiarize students with the design of membrane systems
C5 To familiarize students with basics of separation techniques (ion-exchange chromatography, affinity chromatography, electrophoresis, cristallization)

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 - knows the basic membrane processes, membrane types, types of the membrane modules

PEK_W02 - knows the use of membrane processes in a variety of industries and daily life

PEK_W03 - knows the basics of mass transport in membranes

PEK_W04 - knows the basic modes of membrane techniques

PEK_W05 - has a basic knowledge about the design of membrane units

PEK_W06 – knows basics of separation techniques (ion-exchange chromatography, affinity chromatography, electrophoresis, cristallization)

relating to skills:

PEK_U01 – is able to calculate separation parameters and select membrane module

PEK_U02 – is able to carry out an experiment of mass cristallization

PEK_U03 – is able to use equipment for electrophoresis and chromatography

PROGRAMME CONTENT

	Form of classes - lecture	**Number ohours**
Lec 1	Introduction. Basic information about the separation processes	1
Lec 2	The definition of the membrane. Driving forces. Basic concepts: selectivity, stream. The membrane types. Organic membranes. Inorganic membranes. The design of membrane modules. Modules tubular capillary hollow-fiber, plate, spiral, dynamic.	1
Lec 3	Basics of membrane installation design. Modes of operation of the plant. Economic analysis.	1
Lec 4	Resistance of mass transport in membrane processes. Concentration polarization. Fouling. Scaling. Ways to improve the performance of membrane separation. Modeling of mass transport in the membrane. Model of transport in the pores. Solution-diffusion model.	1
Lec 5	Pressure driven memrane processes. Microfiltration and its application.	1
Lec 6	Ultrafiltration and nanofiltration – basics of the processes and practical application	1
Lec 7	Reverse osmosis. Basics of the proces and application	1
Lec 8	Diffusive membrane processes. Pervaporation, dialysis. Application.	1
Lec 9	Gas and vapour separation. Basics of the proces and application	1
Lec 10	Electric membrane processes. Electrodialysis. Basics of the proces and application	1
Lec 11	Chromatography techniques. Ion-exchange chromatography. Affinity chromatography.	1
Lec 12	Cristallization techniques	1
Lec 13	Sorption processes. Selective sorbents	1
Lec	Modern extraction techniques (supercritical extraction, ionic liquid	1

14	extration)	
Lec 15	Short repetition	1
	Total hours	30

Form of classes - laboratory		Number of hours
Lab 1	Cross flow ultrafiltration	5
Lab 2	Separation of liquids by pervaporation	5
Lab 3	Separation with the use of membranę contactor	5
Lab 4	Crystallization periodic, an exemplary inorganic salt: sodium sulfate decahydrate	5
Lab 5	Column chromatography, selective separation of metals	5
Lab6	Ionic luquid extration	2
Lab7	Electrophoresis	3
	Total hours	30

TEACHING TOOLS USED

N1. Lecture and multimedia presentation

N2 Installation presentation

N3 Performance of experiments

N4 Performance of report

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P (lecture)	PEK_W01 – PEK_W06	crediting with grade
F (laboratory)	PEK_U01 – PEK_U03	crediting with grade

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Bodzek, Techniki membranowe w ochronie środowiska
[2] R.Rautenbach, Procesy membranowe
[3] A. Narębska, Techniki membranowe

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. hab. Anna Witek-Krowiak anna.witek@pwr.wroc.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Modern methods of liquid separation

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and process engineering

AND SPECIALIZATION Applied chemical engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge)				
PEK_W01	K2Aic_W03	C1	Lec1-Lec4, Lec7-Lec9	N1, N2
PEK_W02	K2Aic_W03	C1	Lec10-Lec14	N1
PEK_W03	K2Aic_W03	C3	Lec5	N1
PEK_W04	K2Aic_W03	C4	Lec6	N1
PEK_W05	K2Aic_W03	C4	Lec6	N1
PEK_W06	K2Aic_W03	C5	Lec 11-14	N1
(skills)				
PEK_U01	K2Aic2_U02	C1,C2	Lab 1-3	N3, N3
PEK_U02	K2Aic2_U02	C5	Lab 4	N3, N3
PEK_U03	K2Aic2_U02	C5	Lab 5-7	N3, N3

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

Faculty of Chemistry

SUBJECT CARD

Name in Polish Nowoczesne tendencje zarządzania

Name in English **Modern tendencies in management**

Main field of study (if applicable): …….

Specialization (if applicable): ……..

Level and form of studies: 2nd level, full-time

Kind of subject:

Subject code **ZMZ000383**

Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	0,5				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. None
2.
3.

SUBJECT OBJECTIVES

C1: To provide students with knowledge of the nature, characteristics and directions of development of management and the challenges facing the modern management.

C2: To familiarize students with selected concepts and methods that are regarded as useful in the management of the modern enterprise. To present the evidence and barriers to the implementation of these methods, the basic principles, theirs components, and the advantages and disadvantages as well.

C3: To provide students with knowledge about the values important for modern enterprises that are taken into consideration in the management process.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

Student:

PEK_W01: has a basic knowledge of management processes: can explain the nature and object management and identify the basic problems of management.

PEK_W02: has knowledge of the characteristics and directions of the contemporary management development and of the values relevant to the modern enterprise taken into consideration in the management process.

PEK_W03: Knows the selected modern management concepts and methods (including TQM, CSR, outsourcing, controlling, benchmarking, CRM, lean management, BPR, process management, knowledge management, JIT, virtual organization and learning organization, change management, projects management, time based management, BSC). Recognizes and understands their nature, objectives, conditions and barriers to their implementation, their basic components, and the advantages and disadvantages of their implementation as well.

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Introduction: the nature, object and history of management.	2
Lec 2	Challenges for the contemporary management (globalization and changes in the business environment, the idea of sustainable development). Characteristics and trends of contemporary management (focusing on customers, process approach, network cooperation, etc.).	2
Lec 3 – Lec 5	Chosen modern management concepts and methods (CSR, outsourcing, controlling, benchmarking, CRM, lean management, BPR, process management, knowledge management, JIT, virtual organization and learning organization, TQM, value based management, BSC etc.)	6
Lec 6 – Lec 7	The values relevant to the modern enterprise taken into account in the management process (management of cultural diversity, management of small businesses, family business management, management of information systems, management of communication in organization, time management, business ethics etc.)	4
Lec 8		1
	Total hours	15

Form of classes - class		**Number of hours**
Cl 1		
Cl 2		
Cl 3		
	Total hours	

Form of classes - laboratory		**Number of hours**
Lab 1		
Lab 2		
Lab 3		

	Total hours	

Form of classes - project		Number of hours
Proj 1		
Proj 2		
Proj 3		
	Total hours	

Form of classes - seminar		Number of hours
Sem 1		
Sem 2		
Sem 3		
	Total hours	

TEACHING TOOLS USED

N1. Presentation of knowledge in the form of direct communication (lecture) - audio-visual media (slides, computer projector)
N2. Lecture materials (synthesis) available in electronic form.
N3. Case studies.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_W01 – PEK_W03	Written colloquium
C=**=100% F1**		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[4] Brilman J.: Nowoczesne koncepcje i metody zarządzania, Polskie Wyd. Ekonomiczne, Warszawa 2002.
[5] *Współczesne metody zarządzania w teorii i praktyce*, pod red. M. Hopeja i Z. Krala, Oficyna Wydawnicza PWr, Wrocław 2011.
[6] Zimniewicz K., *Współczesne koncepcje i metody zarządzania*, PWE, Warszawa 2009.

SECONDARY LITERATURE:

[9] Bielski M.: *Podstawy teorii organizacji i zarządzania*, C. H. Beck, Warszawa 2004.
[10] Drucker P.F., *Praktyka zarządzania*, Wyd. Nowoczesność, Warszawa 1994.
[11] *Podstawy nauki o przedsiębiorstwie*, red. J. Lichtarski, Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław 2007.
[12] *Zarządzanie. Teoria i praktyka*, pod red. A.K. Koźmińskiego i W. Piotrowskiego, PWN, Warszawa 1995.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Anna Zabłocka-Kluczka, PhD. Eng., anna.zablocka-kluczka@gmail.com

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Modern tendencies in management
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY ……..
AND SPECIALIZATION ……..

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)				
PEK_W02				
PEK_W03				
…				
PEK_U01 (skills)				
PEK_U02				
…				
PEK_K01 (competences)				
PEK_K02				
…				

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED	
SUBJECT CARD	
Name in Polish	**Nowe trendy w inżynierii chemicznej**
Name in English	**New concepts and solutions in chemical engineering**
Main field of study (if applicable):	Inżynieria chemiczna i procesowa
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**selectable**
Subject code	ICC020011
Group of courses	**NO**

*niepotrzebne usunąć

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	60				
Form of crediting	credit				
For group of courses mark (X) final course					
Number of ECTS points	4				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	2				

*delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of physics, chemistry and chemical engineering.

SUBJECT OBJECTIVES	
C1	To understand role of chemical engineering in modern global economy.
C2	To understand direction of development of chemical engineering.
C3	To understand role of nanotechnology in chemical industry.
C4	To understand role of advanced analytical methods in chemical industry.
C5	To understand role of advanced computer modeling methods in chemical industry.

SUBJECT EDUCATIONAL EFFECTS

Related to knowledge:
The person who completed the course:
P2P_W01 – knows the fundamental challenges in chemical industry,
P2P_W03 – knows advanced computational and analytical methods used in chemical engineering,
P2P_W07 – understands the role of new technologies in the design of technological processes,
P2A_W05 – knows directions of development of new technologies in chemical engineering.

Related to skills:
The person who completed the course:
P2K_U01 - is able to find in the literature information concerning advances in chemical engineering,
P2K_U02 – is able to propose application of new technologies in chemical industry,
P2K_U07 – is able to identify directions of development of chemical engineering.

With a range of social skills:
The person who completed the course:
P2K_K01 - is able to work in a group consisting of several people interchanging and formulating opinions

PROGRAMME CONTENT		
Form of classes - project		**Number of hours**
Lec1	Challenges of the XXI century.	2
Lec2	Advanced analytical methods process I: spectrometric methods in the analysis of the crystallization process.	2
Lec3	Advanced analytical methods for process II: observations in the near-infrared spectroscopy and image analysis in search of pollution during the production of drugs.	2
Lec4	The intensification of the process: nanofluids.	2
Lec5	Nano-biocomposites in chemical engineering.	2
Lec6	Design and development of targeted drug carriers.	2

Lec7	Energy industry based on hydrogen I: methods of energy generation.	2
Lec8	Energy industry based on hydrogen II: storage.	2
Lec9	Nanotechnology in water treatment technologies.	2
Lec10	Radioactive waste treatment.	2
Lec11	Non-invasive measurement methods: tomographic methods, laser methods, advanced image analysis.	2
Lec12	Novel methods of sequestration, distribution and processing of carbon dioxide.	2
Lec13	Microreactors I.	2
Lec14	Microreactors II.	2
Lec15	The future of chemical engineering.	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture
N2	Consultation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P (lecture)	PEK_W01-W15	exam
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 21,5 pnt. **4,0** if P = 20 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: 6. Wirth Thomas, Microreactors in Organic Chemistry and Catalysis, Wiley-Vch, Singapore, 2013 7. Jighai Li, Advances in Chemical Engineering: Characterization of Flow, Particles and Interfaces, Academic Press, 2009. **SECONDARY LITERATURE:** [1] Internet sources

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **BIOTECHNOLOGICAL ENGINEERING** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **BIOTECHNOLOGY**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) P2K_W01	K2Aic3_W07	C1, C2	Wy1- Wy15	N1-N2
P2K_W03	K2Aic3_W07	C4, C5	Wy1- Wy15	N1-N2
P2K_W07	K2Aic3_W07	C1-C5	Wy1- Wy15	N1-N2
P2A_W05	K2Aic3_W07	C2	Wy1- Wy15	N1-N2
(skills) P2K_U01	K2Aic3_W07	C1	Wy1- Wy15	N1-N2
P2K_U02	K2Aic3_W07	C1-C5	Wy1- Wy15	N1-N2
P2A_U07	K2Aic3_W07	C1, C2	Wy1- Wy15	N1-N2
P2K_K01	K2Aic3_W07	C1-C5	Wy1- Wy15	N1-N2

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT of HUMANITIES

SUBJECT CARD

Name in Polish **Filozofia nauki i techniki**

Name in English **Philosophy of science and technology**

Main field of study (if applicable):

Specialization (if applicable):

Level and form of studies: 2nd level, full-time

Kind of subject: obligatory

Subject code FLC023004

Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				
Number of hours of total student workload (CNPS)	30				
Form of crediting	crediting with grade				
For group of courses mark (X) final course					
Number of ECTS points	1				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	0.5				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Non

SUBJECT OBJECTIVES

C1 To acquaint students with specificity of philosophical reflection about science and technology.
C2 Systematize and deepen the knowledge of the basic methods of inference that regulate and organize our knowledge.
C3 Performance considerations of engineer's activity and to present the issue of social responsibility in science and technology.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_ HUM W07 The student gains knowledge of the basic methods of inference (deduction, induction and abduction).

PEK_ HUM W08 The student has knowledge that is essential to understanding and interpreting social and philosophical considerations of engineer's activity.

Relating to social competences:

PEK_HUM K01 The student is aware of the importance of understanding non-technical aspects and of engineer's activity, its consequences and responsibility for undertaken decisions.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1,2	What is the science and technology? The basic concepts and principles of the philosophy of science and philosophy of technology.	2
Lec 3	The main criteria of scientific knowledge.	1
Lec 4	The tradition of doing science from the point of view of the theory	1
Lec 5	The tradition of doing science from the point of view of the experiment.	1
Lec 6	The basic methods of inference – induction.	1
Lec 7	The basic methods of inference – deduction.	1
Lec 8	The basic methods of inference – abduction.	1
Lec 9,10	The main objectives and functions of science and technology from the point of view of classical philosophy of science.	2
Lec 11	The main aims and functions of science and technology from the point of view of the sociology of scientific knowledge.	1
Lec 12, 13	The concept of science laboratory.	2
Lec 14, 15	The problem of social responsibility of science and technology.	2
	Total hours	15

Form of classes – class		**Number of hours**
Cl 1		
Cl 2		
Cl 3		
Cl 4		
..		
	Total hours	

Form of classes – laboratory		**Number of hours**
Lab1		
Lab2		
Lab3		
Lab4		
Lab5		
…		
	Total hours	

Form of classes – Project		**Number of hours**
Proj1		
Proj2		
Proj3		
Proj4		
…		

	Total hours	
Form of classes – seminar		**Number of hours**
Sem1		
Sem2		
Sem3		
…		
	Total hours	

TEACHING TOOLS USED

N1. Multimedia presentation.
N2. Lecture
N3. Interactive lecture

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation(F – forming (during semester), P – concluding (at semester end)	Educationaleffectnumber	Way of evaluating educational effect achievement
F1	PEK_ HUM W07 PEK_ HUM W08 PEK_ HUM K01	Passing test, active participation in lectures
P=F1		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[7] E. Agazzi, *Dobro, zło i nauka. Etyczny wymiar działalności naukowo-technicznej*, Warszawa 1997;
[8] S. Blackburn, *Oksfordzki słownik filozoficzny*, Warszawa 2004;
[9] A. Chalmers, *Czym jest to, co zwiemy nauką*, Wrocław 1997;
[10] R. M. Chisholm, *Teoria poznania*,1994;
[11] Ch. Frankfort- Nachmiast, D. Nachmiast, *Metody badawcze w naukach społecznych*, Poznań 2001;
[12] A. Grobler, *Metodologia nauk*, Kraków 2004;
[13] M. Heidegger, *Budować, mieszkać, myśleć*, Warszawa 1977;
[14] T. Kuhn, *Dwa bieguny*, Warszawa 1985;
[15] B. Latour, *Polityka natury*, Warszawa 2009;
[16] K.R. Popper, *Wiedza obiektywna*, Warszawa 1992;
[17] J. Woleński, *Epistemologia*, Warszawa 2005.

SECONDARY LITERATURE:

[13] [1] D. Sobczyńska, P. Zeidler, *Nowy eksperymentalizm. Teoretycyzm. Reprezentacja*, Poznań 1994,
[14] P. Zeidler, *Spór o status poznawczy teorii*, Poznań 1992.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **Philosophy of science and technology** AND EDUCATIONAL EFFECTS IN THE FIELD OF TECHNICAL SCIENCES

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_ HUM W07; PEK_ HUM W08 (knowledge)	**T2A_W07** **T2A_W08**	C1, C2	Lec1-Lec9	N1, N2
PEK_HUMK01 (competences)	**T2A_K01**	C1	Lec1, Lec10-Lec15	N1, N2, N3

** - enter symbols for main-field-of-study/specialization educational effects

*** - from tableabove

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish **Aparatura procesowa**

Name in English **Process equipment**

Main field of study (if applicable): Chemical and Process Engineering
Specialization (if applicable): ……..
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code ICC024007
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	90		60		
Form of crediting	Examination		crediting with grade*		
For group of courses mark (X) final course					
Number of ECTS points	3		2		
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	1		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Chemical Engineering
2. Chemical Technology
3. Process Design

SUBJECT AIMS	
C1	Familiarization of students with technological process, apparatus and equipment which are the parts of technological system and production installation.
C2	Acquisition of knowledge on a work and construction of apparatus used for realization of heat, mass and flow processes
C3	Familiarization of students with the rules of designing and selection of apparatus, as well as selection of materials for construction of production installation for chemical industry.
C4	Familiarization of students with measurement and control apparatus, systems of automatic control in production installation. Familiarize students with health and safety regulations
C5	Familiarization of students with systems of raw material and energy and delivery.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows, what the technological process, technological system, production installation are; knows the role of apparatus and equipment in technological system and production installation,

PEK_W02 – knows the basic apparatus and equipment, in which the physical processes and chemical reactions are carried out; knows the devices for transportation of the materials, as well as the devices for storing raw materials, products, semi-finished products and wastes,

PEK_W03 – knows fundamentals on selection and design of basic apparatus and equipment, as well as the procedures for selection of constructional materials for production installation needs,

PEK_W04 – knows the rules of production installation equipping with measurement and control apparatus, steering systems and devices; knows the rules of ensuring technical safety of production installation,

PEK_W05 – knows the procedures of raw materials and energy supply.

relating to skills:

PEK_U01 – student can plan and carry out experiments, do measurements of specific magnitudes, interpret the results and make conclusions

PEK_U02 – student is able to determine the dependence of installation efficiency on process parameters

PEK_U03 – student can select preliminarily the measurement and control equipment for production installation

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Technological process, unit operations and processes, technological system, production installation. Rules of apparatus and equipment selection.	2
Lec 2	Devices for raw materials, products, semi-finished products and wastes storing (warehouses, stockpiles, gas and liquid tanks).	2
Lec 3	Devices for materials transportation (conveyors, pumps, blowers, pipelines and fittings).	2
Lec 4	Apparatus for grinding, mixing, sedimentation, filtration, spinning, gas compression.	2
Lec 5	Heat transfer apparatus.	2
Lec 6	Apparatus for dissolution, evaporation, concentration of solutions.	2
Lec 7	Apparatus for absorption, desorption, adsorption.	2
Lec 8	Apparatus for extraction and distillation.	2
Lec 9	Apparatus for crystallization.	2
Lec 10	Batch reactor and continuous stirred tank reactor; reactors working in conditions of complete intermixing or with plug flow.	2
Lec 11	Process apparatus which are designed individually. Rules of apparatus design.	2
Lec 12	Constructional materials selection.	2

Lec 13	Measuring and control apparatus.	2
Lec 14	Technical safety of production installation.	2
Lec 15	Systems of raw materials and energy supply for production installations.	2
	Total hours	**30**

Form of classes - laboratory		**Number of hours**
Lab 1	Organization classes. Health and safety regulations. Description of passing conditions. Presentation of experimental installations.	3
Lab 2	Examination of plate column for the process of rectification.	3
Lab 3	Examination of packed column for the process of rectification.	3
Lab 4	Absorption of carbon dioxide in packed column.	3
Lab 5	Liquid-liquid extraction in packed column.	3
Lab 6	Isothermal adsorption in liquid-solid system.	3
Lab 7	Heat transfer during film and drop condensation.	3
Lab 8	Dynamics and heat transfer in process of fluidization.	3
Lab 9	Ball mill and mesh analysis.	3
Lab 10	Liquid mixer examination.	3
…		
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation
N2. Performance of an experiment
N3. Preparation of a report

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P-lecture	PEK_W01 – PEK_W05	Exam

PRIMARY AND SECONDARY LITERATURE

BASIC LITERATURE:

[18] J. Warych, Aparatura chemiczna i procesowa, Ofic. Wyd. PW, Warszawa 2004.
[19] H. Błasiński, B. Młodziński, Aparatura przemysłu chemicznego, WNT, Warszawa, 1983.
[20] J. Pikoń, Aparatura chemiczna, PWN, Warszawa, 1978.
[21] D.W. Green, R.H. Perry (red.), Perry's chemical engineers' handbook, 8th ed., McGraw–Hill, 2007.
[22] K. Szmidt–Szałowski, M. Szafran, E. Bobryk, J. Sentek, Technologia chemiczna. Przemysł nieorganiczny, PWN, Warszawa, 2013.

ADDITIONAL LITERATURE:

[15] U. Bröckel, W. Meier, G. Wagner (red.), Product design and engineering. Vol. 1: Basics and technologies, Vol. 2: Rawmaterials, additives and application, Wiley, 2007.
[16] G.H. Vogel, Process Development. From the initial idea to the chemical production plant,

Wiley, 2005.
[17] G.I. Wells, L.M. Rose, The art of chemical process design, Elsevier, 1986.
[18] W.D. Seider, Process design principles, J.W.&S., 1999.
[19] K. Szmidt–Szałowski, J. Sentek, J Raabe, E. Bobryk, Podstawy technologii chemicznej. Procesy w przemyśle nieorganicznym, Ofic. Wyd. PW, Warszawa, 2004.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Process equipment

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and Process Engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01 (knowledge)	K2Aic_W03	C1	Wy1	N1
PEK_W02	K2Aic_W03	C2	Wy2–Wy10	N1
PEK_W03	K2Aic_W03	C3	Wy11, Wy12	N1
PEK_W04	K2Aic_W03	C4	Wy13, Wy14	N1
PEK_W05	K2Aic_W03	C5	Wy15	N1
…				
PEK_U01 (skills)	K2Aic_U04	C1,C2,C4	La2-La10	N2,N3
PEK_U02	K2Aic_U04	C1,C2,C4	La2-La10	N2,N3
PEK_U03	K2Aic_U04	C1,C2,C4	La2-La10	N2,N3

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Modelowanie procesów w inżynierii chemicznej**
Name in English	**Process modelling in chemical engineering**
Main field of study (if applicable)	**Chemical and Process Engineering**
Specialization (if applicable)	**Applied Chemical Engineering**
Level and form of studies:	**2st level, full-time**
Kind of subject	**obligatory**
Subject code	**ICC024014**
Group of courses	**NO**

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	Examination / crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	0.5		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

8. Basis of chemical engineering
9. Information Technologies in Design I
10. Information Technologies in Design II
11. Programs for simulation and design of chemical plants

SUBJECT OBJECTIVES	
C1	Know how to model physical properties of fluid and phase equilibrium
C2	Know how to model chemical processes
C3	Be able to calculate physical properties of fluid and phase equilibrium using Matlab, Aspen Plus, and Excel
C4	Be able to simulate of chemical processes using Matlab, Simulink, Aspen Batch Distillation

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_W01 – Know rules of calculation of fluid physical properties and phase equilibrium

PEK_W02 – Know modeling principles and selected models of chemical processes

Relating to skills:

PEK_U01 – Be able to calculate of fluid physical properties and phase equilibrium using Matlab, Aspen Properties, and Excel

PEK_U02 – Be able to simulate of chemical processes using Matlab, Simulink, Aspen Batch Distillation

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec1	Introduction to process modeling	1
Lec2	Modeling of fluid physical properties	1
Lec3	Modeling of phase equilibrium	1
Lec4	Principles of chemical process modeling	1
Lec5	Models of selected chemical processes	1
Lec6	Models of selected chemical processes	1
Lec7	Models of selected chemical processes	1
Lec8	Models of staged processes	1
Lec9	Models of staged processes	1
Lec10	Models of distributed parameter processes	1
Lec11	Input-output models.	1
Lec12	Linearization of nonlinear models. Deviation variables.	1
Lec13	Transfer function	1
Lec14	Dynamic response of processes	1
Lec15	Test	1
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab 1	Simulation of steady and unsteady states of distillation process. Example.	2
Lab 2	Simulation of steady and unsteady states of distillation process. Problem.	2
Lab 3	Calculation of physical properties	2
Lab 4	Modeling and simulation of steady and unsteady states of chemical reactor	2
Lab5	Detailed simulation of steady and unsteady states of chemical reactor. Example.	2
Lab6	Detailed simulation of steady and unsteady states of chemical reactor. Problem.	2
Lab7	Calculation of phase equilibrium. Example.	2
Lab8	Test I	2
Lab9	Calculation of phase equilibrium. Problem.	2

Lab10	Modeling and simulation of simple distillation	2
Lab11	Modeling and simulation of batch distillation. Example.	2
Lab12	Modeling and simulation of batch distillation. Problem.	2
Lab13	Detailed simulation of batch distillation. Example.	2
Lab14	Detailed simulation of batch distillation. Problem.	2
Lab15	Test II	2
	Total hours	30

TEACHING TOOLS USED	
N1	Lecture with multimedia presentation
N2	Mathematical tools for modeling and analysis
N3	Software packages Matlab, Aspen Properties, and Excel for calculation of physical properties and phase equilibrium
N4	Software packages Matlab, Simulink, Aspen Plus, Aspen Batch Distillation, and Comsol Multiphysics for simulation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C (lecture)	PEK_W01 – PEK_W02	Examination / Test
F1 (laboratory)	PEK_U01 – PEK_U02	Test I
F2 (laboratory)	PEK_U01 – PEK_U02	Test II
C (laboratory) = (F1+F2)/2, all forming tests and a project have to be passed		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[23] B. Roffel, B. Betlem. *Process Dynamics and Control. Modeling for Control and Prediction.*, John Wiley & Sons, Ltd, 2006

[24] W. Luyben. *Process Modeling, Simulation, and Control for Chemical Engineers*, McGraw-Hill Inc., 1973

[25] S. Sandler. *Chemical and Engineerings Thermodynamics*, John Wiley and Sons, 1989

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Process modelling in chemical engineering

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and Process Engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic1_W01	C1	Lec1 – Lec4, Lec15	N1
PEK_W02	K2Aic1_W01	C2	Lec1, Lec4 – Lec15	N1
(skills) PEK_U01	K2Aic1_U01	C3	Lab1 – Lab15	N2, N3
PEK_U02	K2Aic1_U01	C4	Lab1, Lab2, Lba4 – Lab6, Lab8, La10b – Lab15	N2, N3, N4

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED

SUBJECT CARD

Name in Polish:	**Odnawialne źródła energii**
Name in English	**Renewable energy sources**
Main field of study (if applicable):	**Inżynieria chemiczna i procesowa**
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject::	**obligatory**
Subject code:	**ICC024005**
Group of courses:	**No**

*delete if not related

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15				15
Number of hours of total student workload (CNPS)	60				30
Form of crediting	Exam				Credited with grade
For group of courses mark (X) final course					
Number of ECTS points	2				1
including number of ECTS points for practical (P) classes					1
including number of ECTS points for direct teacher-student contact (BK) classes	0,5				0,25

* delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of such courses as physics, chemistry, chemical engineering.
2. Understanding of the notions such as energy, power and conservation of energy
3. Understanding of basic of chemical thermodynamics (first principle, heat of reaction)

SUBJECT OBJECTIVES

C1	To examine the current state of energy sources.

C2	To understand the future trends in energy production.
C3	To understand the principles of operation and capabilities of renewable energy production.
C4	To obtain knowledge of the basic techniques used in production of energy from different sources.
C5	To understand the principles of efficient energy applications.

SUBJECT EDUCATIONAL EFFECTS

The scope of knowledge:
The person who completed the course:
PEK_W01 – is familiar with the term "renewable energy" and types of energy sources
PEK_W02 - knows the rules and methods of applications of conventional end renewable energies
PEK_W03 - knows the sources of conventional end renewable energies
PEK_W04 - knows the basic methodology of design of systems for renewable energy production
PEK_W05 – knows the current trends in renewable energy research
PEK_W06 – is able to give example of applications of renewable energy and discuss them in detail

The range of skills:
The person who completed the course:
PEK_U01 – is able to analyze the energy efficiency
PEK_U02 - is able to propose new projects in renewable energy applications
PEK_U03 - is able to compare different energy sources from the point of view of their efficiency
PEK_U04 – is able to describe mathematically interplay between different energy forms

With a range of social skills:
The person who completed the course:
PEK_K01 - is able to work in a group consisting of several people performing analysis as well as modelling using computer

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Le1	Introduction to the topic of the lecture. The idea of green and renewable energy. Fossil fuels. Coal, petroleum and natural gas.	2
Le2	Nuclear power. Short history, critical mass and safety issues.	2
Le3	Biofuels.	1
Le4	Geothermal energy. Wind power.	2
Le5	Hydropower. Energy storage.	2
Le6	Solar radiation and solar thermal.	2
Le7	Photovoltaics.	2
Le8	Energy conservation and climate changes.	2
	Total hours	**15**

Form of classes - seminar		Number of hours
Sem1	Introduction to the topic of the lecture. The idea of green and renewable energy. Fossil fuels. Coal, petroleum and natural gas.	2
Sem2	Nuclear power. Short history, critical mass and safety issues.	2
Sem3	Energy conservation and Efficiency.	2
Sem4	Geothermal energy. Wind power.	2
Sem5	Hydropower. Energy storage.	2
Sem6	Solar radiation and solar thermal.	2
Sem7	Photovoltaics.	2
Sem8	Climate changes. Politics and public opinion.	1
	Total hours	15

TEACHING TOOLS USED	
N1	Lecture .
N2	Discussion.
N3	Internet search.
N4	Consultation.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1 (lecture)	PEK_W01-W07	Written evaluation
P2 (seminar)	PEK_U01-U05	Evaluation of oral presentation of different topics
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 20 pnt. **4,0** if P = 20,5 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE [1] Robert Ehrlich, Renewable energy. A first course. CRC Press 2013 **SECONDARY LITERATURE:** Internet sources.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **Renewable energies**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Chemical engineering**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01	K2Aic_W06	C1-C2	Le1, Le8	N1
PEK_W02	K2Aic_W06	C1-C2	Le1-Le3	N1
PEK_W03	K2Aic_W06	C3-C5	Le1-Le3	N1
PEK_W04	K2Aic_W06	C3-C5	Le4-Le7	N1
PEK_W05	K2Aic_W06	C3-C5	Le4-Le7	N1
PEK_W06	K2Aic_W06	C3-C5	Le4-Le7	N1
(skills) PEK_U01	K2Aic_W06	C1-C2	La1-La3, L8	N2-N4
PEK_U02	K2Aic_W06	C3-C7	Le4-Le7	N2-N4
PEK_U03	K2Aic_W06	C3-C7	Le3-Le7	N2-N4
PEK_U04	K2Aic_W06	C3-C7	Le2-Le7	N2-N4
(social skills) PEK_K01	K2Aic_W06			

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

Wrocław University of Technology
FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Programy symulacji i projektowania instalacji chemicznych**
Name in English	**Software for simulation and design of chemical systems**
Main field of study (if applicable)	**Chemical and Process Engineering**
Specialization (if applicable)	**Applied chemical engineering**
Level and form of studies:	**2st level, full-time**
Kind of subject	**obligatory**
Subject code	**ICC024004**
Group of courses	**NO**

*delete as applicable

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)			30		
Number of hours of total student workload (CNPS)			60		
Form of crediting			crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points			2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes			1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

12. Basis of chemical engineering

SUBJECT OBJECTIVES	
C1	Acquainting with modern software for simulation and design of chemical plants
C2	Know how to build models of unit operation and chemical plant
C3	Be able to perform simulation and design computations
C4	Know how to search and process calculation results

SUBJECT EDUCATIONAL EFFECTS

Relating to skills:

PEK_U01 – Be able to build mathematical model of process and perform simulation computation

PEK_U02 – Be able to perform sensitivity analysis, design specifications and optimization calculation

PEK_U03 – Be able to perform design calculation for some unit operations

PEK_U04 – Be able to perform physical property analysis and determine physical data needed for computation

PROGRAMME CONTENT

Form of classes - laboratory		Number of hours
Lab1	Introduction. Flash simulation.	2
Lab2	Distillation process simulation	2
Lab3	Sensitivity analysis	2
Lab4	Design specification	2
Lab5	Physical property analysis	2
Lab6	Physical property estimation	2
Lab7	Test I	2
Lab8	Simulation and design of heat exhanger	2
Lab9	Plant simulation	2
Lab10	Chemical reactor simulation	2
Lab11	Chemical plant optimization	2
Lab12	Design of distillation column	2
Lab13	Detailed design of heat exhanger	2
Lab14	Parameter regresion	2
Lab15	Test II	2
	Total hours	30

TEACHING TOOLS USED	
N1	Software AspenPlus for simulation and design
N2	Software Conceptual Design for distillation column design
N3	Software Exhanger Design and Rating for heat exhanger design
N4	Software Aspen Properties for calculation of physical properties and phase equilibrium

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation F – forming (during semester), C – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement

F1 (laboratory)	PEK_U01, PEK_U02, PEK_U04	Test I
F2 (laboratory)	PEK_U01 – PEK_U04	Test II
C (laboratory) = (F1+F2)/2, all forming tests and a project have to be passed		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[26] A. Jeżowska, J. Jeżowski, *Wprowadzenie do projektowania systemów technologii chemicznej. Część II. Przykłady*., Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 2002

[27] R. Shefflan, Teach Yourself the Basics of AspenPlus, John Wiley & Sons, 2011

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Programs for simulation and design of chemical plants

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical and Process Engineering

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(skills) PEK_U01	K2Aic_U03	C1, C2, C3, C4	Lab1, Lab2, Lab8 – Lab10	N1, N4
PEK_U02	K2Aic_U03	C3, C4	Lab3, Lab4, Lab11	N1, N4
PEK_U03	K2Aic_U03	C1, C3, C4	Lab8, Lab12, Lab13	N1, N2, N3, N4
PEK_U04	K2Aic_U03	C1, C2, C4	Lab5, Lab6, Lab14	N1, N4

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED

SUBJECT CARD

Name in Polish:	*Thermodynamika statystyczna w modelowaniu molekularnym*
Name in English	**Statistical Thermodynamics in Molecular Modeling**
Main field of study (if applicable):	**Inżynieria chemiczna i procesowa**
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**Non-obligatory**
Subject code:	**ICC020008**
Group of courses:	**No**

*delete if not related

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	60				
Form of crediting	credit				
For group of courses mark (X) final course					
Number of ECTS points	2				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	2				

* delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of such courses as physics, chemistry, chemical engineering.
2. Ability to understand numerical algorithms
3. Understanding of basic of thermodynamics (first principle, heat of reaction, second principle)

SUBJECT OBJECTIVES

C1	To understand the basis of statistical thermodynamics.
C2	To understand the application for numerical modeling.

C3	To understand Monte Carlo methodology
C4	To obtain knowledge of the basic numerical techniques used in modeling
C5	To understand the principles of numerical modeling with multiscale approach.

SUBJECT EDUCATIONAL EFFECTS

The scope of knowledge:
The person who completed the course:
PEK_W01 – is familiar with the statistical physics methodology
PEK_W02 – is familiar with the methods of numerical modeling
PEK_W03 – knows the Monte Carlo technique
PEK_W04 – knows the basic methodology of multiscale modeling
PEK_W05 – understands advantages of numerical modeling
PEK_W06 – is able to model thermodynamical properties of any atomistic model

The range of skills:
The person who completed the course:
PEK_U01 – is able to find in literature information related to numerical modeling
PEK_U02 - is able to present and evaluate applications and results obtained by numerical simulations
PEK_U03 - is able to propose a numerical approach to model any molecular system
PEK_U04 – is able to run modeling software and analyze the results

With a range of social skills:
The person who completed the course:
PEK_K01 - is able to work in a group consisting of several people performing analysis as well as modeling using computer

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Le1	From microscopic to macroscopic. Molecular interpretation of entropy	4
Le2	Notion of statistical ensemble. Deterministic versus probabilistic approach.	4
Le3	Distribution of Maxwell-Boltzmann and its quantum limits. Classical versus quantum approach.	4
Le4	Monte Carlo methods. Ergodic hypothesis.	4
Le5	Multi-scale modeling basis. Interaction models	4
Le6	Maxwell-Boltzmann distribution in atomistic modeling	4
Le7	Molecular modeling of fluids in confined nan-geometry	4
Le8	Fluctuation, correlations and errors in molecular modeling	2
	Total hours	**30**

Form of classes - seminar		Number of hours

TEACHING TOOLS USED	
N1	Lecture
N2	Consultation

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
P1 (lecture)	PEK_W01-W06	Written evaluation
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 21,5 pnt. **4,0** if P = 20 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE [1] Andrew R. Leach, Molecular modeling. Principles and applications, Person education Limited 2001 **SECONDARY LITERATURE:** Allan Hinchliff, Molecular Modelling for Beginners, Wiley 2010

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT **Chemical nanoegineering** AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Chemical engineering**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
(knowledge) PEK_W01		C1	Le1-Le3	N1-N2
PEK_W02		C2	Le2-Le5	N1-N2
PEK_W03		C2,C3,C4	Le2-Le5	N1-N2
PEK_W04		C2,C3,C5	Le2-Le5	N1-N2
PEK_W05		C2,C4	Le3-Le6	N1-N2
PEK_W06		C5	Le4-Le8	N1-N2
(skills) PEK_U01		C1	La1-La3	N2
PEK_U02		C2, C3,C3	La2-La4	N2
PEK_U03		C2, C4	La5-La8	N2
PEK_U04		C2,C5	La7-Le8	N2
(social skills) PEK_K01				

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above

FACULTY OF CHEMISTRY / DEPARTMENT OF CHEMICAL AND BIOCHEMICAL PROCESSED	
SUBJECT CARD	
Name in Polish	**Zjawiska transportu w procesach chemicznych**
Name in English	**Transport phenomena in chemical processes**
Main field of study (if applicable):	**Inżynieria Chemiczna i Procesowa**
Specialization (if applicable):	**Applied chemical engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**ICC024006**
Group of courses	**NO**

*niepotrzebne usunąć

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	90				
Form of crediting	Exam				
For group of courses mark (X) final course					
Number of ECTS points	3				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	1				

*delete if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

13. Chemical engineering
14. Physics
15. Mathematics – partial differential equations.

SUBJECT OBJECTIVES	
C1	Understanding the differences between intensive and extensive properties.
C2	To obtain knowledge of transport processes definitions and rules.
C3	To obtain knowledge of partial differential equations and numerical methods of solving.
C4	To obtain knowledge of momentum, heat and mass transport mechanisms.

SUBJECT EDUCATIONAL EFFECTS
Related to knowledge: The person who completed the course: PEK_W01 – knows and understands the division of physical properties into extensive and intensive ones. PEK_W02 – knows and understands the physical background of transport processes of extensive properties described with partial differential equations. PEK_W03 – understands the idea of momentum, heat and mass transfer mechanisms.

PROGRAMME CONTENT		
Form of classes - project		**Number of hours**
Lec1	Extensive and intensive properties, various processes systems (open, close) presentation.	2
Lec2	Partial differential equations – basics.	2
Lec3	Numerical methods of solving the partial differential equations: finite difference / finite volume methods.	2
Lec4	Initial and boundary conditions.	2
Lec5	Single and multi-component systems.	2
Lec6	Equations of state	2
Lec7	Navier – Stokes equations. Energy conservation equation.	2
Lec8	Bernoulli equations. Viscosity.	2
Lec9	Flow characteristics.	2
Lec10	Heat transfer basics. Conduction, convection and radiation.	2
Lec11	Steady - state heat transfer.	2
Lec12	Unsteady – state heat transfer.	2
Lec13	Mass transfer definitions. Fick's law. Diffusion – basics information. Convective mass transfer.	2
Lec14	Diffusion in solids, gases and liquids.	2
Lec15	Simultaneous heat and mass transfer.	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation (F – forming (during semester), P –	Educational effect number	Way of evaluating educational effect achievement

concluding (at semester end)		
P1 (lecture)	PEK_W01-W03	exam
grade	**2,0** if P < 14,5 pnt. **3,0** if P= 14,5– 18,0 pnt. **3,5** if P = 18,5 – 21,5 pnt. **4,0** if P = 20 – 22 pnt. **4,5** if P = 22,5- 24,5 pnt. **5,0** if P = 25 - 27 pnt. **5,5** if P = 27,5-30 pnt.	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[28] Bird, R.B., Stewart, W.E. and Lightfoot, E.N., Transport Phenomena, various editions.
[29] Saatdjian E., Transport phenomena – equations and numerical solutions, Willey 2000.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Transport phenomena in chemical processes

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Industrial process engineering

Subject educational effect	**Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)****	**Subject objectives*****	**Programme content*****	**Teaching tool number*****
(knowledge) PEK_W01	T2A_W01	C1,C3	Lec1-Lec4	N1
PEK_W02	T2A_W03	C1,C2	Lec5 - Lec8	N1
PEK_W03	T2A_W03	C2	Lec9 – Lec15	N1

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above