FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Agrochemikalia i środki ochrony roślin**
Name in English	**Agrochemicals and plant health products**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**TCC24013**
Group of courses	**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)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	1		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

1. Basic chemistry and chemical technology
2. General knowledge on environmental protection
3. Basic laboratory skills

SUBJECT OBJECTIVES

C1 To provide students with a general knowledge of major agrochemicals classes and uses
C2 To provide student with a knowledge of agrochemical formulations, applications and management and disposal of wastes
C3 To provide students with a knowledge of the methods of analysis of agrochemicals

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:
PEK_W01– trainees will have a general knowledge of the most important aspects of the chemistry and technology of agrochemical formulations
PEK_W02 – student will have specialized knowledge about the of plant health products in the protection of food and fibre crops from weeds, insects and diseases
PEK_W03 – student will have a basic knowledge of legislation/regulations associated with plant protection products
Relating to skills:

PEK_U01 Trainees will be able to select and apply analytical methods to prepare and analyze residual agrochemicals present in water, plants and soil

PEK_U02 Students will be capable of selecting chromatographic system for the analysis of specific agrochemicals, in particular, type of column and detector and of setting up optimal parameters of their running

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Major agrochemical classes and uses: herbicides, insecticides, fungicides etc.	8
Lec 2	Formulation of agrochemicals: conventional and new-generation formulations, surfactants. Recent developments.	3
Lec 3	Packaging and application techniques for agrochemicals.	1
Lec 4	Waste management and disposal of agrochemicals.	2
Lec 5	Legislation and regulations. Regulatory requirements.	1
	Total hours	15

PROGRAMME CONTENT		
Form of classes - laboratory		**Number of hours**
Lab 1	Introductory class. Safety rules and equipment inventory. Pre-lab assignments. Grading. Schedule.	2
Lab 2	Soxhlet extraction of contaminated soil.	4
Lab 3	Solid phase extraction of agrochemicals.	4
Lab 4	QuEChERS method to examine pesticide residues in food.	4
Lab 5	Identification of agrochemicals by spectroscopic methods.	4
Lab 6	Identification of agrochemicals by GC/FID.	4
Lab 7	Identification of agrochemicals by GC/ECD.	4
Lab 8	Identification of agrochemicals by GC/MS.	4
	Total hours	**30**

TEACHING TOOLS USED
N1. Lectures with multimedia presentations N2. Equipment for extraction processes, spectroscopic and chromatographic analyses

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_U01 – PEK_U02	Tests
F2	PEK_U01 – PEK_U02	grade of experimental work (reports)
P1 (lecture)	PEK_W01 – PEK_W03	Written test and assignments
P2 (laboratory) Grade = (0.7 F1 + 0.3 F2)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Chemistry and Technology of Agrochemical Formulations D.A. Knowles, Springer Science+Business Media, B.V., 1998 [2] lectures [3]
SECONDARY LITERATURE:
[1] [2] [3]
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. inż. Piotr Rutkowski; piotr.rutkowski@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Agrochemicals and plant health products
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
CHEMICAL TECHNOLOGY
AND SPECIALIZATION **TECHNOLOGY OF FINE CHEMICALS**

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)	S2Atc3_W04	C1 – C2	Lec 1 – Lec 2	N1
PEK_W02	S2Atc3_W04	C1 – C2	Lec 1 – Lec 4	N1
PEK_W03	S2Atc3_W04	C1 – C2	Lec 5	N1
PEK_U01 (skills)	S2Atc3_U04	C3	Lab 1 – Lab 8	N2
PEK_U02	S2Atc3_U04	C3	Lab 6 – Lab 8	N2

** - 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 analityczne stosowane w analizie chemikaliów specjalistycznych**
Name in English	**Analytical Methods in Fine Chemicals**
Main field of study (if applicable)	**Chemical Technology**
Specialization (if applicable)	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**TCC024014**
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	0		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

1. Basic theoretical knowledge in a field of analytical methods and techniques – spectroscopic and chromatographic.
2. Basic theoretical and practical knowledge in a field of isolating various substances.
3. Ability to use basic laboratory glassware and equipment and to apply the safety rules of work in a chemical laboratory.
4. Fluency in performing chemical calculation.

SUBJECT OBJECTIVES	
C1	To acquaint student with the basics of fine chemicals and REACH regulation.
C2	To acquaint student with the basics concerning fine chemicals, as well as the theoretical and practical aspects of good laboratory practice (GLP) and good manufacture practice (GMP).
C3	To acquaint student with advanced methods and techniques of quantitative and qualitative analysis (physical, chromatographic, chemical, electrochemical and spectroscopic) utilized in different branches of industry related to fine chemicals.
C4	To acquaint student with various techniques of preparing samples of different origin for the analysis.
C5	To acquaint student with practical aspects of selected analytical methods and techniques (physical, chromatographic, chemical, electrochemical and spectroscopic) utilized in different branches of industry related to fine chemicals.
C6	To acquaint student with an analytical equipment and instruments, as well as principles of its operation.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

Student, who has completed the course:

PEK_W01	gained the knowledge concerning fine chemicals and REACH regulation.
PEK_W02	gained theoretical knowledge concerning application of the good laboratory practice (GLP) and good manufacturing practice (GMP) in terms of fine chemicals.
PEK_W03	is familiar with basic definitions and types of errors, their causes and means of elimination in the quantitative analysis of fine chemicals.
PEK_W04	is familiar with definitions and approaches of analytical data quality objectives associated with validation, remediation, assessment, accuracy,

	precision, specificity and sensitivity of analytical methods and techniques, and the basics of their control.
PEK_W05	gained a wide knowledge in a field of various methods and techniques utilized in a qualitative and quantitative analysis (physical, chromatographic, chemical, electrochemical, spectroscopic) of fine chemicals in different industrial branches.
PEK_W06	is familiar with the construction of the laboratory equipment and instruments which are used in analytical methods of fine chemicals in different industrial branches and understands its operating principles.

Relating to skills:

Student, who has completed the course:

PEK_U01	is able to apply principles of good laboratory practice (GLP).
PEK_U02	is able to apply various methods of isolation, extraction and separation of single components of the complex samples.
PEK_U03	is able to obtain an analytical sample in a proper manner, and prepare it to the various analytical processes.
PEK_U04	is able to select and apply appropriate analytical methods (physical, chromatographic, chemical, electrochemical, spectroscopic) to determine quality and purity of fine chemicals.
PEK_U05	is able to select and apply appropriate analytical methods (physical, chromatographic, chemical, electrochemical, spectroscopic) to perform quantitative analysis of fine chemicals.
PEK_U06	is able to select and operate appropriate laboratory equipment to perform instrumental analysis of fine chemicals.
PEK_U07	is able to prepare a report concerning performed experiments and obtained results, including their basic statistical analysis.

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	Introduction to fine chemicals and REACH regulation.	1
Lec 2	Analytical data quality objectives associated with GLP & GMP standards – validation, remediation, assessment, accuracy and precision.	1
Lec 3	General review of quantitative and qualitative analytical methods and techniques utilized in various branches of industry related to fine chemicals.	2
Lec 4	Analysis of active ingredient in different formulations, detection of its contaminations and chemical trace analysis.	2

Lec 5	Analytical methods and techniques used for food and food additives analysis.	2
Lec 6	Identification and testing of polymers, polymers additives, plastics and textiles.	2
Lec 7	Testing and analysis of coatings and thin films.	2
Lec 8	Physicochemical analysis of surfactants and other surface active agents.	2
Lec 9	Chemical analysis of colorants.	1
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab 1	Introductory class: the terms of the subject and its crediting, safety rules, rules of the chemical laboratory in terms of selected aspects of GLP. Release the equipment and glassware to the student.	2
Lab 2	Analysis of the active ingredients in a cosmetic product with spectrophotometric, spectrofluorometric and spectroscopic methods.	4
Lab 3	Shampoo characteristics with physical, chemical and chromatographic methods *(pH determination, identification of class and type of the surfactant; determination of sulphates, total chlorides, chelating agents and parabens).*	4
Lab 4	Analysis of fatty substances in a food product containing a mixture of fats of different origin with chemical methods and chromatographic techniques.	4
Lab 5	Determination of taste-odour food additives with chemical, electrochemical, spectrophotometric and chromatographic techniques.	4
Lab 6	Isolation of phenolic substances form plant material with SPE technique, their qualitative determination with chemical method, quantitative determination with spectrophotometric technique and/or chromatographic method, and estimation of their antioxidant activity with spectrophotometric technique.	4
Lab 7	Identification and analysis of polymer with physical and chemical methods and spectroscopic technique *(estimation of density, melting temperature, its type on the basses of its solubility, flame retardant and estimation of*	4

	resins oils content).	
Lab 8	Comparison of spectrophotometric and chromatographic method of colorant estimation in various products.	4
	Total hours	**30**

TEACHING TOOLS USED	
N1	Multimedial presentation.
N2	Performing experiments with different laboratory equipment and instruments.
N3	Preparation of report including analysis and interpretation of obtained results.

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_W05	Regular attendance and active participation during the lectures.
F2	PEK_U01 – PEK_U07	6 graded reports.
F3	PEK_W02, PEK_U01 – PEK_U07	6 graded admittance short test.
P1 (lecture)	PEK_W01– PEK_W05	Final test.
P2 (laboratory)	PEK_U01 – PEK_U07	Average grade of 6 reports grades (F2); average grade of 6 admittance short test grades (F3). **P2 = (0.6F2 + 0.4F3)/2**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

1. G.D. Christian, *Analytical Chemistry*, John Wiley & Sons, New York, ,1994.
2. R.S. Khandpur, *Handbook of Analytical Instruments*, ed.India Published, New York 2006;
3. H. Schmidt-Traub, P*reparative Chromatography of Fine Chemicals and Pharmaceutical Agents*, Wiley-VCH, Verlag, 2005
4. P. Pollack, *Fine Chemicals. The Industry and the Business*, John Wiley & Sons, New York, 2007.

SECONDARY LITERATURE:

1. *Ullmann's Encyclopedia of Industrial Chemistry*, Vol. A20, 193, VCH Verlagsgesellschaft, Weinheim 1994.
2. F.A. Settle, *Handbook of Instrumental Techniques for Analytical Chemistry*. Prentice-Hall Inc., 1997.
3. K.A. Rubinson, J.F. Rubinson, *Contemporary Instrumental Analysis*, Upper Saddle River Prentice Hall, 2000.
4. S.S. Nielsen, *Food Analysis Laboratory Manual*, Springer, West Lafayette, IN, USA, 2010

SUBJECT SUPERVISOR

(NAME AND SURNAME, E-MAIL ADDRESS)

Marta Tsirigotis-Maniecka, PhD, Eng., marta.tsirigotis@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Analytical Methods in Fine Chemicals

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Technology

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	S2Atc3_W03	C1	Lec 1	N1
PEK_W02	S2Atc3_W03	C2	Lec 2, Lab 2 – Lab 8	N1
PEK_W03	S2Atc3_W03	C2, C3, C4	Lec 2	N1
PEK_W04	S2Atc3_W03	C2, C3, C4	Lec 2	N1
PEK_W05	S2Atc3_W03, S2Atc_U03	C3, C4	Lec 3 – Lec 9 Lab 2 – Lab 8	N1, N2
PEK_W06	S2Atc3_W03, S2Atc3_U03	C3, C6	Lec 3 – Lec 9 Lab 2 – Lab 8	N1, N2
PEK_U01	S2Atc3_U03	C2, C4, C5	Lec 2, Lab 2 – Lab 8	N1, N2, N3
PEK_U02	S2Atc3_U03	C2, C4	Lab 2 – Lab 8	N2, N3
PEK_U03	S2Atc3_U03	C2, C4, C6	Lab 2 – Lab 8	N2, N3
PEK_U04	S2Atc3_U03	C2, C3, C5	Lab 2 – Lab 8	N2, N3
PEK_U05	S2Atc3_U03	C2, C3, C5	Lab 2 – Lab 8	N2, N3
PEK_U06	S2Atc3_U03	C2, C3, C5, C6	Lab 2 – Lab 8	N2, N3
PEK_U07	S2Atc3_U03	C2	Lab 2 – Lab 8	N2, N3

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

*** - from table above

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Inżynieria reaktorów chemicznych**
Name in English	**Chemical reaction engineering**
Main field of study (if applicable):	**Chemical technology**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level / full-time**
Kind of subject:	**obligatory**
Subject code	**ICC024020**
Group of courses	**NO**

	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			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	0.5			0.5	

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of physical chemistry: thermodynamics, kinetics.
2. Knowledge of mathematics: differentiation, integration, differential equations.

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SUBJECT OBJECTIVES

C1 Getting to know the equations kinetic of real processes.
C2 Getting to know the ideal reactor models.
C3 Learning basic concepts in reactor design and ideal reactor models.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 Student has a basic knowledge of kinetic equations of simple and complex reactions.
PEK_W02 Student knows the basic models of ideal reactors.
PEK_W03 Student has information about the simplest models of real reactors.
relating to skills:
PEK_U01 Student is able to solve kinetic equations of simple reactions.
PEK_U02 Student is able to prepare components balances (for ideal reactors) in a steady state system.
PEK_U03 Student is able to solve design equations for ideal reactors.

PROGRAMME CONTENT

Form of classes - lecture	**Number of hours**

Lec 1	The rate of chemical reaction. Definition of the reaction rate: elementary reaction, complex reaction. The dependence of rate on the concentration: first, second and third-order reactions. The elementary reaction rate constant. *Temperature dependence of rate constant. Dimension of rate constant. Determination of conversion. Dependence of conversion on concentration for reactions with different stoichiometry.*	2
Lec 2	The kinetic equation. Dependence of concentration (conversion) on time for the irreversible and reversible reactions of different order. The solution of the obtained differential equations.	2
Lec 3	BATCH. Ideal conditions. *Dependence of volume on concentration (conversion) and reaction time, first and second order reaction, unsteady-state.* CSTR. The assumption of perfect mixing. *Component continuity equation-product or substrate. The components of the balance equation.* The system's working conditions in steady-state, *dependence of reactor volume on concentration (conversion), the residence time*.	2
Lec 4	PFR. Ideal system, plug flow. The component balance. *Dependence of reactor volume on concentration (conversion) in steady-state, the residence time*.	2
Lec 5	Comparison of ideal reactors. Reactors' volume, volumetric flow rates, conversions. Graphic illustration.	2
Lec 6	The battery of reactors. Conversion in the first-order reaction case. Comparison of conversion in the battery of CSTRs and single CSTR. The battery of n-CSTRs and single PFR.	2
Lec 7	The real reactors models. Dynamic characteristics; model parameters, cellular model, model with longitudinal dispersion.	2
Lec 8	Final test	1
	Total hours	15
Form of classes - project		**Number of hours**
Proj 1	The kinetic equation; first, second and fractional-order reactions, the irreversible and reversible reactions. Conversion and concentration as a function of time.	2
Proj 2	The first (second)-order irreversible reaction in a BATCH. Determination of the reactor volume necessary to obtain specified daily product stream with a given conversion. Analysis of connection: volume-	2

	conversion- reaction time.	
Proj 3	Comparison of continuous reactors volumes (CSTR and PFR) - specific reaction order and volumetric flow rate, in a given conversion.	2
Proj 4	Comparison of conversion in a CSTR and a PFR - specific reaction order and volumetric flow rate, in a given volume.	2
Proj 5	Illustration the effect of using an excess of one of the reactants in second and third-order reaction. A CSTR and a PFR.	2
Proj 6	Comparison of conversion in the battery of CSTRs, single CSTR and single PFR.	2
Proj 7	Estimation of concentration in real chemical reactors assuming total segregation model, cellular model and model with longitudinal dispersion.	2
Proj 8	Final test	1
	Total hours	15

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Solving tasks and problems for elaborated project.
N3. Preparation and presentation of a project.

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
F (project)	PEK_U01- PEK_U03	project presentation
P (project)	PEK_U01- PEK_U03	final test
P (lecture)	PEK_W01- PEK_W03	final test

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] O. Levenspiel, Chemical Reaction Engineering, 3rd ed., John Wiley & Sons, New York, 1999.
[2] H.S. Fogler, Elements of Chemical Reaction Engineering, 3rd ed., Prentice Hall PTR, New Jersey, 1999.

SECONDARY LITERATURE:

[1] S. Kucharski, J. Głowiński, Podstawy obliczeń projektowych w technologii chemicznej, 3 wyd., Oficyna Wyd. PWr, Wrocław 2010.
[2] Praca zbiorowa: Przykłady i zadania do przedmiotu Podstawy technologii chemicznej, Oficyna Wyd. PWr, Wrocław 1991.
[3] J. Szarawara i in., Podstawy inżynierii reaktorów chemicznych, WNT, Warszawa 1991.

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and PhD students

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Chemical reaction engineering
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical technology
AND SPECIALIZATION Technology of Fine Chemicals

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)	K2Atc_W05	C1	Lec 1-Lec 2	N1
PEK_W02	K2Atc_W05	C2, C3	Lec 2-Lec 7	N1
PEK_W03	K2Atc_W05	C3	Lec 7	N1
PEK_U01(skills)	K2Atc_U04	C1	Proj 1-Proj 2	N2
PEK_U02	K2Atc_U04	C2, C3	Proj 2-Proj 7	N2,N3
PEK_U03	K2Atc_U04	C3	Proj 7	N2,N3

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

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Zarządzanie bazami danych**
Name in English	**Data mining in chemical technology**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**Obligatory**
Subject code	**TCC024012**
Group of courses	**NO**

	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			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			2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of operating system environment
2. Basic usage of spreadsheet software

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SUBJECT OBJECTIVES

C1 To familiarize students with storage of data in tables
C2 To familiarize students with relations between the tables and data
C3 Learning how to extract desired data from the tables

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
The person who passed the course
PEK_W01 - has a basic knowledge of the form of data storage
PEK_W02 - knows the existing relations between the data
PEK_W03 - knows the most important databases in the field of chemical technology

relating to skills:
The person who passed the course
PEK_U01 - is able to create the databases and tables and alter them according to the needs
PEK_U02 - is able to extract the desired data from one or more tables
PEK_U03 - is able to modify the data in the table in the specified locations
PEK_U04 - is able to extract the data from existing chemical databases

PROGRAMME CONTENT

Form of classes - laboratory		**Number of hours**
Lab 1	Databases: purpose and structure. Relations in databases. Database software.	2
Lab 2	Basic usage of SQL.	2
Lab 3	Creating and altering tables.	2
Lab 4	Queries: formulation, modification, analysis of the results.	2
Lab 5	Forms: creation, usage and modification.	2
Lab 6	Design and modification of reports. Structure of the reports. Printouts.	2
Lab 7	Programming of macros.	2
Lab 8	Relations between tables. Extracting data from multiple tables.	2
Lab 9	Integration with other software packages. Import and export of data.	2
Lab 10	PubChem database of chemical compounds.	2
Lab 11	Extraction and visualization of structures from Protein Data Bank	2
Lab 12	Searching the Catalysts and Catalyzed Reaction database	2
Lab 13	Searching the Database of Zeolite Structures	2
Lab 14	Searching scholar manuscripts online.	2
Lab 15	Credit	2
	Total hours	30

TEACHING TOOLS USED

N1. Online chemistry databases
N2. SQL standard database package
N3. Spreadsheet

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	PEK_W01..W03	Written credit
F	PEK_U01..U04	Assignments

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Data analysis using SQL and Excel, Gordon S. Linoff, John Wiley & Sons, 2007
[2] SQL Queries for Mere Mortals: A Hands-on Guide to Data Manipulation in SQL, John Viescas, Addison Wesley, 2014

SECONDARY LITERATURE:

[1] On-line resources

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

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Data mining in chemical technology
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical Technology
AND SPECIALIZATION
Technology of Fine Chemicals

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)	K2Atc_U05	C1	Lab1-Lab3	N2-N3
PEK_W02	K2Atc_U05	C2, C3	Lab4-Lab7	N2-N3
PEK_W03	K2Atc_U05	C3	Lab10-Lab14	N1
PEK_U01 (skills)	K2Atc_U05	C1, C2	Lab3-Lab5	N2-N3
PEK_U02	K2Atc_U05	C3	Lab4-Lab9	N2-N3
PEK_U02	K2Atc_U05	C2, C3	Lab4-Lab9	N2-N3
PEK_U02	K2Atc_U05	C3	Lab10-Lab14	N1

Wrocław University of Technology

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Projektowanie i studium wykonalności procesu technologicznego**
Name in English	**Design and feasibility study of technological process**
Main field of study (if applicable)	**Chemical Technology**
Specialization (if applicable)	**Technology of fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**TCC024019**
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				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				2	
including number of ECTS points for direct teacher-student contact (BK) classes				2	

*delete as applicable

SUBJECT OBJECTIVES	
C1	Introducing students to investment project cycle from the stage of the initial idea until the plant is in operation.
C2	Presentation of issues relating to fundamental aspects of the pre-investment studies which allow to examining the project idea step by step and presentation of alternative solutions.
C3	To gain knowledge on the identification of investment opportunities include general and specific opportunities studies ready to present for potential investors.
C4	Understanding the nature and role of the preliminary assessment of the investment idea in the form of a pre-feasibility study.
C5	Presentation of the different stages of a feasibility study needed to make investment decisions and formulate the final version of the technical and economic project.
C6	To gain knowledge of product marketing, providing the necessary material inputs, locating the plant at the optimal site and human resource, technical and organizational planning.
C7	Knowledge of the financial viability of the project, planning the structure of overhead costs and the planning and balancing of project realization.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

The person who passed subject:

PEK_W01 – knows the investment project cycle from the stage of the initial idea until the plant is in operation and understands the interrelationship between three distinct phases: the pre-investment, the investment and the operational phase.

PEK_W02 – has knowledge and is able to describe the stages of pre-investment phase includes identification of investment opportunities (opportunity studies), analysis of project alternatives and preliminary project selection as well as project preparation (prefeasibility and feasibility studies).

PEK_W03 – has knowledge about identifying investment opportunities based on area, industrial sector and resource-based studies and specific project opportunity studies which should follow the initial identification of general investment opportunities.

PEK_W04 – knows the key concepts and issues related to the pre-feasibility study taking into account a detailed analysis of variants in the following main fields (components) of the study: project or corporate strategies, market and marketing concept, raw materials and factory supplies, location, site and environment, engineering and technology, organization and overhead costs, human resources, labour costs, project implementation schedule and budgeting.

PEK_W05 – has knowledge of the individual stages of a feasibility study taking into account the market analysis, outline of marketing concept, identification and description of the location, including ecological and environmental impact, a description of the socio-economic and cultural environment, characteristics of raw materials and other inputs needed for operating the plant.

PEK_W06 – is able to develop the functional and physical layout for the industrial plant, production program, is able to determine the production capacity of the plant and corresponding investment expenditures as well as the costs arising during the operational phase.

PEK_W07 – knows how and is able to plan the organization needed to manage and direct all activities of the plant and create a structure of overhead costs.

PEK_W08 – knows how and is able to specify implementation schedule and budget of project as well as describe the characteristics of the main implementation work tasks as well as the major constraints that normally have a particular impact on project implementation.

PEK_W09 – knows the basic aspects of financial analysis of industrial project investment and has knowledge of evaluation concept.

PROGRAMME CONTENT		
Form of classes - project		**Number of hours**
Proj 1	*The investment project cycle: the pre-investment, the investment and the operational chase and promotion of industrial investment projects*	2
Proj 2	*Basic aspects of pre-investment studies*	2
Proj 3	*General and specific project opportunity studies*	2
Proj 4	*Pre-feasibility studies*	2

Proj 5	*The feasibility study - project background and basic idea*	2
Proj 6	*The feasibility study – market analysis and marketing concept*	2
Proj 7	*The feasibility study – raw materials and supplies, location, site and environment*	2
Proj 8	*The feasibility study – engineering and technology*	2
Proj 9	*The feasibility study – organization and overhead costs*	2
Proj 10	*The feasibility study – human resources*	2
Proj 11	*The feasibility study – implementation planning and budgeting*	2
Proj 12	*The feasibility study – financial analysis and investment appraisal*	2
Proj 13	*Presentation of the feasibility study for selected industrial process*	2
Proj 14	*Presentation of the feasibility study for selected industrial process*	2
Proj 15	*Presentation of the feasibility study for selected industrial process*	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	lecture with a multimedia presentation
N2	individual preparation and multimedia presentation

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 (Project)	PEK_W01- PEK_W09	Elaboration + multimedia presentation of the feasibility study for selected industrial process

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Behrens W., Hawranek P.M., Manual for the preparation of industrial feasibility studies, UNIDO, Warszawa 2003.

[2] Overton R., Feasibility Studies Made Simple, Martin Books, Australia, 2007.

[3] Stevens R.E., Sherwood P.K., How to prepare a feasibility study: a step-by-step guide including 3 model studies, Prentice-Hall, 1982

SECONDARY LITERATURE:

[1] Skrzypek J., Zasady konstrukcji studium wykonalności lub biznesplanu dla projektów współfinansowanych ze środków UE, Twigger, Warszawa 2007.

[2] Skrzypek J., Projekty współfinansowane ze środków UE : od pomysłu do studium wykonalności : praca zbiorowa, Twigger, Warszawa 2005.

[3] Filar E., Skrzypek J., Biznesplan, Poltex, Warszawa 2000.

[4] Johnson H., Ocena projektów inwestycyjnych. Maksymalizacja wartości przedsiębiorstwa, Wyd. Liber, Warszawa 2000.

SUBJECT SUPERVISOR

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dr inż. Marta Huculak-Mączka, marta.huculak@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Design and feasibility study of technological process

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Technology - Technology of fine chemicals

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		C1	P1	N1
PEK_W02		C2	P2	N1

PEK_W03		C3	P3	N1
PEK_W04		C4	P4	N1
PEK_W05		C5, C6	P5, P6, P7, P10, P13, P14, P15	N1, N2
PEK_W06		C5, C6, C7	P8, P13, P14, P15	N1, N2
PEK_W07		C5, C6	P9, P13, P14, P15	N1, N2
PEK_W08		C5, C6	P10, P13, P14, P15	N1, N2
PEK_W09		C5, C6, C7	P12, P13, P14, P15	N1, N2

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

*** - from table above

Wroclaw University of Technology

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	Układy dyspersyjne – fizykochemia i technologia
Name in English	**Disperse systems – physicochemistry and technology**
Main field of study (if applicable):	Technologia chemiczna
Specialization (if applicable):	Technology of Fine Chemicals
Level and form of studies:	~~I /~~ II stopień*, stacjonarna / ~~niestacjonarna*~~
Kind of subject	**obowiązkowy ~~/ wybieralny / ogólnouczelniany~~ ***
Subject code	**TCC024009**
Group of courses	TAK / ~~NIE*~~

	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		90		
Form of crediting	Examination		Crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	3		3		
including number of ECTS points for practical (P) classes			3		
including number of ECTS points for direct teacher-student contact (BK) classes	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. English proficiency at level B2.

2. Principles of organic, inorganic and physical chemistry at the Ist level studies.

3. Basic laboratory skills: use of laboratory apparatus and volumetric glassware, preparation of solutions.

	SUBJECT OBJECTIVES
C1	Gaining knowledge on chemical and physical properties of specialty surfactants and disperse systems.
C2	Familiarizing with classification and application of surfactants including the fine chemical products.
C3	Gaining of knowledge on fabrication technologies and physicochemical characterization and stability of emulsion formulations.
C4	Broadening of knowledge concerning influence of surfactants on phenomena at the interface.
C5	Gaining knowledge on the physicochemistry of the dispersed systems.
C6	Gaining new knowledge on achievements in fabrication and physicochemical characterization of materials for bio-medical applications.
C7	Gaining practical skills on physicochemical characterization of the emulsion and colloids.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

Student, who has completed the course:

PEK_W01 - Can define the dispersion systems, including the colloids, which are used in many fields of novel chemical technology.

PEK_W02 - Has knowledge about the structure and classification of surfactants used in technology of disperse systems.

PEK_W03 - Has knowledge on the basics of technological process design to obtaining the emulsion formulations with specific utilities.

PEK_W04 - Has knowledge on physico-chemical methods for testing the stability and performance of the dispersed systems

PEK_W05 - Knows the basis for the assessment and analysis of phenomena occurring at the interface, with particular emphasis on adsorption processes, reduce surface tension and detergencji.

PEK_W06 - Understands the issues describing kinetic, electrochemical and optical properties of the dispersed systems

PEK_W07 - Knows examples of the novel organic and inorganic technologies utilizing the dispersions and colloids

Relating to skills:

Student, who has completed the course:

PEK_K01 - Can plan, conduct and control preparation of chemically and physically stable dispersions with the desired properties and morphology.

PEK_K02 - Can evaluate the basic parameters of physico-chemical processes of aggregation, running at interfaces.

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	Introduction to disperse systems, general issues	2
Lec 2	Classification and application of surfactants. Self-assembly behaviour of surfactants - micellization, critical micelle concentration, hydrophilic-lipophilic balance	2
Lec 3	Emulsions – physicochemistry, technology and applications	2
Lec 4	Nanoemulsions – physicochemistry, technology and applications	2
Lec 5	Microemulsions – physicochemistry, technology and applications	2
Lec 6	Multiple emulsions – physicochemistry, technology and applications	2
Lec 7	Physicochemical methods evaluation of emulsions stability and morphology	2
Lec 8	Disperse systems in drug delivery	2
Lec 9	Surface tension - measurement techniques, the impact of surfactants, Langmuir-Blodgett films	2
Lec 10	Surface phenomena: adhesion, cohesion, wettability, interfacial adsorption	2

Lec 11	Foaming and detergency	2
Lec 12	Molecular-kinetic properties: Brownian motion, diffusion, sedimentation, osmosis, viscosity	2
Lec 13	DLVO theory - the interaction between colloidal particles, the stability of the dispersions and aggregation processes	2
Lec 14	Optical properties of dispersion systems - the Tyndall effect	2
Lec 15	The properties of colloidal nanoparticles solutions	2
	Total hours	**30**

Form of classes - laboratory		Number of hours
Lab 1	Introduction. Presentation of laboratory room. Acquaintance with health and safety (HS) regulations. Division into groups.	2
Lab 2	Emulsions - preparation and stability	4
Lab 3	Microemulsions – construction of a pseudoternary-phase diagram	4
Lab 4	Determination of the critical micelle concentration (CMC) value for ionic surfactants	4
Lab 5	Foaming and wettability of surfactants	4
Lab 6	Determining the weight of the polymer random coil	4
Lab 7	Rating phenomenon of coagulation	4
Lab 8	Evaluation of Tyndall effect in dispersion systems	4
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.

N2. Examination with multiple choice test.

N3. Simple experiments for individual preparation of the dispersion and the measurement of their physicochemical properties, performed in the prepared to this purpose teaching laboratory.

N4. Elaboration of results of the conducted experiments in the form of a written report.

N5. Written or oral test of knowledge regarding carried out experiments

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 – PEK_W06	Final examination
F1-7 (laboratory)	PEK_U01, PEK_U02	Oral or written evaluation of the theoretical preparation for laboratory classes (7 marks)
F8-14 (laboratory)	PEK_U01 – PEK_U02	Evaluation of the report from the performed experiments (7 experiments)
P2 (laboratory) = 2/3((F1+F7)/7)+1/3((F8+F14)/7)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Clarence A. Miller, P. Neogi, *Interfacial phenomena equilibrium and dynamic effects* (second edition), CRC Press Taylor & Francis Group (2008)

[2] Milton J. Rosen, *Surfactants and interfacial phenomena* (third edition), A John Wiley & Sons, Inc., Publication (2004)

[3] Abraham Aserin, *Miltiple emulsions*, A John Wiley & Sons, Inc., Publication (2007)

[4] M. Fanun, *Microemulsions properties and applications*, CRC Press Taylor & Francis Group (2009)

SECONDARY LITERATURE:

[1] M. L. Robins, *Micellization, Solubilization and Microemulsion,* Plenum Press, New York, (1977), 2, 713.

[2] J.L. Salager, *Interfacial Phenomena in Dispersed Systems*, Laboratorio FIRP, Universidad de Los Andes (1993)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS

FOR SUBJECT

Disperse systems - physicochemistry and technology

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Technology

AND SPECIALIZATION

Technology of Fine Chemicals

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives ***	Programme kontent ***	Teaching tool numer ***
PEK_W01 (knowledge)	K2Atc_W07, S2Atc3_W01	C1	Lec 1	N1, N2
PEK_W02	K2Atc_W07, S2Atc3_W01	C2	Lec 2	N1, N2
PEK_W03	K2Atc_W07, S2Atc3_W01	C3	Lec 3 – Lec 6	N1, N2
PEK_W04	K2Atc_W07, S2Atc3_W01	C3	Lec 7	N1, N2
PEK_W05	K2Atc_W07, S2Atc3_W01	C4	Lec 9- Lec 11	N1, N2
PEK_W06	K2Atc_W07, S2Atc3_W01	C5	Lec 12- Lec 14	N1, N2
PEK_W07	K2Atc_W07, S2Atc3_W01	C6	Lec 8, Lec 15	N1, N2
PEK_K01 (skills)	S2Atc3_U01	C6	Lab 1-Lab 8	N3 – N5
PEK_K02	S2Atc3_U01	C6	Lab 1-Lab 8	N3 – N5

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

*** - from table above

Faculty of Chemistry

Subject card

Name in Polish	**Ochrona środowiska w technologii chemicznej**
Name in English	**Environmental protection in chemical technology**
Main field of study	**Chemical Technology**
Specjalization:	**Technology of Fine Chemicals**
Level and form of studies:	MSc
Kind of suject	**Obligatory**
Code	**TCC024006**
Group of courses	NO

	Lecture	Practice	Laboratory	Project	Seminar
Number of hours of organized classes at University ((ZZU)	15		30		
Number of hours of total student workload (CNPS)	60		60		
Form of credit	Colloquium		credit		
Group of curses	X		X		
Poits of ECTS	**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		

Prerequisites

1. Course of general chemistry

2. Completed courses for basic inorganic and organic technologies

3.Completed basic course on chemical engineering

4. Ability for teamwork

Goals

C1 Presentation of backgrounds for environmental management and protection

C2 Presentation of problems related to pollution of atmosphere, water and soil, and methods for their prevention/mitigation

C3 Presentation of international legislation, environment policy in EU and Poland, European directives in environment protection

C4 Principles of environment protection, rules of sustainable development, administration of natural resources

Subject educational effects

Knowlege:

PEK_W01 student knows the concepts of environment protection

PEK_W02 student recognizes the sources of atmosphere, water and soil contaminations

PEK_W03 student is familiar with techniques used for decrease of industry impact

PEK_W04 student knows problems related to sustainable development of chemical industry

Skill:

PEK_U01student knows the benefits of the use of membrane techniques

PEK_U02 student is familiar with sorption processes and can select the proper material

PEK_U03 student recognizes integrated and hybrid processes and can design them

PEK_U04 student is familiar with ion-exchange processes and materials used in clean and cleaning technologies

Social:

PEK_K01 Student can work in team and solve the problems collectively

Program		
Lecture		No of hours
Wy1	**Introduction** Definitions and terms used in environment protection engineering. Natural resources and rational their exploitation, Renewable resources, EU policy in environment protection.	2
Wy2	**Sustainable ecology.** Effect of mankind on environment, Ecological catastrophes and their impact on environment, Prevention of contaminants spreading, Sustainable development, Strategy and policy in ecology	2
Wy3	**Atmosphere conservation**. Air pollutants, Characterization of sources of air pollution, Warming effect, Methods of air protection ,	2
Wy4	**Water conservation.** Shortage of water, Water pollutants, Industrial waste water and municipal sewage, Quality of water, Surface and brackish water, Methods of water protection	2
Wy5	**Soil conservation .** Soil pollutants, Quality of soil, Hazard for soil degradation, Methods of re-cultivation.	2
Wy6	**Waste management.** Definition, Waste classification, Methods for disposal and utilization of wastes, Industrial and municipal wastes, Dangerous wastes,	2
Wy7	**Chemical industry and its impact to environment.** Technological advancement of large and SME industrial plants in Poland and in EU, Clean and cleaning technologies, Concept of zero discharge technologies, Trends in development in new technologies.	2
Wy8	**Sumary and colloquium**	1
	Totally	**15**

Laboratory		**No of hours**
La1	Introduction to laboratory: rules	2
La2	Diffusion dialysis in recovery of acids from hydrometallurgy wastes	4
La3	Membrane methods in removal of organic pollutants from water	4
La4	Adsorption for removal of organic pollutants from water	4
La5	Ion exchange processes in water treatment	4
La6	Herbicides and endocrine disruptors removal by active carbons	4
La7	Micellar enhanced ultrafiltration in water treatment processes	4
La8	Hybrid systems in removal of harmful ions from aqueous systems	4
	Totally	**30**

Educational tools
N1. Multimedia presentation N2. Manual for practice N3. Reporting

Final evaluation

Assessment (F – in the semester run) P – at the end of semester)	No of education effect	Method of evaluation
P (lecture)	PEK_W01-PEK_W04	Colloquium
F1	PEK_K01 PEK_W03 PEK_U01	Report
F2	PEK_K01 PEK_W03 PEK_U01	Report
F3	PEK_K01 PEK_W03 PEK_U02	Report
F4	PEK_K01 PEK_W03 PEK_U02	Report
F5	PEK_K01 PEK_W03 PEK_U02	Report
F6	PEK_K01 PEK_W03 PEK_U03	Report
F7	PEK_K01 PEK_W03 PEK_U03	Report
P= (F1+F2+F3+F4+F5+F6+F7)/7		

PRIMARY AND SECONDARY LITERATURE

PRIMARY:

[1] Angelo Basile, Advances in Membrane Technologies for Water Treatment, (Elsevier, Amsterdam, 2015)

[2] Donald K Anton and Dinah L Shelton, Environmental Protection and Human Rights (Cambridge University Press, New York, 2011) 986

[3] Monzer Fanun, The Role of Colloidal Systems in Environmental Protection, (Elsevier, Amsterdam, 2014)

[4] Mariachiara Alberton and Francesco Palermo, Environmental Protection in Multi-Layered Systems, (Nijhoff Pub., 2012)

SECONDARY:

[1] Nidal Hilal, Mohamed Khayet, Chris Wright, Membrane modification, CRC Press, Boca Raton, 2012

[2] Angelo Basile, Fausto Gallucci, Membranes for Membrane Reactors, Willey, 2011

[3] Marek Bryjak, Nalan Kabay, Bernabe Rivas, Jochen Bundschuh, Innovative Materials and

Processes for Water Treatment, CRC Press, Amsterdam, 2015
Person responsible for the course (Name and e-mail address)
Prof. Dr. Marek Bryjak (marek.bryjak@pwr.edu.pl)(Lecture) **Dr. Joanna Wolska (joanna.wolska@pwr.edu.pl) (Laboratory)**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Environmental protection in chemical technology

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical technology

AND SPECIALIZATION

Fine chemicals

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Golas	Programme content	No of educational tool
PEK_W01		C1	Wy1	N1
PEK_W02		C2	Wy2	N1
PEK_W03		C3, C4	Wy2-Wy5	N1
PEK_W04		C3, C4	Wy3-Wy7	N1
PEK_U01		C2	La2, La3	N2, N3
PEK_U02		C2	La4-La6	N2, N3
PEK_U03		C2	La7, La8	N2, N3
PEK_U04		C2	La8	N2, N3
PEK_K01		C2	La1- La8	N2, N3

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Podstawy biotechnologii**
Name in English	**Fundamentals of biotechnology**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**BTC024021**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)					
Form of crediting	Examination				
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	1				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Biological background at academic level.
2. Basic microbiology knowledge.

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SUBJECT OBJECTIVES

C1 The understanding the specificity of biotechnological process.
C2 The procuration of basic knowledge about industrially relevant microorganism.
C3 The knowledge about typical commercial products obtained in bioprocesses.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
Student who passed the exam:
PEK_W01 can characterize biotechnological process
PEK_W02 can describe bioprocesses for the production of different consumer goods
PEK_W03 know the application of biocatalysis in industry
PEK_W04 know the application of biotechnological processes for the environment protection
PEK_W05 has a knowledge about agrobiotechnology

PROGRAMME CONTENT

Form of classes - lecture	**Number of hours**

Lec 1	**Introduction –** Biotechnology: definition and history. Colors of biotechnology, Basic characteristic of biotechnological process. The sources of microbes for industrial applications.	2
Lec 2	**Biotechnological process:** fermentation resulted in metabolite *versus* fermentation resulted in biomass. Various end-products of bioprocesses.	2
Lec 3	**Biotechnological process: biotransformation:** biocatalyst characteristic, different approaches of biocatalysts preparation and modification	2
Lec 4	**Biotechnological process: biotransformation:** ways of biocatalysts preparation and modification, environment of bioreaction. Perspectives and new trends.	2
Lec 5	**Industrial application of biotransformation**.	2
Lec 6	**Industrial application of biotransformation.**	2
Lec 7	**Biotechnological production of amino acids.**	2
Lec 8	**Enzymatic preparations used for food processing**. HFCS production process.	2
Lec 9	**Food biotechnology**: dairy products	2
Lec 10	**Food biotechnology**: brewing	2
Lec 11	**Biotechnological production of organic acids**. Different methods of citric acid production. The importance of citric acid for industry.	2
Lec 12	**Biotechnological production of organic acids:** acetic acid, itaconic acid, gluconic acid	2
Lec 13	**Agrobiotechnology.** Perspectives and new trends. Genetically modified plants – the application and importance.	2
Lec 14	**Agrobiotechnology.** Bioinsecticides (*Bacillus thuringensis*, entomopathogenic fungi, baculoviruses)	2
Lec 15	**Biotechnology for environment protection.** Biological methods of wastewater treatment. Bioremediation techniques. Phytoremediation.	2
	Total hours	30

TEACHING TOOLS USED
N1. Classical lecture with multimedial presentation.

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
C	PEK_W01- PEK_W05	examination

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Biotechnology J.E Smith (5th ed) Cambridge University Press, 2009

[2] Industrial biotechnology : sustainable growth and economic success / ed. by Wim Soetaert, Erick J. Vandamme. Weinheim : Wiley-VCH, 2012

SECONDARY LITERATURE:

[1] Scientific publications from the field of biotechnology.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Fundamentals of biotechnology
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical Technology
AND SPECIALIZATION **Technology of Fine Chemicals**

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**	S2Atc3_W08	C1, C3	Lec1-Lec2, Lec 7	N1
PEK_W02	S2Atc3_W08	C2, C3	Lec8- Lec11	N1
PEK_W03	S2Atc3_W08	C3, C1	Lec3- Lec6	N1
PEK_W04	S2Atc3_W08	C1, C2	Lec13, Lec14	N1
PEK_W05	S2Atc3_W08	C1, C2	Lec15	N1

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

*** - from table above

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Zielona Chemia**
Name in English	**Green Chemistry**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**CHC024058**
Group of courses	**NO**

	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					
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes					

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The knowledge in the field of basic inorganic and organic chemistry
2. The knowledge in the field of biochemistry

SUBJECT OBJECTIVES

C1 To familiarize students with the functioning and principles of green chemistry
C2 Obtaining basic knowledge of the methods and reactions used in green chemistry
C3 To acquire basic knowledge about the latest achievements in the field of green chemistry

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 – knows the basic concepts and definitions in the field of green chemistry
PEK_W02 – knows basic processes in Green Chemistry
PEK_W03 – has basic knowledge of experimental methods and processes used in green chemistry
PEK_W04 – knows the basic aspects of bioremediation and the use of green chemistry in environmental protection
PEK_W05 – has knowledge about renewable energy and biorefineries
PEK_W06 – knows the rules for the use of natural products in green chemistry

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Introduction to green chemistry.	2
Lec 2	Catalysts for green chemistry and their applications in technological processes	6
Lec 3	Frontiers in benign chemical synthesis and processes	4
Lec 4	Renewable feedstocks and bioraffineries	2
Lec 5	Green analytical chemistry	2
Lec 6	Bioremediation	4
Lec 7	Green reactions in organic chemistry	4
Lec 8	Natural products in green chemistry	4
Lec 5	Exam	2
	Total hours	30

TEACHING TOOLS USED
N1. Lecture with multimedia presentation.

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 (lecture)	PEK_W01- PEK_W06	Exam

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
Green Chemistry: Theory and Practice, Anastas P.T., Warner J.C.
SECONDARY LITERATURE:
[1] Biochemistry, Stryer [2] Any book or basic organic chemistry [3]
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Marcin Drąg; marcin.drag@pwr.edu.pl **Przy współpracy: Michał Jewgiński (Michal.jewginski@pwr.edu.pl)**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Green chemistry

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Technology

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	K2Atc_W09	C1	Lec1	N1
PEK_W02	K2Atc_W09	C2	Lec2, Lec3	N1
PEK_W03	K2Atc_W09	C2	Lec5	N1
PEK_W04	K2Atc_W09	C3	Lec6	N1
PEK_W05	K2Atc_W09	C3	Lec7	N1
PEK_W06	K2Atc_W09	C3	Lec8	N1

** - 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:	Metody matematyczne w projektowaniu i analizie eksperymentu
Name in English	**Mathematical methods in the design and analysis of the experiment**
Main field of study (if applicable):	**Biotechnology, Chemistry, Materials Science, Chemical Technology**
Specialization (if applicable):	
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**MAC024001**
Group of courses:	**Yes**

*delete if not related

	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	Credited 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 if not related

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Completion of Calculus I, Algebra I
2. Ability to use computer.

SUBJECT OBJECTIVES	
C1	To understand application of statistical modeling in chemical experiment.
C2	To learn application of numerical implementation of statistical and optimization methods in control of chemical process.
C3	To understand mathematical apparatus of various problems related with design and analysis of the experiment.
C4	To learn how to process experimental data using statistical using numerical packages.

SUBJECT EDUCATIONAL EFFECTS

The range of skills:
The person who completed the course:
PEK_W01 – is able to process experimental data and empirical observations and understand the role of statistical and mathematical methods in its description,
PEK_W02 - is able to relate physical and chemical problem with appropriate mathematical problem and method to solve it
PEK_W03 – has a scope of knowledge of mathematics and computer science to describe and interpret natural phenomena is able to process them using mathematical and statistical methods, is able to calculate a level of correlation between data and fit appropriate model, is able to solve set of linear, nonlinear and differential equations,
PEK_W04 – using appropriate numerical method and numerical packages MATLAB, Excel and Origin is able to solve given mathematical problem with given accuracy

With a range of social skills:
The person who completed the course:
PEK_K01 – understand the need of self-education using appropriate scientific and technical literature.

PROGRAMME CONTENT		
Form of classes - laboratory		**Number of hours**
Le1	Solving sets of linear equations, matrix equations, inverse matrix, Gauss algorithm: case studies using MATLAB.	2
Le2	Solving sets of nonlinear equations, solution location, Newton-	2

	Raphson method: case study using MATLAB.	
Le3	Solving sets differentials equations, Euler method, Verlet method, explicit and implicit scheme: case study using MATLAB	2
Le4	Linear regression – least squares method, correlation coefficient, sum of squares, error: case study using MATLAB and Excel	2
Le5	Nonlinear regression, linearization, normal equation, Gauss-Newton method: case study using MATAB and Excel.	2
Le6	Fitting model, chi-square test, Kolmogorov-Smirnov test, Grubb test: case study using Origin and MATLAB.	2
Le7	Statistical hypothesis testing, normal distribution, t-Student distribution, ANOVA: case study using Origin and Excel.	2
Le8	Response surface method, Box-Benhken method: case study using MATLAB.	1
	Total hours	15

TEACHING TOOLS USED	
N1	Presentation.
N2	Computer presentation.
N3	Student's self study.
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
P	K1Aic_U08, K1Aic_U11, K1Aic_U19, K1Aic_U25	Test.
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] Steven C. Chapra, Applied Numerical Methods with MATLAB: for Engineers and Scientists, McGrew 2012 **SECONDARY LITERATURE:** Internet sources.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Łukasz Radosiński **Lukasz.radosinski@pwr.wroc.pl**

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Mathematical methods in the design and analysis of the experiment.
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

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	K2Abt_W01, K2Ach_W01, K2Aic_W01, K2Aim_W01, K2Atc_W01	C1-C4	Le1-Le8	N1-N4
PEK_W02	K2Abt_W01, K2Ach_W01, K2Aic_W01, K2Aim_W01, K2Atc_W01	C1-C3	Le1-Le8	N1-N4
PEK_W03	K2Abt_W01, K2Ach_W01, K2Aic_W01, K2Aim_W01, K2Atc_W01	C1, C3, C4	Le1-Le8	N1-N4
PEK_W04	K2Abt_W01, K2Ach_W01, K2Aic_W01, K2Aim_W01, K2Atc_W01	C2, C4	Le1-Le8	N1-N4
(social skills) PEK_K01	K2Abt_W01, K2Ach_W01, K2Aic_W01, K2Aim_W01, K2Atc_W01	C1-C4	Le1-Le8	N1-N4

** - 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	**Farmaceutyki i Biofarmaceutyki**
Name in English	**Pharmaceuticals and Biopharmaceuticals**
Main field of study (if applicable)	**Chemical Technology**
Specialization (if applicable)	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**TCC024008**
Group of courses	**YES**

*delete as applicable

	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			2		
including number of ECTS points for direct teacher-student contact (BK) classes	2		1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES
5. Principles of organic chemistry, theoretical and practical. 6. Knowledge in the field of basis of analytical chemistry, theoretical and practical.

SUBJECT OBJECTIVES	
C1	Acquaintance with the knowledge on the distribution of medicinal products and medical devices on basic groups, according to their mechanism of action on the human body.
C2	Expanding the knowledge on methods of the preparation of biologically active substances, taking into account the modern trends in pharmacotherapy.
C3	Acquaintance with issues of the elementary production processes units in the area of pharmaceutical technology and biopharmacy.
C4	Gaining the knowledge on the technology of receiving of various forms of medicines and medical devices.
C5	Acquaintance with the generally applicable operating in the pharmaceutical industry and related sectors quality standards, concerning the manufacturing process and the final product, including the ways of managing waste.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

Student, who has completed the course:

PEK_W01 – has knowledge on the distribution of medicines and medical products on the basic groups, according to their mechanism of action on the human body,

PEK_W02 – has knowledge on the methods of obtaining biologically active substances, taking into account the modern trends in pharmacotherapy,

PEK_W03 – has knowledge on the elementary production processes units in the area of pharmaceutical technology and biopharmacy.

PEK_W04 – can define the various forms of medicines and medical devices, and has knowledge on the technology of receiving them,

PEK_W05 – has knowledge on the generally applicable operating in the pharmaceutical industry and related sectors quality standards, concerning the manufacturing

process and the final product.

Relating to skills:

Student, who has completed the course:

PEK_U01 – has skills in the preparation of a simple pharmaceutical formulation, i. e. liquid type, ointment type,

PEK_U02 – can to perform a qualitative analysis of pharmaceuticals and their biologically active components, using physical and chemical methods,

PEK_U03 – has skills in extraction of a biologically active compound from a pharmaceutical formulation, is able to determine its amount using basic analytical methods, while maintaining for analysis the principles of proper samples preparation, precision and repetition in measurements and proper interpretation of the results, taking into account the measurement errors,

PEK_U04 – has the ability to analyze biologically active compounds, which are main ingredients of pharmaceuticals and biopharmaceuticals, using spectroscopic methods, such as FT-IR, UV-Vis and NMR,

PEK_U05 – has skills in the interpretation of the results of analyzes, and the preparation of a laboratory report in accordance with the principles of good laboratory practice (GLP).

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours
Lec 1	Pharmacokinetic and pharmacodynamic basis for the use of medicines and medical products, place of administration, availability and biological equivalence.	2
Lec 2	The division of pharmaceuticals and biopharmaceuticals due to disorders.	2
Lec 3	Methods of receiving biologically active substances, possible sources of raw materials for isolation of them. Adjuvants and preservatives.	2
Lec 4	The elementary processes and operations in production of pharmaceuticals, biopharmaceuticals and medical products.	2
Lec 5	Liquid and aerosol forms of pharmaceuticals and biopharmaceuticals.	2

Lec 6	Semi-solid forms of pharmaceuticals and biopharmaceuticals - gels and emulsions.	2
Lec 7	Semi-solid forms of pharmaceuticals and biopharmaceuticals – ointments and pastes.	2
Lec 8	Solid forms of medicines - granules, tablets and pellets.	2
Lec 9	Solid forms of medicines – capsules and nanoforms.	2
Lec 10	The solid forms of medicines - controlled release forms. Slices.	2
Lec 11	Herbal medicines. Dietary supplements. Medical special purposes.	2
Lec 12	Future pharmaceuticals and biopharmaceuticals – the modern trends.	2
Lec 13	Medications used in wound care.	2
Lec 14	Packaging requirements, specifications of the type and form.	2
Lec 15	Quality control in the manufacturing process. Pharmaceutical product quality.	2
	Total hours	**30**

Form of classes - laboratory		Number of hours
Lab 1	Safety rules in the laboratory of chemistry, good laboratory practice (GLP) and the rules of the reports preparation.	2
Lab 2	Ointment with calendula extract – the biopharmaceutical preparation.	4
Lab 3	Unguentum undecylenicum ointment – extraction of the biologically active compounds and their analysis.	4
Lab 4	Rivanol liquid – the medical product preparation, analysis of the main compound.	4
Lab 5	Ibuprophen suspension – viscosity analysis of the formulation, extraction of the main compound and analysis of it.	4
Lab 6	Pyralgin tablet – analysis without isolation of the main compound.	4
Lab 7	Echinapur bolus – analysis basis on biologically active compound equivalent (CE) calibration curve.	4

Lab 8	Repeating of the not successful realized experiments. Consultation of the reports results.	4
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture with multimedial presentation.
N2	Experiment realizing.
N3	Report preparation.

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	PEK_W01– W05	The final note which is the examination note verifying student's knowledge.
F (laboratory)	PEK_U01 – U05	Average note of 6 grades of 6 completed reports, containing result, calculations and conclusions, prepared according to good laboratory practice rules (GLP).

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kurt H. Bauer, Karl-Heinz Frömming, Claus Führer. Technologia Postaci leku z elementami biofarmacji. Pod red. Janusza Pluty, MedPharm Polska, 2012
[2] R. H. Müller i G.E. Hildebrand. Technologia nowoczesnych postaci leków Wydawnictwo Lekarskie, PZWL, Warszawa, 2003
[3] Marshall Sittig. Pharmaceutical manufacturing encyclopedia. Noyes Pubications, USA.
[4] James I. Wells, Michael H. Rubinstein. Pharmaceutical Technology. Controlled Drug Release. Ellis Horwood Limited, Taylor & Francis,1991
[5] Dilip M. Parikh. Handbook of Granulation Pharmaceutical Technology. Taylor & Francis. 2005.

SECONDARY LITERATURE:

[1] EudraLex, The Rules Governing Medicinal Products in the European Union, Volume 4, EU Guidelines for Good Manufacturing Practice for Medicinal Products for Human and Veterinary Use, EUROPEAN COMMISSION, HEALTH AND CONSUMERS DIRECTORATE-GENERAL, Ref. Ares(2012)778531 - 28/06/2012

[2] Mark Gibson. Pharmaceutical Preformulation and Formulation Second Edition. A Practical Guide from Candidate Drug Selection to Commercial Dosage Form. Informa Healthcare USA, Inc. 2009

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Izabela Pawlaczyk-Graja, izabela.pawlaczyk@pwr.wroc.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Pharmaceuticals and Biopharmaceuticals

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Technology of fine chemicals

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	S2Atc3_W05	C1	Lec 1, Lec 2	N1
PEK_W02	S2Atc3_W05	C2	Lec 3, Lec 11, Lec 12, Lec 15	N1
PEK_W03	S2Atc3_W05	C3, C4	Lec 4 – Lec 13	N1
PEK_W04	S2Atc3_W05	C4, C5	Lec 1, Lec 4 – Lec 13	N1
PEK_W05	S2Atc3_W05	C5	Lec 14, Lec 15	N1
PEK_U01	S2Atc3_U05	C3, C4	Lab 2, Lab 4	N1, N2
PEK_U02	S2Atc3_U05	C5	Lab 3, Lab 4, Lab 5, Lab 6,	N2, N3

			Lab 8	
PEK_U03	S2Atc3_U05	C4, C5	Lab 3, Lab 5, Lab 6, Lab 7, Lab 8	N2, N3
PEK_U04	S2Atc3_U05	C5	Lab 3, Lab 4, Lab 5, Lab 6, Lab 7, Lab 8	N2, N3
PEK_U05	S2Atc3_U05	C3, C4, C5	Lab 1 – Lab 8	N2, N3

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

*** - from table above

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Środki pomocnicze do polimerów**
Name in English	**Polymer additives**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**TCC024011**
Group of courses	**NO**

	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	Examination				
For group of courses mark (X) final course					
Number of ECTS points:	2				
including number of ECTS points for practical (P) classes	0				
including number of ECTS points for direct teacher-student contact (BK) classes	1				

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of inorganic, organic and physical chemistry at 1st level of studies.
2. Basic knowledge in the area of polymers and plastics.
3. Ability to use original chemical literature and look through available electronic resources.

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SUBJECT OBJECTIVES

C1 Acquaint students with the significance of polymer additives and their influence on plastics properties.
C2 Introducing the categorization of polymer additives.
C3 Widening the knowledge about the latest trends in polymer additives industry.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

Any person who has got a credit of the subject:

PEK_W01 – has gained knowledge of structure and techniques of various polymers (synthetic and natural) synthesis and modification.

PEK_W02 – has basic knowledge of choice and application of polymer additives.

PEK_W03 – knows relations between the type of additives and plastics properties.

PEK_W04 – is capable of developing the plastics properties and extrapolation of applications for particular polymer composition.

PEK_W05 – understands ecological and economic fallout of polymers and plastics applications.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec 1	Introduction to synthetic polymers.	2
Lec 2	Introduction to natural polymers.	2
Lec 3	Techniques of synthetic polymer synthesis – polymerization additives.	2
Lec 4	Copolymerization and polymer crosslinking.	2
Lec 5	Techniques of natural polymer synthesis – possibilities of targeting the syntheses for industrial purposes.	2
Lec 6	Introduction to processing of plastics – processing aids.	2
Lec 7	Functional additives.	2
Lec 8	Polymers properties stabilizers.	2
Lec 9	Modifiers of functional properties of polymers.	2
Lec 10	Preparation methods for polymers with additives.	2
Lec 11	Polymers for medicine – requirements and examples of applied additives.	2
Lec 12	The problems and hazards involved in application of polymer additives.	2
Lec 13	Possible ways of polymers degradation, problems of recycling and polymer wastes.	2
Lec 14	Polymer additives producers.	2
Lec 15	Forum to discuss the latest trends in polymer additives.	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Expository lecture.

N2. Multimedia presentation.

N3. Interactive lecture - problem solving.

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_W01-W05	Written exam
F2	PEK_W04-W05	Participation in discussions (problem solving)
C = (0.8F1 + 0.2F2)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[5] L.H. Sperling, "Introduction to physical polymer science", 4th ed., Hoboken, NJ: John Wiley & Sons, 2006.
[6] F. Billmayer, "Textbook of Polymer Science", 3rd ed., New York [etc.]: John Wiley & Sons, 1984.
[7] Jan C.J. Bart, "Additives in Polymers", John Wiley & Sons Ltd, 2005.
[8] "Handbook of plastic and rubber additives" [Dokument elektroniczny] /Handbook of Plastics and Rubber Additives, Volumes 1-2 (2nd Edition) Michael and Irene Ash.
[9] S. Al-Malaika (Ed.), "Reactive Modifiers for Polymers", Blackie Academic and Professional, Chapman and Hall, London, 1997, ISBN 0-7514 0265 6.

SECONDARY LITERATURE:

[4] M. Bryjak, I. Gancarz, Polymers in Medicine, wyd. PWr, 2010.
[5] Podstawy recyklingu tworzyw sztucznych : praca zbiorowa / pod red. Marka Kozłowskiego, Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej, 1998.
[6] Tworzywa Sztuczne, środki pomocnicze i specjalne zastosowania polimerów, W. Szlezynger, Z. Brzozowski, tom 3, Fosze, 2013.

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Dr hab. inż. Dorota Jermakowicz-Bartkowiak, dorota.jermakowicz-bartkowiak@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Polymer additives
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical Technology
AND SPECIALIZATION **Technology of Fine Chemicals**

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)	S2Atc3_W06	C1, C2	Lec 1-Lec 14	N1, N2
PEK_W02	S2Atc3_W06	C2, C3	Lec 3-Lec 15	N1, N2
PEK_W03	S2Atc3_W06	C1, C2, C3	Lec 3-Lec 13	N1, N2
PEK_W04	S2Atc3_W06	C1, C2, C3	Lec 4-Lec 13	N1, N2
PEK_W05	S2Atc3_W06	C2, C3	Lec 13, Lec 15	N3

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

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Modelowanie procesów technologicznych**
Name in English	**Process modeling in chemical technology**
Main field of study (if applicable):	**CHEMICAL TECHNOLOGY**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**TCC024007**
Group of courses	**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)	30		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	1		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

1. Knowledge of physical chemistry: kinetics of complex chemical reactions, chemical equilibrium, thermodynamic functions
2. Basic knowledge of differential and integral calculus

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SUBJECT OBJECTIVES

C1 To familiarize students with mathematical models of complex chemical processes
C2 To familiarize students with the goals of modeling: simulation, optimization and controlling
C3 Learning how to formulate and solve easy optimization problems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
The person who passed course
PEK_W01 has a basic knowledge about models of chemical reaction processes
PEK_W02 knows examples of application of modeling in process simulation and Optimization
PEK_W03 has a basic knowledge about regressions analysis and optimization methods

relating to skills:
PEK_U01 is able to apply regression analysis in modeling of chemical reaction
PEK_U02 is able to simulate numerically the operation of chemical reactor
PEK_U03 is able to formulate and solve the task of optimizing the operating conditions of the reactor

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Process modeling: physical object-mathematical model; illustrations with examples of processes running in chemical reactors.	2
Lec 2	Application of modeling. Simulation, optimization, control. The structure of the task: the process equations, boundary conditions, a steady state, the criterion (optimization),examples of solving methods.	2
Lec 3	Process simulation: plug flow reactor (PFR) with reversible and exothermic reaction. Calculation of concentration and conversion under adiabatic or isothermal condition.	2
Lec 4	Optimizing production costs: processes with without recycling of unreacted raw materials.	2
Lec 5	Process optimization: optimum temperature profile, reversible and exothermic reaction, plug flow reactor, method of the calculus of variations.	2
Lec 6	Process optimization: selection of optimum temperature and optimum conversion for reversible and exothermic reaction in series of CSTR.	2
Lec 7	Example of process control with the feedback controller for three CSTR in series.	2
Lec 8	Written credit	1
	Total hours	15
Form of classes - laboratory		**Number of hours**
Lab 1	Regression analysis in modeling the kinetics of chemical reactions; reaction order	2
Lab 2	Regression analysis in modeling the kinetics of chemical reactions; rate data analysis	2
Lab 3	Gas phase reaction with variable volume at constant pressure (PFR) and with the constant volume and variable of pressure (BATCH)	2
Lab 4	Procedures for numerical integration (rectangular, trapezoidal and Simpson methods) and numerical differentiation supported	2

	by experimental data (CSTR, PFR)	
Lab 5	Operation of CSTR in series: simulation of different type of complex reaction	2
Lab 6	Determination of the optimal temperature profile for different type reaction carried out in plug flow reactor (PFR)	2
Lab 7	Determination of the optimal temperature profile for different type reaction carried out in single CSTR	2
Lab 8	Comparison of reactors production efficiency (CSTR, BATCH) for selected industrial reactions	2
Lab 9	Simulation of the PFR adiabatic reactor: gas phase reaction, impact of inerts, $\Delta H(T)$ and $Cp(T)$ dependence	2
Lab 10	Simulation of the PFR reactor under isothermal, adiabatic and non-adiabatic conditions	2
Lab 11	Simulation of the CSTR reactor (and series) under isothermal, adiabatic and non-adiabatic conditions	2
Lab 12	Simulation of the BATCH reactor under adiabatic conditions	2
Lab 13	Simulation of the Packed Bed Reactor under adiabatic and non-adiabatic conditions (the heat losses; the influence of steam as the thermal buffer)	2
Lab 14	Simulation of the PFR with endothermic reaction under adiabatic and non-adiabatic conditions by external heating	2
Lab 15	Written credit	2
	Total hours	30

TEACHING TOOLS USED

N1.Lecture with a multimedia presentation
N2.Using the Excel + Solver software
N3.Using the Polymath software

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_W03	Written credit
F (laboratory)	PEK_U01 – PEK_U03	Written credit

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Luyben, Chemical reactor design and control , Hoboken : Wiley-Interscience, 2007
[2] H. S. Fogler, Elements of Chemical Reaction Engineering Fourth Edition, Prentice Hall 2005

SECONDARY LITERATURE:

[1] J. M. Coulson, J. F. Richardson, Chemical Engineering, Pergamon Press, Oxford 1971
[2] R. E. Hayes Introduction to chemical reactor analysis CRC Press/Taylor & Francis, 2013.

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

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Process modeling of chemical technology
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical Technology
AND SPECIALIZATION
Technology of Fine Chemicals

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)	K2Atc_W05	C1	Wy1 - Wy2	N1
PEK_W02	K2Atc_W05	C2	Wy3	N1
PEK_W03	K2Atc_W05	C3	Wy4-Wy7	N1
PEK_U01 (skills)	K2Atc_U03	C1	La1-La4	N2, N3
PEK_U02	K2Atc_U03	C2, C3	La5, La9-La14	N2, N3
PEK_U03	K2Atc_U03	C2, C3	La6, La7, La9-La14	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	**Projekt procesowy**
Name in English	**Process project**
Main field of study (if applicable)	**Chemical Technology**
Specialization (if applicable)	**Technology of fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**TCC024018**
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				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

7. Chemical technology
8. Chemical engineering
9. Technological project

SUBJECT OBJECTIVES	
C1	Providing the students with main tasks in industrial plants design and analysis of investment feasibility, rules of elaboration of process project of the plant.
C2	Acquiring fundamental knowledge about the systems delivering raw materials and energy, about preparing process data for design, about requirements concerning quality of raw materials and the products.
C3	Providing the students with rules of elaboration of production process course in designed industrial plant, including the rules of general scheme preparation and making technological-equipment scheme in a process project.
C4	Providing the students with the selection rules of process equipment, instruments, constructional materials, selection method of measurement and control instruments in a designed plant.
C5	Presentation of correct estimation of investment costs and calculation of exploitation costs of the designed plant.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_W01 – Knows the design rules for industrial plants, knows the rules for process project elaboration and making the analysis of investment feasibility,

PEK_W02 – Knows the systems delivering raw materials and energy, can make analysis and prepare process data necessary for design, has the knowledge about quality requirements of raw materials and manufactured products, as well as about requirements concerning their storage,

PEK_W03 – Can elaborate production process course in the designed plant,

PEK_W04 – Knows selection rules of process apparatuses, equipment, adjustment of constructional materials and providing the designed plant in measurement and control instruments,

PEK_W05 – Knows how to estimate the investment costs and how to calculate operational costs.	
PROGRAMME CONTENT	
Form of classes – lecture	**Number of hours**
Lec 1	Industrial plant. Design rules of industrial plants. Analysis of investment feasibility.	2
Lec 2	Technological-economical assumptions. Elaboration rules of the process project of industrial plant. Design assumptions.	2
Lec 3	Systems delivering raw materials and energy. Products, wastes. Environment protection.	2
Lec 4	Process data. Quality of raw materials and products, guidelines for their storage. Production process course. General scheme of industrial plant.	2
Lec 5	Process equipment, apparatuses of industrial plant. Selection of constructional materials.	2
Lec 6	Control and adjustment of the designed plant. Measurement and control instruments, systems of automatic control.	2
Lec 7	Elaboration of technological-equipment scheme of the industrial plant. Spatial distribution of equipment items and apparatuses.	2
Lec 8	Investment costs and production costs calculation.	1
	Total hours	**15**

TEACHING TOOLS USED	
N1	Lecture with multimedia presentation.

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_W05	Crediting with grade

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[10] N. Ghasen, R. Henda, Principles of chemical engineering processes, CRC Press, 2009.
[11] D.W. Green, R.H. Perry (red.), Perry's chemical engineers' handbook, 8th ed., McGraw–Hill, 2008.
[12] U. Bröckel, W. Meier, G. Wagner (red.), Product design and engineering. Vol. 1: Basics and technologies, Vol. 2: Raw materials, additives and application, Wiley, 2007.

SECONDARY LITERATURE:

[7] A.C. Dimian, C.S. Bildea, Chemical Process Design. Computer – aided case studies, Wiley, 2008.
[8] G.H. Vogel, Process Development. From the initial idea to the chemical production plant, Wiley, 2005.
[9] M. Zlokarnik, Scale–up in chemical engineering, Wiley, 2002.
[10] G.I. Wells, L.M. Rose, The art of chemical process design, Elsevier, 1986.
[11] W.D. Seider, Process design principles, J.W.&S., 1999.

SUBJECT SUPERVISOR

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Dr inż. Anna Kozik, anna.kozik@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Process project

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical technology

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization	Subject objectives	Programme content	Teaching tool number
(knowledge) **PEK_W01**	K2Atc_W08	C1	Lec1, Lec2	N1
PEK_W02	K2Atc_W08	C2	Lec3	N1

PEK_W03	K2Atc_W08	C3	Lec4	N1
PEK_W04	K2Atc_W08	C3, C4	Lec5–Lec7	N1
PEK_W05	K2Atc_W08	C5	Lec8	N1

Wrocław University of Technology **FACULTY OF CHEMISTRY** **SUBJECT CARD**	
Name in Polish	**Kontrola produkcji i zarządzanie jakością**
Name in English	**Production control and quality management**
Main field of study (if applicable)	**Chemical Technology**
Specialization (if applicable)	**Technology of fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject	**obligatory**
Subject code	**TCC024016**
Group of courses	**NO**

*delete as applicable

	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	Examination			Crediting 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	1			1	

*delete as applicable

SUBJECT OBJECTIVES	
C1	Introducing students to the basic terminology, concepts and definitions of quality management and tools for its improvement.
C2	Presentation of issues concerning the concept of Sustainable Development, Green Chemistry, environmental programs and the impact of the product/technology/ process on the environment.
C3	Acquire basic knowledge about organization and management of the production process
C4	Understanding the nature and role of formation quality management in the production process and implementation of quality control of every stage of it.
C5	Acquire basic knowledge about the product, its life cycle and an efficient system of production management - from raw materials to final product.
C6	Knowledge about the importance of product quality and role of brand in marketing
C7	Presentation of issues concerning the development of sustainable technologies and applied in practice management systems of quality.
C8	Understanding the nature and role of quality management in the production process and elaboration of basic documents on the subject.

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

The person who passed subject:

PEK_W01 – knows the key concepts and definitions of quality and has sufficient knowledge of the basic principles of quality management in chemical enterprise

PEK_W02 – has the knowledge and can describe the Quality Management System in accordance with ISO 9000, knows basic documentation in this area and knows how to use the tools of quality improvement

PEK_W03 – has knowledge of Sustainable Development, Green Chemistry and the documents relating to global sustainable development policy, knows environmental programs

PEK_W04 – knows the key concepts and issues in the field of production management and organization of the production system

PEK_W05 – has knowledge of the product, its life cycle, knows the scope of producer responsibility for the product and has a information about the continuous improvement of product quality and productivity of manufacturing processes

PEK_W06 – has the informations about the improvement of technological processes and audit of technology management as well as the continuous improvement of products and productivity of manufacturing processes in accordance with modern production management system

PEK_W07 - has knowledge of the marketing aspects of the product quality formation

Relating to skills:

The person who passed subject:

PEK_U01 – is able to put into practice the knowledge of production quality management and organization of the production system

PEK_U02 – has the ability to assess the quality of products and services and customer needs analysis

PEK_U03 – has the knowledge and skills in the use of selected quality tools and assessing the ability of production process

PEK_U04 – has the knowledge and knows how to use it in the implementation of quality management systems and knows the basic documentation on the subject

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	*Quality, origin, basic concepts and definitions*	1
Lec 2	*Quality Management Systems - Standards ISO series 9000*	2
Lec 3	*Principles of Sustainable Development, EMAS, environmental programs, "Responsible and Care", Cleaner Production, Cleaner Technology, Green Chemistry*	2
Lec 4	*Techniques and methods for improving the quality*	2
Lec 5	*Organization and management of the production process*	2
Lec 6	*Product - the product life cycle*	2
Lec 7	*Lean Manufacturing, Benchmarking, Controlling, Kaizen*	2
Lec 8	*Marketing aspects of product quality, Brand and its position on the market*	2

	Total hours	**15**

Form of classes - project		**Number of hours**
Proj 1	*Introduction, organization, discuss the range of activities*	1
Proj 2	*Structure of the Quality Manual in accordance with the principles of ISO 9001 regarding the supervision of documentation*	2
Proj 3	*Product Selection, features, standards, requirements, the program of the production process progress and planning of production capacity*	2
Proj 4	*Market analysis and marketing aspects of quality, location planning and assessment of project impact on the environment*	2
Proj 5	*Tools and methods for the improvement of quality - exercises*	2
Proj 6	*Presentation of the Quality Manual including proposed product technology*	2
Proj 7	*Presentation of the Quality Manual including proposed product technology*	2
Proj 8	*Presentation of the Quality Manual including proposed product technology*	2
	Total hours	**15**

TEACHING TOOLS USED	
N1	lecture with a multimedia presentation
N2	individual preparation and multimedia presentation

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
C1 (Lecture)	PEK_W01 – PEK_W07	Exam

F1 (Project)	PEK_U01- PEK_U04	Concept elaboration of the new product + multimedia presentation of the Quality Manual for the technology of proposed product

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Sujak-Cyrul B., Quality management systems: an introduction to the project of documenting and audit of quality management systems, Wrocław University of Technology, Łódź: PRINTPAP, 2011.
[2] Oakland J.S., Total Quality Management. Text with cases. Butterworth-Heinemann, Oxford, 2003.
[3] Kloppenborg T.J., Petrick J.A., Managing project quality, Vienna, Va.: Management Concepts, 2002.
[4] Windsor S.E., An introduction to green process management, Milwaukee, Wis.: ASQ Quality Press, cop. 2011.
[5] Tague N. R., The quality toolbox, Milwaukee, Wis.: ASQ Quality Press, 2005.

SECONDARY LITERATURE:

[1] Łańcucki J., Podstawy Kompleksowego Zarządzania Jakością TQM, Poznań: Wyd. AE, 2006.
[2] Hamrol A., Mantura W., Zarządzania jakością, teoria i praktyka, Poznań: PWN, 1999.
[3] Nowosielski S., Zarządzanie produkcją, Wrocław: Wyd. AE, 2001.
[4] Sosnowska A., Zarządzanie nowym produktem, Warszawa: SGH, 2000.
[5] Żuchowski J., Łagowski E., Narzędzia i metody doskonalenia jakości, Radom: Wyd. Pol. Radomskiej, 2004.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Production control and quality management

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Chemical Technology - Technology of fine chemicals

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	Lec1	N1
PEK_W02		C1, C4	Lec2, Lec 4	N1
PEK_W03		C2	Lec3	N1
PEK_W04		C3	Lec5	N1
PEK_W05		C5	Lec5, Lec6	N1
PEK_W06		C3, C4	Lec7	N1
PEK_W07		C6	Lec 8	N1
(skills) **PEK_U01**		C7	P1	N1
PEK_U02		C7	P3, P4	N1, N2
PEK_U03		C7	P5	N1
PEK_U04		C8	P2, P6, P7, P8	N2

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Zjawiska powierzchniowe i kataliza stosowana**
Name in English	**Surface phenomena and applied catalysis**
Main field of study (if applicable):	**Chemical technology**
Specialization (if applicable):	**Technology of Fine Chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**TCC024010**
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			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1,5		2		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of English language (B2 level).
2. The knowledge of organic and inorganic chemistry.
3. The knowledge of physical chemistry.

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SUBJECT OBJECTIVES

C1 To acquaint the student with basic concept of heterogeneous catalysis.
C2 To familiarize the student with phenomena occurring on catalyst surface.
C3 To enable the student with different methods of catalyst preparation and ways of its characterization.
C4 To acquaint the student with application of heterogeneous catalysis in environmental protection and fine chemicals production.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 The student knows the fundamental definitions used in heterogeneous catalysis.

PEK_W02 The student understands the surface phenomena occurring on the catalyst during reaction.

PEK_W03 The student understands the mechanisms of catalytic reaction.

PEK_W04 The student knows the methods of catalysts preparation and their characterization.

PEK_W05 The student knows the main problems occurring during catalytic processes linked to catalyst deactivation.

PEK_W06 The student can describe popular types of catalysts and reactions used for fine chemicals production and environmental protection.

PEK_W07 The student can describe basic catalytic processes used for fine chemicals production and environmental protection.

relating to skills:

PEK_U01 The student can synthesize solid catalyst on the grounds of literature data.

PEK_U02 The student is able to carry out the catalytic test of hydrocarbon steam reforming and desulfurization, calculate the conversion, selectivity and yields of reaction products.

PEK_U03 The student knows how to calculate the rate of catalytic reaction and activation energy.

PEK_U04 The student can determine the chemical composition of catalyst and describe its structure features on the basis of results of its characterization.

relating to social competences:

PEK_K01

PEK_K02

PROGRAMME CONTENT

Form of classes - lecture		**Number of hours**
Lec 1	Catalysis and catalyst - introduction. The significance of catalysis in everyday life. Catalysis in industry. Description of types of catalysis. Definitions of conversion, selectivity, activity, yield, turnover frequency.	2
Lec 2	Thermodynamics and kinetics of catalytic reaction. Activation energy, equilibrium constant, rate constant, reaction order.	4
Lec 3	Reaction steps in heterogeneous catalysis. active sites, reaction mechanism (Eley-Rideal, Langmuir-Hinshelwood).	2
Lec 4	Adsorption process. Types of adsorption. Energy of adsorption. The significance of surface structure of the catalyst for adsorption process.	2
Lec 5	Crystallographic structure of metals and metal oxides. Classification of crystal imperfections and their impact on catalyst activity.	2

Lec 6	Active sites. Crystallography of active sites, geometrical factor, saturation of active sites. The acid-base character of catalyst surface. Electronic properties of active sites. Bifunctional catalysts.	4
Lec 7	Preparation of solid catalysts. Description of sol-gel method, impregnation, precipitation and co-precipitation. Supported catalyst.	2
Lec 8	Characterization of solid catalyst. Surface structure and chemical composition of catalysts - description of methods and procedures of solid catalysts characterization.	4
Lec 9	Catalyst deactivation. Poisoning, formation of deposits, thermal degradation. Prevention of catalyst deactivation. Catalyst regeneration.	2
Lec 10	Catalysis in environmental protection. Desulfurization, reduction of NOx, methane reforming, VOC's oxidation.	2
Lec 11	The role of catalysis in fine chemicals production. Basic information about the fine chemicals industry. Application of heterogeneous catalysis in fine chemicals production, catalysis for improving production processes, description of the most important processes.	4
	Total hours	

Form of classes - laboratory		**Number of hours**
Lab 1	Preparation of solid catalyst.	4
Lab 2	Preparation of solid catalyst.	4
Lab 3	Determination of acidic and basic active sites of the catalyst.	4
Lab 4	Determination of catalyst chemical composition and structural morphology on the basis of results of its characterization (XRD, XPS, TEM, Sbet of 5 different catalysts).	4
Lab 5	Determination of surface species by infrared spectroscopy.	2
Lab 6	Catalytic steam reforming of hydrocarbons.	4
Lab 7	Catalytic desulfurization.	4
Lab 8	Excursion to BASF.	4
	Total hours	30

TEACHING TOOLS USED
N1. Lecture with a multimedia presentation. N2. Executive instructions for laboratory classes. N3. Laboratory classes carried out with the use of research facilities. N4. Excursion.

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 (lecture)	PEK_W01 - PEK_W07	Exam.
F2 (laboratory)	PEK_U01 - PEK_U04	Report of the laboratory exercise.
C		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[13] „Handbook of Heterogeneous Catalysis", Editors: G. Erti, H. Knözinger, F. Schüth, J. Weitkamp, 2014, Wiley-VCH, ISBN: 9783527610044.

[14] J. Ross „Heterogeneous catalysis. Fundamentals and Applications." 2011, Elsevier, ISBN: 978-0-444-53363-0.

[15] „Heterogeneous Catalysis and Fine Chemicals II", Editors: M. Guisnet et al.,1991, Elsevier, 978-0-444-88514-2.

SECONDARY LITERATURE:

[12] G. Rothenberg „Catalysis: Concepts and Green Applications" 2008, Wiley-VCH, ISBN 978-3-527-31824-7.

[13] M. Ziółek, I. Nowak „Kataliza heterogeniczna. Wybrane zagadnienia" Wydawnictwo Naukowe UAM.

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Surface phenomena and applied catalysis
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY
Chemical technology
AND SPECIALIZATION Technology of Fine Chemicals

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)		C1	Lec1, Lec 2	N1
PEK_W02		C2	Lec 3, Lec 4, Lec 5, Lec 6,	N1
PEK_W03		C1, C2	Lec 3, Lec 4, Lec 6	N1
PEK_W04		C3	Lec 7, Lec 8	N1
PEK_W05		C3, C2, C4	Lec 9	N1
PEK_W06		C4	Lec 10, Lec 11	N1, N4
PEK_W07		C4	Lec 10, Lec 11	N1, N4
PEK_U01 (skills)		C3	Lab 1, Lab 2	N2, N3
PEK_U02		C2, C4	Lab6, Lab 7	N2, N3
PEK_U03		C1, C4	Lab 6, Lab 7	N2, N3
PEK_U04		C3, C4	Lab 3, Lab 4, Lab 5	N2, N3

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

FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish	**Zrównoważony rozwój**
Name in English	**Sustainable development**
Main field of study (if applicable):	**Chemical Technology**
Specialization (if applicable):	**Technology of Fine chemicals**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code	**TCC24017**
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. Basic Chemistry
2. General knowledge on Chemical Technology
3.

SUBJECT OBJECTIVES

C1 To provide students with a general knowledge of sustainability concept
C2 To provide student with a knowledge on sustainable technology and sustainability related to Chemistry and Chemical Technology

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01– trainees will have a general knowledge of sustainability
PEK_W02 – student will have specialized knowledge on sustainability related to chemistry and chemical technology
PEK_W03 – student will be able to solve specific problems concerning sustainability in chemistry and chemical technology

PROGRAMME CONTENT

Form of classes - lecture	**Number of hours**

Lec 1	Introduction to sustainable development (SD) – concepts, principles, definitions, models	1
Lec 2	A role of sustainability in biotechnology and chemical industry – the pollution prevention in chemical industry, the design and modeling of the sustainable manufacturing and industrial processes, conservation and management of resources	2
Lec 3	Sustainable development in chemistry and chemical technology – some aspects of sustainability using case studies	10
Lec 4	Environmental sustainability, Zero emission concept, Cleaner Production concept	1
Lec 5	The challenges of sustainable development	1
	Total hours	15

TEACHING TOOLS USED
N1. Lectures with multimedia presentations

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	PEK_W01 – PEK_W03	Written test and assignments

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Vincenzo Piemonte, Marcello De Falco, Angelo Basile, Sustainable Development in Chemical Engineering: Innovative Technologies, Wiley 2013, ISBN: 978-1-119-95352-4 [2] Sustainable Industrial Processes, ed. By F. Cavani, G. Centi, S. Perathoner and F. Trifiro, Wiley-VCH 2009 [3] lectures [4]
SECONDARY LITERATURE:
[1] [2] [3]
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

SUSTAINABLE DEVELOPMENT

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

CHEMICAL TECHNOLOGY

AND SPECIALIZATION

TECHNOLOGY OF FINE CHEMICALS

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)	K2Atc_W10	C1	Lec 1, Lec 2	N1
PEK_W02	K2Atc_W10	C2	Lec 2, Lec 3	N1
PEK_W03	K2Atc_W10	C2	Lec 1 – Lec 5	N1

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

*** - from table above