JOSIP JURAJ STROSSMAYERA UNIVERSITY OF OSIJEKU
FACULTY OF FOOD TECHNOLOGY OSIJEK

EFFECTIVE CURRICULUM

FOR THE ACADEMIC YEAR 2019/2020

GRADUATE STUDY

PROCESS ENGINEERING

Osijek, 24 September 2019

1st year of studies, academic year 2019/2020

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
I	43763	Mathematics for Engineers	3	1	2	7	D. Marković, PhD, assoc. prof.	S. Miodragović, PhD, assist. prof.
I	43769	Unit Operations in Process Engineering	4	2	2	9	S. Tomas, PhD, full prof. M. Planinić, PhD, full prof. A. Bucić-Kojić, PhD, full prof.	G. Šelo, MSc
I	43765	Mass and Energy Balances	1		3	3	M. Tišma, PhD, assoc. prof.	M. Ostojčić, MSc
I	43766	Modelling of Operation and Processes	2		2	5	D. Magdić, PhD, full prof.	
I	43767	Thermotechnics	2	1		4	S. Budžaki, PhD, assoc. prof.	M. Ostojčić, MSc
I	15909	Elective Course B-I	2	1	0	4		
		SUBTOTAL:	**14**	**5**	**9**	**32**		
		TOTAL:	**28**					

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
II	43768	Basics of Bioprocess Engineering	3	1	2	7	V. Krstanović, PhD, full prof. N. Velić, PhD, assoc. prof. Kristina Mastanjević, PhD, assist. prof.	
II	43764	Engineering Chemistry	3	1	2	7	L. Jakobek Barron, PhD, full prof.	I. Tomac, PhD P. Matić, MSc I. Buljeta, MSc
II	120483	Chemical and Biochemical Reactions	3	1		5	M. Tišma, PhD, assoc. prof.	
II	79483	Process Automatization	2	1	1	4	F. Čačić Kenjerić, PhD, assist. prof.	
II	43762	Company Management	2			3	B. Miličević, PhD, full prof. J. Babić, PhD, full prof.	
II	177794 177796	English Language German Language	2			2	A. Šarić, PhD, assist. prof. A. Šarić, PhD, assist. prof.	
		SUBTOTAL:	**15**	**4**	**5**	**28**		
		TOTAL:	**24**					

2nd year of studies, academic year 2019/2020

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
III	62368	Process Equipment Design	3	2	1	7	D. Velić, PhD, full prof. S. Jokić, PhD, full prof.	
III	43772	Packaging Materials and Package	2	1		4	L. Jakobek Barron, PhD, full prof.	
III	***5754***	Elective Course A-I	3		2	min		
III		Elective Course A-II	3		2	12		
III	***5755***	Elective Course B-II	2		2	min		
III		Elective Course B-III	(2)		(2)	8		
		SUBTOTAL:	**15**	**3**	**9**	**31**		
		TOTAL:	**27**					

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
IV	62370	Process Design and Optimisation	2	1	1	5	D. Velić, PhD, full prof. S. Jokić, PhD, full prof.	
IV	149887	Constuction Materials, Corrosion and Protection	2	2		4	M. Planinić, PhD, full prof. A. Bucić-Kojić, PhD, full prof.	
IV	177800	Diploma Thesis		10	10	20		
		SUBTOTAL:	**4**	**13**	**11**	**29**		
		TOTAL:	**28**					

* One of elective B courses student can choose from any study at University

Elective Courses A (Modul A: Ecological Engineering) - *5754*

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
III	62341	Bioprocesses in Environment Protection	3		2	6	N. Velić, PhD, assoc. prof. V. Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.	
III	62343	Process Ecological Engineering	3		2	6	S. Tomas, PhD, full prof. M. Tišma, PhD, assoc. prof. S. Budžaki, PhD, assoc. prof.	G. Šelo, MSc
III	62347	Water Treatment Prcesses	3		2	6	N. Velić, PhD, assoc. prof. V. Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.	

Elective Courses B (Modul A: Ecological Engineering) - *5755*

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
III	62357	Industrial Ecology	2		2	4	M. Tišma, PhD, assoc. prof.	
III	62349	Water Quality Management and Water Treatment Processes	2		2	4	M. Habuda-Stanić, PhD, assoc. prof.	
III	62351	Energy and Environment	2		2	4	S. Budžaki, PhD, assoc. prof.	M. Ostojčić, MSc
III	62359	Green Chemistry	1		1	2	D. Gašo-Sokač, PhD, assoc. prof. V. Bušić, PhD, assist. prof.	

Elective Courses B-I (Modul A: Ecological Engineering) - *15909*

SEMESTER	COURSE CODE	COURSE TITLE	L	S	LA	ECTS	COURSE LECTURER	COURSE ASSOCIATES
I	43751	Introduction to Scientific and Research Work	2	1		4	J. Hardi, PhD, full prof. Đ. Ačkar, PhD, assoc. prof.	

Course description and learning outcomes of courses at the graduate university study
Process Engineering

Course title	**Mathematics for Engineers**		
Course code	43763	**Course status**	Compulsory
Study programme	Process engineering		
Semester	I		
Course lecturer	Darija Marković, PhD, assoc. prof.		
Course associates	Suzana Miodragović, PhD, assist. prof.		
Course content	Errors. Type of errors. Absolute and relative errors. Significant digits. The inverse problem in the theory of errors. Interpolation: Lagrange's interpolation polynomial. Newton's interpolation polynomial. Error of approximation. Linear interpolating spline. Cubic interpolating spline. Solving nonlinear equations: Nesting of intervals. Method of simple iterations. Newton method and its generalizations. Least squares problem: Linear least squares problem. Nonlinear least squares problem. Gauss-Newton method. Approximation of functions. The best L2 approximation. Orthogonal polynomials. Chebyshev polynomials. The best L∞ approximation. Numerical integration: Trapezoidal rule. Newton-Cotes quadrature formula. Simpson's rule. Numerical solving differential equations: Euler method. Runge – Kutta method. Descriptive statistics: Graphical representation of data. Mean, median and mode, variance, histograms, frequency polygons.		
General and specific knowledge acquired in course (objective)	Students will be introduced to the main ideas and methods of numerical mathematics and descriptive statistics. Theorem demonstration will be avoided except in cases of concrete evidence which automatically indicate method or idea development.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3	1	2
(total)	45	15	30
Examination method	Exam can be taken at the end of all lectures and labs and it is composed of oral and written part. During semester tests will be given which can replace written part of exam. Students can make a seminar paper which has an impact on the final grade.		
Credits	7	**Language**	Croatian
Compulsory reading	[1] R.Scitovski, Numerička matematika, Odjel za matematiku, Osijek, 2000. [2] G.R. Iversen, *Statistics, The Conceptual Approach*, Springer, Berlin, 1997.		
Recommended reading	[1] D.Kincaid, W.Cheney, Numerical Analysis, Brooks/Cole Publishing Company, New York, 1996. [2] J.Stoer, R.Bulirsch, Introduction to Numerical Analysis, 2nd Ed.,Springer Verlag, New York, 1993. [3] B.P. Demidovič, I.A. Maron, Computational Mathematics, Mir Publisher, Moscow, 1987.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	List and explain types of errors.
2	Define and determine absolute and relative error of approximation and the number of significant digits of approximation.
3	Describe minimal and sufficient conditions for the existence of a sulution for nonlinear equation and apply various methds for their solving.
4	Explain the problem of interpolation polynomial.
5	To determine linear interpolating spline.
6	Define least squares problem, know and apply methods for solving linear least squares problem.
7	Diferentiate and apply various methods of numerical integration.
8	Demonstrate numerical solving of differential equations on selected examples
9	List methods of data collection and organisation and represent them graphicaly.
10	Define measures of central tendencies and scattering of a data set.
11	Define probability and list basic characteristics of probability.
12	Diferentiate discrete and continuous randm variable.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures attendance	1	1-12	Attendance	Attendance list	0	5
Exercise attendance	1	1-12	Attendance and active participation	Attendance list	0	5
Continuous knowledge check	3	1-12	Literature studying	2 partial or single complete written exam	30	50
Final exam	2	1-12	Literature studying	Oral exam	20	40
TOTAL	7				**50**	**100**

Course title	**Unit Operations In Process Engineering**		
Course code	43769	**Course status**	Compulsory
Study programme	Process engineering		
Semester	I semestar		
Course lecturer	Srećko Tomas, PhD, full. prof. Mirela Planinić, PhD, full. prof. Ana Bucić-Kojić, PhD, full. prof.		
Course associates	Gordana Šelo, MSc		
Course content	Lectures: Mechanical-physical operations: The characterization of disperse systems. Basic of mechanical macro process. Separation processes in streams of fluids (Sedimentation due to the gravitational and centrifugal force). Separation processes in porous media (Filtration and centrifugal filtration). Sorting. Electrical and magnetically separation processes. Fluidisation, Mixing and knead. Size reduction. Atomising. Agglomeration processes: Agglomeration, briquetting and tebletting. Mass and heat transfer operations: Evaporation. Extraction (leaching) and solubility. Crystallisation. Drying. Humidification. Dry air properties, psychometric chart, air and heat need for drying, and heat recovery during drying. Absorption. Distillation. Adsorption. Flotation. Separation processes by membranes. Seminar: Introducing to equipment that commonly used in industry. Labs: audio-practices - solution of practical problems; industrial; Laboratory: Particle size analysis, Fluid-bed and radiation draying, Psychometric determination of air humidity; industrial exercise.		
General and specific knowledge acquired in course (objective)	The aim of this course is to introduce the students to a basic and auxiliary unit operations and equipment, which are parts of every industrial process. There are mechanical-physical operations, separation processes, and unit operation that involve a heat and mass transport.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	4	2	2
(total)	60	30	30
Examination method	Written, and oral if necessary. Parts of exam will be held during the semester. Each part of exam contains two teaching units.		
Credits	9	**Language**	Croatian
Compulsory reading	1. S. Tomas: *Mehaničko fizikalne operacije*. Interna skripta, Osijek, 1999. 2. S. Tomas: *Operacije uz prijenos topline - Uparivanje*. Interna skripta, Osijek, 1999. 3. S. Tomas: *Ekstrakcija (izluživanje) i otapanje, kristalizacija i destilacija*. Interna skripta, Osijek, 1997. 4. S. Tomas: *Sušenje. Apsorpcija plinova*. Interna skripta, Osijek, 1999. 5. S. Tomas: *Konvekcijsko sušenje, suvremena dostignuća kod proračuna.* Prehrambeno tehnološki fakultet Osijek, 2001.		
Recommended reading	1. J. M. Coulson, et al.: *Chemical Enginnering I-V*. Pergamon Press, Oxford. 1999 2. R. H. Perry, D. W. Green: *Perry's Chemical Engineer's Handbook*. 7nd Ed, McGraw-Hill, New York, 1997. 3. A. S. Mujumdar: *Handbook of Industrial Drying*. 2nd ed., Vol. 1 and 2., Marcel Dekker, Inc., New York, 1995. 4. J. Welti-Chanes, J.F. Velez-Ruiz, G.V. Barbosa-Canovas: *Transport Phenomena in Food Processing*, CRC Press LLC, Boca Raton, London, New York, Washington D.C., 2003. 5. A. Ibarz, G.V. Barbosa-Canovas: *Unit Operations in Food Engineering*, CRC Press LLC, Boca Raton, London, New York, Washington D.C., 2003.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Explain purpose and principles of mechanical-physical unit operations including size reduction, particle separation (solids, fluids, gases), mixing/knead, agglomeration and fluidisation.
2	Sketch and describe equipment for mechanical-physical unit operations and understand their work principles.
3	Apply gained knowledg to solve problems regarding mechanical-physical unit operations in process industry.
4	Explain and diferentiate heat and mass transfer mechanisms as well as the principles of concentarting, dehydration and separation of specific compounds.
5	Sketch and describe equipment used in process industry for unit operations and explain their work principles with focus on heat and mass transfer.
6	Apply gained knowledge to solve problems regarding mechanical-physical unit operations which include heat and mass transfer.
7	Recognise possibility of application of a specific unit operation in process industry.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures, seminars	0.5	1-7	Attendance and active participation	Attendance list	0	5
Laboratory practice	2	1-7	Attendance list and active participation	Attendance list and active participation; solved calculation problems	0	5
Writen knowledge check (calculation problems)	2.5	3, 6	Literature studying	2 partial written exams or written exam	30	40
Written exam (calculation problems)*	2.5*	3, 6	Literature studying*	Written exam*	30*	40*
Final exam	4	1-7	Literature studying	Oral exam	30	50
TOTAL	**9**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Mass And Energy Balances**		
Course code	43765	**Course status**	Compulsory
Study programme	Process engineering		
Semester	I		
Course lecturer	Marina Tišma, PhD, assoc. prof.		
Course associates	Marta Ostojčić, MSc		
Course content	A basic law, terms and techniques in chemical engineering calculations. A process and process variables. Balance of substances (general form, differential and integral). Balance of substances stationary process. Balance of substances no stationary process. Calculations based on balances of substances stationary process (system of linear equations). Balance of substances in process unites with or without a chemical reaction. Balances of substances in process with more than one unite with or without a chemical reaction. Balance of substances with reversible line, bypass line and partial outlet with or without a chemical reaction. Energy and chemical engineering. Basic terms in energy balances. General form of energy balance. Energy balance of closed systems. Energy balance of open systems (stationary process). Calculations in chemical engineering based on energy balance. Energy balance of single-phase processes. Energy balance of poly-phase processes. Energy balance of processes without chemical reaction. Energy balance of processes with chemical reaction. Simultaneous balance of energy and mass. Exercise: Calculations based on balances of energy and mass with use of numerical methods and computers.		
General and specific knowledge acquired in course (objective)	Application of principles of conservation of mass and energy to chemical process systems. Introduction to chemical engineering process analysis, and calculations for steady and non-steady systems.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	1		3
(total)	15		45
Examination method	Written exam. Written completion proof at least two times per semester.		
Credits	3	**Language**	Croatian
Compulsory reading	1. Nastavni materijal dostupan na web-stranici Prehrambeno-tehnološkog fakulteta Osijek		
Recommended reading	1. Himmelblau: *Basic Principles and Calculations in Chemical Engineering*. Prentice Hall, New Jersey, 1982. 2. Felder, Rousseeau: *Elementary Principles of Chemical Processes.* J. Wiley, New York, 1986. 3. Luyben, Wenzel: *Chemical Process Analysis: Mass and Energy Balances*. Prentice Hall, New Jwrsey, 1988.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define and explain basic laws and terms in chemical engineering calculations.
2	Diferentiate and explain balance of substances – general form, diferential and integral balance.
3	Diferentiate and explain balance of substances for stationary and nonstationary process
4	Apply gained knowledge to solve calculations regarding balance of substances in process unites with or without a chemical reaction.
5	Apply gained knowledge to solve calculations regarding balance of substances in process with more than one unite with or without a chemical reaction, with reversible line, bypass line and partial outlet with or without a chemical reaction.
6	Define and explain basic terms in energy balances.
7	Diferentiate and explain energy balances – general form, closed systems, open systems (stationary process), single-phase processes, poly-phase processes, processes with and without chemical reaction.
8	List and correctly interprete Simultaneous balance of energy and mass.
9	Apply gained knowledge to solve calculations regarding balance of energy and/or substance.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures, Laboratory practice	0.5	1-9	Attendance and active participation	Attendance list	5	8
Periodic knowledge check	1	1-9	Literature studying	Partial written exam 1 Partial written exam 2	40	66
Written exam*	1*	1-9	Literature studying*	Written exam*	40*	66*
Final exam	1.5	1-9	Literature studying	Oral exam	15	26
TOTAL	**3**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Modelling Of Operation And Processes**		
Course code	43766	**Course status**	Compulsory
Study programme	Process engineering		
Semester	I		
Course lecturer	Damir Magdić, PhD, full. prof.		
Course associates			
Course content	Lectures: Definition of real system and model (Definitions of basic variables: input, output and state). Classification of mathematical models. Methodology of development of mathematical and computer models. Analysis and validation of mathematical models of real systems. Lumped and distributed process models. Steady state modelling of technological processes. Linear programming (Basics of Simplex method). Basics of computer vision application in technological processes. Basics of sound application in technological processes. Examples: models of chemical and enzymatic reactions, steady state of pH and evaporation process, application of linear programming models (optimisation of technological processes), application of computer vision in technological processes, application of sound in technological processes. Labs: Model of steady state of linear chemical reactions. Steady and dynamic state of pH in chemical reactor. Model of food sterilization. Model of food freezing. Optimisation in food production processes. Modelling of parameters by applying digital image analysis. Modelling by applying acoustic impulse response method. Simulation by different computer programs.		
General and specific knowledge acquired in course (objective)	- personal computers and computer programs application in engineering purposes - preparing of mass and energy bilances, mathematical methods application, calculations and statistical analysis of data - optimisation of operations and processes by appling ended models - optimisation of operations and processes by appling different computer programs		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		2
(total)	30		30
Examination method	Seminar paper (evaluation of work and presentation), examination after finishing computer practice, written and oral examination.		
Credits	5	**Language**	Croatian
Compulsory reading	1. D. Magdić: *Numeričke metode.* PTF, Osijek, 2001. 2. Ž. Kurtanjek: *Matematičko modeliranje procesa.* PBF, Zagreb, 2000. 3. D. Magdić: *Računalna analiza slike*, PTF, Osijek, 2001. 4. … *Inženjerski priručnik - ip1*, Školska knjiga, Zagreb, 1996		
Recommended reading	1. V. Čerić: *Simulacijsko modeliranje.* Školska knjiga, Zagreb, 1993. 2. V. Žiljak: *Simulacija računalom.* Školska knjiga-SNL, Zagreb, 1982. 3. J. Božičević: *Temelji automatike 1.* Školska knjiga, Zagreb, 1990. 4. J. Božičević: *Temelji automatike 2.* Školska knjiga, Zagreb, 1990. 5. T. Stuart: *Mathematical modelling of food processing operations*. Elsevier Applied Science Publishers Ltd, London and New York, 1992.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Compare various softwares for simulation and optimisation of operations and processes.
2	Apply various softwares in modeling and simulation.
3	Solely prepare and analyse reports of th results obtained by models.
4	To compare and diferentiate results of simulatins obtained by various softwares.
5	Apply multidisciplinary knowledge and skills in computer aided problem solving.
6	Explain optimisation of processes, products and profit in food processing and storage.
7	Follow scientific studies in th efiled of process engineering.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	2	1, 2, 5-7	Active participation and problems solving	Attendance list and active participation; Partial evaluation of knowledge	15	25
Computer exercises	2	1-5	Guded computer work	Evaluation of exercise practice and reports	25	40
Individual tasks; Computer aided tasks	1	1-7	Literature studying	Written and oral exam	20	35
TOTAL	**5**				**60**	**100**

Course title	**Thermotechnics**		
Course code	43767	**Course status**	Compulsory
Study programme	Process engineering		
Semester	I		
Course lecturer	Sandra Budžaki, PhD, assoc. prof.		
Course associates	Marta Ostojčić, MSc		
Course content	Combustion. Thermal effects of combustion. Combustion heat. Composition and mass of burnt gases. Types of firing. Boilers. Processing of steam. System of cooling water with circular flow. Cooling towers. Methods for dimension of cooling towers. Cooling in technology process. A mass and energy balance. Types of refrigerating plants. Determining of refrigerating capacity. Calculation of power and dimension of compressors. Calculation, dimension and types of evaporators. Calculation, dimension and types of condenser. A cooling room balance. A jellying (gelling) room balance. A freezer balance. Heat pumps. Seminar: Examples of calculations and dimensions specific cases in accordance with theory.		
General and specific knowledge acquired in course (objective)	Introduction to the refrigerating plants working, cooling in processes technology, and steam processing.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	1	
(total)	30	15	
Examination method	Written and/or oral examination. Written completion proof at least two times per semester.		
Credits	4	**Language**	Croatian
Compulsory reading	1. F. Bošnjaković: *Nauka o toplini III dio*. Tehnička knjiga, Zagreb, 1986. 2. E. Beer: *Priručnik za dimenzioniranje uređaja kemijske procesne industrije*. Kemija u Industriji, Zagreb, 1985. 3. E. Hnatko: Osnove termodinamike i termotehnike. Slavonski Brod, 1995.		
Recommended reading	1. I. Dencer: *Refrigeration Systems and Applications.* John Wiley & Sons, 2003. 2. W.F. Stoeckers: *Industrial Refrigeration Handbook.* McGrow Hill Professional, 1998.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define and analyse combustion process.
2	Apply gained knowledge in combustion related problems solving.
3	Sketch and diferentiate types of equipment used in industrial cooling (compressors, condensers with and without cooling, throttle valve and evaporator).
4	Explain working principles of cooling tower, list equations for enthalpy calculation and construct heat balance for cooling tower.
5	Diferentiate heat balance of a cooling room, jellying (gelling) room and freezing room.
6	Define absolute and relative air humidity, dew point temperature and diferentiate air thermal characteristics.
7	Diferentiate technical and technological steam production.
8	List and sketch types of coolers.
9	Diferentiate air filters in coolers.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures and practical assignments	0.5	1-9	Attendance and active participation	Attendance list active participation	5	8
Periodic knowledge evaluation	1	1-9	Literature studying	Partial written exam 1 Partial written exam 2	40	66
Exam*	1	1-9	Literature studying *	Written exam*	40*	66*
Final exam	2.5	1-9	Literature studying	Oral exam	15	26
TOTAL	**4**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Basics of Bioprocess Engineering**		
Course code	43768	**Course status**	Compulsory
Study programme	Process engineering		
Semester	II		
Course lecturer	Vinko Krstanović, PhD, full. prof. Natalija Velić, PhD, assoc. prof. Kristina Mastanjević, PhD, assist prof.		
Course associates			
Course content	Biotechnology and Biochemical Engineering. Microbiology basics, cells, procaryotes, eucaryotes, cell components, nutrients. Enzymes, kinetics, Michaelis-Menten, complex, immobilized enzymes. DNA replication, transcription, translation, metabolic regulation. Metabolic pathways, aerobic glucose metabolism, anaerobic metabolism. Cell growth. Stochiometry and kinetics of microbial growth and product formation. Bioprocess characteristics-stochiometry, yields, productivity. Batch, fed-batch and semicontinuous cultures. Continuous cultures- chemostat, turbidistat, systems with cell recycle. Mixing. Aeration and oxygen transfer in bioreactors. Oxygen electrodes, oxygen transfer rate determinations. Sterilisation. Bioreactors-configurations and industrial applications. Selection, scale-up, scale-down, operation and control of bioreactors. Recovery and purification of products, separation methods. Upstream and downstream processing- overview, integration in bioprocessing.		
General and specific knowledge acquired in course (objective)	Obtaining education for planning, preparation and control of bioprocesses.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3	1	2
(total)	45	15	30
Examination method	Essay (evaluation of work and presentation), 2 written examinations during the semester and final oral examination.		
Credits	7	**Language**	Croatian
Compulsory reading	1. M.D.Doran, Bioprocess Engineering Principles, AP, NY, 1995. 2. V.Marić et al. Biokemijsko inženjerstvo-skripta, PBF, Zagreb, 1991. 3. J.E.Bailey, D.F.Ollis, Biochemical Engineering Fundamentals McGraw-Hill (1986).		
Recommended reading	1. K.van't Riet, J.Tramper, Basic Bioreactor Design, M.Dekker, New York, (1991) 2. H.W.Blanch, D.S.Clark, Biochemical Engineering, Marcel Dekker, New York, 1996.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define basic characteristics of bioprocesses.
2	Explain basic principles of enzyme kinetics.
3	Diferentiate and compare various types of cultivation – batch, continuous and semicontinuous.
4	Define and calculate indicators of bioprcess productivity.
5	Diferentiate various types of bioreactors and bioprocess control options.
6	Diferentiate sterislisation types and apply gained knowledge to choose type of sterilisatin, temperature and duration in dependence on substrate.
7	Define th eimportance and role of mixing and aeration in bioprocesses.
8	Diferentiate upstream and downstream processes.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures attendance	1.5	1-8	Attendance and active participation	Attendance list and active participation	5	10
Laboratory practice	1.5	1-8	Attendance and active participation	Attendance list laboratory reports	5	10
Periodic knowledge evaluation	2	1-8	Literature studying	Partial written exam 1 Partial written exam 2	30	50
Exam*	2*	1-8	Literature studying*	Written exam*	30	50
Final exam	2	1-8	Literature studying	Oral exam	15	30
TOTAL	**7**				**55**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Engineering Chemistry**		
Course code	43764	**Course status**	Compulsory
Study programme	Process engineering		
Semester	II		
Course lecturer	Lidija Jakobek Barron, PhD, full. prof.		
Course associates	Ivana Tomac, PhD Petra Matić, MSc Ivana Buljeta, MSc		
Course content	Lectures: *Chemical thermodynamics*. The laws and equations of chemical thermodynamics. Thermodynamic properties of solutions. Phase equilibrium of one-component and two-component systems. Chemical thermodynamics of real chemical systems. Application of chemical thermodynamics in engineering. *Chemical engineering kinetics*. The laws and equations of chemical kinetics. Complex chemical reactions. Homogeneous and heterogeneous catalytic reactions. Mechanisms of chemical reactions. Application of chemical kinetics in engineering. *Colloid systems*. Optical, molecular-kinetics and electrical properties of colloid systems. Structure and stability of colloid systems. Colloid systems in industry. *Chemistry of materials*. Chemistry of inorganic materials. Metals and alloys. Chemistry of silicate. Chemistry of organic materials. Chemistry of polymers. Chemistry of cellulose and paper. Chemistry of surfactants. New engineering materials. Superconductors. Organic conducting polymers. Nanomaterials. Labs: Distillation of azeotrope mixtures. Viscosity of liquids. Extraction. Adsorption from solutions. Determination of energy changes of chemical reactions. Determination of kinetics parameters of chemical reactions. Rheological properties of colloids. Chemical properties of metals and alloys. Chemical properties of paper. Electrochemical properties of conducting polymers.		
General and specific knowledge acquired in course (objective)	Acquisition of knowledge from the field of chemistry which is important for further study of engineering courses. The knowledge of engineering chemistry is necessary for understanding and solution of engineering problems in chemical industry.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3	1	2
(total)	45	15	30
Examination method	Oral exam, two written exams during the semester		
Credits	7	**Language**	Croatian
Compulsory reading	1. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry* Vikas Publishing House Pvt. Ltd., New Delhi, 2000. 2. J.M. Smith, H.C. Van Ness, M. Abbott: *Introduction to Chemical Engineering Thermodynamics.* McGraw-Hill Science,New York, 2000. 3. S.I. Sandler: *Chemical and Engineering Thermodynamics*. Wiley, New York,1998. 4. J. H. Espenson: *Chemical Kinetics and Reaction Mechanisms*. McGraw-Hill Science, New York, 2002. J.I. Gersten, F. W. Smith, *The Physics and Chemistry of Materials*, Wiley, 2001.		
Recommended reading	1. J.M. Smith: *Chemical Engineering Kinetics*. McGraw-Hill Science, New York, 1981. 2. J.W. Nicholson: *The Chemistry of Polymers*. Royal Society Chemistry, Cambridge, 1997. J. C. Roberts: *The Chemistry of Paper*. Royal Society Chemistry, Cambridge, 1996.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	List and explain basic laws and terms in chemical thermodynamics (work, heat, energy, enthalpy, enthropy).
2	Analyse problems from the field of chemical energetics and thermochemistry (work, heat, energy, enthalpy, enthropy).
3	List and describe phase balances of one-component and two-component systems, colligative properties, chemical balance.
4	Describe and explain chemical kinetics and mechanisms as well as the colloid systems and their properties.
5	Analyse problems from the field of chemical equilibrium (changes in composition) and in the field of chemical kinetics (composition changes in dependance of time and half life)
6	Conduct various measurements (adsorption, extraction, viscosity, surface tension) on systems used in process industry.
7	Analyse measurement results, formulate and evaluate posible solutions of a specific problem.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1.5	1-5	Attendance, problem solving	Attendance list Evaluation of solved tasks	2,5	5
Laboratory practice	1	6-7	Laboratory practive, result analysis and preparation of the reports	Attendance list and report evaluation	5	10
Seminars	0.5	2,5	Calculation problems	Attendance list	2,5	5
Periodic knowledge evaluation	3.5	1-5	Literature studying	Partial written exam 1 Partial written exam 2	30	50
Exam*	3.5*	1-5*	Literature studying*	Written exam*	30*	50*
Final exam	0.5	1-5	Literature studying	Oral exam	20	30
TOTAL	**7**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Chemical And Biochemical Reactors**		
Course code	120483	**Course status**	Compulsory
Study programme	Process engineering		
Semester	II		
Course lecturer	Marina Tišma, PhD, assoc. prof.		
Course associates			
Course content	Introduction-basic definitions of the subject. Reactors types. Concept of the ideal reactors (batch, continuous-flow-stirred tanks CSTR, fed batch, cascade of CSTRs, plug flow). Membrane reactors. Mass and energy balances. Chemical kinetics, enzyme kinetics, microbial kinetics. Kinetics models. Mixing and flow paterns in reactors. Residence time distribution. Gas-liquid mass transfer. Catalysts and biocatalysts – stability, activity. Diffusion limited kinetics. Heat transfer. Energy consumption. The choise of reactor.		
General and specific knowledge acquired in course (objective)	The objective of this course is to introduce the student to the basic concept of the design of the chemical as well as the biochemical reactors.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3	1	
(total)	45	15	
Examination method	Essay (evaluation of work and presentation), 2 written examinations during the semester and final oral examination.		
Credits	5	**Language**	Croatian
Compulsory reading	1. Z. Gomzi, Kemijski reaktori Gomzi, HINUS, Zagreb, 1998. 2. O.Levenspiel, Chemical Reaction Engineering, J.Wiley, New York, 1999. 3. H.W.Blanch, D.S.Clark, “Biochemical Engineering”, Marcel Dekker, New York, 1996. 4. J.E.Bailey, D.F.Ollis, Biochemical Engineering Fundamentals McGraw-Hill (1986). 5. A.Scragg ed. Biotechnology for Engineers - Biological Systems in Technological Processes, Ellis Horwood Limited, Chichester, (1988).		
Recommended reading	1. Đ.Vasić-Rački, Z.Gomzi, Kemijsko reakcijsko inženjerstvo, Kem. Ind., *24* (1975) 125-128. 2. Đ.Vasić-Rački, E.Pajc, Reaktori s enzimskim katalizatorom, Kem.Ind., *28* (1979) 313-317. 3. Đ.Vasić-Rački, History of industrial biotransformations-dreams and realities. In: Liese, A., Seelbach, K., Wandrey C. (Eds): Industrial Biotransformations.: Wiley-VCH, Weinheim, 2000, 3-29 4. J.A.Williams, Keys to bioreactor selection, CEP 2002, 34. 5. K.van't Riet, J.Tramper, Basic Bioreactor Design, M.Dekker, New York, (1991)		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	List, sketch and interprete various chemical reactors (batch, CSTR, cascade of CSTR,).
2	List, sketch and interprete various biochemical reactors (bioreactor, chemostate, cascade bioreactor).
3	Liste and explain mathematical model of process in each of upper reactors.
4	List and explain methods of chinetic parameters evaluation.
5	Determine the type of chemicaly catalysed reaction and evaluate its kinetical parameters based on experimental data.
6	Determine the type of enzymaticaly catalysed reaction and evaluate its kinetical parameters based on experimental dana and based on th eobtained results select proper enzyme for a specific production.
7	Determine the microorganism growth kinetics, substrate expenditure and product growth and based on th eobtained values determine the appropriate microorganism for a specific biotechnological process.
8	Explain and diferentiate types f bioreactors based on th mixing type.
9	Diferentiate aerobic from anaerobic reactors and properly explain oxigen transfer in aerobic reactors.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures and seminars	1	1-9	Attendance and active participation	Attendance list	5	10
Seminar	1	1-9	Individual work on a selected topic	Public presentation of seminars	5	10
Continuous knowledge check	2	1-9	Literature studying	Partial written exam 1 Partial written exam 2	30	50
Written exam*	2*	1-9	Literature studying*	Written exam*	30*	50*
Final exam	1	1-9	Literature studying	Oral exam	10	30
TOTAL	**5**				**50**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Process Automatization**		
Course code	79483	**Course status**	Compulsory
Study programme	Process engineering		
Semester	II		
Course lecturer	Frane Čačić Kenjerić, PhD, assist. prof.		
Course associates			
Course content	Manufacturing process, industry facilities and their kinds. Process guidance goals and their stratification. Man-machine interface. Application of digital computers for process guidance. Informatisation and automatisation of manufacturing processes. Basic structures of systems for automatic process guidance. Practical examples. Systems for measurement and visualizing process variables. System of automatic control. Advantages of digital regulators. PLC properties and their programming. Interfacing process computer with regulated process equipment. Process (operating) unit – central system unit for automatic process control. Structural unit for simple and complex systems. Centralized, decentralized, hierarchical and distributed control structures. Control unit – subsystem for operator-process communication. Equipment for process and control unit implementation. Communication systems in industry. General purpose transmission technologies/standards as base for some industry communication protocols. Fieldbus communication technologies; ASI, PROFIBUS, CAN, BITBUS. PLC specialized networks; Melsecnet, SINEC, DataHighway. Software support in automatic control systems (SCADA). Programming tools. PC as control unit. Integrating office packages/applications in automatic systems. Development and maintenance of automatic control systems.		
General and specific knowledge acquired in course (objective)	To introduce students to manufacturing processes, automatisation, standards of transmission technologies, communication technologies, programming tools and integrating office packages.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	1	1
(total)	30	15	15
Examination method	Succesfully completed labs and final oral exam		
Credits	4	**Language**	Croatian
Compulsory reading	Jović, F.: Kompjutersko vođenje procesa, Zveza organizacij za tehničko kulturo Slovenije, Ljubljana, 1988.		
Recommended reading	Perić, N.: Automatizacija postrojenja i procesa - predavanja, Zavodska skripta, FER, Zagreb, 2000. Crispin, A. J.: Programmable Logic Controllers and their Engineering Applications, McGraw-Hill Publishing Company, 1997. Smiljanić, G.: Računala i procesi, Školska knjiga, Zagreb, 1991.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define and interprete production system, industrial plant and their types.
2	Define and discuss computer application in process management.
3	Define and demonstrate informatisation and automatisation of manufacturing systems.
4	Define and disscuss advantages of digital regulators.
5	Analyse operation and structure of process automatisation.
6	Define and describe industrial communication systems.
7	Demonstrate (simulate) PLC application in process automatisation.
8	Project unit operation automatisation system.
9	Apply software in design and verification of proces automation systems.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1	1- 9	Attendance and active participatin	Attendance list and active participation	3	5
Seminars	0.5	7, 9	Attendance; Guided problems solving	Disscussion	0	0
Labratory practice	0.5	7, 9	Attendance and individual completion of laboratory tasks	Evaluation of obtained results and submited reports	9	15
Periodic knowledge evaluation	0.3	1– 6	Literature studying	Partial written exam 1 Partial written exam 2	18	30
Written exam*	0.3*	1– 6	Literature studying*	Written exam*	18*	30*
Final exam	0.3	1- 9	Literature studying	Oral exam	18	30
Project work	1.4	8, 9	Report preparation and presentation	Public presentation	12	20
TOTAL	**4**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Company Management**		
Course code	43762	**Course status**	Compulsory
Study programme	Process engineering		
Semester	II		
Course lecturer	Borislav Miličević, PhD, full prof. Jurislav Babić, PhD, full prof.		
Course associates			
Course content	- The nature of strategy - How to create successful strategies - The sense of traditional wisdom - What systems in stable balance disregard in real life - Where systems with complex recurring connections lead - What unpredictability and self-emerging strategies mean for managers - What constant change and political decisions mean for control - What managers do when applying everyday management - What managers do when applying non-everyday management - Strategic management in perspective		
General and specific knowledge acquired in course (objective)	Acquiring general knowledge on management and leadership, ability to create and make decisions that are important for successful implementation of tasks in the field of business systems functioning.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		
(total)	30		
Examination method	Oral exam. Two control tests during the semester.		
Credits	3	**Language**	Croatian
Compulsory reading	1. Stacey, D.R.: Strateški menedžment i organizacijska dinamika, Mate d.o.o. Zagreb, Zagreb 1993. 2. Žugaj, M., Šehanović, J., Cingula, M.: Organizacija, TIVA Tiskara Varaždin, Varaždin 2004.		
Recommended reading	1. Campbell, D.J.: Organizations and the Business Environment, Butterworth – Acinemann, Linacre House, Jordan Hill, Oxford, 1999.		

LEARNING OUTCOMES

No	LEARNING OUTCOMES
1	Define basic elements of the company
2	Define basic skills, role and functions of company management
3	To analyse influence of internal and external factors influencing company management
4	To analyse sucessfullness of company management

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1	1-4	Attendance, Active participation	Attendance list and active participation	0	10
Continuous knowledge check	2	1-4	Literature studying	Partial written exam 1 Partial written exam 2	55	90
Exam*	2*	1-4	Literature studying*	Partial exam*	55*	90*
TOTAL	**3**				**55**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**English language**		
Course code	177794	Course status	Elective
Study programme	Process engineering		
Semester	II		
Course lecturer	Antonija Šarić, PhD, assist. prof.		
Course associates			
Course content	Students are introduced to the following topics:functional food, antioxidants in food, methods in food analysis, diet for various age groups, fast food, genetically modified food. Students are introduced to different scientific discourses and rhetorical functions. The emphasis is on the ways of integrating extralinguistic and linguistic knowledge in generating meanings at the sentence and text level. Complex nominal groups, coordinated and subordinated sentences, prepositional and participle phrases are dealt with.		
General and specific knowledge acquired in course (objective)	The course objective is to enable students to comprehend and interpret various scientific discourses via recognizing text organization at the macro and micro level. Students are exposed to very specific lexis in the field of food science and nutrition.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		
(total)	30		
Examination method	The exam is composed of the written and oral part taken at the end of the first and second semester. Students are also given several smaller test during the academic year.		
Credits	2	**Language**	Croatian, English
Compulsory reading	1.L.Obad: *An English Language Workbook for Students of Food Technology III.* Prehrambeno tehnološki fakultet, Osijek, 2003 2.L.Obad:*Radni materijali iz engleskog jezika za studente četvrte godine*.PTF, Osijek, 2003 . 3.Ž.Bujas: *Veliki englesko-hrvatski rječnik*, Globus, Zagreb, 1999.		
Recommended reading	1.C.Hughes&McCarthy: *Exploring Grammar in Context,* CUP, 2000. 2.Ž.Bujas: *Veliki hrvatsko-engleski rječnik*, Globus, Zagreb, 1999.		

LEARNING OUTCOMES

No	LEARNING OUTCOMES
1	Comprehend and analyse various professional text
2	To select and explain key informatinon from teh professional discourse
3	To recognize and apply langauge in writing of professional text
4	Listen, revide and synthesyze basic information based on audio and video records
5	To prepare oral and written presentation of a selected professional topic

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESMENT METHOD	CREDITS	
					min	max
Lecture attendance	0.20	1-5	Lectures	List of participation	5	10
Continuous knowledge check	0.75	1-5	Literature studying	2 evaluations (written) 2 partial exams (written and oral)	25	40
Seminars	0.30	1-5	Seminar preparation	Public presentation of seminars	5	10
Final exam	0.75	1-5	Literature studying	Final exam (written and oral)	25	40
TOTAL	**2**				**60**	**100**

Course title	**German language**		
Course code	177796	**Course status**	Elective
Study programme	Process engineering		
Semester	2		
Course lecturer	Antonija Šarić, PhD, assist. prof.		
Course associates			
Course content	The collection of texts enables the students to upgrade the language competence In the field of their profession and specialization. The specialized texts are used to introduce students to language structures at the lexical, morphological and syntactic level to facilitate comprehension. The text selection is done in relation with other courses and involves topics that deal with nutrition, food biochemistry, functional food, food quality, chemistry and technology of food products. Students comprehend the text via global and detailed reading, and unite the knowledge and skills in writing and oral discourse. The emphasis is on specialized lexis and word understanding is related to extralinguistic knowledge.		
General and specific knowledge acquired in course (objective)	The course objective is to master reading skills to facilitate understanding of more complex specialized texts and to expand specialized lexis. Students also upgrade the writing skills through summary writing and question posing relating to essential information.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		
(total)	30		
Examination method	Written exam twice in semester and after the second semester both written and oral exams		
Credits	2	**Language**	Croatian, German
Compulsory reading	1. S. Moro: *Radni materijal iz njemačkog jezika*, (Zbirka tekstova iz literature stručnih kolegija) 2. I. Medić: *Kleine deutsche Grammatik*, Školska knjiga, Zagreb, 1999. 3. T. Marčetić: *Deutsche Grammatik im Ueberblick*, Školska knjiga, Zagreb,1999. 4. M. Uroić, A. Hurm: *Njemačko - hrvatski rječnik*, Školska knjiga, Zagreb, 1994.		
Recommended reading	1. Z. Glovacki-Bernardi: *Osnove njemačke gramatike*, Školska knjiga, Zagreb, 1999. 2. B. Jakić, A. Hurm: *Hrvatsko - njemački rječnik*, Školska knjiga, Zagreb, 1991. 3. G. Wahrig: *Deutsches Woerterbuch*, Bertelsmann Lexikon Verlag, 1997.		

LEARNING OUTCOMES

No	LEARNING OUTCOMES
1	Comprehend and analyse various professional text
2	Follow oral presentations from the profession on german language
3	Reproduce text information ino ral and written form
4	Listen, revide and synthesyze basic information based on audio and video records

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	BODOVI	
					min	max
Lectures attendance	0.20	1-4	Lectures	List of participation	5	10
Continuous knowledge check	0.75	1-4	Literature studying	2 evaluations (written) 2 partial exams (written and oral)	25	40
Seminars	0.30	1-4	Seminar preparation	Public presentation of seminars	5	10
Final exam	0.75	1-4	Literature studying	Final exam (written and oral)	25	40
TOTAL	**2**				**60**	**100**

Course title	**Process Equipment Design**		
Course code	62368	**Course status**	Compulsory
Study programme	Process engineering		
Semester	III		
Course lecturer	Darko Velić, PhD, full. prof. Stela Jokić, PhD, full. prof.		
Course associates			
Course content	Lectures: Process diagrams; equipments, plants, battery limits, off sites. Symbols. Standards. Specification. The role of process engineer in equipment design. R&D in equipment design. The basic of mechanical design. Materials. The basics of calculation. The application of similarity theory. Dimensional analyses. Modelling. Equipment design in process industry: pipelines, tanks, valves, fittings, pumps and compressors, fans, transporters, particle disintegration, mixing, chemical and biochemical reactors, hydro-cyclones and cyclones, filtration equipment, heat exchangers, evaporators, distillation and rectification, adsorption, extraction, drying. Measurement and regulation equipment. Process equipment automatisation. Energetic analysis and recuperation. Heat duty. Equipment optimisation. Seminars: Example of process equipment design. Determination of critical equations, coefficients and exponents from experimental data. R&D in process equipment design. Teamwork on project. Case studies. Labs: Computer aided drawing (CAD): equipment, Flowsheet, P&I diagrams, 2D & 3D diagrams, layouts, plants. Video projections and animations. Simulation software. Process industry visit.		
General and specific knowledge acquired in course (objective)	Obtaining advance engineering knowledge in Process Equipment Design. Detailed Design. Computer-Aided Equipment Design. Good manufacturing practices. Case studies.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3	2	1
(total)	45	30	15
Examination method	Written exam, seminar work, final oral exam 2 written examinations during the semester and final oral examination.		
Credits	7	**Language**	Croatian, English
Compulsory reading	1. E. Beer: Priručnik za dimenzioniranje uređaja u kemijskoj industriji, Kemija u industriji, Zagreb, 1985. 2. F. Šef, Ž. Olujić: Projektiranje procesnih postrojenja, Kemija u industriji; Zagreb, 1988. 3. R. H. Perry, D. W. Green: Perry's Chemical Engineer's Handbook. 7. ed., McGraw Hill, New York, 1997. 4. Z. B. Maroulis, G. D. Saravacos: Food Process Design, Marcel Dekker, 2003. 5. Mate Bilić, Darko Velić: Projektiranje uređaja, interna skripta, Prehrambeno tehnološki fakultet Osijek, 2003.		
Recommended reading	1. W. D. Seider, J. D. Seader, D. R. Lewin: Proces Design Principles Synthesis, Analysis and Evaluation of Process Flowsheets, J. Wiley & Sons, 2000. 2. N. P. Libermann: Process Design For Reliable Operations, Gulf Publishing, 1984. 3. R. P. Singh, D. R. Heldman: Introduction to Food Engineering, 3. ed., Marcel Dekker, 2001. 4. N. P. Libermann: Process Design For Reliable Operations, Gulf Publishing, 1984.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Compare, define and diferentiate basic principles of process equipment design.
2	Define and understand process engineer role in process equipment design.
3	Apply gained knowledge in design of process equipment used in fluid transport an mechanical transport.
4	Apply gained knowledge in design of process equipment used in mechanical.physical and separation processes.
5	Apply gained knowledge in design of process equipment used in heat and mass transport.
6	Apply gained knowledge in design of process equipment used in membrane separation.
7	Apply gained knowledge in design of process equipment used in measurement and regulation.
8	Compare and analyse softwares used in process equipment design and apply the proper one.
9	Properly interprete and diferentiate laws ind the field of process equipment design.
10	List and analyse examples of good engineering practice.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures, seminars and computer exercises	2	1-10	Attendance; Active participation	Attendance list and active participation	0	5
Periodic knowledge evaluation	3	1-10	Literature studying	Partial written exam 1 Partial written exam 2	35	65
Written exam*	3*	1-10	Literature studying*	Written exam*	35*	65*
Finasl exam	2	1-10	Literature studying	Oral exam	15	30
TOTAL	**7**				**50**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Packaging Materials And Package**		
Course code	43772	**Course status**	Compulsory
Study programme	Process engineering		
Semester	III		
Course lecturer	Lidija Jakobek Barron, PhD, full. prof.		
Course associates			
Course content	Lectures: The role and importance of a package. Systematisation and function of packages. The elements important for creating of a package. Packaging materials: metals (tin-plate, aluminium, chromium coated steel, steel), glass, plastic packaging materials, laminated food packaging materials, paper, cardboard and paperboard, wood, textile. Biodegradable packaging materials. Possible shapes of a package. Chemical interactions in a product-package-environment systems. Permeation and migration processes. New features in a packaging technology. Active and intelligent packaging. Package and environment. Ecologically acceptable package. Package for various products in chemical industry. Recycling of package. Safety and legislative regulations related to the usage and application of a package.		
General and specific knowledge acquired in course (objective)	The aim of this study is to familiarize the students with packaging materials that are used in packing of various products together with packaging technology. Also students will learn about interactions in food-package-environment systems. This study will give the basic knowledge for practical work in industry.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	1	
(total)	30	15	
Examination method	Written exam and/or 2 written exams during the semester.		
Credits	4	**Language**	Croatian
Compulsory reading	1. G. L. Robertson: *Food Packaging-Principles and practice*. Marcel Dekker, New York, 1993. 2. P. Ackerman, M. Jägerstad, T. Ohlsson*: Foods and Packaging Materials-Chemical Interactions*. The Royal Society of Chemistry, Cambridge, 1997. 3. R. Coles, D. McDowel, M. J. Kirwan: *Food Packaging Technology*. Blackwell Publishing, CRC Press, New York, 2003. 4. R. Ahvenainen: *Novel Food Packaging Techniques*. Woodhead Publishing, Cambridge, 2003.		
Recommended reading	1. N. Stričević: *Suvremena ambalaža 1*. Školska knjiga, Zagreb, 1982. 2. N. Stričević: *Suvremena ambalaža 2*. Školska knjiga, Zagreb, 1983.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Explain characteristics of various ambalage materials (tin-plate, aluminium, chromium coated steel, steel, glass, plastic packaging materials (PEHD, PELD, PELLD, PP, PS, PVC, PVDC, EVAC, EVAL, PET), laminated food packaging materials, paper, cardboard and paperboard, wood, textile)
2	Explain production of varius package materials (metal materials, gass, paper)
3	Describe and explain influence of various parameters on package (thermal processes – tin-plate and glass, corosion – metal package)
4	Describe ecologically acceptable package and recycling
5	Analyse package material in which food was packaged (design, function, material selection, graphycal design, package characteristics) and evaluate package.
6	Argument better selection of package (enhanced function package)
7	Identify package made of new materials accptable for packageing

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1	1-4	Attendance, written asignments	Attendance list, written asignment evaluation	2.5	5
Seminars	0.5	5-7	Individual work on a project for the oral presentation	Attendance list, project evaluation	7.5	15
Continuous knowledge check	2	1-4	Literature studying; partial written exams	Partial written exam 1 Partial written exam 2	30	50
Written exam*	2*	1-4*	Literature studying; oritten exam*	Written exam*	30*	50*
Final exam	0.5	1-4	Literature studying; oral exam	Oral exam	20	30
TOTAL	**4**				**60**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Process Design And Optimisation**		
Course code	62370	**Course status**	Compulsory
Study programme	Process engineering		
Semester	IV		
Course lecturer	Darko Velić, PhD, full prof. Stela Jokić, PhD, full prof.		
Course associates			
Course content	Lectures: Industrial process design – general approach. Process research and development. Process and equipment scale up. Investment decision. Plant location. Project implementation phases. Project evaluation. Process design. Energy and mass balances. Process diagrams. Process diagrams simulation. Process equipment cost estimation. Hierarchy in process design. Process design models. Synthesis of process systems. Heat integration. Heat exchangers network and network design. Pinch method. Capital investment. Economic comp rations. Process optimisation. Process safety. Waste minimization. Waste management. Process changes in design phases. Heat exchangers network optimisation. Process control and automatisation. Process equipment specification. Feasibility study. Detail engineering. Start up. Process design and legalisative. Seminars: Application of techno economic analyses as process design basis. The examples of process diagrams. Process design from idea to basic design. Labs: The exercise of numerical calculations of energy and mass balance. Calculations of process waste, mass and energy. The choice of construction materials. Process and equipment optimisation, process equipment specifications, plant layouts, in order to get the knowledge for the writing exam. Computer aided process design and optimisation. Video projections and animations. Simulation software.		
General and specific knowledge acquired in course (objective)	Obtaining advanced engineering knowledge in Process Design and Optimisation. Detailed process design. Computer aided process design and optimisation. Good manufacturing practices. New product and technology development.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	1	1
(total)	30	15	15
Examination method	Written exam, seminar work, final oral exam 2 written examinations during the semester and final oral examination.		
Credits	5	**Language**	Croatian, English
Compulsory reading	1. R. Smith, Chemical Process Design, McGraw Hill, 1995. 2. F. Šef, Č. Olujić, Projektiranje procesnih postrojenja, SKTH/ Kemija u industriji, 1988. 3. D. R. Woods, Process Design and Engineering Practice, Prentice Hall, 1994. 4. W. D. Seider, J. D. Seader, D. R. Lewin, Proces Design Principles Synthesis, Analysis and Evaluation of Process Flowsheets, J. Wiley & Sons, 2000. 5. Mate Bilić, Darko Velić: Optimizacija i projektiranje industrijskih procesa, interna skripta, Prehrambeno tehnološki fakultet Osijek, 2004.		
Recommended reading	1. N. P. Libermann, Process Design For Reliable Operations, Gulf Publishing, 1984. 2. R. Perry, Chemical Engineers Handbook, McGraw Hill, 1998. 3. E. Beer: Priručnik za dimenzioniranje uređaja u kemijskoj industriji, Kemija u industriji, Zagreb, 1985. 4. Z. B. Maroulis, G. D. Saravacos: Food Process Design, Marcel Dekker, 2003. 5. P. J. Fellows: Food processing technology; Principles and practice, Second Edition, Woodhead Publishing Limited, 2000.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Properly explain, compare and diferentiate phases of industrial prcess design (from idea to basic design).
2	Define the role of a process engineer - designer
3	Define and analyse possible solutions and define project task.
4	Analyse and construct mass and heat balance for a specific process plant.
5	Define and determine production capacity, select optimal process solutions adn evaluate costs.
6	Analyse various optimisation methods (LP, NLP, RSM, ANN) and apply RSM method in optimisation of industrial processes by *Design Expert®.*
7	Draw process diagrams and projects in *MS Visio®* and *CAD* softwares.
8	Analyse and optimise heat exchange network.
9	Interprete and diferentiate legislative in the field of industrial plan design.
10	Compare, analyse and apply gained knowledge in process/technological project.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures, seminars and computer exercises	2	1-10	Attendance and active participation	Attendance list and active participation	0	5
Periodic knowledge evaluation	2	1-10	Literature studying	Partial written exam 1 Partial written exam 2	35	65
Written exam*	2*	1-10	Literature studying*	Written exam*	35*	65*
Final exam	2	1-10	Literature studying	Oral exam	15	30
TOTAL	**7**				**50**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Construction Materials, Corrosion And Protection**		
Course code	149887	**Course status**	Compulsory
Study programme	Process engineering		
Semester	IV		
Course lecturer	Mirela Planinić, full prof. Ana Bucić-Kojić, full prof.		
Course associates			
Course content	Lectures: Importance of corrosion studying from the viewpoint of industrial application of different construction materials. Types and characteristics of construction materials. Structure, mechanical, physical, and chemical properties of construction materials. Types of corrosion damages. Mechanisms and kinetics of electrochemical and chemical corrosion processes. Thermodynamics of corrosion process. Passivity. Types of corrosion tests. Metallic construction materials in industrial applications. Inorganic non-metallic construction materials. Organic materials, polymers and composite materials. Protection of materials - basic principles. Preparation of materials for corrosion protection. Types and characteristics of particular corrosion protection systems. Maintains of corrosion protection systems. Economic aspect of corrosion protection in industrial applications. Labs: Electrochemical polarization measurements, Tafel analysis, polarization resistance. Non-electrochemical methods of corrosion monitoring, indicators of corrosion. Inhibitor efficiency. Quality of metallic coatings. Mechanical properties of materials. Tour of the industrial plants, presentation of practical examples.		
General and specific knowledge acquired in course (objective)	Course objective is to get students acquanted with types and major properties of construction materials used in industry. Explanation of mechanisms of corrosion processes on the basis of macroscopic and microscopic structural properties. Understanding the factors which influence a selection of construction materials and importance of these factors in designing and maintaining of industrial plants. Presentation of corrosion protection systems.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	2	
(total)	30	30	
Examination method	oral or two written exams during the semester		
Credits	4	**Language**	Croatian, English
Compulsory reading	1. D.A. Jones: *Principles and Prevention of Corrosion. Prentice Hall*, New Jersey, 1996. 2. P. Marcus, J. Oudar (Eds.): *Corrosion Mechanisms in Theory and Practice*. Marcel Dekker, New York, Basel, Hong Kong, 1995. 3. R.J. Landrum: *Fundamentals of Designing for Corrosion Control*. NACE, Houston, 1992. 4. I. Esih, Z. Dugi: *Tehnologija zaštite od korozije*. Školska knjiga, Zagreb, 1990. 5. H. H Uhlig, R.W. Revie: *Corrosion and Corrosion Control*. John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore, 1985.		
Recommended reading	1. I. Esih: *Osnove površinske zaštite*, Fakultet strojarstva i brodogradnje, Zagreb, 2003. 2. S. Martinez, I. Štern: *Korozija i zaštita – eksperimentalne metode*. Hinus, Zagreb, 1999. 3. D.R. Askeland: *The Science and Engineering of Materials*. Chapman & Hall, London, 1996. 4. M.G. Fontana: *Corrosion Engineering*. McGraw-Hill, New York, 1985. 5. F.L. Laque, H.R. Copson: *Otpornost metala i legura na koroziju*. Naučna knjiga, Beograd, 1975.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define corrosion and recognice type of corrosion damage.
2	Explain mechanism of electrochemical corrosion and understand thermodynamics of corrosion process.
3	List physico-chemical factors influencing kinetics and mechanism of corrosion process.
4	List and cllasify methods of corrosion monitoring and studying.
5	Describe factors which influence a selection of construction materials in industry.
6	Identify specifics of a selected industry regarding construction material selection and terms in which corrosion occurs.
7	Liste and clasify corrosion protection methods.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures and laboratory practice	1	1-7	Attendance and active participation	Attendance list	0	10
Seminars	3	1-7	Individual literature search on selected topis, preparatin od presentation	Seminar presentation	50	60
Final exam*	1*	1-7	Written and oral exam*	Written and oral exam*	10*	30*
TOTAL	**4**				**50**	**100**

*Final exam is obligytory only in case if student did not collect min credits through the semester

Course title	**Bioprocesses in Environment Protection**		
Course code	62341	**Course status**	Elective A
Study programme	Process engineering		
Semester	III		
Course lecturer	Natalija Velić, PhD, assoc. prof. Vinko Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.		
Course associates			
Course content	Basic concepts of bioprocess engineering. Basic metabolic functions of microorganisms, growth and methods of cultivation. Interactions between microorganisms and environment, adaptation and selection. Microbial degradation of xenobiotics. Design and operation of bioreactors. Biological wastewater treatment: activated sludge processes, nitrogen removal (nitrification, denitrification), biological phosphorous removal, aerobic biofilters. Composting process: kinetics of microbial growth, relationship between temperature and the substrate degradation rate, mechanisms of heat transfer, kinetic analysis of composting process. Principles of bioremediation. Selection of microbiological processes for treating soils and groundwater contaminated with organic and inorganic pollutants. Microbiological characterization. Environmental factors. In-situ and ex-situ bioremediation. Reactor options. Bioremediation of petroleum contaminations, nitroaromatic compounds and chlorinated phenols. Microbial remediation of metals. Microbial removal of ammonia and nitrate from groundwater.		
General and specific knowledge acquired in course (objective)	Application of engineering principles to design, develop and analyze processes using biocatalysts. These processes may result in the formation of desirable compounds or in the destruction of unwanted hazardous substances.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3		2
(total)	45		30
Examination method	Essay (evaluation of work and presentation), 3 written examinations during the semester and final oral examination.		
Credits	6	**Language**	Croatian
Compulsory reading	1. G. Bitton, Wastewater Microbiology,Wiley-Liss, Inc., New York, 1994. 2. J. Casey, Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, New York, 1995. 3. R.L. Crawford, D.L. Crawford, Bioremediation: principles and applications, Cambridge University Press, 1998. 4. M.L. Shuler, F. Kargi, Bioprocess engineering, Prentice Hall PTR, Upper Saddle River, 2002. 5. J.A. Salvato, et al., Environmental Engineering, John Wiley&Sons, Hoboken, New Jersey, 2003.		
Recommended reading			

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define basic principles in bioprocess engineering.
2	Diferentiate and compare various types of bioreactors used in processes aimed to environment protection.
3	List and define bioprocesses used in environment protection (reducing pollution) – biological wastewater treatment, composting, bioremediation, phytoremediation.
4	Diferentiate bioprocesses based on thier applicability in reducing the pollution in environment constituents.
5	Interprete an cmpare national and international legislation in the field of environment protection.
6	Suggest apropriate procedure for pollution removal based on a hypothetical problem.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1	1-6	Attendance and active participation	Attendance list and active participation	5	10
Laboratory practice	1	1-6	Attendance and active participation	Attendance list and laboratory reports	5	10
Periodic knowledge evaluation	2	1-6	Literature studying	Partial written exam 1 Partial written exam 2	30	50
Written exam*	2*	1-6	Literature studying*	Written exam*	30*	50*
Final exam	2	1-6	Literature studying	Oral exam	15	30
TOTAL	**6**				**55**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Process Ecological Engineering**		
Course code	62343	**Course status**	Elective A
Study programme	Process engineering		
Semester	III		
Course lecturer	Srećko Tomas, PhD, full prof. Marina Tišma, PhD, assoc. prof. Sandra Budžaki, PhD, assoc. prof.		
Course associates	Gordana Šelo, MSc		
Course content	Lectures: Basics of ecological engineering. Development and environment: Influence of process industry on environment. Rational use of raw materials, water and energy, and prevention and reduction of wastes at source, before leaving a process. Gas cleaning: Characterization of solid particles, size distribution, separation efficiency; Dedusters; Cyclones; Electric filters; Industrial filter for air cleaning; Air filters; (Adsorption filters) Equipment for absorption and chemisorptions of gases; Scrubbers; Gas cleaning plants. Water and water quality, Water purification process, Mechanical and physical-chemical treatments of wastewater cleaning: Riddle; Size reduction; Equalizing; Sedimentation; Flotation; Coagulation; Flocculation; Centrifugation; Adsorption; Ion exchanging; Membrane process; Chemical precipitation; Biochemical purification of wastewaters; Neutralisation; Oxidation and reduction; Disinfections; Evaporation; Heat treatment of sludge. Waste engineering: Source, collecting, classifying and waste management; the nature and using of solid waste; Heat treatment of waste with purpose of energy using. Role of environmental engineering in insuring of sustainable development. Exercise: Industrial exercise and laboratory work.		
General and specific knowledge acquired in course (objective)	Introducing to influence of industry on environment. Implementation of preventive environmental strategies to processes, products and services (cleaner production, sustainable development). Design of cleaner chemical processes. Equipment and devices for different treatment of waste.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3		2
(total)	45		30
Examination method	Written exam and seminar work.		
Credits	6	**Language**	Croatian
Compulsory reading	1. S. Tomas: Procesno ekološko inženjerstvo. Interna skripta, Prehrambeno tehnološki fakultet Osijek, 2005. 2. N.P. Cheremisinoff: Handbook of Pollution Prevention Practices. Marcel Dekker, New York, 2001. 3. Z. Milanović, S. Radović, V. Vučić: Otpad nije smeće. Gospodarstvo i okoliš, Mtg-topograf, Zagreb, 2002. 4. N.P. Cheremisinoff: Handbook of Solid Waste Management and Waste Minimization Technologies. Butterworth Heinemann, Elsevier Science, London, 2003. 5. L. Theodore, A.J. Buonicore, J.D. McKenna, I.J.Kugelman, J.S. Jeris, J.J. Santoleri, T.F. McGowan: Waste Management. U Perry's Chemical Engineering Handbook, R.H. Perry, D.W. Green (ur.), 7ndEd, McGraw-Hill, New York, 1997		
Recommended reading	1. Metealf & Eddy: Wastewater Engineering: Treatment, Disposal, Reuse.McGraw-Hill, New York, 1979. 2. G.M. Fair, J.C. Geyer, D.A. Okun: Elements of Water Supply and Wastewater Disposal. John Wiley & Sons, Inc., New York – London, 1981. 3. V. Podlesnik, R. Podhorsky: Čišćenje plinova. Tehnička enciklopedija 3, Zagreb, 1969.. 4. S. Tedesci: Otpadne vode. Tehnička enciklopedija 10, Zagreb, 1986. 5. M. Pavlović: Ekološko inženjerstvo. Tehnički fakultet "Mihajlo Pupin" u Zrenjaninu, Zrenjanin, 2002.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Properly define, compare and diferentiate basics of process ecological engineering in comparison to other engineering branches.
2	Properly define and diferentiate legislative regarding ecology, sustainability and natural resources management.
3	Describe and explain basic types of equipment use din prcess ecological engineering (transport, mechanical and physico-chemical operations equipment, heat and mass transfer equipment).
4	Analyse and construct heat and mass balance for a specific process plant with the aim of waste minimisation and energy expanditure rationalisation.
5	Diferentiate and explain phases of solid waste heat treatment as well as its reuse in energy production processes.
6	Diferentiate and apply relevant optimisation techniques in process ecological engineering.
7	Describe and analyse possible project options regarding process ecological design and define project task.
8	Compare, analyse and apply gained knowledge in seminar preparation.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures, laboratory practice	2	1-8	Attendance and active participation	Attendance list and active participation	0	5
Peridic knowledge evaluation	2	1-8	Literature studying	Partial written exam 1 Partial written exam 2	35	65
Written exam*	2*	1-8	Literature studying*	Written exam	35*	65*
Final exam	2	1-8	Literature studying	Oral exam	15	30
TOTAL	**6**				**50**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Water Treatment Processes**		
Course code	62347	**Course status**	Elective
Study programme	Process engineering		
Semester	III		
Course lecturer	Natalija Velić, PhD, assoc. prof. Vinko Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.		
Course associates			
Course content	Lectures: Wastewater, origin and classification. Biogeochemical cycles in biosphere. Primary wastewater treatment. Biodegradation (aerobic, anaerobic). Nitrification. De-nitrification. Bioaccumulation of phosphorus. Bio-removal of sulphur. Xenobiotics biodegradation. New microbial species in wastewater treatment. Modern methods for monitoring of microorganisms. Bioaugmentation methods. Sludge disposal. Technology of activated sludge. Lagoons. Rotating biodisc. Biofilter. Bioreactors in wastewater treatments (UASB; SBR; Caroussell, MBR ...). Tertiary wastewater treatment. National and international regulations. Labs: Biotests (aerobic, anaerobic). Physical, chemical, microbiological quality of wastewater different origin. Microscopy. Biodegradation, nitrification and denitrification. Definition of aerobic and anaerobic parameters in wastewater treatment. Efficiency of wastewater treatment processes. Auditory practice: Video-tape or CD-ROM: Parts of wastewater treatment plants. Sludge disposal. Analytical methods. Field work: A visit-touring of the wastewater treatment plants, incinerator, landfills and a composting plant.		
General and specific knowledge acquired in course (objective)	In addition to basic facts, the students are introduced with the latest achivements in wastewater treatment.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	3		2
(total)	45		30
Examination method	Written (2x) Oral		
Credits	6	**Language**	Croatian
Compulsory reading	1. Henze, M., Harremoes, P., Cour Jansen, J.I., Arvin, E. (2002) Wastewater Treatment: Biological and Chemical Processes. 3th edition, Springer, 420 str.. (ISBN: 3-540-42228-5) 2. Glancer-Šoljan, M., Landeka Dragičević, T., Šoljan , V., Ban, S. (2002) Biološka obradba otpadnih voda. Interna skripta. Izdavač Kugler, Zagreb. 194 str.		
Recommended reading	1. Wilson, F. (1981) Design calculations in wastewater treatment. E.&F.N. Spon Ltd, London, New York, 221 str. (ISBN: 0-419—11700-8)		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define wastewaters and clasify them by origin.
2	Interprete and compare national and international (EU) regulation regarding water and wastewater.
3	Define wastewater quality indicators and analyse them.
4	Diferentiate and explain primary, secondary and tertiary wastewater treatments.
5	Determine basic factors influencing biological wastewater treatment.
6	Compare various technologies and equipment used in biological wastewater treatment.
7	Recommend adequate wastewater treatment precedure based on its quality indicators, origin, amount and other available and relevean information.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	1	1-7	Attendance and active participation	Attendance list and active participation	5	10
Laborator, auditory and field practice	1	1-7	Attendance and active participation	Attendance list and laboratory reports	5	10
Periodic knowledge evaluation	2	1-7	Literature studying	Partial written exam 1 Partial written exam 2	30	50
Written exam*	2*	1-7	Literature studying*	Written exam*	30*	50*
Final exam	2	1-7	Literature studying	Oral exam	15	30
TOTAL	**6**				**55**	**100**

*Activity performed only in case if minimum is not achieved throughout the semester on continuous knowledge check.

Course title	**Industrial Ecology**		
Course code	62357	**Course status**	Elective B
Study programme	Process engineering		
Semester	III		
Course lecturer	Marina Tišma, PhD, assoc. prof.		
Course associates			
Course content	The concept of industrial ecology: changing today′s way of thinking with advanced. Linking industrial activity and environmental and social sciences. Physical, biological and societal framework (food chains, nutrient and energy transfer and population ecology). The status of resources (water, energy, minerals). Industrial product design and development (from preliminary design, development, manufacture to sales and use). Environmental interactions during product use (generation of liquid, gaseous and solid residues). Prevention of pollution. The life-cycle assessment and impact. Remanufacturing and recycling (metals, plastics, forest products). Corporate industrial ecology – environment protection as strategy of the firm. Implementing environmental management systems – EMAS, ISO 14001 and ISO 14004. Case study.		
General and specific knowledge acquired in course (objective)	Familiarizing with the concept, which requires that the industrial system be viewed not in isolation from its surrounding systems, but in concept with them. It is a system in which one seeks to optimize the total materials cycle from virgin material to finished material, and to ultimate disposal.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		2
(total)	30		30
Examination method	Essay (evaluation of work and presentation), 3 written examinations during the semester and final oral examination.		
Credits	4	**Language**	Croatian
Compulsory reading	1. Lowe, E.A., Discovering Industrial Ecology, Battelle Press, Columbus, 1997. 2. Gradel, T.E., Allenby B.R., Industrial Ecology, Second Ed., Pearson Education Inc., Upper Saddle River, 2003.		
Recommended reading			

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define, explain and understand sustainabilty of products and processes.
2	Describe life cycle of a product and process.
3	List, analyse and compare renewable energy sources.
4	List, analyse and compare nonrenewable energy sources.
5	List and explain methods of prouct environmental fingerprint.
6	Write a report in the field of industrial ecology.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures laboratory practice	1	1-6	Attendance	Attendance list and active participation	10	20
Seminar	2	1-6	Individual work on a selected topic	Public presentation of seminar	30	50
Final exam	1	1-6	Oral exam preparation	Oral exam	10	30
TOTAL	**4**				**50**	**100**

Course title	**Water Quality Management And Water Treatment Processes**		
Course code	62349	**Course status**	Elective B
Study programme	Process engineering		
Semester	III		
Course lecturer	Mirna Habuda-Stanić, PhD, assoc. prof.		
Course associates			
Course content	Lectures: Water quality management and quality guarantee; fundamentals; initiation of ISO 9000 quality system Water quality for specific purposes. Coagulation and flocculation: colloids and destabilization of colloids, types of coagulant. Adsorption: types of adsorption, adsorption equilibrium and kinetics. Adsorbents: types of adsorbent, adsorption of organics from water by activated carbon. Ion exchange: equilibrium and kinetics, ion selectivity and capacity. Ion exchangers: the choice of ion exchanger resin, the estimate of ion exchanger quantity. Membrane processes: membranes and modules, pressure-driven membrane processes, desalination. Advanced oxidation processes: ozone, H_2O_2, photochemical methods. Disinfections: types of disinfections, formation of by-products. Labs: Parameters important for the choice of treatment process. The treatment of water through membranes, ion exchangers and precipitation. Controlling and simulation of water treatment processes. Adsorption capacity of activated carbon. Humic substances and THM formation potential in chlorination process.		
General and specific knowledge acquired in course (objective)	The objective of this course is to make students familiar with water quality parameters, physical-chemical properties of natural waters, water treatment processes as well as with conditions for appliance of particular processes.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		2
(total)	30		30
Examination method	Written and oral examination. Two written completion proof through semester		
Credits	4	**Language**	Croatian
Compulsory reading	1. A.P. Sincero, G.A. Sincero: Physical-Chemical Treatment of Water and Wastewater. CRC Press, New York, 2002. 2. Standard Methods for the Examination of Water and Wastewater, 20th edition. American Public Health Association, Washington, 1999. 3. B. Hauser: Drinking Water Chemistry: A Laboratory Manual.CRC Press, New York, 2001.		
Recommended reading	1. AWWA: Water Quality and Treatment, A Handbook of Community Water Supplies, Fifth Edition. McGraw-Hill, New York, 1999. 2. S. Tedeschi: Zaštita voda. Hrvatsko društvo građevinskih inženjera, Zageb,1997. 3. Pravilnik o zdravstvenoj ispravnosti vode za piće. Narodne novine,182/2004		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define measures of water quality manegement and diferentiate water used for various purposes.
2	List process parametres, sketch equipment, basic and auxiliary resources in water treatment by coagulatin and floculation.
3	List and explain adsorption mechanisms, the most important factors influencing adsorption efficiency and the most often used adsorption materials in wastewater treatment.
4	List isoterm models and explain Langmuire and Freundlich isotherme application.
5	List process parameters for membrane filtration in wastewater treatment; explain types and backgroung for selection a specific membrane process.
6	Define and diferentiate advanced oxydation processes (AOPs) and explain principles of AOP based equipment operation.
7	List types and process parameters of water desinfestion and explain desinfestant selection. Explain desinfection efficacy.
8	Apply gained knowledge in problem solving related to water treatment.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures	0.5	1-8	Attendance and active participation	Attendance list and active participation	5	15
Experimental work	0.5	2-7	Expermental work	Evaluation of laboratory reports	15	25
Periodic knowledge evaluation	2	1-8	Literature studying	Partial written exam 1 Partial written exam 2	30	60
Final exam	1	1-8	Literature studying	Oral exam	30	60
TOTAL	**4**				**50**	**100**

Course title	**Energy And Environment**		
Course code	62351	**Course status**	Elective B
Study programme	Process engineering		
Semester	III		
Course lecturer	Sandra Budžaki, PhD, assoc. prof.		
Course associates	Marta Ostojčić, MSc		
Course content	Energy in industry. Kinds and places of used. Energy production, economic usage and environmental management. Primary energy resources. Renewable source. Non-renewable resource. Water as energy. Consumption in industrial processes. Real and projected values, energetic and ecological comparison. Process improvement. Losses determination, loss types, waste heat. Heat and chemical load of environment.		
General and specific knowledge acquired in course (objective)	Informing the students with kinds of energy and how and where energy is used, types of energy loss and ways of processes improvement. Focus on heat and chemical load of environment.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2		2
(total)	30		30
Examination method	Written or oral.		
Credits	4	**Language**	Croatian
Compulsory reading	1. H. Požar: *Osnove energetike 1, 2, 3.* Školska knjiga, Zagreb, 1992. 2. M. Matić: *Gospodarenje energijom*. Školska knjiga Zagreb, 1995.		
Recommended reading	1. B. Udovičić: *Energetika i okoliš u globalizaciji.* Kika-graf, Zagreb, 2002. 2. R. Gavasci, S. Zandarya: *Environmet Engineering and Renewable Energy.* Pergamnon Press, 1998. 3. T. Ochta: *Energy Technology.* Pergamon Press, Oxford, 1994.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define and clasify primary, renewable and non-renewable energy sources.
2	Analyse energy production plants which use renewable sources of energy as only or supplemental energy source.
3	Analyse possibility of replacing fosile fuel with renewable one and offer the acceptable solution for a specified existing production plant.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lectures laboratory practice	1	1-3	Attendance and active participation	Attendance list and active participatin	5	10
Seminars	3	3	Indivdual seminar work on a selected topic	Public presentation	55	90
TOTAL	**4**				**60**	**100**

Course title	**Green Chemistry**		
Course code	62359	**Course status**	Elective B
Study programme	Process engineering		
Semester	III		
Course lecturer	Dajana Gašo-Sokač, PhD, assoc. prof. Valentina Bušić, PhD, assist. prof.		
Course associates			
Course content	Introduction to green chemistry. Catalytic reaction – basic of green chemistry. Biocatalytic reaction. Green alternative reaction media. Green alternative reaction condition. Photo catalytic reaction. Biocatalytic processes - products of conversion from biomass and bioproceses from renewable feedstock. Green methods and products in food and pharmaceutic industry, allso in the synthesis of special chemicals. Chemistry withouth solvents- reaction in microwale oven.		
General and specific knowledge acquired in course (objective)	The aim is to demonstrate and teach students methods with which Green Chemistry reduces the environmental impact of chemical processes and technologies.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	1		1
(total)	15		15
Examination method	Grades are based on oral examinations, class participation and written reports.		
Credits	2	**Language**	Croatian
Compulsory reading	1. P. T. Anastas, J. C. Warner: Green Chemistry, Theory and Practice, Oxford University Press, 1998. 2. K. Doxsee, J. E. Hutchison, Green Organic Chemistry: Strategies, Tools, and Laboratory Experiments, Brooks/Cole, ISBN: 0-759-31418-7 2004. 3. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, Weinheim 2000.		
Recommended reading	1. K. Faber: Biotransformations in Organic Chemistry, Springer, Berlin, 2000. 2. W-H. Xie, L. Yu, D. Chen, J. Li, J. Ramirez, N. F. Miranda, P. G. Wang, u: P.T. Anastas, T. C. Williamson (ur.), Green Chemistry: Frontiers in Benign Chemical Syntheses and Processes, Vol. 8, Oxford Univeristy Press, New York, 1998.		

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1	Define and group principles of ecologicaly acceptable sysntheses.
2	Identify alternative methods of organic synthesys.
3	Elucidate reaction mechanisms in alternative conditions.
4	Apply gained knowlege in individual laboratory work.
5	Demonstrate systematic understanding and skill of conduction new organic synthesys methods in green chemistry.

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Oral presentation, prolem solving, laboratory practice	0.5	1-5	Attendance and active participation	Attendance list laboratory reposrts	15	30
Written exam, disscussion	1.5	1-5	Literature studying	Written and ral exam	45	70
TOTAL	**2**				**60**	**100**

Course title	**Introduction to Scientific and Research Work**		
Course code	43751	**Course status**	Elective B-I
Study programme	Food science and nutrition		
Semester	I		
Course lecturer	Jovica Hardi, PhD, full prof. Đurđica Ačkar, PhD, assoc. prof.		
Course associates			
Course content	Lectures: Definition of science. Characteristics of science. Classification of scientific work. Category of scientific research. Methods of research. Overview and presentation of literature. Classification of publications. Computer browsing of literature. Setting of operating hypothesis. Planning and conducting of experiment. Analysing results. Preparation of manuscripts of scientific paper. Writing of thesis and other qualification papers. Congress and other scientific meetings. Scientific projects. Evaluation and classification of scientific paper. Selection procedure of scientific research and teaching profession. Scientific Research Activities Act. Classification and browsing of primary, secondary and tertiary databases. News and latest achievements in Croatian and world science. Seminar: Writing a seminar paper – suggested or choice theme.		
General and specific knowledge acquired in course (objective)	The aim of the course is to provide knowledge of opportunities for scientific work in Croatia. During the course students will be introduced with planning, setting and conducting of experiments, with manuscript preparation of scientific paper and thesis. They are introduced with databases and methodology of browsing databases. They acquire knowledge about selection procedure of scientific research and teaching profession and introduce Research Activities Act basic elements.		
Teaching method	**Lectures**	**Seminars**	**Labs**
(hrs/week)	2	1	
(total)	30	15	
Examination method	Seminar paper: Oral exam		
Credits	4	**Language**	Croatian
Compulsory reading	1. J. Kniewald: *Metodika znanstvenog rada*. Sveučilište u Zagrebu, Zagreb, 1993. 2. Lj. Baban, K. Ivić, S. Jelinić, M. Lamza-Maronić, A. Šundalić: *Primjena metodologije stručnog i znanstvenog istraživanja*. Ekonomski fakultet, Osijek, 2000. 3. Knežević: *Uvod u znanstveni rad*. Poljoprivredni fakultet, Osijek, 1988. 4. T. Salitrežić: *Uvod u znanstvenoistraživački rad*. Fakultet organizacije i informatike, Varaždin, 1981. 5. M. Žugaj: *Metodologija znanstvenoistraživačkog rada*. Fakultet organizacije i informatike, Varaždin, 1997.		
Recommended reading	1. V. Silobrčić: *Kako sastaviti i objaviti znanstveno djelo*. Jumena, Zagreb, 1989. 2. M. Žugaj, K. Dumičić, V. Dušak: *Temelji znanstvenoistraživačkog rada – metodologija i metodika*. Fakultet organizacije i informatike, Varaždin, 1999. 3. R. Zelenika: *Metodologija i tehnologija izrade znanstvenog i stručnog djela*. Ekonomski fakultet, Rijeka, 2000. 4. M. Q. Patton: *Qualitative Evaluation and Research Method*, 2nd Edition. Sage Publications Newbury Park, London, 1990. 5. G. G. Chowdhury: *Introduction to modern information retrieval*. Facet Publishing, London, 2004.		

LEARNING OUTCOMES

No	LEARNING OUTCOMES
1	Present the system of higher education and scientific research in the Republic of CroatiaZnati sustav visokog obrazovanja i znanstvenog istraživanja u RH
2	Diferentiate the methods of scientific research
3	Search scientific databases
4	Write scientific review without plagiarism
5	Know the rules of writig the diploma theses

CONSTRUCTIVE ALIGNMENT OF LEARNING OUTCOMES, TEACHING AND ASSESMENT METHODS

TEACHING METHOD	ECTS	LEARNING OUTCOME	STUDENT ACTIVITY	ASSESMENT METHOD	CREDITS	
					min	max
Lecture attendance	0.5	1-5	Oral presentation; Discussion; Active participation	Attendance list	5	10
Seminars	0.5	2-4	Preparatin of seminars, Work on specific tasks	Evaluation of seminars ant specific tasks	10	20
Final exam	3	1-5	Literature search; Preparation of scientific review on a selected topic; Discussion	Evaluation of scientific review and oral exam	40	70
TOTAL	**4**				**55**	**100**