Part Two: Information on degree programs

B) Description of individual course units

COMPULSORY COURSES

Course title:	Course code:	Year of study/Semester:
Machine Elements	**0004**	**1/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 45**	**5,5***

Lecturer: Jurij Krope

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
The students are acquainted with engineering drawings and the design of mechanical elements and structures. The basic aim is to familiarise students whose majors are in chemical processes with the areas of media, heating and the effects of processes on the environment. The students learn the approach to engineering design in regard to the requirements of chemical processes and reactions. The graduates of this study are equipped with the theoretical and practical knowledge needed for modern design structures and machines. They are trained to combine basic knowledge with the modern procedures and design methods of mechanical elements parts, assemblies, structures and machines in the chemical and process industry.

Course contents:
- Intro to engineering drawing, fundamental of engineering static and approach to mechanical design by considering material properties,
- Stresses and strain analyses,
- Welding processes, welded joints and fastening of materials,
- Pressure vessels and pipelines,
- Belt and chain drivers,
- Shaft design,
- Gear and pumps,
- Agitators,
- Heating exchanges,
- Column devices

Recommended reading:

1. B. P. Ferdinand, Vector Mechanics for Engineers – Static, New York McGraw-Hill, 1990.
2. L. Robert, P. E. Mott, Machine Element in Mechanical Design, Prentice Hall, 1999.
3. H. Titze, P Willke, Elements des Apparatebaues, Springer Verlag, 1992.
4. R. C. Jovinall, K. M. Marshek, Fundamentals of Machine Component Design, 2d cd, New York, John Wiley and Son, 1991.

Teaching methods: Lectures, practical, seminar
Prerequisites: Mathematics, Physics
Assessment methods: Written and oral examination, project presentation

* The course is in the 3rd year (fall semester) in the higher educational program; the number of ECTS credits is 6.

Course title:	Course code:	Year of study/Semester:
Mathematics I.	**0001**	**1/Fall, 1/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**60 / 30 (1/Fall)** **60 / 30 (1/Spring)**	**7*** **6**

Lecturer: Brane Butinar

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
It provides a fundamental knowledge of mathematics, essential for a chemical engineer.

Course contents:
- Basic concepts of mathematics: sets, relations, algebraic structures, functions, numbers.
- Real functions: fundamental definitions, ways of representing (explicit, implicit, parametric function), basic elementary functions and elementary functions, real sequences and series, limit of the function, continuity of the function.
- Differential calculus of real functions: derivative and differential, some theorems on differentiable functions (Rolle, Lagrange, Cauchy), some utilities (tangent line, monotonicity, convexity and concavity, L′Hospital, approximation — Taylor´s formula, local and global extremum, expansion in Taylor series), indefinite integral.
- Integral calculus of real functions: definite integral, basic properties and evaluating a definite integral, improper integrals, some geometric and mechanical applications).
- Ordinary differential equations: basic definitions, Eulers´numerical solution of the initial value 1^{st} order problem, some types of ODE1^{st} integrable by quadratures, integration of linear equations with constant coefficients.
- Linear algebra:
- Systems of linear algebraic equations, Gauss elimination method.
- Matrices and operations on them (addition, multiplication of a matrix by scalar, multiplication of a matrix by matrix, inverse matrix, transpose matrix), determinant of a matrix, connection between systems of linear algebraic equations and matrices.
- Geometrical vectors as recall from high school.
- It is continued in Math II.

Recommended reading:

1. B. Butinar, Matematika, 1. del (textbook).
2. B. Butinar, Matematika, 2. del (textbook).
3. F. Brešar, Matematika, 3. del (textbook).
4. N. Piskunov, Differential and integral calculus, vol. 1, Mir Publishers, Moscow, 1974.
5. F. Ayres, jr., Matrices, Schaum's outline series, McGraw-Hill Book Company.

Teaching methods: Lectures, practical
Assessment methods: Written and oral examination

* The number of ECTS credits in the higher educational program is 8,5 (1/Fall).

Course title:	Course code:	Year of study/Semester:
Inorganic Chemistry	**0079**	**1/Fall, 1/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar / Practical	**45 / 15 / 90 (1/Fall)** **60 / 15 / 0 (1/Spring)**	**11,5*** **5,5***

Lecturer: Miha Drofenik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Students learn the elementary course in general and inorganic chemistry in order to obtain the necessary knowledge and understanding of chemistry to follow the other courses related to the proposed global Environmental and/or Chemical Engineering Education Programs.

Course contents:
Elementary Principles of Chemistry, Atomic Structure, Periodic Properties, Chemical Bonding, Ions and Molecules, Colloide and Surface Chemistry, Gasses, Solids, Liquids, Solutions, Chemical Kinetics and Equilibrium, Electrochemistry, The Driving Force in Chemical Reactions, Monoatomic Anions and Cations, Elements and Atoms, Main-Group Compounds, Transition-Metal Compounds, Coordination Compounds and Nuclear Chemistry.

Recommended reading:

1. K. W. Witten, R. A. Davis, M. L. Peck, General Chemistry with Qualitative analyses, Sounders College Publishing, Orlando, 1995.
2. W.H. Slabaugh, T.D. Parsons, General Chemistry, John Wiley and Sons, Inc. New York, 1976.
3. W.W. Porterfield, Inorganic Chemistry, Academic Press, Inc, New York, 1989.
4. F. Lazarini, J. Brenčič, Splošna in anorganska kemija, DZS, Ljubljana, 1984 (in Slovenian).
5. I. Filipović, S. Lipanović, Opća i Anorganska kemija, Školska knjiga, Zagreb, 1982 (in Croatian).
6. M. Drofenik, Zbrana gradiva iz splošne in anorganske kemije, FKKT Maribor, 1999 (in Slovenian).

Teaching methods: Lectures, practical, laboratory
Prerequisites: Laboratory course work including lab reports followed by oral presentation. At least a 75 % success in laboratory exercises and a successful oral examination are required for passing the subject.
Assessment methods: Written and oral examination including lab attendance

* The number of ECTS credits in the higher educational program is 14,5 (1/Fall) and 5 (1/Spring).

Course title:	Course code:	Year of study/Semester:
Physics I.	**0002**	**1/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**60 / 15**	**6***

Lecturer: Samo Korpar

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Systematic treatment of elementary physics, by making use of selected experiments, as well as calculus and vectors. Basis for understanding of other natural science courses.

Course contents:
Kinematics: reference frames, 1-D kinematics, 2-D and 3-D motion, circular motion, simple harmonic motion, relative motion.
Dynamics: force, Newton's laws, weight, friction, circular motion, inertial and non inertial frames, system of particles, center of mass, rigid body rotation, equilibrium, work, kinetic energy, potential energy, conservation of energy, momentum, conservation of momentum, collisions, angular momentum, conservation of angular momentum, gravitation.
Elasticity: tension, compression, shearing.
Fluids: pressure, hydrostatic pressure, Archimedes' principle, Bernoulli's equation.
Thermodynamics: temperature, thermal expansion, internal energy, heat, first law of thermodynamics, heat transfer, kinetic theory of gases, ideal gases, engines, entropy, second law of thermodynamics.

Recommended reading:
1. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons, 1997.
2. R. Kladnik, Fizika 1. del, DZS, 1989.
3. J. Strnad, Fizika 1. del, DMFA, 1985.

Teaching methods: Lectures, practical
Prerequisites: None
Assessment methods: Written and oral examination, active participation at seminar

* The number of ECTS credits in the higher educational program is 7.

Course title:	Course code:	Year of study/Semester:
Physics II.	**0007**	**1/Spring**
Course type:	Hours/Week:	ECTS:
Lecture / Seminar / Practical	**60 / 15 / 45**	**8,5**

Lecturer: Samo Korpar

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Systematic treatment of elementary physics, by making use of selected experiments, as well as calculus and vectors. Basis for understanding of other natural science courses.

Course contents:
Electricity: electric charge, Coulomb's law, electric fields, electric dipole, Gauss' law, electric potential, conductor in electric field, capacitors and capacitance, dielectrics, energy of electric field, electric current, resistance, DC circuits, emf device, Kirchhoff's voltage and current laws, ammeter and voltmeter, RC circuits.
Magnetism: magnetic field, magnetic force, Hall effect, torque on a current loop, magnetic dipole, law of Biot and Savart, Ampere's law, induction, Faraday's law, inductors and inductance,
RL circuits, energy of magnetic field, magnetic materials, diamagnetism, paramagnetism, ferromagnetism, Maxwell's equations.
AC currents: alternating current, AC circuits, RLC circuits, phasors, transformers.
Mechanical oscillations and waves: pendulums, energy in simple harmonic motion, damped simple harmonic motion, forced oscillations, resonance, 1D waves, transverse and longitudinal waves, wavelength and frequency, speed, energy and power of traveling wave, interference, standing waves and resonance, 2D waves, reflection and refraction, Doppler effect, shock wave, 3D waves, sound waves, speed of sound, sound intensity.
Electro magnetic oscillations and waves: LC oscillations, RLC circuit, traveling EM wave, energy of EM waves, Poynting vector, radiation pressure, polarization, reflection and refraction,
optical instruments, interference, diffraction, diffraction gratings.
Modern physics: relativity, matter waves, atoms.
Laboratory work: practical work on selected subjects of Physics I and II.

Recommended reading:
1. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons, 1997.
2. R. Kladnik, Fizika 1., 2. in 3. del, DZS, 1989.
3. J. Strnad, Fizika 1. in 2. del, DMFA, 1985.

Teaching methods: Lectures, practical, laboratory work
Prerequisites: Physics I.
Assessment methods: Written and oral examination. Active participation at seminar and laboratory work including lab reports. Laboratory work is evaluated separately by evaluating lab reports and by written examination.

Course title:	Course code:	Year of study/Semester:
Analytical Chemistry I., II.	**0009, 0010**	**1/Spring, 2/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 90 (1/Spring)** **60 / 90 (2/Fall)**	**10*** **10***

Lecturer: Darinka Brodnjak Vončina

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Data about material structure lead every production process through different phases from the primary (raw) material to the final products. Analyses are a basis for the evaluation (assessment) of food, the environment, activities of organisms. These facts determine the role and the importance of analytical chemistry. An essential role is given to the basic and supplemental education of chemical engineers. In the subject »Analytical Chemistry« the field of chemical analysis is theoretically absorbed and practically directed to qualify students not only to understand but to also solve analytical problems in the production process. A sound knowledge of managing analytical laboratories is given to students as well.

Course contents:
- treatment and interpretation of results: systematic and random errors, the application of statistics and artificial intelligence
- types, selectivity and sensitivity of reagents and reactions
- equilibrium in homogene and heterogene systems: neutralization, oxydation, reduction, precipitation and complexation as the basis of analytical methods
- electrochemical methods: electrogravimetry, coulometry, potentiometry, voltametry, conductometry
- spectrometric methods: spectrography, flame emmision spectrometry, inductive coupling plasma, fluorescence, spectrophotometry, atomic absorption spectrometry
- separation methods: extraction, thin layer, gas, high pressure liquid, and ion chromatography

Recommended reading:

1. D.A. Skoog, D.M. West, F.J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th Edition, NewYork, 1996.
2. D.C. Harris, *Quantitative Chemical Analysis*, 7th Edition New York, 1987.
3. J.S. Fritz, G.H. Schenk, *Quantitative Analytische Chemie*, Vieweg, Braunschweig, 1989.
4. D.A. Skoog, J.J. Leary, *Principles of Instrumental Analysis*, Saunders College Publishing, 4th Edition, New York, 1992.

Teaching methods: Lectures, practical, laboratory
Prerequisites: Basic and inorganic chemistry
Assessment methods: Written and oral examination including lab attendance. Laboratory coursework including lab reports followed by oral presentation. At least an 80 % success in laboratory exercises and a successful written examination are required for passing the subject.

* The number of ECTS credits in the higher educational program is 10,5 (1/Spring) and 11,5 (2/Fall).

Course title:	Course code:	Year of study/Semester:
Mathematics II.	**0006**	**2/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**75 / 45**	**8**

Lecturer: Brane Butinar

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
It includes a relatively broad selection of mathematical topics, which provide a mathematical background at a somewhat advanced level, important for the modern chemical engineer to know.

Course contents:
- Linear Algebra, a continuation of Math I and:
  - Vector space (as an algebraic structure—with many examples): basic concept, change of basis, rank of a matrix, scalar product, euclidean space, orthogonal basis, idea of the Fourier series and some examples of approximation of functions.
  - Linear transformations: basic ideas, matrix of linear transformation, eigenvalues and eigenvectors of linear transformations and matrices.
  - Bilinear and quadratic forms: basic ideas, matrix of bilinear and quadratic forms, positive and negative definite quadratic forms and matrices.
- Differential calculus of vector functions:
  - Scalar function of vector variable: differential, derivative (gradient), directional derivative, some theorems on differentiable functions, implicite functions, approximation — Taylor´s formula (in scalar and matrix form), local extremum of the scalar function of vector variable, conditional optimization of the scalar function of vector variable – the Lagrange function.
  - Vector function of vector variable: differential, derivative, solution of the system of nonlinear equations, implicite functions, introduction to differential geometry.
- Ordinary differential equations:
  - Continued from Math I, the solution of linear equations is presented by a power series (e.g. Legendre and Bessel).
  - System of linear equations with constant coefficients: solution by eigenvalues and eigenvectors of the matrix of a system.
- Partial differential equations: the one dimensional wave equation as a boundary-initial-value problem — by the Fourier method.
- Basic ideas of the Laplace transform and some examples of its tabular usage.

Recommended reading:

1. B. Butinar, Matematika, 2. del (textbook).
2. F. Brešar, Matematika, 3. del (textbook).
3. S. Lang, Calculus of several variables, Springer-Verlag, New York, 1987.
4. A. Varma, M. Morbidelli, Mathematical methods in chemical engineering, Oxford University Press, 1997.

Teaching methods: Lectures, practical
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Physical Chemistry	**0056**	**2/Fall, 2/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 0 (2/Fall)** **45 / 120 (2/Spring)**	**4*** **13***

Lecturer: Aljana Petek

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Students learn the fundamentals of physical chemistry and its practical use.

Course contents:
Fall Semester:

The properties of gases, The First Law: the concepts, The First Law: the machinery, The Second Law: the concepts, The Second Law: the machinery, Physical transformation of pure substances, Simple mixtures, Phase diagrams.

Spring Semester:

Chemical equilibrium, Equilibrium electrochemistry, Molecules in motion, The rates of chemical reactions, The kinetics of complex reactions, Molecular reaction dynamics, Processes at solid surfaces, Dynamic electrochemistry.

Laboratory:

Steam destillation, Absorption spectrum of a conjugated dye, Partial molar volume, Calorimetry-Enthalpy of solution, Vapour pressure and Enthalpy of vaporization, Temperature-composition diagram, Cryoscopy, Heterogeneous equilibrium, Galvanic cell potential and internal resistance, pH, Transport number, Conductivity of electrolyte solutions, Viscosity, Surface tension, Adsorption, Chemical kinetics a) Inversion of saccharose b) Rate of salt solution.

Recommended reading:

1. P. W. Atkins, Physical Chemistry, 6th Ed., Oxford University Press, 1998.
2. P. W. Atkins, Physical Chemistry, 5th Ed., Oxford University Press, 1997.
3. R. A. Alberty, R. J. Silbey, Physical Chemistry, 1st Ed., John Wiley & Sons, Inc, 1992.
4. More autors, Laboratory Practice in Physical Chemistry, FKKT-UL Ljubljana, 1998 (in Slovenian).

Teaching methods: Lectures, practical, laboratory
Prerequisites: Physics I, Mathematics, or consent of the lecture
Assessment methods: Written and oral examination including lab attendance. Successful laboratory coursework including lab reports, final test with oral examination

* The number of ECTS credits in the higher educational program is 5 (2/Fall) and 12,5 (2/Spring).

Course title:	Course code:	Year of study/Semester:
Process balances	**0031**	**2/Fall, 2/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30 (2/Fall)** **30 / 30 (2/Spring)**	**4,0** **4,5**

Lecturer: Majda Krajnc

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Students learn the fundamentals of computer programming with FORTRAN and of calculating material balances in systems with and without chemical reactions. They became familiar with numerical methods for solving single nonlinear equations containing one unknown, with methods for solving sets of simultaneous linear and nolinear equations and data processing. For that purpose they use POLYMATH and Aspen Plus programs.

Course contents:
- programming with FORTRAN,
- process synthesis,
- data processing,
- material balances of process units,
- material balances of chemical reactors,
- material balances of systems of process units,
- solution of single equations,
- simultaneous linear equations,
- simultaneous nonlinear equations.

Recommended reading:

1. C. Middlebrooks, VAX FORTRAN, Reston Publishing Company, Inc., Reston, Virginia, A prentice-Hall Company, 1984.
2. V. Žumer, FORTRAN, TF Maribor, 1993.
3. A. P. Myers, W. D. Seider, Introduction to Chemical Engineering and Computer Calcualtion, Prentice-Hall, Inc., New Jersey, 1976.
4. D. M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice-Hall, New Jersey, 1996.
5. M. Shacham, M.B. Cutlip, M. Elly, Polymath 5.0, The CACHE Corporation, The University of Connecticut, Ben Gurion University of the Negev, The University of Michigan, 2000.
6. SmartDraw and SmartDraw Professional, Version 4, SmartDraw Software Inc., San Diego, CA, 1998.
7. Aspen Plus, Version 10.2.1, Aspen Technology, Inc., Cambridge, MA, 2000.

Teaching methods: Lectures, practical, work in computational laboratory
Prerequisites: General chemistry, mathematics
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Organic Chemistry	**0088**	**2/Fall, 2/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 0 (2/Fall)** **45 / 120 (2/Spring)**	**4,0*** **12,5**

Lecturer: Črtomir Stropnik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university and higher professional program Chemical Engineering.

Objectives of the course:
Students become acquainted with the electronic and the stereo structure of the skeleton and the functional groups of the organic substances on the ground of the qualitative knowledge of the molecular orbital and valence bond theory of chemical bonding. They acquire knowledge of the structure and the reactivity of organic compounds as well as of the mechanisms of their chemical transformations. Acquainting the students with some spectroscopic methods and preparing them for autonomous individual practical laboratory work in the field of preparative organic chemistry are also the objectives of the course.

Course contents:
Electronic structure of organogenic elements, their hybridisation and bonding in organic substances. Structure of various skeletons (hydrocarbons, heterocycles; aromatics) and functional groups. Stereochemistry and some spectroscopy. Acids and bases as well as tautomerism and resonance in organic chemistry.
Brief systematic presentation of skeleton and inter-functional groups conversions. Transition state theory as a qualitative basis for the presentation of reaction mechanisms. Substitutions (nucleophilic on sp^3 and sp^2 hybridised carbon; electrophilic and nucleophilic on aromatic systems; radical), additions (electrophilic and nucleophilic; radical and conjugate) and eliminations are beside oxidations and reductions as well as rearrangements and pericyclic reactions various mechanisms of organic reactions presented to students.
Structure and reactivity of some terpenes, carbohydrates, vitamins, antibiotics and steroids are presented. Some dies and surfactants as well as synthetic polymers are reviewed. The structure of natural macromolecules, namely proteins (enzymes), polysaccharides and nucleic acids and their role in biological systems is briefly presented.
Methods of isolation-purification of organic compounds (various distillations, crystallisation, extraction, sublimation) and some preparative organic chemistry, conducted through some above mentioned reaction mechanisms, are together with spectroscopic characterisation the backbone of the individual laboratory practical.

Recommended reading:

1. S. H. Pine, Organic Chemistry, McGraw-Hill, International edition, 1987.
2. S. H. Pine, James B. Hendrickson, Donald J. Cram and George S. Hammond, Organska kemija, Školska knjiga, Zagreb, 1984 (in Croatian).
3. M. Tišler, Organska kemija, Državna založba Slovenije, Ljubljana, 1988 (in Slovenian).
4. K. Peter C. Vollhardt and Neil E. Schore, Organic Chemistry, Structure and Function, W. H. Freeman and Company, New York, 1999.

* The number of ECTS credits in the higher educational program is 5 (2/Fall).

Recommended reading (cont'd):

5. M. A. Fox and J. K. Whitesell: Organic Chemistry, Jones and Bartlett Publishers, Sudbury, Massachusetts, 1997.
6. Any comprehensive university text book on organic chemistry.

Teaching methods: Lectures, seminar, practical
Assessment methods: Written and oral examination. Attendance in laboratory practical with two successful main oral examinations; reports on the exercises.

Course title:	Course code:	Year of study/Semester:
Thermodynamics	**0091, 0118**	**3/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 60 (CE)** **60 / 30 (BE)**	**9 (CE)** **7 (BE)**

Lecturer: Valter Doleček

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Students learn the fundamentals of chemical engineering thermodynamics and their use in process engineering.

Course contents:
The Scope of Thermodynamics, The First Law and Other Basic Concepts, Volumetric Properties of Pure Fluids, Heat Effects, The Second Law of Thermodynamics, Thermodynamic Properties of Fluids, Solution Thermodynamics: Theory, Solution Thermodynamics: Applications, VLE at Low to moderate Pressures, Thermodynamic Properties and VLE from Equations of State, Topics in Phase Equilibria, Chemical-Reaction Equilibria.
Laboratory: VLE, LLE, Solution Calorimetry, Partial Molar Volumes and Excess Volumes
Computer Exercise: Activity Coefficients-UNIFAC; CEMCO-BUBL T, DEW T, Physical Constants; Development of a BUBLE T Computer Program for Calculations using Experimental Data.

Recommended reading:
1. J. M. Smith, H. C. Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 5th Ed., McGraw-Hill Companies, 1996.
2. J. M. Smith, H. C. Van Ness, Introduction to Chemical Engineering Thermodynamics, 4th Ed., McGraw-Hill, Inc. 1987.
3. A. Petek, Experiments in Chemical Thermodynamics, FKKT, Maribor, 2000 (in preparation in Slovenian).

Teaching methods: Lectures, practical, laboratory, computer exercises
Prerequisites: Physical Chemistry or consent of the lecturer
Assessment methods: Seminar-work and oral examination. Laboratory coursework including lab reports, final test and oral examination, computer exercises with written reports.

Course title:	Course code:	Year of study/Semester:
Transport Phenomena	**0100, 0119**	**3/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**90 / 60**	**11**

Lecturer: Jurij Krope

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
The students are acquainted with the basics of fluid mechanics and heat transfer. After successfully completing this module the students should understand the principles of fluid flow and momentum transfer, hydrostatics, mechanisms and modes of heat transfer when solving elementary and practical problems.

Course contents:
Compressible flow of gases. Adiabatic flow in a pipe with friction, isothermal flow in a pipe with friction, working equations for flow in pipes, flow through an orifice or nozzle, pipe leading from a storage vessel.
Non-Newtonian fluids. Classification of fluids, shear stress and viscosity, flow in pipes.
Flow through packed beds. Characterization of a packed bed, frictional loss for packed beds, mechanical energy balance for packed beds.
Flow in fluidized beds. The fluidized state, frictional loss and pumping requirement for the fluidizing of a bed of solids, minimum fluidizing velocity.
Fluid static. Fluid properties, pressure variation in a static fluid, manometry and pressure measurement of submerged and floating bodies, mechanics of fluids in rigid body motion.
Fluid dynamics. Fundamental principles and concepts of flow analysis, the differential approach to flows analysis, applications of flow analysis (steady incompressible flow in pipes and ducts, external flow), flow analysis in open channels.
Heat transfer. Mechanisms of heat transfer – conduction, convection and radiation, combination of heat transfer resistances, unsteady-state heating and cooling of solid objects, introduction to heat exchangers, recuperators – through wall nonstoring exchangers.

Recommended reading:

1. O. Levenspiel, Engineering Flow and Heat Exchange, Plenum Press, New York, 1984.
2. J. M. Coulson, J. N. Richardson, Chemical Engineering, Vol. 1, Pergamon Press, 1990.
3. Noel De Nevers, Fluid Mechanics for Chemical Engineering, McGraw-Hill, 1991.
4. Palffy, Fluidmechanik I, Birkhänser Verlag, Basel, 1977.
5. J. P. Holman, Heta Transfer, McGraw Hill, Kogakusha, Tokyo, 1986.
6. G. Sam Samdami, Heat Transfer Technologies and Practices, Chemical Eng. Staff, 1996.

Teaching methods: Lectures, practical, seminar. Computational and experimental laboratory.
Prerequisites: Mathematics, Physic, Machine elements, Thermodynamics
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester r:
Process Dynamics	**0071**	**3/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**75 / 60**	**10**

Lecturer: Zdravko Kravanja

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
The aim is to give a basic overview and knowledge of the theory of mathematical modeling, process dynamics and control.

Course contents:
Introduction: Incentives for process control, basic control structures. Mathematical modeling: equation-oriented modeling by MathCAD and dynamical modeling in FORTRAN, numerical integration and solving systems of DAE, input-output models for process control, degree of freedom in control systems. Dynamic analysis of chemical processes: transfer functions, first, second and higher order systems. Feedback control: close-loop response, P-, I-, D- and composite control actions, stability analysis, design of controllers, analysis of frequency response and frequency response design techniques. Other control configurations: systems with large dead time or inverse response; multiple loop systems of cascade, selective and split-range control; feedforward control, design of feedforward controllers and ratio control; adaptive and inferential control. Multivariable control systems (MIMO): degree of freedom and number of manipulated and control variables, alternative control configurations, interaction of control loops, relative-gain array, decoupling of interactive control loops. Basic aspects in designing a control system for overall plant. Basic structure of computer control systems. Safety aspects in designing process systems.

Recommended reading:

1. Stephanopoulos G., Chemical Process Control: An Introduction to Theory and Practice, Englewood Cliffs, New Jersey, 1984.
2. Seborg, D.E., T.F.Edgar in D.A. Mellichamp, Process Dynamics and Control, John Wiley & Sons, New York, 1989.
3. Kletz T., HAZOP and HAZAN. Identifying and Assessing Process Industry Hazards, Institution of Chemical Engineering, Rugby, 1992.
4. Shinskey, F.G., Process Control Systems, Application, Design and Tuning, McGraw-Hill, New York, 1996.

Teaching methods: Lectures and practice. Work with computer and work in laboratory.
Prerequisites: Mathematics II
Assessment methods: Written and oral examination, laboratory report

Course title:	Course code:	Year of study/Semester:
Material Science	**0037, 0121**	**3/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 45**	**7,5**

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Solid state physics and chemistry is used to explain the influence of materials structure on physical and chemical properties as well as on corrosion prevention.

Course contents:
Lectures:
Introduction. Structure of solids (ideal and real). Mechanical properties of solids (elastic, plastic deformation). Processes in materials (viscoelastic, diffusional, electrical and magnetic). Equilibrium in solids (phase equilibria, kinetics of phase transformations). Strengthening of materials (mechanism, creep, failure). Phase structures (single phase, multiphase, composites). Chemical properties of materials (thermodynamics and kinetics of corrosion, corrosion prevention, forms of corrosion).
Laboratory:
Identification of plastics. Degradation of low density polytehylene. Hydrolysis of glass. Metalographic examination of metals. Corrosion resistance of metals. Gas chromatography. Tensile strength of steel and compressive strength of concrete.

Recommended reading:

1. P. Glavič, Gradiva, Zbrano gradivo, FKKT Maribor, 1999.
2. A. Goršek, P. Glavič, Laboratorijske vaje iz gradiv (UNI), FKKT, Maribor, 1997.
3. L. H. van Vlack, Elements of Materials Science and Engineering, Addison-Wesley, Reading, 1996.
4. C. R. Barret et al., The Principles of Engineering Materials, Prentice-Hall, Englewood Cliffs, 1973.
5. M. G. Fontana and N. D. Greene, Corrosion Engineering, McGraw-Hill, New York, 1986.
6. Quantities, Units and Symbols in Physical Chemistry, I. Mills (Ed.), Blackwell, Oxford, 1993.

Teaching methods: Lectures, laboratory
Prerequisites: Inorganic Chemistry, Physical Chemistry
Assessment methods: Written and oral examination. Laboratory with written reports followed by oral presentation.

Course title:	Course code:	Year of study/Semester:
Mass Transfer	**0042, 0122**	**3/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**45 / 30**	**5,5**

Lecturer: Željko Knez

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Basic knowledge of the mass transfer enables students to understand transport phenomena in macroscopic separation processes.

Course contents:
- introduction of flux relationships (Fick's law)
- molecular diffusion in gases, liquids, solids
- formulation of diffusional mass transfer problems by the differential shell balance method
- simple steady-state diffusion models (one and two dimensional), steady-state diffusion with homogeneous and heterogeneous reaction
- unsteady diffusion and application of graphical solutions
- convective mass transfer (discussion of the film theory and penetration theory, interfacial mass transfer and the use of overall mass transfer coefficients, methods for predicting convective mass transfer coefficients for various geometries).
- the analogies between heat, momentum and mass transfer are discussed

Recommended reading:

1. T. Koloini, Heat and Mass Transfer, FKKT Ljubljana, SI, 1999 (in Slovenian).
2. L. Hines, R. N. Maddox, Mass Transfer, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1985.
3. J. Geankopolis, Transport Processes and Unit Operations, Allyn and Bacon, Inc., Boston, USA, 1983.
4. R. S. Brodkey, H. C. Hershey, Transport Phenomena. A unified Approach, McGraw-Hill Book Company, New York, USA, 1988.

Teaching methods: Lectures, seminar. Solution of problems referring to basic mass transfer knowledge and designing unit separation processes.
Prerequisites: General chemistry, physical chemistry and thermodynamics or consent of the lecturer.
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Separation Processes	**0064, 0123**	**3/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 60 (CE)** **60 / 45 (BE)**	**8,5 (CE)** **7,5 (BE)**

Lecturer: Željko Knez

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Basic knowledge of the more important unit operations (mainly physical in nature) used in chemical and process industries enables the students to understand industrial technological processes.

Course contents:
Unit operations:
- size reduction of solids
- magnetic separation
- sieving
- flotation
- filtration
- membrane separation processes
- centrifugation
- emulsifying
- mixing
- sedimentation
- gas cleaning
- compacting

Exercises:
- filtration with laboratory filter plate
- ultrafiltration
- reverse osmozis
- emulsifying
- mixing of liquids
- crushing and sieving

Recommended reading:

1. J.M. Coulson, J.F. Richardson, Chemical engineering (Vol. II), Pergamon press, NY, 1978.
2. Vauck/Műller, Grundoperationen chemischer Verfahrenstechnik, VCH, Weinheim, 1987.
3. Lerbuch der chemischen Verfahrenstechnik, VEB, Leipzig, 1973.
4. V. Ozim, Ž .Knez, Unit operations, FKKT, Maribor, 1995. (in Slovenian)
5. Ž. Knez, M. Habulin, V. Ozim, Exercises from process analysis and mechanical separation processes, FKKT, Maribor, 1997.

Teaching methods: Lectures, practical. Laboratory work.
Prerequisites: General chemistry, analytic and physical chemistry or consent of the lecturer.
Assessment methods: Oral examination including lab attendance

Course title:	Course code:	Year of study/Semester:
Biochemical Engineering	**0050**	**3/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**45 / 30**	**5.5**

Lecturer: Maja Habulin

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering

Objectives of the course:
Understanding of reactions in biological systems, enzymes and their action in different systems and overview of industrial biotechnology.

Course contents:
Microbiology and biology of the cell (microorganisms as cells, molecular processes in the cell, structure of the cell). Water as biological solvent. Proteins (structure, denaturation and functions). Enzymes (structure, catalysis, kinetics, deactivation). Enzymatic reactions. Immobilized enzymes. Genetic engineering and biotechnology.

Recommended reading:

1. Murray R.K., Granner D.K., Mayes P.A., Rodwell V.W. Harper's Biochemistry (1996) Prentice Hall, London.
2. Lehninger A.L. Prinzipen der Biochemie (1987) Walter de Gruyter, Berlin.
3. Brock T.D. Biology of microorganisms (1997) Prentice Hall, London.
4. Bailey J.E., Ollis D.F. Biochemical Engineering Fundamentals (1986) McGraw Hill Book Company, New York.
5. Karlson P. Biokemija (1993) Školska knijga, Zagreb.
6. Präve P., Faust U., Sittig W., Sukatsch D.A. Fundamentals of Biotechnology (1987) VCH, Weinheim.
7. Jessop P.G., Leitner W. Chemical Synthesis Using Supercritical Fluids (1999) Wiley-VCH, Weinheim.

Teaching methods: Lectures, laboratory exercises
Prerequisites: General Chemistry, Organic Chemistry, Physical Chemistry
Assessment methods: Written examination, oral examination

Course title:	Course code:	Year of study/Semester:
Organic Synthesis	**0099**	**3/Spring**
Course type:	Total Hours:	ECTS:
Practical	**45**	**3**

Lecturer: Črtomir Stropnik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
Students do laboratory experiments on topics, which are part of the research work performed by the research group for organic chemistry. They use original scientific literature and conduct their practical work under the supervision of assistants via classical preparative and instrumental methods.

Course contents:
Syntheses and characterisation of organic substances; polymeric asymmetric porous membranes preparation by wet phase inversion and their characterisation; polymeric membranes surface modification and activation; preparation of functionalised crosslinked polymer supports.

Recommended reading: Scientific journals and books

Teaching methods: Attendance in laboratory practical.
Prerequisites: Organic Chemistry
Assessment methods: Successful report examination

Course title:	Course code:	Year of study/Semester:
Stagewise Processes	**0063, 0127**	**4/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 60**	**8,5**

Lecturer: Željko Knez

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Basic knowledge on thermal separation processes used in chemical and process industries enables the students to understand industrial technological processes.

Course contents:
Thermal separation processes:
- evaporation
- crystallization
- distillation
- liquid-liquid extraction
- solid liquid extraction
- technologies with supercritical fluids
- drying

Exercises:

Experimental lab.:
- distillation (batch, rectification)
- drying
- extraction (solid-liquid)
- thin layer evaporation

Computational lab.:
Aspen Plus calculations

Recommended reading:
1. K. Sattler, H.J. Feindt, Thermal Separation Processes, VCH, Weinheim, 1995.
2. Ž. Knez, M. Škerget, Thermodiffusional Separation Processes, FKKT, Maribor, 1999.

Teaching methods: Lectures, practical. Experimental and computational laboratory work.
Prerequisites: General chemistry, analytic and physical chemistry or consent of the lecturer.
Assessment methods: Written and oral examination including lab attendance

Course title:	Course code:	Year of study/Semester:
Chemical Reaction Engineering	**0073, 0128**	**4/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**45 / 60**	**7,5**

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.

Objectives of the course:
Reactor design, operation and optimisation.

Course contents:
Lectures:
Single phase reactors: batch, plug flow, mixed flow, recycle, staged. Parallel and multiple reactions. Multiphase catalytic reactors: porous catalyst, adiabatic, packed bed, fluidized bed, deactivation. Noncatalytic systems: fluid-fluid, fluid-particle. Biochemical reaction systems: enzyme, microbial. Non-ideal flow: compartment model, dispersion model. Temperature effects.
Laboratory*:*
Ideal reactors: batch, mixed flow, plug flow, cascade. Non-ideal flow: retention time distribution. Reactor modelling, simulation and design.

Recommended reading:
1. O. Levenspiel, Chemical Reaction Engineering, J. Wiley, New York, 1999.
2. P. Glavič, Modeliranje procesnih operacij, FKKT, Maribor, 1999.

Teaching methods: Lectures, laboratory
Prerequisites: Thermodynamics, Mass transfer
Assessment methods: Written and oral examination. Laboratory with laboratory reports and computer programs followed by oral presentation.

Course title:	Course code:	Year of study/Semester:
Economics	**0076, 0129**	**4/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Seminar / Practical	**45 / 15 / 15 (CE)** **45 / 0 / 15 (BE)**	**5 (CE)*** **4 (BE)**

Lecturer: Dušan Klinar

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering.
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
The student familiarizes with the basics of Economics, with the correct understanding of economic categories and market economy. Stress is on management in enterprises and on organizing the management system. Mastering these basics enables the students to understand vital economic phenomena in the enterprise and its environment.

Course contents:
An overview of the development of economic thought. Micro-economic categories of economic phenomena, such as the notion of market, production, production factors. The macro-economic categories are dependent on the range of production, distribution, consumption, investments, savings, interests, financial means, unemployment, inflation.
The management system and processes in it with emphasis on the business process. The types and characteristics of enterprises, the goals of management. Elements of the business process, costs, types of costs, costs accounts and their users, the influence the extent of the business has on the costs. Sales prices, incomes, outcomes, profit, planning of profit. Means of reorganization, types of means, obligations towards financial sources. The balance of state and the balance of success. The efficiency and success of the business. Elements of the policy and strategy with basics of decision-making.

Recommended reading:
1. A. Majerič, Osnove ekonomske teorije, TF, Maribor, 1992.
2. P. Senčar, Osnove ekonomike poslovnega sistema za inženirje, TF, Maribor, 1992.
3. I. Turk, Uvod v ekonomiko gospodarske družbe, ZRFR Slovenije, Ljubljana, 1993.
4. M. Rebernik, Ekonomika podjetja, GV, Ljubljana, 1995.

Teaching methods: Lectures, seminar work.
Prerequisites: The subject is related to subjects dealing with the production process in that it covers the economic aspect of the production process.
Assessment methods: Oral examination

* The course is in the 3rd year (fall semester) in the higher educational program; the number of ECTS credits is 6.

Course title:	Course code:	Year of study/Semester:
Process Design I., II.	**0075**	**4/Fall, 4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30 (4/Fall)** **0 / 90 (4/Spring)**	**4,5** **7,0**

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
Theoretical basis and practical experiences in technology selection and design technics of operations and processes is given. Team work, synthesis of the acquired professional knowledge, efficient use of commercial software and literature is provided. The course is connected with others through a common case study.

Course contents:
Lectures
Process synthesis: strategy and conceptual design. Pinch analysis: thermodynamics, heat exchanger network, utilities. Process integration: heat engines, heat pumps, separators, reactors. Process design using pinch technology. Process retrofit. Total site integration. Water pinch. Targeting of emissions. Evaluation of process alternatives.
Practical work
Project task. Process flowsheet. Material and energy balances. Investment and operating costs. Process modelling using a commercial simulator. Thermodynamic analysis. Structural and parameter optimisation. Investment evaluation. Equipment specification. Project report.

Recommended reading:

1. P. Glavič, Načrtovanje procesov, zbrano gradivo in navodila za vaje z nalogami, FKKT, Maribor, 1998.
2. R. Smith, Chemical Process Design, McGraw-Hill, New York, 1995.
3. J. H. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, New York, 1988.
4. U. V. Shenoy, Heat Exchanger Network Synthesis, Gulf Publishing, Huston, 1995.
5. Perry's Chemical Engineers' Handbook, Don W. Green (Ed.), McGraw-Hill, NewYork, 1997.

Teaching methods: Lectures, laboratory, computer software
Prerequisites: Thermodynamics, Separation Processes, Reaction Engineering
Assessment methods: Oral examination and design evaluation. Process simulation, design and optimisation followed by oral presentation.

Course title:	Course code:	Year of study/Semester:
Process Optimization	**0110**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**90 / 60**	**11,5**

Lecturer: Zdravko Kravanja

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
The aim is to give a basic overview and knowledge in the theory of mathematical programming and application in process optimization for process design/synthesis, planning, operation and handling engineering data.

Course contents:
Introduction: definition of system border, optimization criteria, structure of models, overview of applications in engineering. Theory and optimization methods: Properties of single-variable functions, optimality criteria and solution methods. Optimality criteria and methods for solving functions of several variables. Linear programming, standard formulation, Simplex method. Nonlinear programming, Lagrange multipliers, Karush-Kuhn-Tucker optimality conditions, active set method. Direct search, methods, e.g. the complex method. Mixed-integer linear programming, branch-and-bound algorithm with depth-first and bread-first branching. Mixed-integer nonlinear programming, outer approximation algorithm. Applications in synthesis/design (HEN, separation sequences, reactor networks, overall flowsheet), operation and planning, data reduction, project planning. Optimization with GAMS (equation oriented), Hysys (implicit flowsheet optimization) and DCA (direct search).

Recommended reading:

1. G.V. Reklaitis, A. Ravidran, K.M. Ragsdell, Engineering Optimization, Methods and Applications, John Wiley and Sons, New York, 1986.
2. Brooke, D. Kendrick, A. Meeraus, GAMS - A user Guide, Scientific Press, Reewood City, CA 1992.
3. M. Morari, I.E. Grossmann (Editors), CACHE Process Design Case Studies, Volume 6: Chemical Engineering Optimization Models with GAMS, USA, 1991.
4. T.F. Edgar, D.M. Himmelblau, Optimization of Chemical Processes, McGraw-Hill, New York, 1989.
5. L.T. Biegler, I.E. Grossmann, A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, New Jersey, 1997.

Teaching methods: Lectures, practice, seminars. Work with computer in laboratory.
Prerequisites: Mathematics II
Assessment methods: Written examination, seminar and oral presentation of seminar results

Course title:	Course code:	Year of study/Semester:
Process Apparata	**0117, 0049**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Jurij Krope

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering opt. Chemical Engineering.

Objectives of the course:
The students of chemical engineering become familiar with the fundamental procedures and are introduced to the operation, construction and design of plant elements and process machinery. They are introduced to the fundamentals of draft design regarding particular devices (type, sizes, and necessary power).

Course contents:
Ventilation: ventilation of chemical manufacturing plant and laboratory, ventilation devices.
Flow of fluids in pipes and conduits: compressible fluids, two-phase flow, flow meters, valves, pumps, fans, compressors, size classification.
Vacuum systems: vacuum pumps, ejectors.
Heat transfer process equipment and components: design methods and principles for shell and tube, plate and spiral heat exchangers, calculation of heat transfer coefficients, pressure drop, fouling and an appreciation of different types of condensers and reboilers.
Heat pumps: type of heat pumps, efficiency.
Insulation: type of insulation materials, heat transfer, economic thickness of insulation.
Vessels: design of reservoirs and pressure vessels.
Mixing: basic principles and purpose, static mixers, mixing vessel and mixer, determination of power and number of revolutions, heat transfer of mixing suspension and dispersion systems.
Separation of volatile compounds: heat calculation and the construction of different types of column.
Separation: centrifugation, filtration, sedimentation, cyclones, size and type classification.
Absorption: determination of size and construction of absorption devices.

Recommended reading:

1. F. Wolfang, G. Gruhn, K. S. Militzer, G. Neugebauer, Apparatetechnik, VEB Deutscher Verlag Für Grundstoffindustrie, Leipzig, 1990. (in German)
2. H. Titze, P. Wilke, Elemente des Apparatebaues: Grundlagen-Bauelemente-Apparate, Springer Verlag, 1992. (in German)
3. P. Grassman, F. Widmer, Einführung in die Termische Verfahrenstechnik, de Gruyter, 1997. (in German)
4. S. M. Walas, Chemical Process Equipment, Butterworth-Heinemann, 1990.

Teaching methods: Lectures, practical, seminar. Work in computational laboratory.
Prerequisites: Machine Elements, Transport Phenomena, Materials, Process Design
Assessment methods: Written and oral examination

* The course in the 3rd year (spring semester) in the higher educational program; the number of ECTS credits is 6,5.

Course title:	Course code:	Year of study/Semester:
Process Development	**0062**	**4/Spring**
Course type:	Hours/Week:	ECTS:
Lecture / Practical	**45 / 45**	**7**

Lecturer: Zorka Novak Pintarič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
To acquaint the students with the methodology used in chemical process industries for evaluating the ultimate commercial feasibility of proposed new projects.

Course contents:
The mathematics in economics (interest, inflation, present and future worth, net present worth, discounting, annuities).
Project evaluation systematics (marketing research, demand projection, price projection).
Equipment sizing and costing (purchased cost of equipment, cost of installation, effect of inflation).
Direct fixed capital estimation (cost factors, power factors, modular factors).
Depreciation (the economic impact, methods).
Cost of manufacture (raw materials and utilities, operating labor, fixed charges).
Criterion of economic performance (working capital, return on investment, payback period).
Cash flow analysis (net present worth, discounted cash rate of return, analysis of risk).
Benchmarking.

Recommended reading:

1. Seider W.D., Seader J.D., Lewin D.R., *Product and process design principles: synthesis, analysis, and evaluation*, 2nd edition. Wiley, 2004.
2. Peters S.M., Timmerhaus K.D., *Plant Design and Economics for Chemical Engineers*, 5th edition. McGraw-Hill, New York, 2002.
3. Chauvel A., *Manual of process economic evaluation*. Editions Technip, Paris, 2003.
4. Valle-Riestra J.F., *Project Evaluation in the Chemical Process Industries*. McGraw-Hill, Inc., 1983.
5. Biegler L.T., Grossmann I.E., Westerberg A.W., *Systematic methods of chemical process design*. Prentice-Hall, New Jersey, 1997.
6. Ahmad M., R. Benson, *Benchmarking in the Process Industries*, IChemE, Rugby, UK, 1999.

Teaching methods: Lectures, practical, seminar.
Prerequisites: Mathematics, Economics
Assessment methods: Written examination and oral examination.

Course title:	Course code:	Year of study/Semester:
Biochemistry	**0050**	**3/Fall**
Course type:	Total hours:	ECTS:
Lecture / Practical	**45 / 30**	**5.5**

Lecturer: Leon Senčič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Inform the students about the chemical structure and reactions in biological systems and introduce them to the practice of fundamental biochemical methods.

Course contents:

- Proteins: amino acids, peptides, proteins, enzymes, coenzymes, immobilized enzymes,
- metabolism of proteins and amino acids.
- Lipids: structure, classification, function, digestion, biosynthesis.
- Carbohydrates: structure, classification, function, catabolism, biosynthesis.
- Nucleic acids: structure, biosynthesis, degradation.
- Respiratory chain, oxydative phosphorylation, photosynthesis.
- Hormone mechanisms.

Practical:

- Preparative biochemical methods: homogenization, extraction, fractionary precipitation, gel chromatography, electrophoresis.
- Analytical methods: reactions on proteins, lipids and carbohydrates.
- Enzymatics: kinetic properties of catalase.

Recommended reading:

1. D. L. Nelson and M. M. Cox, Lehninger principles of biochemistry, W. H. Freeman and Comp., New York, 2004.
2. L. Stryer, Biochemistry, W. H. Freeman and Comp., New York , 2002.
3. P. Karlson, Biokemija, Školska knjiga, Zagreb, 1993. (in Croatian).

Teaching methods: Lectures, practical. Laboratory work.
Prerequisites: Inorganic and organic chemistry
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Microbiology	**0125**	**3/Fall**
Course type:	Total hours:	ECTS:
Lecture / Practical	**60 / 30**	**6.5**

Lecturer: Uroš Potočnik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Students will be introduced to the basics of microbiology, including cell structure, physiology and genetics of microorganisms. The role of microorganisms in industry, medicine and ecology will be discussed.

Course contents:
Microorganisms in environment (water, soil, air, plants, animals and human).
General characteristics of microorganisms: prokaryotic and eukaryotic cells, cellular metabolism and methods of reproduction.
Grow of the microorganisms: nutrition, physiology, sterilization, and disinfection.
Classification of microorganisms: bacteria, fungi, viruses
Metabolism of microorganisms and regulation of metabolism: basic principals and aerobic and anaerobic processes.
Interactions microorganism-microorganism and microorganism-macroorganism (plants, animals, human). Parasites and pathogenicity.
The fundamentals of the immune response to infection. Diagnostic methods.
Pathogenic microorganisms in the food and technical environment (bacteria, viruses, prions, fungi).
Monitoring of pathogen microorganisms in the food production: aspects of monitoring, milk, meat, eggs, fish, see food, other food.
Antibiotics and chemotherapeutics. Vaccines. Genetics of microorganisms. Medical microbiology: infection diseases. Microorganisms in applications: basics of biotechnology.

Recommended reading:

1. Walker, T.S., Microbiology. Saunders, 1998.
2. Madigan, T.M., Martinko, J.M., Parker, J., Brock Biology of Microorganisms, 9th Ed., Prentice Hall, Inc., New Jersey, 2000.
3. Schlegel, H.G.: Zaborosch, C., General microbiology, 7th ed., Cambridge University Press, 1995.
4. Filipič B., Cencič, A., Splošna mikrobiologija, navodila za vaje. Maribor, 1999.
5. B. Alberts et al.: *Molecular biology of the cell., 4th Ed.*, Gerland Publish, Inc., New York, 2002
6. Lodish H., Baltimore D., Berk A., Zipursky S.L., Matsudaira P., Darnell J., Molecular Cell Biology, 5th Ed., Scientific American Books, Freeman and Co., New York, 2004
7. Samuel B., Medical Microbiology, Fourth Edition, The University of Texas Medical Branch at Galveston, 1996

Teaching methods: Lectures, practical. Computational and experimental laboratory.
Assessment methods: Written examination, seminar

Course title:	Course code:	Year of study/Semester:
Cell Physiology	**0124**	**3/Spring**
Course type:	Total hours:	ECTS:
Lecture / Practical	**45 / 30**	**5.5**

Lecturer: Marjana Glaser

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Cell physiology focuses on essential principles and processes in cell physiology and integrates these in the context of molecular biology. This course considers cell structure and function, bioenergetics, membranes, molecular genetics, intercellular signalling, immunology and malignant transformation of cells. Students who successfully complete this course should be able: to explore major biological concepts, to outline the steps of the scientific method, to discuss the attributes of life, including cell structure and function, cell metabolism and division and malignant transformation.

Course contents:
- An overview of cells and cell research
- Cell structure and function
- Chemical structure of cells
- Membrane structure, function and chemistry
- Membrane transport
- Messengers and receptors
- Electrical signals in nerve cells
- Intracellular compartments
- Glycolysis and fermentation
- Aerobic respiration
- Photosynthesis
- Cellular information: nucleus, chromosomes, DNA, the regulation of gene expression
- Mitosis and meiosis
- The genetic code and transcription
- Protein synthesis and sorting
- Cytoskeletal structure and function
- Cellular movement: motility and contractility
- The extracellular matrix and cell to cell interactions.
- Immunology and cancer

Recommended reading:
1. Alberts B, Bray D, Hopkin K et al. Essential cell biology. 2nd Ed. Garland Science, New York, 2004
2. Cooper GM. Hausman RE. The cell. A molecular approach. 3rd Ed. ASM Press, Washington, 2004
The course material includes a student manual and study guide.

Teaching methods: Lectures, practical. Computational and experimental laboratory.
Prerequisites: Biology, chemistry, physics
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Raw Materials for Bio- and Food Industries	**0126**	**3/Spring**
Course type:	Total hours:	ECTS:
Lecture / Practical	**45 / 15**	**4**

Lecturer: Maja Habulin

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering direction Biochemical Engineering

Objectives of the course:
Understanding of techniques for raw materials preparation in industrial use.

Course contents:
- Raw materials in food industries.
- Storage of raw materials.
- Preparation of raw materials.
- Raw materials in biotechnology.
- Biomass from plant and animal origin.
- Raw materials for biomass production and their preparation.
- Microorganisms for biomass production.
- Processes and apparatus.
- Examples.

Recommended reading:
1. P. Fellows, Food Processing Technology, Ellis Norwood Ltd., Chichester (England), 1988.
2. P. Präve, U. Faust, W. Sittig, D.A. Sukatisch, Fundamentals of Biotechnology, VCH Verlagsgesellschaft, Weinheim (Germany), 1987.
3. A.N. Collins, G.N. Sheldrake, J. Crosby, Chirality in Industry, John Wiley & Sons, New York, 1992.
4. G.T. Austin, Shreve's Chemical Process Industries, McGraw-Hill, New York, 1984.
5. B. Phillip, P. Stevens, Grűndzuge der Industriellen Chemie, VCH, Weinheim, 1987.

Teaching methods: Lectures, seminar
Prerequisites: General Chemistry, Separation Processes, Microbiology
Assessment methods: Oral examination

Course title:	Course code:	Year of study/Semester:
Industrial Microbiology	**0130**	**4/Fall**
Course type:	Total hours:	ECTS:
Lecture / Seminar	**45 / 30**	**5,5**

Lecturer: Maja Habulin

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering direction Biochemical Engineering

Objectives of the course:
Understanding of traditional industrial microbiological processes, emphasizing the unique problems and requirements of large-scale industrial cultivation of microorganisms.

Course contents:
Definition of industrial microbiology. Fermentation equipment and its use. Hydrolysis (ethers, apoxydes,…). Industrial microorganisms and products. Detection and assay of fermentation products (physical – chemical assays and biological assays). Fermentation media (composition, sterilization and contamination, inoculum media). Inoculum preparation. Antibiotic fermentations (penicillin, strptomycin). Anaerobic fermentations (acetone – butanol fermentation, brewing, industrial alcohol, lactic acid). Indirect and direct fermentation. Microbial oxidative transformations of substrate (vinegar, gluconic acid). Microbial cells as fermentation products (bakers' yeast, food and feed yeasts, bacterial insecticides, mushrooms, algae). Vitamins. Enzymes as fermentation products (amylases, proteolytic enzyme, pectinases, invertase). Organic acids (citric acid, fumaric acid). Genetic control of metabolic pathways. Patents and secret processes. Fermentation economics.

Recommended reading:

1. L.E. Casida, Industrial microbiology, John Wiley and Sons, New York, 1986.
2. M.T. Madigar, J.M. Martinko, J. Parker, Brock Biology of Microorganisms, Prentice Hall, London, 1997.
3. R.K. Murray, D.K. Granner, P.A. Mayes, V.W. Rodwell, Harper's Biochemistry, Prentice Hall, London, 1996.
4. G.T. Austin, Shreve's Chemical Process Industries, McGraw-Hill, New York, 1984.
5. M. Moo-Young, Immobilized Enzymes and Cells, Elsevier, London, 1988.
6. R.G. Berger, Aroma Biotechnology, Springer Verlag, Berlin, 1995.

Teaching methods: Lectures, seminar
Prerequisites: General Chemistry, Microbiology, Cell Physiology
Assessment methods: Oral examination

Course title:	Course code:	Year of study/Semester:
Process Integration I		**4/Fall**
Course type:	Total hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5**

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Theoretical basis and practical experiences in process selection, modelling, simulation, integration and design of processes is given. Team work, synthesis of the acquired professional knowledge, efficient use of commercial software and literature is provided. The course is connected with other ones through a common case study.

Course contents:
Lectures
Process synthesis: strategy and conceptual design. Pinch analysis: thermodynamics, heat exchanger network, utilities. Process integration: heat engines, heat pumps, separators, reactors. Process design using pinch technology. Process retrofit. Total site integration. Water, hydrogen pinch. Targeting of emissions. Evaluation of process alternatives.
Practical work
Project task. Process flowsheet. Material and energy balances. Investment and operating costs. Bioprocess modelling using a commercial simulator. Equipment specification. Project report.

Recommended reading:

1. P. Glavič, Načrtovanje procesov, zbrano gradivo in navodila za vaje z nalogami, FKKT, Maribor, 1998.
2. R. Smith, Chemical Process Design, McGraw-Hill, New York, 1995.
3. J. H. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, New York, 1988.
4. U. V. Shenoy, Heat Exchanger Network Synthesis, Gulf Publishing, Huston, 1995.
5. Perry's Chemical Engineers' Handbook, Don W. Green (Ed.), McGraw-Hill, NewYork, 1997.

Teaching methods: Lectures, laboratory, computer software. Process modeling, simulation, and design followed by oral presentation.
Prerequisites: Thermodynamics, Separation Processes, Reaction Engineering
Assessment methods: Oral examination and design project evaluation

Course title:	Course code:	Year of study/Semester:
Biochemical Reaction Engineering	**0136**	**4/Spring**
Course type:	Total hours	ECTS:
Lecture / Practical	**30 / 30**	**4.5**

Lecturers: Peter Glavič, Đurđa Vasić Rački

Language of instructions: Croatian

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering, option Biochemical Engineering.

Objectives of the course:
The course is classified as a Chemical engineering one. In the first part of the lecture student acquires knowledge about fundamental biochemical reaction systems and in the second part the methodology for their development and design is presented.

Course contents:
Lectures:
INTRODUCTION – biotechnology, biochemical engineering, bioreaction engineering, biological materials, biocatalysts, biotransformation. BASIC TERMS – bioprocess material balances, stehiometry, kinetics of growth and bioconversion, enzyme kinetics, biocatalysts stability, immobilization, deactivation, transport phenomena in bioreactors - dispersion, coalescence, multiple phase systems, yield, process productivity, bioproduct concentration, bioreactor-fermentor. TYPES OF BIOREACTORS: mixed flow reactor, biorector with recycle, chemostat, air-lift bioreactor, column with gas bubbles, reactor with fixed bed of catalysts, membrane bioreactor. BIOCHEMICAL REACTION SYSTEMS - enzyme fermentation: Michaelis-Menten kinetics, inhibition; microbial fermentation: batch fermentor, mixed flow fermentor, yield, kinetics, design; substrate-limiting microbial fermentation: batch fermentor, plug flow fermentor, mixed flow fermentor, optimal operation of fermentors; product-limiting microbial fermentation: batch fermentor, plug flow fermentor, mixed flow fermentor.
Practical work:
Aerobic reactor, anaerobic reactor, reaction calorimeter.

Recommended reading:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Ed., John Wiley and Sons, New York, 1999.
2. H. W. Blanch, D. S. Clark: Biochemical Engineering, Marcel Dekker, New York, 1996.
3. J. E. Bailey, D. F. Ollis: Biochemical Enginering Fundamentals, McGraw-Hill, 1986.
4. A. Scragg ed.: Biotechnology for Engineers-Biological Systems in Technological Processes, Ellis Horwood Limited, Chichester, 1988.
5. K. van't Riet, J. Tramper: Basic Bioreactor Design, M. Dekker, New York, 1991.

Teaching methods: Lectures with an illustrative examples and problems. Visiting of two industrial plants. Laboratory practice.
Prerequisites: Thermodynamics, Reaction Engineering
Assessment methods: Written and oral examination. Seminar work followed by oral presentation, laboratory practice report.

Course title:	Course code:	Year of study/Semester:
Toxicology	**0133**	**4/Spring**
Course type:	Total hours:	ECTS:
Lecture / Seminar	**15 / 15**	**2,5**

Lecturer: Uroš Potočnik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Theoretical and practical basics of Toxicology

Course contents:
Exposition.
Biotransformation.
Xenobiotics elimination.
Toxicokinetics.
Toxicity of the mixtures.
Cytotoxycity.
Toxicogenetics.
Carcinogenesis and estimation of the hazard of carcinogenic compounds.
Organ specific toxicity.
Toxicity tests.
Risk assessment.
Law.

Recommended reading:

1. R.J.M. Niesink et al., *Toxicology*, CRC Press London, 1995
2. Curtis D. Klaassen et al., Casarett & Doull's Toxicology: The Basic Science of Poisons, 6 edition, McGraw-Hill Professional; 2001
3. B. Alberts et al., *Molecular biology of the cell., 4th Ed.*, Gerland Publish, Inc., New York, 2002
4. Lodish H., Baltimore D., Berk A., Zipursky S.L., Matsudaira P., Darnell J., Molecular Cell Biology, 5th Ed., Scientific American Books, Freeman and Co., New York, 2004

Teaching methods: Lectures, seminar. Computational and experimental laboratory.
Assessment methods: Written exam, seminar

Course title:	Course code:	Year of study/Semester:
Molecular Biology & Gene Technology	**0134**	**4/Spring**
Course type:	Total hours:	ECTS:
Lecture / Practical	**45 / 15**	**4,5**

Lecturer: Uroš Potočnik

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
The students are acquainted with the basics of biological molecules and how these molecules form cells, tissues and living organisms. The course will focus particularly on the transfer of genetic information and on applications of gene technology in biotechnology and medicine.

Course contents:
DNA: structure, characteristics, replication (prokaryotes, eukaryotes), recombination, repair and mutations. RNA: structure, characteristics, types, function, transcription (prokaryotes, eukaryotes), posttranscriptional modification.
Proteins: structure, synthesis, posttranslational modification, folding, transport.
Regulation of protein synthesis, regulation of gene expression in prokaryotes, eukaryotes and in embryonic development, regulation of translation, posttranslational modifications.
Cell cycle, proliferation, differentiation, apoptosis.
Tissue organization, cell junctions, cell adhesion, cell to cell signalling, signal transduction pathways, receptors, hormones.
Immune system.
Viruses, HIV, SARS, DNA diagnosis of infection diseases.
Chromosomal basis of heredity, Mendelian inheritance, polygenic inheritance.
Human Genome Project, organization, structure and function of genes and chromosomes, gene mapping, mitochondrial genome.
Genetic variation in individuals: mutations, DNA and protein polymorphisms, uses of polymorphisms in medical genetics, phenotype, genotype, allele frequency, haplotypes, haplotype blocks (HapMap project), the Hardy-Weinberg law, linkage analysis, linkage disequilibrium.
Genetic variation in populations.
Recombinant DNA technology, cloning.
Genetic diseases with classical Mendelian and complex inheritance.
Cancer genetics: oncogenes, tumour suppressor genes, hereditary cancers, molecular diagnostics and therapy.
DNA analysis in forensics and bone marrow transplantation typing.
Gene technology in drug discovery, production of drugs and diagnostics.
Gene therapy.
Molecular genetics and society: ethical, social and economical issues.

Recommended reading:

1. B. Alberts et al., *Molecular biology of the cell., 4th Ed.*, Gerland Publish, Inc., New York, 2002
2. Lodish H., Baltimore D., Berk A., Zipursky S.L., Matsudaira P., Darnell J., Molecular Cell Biology, 5th Ed., Scientific American Books, Freeman and Co., New York, 2004

Recommended reading (cont'd):

3. Nussbaum RL, McInnes,RR, Huntington FW, Thompson & Thompson Genetics in Medicine., 6th Ed, Saunders Co.,Philadelphia, 2001
4. B. Lewin, *Genes V.*, Oxford Univ. Press, Oxford, 1997
5. Glick B.R. and Pasternak J.J.: *Molecular biotechnology: principles and applications of recombinant DNA*., ASM Press, Washington, 1994

Teaching methods: Lectures, practical, seminar. Computational and experimental laboratory.
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Process Integration II	**0135**	**4/Spring**
Course type:	Total hours:	ECTS:
Lecture / Practical	**30 / 30**	**5**

Lecturer: Zdravko Kravanja

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
The aim is to give a basic overview and knowledge in the theory of mathematical programming and application in process optimization for process design/synthesis, planning, operation and handling engineering data.

Course contents:
Introduction: definition of system border, optimization criteria, structure of models.
Overview of applications in engineering.
Survey of theory and optimization methods.
Direct search methods, e.g. complex algorithm.
Linear programming (LP) and simplex method.
Nonlinear programming, Lagrange multipliers, Karush-Kuhn-Tucker optimality conditions, active set method.
Optimization with GAMS (equation oriented), ASPEN PLUS or HYSYS (implicit flowsheet optimization) and DCA (direct search).

Recommended reading:

1. G.V. Reklaitis, A. Ravidran, K.M. Ragsdell, Engineering Optimization, Methods and Applications, John Wiley and Sons, New York, 1986.
2. M. Morari, I.E. Grossmann (Editors), CACHE Process Design Case Studies, Volume 6: Chemical Engineering Optimization Models with GAMS, USA, 1991.
3. A. Brooke, D. Kendrick, A. Meeraus, R. Raman, GAMS - A user Guide, Scientific Press, GAMS Development Corporation, 1998,
4. L.T. Biegler, I.E. Grossmann, A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, New Jersey, 1997.

Teaching methods: Lectures, practice, seminars. Work with computer in laboratory.
Prerequisites: Mathematics II
Assessment methods: Written examination, seminar and oral presentation of seminar results

Course title:	Course code:	Year of study/Semester:
Process Safety	**0014**	**2/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 15**	**3,5**

Lecturer: Zorka Novak Pintarič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
To acquaint the students with the techniques of Chemical Process Quantitative Risk Analysis.

Course contents:
Legislation.
Typical hazards in process industries (Fire, Explosion, Toxic Release, Chemical Reaction, DOW Fire and Explosion Index, Reaction Hazard Index).
Hazard identification (HAZOP).
Consequence analysis (Discharge Rate Models, Flash and Evaporation, Dispersion Models, UVCE, BLEVE, Physical Explosion).
Plant Availability and Process Reliability.
Event probability and failure frequency estimation (Failure Tree Analysis, Event Tree Analysis).
Risk assessment:

- Risk indices (The Fatal Accident Rate – FAR, The Average Rate of Death)
- Individual risk (Risk Contours, Maximum Individual Risk, Average Individual Risk)
- Societal risk (Frequency-Number Curve)

Recommended reading:

1. Marshall V.C. and Ruhemann S., *Fundamentals of Process Safety*, IChemE, Rugby, UK, 2001.
2. Lees F.P., *Loss Prevention in the Process Industries*. Butterworth-Heinemann, 2001.
3. Centre for Chemical Process Safety of the AIChE, *Guidelines for chemical process quantitative risk analysis*. AIChE, New York, USA, 2003.
4. Centre for Chemical Process Safety of the AIChE, *Guidelines for process equipment reliability data, with data tables*. AIChE, New York, USA, 2003.
5. Kletz T., *HAZOP and HAZAN*, IChemE, Rugby, UK, 1992.
6. Barton J. and Rogers R. (Eds.), *Chemical Reaction Hazards – A Guide*. IChemE, Rugby, UK, 1993.

Teaching methods: Lectures, practical. Work in computational and experimental laboratory.
Prerequisites: Mathematics, Inorganic Chemistry
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Process Calculation	**0109**	**2/Fall** **2/Spring**
Course type:	Hours/Week:	ECTS:
Lecture / Practical	**30 / 30 (3-Fall)** **30 / 30 (4-Spring)**	**5** **5**

Lecturer: Majda Krajnc

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
Students learn the fundamentals of computer programming with FORTRAN, of systems of units and of material balances in systems with and without chemical reaction. They became familiar with numerical methods for solving single nonlinear equations containing one unknown and with methods for solving sets of simultaneous linear and nonlinear equations. In these cases they use POLYMATH and Aspen Plus programs.

Course contents:
- programming with FORTRAN,
- systems of units,
- process synthesis,
- data processing,
- material balances of process units,
- material balances of chemical reactors,
- material balances of systems of process units,
- solution of single equations,
- simultaneous linear and nonlinear equations.

Recommended reading:

1. C. Middlebrooks, VAX FORTRAN, Reston Publishing Company, Inc., Reston, Virginia, A prentice-Hall Company, 1984.
2. V. Žumer, FORTRAN, TF Maribor, 1993.
3. A. P. Myers, W. D. Seider, Introduction to Chemical Engineering and Computer Calcualtion, Prentice-Hall, Inc., New Jersey, 1976.
4. D. M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice-Hall, New Jersey, 1996.
5. M. Shacham, M.B. Cutlip, M. Elly, Polymath 5.0, The CACHE Corporation, The University of Connecticut, Ben Gurion University of the Negev, The University of Michigan, 2000.
6. SmartDraw and SmartDraw Professional, Version 4, SmartDraw Software Inc., San Diego, CA, 1998.
7. Aspen Plus, Version 12.1, Aspen Technology, Inc., Cambridge, MA, 2004.

Teaching methods: Lectures, practical. Work in computational laboratory.
Prerequisites: General Chemistry, Mathematics
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Process Analysis	**0013**	**3/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**60 / 90**	**12**

Lecturer: Željko Knez

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
Basic knowledge of the more important unit operations (mainly physical in nature) as well as thermal separation processes used in chemical and process industries enables students to understand industrial technological processes.

Course contents:
Unit operations:
- size reduction of solids
- magnetic separation
- sieving
- flotation
- filtration
- membrane separation processes
- centrifugation
- emulsifying
- mixing

Exercises:
- filtration with laboratory filter plate
- ultrafiltration
- reverse osmozis
- emulsifying
- mixing of liquids
- crushing and sieving
- distillation
- drying
- extraction
- crystallization

Thermal separation processes:
- evaporation
- crystallization
- distillation
- liquid-liquid extraction
- solid liquid extraction
- drying

Recommended reading:

1. J.M. Coulson and J.F. Richardson, Chemical engineering (Vol. II), Pergamon press, NY, 1978.
2. Vauck/Műller, Grundoperationen chemischer Verfahrenstechnik, VCH, Weinheim, 1987.
3. Lerbuch der chemischen Verfahrenstechnik, VEB, Leipzig, 1973.
4. V. Ozim, Ž .Knez, Unit operations, FKKT, Maribor, 1995. (in Slovenian)
5. Ž. Knez, M. Habulin, V. Ozim, Exercises from process analysis and mechanical separation processes, FKKT, Maribor, 1997.
6. K. Sattler, H.J. Feindt, Thermal Separation Processes, VCH, Weinheim, 1995.
7. Ž. Knez, M. Škerget, Thermodiffusional Separation Processes, FKKT, Maribor, 1999.

Teaching methods: Lectures, practical. Laboratory work.
Prerequisites: General chemistry, analytic and physical chemistry or consent of the lecturer.
Assessment methods: Oral examination including lab attendance

Course title:	Course code:	Year of study/Semester:
Material Science	**0107**	**3/Fall**
Course type:	Hours/Week:	ECTS:
Lecture / Laboratory	**45 / 30**	**6**

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
Solid state physics and chemistry is used to explain the influence of materials structure on physical and chemical properties as well as on corrosion prevention.

Course contents:
Lectures:
Introduction. Structure of solids: ideal and real. Mechanical properties of solids: elastic and plastic deformation. Processes in materials: viscoelasticity, diffusion, electrical and magnetic properties. Equilibrium in solids: phase equilibria. Phase structures: single phase, multiphase, composites. Chemical properties of materials: thermodynamics and kinetics of corrosion, corrosion prevention, forms of corrosion.
Laboratory:
Identification of plastics. Hydrolysis of glass. Metalographic examination of metals. Corrosion resistance of metals.

Recommended reading:

1. P. Glavič, Gradiva, Zbrano gradivo, FKKT Maribor, 1999.
2. A. Goršek, P. Glavič, Laboratorijske vaje iz gradiv (VS), FKKT, Maribor, 1997.
3. L. H. van Vlack, Elements of Materials Science and Engineering, Addison-Wesley, Reading, 1996.
4. M. G. Fontana and N. D. Greene, Corrosion Engineering, McGraw-Hill, New York, 1986.
5. Quantities, Units and Symbols in Physical Chemistry, I. Mills (Ed.), Blackwell, Oxford, 1993.

Teaching methods: Lectures, laboratory
Prerequisites: Inorganic Chemistry, Physical Chemistry
Assessment methods: Written and oral examination. Laboratory with written reports followed by oral presentation.

Course title:	Course code:	Year of study/Semester:
Process Synthesis	**0019**	**3/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**75 / 75**	**12,5**

Lecturer: Majda Krajnc

Language of instructions: Slovene

Status of the course in the study program:
Compulsory course in the higher professional program Chemical Engineering.

Objectives of the course:
Students learn the history of processing, the chemical reaction sequence synthesis, the ability to make a material balance, how to allocate materials to support process chemistry, how to choose the proper separation technology, how to use thermal energy balances and heat integration methods, how to recognize the differences among chemical reactors and something about methods for investment and operating costs estimation.

Course contents:
- the engineering of process systems,
- reaction-path synthesis,
- material balances and species allocation,
- separation technology,
- separation task selection,
- energy balances,
- heat integration,
- chemical reactors,
- investment and operating cost estimation.

Recommended reading:

1. R. F. Dale, G. J. Powers, J. J. Siirola, Process Synthesis, Prentice-Hall Inc., New Jersey, 1974.
2. J. M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, New York, 1988.
3. O. Levenspiel, Chemical Reaction Engineering, John Wiley&Sons, New York, 1972.
4. O. Levenspiel, The Chemical Reactor Minibook, Chemical Engineering Department, Oregon State University, Corvallis, Oregon, 1979.
5. Aspen Plus, Version 10.2.1, Aspen Technology, Inc., Cambridge, MA, 2000.
6. SuperTarget Process, Version 5.0.08, Linnhoff March Ltd., 2000.

Teaching methods: Lectures, practical. Work in experimental and computational laboratory.
Prerequisites: Process Analysis, Physical Chemistry, General Chemistry
Assessment methods: Written and oral examination

ELECTIVE COURSES

Course title:	Course code:	Year of study/Semester:
Industrial Analytics	**0026**	**4/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Darinka Brodnjak Vončina

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program (option Chemical Engineering) and higher professional program.

Objectives of the course:
Broadening the knowledge of chemical technology in the field of industrial process control from the point of view of chemical analysis.

Course contents:
- sampling methods and sample preparation methods
- process potentiometric, amperometric and conductometric measuring procedures (electrochemical sensors in industrial process control)
- optical measuring procedures (process spectrophotometry in the UV, VIS and IR region, refractometry and measuring of scattering light)
- process chromatography (the use of gas, liquid and ion chromatography in the production process control).
- other measuring procedures (particular fields of interest can be included in the program in accordance with the participants' specialization).

Recommended reading:

1. K.J. Clevet, *Process Analyzer Technology*, J.Willey, New York, 1986.
2. J. Hengsteberg, B. Sturm, O. Winkler, *Messen, Steuern und Regeln*, Part II, 3rd Edition, Springer, Berlin, 1980.
3. B.W. Rossiter, J.E. Hamilton, *Physical Methods of Chemistry*, 2nd Edition, J. Willey, New York, 1986.
4. E. Katz, *Quantitative Analysis using Chromatographic Techniques*, J. Willey, Chirchester, New York, 1987.

Teaching methods: Lectures, practical, laboratory
Prerequisites: Analytical Chemistry and Process Engineering
Assessment methods: Seminar paper including successful oral defence and oral examination. Laboratory coursework including lab reports followed by oral defence.

* Higher educational program: year 3 (spring semester), Total Hours 30 L / 45 P, ECTS 6.

Course title:	Course code:	Year of study/Semester:
Ceramics	**0051**	**4/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5**

Lecturer: Miha Drofenik

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
Education of students in the field of ceramic materials. The acquired knowledge will enable students to understand the processes of manufacturing ceramic materials, such as traditional ceramic, magnetic, electronic and engineering ceramic materials.

Course contents:
Ion exchange in Clay Minerals, Reological Properties of Aqueous Clay Systems, Slip Casting Nonclay Ceramics, Pressure Forming of ceramics, Clay-Water Pastes, Recrystallization and Sintering in Ceramics, Ceramics Microstructures, Effect of Microstructure on the Electrical and Magnetic Properties of Ceramics, Effect of Microstructure on the Mechanical Properties of Ceramic Materials.

Recommended reading:
1. W. D. Kingery, Ceramic Fabrication processes, John Wiley & Sons, Inc., New York, 1960.
2. W. D. Kingery, H. K. Bowen, D. R. Uhlmann, Introduction to Cearmics, John Wiley & Sons, Inc., New York, 1976.
3. P. Rado, An Introduction to the Technology of Pottery, Pergamon Press, Oxford, 1989.

Teaching methods: Lectures, practical
Prerequisites: Elements of Material Science and Engineering
Assessment methods: Oral examination and seminar

Course title:	Course code:	Year of study/Semester:
Inorganic Technology	**0022**	**4/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Peter Glavič

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program (option Chemical Engineering) and higher professional program.

Objectives of the course:
The course delivers selected processes from inorganic chemical technology. As an elective its goal is to prepare the student for his/her future employment and/or his/her thesis. The program is adapted to the needs and interests of the student and his/her future employer.

Course contents:
Lectures
Fertilizers (basic, mixed, complex, liquid, organic), inorganic acids (sulfuric, nitric, phosphoric, hydrochloric). Technical gases (nitrogen, oxygen, carbon dioxide, acetylene, mixtures). Abrasives (alumina, corundum, silicon carbide, grinding and polishing materials). Inorganic pigments (sulfuric acid, titanium dioxide, zinc oxide). Electrochemistry (calcium carbide, ferroalloys, iron and steel). Aluminium (alumina, refractories, aluminium, graphite). Nonmetals (glass, enamel, refractories, cement, lime). The student selects the most convenient chapters from a list. Some of them can be studied in more detail or some processes can be selected outside the list to enable the student to satisfy his personal wishes or meet his future employer's requirements.
Laboratory*:*
Practical work is selected individually according to the research subject and future employment. The course is a preparation for research work and can have a laboratory and/or seminar character.

Recommended reading:

1. Winnacker-Küchler, Chemische Technologie, Band 2,3,4, Carl Hanser Verlag, München, 1982-1997.
2. Ullmanns Encyclopedia of Industrial Chemistry, Verlag Chemie, Weinheim, 1985-1996.
3. Dürrer-Frank, Metallurgie der Ferrolegierungen, Springer Verlag, Berlin, 1972.
4. Riegel's Handbook of Industrial Chemistry, J. A. Kent (Ed.), Chapman & Hall, New York, 1992.
5. McKetta, Encyclopedia of Chemical Processing and Design, Marcel Dekker, New York, 1976-1999.

Teaching methods: Tutorial, seminar, laboratory
Prerequisites: Inorganic Chemistry, Physical Chemistry
Assessment methods: Seminar report and oral examination. Laboratory and/or seminar work followed by oral presentation.

* Higher educational program: year 3 (spring semester), Total Hours 30 L / 45 P, ECTS 6.

Course title:	Course code:	Year of study/Semester:
Computer Aided Process Design	**0055**	**4/Fall**
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5**

Lecturer: Zdravko Kravanja

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Chemical Engineering.

Objectives of the course:
The aim is to give a basic overview and knowledge in computer aided process design

Course contents:
Introduction: Different techniques for process analysis and optimization/synthesis.
Mathematical modeling of unit models. General concepts of simulation of process flowsheets, steady state and dynamic simulation. Process simulators ASPEN PLUS and HYSYS. Optimization of process flowsheets using sequential simulators or equation-oriented modular simulators. Process synthesis using the superstructure approach: a) generation of alternatives (heuristics, base case designs, expert systems, mathematical modeling), b) MINLP formulation of unit models and MINLP model by model generators, c) solving the synthesis problem. Mixed-Integer Process Synthesizer MIPSYS. Design under uncertainty. Integrated synthesis/analysis approach.

Recommended reading:

1. ASPEN PLUS User Guide, Aspen Technology, Cambridge, MA, 1988.
2. Brooke A., D.Kendrick, A.Meeraus, GAMS A User's Guide, Scientific Press, Palo Alto, 1992.
3. Biegler L.T., I.E.Grossmann, A.W.Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall, New Jersey, 1997.
4. HYSYS, Tutorials, Applications, Hyprotech Ltd., Calgary, 1996.
5. Rose L.M., Engineering Investment Decision - Planing Under Uncertainty, Elsevier, New York, 1976.

Teaching methods: Lectures and practice. Work with computer.
Assessment methods: Oral and written seminar report

Course title:	Course code:	Year of study/Semester:
Organic Technology	**0023**	**4/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Željko Knez

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program (option Chemical Engineering) and higher professional program.

Objectives of the course:
Students learn the fundamental processes in organic chemical technology and their use in process engineering as well as processes by which some organic chemistry products are manufactured.

Course contents:
Unit processes: halogenation, nitration, sulfonation, amination, alkalisation, orilation, hydrogenation, oxidation

Synthesis of polymers, reaction kinetics, physicochemical properties of polymeric materials. Technologies for petroleum refining, products.

Exercises:
Unit processes: hydrogenation, sulfonation, properties of polymers

Recommended reading:
1. P.H. Grogens, Technological processes in organic synthesis, Građevinska knjiga, BG, 1967. (in Croatian)
2. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, N.Y., 1992.
3. G.T. Austin, Shreve's Chemical Process Industries, McGraw-Hill Book Company, N.Y., 1984.

Teaching methods: Lectures, practical. Laboratory work.
Prerequisites: General chemistry, inorganic and analytic chemistry or consent of the lecturer.
Assessment methods: Written and oral examination

* Higher educational program: year 3 (spring semester), Total Hours 30 L / 45 P, ECTS 6.

Course title:	Course code:	Year of study/Semester r:
Water Treatment	**0025**	**4/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Marjana Simonič

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program (option Chemical Engineering) and higher professional program.

Objectives of the course:
Students obtain an overview of Water quality and treatment.

Course contents:
- the characteristics of drinking waters
- orders about drinking water quality
- chemical analysis of drinking waters
- mechanical and chemical water purification
- specific pollutants in water and their purification
- carbonic equilibria in water
- standard drinking water treatment overview
- waste water treatment

Recommended reading:
1. Hütter L.A., Wasser und wasser untersuchung, 3rd edition. Diesterweg Salle Sauerländer, 1989.
2. Water quality and treatment, a handbook of community Water Supplies, 4th edition. American Water Works Association, Mc Grew Hill Co, 1990.
3. Kegley S.E., Andrews J., The Chemistry of Water, University Science Book, USA, 1997.
4. Hancke K., Wasseraufbereitung, 3rd edition, VDI-Verlag GmbH, Düsseldorf, Germany, 1994.

Teaching methods: Lectures, laboratory
Prerequisites: Inorganic Chemistry
Assessment methods: Oral examination. Laboratory with written reports followed by oral examination.

* Higher educational program: year 3 (spring semester), Total Hours 30 L / 45 P, ECTS 6.

Course title:	Course code:	Year of study/Semester:
Ecology	**0024**	**4/Fall***
Course type:	Total Hours:	ECTS:
Lecture / Practical	**30 / 30**	**4,5***

Lecturer: Janez Petek

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program (option Chemical Engineering) and higher professional program.

Objectives of the course:
Students have to be able to examine production processes in order to find possibilities of waste minimisation, pollution prevention and end-of-pipe technologies.

Course contents:
- Waste minimisation. The methodology consists of 4 phases: Planning and organisation, the Assessment phase, the Feasibility phase and Implementation
- Environmental Management and Audit Scheme, ISO 14000, Life cycle analysis of products
- Rational energy consumption in process industries
- Typical end-of-pipe technologies. Basic processes and equipment of effluents treatment: wastewater, waste gasses and solid waste.

Recommended reading:
1. J. Petek, Waste minimisation handbook, Univerza v Mariboru, Oddelek za kemijo in kemijsko tehnologijo, Maribor, 1992.
2. International standard ISO 14000, Waste management systems, specification with guidance for use.
3. UNEP, Life cycle assessment: What it is and how to do it, ISBN: 92-807-1546-1, 1996.
4. R. Noyes, Unit operations in environmental engineering, Noyes Publications, New Jersey, 1994.

Teaching methods: Lectures, seminar work
Prerequisites: Basic chemical engineering and environmental processes, mass and energy balances, consent of the lecturer
Assessment methods: Oral examination, seminar work presentation

* Higher educational program: year 3 (spring semester), Total Hours 30 L / 45 P, ECTS 6.

Course title:	Course code:	Year of study/Semester:
Biotechnology	**0140**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Maja Habulin and Walter Steiner

Language of instructions: Slovene, English

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
Study of microbiological and enzymatic processes in industry. Development of engineering knowledge for industrial fermentation processes and application of enzymes.

Course contents:
Kinetics of biochemical reactions: life cycle of microorganisms, mathematical model, reaction kinetics, mass transfer in batch reactor.
Transport phenomena in microbial systems.
Analysis and design of biochemical reactors.
Reactors for homogeneous populations.
Interactions of homogeneous populations.
Reactors for heterogeneous populations.

Recommended reading:
1. J.E. Bailey, D.F. Ollis: *Biochemical Engineering Fundamentals*, McGraw-Hill, 1986
2. H.V. Blanch, D.S. Clark: *Biochemical Engineering,* Marcel Dekker, New York, 1996
3. K. van't Riet, J. Tramper: *Basic Bioreactor Design*, M. Dekker, New York, 1991

Teaching methods: Lectures, seminar, laboratory exercises
Prerequisites: Organic Chemistry, Physical Chemistry, Thermodynamics, Unit Operations, Chemical Reaction Engineering
Assessment methods: Oral examination

Course title:	Course code:	Year of study/Semester:
Enzyme Technologies	**0141**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Maja Habulin

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
Understanding of the use of natural catalysts-enzymes for the transformation of non-natural man-made organic compounds.

Course contents:
- Isolation of enzymes in laboratory and industrial scale.
- Biotechnology of enzymes and other proteins and production (usefull cases of todays industries).
- Hydrolysis (ethers, apoxydes,…).
- Reduction (reduction of aldehydes and ketones with isolated enzymes /cells, reduction of C=C bonds with cells).
- Oxidations (oxidation of alcohols and aldehydes, epoxidation of alkenes,…).
- C-C bond formation.
- Reactions of addition and elimination.
- Special techniques:
  - enzymes in organic media (ester synthesis, amide synthesis, peptide synthesis)
  - immobilization
  - synthetic enzymes
  - enzymes under extreme conditions (high temperatures, high pressures, stability and activity of enzymes, enzymatic syntheses, reactors, chrystallization).

Recommended reading:

1. K. Faber, Bio-transformations in Organic Chemistry, Springer – Verlag, Berlin, 1992.
2. P.G. Jessop, W. Leitner, Chemical Synthesis Using Supercritical Fluids, Wiley-VCH, Weinheim, 1999.
3. A.N. Collins, G.N. Sheldrake, J. Crosby, Chirality in Industry, John Wiley & Sons, New York, 1992.
4. A. Wiseman, Handbook of Enzyme Biotechnology, John Wiley & Sons, New York, 1985.
5. R.G. Berger, Aroma Biotechnology, Springer Verlag, Berlin, 1995.

Teaching methods: Lectures, seminar
Prerequisites: Organic Chemistry, Physical Chemistry, Thermodynamics, Unit Operations, Chemical Reaction Engineering.
Assessment methods: Oral examination

Course title:	Course code:	Year of study/Semester:
High Pressure Processes	**0142**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Željko Knez and Eckhard Weidner

Language of instructions: Slovene, English

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
Student acquires elementary knowledge of different high-pressure processes.

Course contents:
Acquisition of elementary knowledge of different high-pressure processes, study of phase equilibria and mass transfer at high pressures.

- Introduction to technologies with supercritical fluids.
- Extraction processes with supercritical fluids. Phase equilibria. Mass transfer. Scale up of processes. Application. Energy consumption. Comparison with extractions with organic solvents.
- Biochemical reactions in supercritical fluids.
- Application of supercritical fluids for micronisation. Crystallisation in supercritical fluids. Rapid expansion in supercritical solution (RESS). Recrystallisation with gas as antisolvent. Particles from the gas saturated solution (PGSS).

Recommended reading:

1. Knez Željko, Škerget Mojca. Phase equilibria of the vitamins D2, D3 and K3 in binary systems with CO2 and propane. *J. supercrit. fluids*., 2001, 20, 131-144.
2. Knez Željko, Habulin Maja. Compressed gases as alternative enzymatic-reaction solvents: a short review. *J. supercrit. fluids*., 2002, 23, 29-42.
3. Knez, Željko, Weidner, Eckhard. Particles formation and particle design using supercritical fluids. *Curr. opin. solid state mater. sci.*, 2003, vol. 7, iss. 4/5, 353-361.

Teaching methods: Lectures, practical
Prerequisites: Stagewise processes
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Bioengineering and Fermentation Technology	**0143**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Željko Knez and Đurđa Vasić Rački

Language of instructions: Slovene, Croatian

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
Student acquires elementary knowledge of fermentation processes, fermentors and some industrial applications.

Course contents:
- Introduction to industrial fermentation processes.
- Basic types of the fermentors (configurations, batch fermentation, types of batch fermentors, heat transfer, mixing, sterilization, foam prevention). Continuous fermentation in mixer fermentors, tubular fermentors and basic characteristic of the fermentors.
- Kinetics of biochemical engineering (differences between chemical and biochemical processes, classification of biochemical reactions, constant conditions in the fermentor (dwell time, concentration, temperature, designing fermentors, rate of the reactions (kinetics)).
- Equation of biological rate (model for one microorganism, kinetic model for growing of microbes, formation of product).
- Determination of the biological system parameters.
- Fermentors with microbe films.
- Reactors with enzymes in the solution.
- Industrial processes (penicillin, vitamins and amino acids, enzymes, citric acid, yeast).

Recommended reading:

1. Krmelj Vlasta, Habulin Maja, Knez, Željko, Bauman, Davorin. Lipase-catalyzed synthesis of oleyl oleate in pressurized and supercritical solvents. *Fett (Weinh.)*, 1999, 101, no. 1, 34-38.
2. Habulin Maja, Knez Željko. High-pressure enzymatic hydrolysis of oil. *Fett (Weinh.)*, 2002, vol. 104, no. 7, 381-386.
3. Primožič Mateja, Habulin Maja, Knez, Željko. Parameter optimization for the enzymatic hydrolysis of sunflower oil in high-pressure reactors. *J. Am. Oil Chem. Soc.*, 2003, vol. 80, no. 7, 643-646.

Teaching methods: Lectures, practical. Seminar work.
Prerequisites: Stagewise processes, Chemical reaction engineering
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Active Pharmaceutical Ingredients	**0144**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Janko Žmitek

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
To make an acquaintance with (and understanding of) basic definitions and requirements related to active pharmaceutical ingredients, their pharmacological and chemical classifications, typical representatives and technologies.

Course contents:
- Clasification
- Alkylation (Phenobarbital)
- Condensation and cyclisation (diazepam, phenolphthalein, piperazine citrate, vitamin B1, vitamin B2)
- Dehydration
- Halogenation (chlorophorm)
- Oxidation (nicotinic acid and nicotinamide)
- Sulfonation
- Complex chemical transformations (ascorbic acid)
- Fermentation and production of antibiotics, hormones and vitamins

Recommended reading:
1. Selected articles
2. F. Krašovec: *Pregled organske kemijske tehnologije*, VTŠ Maribor, 1976
3. Wanacher-Kuechler: *Chemische Technologie, BD 3, 4, 5 (Organische Technologie)*, C. Hanser Verlag, München, 1972-74
4. Special literature for project work on selected technologies
5. George T. Austin: *Shreve's Chemical Industries*, McGraw-Hill Book Company, N.Y., 1984

Teaching methods: Lectures and seminars
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Meat Processing	**0145**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Marko Volk

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
To provide students with the knowledge about meat science, meat quality and meat processing technologies.

Course contents:
- histological structure and biological, chemical characteristics of meat of domestic animals
- nutritive and biological value of meat
- technology of slaughter and chopping of carcases
- cooling, freezing and storing
- technology of meat processing (pickling salting, smoking, drying and maturing)
- sorts and characteristics of meat products (permanent, half - permanent, dried meat products, sausages, tinned meat and ready dishes
- legislation overview, which states the organisation of food processing plants and the conditions of quality, hygiene and marketing meat and meat products

Recommended reading:

1. S. Rahelić: *Osnove tehnologije mesa,* Školska knjiga, Zagreb, 1978
2. J. ŽivkoviĆ: *Higijena i tehnologija mesa, Kakvoča i prerada,* Učbenici Sveučilišča u Zagrebu, Zagreb, 1986
3. N. N. Potter, J. H. Hotchkiss: *Food Science,* Aspen Publishess, N.Y., 1995
4. H. D. Belitz, W. Grosch, M. M. Burghage: *Food Chemistry,* Springer Verlag, Berlin, 1999
5. J. M. Deman: Principles of Food Chemistry, Aspen Publishess, N.Y., 1999
6. C. O. Gill: Encyclopedia of Food Science and Technology, Wiley, N.Y., 1994

Teaching methods: Lectures, seminar
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Fruit and Vegetable Processing	**0146**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Stanislav Tojnko and Martina Bavec

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
The aim of this course is to give basic information and knowledge about fruit and vegetable processing with the main techniques, ensuring quality of raw material and nutritional value of processed fruit and vegetable. The objective is to promote new trends and options in fruit and vegetable processing (organic, functional, special foods,…).

Course contents:
Lectures:
Fruit and vegetable processing from economic, technological and dietary aspect. Basic raw material and classification. Differences among growing techniques (conventional, integrated, organic) ensuring quality of raw material following different schemes. Ripening and over ripening. Differences among botanical and technological maturity and influences. Chemical composition of fruit and vegetables. Bioactive substances in fruit and vegetables. Storage of raw material and post-harvest changes. Degradation processes in processing and storage of fruit and vegetables and methods of avoiding them. Conservation methods. Fruit and vegetable semi products. Fruit juices technologies. Products based on pectin gel. Candied fruits. Processed fruit and vegetable based on sterilisation, pasteurization, freezing, fermentation, dehydration,… Fruit and vegetable foods for children. Special demands in organic fruit and vegetable processing. Rules for special foods and higher qualities. Fruit and vegetable processing on farm. Legislation for fruit and vegetable processing.

Practical work:
Comparison of some quality parameters in different ways of storaging. Defining stages of maturity and harvesting time. Dehidratization. Stabilization of fruit juices. Defining ingredients of tomato products. Measurement of SO_2 . Measurement of sugar and acids in fruits, vegetables and processed products.

Recommended reading:

1. T. Lovrić, V. Piližota, *Konzerviranje i prerada voća I povrća,* Globus, Zagreb, 1994
2. T. Lovrić (V. Regedušić), *Procesi u prehrambenoj industriji osnovama prehrambenog inženjerstva (skripta I dio)*, II izdanje Prehrambeno-biotehnološki fakultet, Zagreb, 1991
3. J.G. Woodroof, B.S. Luh, *Commercial Fruit Processing,* Publishing Co., Inc. Wesport, Conn, 1986
4. R.S. Luh, J.G. Woodroof, *Commercial Vegetable Processing*, Book, Van Nostrand Reinhold, New York, 1988
5. N. Chioffi, G. Mead, L.M. Thompson, J. Masa, K. Foster, *Keeping the harvest: Preserving your fruits, vegetables & herbs,* Storey Books, N.Y., 1991
6. N.N. Potter, J.H. Hotchkiss, *Food Science,* Aspen Publishers, N.Y., 1995

7. Ohlsson T., Bengtsson, N. *Minimal Processing Technologies in the Food Industry,* 2002 Woodhead Publishing.

Teaching methods: Lectures, practical work in the lab, seminar work, practical work outside, professional excursion to some processing companies.
Prerequisites: Colloquium, written and oral exam, seminar
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Carbohydrate Processing	**0147**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Črtomir Stropnik

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering

Objectives of the course:
Students are acquainted with the scientific presentation of the carbohydrates and with their role in the human nutrition. Raw material production and processing (manufacturing) of carbohydrates: bread and pastries (cakes, cookies), confectionery, various beverages etc.

Course contents:
Physical properties as well as chemical structure and reactivity of (some) carbohydrates: mono-, di-, oligo- and poly- (homo- and hetero-glicans) saccharides; also some of their derivatives.
Carbohydrates in human nutrition: fruits and vegetable, bread and pastries, confectionery, various beverages. Physico-chemical interactions of carbohydrates with other basic food's constituents: with proteins, with various lipids and aroma substances, with minerals and with various additives. Mechanical processing of carbohydrates (mixing into the various food products), carbohydrates and some artificial sweet compounds in various beverages, thermal processing of carbohydrates (bacon of bread and pastries, caramel preparation etc.).

Recommended reading:
1. N.N. Potter, J.H. Hotchkiss, *Food Science*, Aspen Publishers, N.Y., 1995.
2. H. D. Belitz, W. Grosch, M.M. Burghage, *Food Chemistry*, Springer Verlag, Berlin, 1999.
3. J.M. Deman, *Principles of Food Chemistry*, Aspen Publishers, N.Y., 1999.
4. C.O. Gill, *Encyclopedia of Food Science and Technology*, Wiley, N.Y., 1994.

Teaching methods: Lectures, seminar, practical
Assessment methods: Successful report examination

Course title:	Course code:	Year of study/Semester:
Wine Technology	**0148**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Stanko Vršič

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
To enable students to understand:
- the importance of techniques and technology during grape management, wine treatments and bottling procedures;
- the most important wine analysis and wine control procedures.

Course contents:
- Composition of grapes and grape harvesting;
- Grape management and must treatments;
- Alcoholic and malolactic fermentation;
- Wine ageing, stabilisation and bottling;
- Wine defects;
- Wine analysis and sensory evaluation;
- Wine legislation.

Recommended reading:

1. R. Jackson, Wine Science, 1994.
2. R.B. Boulton et all. Principles and Practices of winemaking, 1995.
3. K.C. Fugelsang, Wine Microbiology, 1996.
4. R.P. Vine et all., Winemaking, 1997.
5. C. Zambonelli, Microbiologia e Biotechnologia dei vini, 1998.
6. P. Riberau-Gayon et all., Traité d'Oenologie, 1999.
7. M. Castino, Vini biamchi, Technologia e Produzione, 2000.
8. G. Flect, Wine Microbiology and Biotechnology, 2001.

Teaching methods: Lectures, seminar
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Milk and Milk Products Processing	**0149**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Marko Volk

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
To acquaint the students with basic characteristics of milk and its processing.

Course contents:
- Basic knowledge about milk and its chemical and biological characteristics and its nutritive values.
- Technological means and veterinary sanitary conditions in processing milk for consumption and the arrangement of dairy houses.
- Technology of producing dairy products (fermented products, ice creams, cheeses, butter, condensed milk and powder milk.
- Important facts about legislature, which makes out the conditions of quality and hygiene of milk and hygiene of milk processing and marketing.

Recommended reading:

1. S. Miletič: *Mlijeko in mliječni proizvodi*, Hrvatsko mljekarsko društvo, Zagreb, 1994
2. M. Rohrlich, G. Bruckner: *Das Getreide und seine Verarbeitung,* Verlag A.W. Hayn und Erben, Berlin, SO36, 1956
3. V. Pomoranz: *Wheat, Chemistry and Technology*, American Association of Cereal Chemists, St. Paul, Minnesota, 1971
4. H. Feridi: *Rhoology of Wheat Products*, American Association of Cereal Chemists, St. Paul, Minnesota, 1986
5. Hiraekorn, Nehrkorn, Miekley: *Grundprozesse der Backwerenheratellung,* VEB Fachbuchverlag, Leipzig, 1986
6. J. Harbutt, R. Denry: *The world encyclopedia of cheese,* Lorenz Books, N.Y., 1998
7. N.N. Potter, J. H. Hotchkiss: *Food Science,* Aspen Publishess, N.Y., 1995
8. H. D. Belitz, W. Grosch, M. M. Burghage: *Food Chemistry,* Springer Verlag, Berlin, 1999
9. J. M. Deman: *Principles of Food Chemistry,* Aspen Publishess, N.Y., 1999

Teaching methods: Lectures, seminar
Assessment methods: Written and oral examination

Course title:	Course code:	Year of study/Semester:
Food Processing Fundamentals	**0150**	**4/Spring**
Course type:	Total Hours:	ECTS:
Lecture / Seminar	**30 / 30**	**4,5**

Lecturer: Željko Knez and Ivan Krajnc

Language of instructions: Slovene

Status of the course in the study program:
Elective course in the university program Chemical Engineering option Biochemical Engineering.

Objectives of the course:
Student acquires elementary knowledge of some food and basic knowledge of contemporary technological procedures for modification and treatment of foods.

Course contents:
Water and ice. Carbon hydrates. Amino acids, peptides, proteins. Enzymes. Vitamins and minerals. Pigments and others dye. Additions for food products. Uneager and potential uneager components of food products. Characteristics of muscle tissue. Characteristics of eatable food fluids: milk, eggs. Characteristics of eatable plant tissues. Integrate accession to chemistry of food products. Applications.
Contemporary technological procedures in production and alteration of food products: preparation of substance, reduction of small parts, mixing, mechanical separation, concentration with membrane, fermentation and enzyme technologies, irradiation, pasteurization, heat sterilization, dehydration, baking and roasting, microwave heating and infrared radiation, cooling, freezing, freeze-drying, packing of products. Basic of food products and basic technology procedures.

Recommended reading:

1. H. D. Belitz, W. Grosch. Food Chemistry, Berlin, Springer 1999
2. P. Fellows. Food Processing Technology: Principles and Practice, Horwood, New York, 1990.
3. Harrision's: Of Internal Medicine, New York, McGraw-Hill, 1998

Teaching methods: Lectures, practical. Seminar work.
Prerequisites: Stagewise processes
Assessment methods: Written and oral examination