I. General Description of the Chemical Engineering, BSc Program

Objectives and Perspectives

Our objective is to train professionals who possess the general knowledge, technical intelligence, mastery of at least one foreign language, the basics of natural, social and engineering sciences, which are essential for the practice of the chosen profession.

It is likewise important that students acquire the most essential skills in technology and safety, environmental protection, management and social sciences. Concrete practical methods as well as the capability to apply acquired skills will help them to get accustomed to the professional requirements and standards of their future workplace. They will be capable of understanding/controlling production processes, preparing quality insurance and technical services and solving tasks regarding planning and development.

Through the learning of basic legal, economic and management skills, students will be trained to carry out projects concerning production and marketing. In addition, senior students will possess the necessary theoretical and practical expertise to solve problems appearing in the processes of the chemical and related industries, can furthermore plan and operate complex technological systems and carry out research and development tasks.

Requirements
Duration of studies: 7 semesters
Number of teaching (contact) hours: 1,800
Number of required ECTS credits: 210

Compulsory subjects
General and scientific foundations (mathematics, physics, general and inorganic-, organic-, macromolecular-, colloid- and bio- chemistry)
Economic and human sciences (basics of legal, economic and management sciences)
Basics of professional knowledge (physical- and analytical- chemistry, informatics and computer models, mechanics, unit operations, chemical technology, safety)
Higher engineering (petrol chemistry, plastics, environmental technology, radiochemistry, management of value creating processes, instrumental analytical methods)
Thesis
Elective subjects
e.g. chemical technology of hi-tech materials, production of plastics etc.

Graduate Study Opportunities

- *MSc programs in development:*
  - § Chemical Engineering
  - § MSc in Materials Science
  - § Environmental Engineering
  - § Bioengineering
- PhD in Chemistry

II. Description of Study Program

After graduation, a first level degree chemical engineer should

- have a knowledge of relevant basic sciences (mathematics, chemistry, physics) to help understand, describe and solve chemical engineering phenomena.
- understand the basic principles underlying chemical engineering: material and energy balances, equilibrium, rate processes (chemical reaction, mass, heat, momentum transfer) and be able to use them to set up and to solve (analytically, numerically, graphically) a variety of chemical engineering problems.
- understand the main concepts of process control
- understand the principles underlying modern methods of chemical analysis
- be able to plan, perform, explain and report simple experiments
- have a knowledge of relevant literature and data sources
- be able to take a structured approach to safety and health
- understand the concept of sustainability and be aware of the central role chemical engineering plays in preventing and solving environmental problems
- have an ability to analyze complex problems in the choosen area of specialization
- have some experience in using appropriate software
- be able to perform appropriate design in chosen specialization
- be able to calculate process and project economics
- have some industrial experience – gained before or between the semesters

History of Chemistry and Chemical Engineering at Debrecen University.

The teaching of natural sciences at the University of Debrecen dates back to 1949 when the Faculty of Sciences was established in Debrecen by the Hungarian government. During the integration process of 2000 the Faculty of Sciences became one of the most populous faculties of the University of Debrecen. It cultivates mediates and teaches a number of fields of biology, physics, geography, chemistry, environmental science and mathematics at an advanced level. In these disciplines the faculty plays a major role in the eastern Hungarian region while its influence reaches beyond borders and influences Hungarian communities in the neighboring countries. The training of the students focuses on the applicability of the newest results in science and technology.
Technical academic education has been improved constantly since the 1960s. Nowadays the Faculty of Engineering is the most significant center of academic education in the eastern region. During the integration process of the university the instructors of the faculty provide engineering knowledge for other faculties. Chemical engineer training at

college level was started in 1999 by the cooperation of the Faculty of Sciences namely the Institute of Chemistry and the faculty of Engineering.

The prognosis of regional and national demand for graduates of the new academic courses the possible documentation/presentation of the demand for employment.

The setting up of the chemical engineering BSc is justified by the significant changes in the economic technical and social environment of the region. Beside heavy industry middle sized self employed industries have appeared. This cause for the development of engineering training that includes economic knowledge necessary for the maintenance of the above mentioned economic structure. Industrial companies nowadays have concrete demand for practice oriented chemical engineers who relying on their concrete knowledge are capable of adapting and controlling complex chemical technologies. As a regional center of higher education in Hungary the University of Debrecen could train engineers for the plastic-processing, food-processing and pharmaceutical industries. Due to the change of the economic structure small and middle scale companies will emerge in the field of plastic manufacturing and the processing of agricultural products in the near future. The direct aim of the widening of the educational and training spectrum at the university is to ensure the required number of professionals in these economic sectors.
The training objective of the chemical engineering BSc is to improve the supply of engineering professionals in the region, to keep those with a secondary school degree from migrating. Our objective is to train professionals who possess the general knowledge, technical intelligence, mastery of at least one foreign language, the basics of natural, social and engineering sciences, which are essential for the practice of the chosen profession.

It is likewise important that students acquire the most essential skills in technology and safety, environmental protection, management and social sciences. Concrete practical methods as well as the capability to apply acquired skills will help them to get accustomed to the professional requirements and standards of their future workplace. They will be capable of understanding/controlling production processes, preparing quality insurance and technical services and solving tasks regarding planning and development.

Through the learning of basic legal, economic and management skills, students will be trained to carry out projects concerning production and marketing. In addition, senior students will possess the necessary theoretical and practical expertise to solve problems appearing in the processes of the chemical and related industries, can furthermore plan and operate complex technological systems and carry out research and development tasks.
Graduate chemical engineers will specialize for practical task solving which means that they will be able to fill in positions of workmaster or higher at various corporations, factories and firms. The filling of these positions with well trained professionals is demanded by companies, for this reason there is a clear and real need for the training of such qualified labourers is. The starting of such academic course makes further education possible in Hungary.
We are not planning to start different specializations within the chemical engineering BSc at the Faculty of Science at the University of Debrecen. Relying on the acquired BSc diploma we are planning to offer a great variety of MSc courses. This way the students can directly carry on Chemistry MSc.
The training of chemists is already in progress at the University of Debrecen. The accreditation of the environmental engineer MSc is also at advanced stage. The MSc level chemical engineer training will happen while we switch over to two level training (BSc, MSc). At MSc level all three majors we will offer wide range of specializations demanded by the needs of the region.

The curriculum and subject thematic of the chemical engineering BSc course to be started was compiled in such a way that the outstanding students will receive in depth knowledge of mathematic, scientific and engineering disciplines during their training. The outstanding students will be guided towards doing student research at the departments. They will be able to join the Hatvani István special college a special institution for talent nurturing. the Hatvani István special college is interdisciplinary academic center at the University of Debrecen that aims to prepare students of great talent and outstanding results through the following means:

Tutorial training: Each member of the college has a tutor who is a mentor and patron and navigates him or her through the labyrinth of science.
General lecture: 3-4 times in a semester an outstanding representative of a particular field of science holds a lecture before the members of the special college. Attendance is required and involvement is expected of them.
Language courses: During the semester and in the summer holyday offers language courses to encourage application for international scholarships and research trips and to help the students to come together and communicate their thoughts about themselves and the world.
Special lectures: Every semester a predetermined field of study (relying on the needs of the members) will offer lectures that will place emphasis on interdisciplinary knowledge.
Seminars: the leaders of the special college will ask outstanding researcher to hold seminar and practice for a specific group of college members (relying on the topics of their diploma works and professional interest).
Special college research topic: the branches will establish individually and jointly research topics that can be dealt with on a collective basis.
Student conferences: The special college members give presentations to each other the aim of which is to learn about fields other than their own and consequently to create a stronger community.

The training of chemists and chemical engineers is run through the participation and cooperation of two faculties, namely the Faculty of Science and Technology and the Faculty of Engineering of the University of Debrecen. The material requirements of the training are ensured by the infrastructure located at the Institute of Chemistry and the Faculty of Engineering. 3 members of the academy, 9 doctors of the academy, 5 candidates of science and 11 PhD doctors take part in the training.

III.
III. 1. Outline of the Study Programme
Chemical Engineer BSc

			Semester							Credits ECTS
Course title	**Code**	**Prerequisite**	1	2	3	4	5	6	7	
1. Introduction course	TKBG0000_EN		010							0
Mathematical and scientific foundations										**50**
Mathematics module										**12**
2. Mathematics I.	TMBE0606EN TMBG0606EN		400k 030g							5 2
3. Mathematics II.	TMBE0607EN TMBG0607EN	TMBE0606EN TMBG0606EN		200k 030g						3 2
Physics module										**6**
4. Physics for Engineers I.	TFBE2111-EN		210k							3
5. Physics for Engineers II.	TFBE2113-EN	TFBE2111-EN		210k						3
Chemistry module										**32**
6. General Chemistry	TKBE0101_EN TKBG0101_EN TKBL0101_EN		300k 020g 003g							4 3 1
7. Inorganic Chemistry	TKBE0212EN TKBL0212EN	TKBE0101_EN TKBL0101_EN		300k 006g						4 4
8. Organic Chemistry I.	TKBE0301EN	TKBE0101_EN		210k						4
9. Organic Chemistry II.	TKBE0312_EN TKBL0312_EN	TKBE0301EN TKBL0101_EN			210k 003g					4 2
10. Organic Chemistry III.	TKBE0303_EN	TKBE0302EN				200k				3
11. Biochemistry	TBBE0302_EN	TKBE0303_EN				200g				3
Economic and Human Sciences										**20**
Micro- and macroeconomic module										**3**
12. Introduction to economics.	TTBEBVVM-KT1		200k							3
Management and Business module										**7**
13. Introduction to Business	TTBEBVVM-KT2		200k							3
14. Basics of civil law I.	TTBEBVVM-JA1			200k						2
15. Basics of civil law II.	TTBEBVVM-JA2	TTBEBVVM-JA1					200k			2
16. History and Structure of European Union	TTBE030-K1		200k							1
Economic and Human Sciences										**9**
17. Macroeconomics II.	TTBEBVM-KT3	TTBEBVVM-KT1			200k					3

			Semester							Credits ECTS
Course title	**Code**	**Prerequisite**	1	2	3	4	5	6	7	
18. Engineering Ethics	TTBEVEM-MK1		200f							3
19. Management of value creating processes	TTBEBVM-KT4	TTBEBVVM-KT2		200						3
Basics of Professional knowledge										**92**
Physical-, Analytical-Chemistry and Materials Science										
Analytical module										**8**
20. Analytical chemistry I.	TKBE0513EN	TKBE0212EN TFBE2111-EN					310gk			4
	TKBL0513EN	TKBL0212EN TKBE0513EN						003g		2
21. Analytical Chemistsry II	TKBL0514EN	TKBE0513EN						003g		2
Physical Chemistry and Materials Science module										**22**
22. Physical Chemistry I.	TKBE0401_EN	TKBE0101-EN TMBE0606EN TFBE2111-EN			220kz					4
23. Physical Chemistry II.	TKBE0403-11_EN TKBL0403_EN	TKBE0401_EN TKBL0101_EN				220kz 002g				4 1
24. Macromolecular Chemistry	TKBE0611_EN	TKBE0301EN				200k				3
25. Colloid Chemistry	TKBE0404EN	TKBE0401_EN				200k				3
26. Materials of Construction	TKBE1211_EN	TKBE0611_EN					200g			3
27. Plastics and Processing I.	TKBE1212_EN TKBL1212_EN	TKBE0611_EN or TKBE0301EN						200k 002g		2 2
Measurement and Processing module										**8**
28. Informatics for Engineers	TKBL0911_EN				002g					2
29. Process Control I.	TKBG0612_EN	TKBL0911_EN				220f				4
30. Process Control II.	TKBG0613_EN	TKBG0612_EN					020k			2
Mechanics and Unit Operation module										**24**
Mechanics										
31. Mechanics for Chemical Engineers I.	MFVGE31V03_EN				210f					3
32. Mechanics for Chemical Engineers II.	MFVGE32V03_EN	MFVGE31V03_EN				210f				3

			Semester							Credits ECTS
Course title	**Code**	**Prerequisite**	1	2	3	4	5	6	7	
33. Mechanics for Chemical Engineers III.	MFVGE33V04_EN	MFVGE32V03_EN					210k			3
Chemical Unit Operation										
34. Unit Operations I.	TKBG0614_EN	TKBE0401_EN			240f					5
35. Unit Operations II	TKBG0615_EN	TKBG0614_EN				240f				5
36. Unit Operations III	TKBG0616_EN	TKBG0615_EN					240kz			5
Technology module										**27**
Planning										
37. Computer modeling of Chemical Technology Systems I.	TKBG0912-11_EN	TKBL0911_EN						020g		2
38. Computer modeling of Chemical Technology Systems II.	TKBG0913-11_EN	TKBG0912-11_EN							020g	2
Chemical Technologies										
39. Chemical Technology I.	TKBE1111-11_EN TKBL1111-11_EN	TKBE0401_EN				224gk				4 3
40. Chemical Technology II.	TKBE1112-11_EN TKBL1112-11_EN	TKBE1111-11_EN TKBL1111-11_EN					224gkz			4 3
41. Environmental Technology	TKBE1114-11_EN TKBL1114-11_EN	TKBE1111-11_EN TKBL1111-11_EN						212gk		3 2
42. Pilot Plant Work	TKBL1115_EN	TKBE1111-11_EN TKBL1111-11_EN						015g		4
Safety Field										**3**
43. Safety	TKBE0711_EN								200g	3
Special Courses										**39**
44. Basics of Petrochemistry	TKBE1113_EN	TKBE1111-11_EN					200g			3
45. Radioisotopes	TKBG0412_EN	TKBE0403-11_EN							102g	3
46. Waste management	TKBE1116-11_EN TKBG1116-11_EN	TKBE1111-11_EN						220gk		3 2
47. Spectroscopy	TKBE0503_EN	TKBE0312_EN TFBE2113-EN						200k		3
48. Structure of Matter I.	TKBL0513-11_EN	TKBE0312_EN						002g		2
49. Structure of Matter II.	TKBL0514_EN	TKBL0513-11_EN							004g	2

			Semester							Credits ECTS
Course title	**Code**	**Prerequisite**	1	2	3	4	5	6	7	
50. Quality Management	TTBEBVM-KT6	TTBEBVM-KT4							200k	3
51. Design of experiments	TKBE0617_EN	TKBE0403-11_EN						200f		3
52. BSc Thesis	TKBG2011_EN	TKBE0403-11_EN 177 credits								15
Optional courses										**10**
53. Basic Chemical Informatics	TKBL0901EN		002G							2
54. Mathematic Methods in Chemistry and Chemical Enginering	TKBE0904_EN	TMBE0607EN TMBG0607EN			200k					3
55. Chemical Technology III.	TKBE1117_EN	TKBE1112-11_EN TKBL1112-11_EN							200g	3
56. Modeling of Chemical Reactors	TKBE0618_EN	TKBE0403-11_EN					200f			3
57. Plastics and Processing II.	TKBE1213_EN	TKBE0611_EN						100g		2
58. Plastics and Processing III.	TKBE1214_EN	TKBE0611_EN							200g	3
Additional requirements										
59. Visits at Chemical Companies (five days)	TKBG1118_EN	TKBE1111-11_EN				002a				
60. Industrial Placement	TKBG1119_EN	TKBE1111-11_EN TKBL1111-11_EN						a		
61. Physical Education			002a	002a						
Total credits:										**211**

III. 2. Subject programes

2. Mathematics I.

Code: TMBE0606
Classes/week: 4 hours of lecture
ECTS Credit Points: 5
Prerequisites: None
Lecturer: Muzsnay, Zoltán

Topics: Real and complex numbers, basic notions of combinatorics. The calculus of functions of one variables: limits, continuity, derivative applications and interpretations. Series in one variable with emphasis on Taylor series. An introduction to the principles and methods for solving first order ordinary differential equations. The calculus of functions of several variables with an introduction to vector calculus: limits, continuity, partial derivatives, gradients, differentials. Riemann integration, applications to area, volume, etc., and basic methods for conversion of integrals including change of variable, substitutions, partial fractions, integration by parts, improper integrals. Multiple integrals. Vector spaces, basis and dimension, rank of a system. Matrix algebra including basic algebraic operations, determinants, inversion, rank. Solution of systems of linear equations. Linear transformations, eigenvalues, and eigenvectors.

Compulsory/Recommended Readings:

1. D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publications

Code: TMBG0606
Classes/week: 3 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: None
Lecturer: Muzsnay, Zoltán

Topics: Real and complex numbers, basic notions of combinatorycs. The calculus of functions of one variables: limits, continuity, derivative applications and interpretations. Series in one variable with emphasis on Taylor series. An introduction to the principles and methods for solving first order ordinary differential equations. The calculus of functions of several variables with an introduction to vector calculus: limits, continuity, partial derivatives, gradients, differentials. Riemann integration, applications to area, volume, *etc*., and basic methods for conversion of integrals including change of variable, substitutions, partial fractions, integration by parts, improper integrals. Multiple integrals. Vector spaces, basis and dimension, rank of a system. Matrix algebra including basic algebraic operations, determinants, inversion, rank. Solution of systems of linear equations. Linear transformations, eigenvalues, and eigenvectors.

Compulsory/Recommended Readings:
D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publications

3. Mathematics II.

Code: TMBE0607
Classes/week: 2 hours of lecture
ECTS Credit Points: 3

Prerequisites: Mathematics I. (TMBE0606), Mathematics seminar I. (TMBG0606)
Lecturer: Muzsnay, Zoltán

Topics: Series in several variables with emphasis on Taylor series. The calculus of vector valued functions of several variables: limits, continuity, partial derivatives, gradients, differentials. Inverse and implicit function theorem. An introduction to the principles and methods for solving partial differential equations. Multiple integrals, applications to area, volume. Euclidean vector space, inner product, norm, orthogonality, orthonormal basis. Vector analysis: vector algebra and calculus, gradients, rotation, divergence, line and surface integrals, conservative fields and potential functions, Stokes, Gauss and Green's theorem. The basic concepts and methods of probability and an introduction to statistics. Elementary combinatorics, fundamentals of probability, families of discrete and continuous probability distributions. The central limit theorem. The uses of probability and statistics in engineering areas are illustrated.

Compulsory/Recommended Readings:
D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publications

Code: TMBG0607
Classes/week: 3 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: Mathematics I. (TMBE0606), Mathematics seminar I. (TMBG0606)
Lecturer: Muzsnay, Zoltán

Topics: Series in several variables with emphasis on Taylor series. The calculus of vector valued functions of several variables: limits, continuity, partial derivatives, gradients, differentials. Inverse and implicit function theorem. An introduction to the principles and methods for solving partial differential equations. Multiple integrals, applications to area, volume. Euclidean vector space, inner product, norm, orthogonality, orthonormal basis. Vector analysis: vector algebra and calculus, gradients, rotation, divergence, line and surface integrals, conservative fields and potential functions, Stokes, Gauss and Green's theorem. The basic concepts and methods of probability and an introduction to statistics. Elementary combinatorics, fundamentals of probability, families of discrete and continuous probability distributions. The central limit theorem. The uses of probability and statistics in engineering areas are illustrated.

Compulsory/Recommended Readings:
D. S. Sivia, S.G. Rawlings: Foundations of Science Mathematics, Oxford Science Publications

4. PHYSICS FOR ENGINEERS I.

Code: TFBE2111
Classes/week: 2 hours of lecture and 1 hour of follow up seminar
ECTS Credit Points: 3
Prerequisites: none

Lecturer: Trócsányi, Zoltán

Topics: Physical concepts, physical quantities, systems of units, dimensional analysis. Description of the movement of a mass point. Concepts of mass and and momentum, the law of momentum conservation. Newton's laws, force laws. Basic applications: motion of a projectile, oscillations. The concept of angular momentum, conservation of angular momentum. Equilibrium of rigid bodies. Concepts of kinetic energy and work. Potential energy, conservation of mechanical energy. Galilei's relativity theory, inertial forces. Deformable bodies, Hooke's law. Equilibrium in liquids and gases, surface tension, capillary phenomena. Elastic waves, wave propagation, basic wave phenomena: interference, standing waves, Doppler-effect. Concept of temperature, temperature scales, state equations. Concept of internal energy, the first law, specific heat. reversible and irreversible processes. Carnot-cycle, heat pump, refrigerator. The second law. Concepts of entropy, free energy, free enthalpy. Phase changes, chemical potential. Transport phenomena: diffusion, osmosis, heat conduction.

Compulsory/Recommended Readings:
Tipler PA.: Physics for Scientist and Engineers, Freeman, 1998.

5. PHYSICS FOR ENGINEERS II.

Code: TFBE2113
Classes/week: 2 hours of lecture and 1 hour of follow up seminar
ECTS Credit Points: 3
Prerequisites: TFBE2111
Lecturer: Trócsányi, Zoltán

Topics: Phenomena and physical quantities of electrostatics: Coulomb's law, electric intensity, Gauss's law, electric potential, electric dipoles; conductors and isolators in electric fields; influence, capacitors, dielectrics, polarization. Current, electric circuits: resistivity, Ohm's law; electric currents in metals, semiconductors, liquids and in gases. The magnetic field: forces in magnetic fields, the flux density, Ampere's law. Induction: Faraday's law, Lenz's law, magnetic properties of matter; alternating currents and electromagnetic vibrations. Light and electromagnetic waves: phenomena of interference, diffraction and polarization; propagation of light, absorption and scattering. The failures of classical physics: thermal radiation, photoelectric effect; the Rutherford experiment, the Bohr model, the Franck-Hertz experiment. Particle-wave dualism: de Broglie's relation, matter waves, wave function, the Schrödinger-equation, tunneling, chemical bond, uncertainty principle.
Band model of solids, conduction phenomena in semiconductors, superconductivity, lasers.
Radioactivity: radiations, the law of radioactive decay. Nuclear structure: properties of nuclei, nuclear fission and fusion; reactors.
Elementary particles, fundamental interactions, basic terms of cosmology.

Compulsory/Recommended Readings:
Tipler PA.: Physics for Scientist and Engineers, Freeman, 1998.

6. GENERAL CHEMISTRY

Code: TKBE0101, TKBG0101 and TKBL0101
Classes/week: 2 hours of lecture, 2 hours of follow up seminar and 3 hours of laboratory practice
ECTS Credit Points: 4+3+1 = 8
Prerequisites: none
Lecturer: Lente, Gábor

Topics: Basic definitions in chemistry: atom, molecule, element, compound, mixture, chemical symbol, chemical formula, relative atomic and molecular weight, molar mass, law of definite and variable proportions, chemical equations, classification of chemical reactions. Atoms and the Atomic Theory, electrons and the nuclear atom chemical elements, the mole. Radioactivity , isotopes. Electron Configurations, Electron Configurations and the Periodic Table. Chemical bonds: primary (covalent, ionic, metallic) and secondary (dipole-dipole, dipole-induced dipole, hydrogen bonding). States of matter: Ideal gases, gas laws. Boyle-Mariotte- and Gay-Lussac laws ideal and general gas equation, thermodynamic temperature scale. Avogadro- and Dalton laws. The kinetic molecular theory of gases. Real gases and their behavior, the van der Waals equation. Liquid state and its properties: compressibility, viscosity, surface tension, evaporation, vapor pressure, boiling. Solid state and its properties. Crystalline and amorph matters, unit cells, atomic, metallic, ionic and molecule lustre. Solutions. Units of concentrations, percent concentrations, molarity, molality and other units (ppm, ppg, ppt). Solubility, the properties of dilute solutions: osmosys, boiling point elevation, freezing point depression. Ideal and real solutions, distillation. Basics of colloid systems.
Principles of chemical equilibrium, homogeneous and heterogesneous equilibra, the equilibrium constant expression, the significance of the magnitude of an equilibrium constant, altering equilibrium conditions:Le Châtelliers Principle.
Acids and bases. Early theories (Arrhenius, Lux, Lewis). Brønsted-Lowry theory of acids and bases, the self-ionization of water and the pH scale. Strong acids and strong bases, weak acids and weak bases, ions as acids and bases. Molecular structure and acid-base behaviour. Lewis acids and bases. Chemical Kinetics: The rate of a chemical reaction effect of concentration on reaction rates, the rate law. Theoretical models for chemical kinetics. The effect of temperature on reaction rates. Reaction mechanisms, catalysis. Thermochemistry: Heats of reaction and calorimetry. The laws of thermodynamics, Hess's Law. The concept of entropy, standard free energy change, $\Delta G°$, $\Delta G°$ and Keq as functions of temperature. Electrochemistry: Electrode potentials and their measurement. Batteries, Corrosion and Electrolysis

Compulsory/Recommended Readings:
1. J.McMurray, R.C. Fay, Chemistry, Pearson Education , Inc., New Yersey, 2004.
2. S.S. Zumdahl, Chemistry, D.C. Heath and company, Lexington MA, 1993.
3. J. W. Hill, R. H. Petrucci, General Chemistry, Prentice Hall, ISBN-10:0130334456, ISBN-13: 9780130334459
4. F. A. Cotton, G. Wilkinson: Basic Inorganic Chemistry, John Villay and Sons (1976)
5. D. D. Ebbing: General Chemistry, Houghton M. Company (1984)

7. INORGANIC CHEMISTRY
Code: TKBE0212, TKBL0212
Classes/week: 3 hours of lecture and 6 hours of laboratory practice
ECTS Credit Points: 4 + 4
Prerequisites: TKBE0101, TKBL0101

Lecturer: Buglyó, Péter

Topics: The physical and chemical properties of the p-field elements, occurrence, basic industrial production. Survey of the structure of the compounds, chemical (especially acid-base and redox) properties considering hydrides, halides, oxides, acids and sulfides in particular. The biological effects of the elements and compounds. Laboratory preparation of the most important compounds and the chemical background of their industrial production. Survey of the compounds and ions as ligands, introduction to analytical chemistry. Practical application of the important elements and compounds in the laboratory and industry. Alkali- and alkali-earth metals and their important compounds. Formation of complex compounds, the coordinative bond, types, important properties. The coordination behavior of the metal ions and ligands. General description of the transition metals, properties and their well-known compounds. Important representatives of organometallic compounds, biological aspects of inorganic chemistry.

LABORATORY PRACTICE:
Work schedule in the laboratory and acquainted with the laboratory instruments. Mass, volume and density measurements, titrimetry-based measurements. Basic laboratory methods: dissolution, dilution, decantation, filtration, gas production, use of gas cylinders, extraction, distillation methods. Preparation of some simple chemical compounds. Reactions of important cations and anions, qualitative analysis.

Compulsory/Recommended Readings:
N. N. Greenwood and A. Earnshaw, Chemistry of the elements, Pergamon press, Oxford, New York, Seoul, Tokyo, 1994.

8. ORGANIC CHEMISTRY I.
Code: TKBE0301
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: General chemistry (TKBE0111, TKBL0111)
Lecturer: Kónya, Krisztina

Topics: Classification, nomenclature and structure of organic compounds, their physical and chemical properties, preparation and reactivity according to their functional groups and structure-chemical reactivity relationship. The lecture is supplemented by a weekly seminar (1 hour) that follows the lecture and helps its adoption. Summary of basic organic chemistry concepts. Occurrence, nomenclature, preparation and reactions of alkanes, cycloalkanes, alkenes, cycloalkenes, alkynes, mono- and polycyclic aromatic hydrocarbons, alkyl halides, alcohols and phenols, ethers and certain organometallic derivatives.

Compulsory/Recommended Readings:
1. E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994
2. Volhard: Organic Chemistry, New York (1987)

9. ORGANIC CHEMISTRY II.

Code: TKBE0312 and TKBL0312
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar, 3 hours of laboratory practice, 1 hour of laboratory seminar
ECTS Credit Points. 6

Prerequisites: Organic chemistry I. (TKBE0301)
Lecturer: Kónya, Krisztina

Topics: Amines, nitro-compounds, diazonium salts and reactions of. Coloring agents. Preparation and reactions of aldehides and ketones. Nucleophilic addition. Preparation and reaction of carboxilic acids and important acid derivatives. Nucleophilic substitution reaction of acyl group. Macromolecules via polycondensation. Chemical propertie and importance of b-dicarbonyl compounds. Carboxylic acid derivatives. Natural carboxylic acid derivatives: amino acids, nucleic acids. Vitamines, alkaloids, antibiotics, carbohydrates. Heterocyclic compounds.
Practice: Basic procedures: crytallization, distillation, extraction, TLC and coloumn chromatography. Simple chemical reactions using micro and semi micro methodes. Basics of literature search of synthetic procedures.

Compulsory/Recommended Readings:
1. Volhard: Organic Chemistry, New York (1987)

10. ORGANIC CHEMISTRY III.
Code: TKBE0303
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Juhász, László

Discussion of the chemistry of the most important natural products: amino acids (peptides and proteins), carbohydrates, nucleic acids, flavonoids, alkaloids, antibiotics, isoprenoids and porphyrins. Methods for structure elucidation of organic compounds, discussion of principles and applications of the physical methods for molecular structure determination.

Compulsory/Recommended Readings:
1. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry, 10th Edition, ISBN-10: 0470556595; 2009; Wiley & Sons
2. Leroy G. Wade: Organic Chemistry; 8th Edition; ISBN-10: 0321768140; 2012; Pearson
3. John McMurry: Organic Chemistry: A Biological Approach; 2nd Edition; ISBN-10: 1408009714; 2010; Brooks/Cole
4. Paul M. Dewick, Medicinal Natural Products: A Biosynthetic Approach; 3rd Edition; ISBN-10: 0470741678; 2009; Wiley

11. BIOCHEMISTRY

Code: TBBE0302
Classes/week: 2 hours of lecture
ECTS Credit Points: 2
Prerequisites: Organic Chemistry II. (TKBE0302)
Lecturer: Kerékgyártó, János

Topics:
Week 1: Introduction to Biochemistry. Molecular design of life. Amino acids. Peptides. Primary, secondary, tertiary, quaternary structures.
Week 2: Determination of peptide structures. Protein structure and function. Oxigen-transporting proteins: Myoglobin and Hemoglobin.

Week 3: Carbohydrates. Biological role of carbohydrates. Monosaccharides, disaccharides. polysaccharides. Glycoconjugates. Glycobiology.
Week 4: Introduction to biological membranes. Lipids. Classification and functions of lipids. Neutral fats, oils and waxes. The major classes of membrane lipids. Membrane models.
Week 5: Enzymes. Classification. Coenzymes. Mechanism of enzyme action. Control of enzyme activity.
Week 6: The kinetic properties of enzymes. The Michaelis-Menten model. Graphic evaluation of the kinetic parameters. Inhibition of enzyme activity. Diagnostic importance of enzymes.
Week 7: Metabolism: basic concepts and design. Metabolism of carbohydrates. Glycolysis. The fate of pyruvate. Entry of fructose and galactose into glycolysis. Gluconeogenesis. Cory cycle.
Week 8: The pentose phosphate pathway.
Glycogen metabolism. Glycogen degradation and synthesis. The coordinated control of synthesis and breakdown.
Week 9: Citric acid cycle. Pyruvate dehydrogenase complex. The citric acid cycle is a source of biosynthetic precursors. Control of the citric acid cycle.The glyoxylate cycle.
Week 10: Oxidative phosphorylation. The three enzyme complexes of the respiratory chain. Synthesis of ATP. The ATP yield of the complete oxidation of glucose.
Week 11: Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Energetics of fatty acid oxidation. Synthesis of ketone bodies.
Week 12: Biosynthesis of fatty acids. The elongation cycle. Biosynthesis of cholesterol.
Week 13: Digestion of proteins. Amino acid degradation. Transamination and oxidative deamination. The urea cycle. The link between the urea and the citric acid cycle. The fates of the carbon skeletons of amino acids.
Week 14: DNA and RNA: Molecules of heredity. Purine and pyrimidine bases, nucleosides and nucleotides. cAMP, ATP. Nucleotid coenzymes.

Compulsory/Recommended Readings:
1. J. M. Berg, J. L. Tymoczko, L. Stryer: Biochemistry V. edition (W. H. Freeman and Co. 2002. ISBN 0-7167-4684-0)

12. INTRODUCTION TO ECONOMICS
Code: TTBEBVVM-KT1
Course coordinator Dr. Judit Kapás
Hours per week (Lecture, 2)
Assessment: Exam
Credit: 3
Course content:
The subject, method and the short history of Economics; the concept of economic agents; national income; the market mechanisms: the analysis of demand and supply; comparative static analysis; the concept of the product-, money- and labour market; the instruments of economic policy: fiscal and monetary policy; the role of the Central Bank; development of banks and the financial system; the functions of financial intermediary; the process of money creation; current issues of the Hungarian economy
Required reading:
Heyne, P., Boettke, P., Prychitko, D.: The Economic Way of Thinking, 10th edition. Prentice Hall, 2002
Suggested reading:
Samuelson, P.A., Nordhaus, W.D.: Economics, 17th edition. McGraw-Hill, 2001

Heyne, P: The Economic Way of Thinking. Prentice Hall, 1973
Buchholz, T.G.: New Ideas from Dead Economists. New York, Penguin Group, 1989
Buchholz, T.G.: From Here to Economy: A Shortcut to Economic Literacy. Plume, 1996
Assessment:
Final exam: written
Grade: based on the mid-term and final exam

13. INTRODUCTION TO BUSINESS
Code: TTBEBVVM-KT2
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: none
Lecturer: Szanyi, Miklós and Renáta Szarvasné Kádár

Topics: The course explores the question 'what is a business'; and investigates the business functions of human resource management, marketing, operations management, accounting and finance. Different internal and external elements of a business are introduced, and the context in which a business operates explained. Students will explore the common aims and characteristics of business – investigating what makes them different. Business structures, cultures and functions are identified and the political, social, economic, and technological considerations affecting business are introduced. Students get an insight into the international competition, too.
After fulfilling the course, students will be able to identify and analyse the situation of the businesses, and to identify the functional areas of the firms. Building on the knowledge they received, students will be able to communicate these issues consequently.

Compulsory readings:
Nickels, William G. – McHugh, James M. – McHugh, Susan M. (2008): Understanding Business. Eighth edition, McGraw-Hill/Irwin, New York, pp.1-87, 116-147, 180-319, 348-543, ISBN 978-0-07-310597-0
Recommended readings:
Ferrell, O. C. – Hirt, Geoffrey (1993): Business – A Changing World. Irwin, Homewood, pp.1-29, 80-471, 502-633, ISBN 0-256-11683-0
Skinner, Steven J. – Ivancevich, John M. (1992): Business for the 21st Century. Irwin, Homewood, pp.1-121, 188-701, 736-771, ISBN 0-256-09222-2

14. Basics of Civil Law I.
Code: TTBEBVVM-JA1
Credits: 2
Class/week: 2 hours of lecture
Prerequisites: -
Lecturer: Frézer, Tamás

Topics: The primary purpose of the course is to give basic knowledge about selected topics of the Hungarian and European private law. Classes deal with topics that might be useful for students establishing innovations to the market, being employed in their professional field or contracting with others for licensing, developing, researching, etc. In order to fulfill the above mentioned goals the most important topics of the course are the followings: civil law systems vs. common law systems; private law codifications in Europe; legislative competence of the European Union; legal capacity in private law; personality right protection; law of intellectual property; business associations. Classes follow the Socratic method, an interactive, participation encouraging method. By the end of the course students will have a general look

at the private law system in Hungary and Europe and they can identify the most important legal problems connecting to their profession.

Compulsory/Recommended Readings:

SAUTER, Wolf – SCHEPEL, Harm: *State and Market in European Union Law: The Public and Private Spheres of the Internal Market before the EU Courts*, Cambridge University Press, London, 2009. 270. p. ISBN 978-0521857758

TWIGG-FLESNER, Christian (ed.): *The Cambridge Companionto European Private Law*, Cambridge University Press, London, 2010. 380. p.ISBN 0521736153

BUSSANI, Mauro – WERRO, Franz: *Europen Private Law: A Handbook*, Carolina Academic Press, London, 2009. 600. p. ISBN 978-1594605550

15. Basics of Civil Law II.
Credits: 2
Class/week:
Prerequisites: Basics of Civil Law I. (TTBEBVVM-JA1)
Lecturer: Fézer, Tamás

Topics: The primary purpose of the course is to continue the discussion on Hungarian and European private law. Classes deal with topics that might be useful for students establishing innovations to the market, being employed in their professional field or contracting with others for licensing, developing, researching, etc. In order to fulfill the above mentioned goals the most important topics of the course are the followings: property law; formation of a contract; performance and breach of a contract; general and special contractual warranties; consumer contracts; contracts in the field of R&D; tort law. Classes follow the Socratic method, an interactive, participation encouraging method. By the end of the course students will have a general look at the private law system in Hungary and Europe, especially contractual situation and the law of torts, and they can identify the most important legal problems connecting to their profession.

Compulsory/Recommended Readings:

SAUTER, Wolf – SCHEPEL, Harm: *State and Market in European Union Law: The Public and Private Spheres of the Internal Market before the EU Courts*, Cambridge University Press, London, 2009. 270. p. ISBN 978-0521857758

TWIGG-FLESNER, Christian (ed.): *The Cambridge Companion to European Private Law*, Cambridge University Press, London, 2010. 380. p. ISBN 0521736153

BUSSANI, Mauro – WERRO, Franz: *Europen Private Law: A Handbook*, Carolina Academic Press, London, 2009. 600. p. ISBN 978-1594605550

FÉZER, Tamás: *Adjudging moral damages for personal injuries in the Dutch Civil Code*, Evroperska Iuridicna Osvita I. Nauka, Kiev, Ukraine, 2007. pp. 127-131.

EGTL: Principles of European Tort Law: Text and Commentary, Springer, Vienna, 2005. 294. p. ISBN 978-3211230848

16. History and Structure of European Union
Credits: 1
Class/week: 1
Prerequisites:
Lecturer: Kozma, Gábor

17. Macroeconomics
Code: TTBEBVM-KT3

Credits: 3
Class/week: 2 hours of lecture
Prerequisites: Introduction to Economics (TTBEBVVM-KT1)
Lecturer: Kapás, Judit

Topics: Production and distribution of national income; functions of the money; the quantity theory of money; seigniorage; theories of money demand, money supply and the financial system; labour market and unemployment; macroeconomic consumption; investment; commodity market and the IS curve; the multiplier effect; aggregate demand; money market and the LM curve; inflation and the Phillips curve; fiscal and monetary policy in the IS-LM model; aggregate supply; business cycles; macroeconomic debate on economic policy; economic growth.

Compulsory/Recommended Readings:
Mankiw, Gregory: Macroeconomics. Seventh Edition. Worth Publisher, New York, 2010. (ISBN-10: 1429218878)
Recommended readings:
Kaufman, Roger T.: Student Guide and Workbook for Use with Macroeconomics. Worth Publisher, New York, 2007. (ISBN: 0-7167-6132-7)

18. ENGINEERING ETHICS
Code: TTBEVEM-MK1
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: none
Lecturer: Tiba, Zsolt

The origin of the word: engineer and progress of the engineering. The history of the education of the engineering in Hungary. The task, the profession and the attitude of engineer. The criterion of engineer. The concept and content of engineering ethics. The relation between technology and ethics. Engineer and the rate of living. Engineer and the society. Engineer and the environment. Engineer and the energy. Engineering ethics (disciplinary) codex.

Compulsory/Recommended Readings:
1. Gyürk I.: Engineering Ethics, Budapest, Mezőgazda Kiadó (1998)

19. MANAGEMENT OF VALUE CREATING PROCESSES
Code: TTBEBVM-KT4
Course coordinator: Ágnes Kotsis and András Kun
Hours per week (Lecture, 2)
Assessment: Exam
Credit: 3
Course content:
The objective of production management; Designing the production task; Planning production and services; Planning and analysing product structure; The characteristics and design of the core production processes; Planning costs and benefits; Stock management; Site and development of establishments; Quality insurance and TQM; Fundamental concepts and areas of logistics; Fundamental concepts of project management; Computerised production management systems; Processes in the organization, understanding defining and classifying processes; Subsystems and processes of classical industrial and commercial firms; Characteristics of production processes; Profile of production, verticality of production; Mass

production, non-series production, repetitive production; The organizational type of the production's core processes; Defining the time for getting through the process, process management supported by computers;

Required reading:

Jeston J., Nelis J.: Business Process Management: Practical Guidelines to Successful Implementations, 2006.

Suggested reading:

Krejewski L. J., Ritzman L. P., Malhotra M. K.: Operations Management: Process and Value Chains, 2007

Anpindi R.: Managing Business Process Flows: Principles of Operations Management, 2006

Assessment:

Mid-term test and final exam

20, 21. Analytical Chemistry I., II.
Code: TKBE0513, TKBL0513, TKBL0514
Credits: 8
Class/week: Analytical Chemistry I.: 3 hours of lecture and 1 hour seminar and 3 hour practice Analytical Chemistry II.: 3 hours of practice
Prerequisites:-
Lecturer: Kövér, Katalin and Farkas, Etelka and Buglyó, Péter and Gáspár, Attila

Topics:

LECTURE: Sampling, sample preparation methods. Basics of qualitative analysis. Quantitative description of equilibria in solution (aqueous) phase: acid-base equilibria, complex formation, precipitation reactions, redox equilibria. Basics of titrimetry: acid-base, redox, precipitation and potentiometric titrations. Heterogeneous equilibria (separation techniques) in analytical chemistry: gravimetry, extraction, various chromatographic methods. Evaluation of experimental results: statistical analysis. Errors (systematic, random) in chemical analysis.

Continuous analysis (Contiflow), pH-metry, spectrophotometry (UV/VIS), potentiometry, X-ray fluorescence (XRF), thin layer chromatography (TLC), gas chromatography (GC), liquid chromatography (LC), flame emission spectrometry (FES), atomic absorption spectrometry (AAS). Electrometric methods of analysis. Potentiometry. Types of electrodes. pH measurement. Potentiometric methods: direct potentiometry, potentiometric titration. Measurements. Basic concepts of polarography. The potential of the dropping mercury electrode. Current types in polarography. Polarographic instruments. Derivative polarography. Square wave polarography. Alternating current polarography. Amperometric titrations. Dead stop titration. Electrogravimetry. Coulometry. Conductometry. Conductometric titration. Oscillometry. Dielectrometry. Methods of thermal analysis. Differential thermal analysis. Differential Scanning Calorimetry. Thermogravimetry. Derivatography. Atomic spectrometry: basic theory. Emission spectral analysis, qualitative and quantitative analysis. Flame spectrometry. Atomic absorption spectrometry. Methods of molecular spectroscopy. Ultraviolet and visible spectrophotometry. The laws of light absorption. Procedure of UV-vis analysis: qualitative and quantitative aspects. Infrared spectroscopy. Fluorescence analysis. Chemical and biological sensors. Piezoelectric sensors. Determination of gases and components dissolved in water. Biosensors. Use of optical fibres, instruments and analytical procedures.

PRACTICE (I): Classical quantitative analytical methods: volumetric titrations based on acid-base equilibria, complex formation, precipitation reactions and redox equilibria; gravimetric analyses.

PRACTICE (II): Instrumental analytical methods. Electroanalytical methods: conductimetry, pH measurements or potentiometry, polarography (dead stop endpoint indication) (analysis of 3 samples); spectroscopic methods: UV-VIS spectrometry, atomic absorption spectrometry (demonstration of + ICP-AES technique) (analysis of 2 samples); chromatographic separations and quantitative analyses: gas chromatography, HPLC, thin-layer chromatography (3 measurements).

Compulsory/Recommended Readings:

1. G. Svehla: Vogel's Qualitative Inorganic Analysis, John Wiley and Sons, New York, 1994
2. D.A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Analytical Chemistry: An Introduction, 7th edition, Harcourt Inc., 2000,
3. D. C. Harris, Quantitative Chemical Analysis, 6th edition, W.H. Freeman and Company, New York, 2003
4. Willard H.H., Merritt Jr. L.L., Dean J.A., Settle Jr. F.A.: Instrumental Methods of Analysis, Wadsworth Publ. Co. (1998)
5. Kellner R., Mermet J.M., Otto M., Widmer M.M.: Analytical Chemistry, Willey-VCH (1998)
6. Braun, R. D.: Introduction to Instrumental Analysis, Marcel Dekker Inc. New York, 1987
7. Fifield, F. W., Kealey, D.: Principles and Practice of Analytical Chemistry, Blackie Academic and Professional, London, 1995

22. PHYSICAL CHEMISTRY I.

Code: TKBE0401
Classes/week: 2 hours of lecture, 2 hours of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: TKBE0211, TKBL0211

Lecturer: Joó, Ferenc, Gáspár, Vilmos, Bényei, Attila

Topics: The properties of gases: the perfect gas, real gases. The Zeroth and First Law of thermodynamics: internal energy, enthalpy, heat and work. The Second Law of thermodynamics: definition of entropy. The Third Law of thermodynamics: statistical definition of entropy. Thermochemistry: application of the First Law to reactive systems, enthalpies of reaction, enthalpies of formation, enthalpies of combustion, standard states. Hess's law. Kirchhoff's law. Potential functions: combining the First and Second Laws. Thermodynamics of liquid phase, Clausius-Clapeyron equation, surface tension of curved surfaces. The thermodynamic description of mixtures. Chemical potential. Gibbs-Duhem equation. Mixtures of volatile liquids; distillation. The thermodynamic description of dilute solutions. Colligative properties. The phase rule and its applications. Chemical equilibrium. The response of equilibria to temperature. Le Chatalier principle.

PROBLEM SOLVING SEMINAR
Goal: helping the students to work out checklists of key ideas and solve exercises and problems closely related to the subject of the lecture on a weekly schedule.

Compulsory/Recommended Readings:

P. Atkins, J. de Paula: The elements of Physical Chemistry, 4th Edition, Oxford, 2005. Introduction, Chapters 1–7.

23. PHYSICAL CHEMISTRY II.

Code: TKBE0403 and TKBL0403
Classes/week: 2 hours of lecture, 2 hours of laboratory work
ECTS Credit Points: 4
Prerequisites: TKBE0401
Lecturer: Joó, Ferenc, Gáspár, Vilmos, Bényei, Attila

Topics: Proton transfer equilibria, solubility equilibria, week and strong electrolyte solutions, Debye-Hückel theory, activity and mean activity coefficient. Electrochemical cells at equilibrium, standard potentials. Nernst equation. Cell potentials and the thermodynamic functions of the cell reaction. Varieties of electrodes; electrode potentials. Electrochemical cells at practice. The conductivities of electrolyte solutions, the mobilities of ions. Laws of electrolysis, transition number. Empirical chemical kinetics: the definition of rate. Simple rate laws, reaction order and rate constants. The determination of the rate law. Accounting for the rate laws: elementary reactions, consecutive reactions, chain reactions. Reaction mechanisms: kinetic order and molecularity. The steady-state approximantion, the rate determining step, kinetic control. Catalysis. Enzymatic reactions: Michaelis-Menten mechanism. The temperature dependence of reaction rates. The Arrhenius equation. Determination of the Arrhenius parameters. Collision theory.

Transition state theory. Reactions in solution: activation and diffusion control. Processes at solid surfaces. The extent of adsorption. Catalityc activity at surfaces. Photochemistry.
LABORATORY EXCERSISES (5 hours / week – for 6 weeks only):
1. Determination of the heat of combustion in a bomb calorimeter. 2. Liquid-gas equilibrium and determination of the heat of evaporation. 3. Spectrophotometric determination of the equilibrium constant of the $I_2 + I^- = I_3^-$ reaction. 4. Determination of the mean activity coefficient of a strong electrolyte by measuring electrochemical cell potential. 5. Determination of the dissociation constant of a week electrolyte by conductometric measurements based on Ostwald's law of dilution. 6. Kinetics of second order reactions: determination of the rate constant of the hydrolysis of esters.

Compulsory/Recommended Readings:
P. Atkins, J. de Paula: The elements of Physical Chemistry, 4th Edition, Oxford, 2005.
Chapters 8–11, 16, and 20.

24. MACROMOLECULAR CHEMISTRY

Code: TKBE0611
Classes/week: 2 hours of lectureECTS Credit Points: 3
Prerequisites: Organic chemistry I. (TKBE0301)
Lecturer: Kéki, Sándor

Topics: Classification of polymers. Structure, chemical structure and fine structure of the polimer chain. Polymolecularity. Molecular weight averages, molecular weight distribution and their determination. Size exclusion Chromatography. MALDI TOF Mass Spectrometry. Physical states of polymers, glass transition temperature. Characterization of amorph polymers. Crystallization of polymers, polymer solutions. Synthesis of macromolecules. Radical polymerization. Basic steps of radical polymerization. Radical initiation, propagation, termination, chain transfer, inhibition and retardation. Kinetics of radical polymerization, radical copolymerization. Ionic polymerization. Stereospecific

polymerization. Polycondensation. Poliaddition. Ring opening polymerization. Polymer analog reactions.

Compulsory/Recommended Readings:
1. F. Rodriguez: Principles of Polymer Systems, McGraw-Hill, London, Singapore, Tokyo (1985).
2. G. Odian: Principles of Polymerization, McGraw-Hill, New York (1983).
3. Hans-Georg Elias: Makromoleküle, Hüthig Wepf Verlag Basel, Heidelberg, New York (1990)

25. COLLOID CHEMISTRY

Code: TKBE0404
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physical Chemistry I. (TKBE0401)
Lecturer: Bányai, István

Topics: Colloid state, colloid systems, intermolecular interactions. Interfacial chemistry: surface tension of pure liquids, connecting phenomena. Interfacial chemistry of solutions. State equations of interfacial layers, monomolecular films. Liquid-liquid interface, spreading. Adsorption of gases on solids. Enthalpy of adsorption. Hysteresis of adsorption, capillary condensation. Adsorption of gas mixtures. Liosorption. Contact wettability. Adsorption of non-electrolytes, electrolytes, ion exchange. Electric double layer. Electrokinetic phenomena. Disperse systems, degree of dispersity. Particle morphology, spatial distribution of dispersions. The stability of colloids. Aerodisperse systems. Gaseous dispersions and foams. Emulsions, suspensions and sols. Theories of sol stability. Adhesion. Optical properties of dispersions. Rheology. Macromolecular colloids. Size and shape of the molecules. Determination of molar mass. Association colloids, formation of micelles, solubilization. Coherent systems.

Compulsory/Recommended Readings:
1.Robert J. Hunter: Introduction to Modern Colloid Science, Oxford Science Publications, 1993
2.Douglas Hugh Everett:Basic Principles of Colloid Science, Royal Society of Chemistry Paperbacks, 1989
3.Goeffry Barnes, Ian Gentle: Interfacial Science, Oxford University Press, 2005

26. MATERIALS OF CONSTRUCTION

Code: TKBE1211
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE1111, TKBL1111
Lecturer: Deák, György

Topics:
Mechanical properties of the materials of construction. (ultimate tensile stress, hardness, stiffness, toughness, fatigue and creep). Effect of temperature on the mechanical properties. Special properties and manufacturing of materials. Iron and steel. Heat treatment of iron and steel. Alloys of iron. Non iron metals (light and heavy metals, metallic glasses). Wood as material of construction. Inorganic non metallic materials (glass, enamel, porcellan,

granite, andezit, basalt, heat resistant stoneware, artificial carbon). Plastics. Corrosion of metallic materials. Categories of corrosion, measurement of the corrosion rate.

Compulsory/Recommended Readings:

1. J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press (1983)
2. L. H. Van Vlack: Elements of Materials Science, Addison-Wesley, Reading-London (1980)

27. PLASTICS AND PROCESSING I.

Code: TKBE1212
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Macromolecular chemistry (TKBE0611)
Lecturer: Deák, György

Topics: Classification of polymers. Selected synthetic polymers. Polyethylene and polypropylene, Polyisobutylene and its copolymers, butyl rubber. Polystyrene and polystyrene copolymers – ABS. Poly(vinyl chloride) and poly(vinylidene chloride). Poly(vinyl acetate) and poly(vinyl alcohol). The flouro carbon polymers – poly(tetrafluoroethylene) and poly(trifluoroethylene). Polydienes: polybutadiene, polyisoprene (synthetic and natural), polychloroprene. Vulcanization. Polyacrylates: poly(acrylic acid), poly(metacrylic acid) and their esters. Polyacrylonitrile. Polyesters: aliphatic, aromatic, unsaturated. Poly(ethylene terephthalate), polycarbonate from bis-phenol A, alkyd resins. Polyethers. Polyamides. Phenol-formaldehyde and urea-formaldehyde resins. Polyurethanes. Silicones. Cellulose based polymers.

Compulsory/Recommended Readings:

1. F. Rodriguez: Principles of Polymer Systems, McGraw-Hill, London, Singapore, Tokyo (1985).
2. G. Odian: Principles of Polymerization, McGraw-Hill, New York (1983).

28. INFORMATICS FOR ENGINEERS

Code: TKBG0911
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites:TMBE0607, TMBG0607
Lecturer: Kuki, Ákos

Topics: Binary and hexadecimal systems, definition and acquirement of bit, byte, word-length. Set-up of computers, exchange of cards, expansion. Definition of the operating system, the use of operating systems of PCs. Principles and technical basics of computer networks. Network card, connection of PCs to networks, view/setting of network data. Internet, browsers, FTP and HTTP download. Mailing: setting of web hosting, username, password. Web searching. Searching of chemical information and source materials. Remote control desktop. The use of telnet and SSH protocols, some specific commands. Command mode ftp software. Virus threat, overview and setting of anti-virus softwares, virus search. Simple spreadsheets in chemistry (literature, citation etc.). Application of word processors. Application of spreadsheets. Vector graphic applications. Preparation of scientific, chemical schemes, flowcharts. Basics of computer imaging. Connection facilities of digital cameras,

video cameras, uploading. Application of computer imaging software. Image formats, conversion. Basics of computer graphics. Application of effects (shading, fading, erasing etc.), image layers, making montage. Images and video recordings in chemistry. Website design, basics of HTML. Application of modular scripts. Internet Ethics, copyright.
Application of mathemathical(i.e.. Derive, Maple, Mathematica, Scilab, Octave, Mupad etc.) and table manager programs in chemistry. Instrument controlling and evaluating softwares. Chemistry on the internet, databases, papers, books. Softwares and hardwares needed for quality presentations: drawing chemical structures with computer, making figures and charts, presentations.

Compulsory/Recommended Readings:

1. Pauline Cushman, Ramon Mata-Toledo: Schaum's Outline of Introduction to Computer Science, McGraw-Hill 2000
2. Carol Brown: Microsoft Office XP Plain & Simple, Microsoft Press, Redmond 2004
3. Ramesh Kumari: Computers and Their Applications to Chemistry**,** Narosa, 2002
4. Mark G. Sobell: A Practical Guide to Linux(R) Commands, Editors, and Shell Programming, Prentice Hall PTR, 2005

29. PROCESS CONTROL I.

Code: TKBG0612
Classes/week: 2 hours of lecture, 2 hours of follow up seminars
ECTS Credit Points: 4
Prerequisites: TKBE0401
Lecturer: Gulyás, Lajos

Course Description:

The substance of process control science. Open- and closed loop control systems. Feed back and feed forward control. Feed forward control of batch processes. Booe algebra. Control with PLC. Automatic, continuous fixed set point control. Simple control system or loop and block diagram. Signal flow diagram. Linear systems and the principle of superposition (block in series, block in parallel, summation of signal, etc.). Feed forward- and feed back control schematic block diagram. Examples: Control of volumetric flow of liquid, Control of temperature and Control of level of liquid. Description of elements of control loop (process, controller, actuator, etc.). time-, Laplace- and frequency domain. Nyquist- and Bode diagram. Equivalent transfer function of control loop. Development of empirical dynamic model from step response data. Identification of step response. P, I, PI, PD and PID controllers. Examination of open- and closed loop control systems. Nyquist- and Bode stability criterion.

References:

1. Harriott, P.: Process Control. McGraw-Hill, New-York, 1964.
2. Shinskey, F. G.: Process-Control Systems. Second Edition. McGraw-Hill. New-York. 1979.
3. Luyben, W. L.: Process Modeling Simulation and Control for Chemical Engineers. Second Edition. McGraw-Hill. New-York. 1989.
4. Stephanopoulos, G.: Chemical Process Control. Prentice-Hall. Englewood Cliffs. New-Jersey, 1984.
5. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Three. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
6. Using Simulink. Dynamic System Simulation for MATLAB. The MathWorks Inc. 2007.

7. User's Guide Control System Toolbox. For Use with MATLAB. The MathWorks Inc., 2007.

30 PROCESS CONTROL II.

Code: TKBG0613
Classes/week: 2 hours of seminars
ECTS Credit Points: 2
Prerequisites: TKBG0612
Leurer: Gulyás, Lajos

Course Description:
Knowledge of process control with chemical engineering examples. Using Matlab Control SystemToolbox and Simulink for process control. Mathematical modeling of chemical processes. Linearization of nonlinear models. Description of Linear Time-invariant Systems with Differential equations. Constructing models: State-space models, Transfer functions, Zero-pole-gain models and Frequency response models. SISO and MIMO systems. Solution of state-space equation in time-, Laplace- and frequency domain. Sampled data systems. Syntheses of control loop. Designing compensators. Two-position controlling.

References:
1. Harriott, P.: Process Control. McGraw-Hill, New-York, 1964.
2. Shinskey, F. G.: Process-Control Systems. Second Edition. McGraw-Hill. New-York. 1979.
3. Luyben, W. L.: Process Modeling Simulation and Control for Chemical Engineers. Second Edition. McGraw-Hill. New-York. 1990.
4. Stephanopoulos, G.: Chemical Process Control. Prentice-Hall. Englewood Cliffs. New-Jersey, 1984.
5. Using Simulink. Dynamic System Simulation for MATLAB. The MathWorks Inc. 2007.
6. User's Guide Control System Toolbox. For Use with MATLAB. The MathWorks Inc., 2007.
7. Coughhanowr, D. R.:ProcessSystemAnalysis and Control, 2nd ed. McGraw-Hill, New York, 1991.
8. Marlin, T. E.: Process Control: Designing Processes and Control Systems for Dynamic Performance, 2nd ed. McGraw-Hill, New York. 2000.

31. MECHANICS FOR CHEMICAL ENGINEERS I.

Code: MFVGE31V03
Classes/week: 2 hours of lecture and 1 hour of follow up seminar
ECTS Credit Points: 3
Prerequisites: TFBE2113
Lecturer: Tiba, Zsolt
It reviews the fundamental rules of the formal requirements of the technical drawing, the drawing of the projections, profile and sectional drawing of the components. After that it deals with the drawing of standardized machine elements and the concept of manufacturing tolerance and fitting, dimensional specification, geometrical and positioning tolerance, surface irregularity and the rules of elaboration of the workshop drawing.
In seminar there are six tasks to elaborate: to elaborate the workshop drawing of different machine elements and components. Endurance technical definitions. Contact among

machine elements.Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipe fittings, tanks etc. Structural materials and their technology in chemical industry. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis. Alloy steel and non-ferrous metals. Modification of based properties by annealing. Static and metallographic investigation of metals. Breaking of materials. Non-destruction tests. Notation of steel. Formation of welded bound by smelting processes. Destruction tests and non-destruction tests of welded bounds. Works of chemical machines: determination of machine, grouping. Types of energy, energy sources. Diffusion of energy in space and time. Efficiency.

Compulsory/Recommended Readings:
J. H. Perry: Chemical Engineer's Handbook, McGraw-Hill Book Company, 8. Edition, New York, 2007.

32. MECHANICS FOR CHEMICAL ENGINEERS II.

Code: MFVGE32V03
Classes/week: 2 hours of lecture and 1 hour of follow up seminar
ECTS Credit Points: 3
Prerequisites: MFVGE31V03
Lecturer: Kuki, Ákos

Heat prime movers: Definition, determination and grouping of prime movers. Development of Otto and Diesel engines. Labour process of Otto engines. Functioning of four-stroke Otto engines, two-stroke Otto engines and Diesel engines. Efficiency and capacity of engines, characteristic curve of engines. Structural parts of engines: cylinder, sucker, crankshaft, control of engines, fuel supplying of engines.
Hydrodynamics machines: Energy transport with fluid and gas materials. Principles of hydrodynamics machines. Pipelines and their characteristic curves. Movement of whirlpool pumps. Structures and types of whirlpool pumps. Cavitation. Suction facility of pumps. Vacuum pumps and stream pumps. Ventilators and compressors. Service properties of ventilators and compressors.
Electrical machines: service of one phase and three phase transformers. Measuring transformers. Electrical suckers and their kinetics. Asynchronous machines. Construction of three phase asynchronous machine. Construction of direct current machine: starting, breaking, control of rev. Direct current suckers with changing voltage. Choosing and warming of electrical engines. Engine power determination.

Compulsory/Recommended Readings:
J. H. Perry: Chemical Engineer's Handbook, McGraw-Hill Book Company, 8. Edition, New York, 2007.

33. MECHANICS FOR CHEMICAL ENGINEERS III.

Code: MFVGE33V04
Classes/week: 2 hours of lecture and 1 hour of follow up seminar
ECTS Credit Points: 3
Prerequisites: MFVGE32V03
Lecturer: Kotsis, Imre

Heat exchangers and reactors. Heat conduction. Heat convection, heat transfer and definition of heat exchanger. Overview and equations of heat exchangers. Mean temperature difference. Heat transfer factor. Heat convection. Heat transfer without phase changing. Heat transfer under duress convection. Heat transfer with free convection. Heat transfer of corded pipes. Heat transfer in agitator. Principles of sizing. Heat emission. Application and types of pipe bunching heat exchangers. Other heat exchangers. Stirring condensers. Cooling tower. Chemical reactors. Models of hydrodynamics ideal reactors. Descriptive quantities and equations. Examples for industrial reactors. Appliance for high temperature homogenous gas reactions. Stability and choosing of reactors. Reactors with intermittent-duty. Ovens. Oven with rotation drum, rotation arm and fluidization. Reactors for water electrolysis. Refrigerators. Cooling in chemical industry. Refrigerators with compressors. Carnot-cycle. Application of heat pumps.

Compulsory/Recommended Readings:
J. H. Perry: Chemical Engineer's Handbook, McGraw-Hill Book Company, 8. Edition, New York, 2007.

34. UNIT OPERATIONS I.

Code: TKBG0614
Classes/week: 2 hours of lectures, 4 hours of seminars
ECTS Credit Points: 5
Prerequisites: TFBE2113
Lecturer: Gulyás, Lajos

Topics: The substance of chemical engineering science. Unit Operations of Chemical Engineering. Basis of chemical engineering thermodynamics of unit operations. Quantities describing the operational unit. Measurement, units and dimensions in chemical engineering. Conversion of units. Conditions of thermal, mechanical and component equilibriums. Transport processes, component, heat and momentum streams. The extended-Damköhler's equation. The classification of operational units. The theory of similitude, dimensional analysis.
Flow of fluids, energy and momentum relationships. Pumping of fluids. Pumps, compressors and vacuum pumps.
Separation of heterogeneous systems: Sedimentation, filtration, centrifugation, mixing of liquid, gas cleaning.

Compulsory/Recommended Readings:
1. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume One. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
2. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Solution to the Problems in Volume 1. Volume Four. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.

35. UNIT OPERATIONS II.

Code: TKBG0615
Classes/week: 2 hours of lectures, 4 hours of seminars
ECTS Credit Points: 5
Prerequisites: TKBG0614

Lecturer: Gulyás, Lajos

Topics: General characterization of transfer processes. Classification of transfer processes. Heat transfer. General characterization of heat transfer. Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Heating and cooling. Heat transfer at standard- and changeable temperature difference. Unsteady- and steady state transfer of heat. The logarithmic mean temperature difference. Heat exchangers.
Evaporation and crystallization. Evaporators and crystallizers. Cooling and coolers.
Mass transfer processes. Mass transfer across a phase boundary, the two-film theory. Common interpretation of the operating line and the equilibrium curve. Mass transfer in the columns, the transfer units. Mass transfer in the cascades, the equilibrium units.

Compulsory/Recommended Readings:
1. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume One. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
2. Lienhard, J. H. IV., Lienhard, J. H. V.: A Heat Transfer Textbook, Third Edition. Phlogiston Press. Cambridge, Massachusetts, 2004.
3. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Solution to the Problems in Volume 1. Volume Four. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.

36. UNIT OPERATIONS III.

Code: TKBG0616
Classes/week: 2 hours of lectures, 4 hours of seminars
ECTS Credit Points: 5
Prerequisites: TKBG0615
Lecturer: Gulyás, Lajos

Topics: Mass transfer processes. Absorption. Evaporation. Distillation. Rectification. Extraction. Adsorption. Draying. Crystallization.
Chemical reaction engineering. Chemical reactors. Classification of reactors and choice of reactor type in the industry. Chemical kinetics. Residence time and distribution of residence time. Batch reactors and continuous reactors. Influence of heat of reaction on reactor type. Isothermal, adiabatic polytrophic reactors.
Mechanical operations. Size reduction of solids. Methods of operating crushers: coarse-, intermediate-, fine crushers and colloid mills. Classification of solid particles and settling. Blending of solid particles.

Compulsory/Recommended Readings:
1. Fogler, H. S.: Elements of Chemical Reaction Engineering. Third Edition. Prentice Hall PTR, Paramus, NJ, U.S.A. 1999.
2. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Two. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
3. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Three. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
4. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Solution to the Problems in Volume 2. Volume Five. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.

37. COMPUTER MODELLING OF CHEMICAL TECHNOLOGY SYSTEMS I.

Code: TKBG0912
Classes/week: 2 hours of seminars
ECTS Credit Points: 2
Prerequisites: TKBG0911
Lecturer: Kuki, Ákos

Topics: Chemcad is a chemical process simulation software which enables the drawing of flow charts and the simulation of industrial processes. The aim of the course is that chemical engineer students acquire the knowledge of using the Chemcad software package. They will have the opportunity to modell technologies known from their previous studies as well as planning new processes. Through using the software they can broaden their knowledge in the field of industrial devices and processes, besides they can learn novel, up to date industrial and environmental technologies. By the end of the semester the skilled application of the software is required which will be tested by a practical exam including the construction of a complex industrial process.

Compulsory/Recommended Readings:

1. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Six. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.
2. Kafarov, V.: Cybernetic methods in chemistry and chemical engineering. MIR Publishers. Moscow. 1976.
3. Chemcad user manual.

38. COMPUTER MODELLING OF CHEMICAL TECHNOLOGY SYSTEMS II.

Code: TKBG0913
Classes/week: 3 hours of seminars
ECTS Credit Points: 3
Prerequisites: TKBG0912
Lecturer: Kuki, Ákos

Course Description:
Using MATLAB for modeling of chemical processes and for systems of chemical technology. Systems and processes. Modeling. Development a mathematical models for chemical engineering processes. General transport equation. Standard mathematical models of fluid flow. Modeling of thermal processes. Modeling of mass transfer processes. Calculation of mass and energy balances for chemical engineering systems. Dynamic modeling and stability of chemical processes.
Compulsory/Recommended Readings:

1. Fogler, H. S.: Elements of Chemical Reaction Engineering. Third Edition. Prentice Hall PTR, Paramus, NJ, U.S.A. 2001.
2. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Six. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.3. Kafarov, V.: Cybernetic methods in chemistry and chemical engineering. MIR Publishers. Moscow. 1976.
4. Using Simulink. Dynamic System Simulation for MATLAB. The MathWorks Inc. 2007.

39. CHEMICAL TECHNOLOGY I.

Code: TKBE1111 and TKBL1111
Classes/week: 2 hours of lecture, 2 hours of seminar and 4 hours of laboratory work
ECTS Credit Points: 7
Prerequisites: MFVGE31V03
Lecturer: Nagy, Lajos

Topics: Basic terms of chemical technology: continuous and batch processing, yield, conversion, efficiency, volume, basic laws of chemical technology. Combustion: burning and combustors. Water processing: production of drinking and process waters, wastewater, wastewater management. Nitrogen industries: synthesis of ammonia and nitric acid. Sulfur industries: production of sulfuric acid. Fertilizers. Electrolysis of brine. Production of alumina, iron and steel.
Topics of the seminar: Exploration of the terms, laws of lecture topics. Problem solving and calculations based on technologies. Overview of flowcharts and processes.
Topics of the laboratory work:

Compulsory/Recommended Readings:
1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.

40. CHEMICAL TECHNOLOGY II.
Code: TKBE1112 and TKBL1112
Classes/week: 2 hours of lecture, 2 hours of seminar and 5 hours of laboratory work
ECTS Credit Points: 8
Prerequisites: TKBE1111 and TKBL1111
Lecturer: Nagy, Lajos

Topics
The coal: genesis, types, ingredients, mining, process (gasification, distillation, liquefaction) Crude oil and natural gas: genesis (organic and inorganic theories), types, ingredients, mining. Processes of natural gas, cool oil absorption method. Atmospheric distillation of crude oil. Engine fuels, destructive methods (thermic-, catalitic- and hydrocrackig), reforming of gasoline. Vacuumdistillation of pacura, lubricants (type, properties, perparation). Pyrolisis of naphta, separation of pyrogas.

Compulsory/Recommended Readings:
1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.

41. ENVIRONMENTAL TECHNOLOGY

Code: TKBE1114 and TKBL1114
Classes/week: 2 hours of lecture, 1 hours of seminar and 2 hours of laboratory work
ECTS Credit Points: 5
Prerequisites: TKBE1112 and TKBL1112
Lecturer: Deák, György

Topics: Envirionmental effects of industrial production. Waste-poor technologies. General theories of waste management. Classification of wastes. Types of envirionmental protection: additive, integrated to the process, integrated to the product. Pollution of the most important industries. Gas, liquid and solid phase industrial wastes, handling and amount reducing. Dangerous wastes: types, handling. Communal wastes: types, handling. Waste deposits and burning.

Compulsory/Recommended Readings:

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.
3. J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press (1983)

42. PILOT PLANT WORK

Code: TKBL1115
Classes/week: 1 hour of problem-solving seminar and 5 hours of pilot plant work
ECTS Credit Points: 4
Prerequisites: Chemical technology I. (TKBE1111)
Lecturer: Nagy, Miklós

Topics: Film evaporators. Absorbtion. Grinding-size distribution measurement. Liquid-liquid extraction. Water treatment. Distillation. Decomposition of PUR foams. Oil collection from water surface. Fluidization.

Compulsory/Recommended Readings:

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.

43. SAFETY

Code: TKBE0711
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE1112
Lecturer: Deák, György

Topics:
Basic definitions. Safety in a workplace, legal and organization issues. Accident-free work and safety. Health-protection at workplaces, working conditions. Influence of Environmental effects and the personality on safety at work. Safety issues of handtools, machinery and electricity. Chemical safety and safety in the chemical industry. Man protection tools. Fire protection: definition of, appliances of and the rules in case of a fire, legal issues. Rules and safety measures in a chemical laboratory.

Compulsory/Recommended Readings:

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.

2. R.E. Kirk-Othmer: Kirk-Othmer Encyclopedia of Chemical Technology, 5. Edition, Volumes: 1-27, JohnWiley & Sons, New York, 2001-2007.

44. BASICS OF PETROCHEMISTRY

Code: TKBE1113
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE1111
Lecturer: Nemes, Sándor

Topics: Primary raw materials for petrochemicals: crude oils and natural gas; hydrocarbon intermediates: paraffinic hydrocarbons, olefinic hydrocarbons, aromatic hydrocarbons; processing and production of hydrocarbon intermediates: methane, ethane, propane, butanes, ethylene, propylene, butylenes, butadiene, isoprene, benzene, toluene, xylenes; physical separation processes (distillation, absorption, adsorption, extraction); conversion processes (cracking, catalytic cracking, hydrocracking, catalytic reforming, pyrolysis); process and product schemes; uses of synthesis gas; syntheses involving carbon monoxide.

Recommended Readings:
1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., VCH, Weinheim, Volumes: A1-A28, 1985-1996.
2. R.E. Kirk-Othmer: Kirk-Othmer Encyclopedia of Chemical Technology, 5. Edition, Volumes: 1-27, JohnWiley & Sons, New York, 2001-2007.
3. K. Weissermel and H.-J. Arpe: Industrial Organic Chemistry, 2nd ed., VCH Publishers, Weinheim,1993.
4. S. Matar and L. F. Hatch: Chemistry of Petrochemical Processes, 2nd ed., Gulf, Dharan, 2001.

45. RADIOISOTOPES

Code: TKBG0412
Classes/week: 1 hour of lecture and two hours of laboratory practice
ECTS Credit Points: 3
Prerequisites: TKBE0512
Lecturer: M. Nagy, Noémi

Topics of the lecture: The nucleus, parts and models of nuclei. Isotopes, isotopic effects. Stable and radioactive nuclei. Mechanism and kinetics of radioactive decays. Radioactive equilibria. Determination of geological and historical ages. Radiation-matter interactions. Nuclear reactions. Nuclear energetics. Detection and measurements of radiation. Dosimetry. Basic rules of tracers. Measurements of radioactive intenzity. Radioactive isotopes: analitycal and industrial applications. Safety and dosimetry.
Topics of the practice: One of the following:
- Charasteristics of a GM-tube
- Liquid scintillation technic
- Self adsorption of beta rays

Two of the following:
- Thickness measurement using beta-rays
- Radioactive volumetry
- Radiometric titration

- Gamma spectroscopy
- Solubility measurement of a salt

Compulsory/Recommended Readings:

1. McKay, H.A.C. Principles of Radiochemistry, The Butterworth Group, 1971
2. Choppin, G.R., Rydberg, J.: Nuclear chemistry: theory and applications, Pergamon Press, 1980.
3. Friedlender, G., Kennedy, J.W., Macias, E.S., Miller, J.M.: Nuclear and radiochemistry, John Wiley and Sons, 1981.
4. Lieser, K.H.: Nuclear and radiochemistry, Wiley VCH, 2001
5. A. Vértes, S. Nagy, Z. Klencsár: Handbook of nuclear chemistry, Kluwer Academic Publishers, Boston, 2003.

46. WASTE MANAGEMENT

Code: TKBE1116 and TKBG1116
Classes/week: 2 hours of lecture, 2 hours of seminars
ECTS Credit Points: 3+2
Prerequisites: TKBE1112, TKBL1112
Lecturer: Nemes, Sándor

Topics: Its aim is to educate and prepare waste management professionals for the challenges facing the industry and environment. Waste management is the collection, transport, processing, recycling or disposal of waste materials. Waste management is also carried out to reduce the materials' effect on the environment and to recover resources from them. Grouping of wastes (solid, liquid or gaseous substances), and application of different methods for their handling. Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial, producers. Utilization of wastes. Plastic wastes. Importance and application biodegradable polymers/plastics. Natural and synthetic biodegradable polymers/plastics. Biodegradation. Environmental importance of these materials.

Compulsory/Recommended Readings:

1. Bodnár Ildikó: Ph.D. Theses, Debrecen University (2002)
2. Fleischer Tamás: EU integration mechanisms affecting hungarian public policies in waste management / (Working papers / Institute for World Economics Hungarian Academy of Sciences, 1215-5241 ; 153.) Bibliogr.: p. 23-24.
3. Jřrgensen, Sven Erik: Industrial waste water management, Amsterdam ; New York : Elsevier Scientific Pub. Co. ; New York : distributors for the U.S. and Canada, Elsevier/North-Holland, 1979.
4. George Odian: Principles of Polymerization, Second Edition, Wiley-Interscience Publication (1981)

47. SPECTROSCOPY

Code: TKBE0503
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE0312, TKBL0312
Lecturer: Kurtán, Tibor; Kiss, Attila

Topics: Zeeman interaction, principles of NMR ans ESR spectroscopy. NMR chemical shift and its measurement. Structure and operation of NMR spectrometers. Proton chemical shifts and their applications in structure elucidation. Nuclear spin-spin coupling. NMR multiplets and rules of spectrum analysis. Nuclear spin-spin coupling constants and their application in structure elucidation. Chemical shifs of ^{13}C and other nuclei and its application. ESR spectroscopy to study chemical reactivity and structure. Absorption spectra (UV, IR, Raman). Beer's law and its analytical applications. Conjugation in absorption spectra. Structure and operation of spectrophotometers. Inter- and intramolecular effects in IR spectra. Basic principles of mass spectrometry: ionization of molecules, methods of ionization and mass-to-charge ratio analysis. Structure and operation of mass spectrometers. Fragmentation rules in mass spetrometry. Combined methods of mass spectrometry (GC-LC-CE-MS): applications in analytical chemistry and structure elucidation. Tandem mass spectrometry. Strategy for the application of spectroscopic methods. Spectrum analysis, quality ensuring parameters.

Compulsory/Recommended Readings:
1. Hesse M., Meier H., Zeeh B.: Spectroscopic Methods in Organic Chemistry, Thieme, 1997.

48. STRUCTURE OF MATTER I.

Code: TKBL0513
Classes/week: 2 hours of laboratory practice
ECTS Credit Points: 1
Prerequisites: TKBE0511, TKBL0511
Lecturer: Nagy, Lajos and Kuki, Ákos

Topics: UV-VIS photometry: Basics of UV-VIS photometry. Recording and evaluation of UV-VIS spectra obtained on aqueous solutions of ferroin and $KMNO_4$. Investigation of the validity of Lambert-Beer's law for aqueous solutions of ferroin: calibration, determination of the concentrations of ferroin solutions. Determinations of the component concentrations in a mixture consisting of two components by means of UV-VIS photometry. Application of UV-VIS photometry for the monitoring of chemical reactions: Investigation of the permanganate-oxalic acid reaction by UV-VIS photometry. IR-spectroscopy: Recording and evaluation of IR spectra obtained on carboxylic acids, esters, alcohols, amines and amides. Evaluation of IR-spectrum obtained on an unknown sample, determination of its functional groups. Light scattering: Basics of static light scattering (SLS). Determinations of weight-average molecular weight, R_G and A_2 values for polystryrene using static light scattering. Dynamic light scattering (DLS): Determination of hydrodynamic radius and particle size distribution for latex particles.

Compulsory/Recommended Readings:
1. Heinz-Helmut Perkampus: UV-VIS Spectroscopy and Its Applications, Springer (1994)
2. Helmut Günzler, Hans-Ulrich Gremlich: IR Spectroscopy: An Introduction, Wiley-VCH (2002)
3. Wolfgang Schärtl: Light Scattering from Polymer Solutions and Nanoparticle Dispersions Springer (2007)

49. STRUCTURE OF MATTER II.

Code: TKBL0514
Classes/week: 4 hours of laboratory practice
ECTS Credit Points: 2
Prerequisites: TKBL0513
Lecturer: Nagy, Lajos and Kuki, Ákos

Topics: Mass Spectrometry I. MALDI-TOF MS: Recording of MALDI-TOF mass spectra of poly(ethylene glycol), poly(propylene glycol), polystyrene and poly(nethyl methacrylate). Determinations of the mass of the repeat units and the end-groups. ESI-MS: Recording of ESI mass spectra of low (e.g. plasticizers) and high molecular weight (e.g. cytochrom C, poly(ethylene glycol) compounds. Evaluation of the obtained mass spectra. Comparison of the measured and calculated masses. Determinations of mass resolution and accuracy. Calculation of molecular mass for multiply charged species. Liquid chromatography: Recording of HPLC-UV traces for different plasticizers (e.g. DOP, DUP, TOTM). Calibrations. Qualitative and quantitative determinations of plasticizers. Size exclusion chromatography (SEC): Recording of SEC traces of poly(ethylene glycol), poly(propylene glycol), polystyrene and polyisobutylene. Determinations of number- average(M_n), weight average molecular weight and polydispersity of these samples.

Compulsory/Recommended Readings:
1. P.J. Hore: Nuclear Magnetic Resonance, Oxford, New York, Tokyo, Oxford University Press. (1995)
2. Eberhard Breitmaier: Structure Elucidation by NMR in Organic Chemistry, John Wiley & Sons (1995)

50. QUALITY MANAGEMENT
Code: TTBEBVM-KT6
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TTBEBVM-KT4
Lecturer: Kotsis, Ágnes

Topics:
The Basics of Quality Management; TQM, Quality Control Systems, EFQM, Quality Prizes, Standardization, Quality Costs, Methods of Quality Management Special topics: Quality of Services, Quality of Higher Education, Quality in Libraries, Quality in Public Services
Required reading:
David L. Goetsch, Stanley B. Davis, : Quality Management, Prentice Hall Publishing, 2005
Suggested reading:
Assessment:
Written examination; multiple choices and essay

51. DESING OF EXPERIMENTS

Code: TKBE0617
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physical chemistry II. (TKBE0403)
Lecturer: Kuki, Ákos

Topics: MATLAB software package is used for evaluating real problems from the practice. Basics of statistics. Random experiment, random variables. Expected value and variance of a probability distribution. Testing hypotheses, estimation. Ditributions of paired variables. Linear regression. Multiple regression and correlation. The design of experiments via simplex method.

Compulsory/Recommended Readings:

1. J. P. Adler, E. V. Markov, J. V. Granovszkij: The design of experiments, determination of optimal conditions.. Moszkva (1977)
2. R. A. Fisher: The design of experiments, London (1971)
3. H. Smith, A. Rose: Industrial and engineering chemistry 55, 7 (1963)

52. BSc Thesis

Code: TKBG2011
Classes/week: 15 hours of engineering, or laboratory work
ECTS Credit Points: 15
Prerequisites: at least 180 credits
Lecturer: Kéki, Sándor or the individually assigned supervisors

Topics: Individual engineering or laboratory research at selected industrial companies, or one of the research groups of the Chemistry Institute with the guidance of a supervisor. Students are expected to carry out novel work and write a 20-40 page B.Sc. thesis as a result.

Compulsory/Recommended Readings:
Assigned by the supervisors depending on the individual research projects.

OPTIONAL COURSES

53. Basic Chemical Informatics

Code: TKBL0901
Classes/week: 2
ECTS Credit Points: 2
Prerequisites: at least
Lecturer: Purgel, Mihály

54. Mathematic Methods in Chemistry and Chemical Enginering
Code: TKBE0904
Classes/week: 2
ECTS Credit Points: 3
Prerequisites: TMBE0607, TMBG0607
Lecturer: Póta, György

55. CHEMICAL TECHNOLOGY III.

Code: TKBE1117
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE1112
Lecturer: Nagy, Lajos

Topics: Silicate industry: processes and products of glass, ceramics and enamell. Micromiological industries: types, conditions and products of fermentation. Production of yeast, ethanol, vinegar, antibiotics and beer. Production of sugar and vegetable-oil, usage of byproducts.

Compulsory/Recommended Readings:
1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.
2. Muhlynov I.: Chemical Technology I-II.
3. J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press (1983)

56. MODELING OF CHEMICAL REACTORS

Code: TKBE0618
Classes/week: 2 hours of lectures
ECTS Credit Points: 3
Prerequisites: Physical chemistry II. (TKBE0403)
Lecturer: Gulyás, Lajos

Course Description:
The substance of Chemical reaction engineering. Developing of problems in the industry. General mole balance equation. Apply the mole balance equations to a batch reactor, CSTR, PFR and PBR. Conversion and reactor sizing. Rate law and stoichiometry. Isothermal rector design. Pressure drop and unsteady-state reactor operation. Mathematical model of multiple reactions for reactors. Nonisothermal reactor design. Multiple steady states reactors Non-ideal reactors. Stability of reactors.
References:
1. Fogler, H. S.: Elements of Chemical Reaction Engineering. Third Edition. Prentice Hall PTR, Paramus, NJ, U.S.A. 2001.
2. Coulson, J. M., Richardson, J. F.: Chemical Engineering. Volume Three. Third Edition. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 1978.

57. PLASTICS AND PROCESSING II.

Code: TKBE1213
Classes/week: 1 hour of lecture
ECTS Credit Points: 2
Prerequisites: Macromolecular chemistry (TKBE0611)
Lecturer: Deák, György

Topics: Production and consumption of plastics. The future of the plastic production. Technology of production of LDPE. (high pressure process). Technology of production of HDPE, MDPE and LLDPE (mid and low pressure processes). Polypropilene production methods in Hungary and in the wold (bulk and gas phase processes). Polystyrene (high impact, expanded PS) PVC production methods. PVC production in Hungary. Polyamides. PA-6 process. Production of poly-acrylo-nitrile. Polyesters. Additives of the plastic indusry.

Compulsory/Recommended Readings:

1. F. Rodriguez: Principles of Polymer Systems, McGraw-Hill, London, Singapore, Tokyo (1985).
2. G. Odian: Principles of Polymerization, McGraw-Hill, New York (1983).
3. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.

58. PLASTICS AND PROCESSING III.

Code: TKBE1214
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: TKBE1213
Lecturer: Deák, György

Topics: Theory of extrusion. Products of extrusion: tube, rod, sheet and hollow fibers and tanks. Fiber, foil, sheet and tubing formation. Theory of die casting. Machinery of extrusion. Cold-forming. Thermoforming methodes (bending, slip-ring forming, pressure forming, vacuum forming). Atmospheric methodes (molding, rotational molding, dipping). Plastic coatings. Plastic foams. Merging of plastic pieces.

Compulsory/Recommended Readings:
1. F. Rodriguez: Principles of Polymer Systems, McGraw-Hill, London, Singapore, Tokyo (1985).
2. G. Odian: Principles of Polymerization, McGraw-Hill, New York (1983).
3. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Weinheim, Federal Republic of Germany, VCH, Volumes: B1-B8, 1990-1995.

59. VISITS AT CHEMICAL COMPANIES

Code: TKBG1118
Classes: 5 full days in semester 4
ECTS Credit Points: 0
Prerequisites: TKBE1111 and TKBL1111

Lecturer: Kuki, Ákos (organizer)

Topics: Participating chemical companies (all within 150 km from the campus of the University of Debrecen): Biogal-Teva Rt., AKSD Rt., Tiszai Vegyi Kombinát Rt., TAURUS AGROTYRE LTD, BorsodChem Rt., Borsodi Sörgyár Rt., Pannoncem Cementipari Rt., MOL Rt. Tiszai Finomító, AGROFERM Rt., UNILEVER Rt., Tiszamenti Vízművek Rt., Rubbermaid Kft., Helioplast Kft., Eurofoam Kft., Nuclear Power Plant Ltd Paks.

Compulsory/Recommended Readings:
none

60. INDUSTRIAL PLACEMENT

Code: TKBG1119
Classes: 6 weeks of practice in the summer after semester 6
ECTS Credit Points: 0

Prerequisites: TKBE1111 and TKBL1111

Lecturer: Kuki, Ákos (organizer)

Topics: Industrial placement is an ideal opportunity to apply existing skills and to develop new ones whilst getting a practical insight into working life in chemical industry, it gives real world experience, and a possible step in a career and provides with the opportunities for the future. All these experiences greatly enhance career prospects for when students graduate.
Industrial placement is an extraordinary opportunity to train and develop personal abilities with competent professionals and gain first hand experience of chemical industry and is an ideal grounding for a future career in chemical industry. It provides integrated industrial and professional training in an area such as operation of a chemical plant and a chance to sharpen skills and acquire work experience.

Compulsory/Recommended Readings:
Individually assigned by the host company and/or industrial tutor.

3. The institutional conditions of fulfilling the foreign language
requirements stated in the training and graduation manual.
For acquiring a BSc diploma candidates must obtain at least an oral or written intermediate level state language certificate or an equivalent language certificate

4. Thesis and Final Exam

Students of the major receive an absolutorium after they satisfied every aspect of their educational and examinational requirements. Students have to write a diploma work after the 6th semester. Writing this is the precondition of the entrance to the final exam. The diploma work will be graded by the final exam committee. In case the diploma work is not accepted he/she cannot carry on with the exam. The final exam is the essential for anyone who wants to get a chemical engineer BSc diploma. The final exam must be taken in front of the final exam committee.

Subjects of the Final Exam:

a.. Physical Chemistry

b., Chemical Technology

c., Unit Operation

Requirements of the diploma work

The diploma work is the solution of a chemical engineering task which the student should solve relying on previous studies and secondary literature under the guidance of a tutor in one semester. The diploma work must prove that the author can apply the acquired theoretical knowledge.

The student can choose any topic for a diploma work suggested by the faculty or in occasional cases individual topics acknowledged by the head of the department. Only those tasks can be given as diploma work that can be accomplished within the allotted time limit relying on the skills acquired during the years of study. The topics of the diploma work should be given in completely uniform manner and based on the system of requirements set up by the head of the institute and the head of the department responsible for the specialization. Students must be informed of the diploma topics in the first academic week of the first semester the latest. The diploma works are written with the close collaboration of the candidate and the tutor.
The formal requirements of the diploma work are detailed in the “manual for writing diploma works” which is handed out to every candidate when they decide upon their topic. The diploma works must be handed in to the department responsible minimum ten days before the beginning of the final exam period. The thesis paper is evaluated by an external graduate professional who gives a grade as well as a short written comment on it. The head of the department makes a proposal for the final evaluation of the diploma work based opn the comments. The diploma work receives a grade from the final exam committee.