

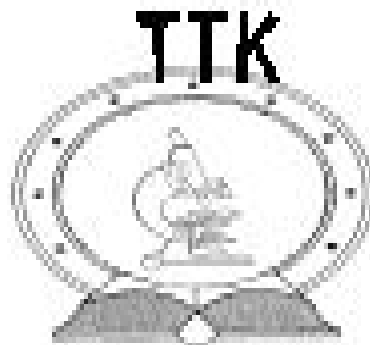
UNIVERSITY OF DEBRECEN,
CENTRE OF ARTS, HUMANITIES, AND SCIENCES,
FACULTY OF SCIENCE AND TECHNOLOGY



Bachelor of Chemical Engineering
(BSc degree program)



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

Graduate Study Opportunities
– <i>MSc programs in development:</i> <ul style="list-style-type: none">▪ Chemistry▪ Chemical Engineering▪ MSc in Materials Engineering▪ MSc in Materials Science▪ Environmental Engineering▪ Environmental Science▪ Bioengineering
– PhD in Chemistry (see p. Y)

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 chosen 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. One can choose from 22 different majors as a full time student at the university. In addition the Faculty of Sciences has basic college level training, subsidiary basic training and specialised teacher training in 20 different majors. 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. The applicants can choose from 10 majors while the preparation of the university level engineer training is in progress. During the integration process of the university the instructors of the faculty provide engineering knowledge for other faculties. Chemist and chemistry teacher training is continuous since the establishment of the Faculty of Sciences relying on the staff above mentioned institutes. 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 within the reach of Debrecen have concrete demand for practice oriented chemical engineers who relying on their concrete knowledge are capable of adapting and controlling complex chemical technologies. Chemical engineers who receive their diploma at other universities of the country will find employment in western Hungary so there is not enough well trained professionals for companies in Eastern Hungary. As a regional center of higher education in Hungary the University of Debrecen could train engineers for the plastic 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.

Relying on the previous negotiations with companies of the region we forecast that there will be an annual demand for 50-60 graduate chemical engineers.

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 of Eastern Hungary 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 for those who cannot afford to begin studies at more distant universities 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 MSc studies at the following branches:

Chemical Engineer MSc
Chemistry MSc
Environmental Engineer 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 holiday 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 ran 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. 2 corresponding members of the academy, 6 doctors of the academy, 5 candidates of science and 11 PhD doctors take part in the training. The planned number of the students at the chemical engineering BSc is 40 people.

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

Course title	Code	Semester							Credits ECTS
		1	2	3	4	5	6	7	
Mathematical and scientific foundations									50
<i>Mathematics module</i>									12
1. Mathematics I.	TMBE0606 TMBG0606	430gk							5 2
2. Mathematics II.	TMBE0607 TMBG0607		230gk						3 2
<i>Physics module</i>									6
3. Physics for Engineers I.	TFBE2111	210k							3
4. Physics for Engineers II.	TFBE2113		210k						3
<i>Chemistry module</i>									30
5. General Chemistry I.	TKBE0111 TKBL0111	213gk							3 2
6. General Chemistry II.	TKBE0112 TKBL0112		213gk						3 2
7. Inorganic Chemistry	TKBE0211 TKBL0211		202gk						3 1
8. Organic Chemistry I.	TKBE0301		210g						4
9. Organic Chemistry II.	TKBE0312 TKBL0312			213gk					3 3
10. Macromolecular Chemistry	TKBE0611				200k				3
11. Colloid Chemistry	TKBE0404				200k				3
12. Biochemistry	TBBE0313				100g				2
Economic and Human Sciences									20
<i>Micro- and macroeconomic module</i>									4
13. Economics I.	MFKGT31V04	210k							4
<i>Management and Business module</i>									4
14. Management	MFMEN31V03	210k							4
15. State Administration and Law	MFAJI31V02	110f							2
<i>Economic and Human Sciences (obligatory module)</i>									10
16. Economics II.	MFKGT32V04		210k						4
17. Engineering Ethics	MFMRE31X03	200f							3

Course title	Code	Semester							Credits ECTS
		1	2	3	4	5	6	7	
18. Business and Investment Organization	MFSZE31X03						200k		3
Basics of Professional knowledge									89
<i>Physical-, Analytical-Chemistry and Materials Science</i>									20
Analytical module									11
19. Qualitative and Quantitative Analysis	TKBE0511 TKBL0511					204gk			3 3
20. Instrumental Methodes of Analysis	TKBE0512 TKBL0512						203gk		3 2
Physical Chemistry and Materials Science module									15
21. Physical Chemistry I.	TKBE0401			220k					4
22. Physical Chemistry II.	TKBE0403 TKBL0403				202gkz				3 1
23. Materials of Construction	TKBE1211					200g			3
24. Plastics and Processing I.	TKBE1212 TKBL1212						202gk		2 2
<i>Measurement and Processing module</i>									9
25. Informatics for Engineers	TKBG0911			103g					3
Process Control									6
26. Process Control I.	MFFOI31V04				220f				4
27. Process Control II.	MFFOI32V02					020k			2
<i>Mechanics and Unit Operation module</i>									25
Mechanics									10
28. Mechanics for Chemical Engineers I.	MFVGE31V03			210f					3
29. Mechanics for Chemical Engineers II.	MFVGE32V03				210f				3
30. Mechanics for Chemical Engineers III.	MFVGE33V04					220k			4
Chemical Unit Operation									15
31. Unit Operations I.	MFVMU31V05			240f					5
32. Unit Operations II	MFVMU32V05				240f				5
33. Unit Operations III	MFVMU33V05					240kz			5
<i>Technology module</i>									35

Course title	Code	Semester							Credits ECTS
		1	2	3	4	5	6	7	
Planing									6
34. Computer modeling of Chemical Technology Systems I.	TKBG0912						030g		3
35. Computer modeling of Chemical Technology Systems II.	TKBG0913							030g	3
Chemical Technologies									26
36. Chemical Technology I.	TKBE1111 TKBL1111				225gk				4 4
37. Chemical Technology II.	TKBE1112 TKBL1112					225gkz			4 4
38. Environmental Technology	TKBE1114 TKBL1114						222gk		4 2
39. Pilot Plant Work	TKBL1115						015g		4
Safety Field									3
40. Safety	TKBE0711							200g	3
Special Courses									40
41. Basics of Petrochemistry	TKBE1113					200g			3
42. Radioisotopes	TKBG0412							102g	3
43. Waste management	TKBE1116 TKBL1116						204gk		3 3
44. Spectroscopy	TKBE0503						110k		3
45. Sructure of Matter I.	TKBL0513						002g		1
46. Sructure of Matter II.	TKBL0514							004g	2
47. Quality Management	TKBE0711							210k	3
48. Design of experiments	MFVKT31X03						200f		3
49. BSc Thesis	TKBG2011								15
Obligatory courses									11
50. Chemical Technology III.	TKBE1117							200g	3
51. Modelling of Chemical Reactors	MFVRE31V03					200f			3
52. Plastics and Processing II.	TKBE1213						100g		2
53. Plastics and Processing III.	TKBE1214							200g	3
Additional requirements									
54. Visits at Chemical Companies (five days)	TKBG1118				002a				
55. Industrial Placement	TKBG1119						a		
56. Physical Education		002a	002a	002a	002a				

Symbols: a – acceptance (no grade), g – practical, f – mid semester grades (practical)
k – examination (written, or oral), z – Subjects of the Final Exam.

III. 2. Subject programmes

1. 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 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:

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

2. 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

3. 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: Erdélyi, Gábor

Topics: Physical concepts, physical quantities, systems of units, dimensional analysis. Description of the movement of a mass point. Concepts of mass 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.

4. 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: Erdélyi, Gábor

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.

5. GENERAL CHEMISTRY I.

Code: TKBE0111 and TKBL0111

Classes/week: 2 hours of lecture, 1 hour of follow up seminar and two hours of laboratory practice

ECTS Credit Points: 5

Prerequisites: none

Lecturer: Nagy, Miklós

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.

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)

6. GENERAL CHEMISTRY II.

Code: TKBE0112 and TKBL0112

Classes/week: 2 hours of lecture, 1 hour of follow up seminar and two hours of laboratory practice

ECTS Credit Points: 5

Prerequisites: TKBE0111 and TKBL0111

Lecturer: Nagy, Miklós

Topics:

Principles of chemical equilibrium, homogeneous and heterogenous equilibria, the equilibrium constant expression, the significance of the magnitude of an equilibrium constant, altering equilibrium conditions: Le Châteliers 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, ΔG° , ΔG° and K_{eq} 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 Jersey, 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: TKBE0211, TKBL0211

Classes/week: 2 hours of lecture and 2 hours of laboratory practice

ECTS Credit Points: 3 + 1

Prerequisites: TKBE0111, TKBL0111

Lecturer: Micskei, Károly

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: Antus, Sándor

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, McGraw-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

ECTS Credit Points: 6

Prerequisites: Organic chemistry I. (TKBE0301)

Lecturer: Antus, Sándor

Topics: Amines, nitro-compounds, diazonium salts and reactions of. Coloring agents. Preparation and reactions of aldehydes and ketones. Nucleophilic addition. Preparation and reaction of carboxylic acids and important acid derivatives. Nucleophilic substitution reaction of acyl group. Macromolecules via polycondensation. Chemical properties and importance of β -dicarbonyl compounds. Carboxylic acid derivatives. Natural carboxylic acid derivatives: amino acids, nucleic acids. Vitamins, alkaloids, antibiotics, carbohydrates. Heterocyclic compounds.

Practice: Basic procedures: crystallization, distillation, extraction, TLC and column chromatography. Simple chemical reactions using micro and semi micro methods. Basics of literature search of synthetic procedures.

Compulsory/Recommended Readings:

1. Volhard: Organic Chemistry, New York (1987)

10. MACROMOLECULAR CHEMISTRY

Code: TKBE0611

Classes/week: 2 hours of lecture

ECTS Credit Points: 3

Prerequisites: Organic chemistry II. (TKBE0312)

Lecturer: Kéki, Sándor

Topics: Classification of polymers. Structure, chemical structure and fine structure of the polymer 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 amorphous 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. Polyaddition. 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)

11. 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. Adsorption. 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. Geoffrey Barnes, Ian Gentle: Interfacial Science, Oxford University Press, 2005

12. BIOCHEMISTRY

Code: TBBE0313

Classes/week: 1 hour of lecture

ECTS Credit Points: 2

Prerequisites: Organic Chemistry II. (TKBE0312)

Lecturer: Gyémánt, Gyöngyi

Topics: Protein structure and function; Oxygen-transporting proteins; Enzymes and mechanisms of enzyme action; Structure and function of biological membranes; Carbohydrate metabolism: glycolysis and glycogenesis, glycogen metabolism, the pentose phosphate pathway; Fatty acid metabolism; Amino acid metabolism; Structure of RNA and DNA. Movement of genetic information.

Compulsory/Recommended Readings:

1. J. M. Berg, J. L. Tymoczko, L. Stryer: *Biochemistry* Fifth ed. (W. H. Freeman and Co. 2002)
2. C. K. Mathews, K. E. van Holde, K. G. Ahern: *Biochemistry* Third ed. (Addison Wesley Longman 2000)
3. A. L. Lehninger, D. L. Nelson: *Principles of biochemistry* Third ed (Worth 2000)
4. Lubert Stryer: *Biochemistry* (1995).

13. ECONOMICS I.

Code: MFKGT31V04

Classes/week: 2 hours of lecture and 1 hour of problem solving seminar

ECTS Credit Points: 4

Prerequisites: none

Lecturer: Egri, Imre, T. Kiss, Judit

The basics of supply and demand (Demand and supply curves, equilibrium price and output). Elasticity of demand (price-, cross-price-, income elasticity of demand and price elasticity of supply, price elasticity of demand and sales revenue). Consumer behavior, Marginal utility theory, indifference (curve) analysis. Production (factors), costs of production, profit maximization. Market structures (perfect competition, imperfect competition: monopoly, oligopoly, monopolistic competition). Profit maximizing under perfect competition, and monopoly. Price discrimination. Efficiency under perfect competition. Interest, profits and capital. The rate of return on capital. Present value, Net Present value.

Compulsory/Recommended Readings:

1. Samuelson, Nordhaus: *Economics I. II.*

14. MANAGEMENT

Code: MFMEN31V03

Classes/week: 2 hours of lecture and 1 hour of problem solving seminar

ECTS Credit Points: 4

Prerequisites: none

Lecturer: Pokorádi, László, Varga Emilné Szűcs, Edit

Topics: History of management (classical school, bureaucratic management, scientific management, administrative management, human relations school, human resources school, integrating the management theories, emerging management positions). What managers and organizations do (managers and organizations, strategic thinking, planning and control, organizing work teams and structures, organizational culture). Managing people (perception, learning and personality, motivation and organizational learning). Managing relationships (communications, interpersonal relations, building groups into teams). Leading and managing practices (problem solving, power and organizational politics). Managing change (stress at work, change and organizational development, origins and methods of management and OB theories). The basics of strategic management (strategic analysis, strategy formulation, strategy implementation). The basics of Total Quality Management (customer focus, process improvement, total involvement, developing the quality strategy).

Compulsory/Recommended Readings:

1. Curtis W. Cook – Phillip L. Hunsaker – Robert E. Coffey: Management and Organizational Behavior, IRWIN, Chicago, 1997.
2. Alex Miller – Gregory G. Dess: Strategic Management, The McGraw-Hill Companies, Inc., New York, 1996.
3. Carry L. Cooper – Chris Argyris: Encyclopedia of Management, Blackwell Publisher Ltd., 1998.
4. Arthur R. Tenner – Irving J. DeToro: Total Quality Management, Addison-Wesley Publishing Company, Massachusetts, 1993.

15. STATE ADMINISTRATION AND LAW

Code: MFAJI31V02

Classes/week: 1 hour of lecture and 1 hour of follow up seminar

ECTS Credit Points: 2

Prerequisites: none

Lecturer: Zentay, Isvänné

Topics: The constitutional basics of the municipality structure, state organisation, municipality levels, basic civil rights, the historical overview of the civil institutions. Operation of municipalities, their organisation system, statutory supervision, and the major rules and regulations of the municipal, state and administrative procedures. The characteristics of the Hungarian municipality structure in light of the EU municipality systems. The introductory lectures include legal rudiments and the structure of the legal system. The knowledge of corporate law, commercial law and proprietary rights. The major responsibility forms (compensation, indemnification) related to the activity, the general rules and regulations of concluding a contract.

Compulsory/Recommended Readings:

1. Fogarasi, Ivancsics, Kiss: The handbook of the local authorities Union Publishing house, Debrecen (1997)
2. Hungarian acts and decrees

16. ECONOMICS II.

Code: MFKGT32V04

Classes/week: 2 hours of lecture and 1 hour of problem solving seminar

ECTS Credit Points: 4

Prerequisites: MFKGT31V04

Lecturer: Egri, Imre, T. Kiss, Judit

Topics: Measuring national income and output (real vs. nominal GNP, GDP, NNP, NDP, the problem of double counting) Economic growth. Consumption and Investment. IS model. Economic role of government (externalities). Fiscal policy and output determination. The effectiveness of fiscal policy. The role of money in the economy, the evolution of money, central bank, commercial banking, the supply and the demand for money. Monetary policy (varieties and problems of monetary policy). IS-LM analysis: the integration of the goods and money market models. Aggregate demand and supply. Labor market. Unemployment and inflation.

Compulsory/Recommended Readings:

1. Samuelson, Nordhaus: Economics II. III.

17. ENGINEERING ETHICS

Code: MFMRE31X03

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)

18. BUSINESS AND INVESTMENT ORGANISATION

Code: MFSZE31X03

Classes/week: 2 hour of lecture

ECTS Credit Points: 3

Prerequisites: none

Lecturer: Zentay, Isvánné

Topics:

The concept of investment, its types and groups The process of organising investments, their documentation, analysis and the introduction of the related methodologies and technologies. Participants of investments. Financing and activating investments. Investment policy from the point of view of the investors and the national economy. The concept of tenders, and their types The application of the public procurement act in case of investments. The general rules and regulations of the public procurement procedures and tenders.

Compulsory/Recommended Readings:

1. Husti István: Handbook on investments for entrepreneurs and business associations, Budapest Műszaki Publishing House (1999)
2. Papp Péter, Molnár István, Zentay István: Structure theory and methodology – Budapest TK Publishing House (1985)
3. Lock Dennis: Project management, Modern Business Knowledge, Panem Publishing House Budapest (1998)
4. Husi Géza: Project management DE MFK (2000)
5. Darázs Imréné, Habis László: Planning municipal investments, Know How program of local authorities, Budapest (1997)

19. QUALITATIVE AND QUANTITATIVE ANALYSIS

Code: TKBE0511 and TKBL0511

Classes/week: 2 hours of lecture and 4 hours of laboratory practice

ECTS Credit Points: 6

Prerequisites:TKBE0211, TKBG0211

Lecturer: Farkas, Etelka

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.

PRACTICE: Classification of ions by precipitation reactions. Classical quantitative analytical methods: volumetric titrations based on acid-base equilibria, complex formation, precipitation reactions and redox equilibria; gravimetric analyses.

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)

20. INSTRUMENTAL METHODS OF ANALYSIS

Code: TKBE0512, TKBL0512

Classes/week: 2 hours of lecture and 3 hours of laboratory practice

ECTS Credit Points: 5

Prerequisites: TKBE0511 and TKBL0511

Lecturer: Posta, József, Farkas, Etelka

Topics: 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.

Compulsory/Recommended Readings:

1. Willard H.H., Merritt Jr. L.L., Dean J.A., Settle Jr. F.A.: Instrumental Methods of Analysis, Wadsworth Publ. Co. (1998)
2. Kellner R., Mermet J.M., Otto M., Widmer M.M.: Analytical Chemistry, Willey-VCH (1998)

21. 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

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 Chatelier 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.

22. 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 and Nagy, István

Topics: Proton transfer equilibria, solubility equilibria, weak 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 approximation, 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. Catalytic activity at surfaces. Photochemistry.

LABORATORY EXERCISES (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 weak 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.

23. 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, porcelain, 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. Sinnott: Chemical Engineering, Volume 6., Pergamon Press (1983)
2. L. H. Van Vlack: Elements of Materials Science, Addison-Wesley, Reading-London (1980)

24. 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 fluoro 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).

25. 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 mathematical(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

26. PROCESS CONTROL I.

Code: MFFOI31V04

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. Boole 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.

27. PROCESS CONTROL II.

Code: MFFOI32V02

Classes/week: 2 hours of seminars

ECTS Credit Points: 2

Prerequisites: MFFOI31V04

Lecturer: Gulyás, Lajos

Course Description:

Knowledge of process control with chemical engineering examples. Using Matlab Control System Toolbox 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. Coughanowr, D. R.: Process System Analysis 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.

28. 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: Horváth, Róbert

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.

29. 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: Horváth, Róbert

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.

30. MECHANICS FOR CHEMICAL ENGINEERS III.

Code: MFVGE33V04

Classes/week: 2 hours of lecture and 2 hours of follow up seminars

ECTS Credit Points: 4

Prerequisites: MFVGE32V03

Lecturer: Horváth, Róbert

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.

31. UNIT OPERATIONS I.

Code: MFVMU31V05

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.

32. UNIT OPERATIONS II.

Code: MFVMU32V05

Classes/week: 2 hours of lectures, 4 hours of seminars

ECTS Credit Points: 5

Prerequisites: MFVMU31V05

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.

33. UNIT OPERATIONS III.

Code: MFVMU33V05

Classes/week: 2 hours of lectures, 4 hours of seminars

ECTS Credit Points: 5

Prerequisites: MFVMU32V05

Lecturer: Gulyás, Lajos

Topics: Mass transfer processes. Absorption. Evaporation. Distillation. Rectification. Extraction. Adsorption. Drying. 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.

34. COMPUTER MODELLING OF CHEMICAL TECHNOLOGY SYSTEMS I.

Code: TKBG0912

Classes/week: 3 hours of seminars

ECTS Credit Points: 3

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 model 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.

35. 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.

36. CHEMICAL TECHNOLOGY I.

Code: TKBE1111 and TKBL1111

Classes/week: 2 hours of lecture, 2 hours of seminar and 5 hours of laboratory work

ECTS Credit Points: 8

Prerequisites: MFVGE31V03

Lecturer: Zsuga, Miklós

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.

37. 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: Zsuga, Miklós

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. Vacuum distillation of pacura, lubricants (type, properties, perparation). Pyrolysis 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.

38. ENVIRONMENTAL TECHNOLOGY

Code: TKBE1114 and TKBL1114

Classes/week: 2 hours of lecture, 2 hours of seminar and 2 hours of laboratory work

ECTS Credit Points: 6

Prerequisites: TKBE1112 and TKBL1112

Lecturer: Deák, György

Topics: Environmental effects of industrial production. Waste-poor technologies. General theories of waste management. Classification of wastes. Types of environmental 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. Sinnott: Chemical Engineering, Volume 6., Pergamon Press (1983)

39. 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. Absorption. 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.

40. SAFETY

Code: TKBE0711

Classes/week: 2 hours of lecture

ECTS Credit Points: 3

Prerequisites: TKBE1112

Lecturer: Deák, György; Nagy József

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.

41. 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. Weissmermel 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.

42. 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 intensity. Radioactive isotopes: analytical and industrial applications. Safety and dosimetry.

Topics of the practice: One of the following:

- Characteristics of a GM-tube
- Liquid scintillation technique
- 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. Friedlander, 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.

43. WASTE MANAGEMENT

Code: TKBE1116 and TKBL1116

Classes/week: 2 hours of lecture, 4 hours of seminars

ECTS Credit Points: 3+3

Prerequisites: TKBE1112, TKBL1112

Lecturer: Bodnár, Ildikó and Deák, György

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. [Jørgensen, 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)

44. SPECTROSCOPY

Code: TKBE0503

Classes/week: 1 hour of lecture and 1 hour of problem solving seminar

ECTS Credit Points: 3

Prerequisites: TKBE0312, TKBL0312

Lecturer: Kurtán, Tibor; Szilágyi, László; Kiss, Attila

Topics: Zeeman interaction, principles of NMR and 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 shifts 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 spectrometry. 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.

45. STRUCTURE OF MATTER I.

Code: TKBL0513

Classes/week: 2 hours of laboratory practice

ECTS Credit Points: 1

Prerequisites: TKBE0511, TKBL0511

Lecturer: Kéki, Sándor

Topics: UV-VIS photometry: Basics of UV-VIS photometry. Recording and evaluation of UV-VIS spectra obtained on aqueous solutions of ferriin and KMnO_4 . Investigation of the validity of Lambert-Beer's law for aqueous solutions of ferriin: calibration, determination of the concentrations of ferriin 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 polystyrene 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)

46. STRUCTURE OF MATTER II.

Code: TKBL0514

Classes/week: 4 hours of laboratory practice

ECTS Credit Points: 2

Prerequisites: TKBL0513

Lecturer: Kéki, Sándor

Topics: Mass Spectrometry I. MALDI-TOF MS: Recording of MALDI-TOF mass spectra of poly(ethylene glycol), poly(propylene glycol), polystyrene and poly(methyl 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)

47. QUALITY MANAGEMENT

Code: TKBE0711

Classes/week: 2 hours of lecture and 1 hour of problem solving seminar

ECTS Credit Points: 3

Prerequisites: MFSZE31X03

Lecturer: Varga Emilné Szűcs, Edit

Topics: History of Quality management. Quality leaders (Taylor, Shewhart, Deming, Juran, Crosby, Feigenbaum). Quality management systems (quality check, statistical quality control, quality assurance, total quality control, quality assurance system, total quality management). ISO 9001:2000 quality management systems. ISO 14001:2004 environmental management systems. Basics of TQM (customer focus, process improvement, total involvement, developing the quality strategy). Quality management in the field of chemical analysis (validation, verification, calibration, standard errors of measurements).

Compulsory/Recommended Readings:

1. Joel E. Ross: Total Quality Management (Text, Cases and Readings), Florida, St. Luice Press, 1995.
2. John Bank: The Essence of Total Quality Management, USA, Prentice Hall, 1992.
3. Tenner, A.R. –DeToro, I.J.: Total Quality Management, Three Steps to Continuous Improvement, USA, Addison-Wesley Publishing Company, 1993.
4. ISO 9001:2000 Quality Management Systems. Requirements.
5. ISO 9000:2005 Quality Management Systems. Fundamentals and vocabulary.
6. ISO 9004:2000 Quality Management Systems. Guidelines for performance improvements.
7. ISO 14001:2004 Environmental Management Systems. Requirements with guidance for use.

48. DESIGN OF EXPERIMENTS

Code: MFVKT31X03

Classes/week: 2 hours of lecture

ECTS Credit Points: 3

Prerequisites: MFVMU33V05

Lecturer: Gulyás, Lajos

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. Distributions 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)

49. BSc Thesis

Code: TKBG2011

Classes/week: 15 hours of engineering, or laboratory work

ECTS Credit Points: 15

Prerequisites: at least 180 credits

Lecturer: Zsuga, Miklós; 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.

50. CHEMICAL TECHNOLOGY III.

Code: TKBE1117

Classes/week: 2 hours of lecture

ECTS Credit Points: 3

Prerequisites: TKBE1112

Lecturer: Zsuga, Miklós

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. Sinnott: Chemical Engineering, Volume 6., Pergamon Press (1983)

51. MODELING OF CHEMICAL REACTORS

Code: MFVRE 31V03

Classes/week: 2 hours of lectures

ECTS Credit Points: 3

Prerequisites: MFVMU32V05

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 reactor 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.

52. 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 world (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 industry.

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.

53. 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.

54. VISITS AT CHEMICAL COMPANIES

Code: TKBX0608

Classes: 5 full days in semester 4

ECTS Credit Points: 0

Prerequisites: TKBE1111 and TKBL1111

Lecturer: Nemes, Sándor (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., Kabai Cukorgyár Rt., Borsodi Sörgyár Rt., Pannoncem Cementipari Rt., MOL Rt. Tiszai Finomító, AGROFERM Rt., UNILEVER Rt., Tiszamenti Vízművek Rt., Rubbermaid Kft., Helioplast Kft., Eurofoam Kft.

Compulsory/Recommended Readings:

none

55. INDUSTRIAL PLACEMENT

Code: TKBX0607

Classes: 4 weeks of practice in the summer after semester 6

ECTS Credit Points: 0

Prerequisites: TKBE1111 and TKBL1111

Lecturer: Nemes, Sándor (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 on the comments. The diploma work receives a grade from the final exam committee.