UNIVERSITY OF DEBRECEN,

CENTRE OF ARTS, HUMANITIES, AND SCIENCES,

FACULTY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF CHEMISTRY

Bachelor of Chemistry

(BSc degree program)

2007

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Hungary
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englishstudies@detek.unideb.hu
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http://englishstudies.sci.unideb.hu

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THE INSTITUTE OF CHEMISTRY

The Institute of Chemistry with its 50 teaching and more than 20 research staff members and 35 other personnel is the largest educational and research unit of the Faculty of Science and Technology at the University of Debrecen. The staff consists of 3 Members and 18 Doctors of the Hungarian Academy of Sciences, 41 PhD, and thus the Institute concentrates a considerable body of highly qualified people. With this staff and the available equipment listed with the Departments' descriptions the Institute of Chemistry represents one of the most important sites of chemical education and research in Hungary.

The Institute is dedicated to teaching chemistry and chemical engineering at BSc, MSc, and PhD levels, and contributing to the education of chemistry non-majors (studying biology, biological engineering, environmental science, physics, pharmacy, etc.) by chemistry and chemistry-related subjects.

The curriculum for the Bachelor of Chemistry program has been elaborated to provide students with significant practical knowledge of the most important fields of chemistry together with solid foundations in other branches of science, first of all mathematics and physics. Chemistry BSc is also available with the so called Research Chemist Specialization (for a detailed outline and description see p. 13 ff.) comprising a significantly higher ratio (80 %) for chemical subjects as compared to the basic program (64 %). While this specialization makes outstanding preparations for entering the MSc programs both in Chemistry and Chemical Engineering, everybody with a Chemistry BSc degree has the right to apply for MSc level education in the above fields as well as in Chemistry Teacher MSc programs at the University of Debrecen or in any other higher educational institution in Hungary offering similar degree courses.

Curricula for BSc and MSc programmes in chemistry are about to acquire the Eurobachelor and Euromaster labels, respectively, thereby facilitating mobility of the students in the European Higher Education Area as well as finding jobs in all over Europe.

As a background to education basic as well as developmental research of high standard is performed with the participation of students at all levels. All branches of chemistry are represented in education and research for which peculiarities are detailed in the description of the departments.

For more and more detailed information about the Institute of Chemistry, please, consult the website:

http://www.chem.science.unideb.hu

Dr. László SOMSÁK
full professor
Responsible for the
Chemistry BSc Program

Dr. Gyula RÁBAI
full professor
Director of the
Institute of Chemistry

GENERAL DESCRIPTION OF THE BACHELOR OF CHEMISTRY DEGREE PROGRAM

The aim of this study program is the training of chemists possessing theoretical and practical knowledge in chemistry as well as satisfactory basic knowledge in related fields of science (e. g. mathematics, physics, informatics, biology) and at least one foreign language. The degree holders will be able to apply their knowledge in recognizing and solving first of all practical problems in chemical industrial production, in analytical, agricultural, and quality assurance laboratories, as well as in various fields of administration and environmental protection. The Bachelor of Chemistry will have in depth knowledge to continue his/her studies in the second (MSc) cycle and will be able to gain further knowledge either individually or in any organized manner.

The Bachelor of Chemistry will

- be familiar with the principles and practical applicability of the most important methods in the chemical laboratory;
- be able to communicate efficiently the results of his/her work for both professional or non-experienced audience also in a foreign language by using multimedia methods;
- be able to acquire new competences by way of further education.

The Bachelor of Chemistry will be qualified for

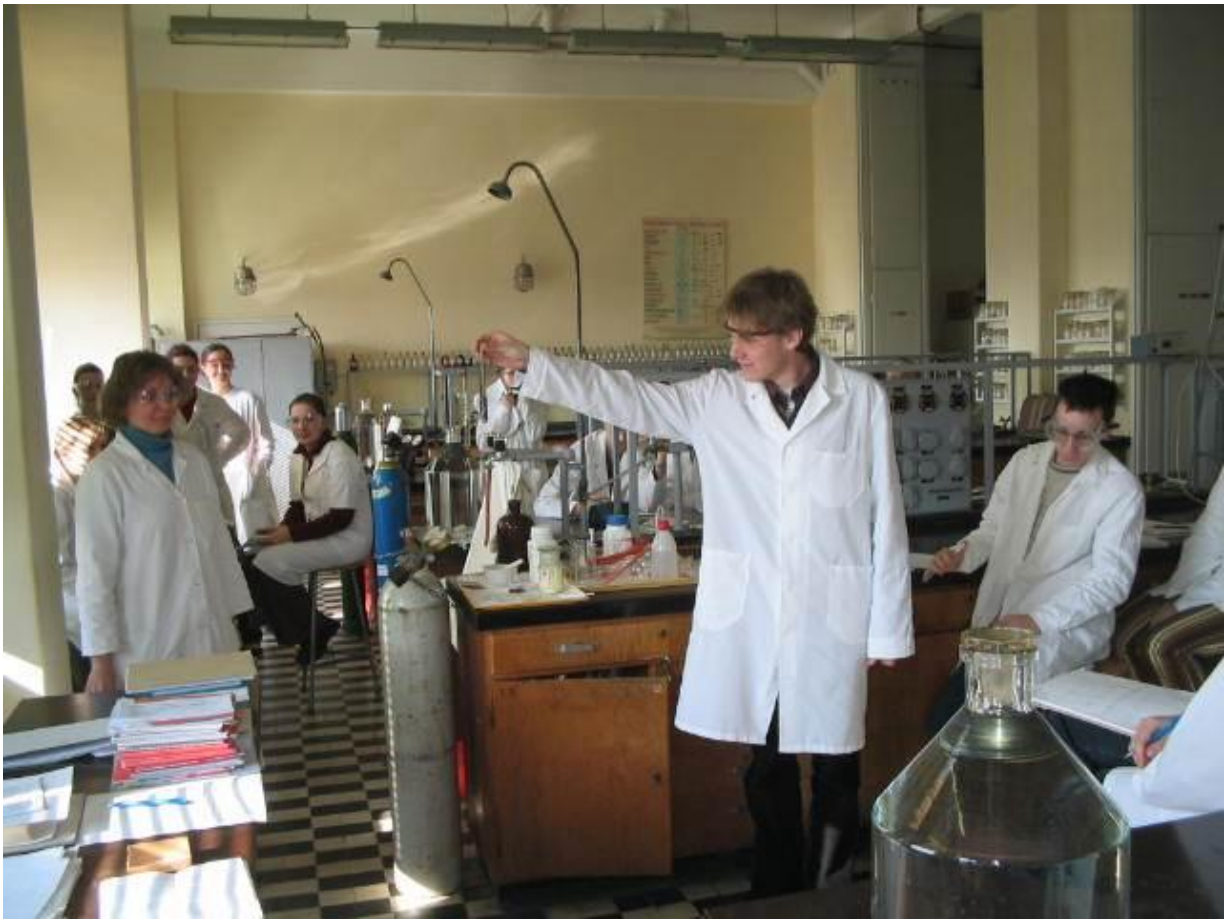
- identification and independent solution of mainly practical problems and tasks in the production process of chemical industry, in academic and industrial research institutions, in laboratories with agrochemical, food industry, crop protection, quality assurance, medical analytical profiles;
- performing daily operation of chemical apparatus, carrying out routine measurements;
- responsible operation of large laboratory instruments;
- individual decision making in his/her special field;
- doing his/her job in a quality-conscious, success-oriented, and value-committed way.

Bachelor of Chemistry degrees shall be awarded to students who have shown themselves by appropriate assessment to:

- have a good grounding in the core areas of chemistry: inorganic, organic, physical, biological and analytical chemistry; and in addition the necessary background in mathematics and physics;
- have basic knowledge in several other more specialised areas of chemistry
- have built up practical skills in chemistry during laboratory courses, at least in inorganic, organic and physical chemistry, in which they have worked individually or in groups as appropriate to the area;
- have developed generic skills in the context of chemistry which are applicable in many other contexts;
- have attained a standard of knowledge and competence which will give them access to second cycle course units or degree programmes (such as MSc and further on PhD).

Such graduates will:

- have the ability to gather and interpret relevant scientific data and make judgements that include reflection on relevant scientific and ethical issues;
- have the ability to communicate information, ideas, problems and solutions to informed audiences;
- have competences which fit them for entry-level graduate employment in the general workplace, including the chemical industry;
- have developed those learning skills that are necessary for them to undertake further study with a sufficient degree of autonomy.



DEPARTMENTS

Department of Applied Chemistry

Head of Department: Dr. Zsuga, Miklós full professor

E-mail: zsugam@tigris.klte.hu

Home-page: http://www.chem.science.unideb.hu

STAFF

Dr. Kéki, Sándor	associate professor
Dr. Borda, Jenő	associate professor
Dr. Deák, György	associate professor
Nagy, József	chemical engineer
Nagy, Lajos	chemist
Dr. Nagy, Miklós	assistant lecturer
Dr. Nemes, Sándor	assistant lecturer
Dr. Török, János	assistant lecturer

Research fields

- Polymer syntheses
- Soft ionization mass spectrometry of polymers and low molecular weight naturally occuring compounds
- Functional and block copolymers
- Nanocomposites

Facilities, instrumentation

- BIFLEX III MALDI-TOF mass spectrometer (Bruker Daltonik)
- MicroTof –Q mass spectrometer equipped with ESI, APCI and APPI ion-sources.
- HPLC-MS (Waters, Aliance), GPC-SEC (Waters, Series 600)
- GC (Hewlet Packard, Carlo Erba)
- Dry box
- Brookhaven Static and Dynamic Laser Light Scattering instrument
- Pilot plant

Department of Colloid and Environmental Chemistry

Head of Department: Dr. Bányai, István full professor

E-mail: ibanyai@delfin.unideb.hu

Home-page:
http://dragon.unideb.hu/~kolloid/kolloid.html
http://dragon.unideb.hu/~ibanyai/ibanyai.html

Staff

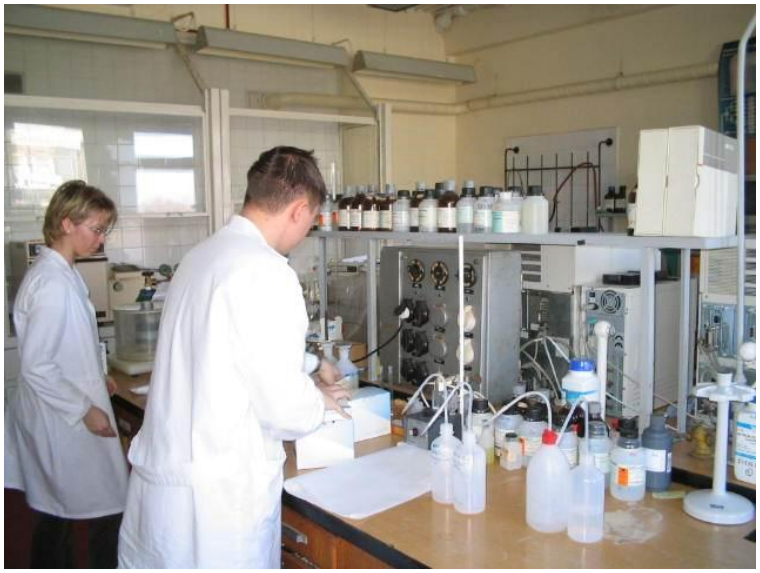
Dr. Berka, Márta	assistant lecturer
Dr. Borbély, János	associate professor
Dr. Nagy, Noémi	associate professor
Dr. Nagy, Zoltán	assistant lecturer
Dr. Nemes, Zoltán	teaching assistant
Dr. Novák, Levente	assistant lecturer

Research fields

- Structural study of functionalized macromolecular ligands and their metal complexes.
- Application a natural polymers and macromolecules.
- Surface chemistry of soils. Transport and handling of nuclear waste.

Facilities, instrumentation

- Equipments for rheology of different levels
- Spectrophotmeters
- Tensiometers
- Bruker DRX 360 NMR for special courses
- Equipments macromolecular tests.



Department of Inorganic and Analytical Chemistry

Head of Department: Dr. Fábián, István full professor

E-mail: inorg@puma.unideb.hu

Home-page:
http://www.klte.hu/~wwwinorg/inorg.html

Staff

Dr. Braun, Mihály	assistant lecturer
Dr. Brücher, Ernő	professor emeritus
Dr. Buglyó, Péter	associate professor
Dr. E. Kövér, Katalin	full professor
Dr. Farkas, Etelka	full professor
Dr. Gáspár, Attila	assistant lecturer
Dr. Lázár, István	associate professor
Dr. Gábor, Lente	assistant lecturer
Dr. Király, Róbert	associate professor
Dr. Micskei, Károly	associate professor
Dr. Pap, Lajos	professor emeritus
Dr. Posta, József	full professor
Dr. Sóvágó, Imre	full professor
Dr. Tóth, Imre	full professor
Dr. Tóth, Zoltán	associate professor
Dr. Várnagy, Katalin	associate professor
Nagy, István	senior teaching associate
Zékány, László	senior teaching associate

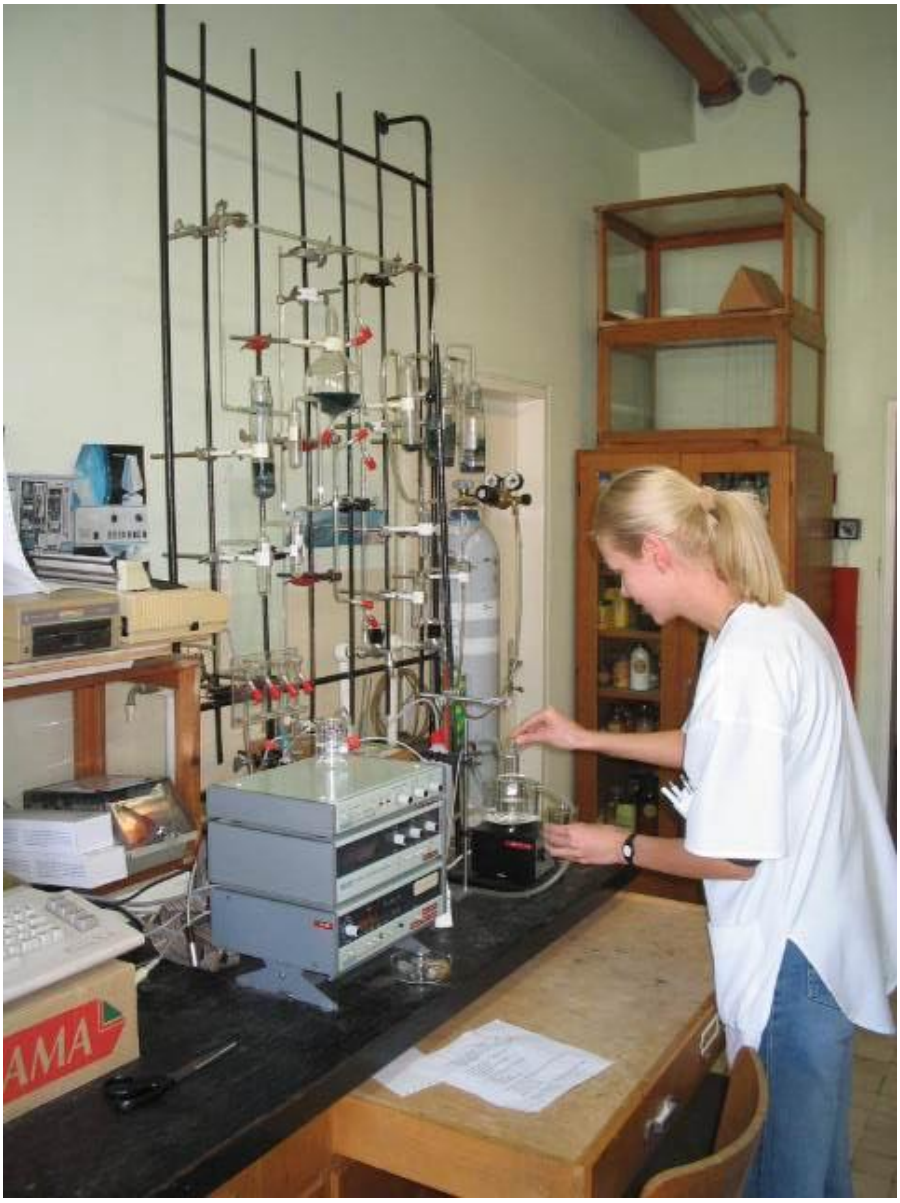
Research fields

- Bio-coordination chemistry.
- The coordination chemistry of rear earth metal ions, developing MRI agents.
- Desing and preparation of new polydentate ligands.
- Kinetics and mechanisms of complex redox reactions of simple inorganic species.
- NMR methodological developments.
- Atomic spectroscopy, speciation analysis.
- Analytical methods using separation techniques.

Facilities, instrumentation

- Potentiometric titration systems: 6 units
- Conventional spectrophotometers: 6
- AVANTES Fiberoptic moduláris spektrofotométer: 2
- Atomic absorption spectrometers: 3
- Spectroflame ICP spectrometer
- NMR spectrometers: 360 and 400 MHz frequencies for protons
- NMR relaxometer

- APL DX-17MV sequential stopped-flow instrument
- Hi-Tech Scientific RQF-63 Rapid Quench Flow instrument
- APL RX200 fast reaction kinetics mixer
- Tecator Fia Star 510 flow injection analysator
- Perkin Elmer spektrofotométerek
- Metrohm MIC-6B modular ionchromatograph
- HP 5890 Series II gaschromatograph
- TRACE GC ULTRA (THERMO) with POLARIS Q MS^5 detection
- IRIS Interpid II. XSP ICP instgrument (THERMO)
- MINIPAL 2 EDXRF (PANalytical) X-ray unit



Department of Physical Chemistry

Head of Department: Dr. Joó, Ferenc, full professor,
Member of the Hungarian Academy of Sciences

E-mail: fjoo@delfin.unideb.hu

Home-page:
http://dragon.klte.hu/~wwwphch/fkem.html

STAFF

Dr. Bazsa, György	full professor
Dr. Beck, Mihály	professor emeritus, member of Hung. Acad. Sci
Dr. Bényei, Attila	senior researcher
Horváthné Dr. Csajbók, Éva	teaching assistant
Dr. Gáspár, Vilmos	research professor
Dr. Kathó, Ágnes	senior researcher
Dr. Kovács, Gábor	teaching assistant
Dr. Nagy, István	associate professor
Dr. Ősz, Katalin	assistant professor
Dr. Póta, György	associate professor
Dr. Rábai, Gyula	full professor

Staff of the Research Group of Homogeneous Catalysis, Hungarian Academy of Sciences
(placed at the Department of Physical Chemistry)

Győrváriné Dr. Horváth, Henrietta	junior researcher
Horváth, Henrietta H.	junior researcher
Fekete, Marianna	junior researcher
Papp, Gábor	junior researcher
Udvardy, Antal	chemist

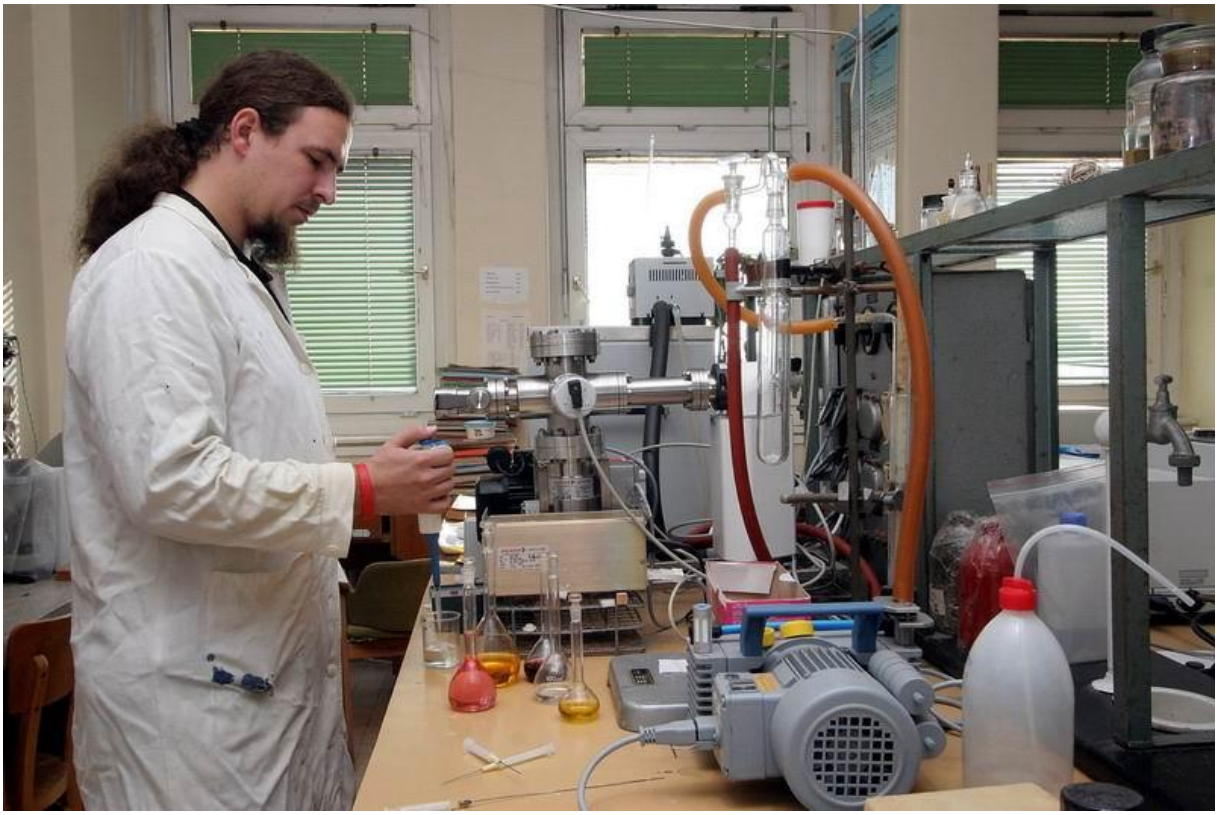
Research fields

- Homogeneous catalysis; organometallic catalysis in aqueous solutions and in aqueous/organic liquid biphasic systems; hydrogenation, transfer hydrogenation, hydrosilylation, hydration of alkynes and alkenes, redox isomerization of allylic alcohols, olefin metathesis.
- Synthesis and characterization of new water-soluble catalysts, including the study of their solution equilibria.
- Modification of biomembranes in model systems and cells by homogeneous catalysis.
- Theoretical studies of transition metal complex catalysis using *ab initio* and MM plus QM-MM methods.
- Activation of chemical reactions by microwave irradiation.
- Experimental and modelling study of nonlinear dynamics (oscillations, chaos and pattern formation) in chemical systems.
- Control and synchronization of coupled dynamical systems.

- Study of new composite materials produced by frontal polymerization and their application in electrochemical devices.
- Research on polymorphism using single crystal X-ray diffractometry.

Facilities, instrumentation

- Equipment for analytical and structural studies: HP gas chromatographs (2), Waters HPLC (2), PE Paragon FTIR spectrometer equipped with an IR microscope, PE Spectrum One FTIR spectrometer, Hitachi 2000 UV-VIS spectrophotometer.
- Fully equipped microwave laboratory including batch and flow-through microwave reactors for studies of the activation of chemical reactions by microwave irradiation.
- Glass and stainless steel reactors for studies of homogeneously catalyzed reactions from atmospheric to 150 bar pressure, including an H-Cube (Thales Nanotechnology) microfluidic flow-through reactor.
- Radiometer automatic burettes (2) for pH-potentiometric studies of solution equilibria.
- Pfeiffer Vacuum QME 200 quadrupole MS gas analyzer, equipped with membrane inlet sample chamber.
- Computer controlled potentiostat/galvanostat for studies of nonlinear dynamics in electrochemical systems.
- Enraf-Nonius Mach 3 X-ray diffractometer.



Department of Organic Chemistry

Head of Department: Dr. Antus, Sándor, full professor,
Member of the Hungarian Academy of Sciences

E-mail: antuss@tigris.unideb.hu

Home-page:
http://szerves.science.unideb.hu

Staff

Dr. Berényi, Sándor	associate professor
Dr. Czifrák, Katalin	research associate
Dr. Gulácsi, Katalin	assistant professor
Dr. Juhász László	assistant professor
Dr. Juhászné Dr. Tóth, Éva	teaching assistant
Kerti, Gábor	teaching assistant
Kertiné Ferenczi, Renáta	junior researcher
Dr. Kiss Attila	research associate
Dr. Kónya Krisztina	research associate
Dr. Kurtán, Tibor	assistant professor
Dr. Makleit, Sándor	professor emeritus
Dr. Patonay, Tamás	full professor
Dr. Somsák, László	full professor
Dr. Szilágyi, László	professor emeritus
Tóthné Dr. Illyés, Tünde Zita	teaching assistant
Vágvölgyiné Dr. Tóth, Marietta	assistant professor

Staff of the Research Group for Carbohydrate Chemistry, Hungarian Academy of Sciences
(placed at the Department of Organic Chemistry)

Dr. Borbás, Anikó	senior researcher
Dr. Fekete, Anikó	research associate
Dr. Lázár, László	research associate
Dr. Lipták, András	professor emeritus Member of the Hungarian Academy of Sciences

Research fields

- Isolation, structure elucidation, and synthesis of naturally occurring complex *O*-heterocycles (flavonoids, isoflavonoids and related compounds) with potential biological (e. g. hepatoprotective and antioxidant) activity.
- Transformation of natural *N*-heterocycles, especially morphine type alkaloids and their potentially pharmacologically active derivatives.
- Study of new methodologies using modern carbon-carbon bond formation methods for the synthesis of heterocycles.

- Synthetic chemistry of carbohydrates and their derivatives, chemical biology of saccharides, synthesis of glycoenzyme inhibitors, potential antidiabetics.
- Stucture analysis of biologically active molecules (carbohydrates, aminoglycosides and macrolide antibiotics, peptides, glycopeptides, flavanoids and morphine alkaloids) by spectroscopic methods (various nuclear magnetic resonance (NMR) methodologies, elcetronic (UV-VIS), vibrational (FTIR), chiroptical (CD, ORD) spectroscopy, mass spectrometry (MS) also in combination with various gas- (GC) and liquid chromatographic (LC) separation methods).

Facilities, instrumentation

- Bruker AC-200 and Bruker DRX-500 NMR spectrometers.
- Perkin Elmer 341 type polarimeter.
- VG 7035 mass spectrometer (GC+ solid sample measurements with EI and CI ionization techniques).
- Jasco HPLC (with UV-, diode array and electrochemical detector; chiral column and LCCD measurements).
- Perkin Elmer 16PC FT-IR spectrophotometer.
- Perkin Elmer Lambda 11 UV spectrophotometer.
- Perkin Elmer Autosystem XL gas chromatograph (with chiral column).
- Jasco J-810 (CD+ORD+ LCCD measurement).

STUCTURE OF THE CURRICULUM IN ECTS CREDITS

Credit distribution – Bachelor of Chemistry (without specialization)

	Science	Chemistry	General courses	Other	Total	
Core	16	84	5	V*	105	
Other compulsory courses		18 To be elected from the compulsory courses for the research chemist (43 credits)		Pl**	18	**Σcomp. 123 +V***
Optional courses		22 ◄——————►		25	47	
BSc Thesis		10			10	
Total	min 35	min 115				
	min 150		5	25	180	

*V: Visit in chemical industry (5 days). **Pl: External placement (4 weeks)

Credit distribution – Bachelor of Chemistry with Research Chemist specialization

	Science	Chemistry	General courses	Other	Total	
Core	16	84	5	V*	105	
Other compulsory courses	7	43		Pl**	50	**Σcomp. 155 +V***
Optional courses		6		9	15	
BSc Thesis		10			10	
Total	23	143				
	166		5	9	180	

*V: Visit in chemical industry (5 days). **Pl: External placement (4 weeks)

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc without Specialization

Year 1

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Mathematics I.	7	C	4			3	none
	Physics I.	4	C	2			1	none
	History and Structure of the EU	1	C	1				none
	Environmental Science	2	C	1			1	none
	General Chemistry	8	C	3	3		2	none
	Basic Chemical Informatics	2	C				3	none
	Topics in Modern Chemistry	3	E	2				none
Semester 2	Physics II.	3	C	2				Physics I.
	Inorganic Chemistry I.	7	C	2	6			General Chem.
	Organic Chemistry I.	4	C	2			1	General Chem.
	Introductory Physical Chemistry Laboratory	3	C		4			General Chem.
	Nuclear Chemistry	1	C	1				General Chem.

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc without Specialization

(continued)

Year 2

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Economics and Management	1	C	1				none
	Inorganic Chemistry II.	3	C	2				Inorganic Chem. I.
	Physical Chemistry I.	4	C	2			2	General Chem., Mathematics I, Physics I.
	Organic Chemistry II.	4	C	2			1	Organic Chem. I.
	Analytical Chemistry I.	8	C	2	4		2	Inorganic Chem.
	Separation Techniques	3	C	1	3			Inorganic Chem.
	Chemical Technology I.	4	C	2			1	General Chem.
Semester 2	Spectroscopy	3	C	1	1			Organic Chem. II.
	Organic Chemistry III.-IV.	6	C	2	3		1	Organic Chem. II.
	Colloid Chemistry I.	4	C	2	2			Physical Chem. I., Introduct. Phys. Chem. Lab.
	Physical Chem. II.	8	C	3	4		2	Physical Chem. I., Introduct. Phys. Chem. Lab.
	Industrial Placement	0	C*					Chemical Technology I.

* Prerequisite of the degree

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc without Specialization

(continued)

Year 3

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Quality Management	1	C	1				none
	Organic Chem. V.	3	C		3		2	Organic Chem. IV.
	Biochemistry I.	3	C	2				Organic Chem. III.
	Chemical Technology II.	4	C	2			2	Chem. Technology I.
Semester 2	Environmental Chemistry and Technology	4	C	2			1	Chem. Technology II.
	BSc Thesis	10	C		13-15			see subject description
	Visits at Chemical Companies	0	C*					Chem. Technology II.

* Prerequisite of the degree

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc with Research Chemist Specialization

Year 1 (in addition to compulsory courses in Chemistry BSc without specialization):

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Crystallography	3	S	2				none
	Introduction to Chemical Calculations	2	E				2	none
	Chemical Concepts and Misconceptions	2	E				2	none
Semester 2	Mathematics II.	5	C	2	3			Mathematics I.
	Basic Radiochem. Measurements	1	C		2			Nuclear Chem. (co-requisite)
	Physics II. Alternative	4	S	2			1	Physics I.
	Chemical Informatics	2	S				3	Basic Chem. Informatics
	Chemical Programming	2	S				3	Basic Chem. Informatics
	Physical Methods Laboratory	1	S		1			Physics I.
	Chemical Experiments	1	E		2			none

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc with Research Chemist Specialization

(continued)

Year 2 (in addition to compulsory courses in Chemistry BSc without specialization):

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Analytical Chemistry III.	3	C		4			Inorganic Chem. I.
	Application of Radioactive Isotopes	3	S	2				Nuclear Chem.
Semester 2	Analytical Chemistry II.	5	C		6			Analytical Chem. I.
	Organic Stereochemistry and Reaction Mechanism	4	C	3				Organic Chem. II.
	Mathematical Methods in Chemistry	2	S				3	Mathematics II.
	Special and Dangerous Materials	3	E	2				Inorganic Chem. I., Organic Chem. II.

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc with Research Chemist Specialization

(continued)

Year 3 (in addition to compulsory courses in Chemistry BSc without specialization):

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 1	Organic Chemistry VI.*	8	C		6		2	Organic Chem. IV.
	Biochemistry II.	4	C		3		1	Biochem. I. (co-requisite)
	Macromolecular Chemistry I.	4	C	2			1	Organic Chem. II.
	Reaction Kinetics and Catalysis	4	S	2	2			Physical Chem. II.
	Colloid Chemistry II.	4	S	2	2			Colloid Chem. I.
	Inorganic Environmental Analytical Chemistry	4	S	1	4			Analytical Chem. I., Inorganic Chem. II.
	Atomic Absorption Spectroscopy	3	S	2				Analytical Chem. I.
	Principles of Medicinal Chemistry	3	S	2				Organic Chem. II.
	Analysis of Organic Micropollutants	3	S		3		1	Organic Chem. II., Analytical Chem. II., Separation Techniques
	Bioinorganic Chemistry	3	E	2				Inorganic Chem. II.
	Project	5	C		5-8			see subject description

* replaces Organic Chemistry V. for research chemist specialization

OUTLINE OF THE STUDY PROGRAMME

Chemistry BSc with Research Chemist Specialization

(continued)

Year 3 (in addition to compulsory courses in Chemistry BSc without specialization):

	Module/course unit title	Credits (ECTS)	Compulsory (C) Semi-optional (S) or Elective (E)	Total Teaching Hours				Pre-requisites
				Lecture	Practical		Seminar	
Semester 2	Structural Chemistry	5	C	2			2	Physical Chem. II.
	Theoretical Chemistry	2	C	1				Structural Chem. (co-requisite)
	Macromolecular Chemistry II.	4	C	2			1	Macromolecular Chem. I.
	Biochemistry III.	3	S	2				Biochem. I.
	Properties of Plastics	3	S		4			Macromolecular Chem. I.
	Macromolecular Colloids	4	S	2	2			Colloid Chem. I.
	Biological Macromolecules	3	S	2				Colloid Chem. I.
	Green Chemistry	3	E	2				Physical Chem. II., Organic Chem. II.

SUBJECT PROGRAMMES

(in alphabetical order)

ANALYSIS OF ORGANIC MICROPOLLUTANTS

Code: TKBL0304
Classes/week: 1 hour of problem-solving seminar, 3 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302), Spectroscopy (TKBE0503), Separation techniques (TKBE0502, TKBL0502)
Lecturer: Kiss, Attila

Topics: Place and role of organic analytics in GMP conditions in research and development, production, quality ensurance, protection of environment and health. Practice and parameters of organic analitics (ISO, ICH). Formation and characterization of instrument signal, measuring methods, validation of procedures regarding the quality of life, protection of environment and food safety. Qualitative and quantitative organic analytical applications of spectrophotometric methods (UV-Vis, IR, Raman, fluorescence), practical regulations of their applications. GLP (ISO, ICH, FDA, EPA) characterization and evaluation of separation methods (VRK, GC, HPLC, CE). Application of chromatographic methods, optimization of conditions. Methods for elemental and functional group analysis. Practice of organic mass spectrometry. Tandem spectrometry. Combined instrumental methods (GC-IR, GC-LC-CE-MS/MS, LC-NMR-MS/MS) and their application. GLP (ISO, ICH) practice of organic analytics for solving complex analytical problems, examples for the combined application of methods.

Compulsory/Recommended Readings:
J. R. Dean: Methods for environmental trace analysis, John Wiley & Sons, 2003.

ANALYTICAL CHEMISTRY I.

Code: TKBE0501
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Inorganic chemistry I. (TKBE0201), Physical chemistry I. (TKBE0401)
Lecturer: Fábián, István

Topics: Introduction to analytical chemsitry, characterization of measurements, basics of error estimation. Quantitative description of equilibria in solution (aqueous) phase: the definition of pH, equilibrium constant, solubility product, redox potential. Basics of titrimetry: acid-base, redox, precipitation and potentiometric titrations. Heterogeneous equilibria in analytical chemistry: gravimetry, extraction, chromatographic methods. The basics of atomic absorption and emission spectroscopic methods: principles and instrumentation. The instrumetation of UV-VIS spektroscopy; applications in analytical chemistry. Electrochemical methods: direct and indirect potentiometry, voltammetry, galvanometry, conductometry. Thermal analysis. The use of X-ray radiation in analytical chemistry. Kinetic methods in analytical chemistry. Sampling and sample preparation methods. Quality control and assurance in analytical chemistry.

Compulsory/Recommended Readings:
1. D.A. Skoog, D.M. West, F.J. Holler: Fundamentals of Analytical Chemistry, Saunders College Publ., New York, 1988
2. H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.: Instrumental methods of Analysis, Wadsworth Publ., Co., Belmont, CA, U.S.A., 1988

ANALYTICAL CHEMISTRY II.

Code: TKBL0503
Classes/week: 6 hours of laboratory work
ECTS Credit Points: 5
Prerequisites: Analytical Chemistry I. (TKBE0501), Analytical Chemistry Laboratory I. (TKBL0501)
Lecturer: Fábián, István

Topics: The following methods will be tought: atomic absorbtion spectrometry, atomic emission spectrometry, UV-VIS spectroscopy, infrared spectroscopy, light scattering spectroscopy, X-ray fluorescence spectroscopy, pH-metry, polarography, thermal analysis, chiral separation with HPLC, coupled analytical methods (HPLC-CD and GC-MS), validation of separation methods. The training is focused on the method-specific practical aspects of the evaluation of experimental data.

Compulsory/Recommended Readings:
1. D.A. Skoog, D.M. West, F.J. Holler: Fundamentals of Analytical Chemistry, Saunders College Publ., New York, 1988
2. H.H. Willard, L.L. Merritt Jr., J.A. Dean, F.A. Settle Jr.: Instrumental methods of Analysis, Wadsworth Publ., Co., Belmont, CA, U.S.A., 1988

ANALYTICAL CHEMISTRY III.

Code: TKBL0504
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Inorganic chemistry I. (TKBE0201), Inorganic chemistry laboratory (TKBL0201)
Lecturer: Fábián, István; Király, Róbert

Topics: Analysis of nonmetals and anions. Dissolution of some important metals and their properties in aqueous solutions. Reactions of cations with hydrogen sulfide. Reactions with precipitate-forming and complex-forming agents. Separation experiments. Complex analysis tests.

Compulsory/Recommended Readings:
1. Reeve, R.N., Environmental Analysis, John Wiley and Sons, Chichester, 1994

ANALYTICAL CHEMISTRY CALCULATIONS

Code: TKBG0501
Classes/week: 2 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: General Chemistry Problems (TKBG0101), Analytical chemistry I. (TKBE0501 co-requisite))
Lecturer: Fábián, István; Farkas, Etelka

Topics: Acid-base equilibria: Calculation of the pH for various monoprotic, polyprotic solutions, buffers, intermediate forms (ampholytes). Calculation of concentration distribution (fractional composition) diagram.
Acid-base titrations: Calculation of titration curves of strong acids and strong bases and monoprotic weak acids and bases.
Precipitate formation: The solubility product. The effects of the component excess of the pH on the solubility. The construction of the argentometric titration curves.
Complex equilibria in titrimetry: The analytical use of the complex stability constants, the calculation of conditional stability constant. The equilibrium concentrations of the components in the solution of parent complexes. The calculation of complexometric titration curves.
Redox titrations: The calculation of redox potentials in different individual redox systems and their mixtures. Calculation of equilibrium constants for redox reactions. Redox reactions in the titrimetry, the construction of redox titration curves.

Compulsory/Recommended Readings:
1. Problem Solving in Analytical Chemistry, A Practical Handbook plus Solutions Manual, Pergamon Press, Oxford, 1988

ANALYTICAL CHEMISTRY LABORATORY I.

Code: TKBL0501
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Inorganic chemistry laboratory (TKBL0201), Analytical chemistry I. (TKBE0501 co-requisite)
Lecturer: Fábián, István; Farkas, Etelka

Topics: Classical analytical methods, volumetric (acid-base, complexometric, precipitation and redox titrations) and gravimetric analyses (ca. 15-20 by titrimetry, ca. 2 samples by gravimetry during the course, most of them are environmentally or industrially important). Knowledge and skills needed to determine accurately and precisely the percent composition or the quantity of one or more of the components of varying unknowns. Individual work in most tasks, team-work in some examples. An individual complex task at the end of the course, in which the student has to choose the applied method, prepare the analytical sample, prepare the necessary titrant with known concentration or determine its concentration, and following the analysis, calculate and present the final results based on the collected experimental data.

Compulsory/Recommended Readings:
1. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Analytical Chemistry: An Introduction, 7th edition, Harcourt Inc., 2000,

2. C. Harris, Quantitative Chemical Analysis, 6th edition, W.H. Freeman and Company, New York, 2003

APPLICATION OF RADIOACTIVE ISOTOPES

Code: TKBE0506
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Nuclear chemistry (TKBE0405)
Lecturer: M. Nagy, Noémi

Topics: Basic principles of the interactions of radioactive radiation and matter. Radioactive indicators, physical chemistry of carrier-free isotopes. Labeling methods, radioactive tracers. The production of tracers: general methods. Production of ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{36}Cl isotopes. Place and distribution of the tracer atom in the molecules. Separation of radioactive isotopes. Role of mixing entropy in the labeling methods. Tracers in physical chemistry. Kinetics of homogenous and heterogeneous exchange reactions. Radioanalysis. Nuclear methods in the structural and surface studies. Industrial applications. Biological and medical applications. Physical chemistry of nuclear medicine.

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

APPLIED SPECTROSCOPY

Code: TKBL0001
Classes/week: 1 hour of problem-solving seminar, 5 hours of laboratory work
ECTS Credit Points: 5
Prerequisites: Organic chemistry II. (TKBE0302), Spectroscopy (TKBE0503), Inorganic chemistry II. (TKBE0202)
Lecturer: Patonay, Tamás

Topics: UV-Vis, IR, NMR, MS spectroscopy and diffraction methods for the organic and inorganic structure elucidation, determination of concentration and simple kinetic measurements. During the practice, the structural information and assignments gained from the different spectra and their combination are emphasized. In small seminar groups, the students practice their application with excercises from different fields of chemistry. Part of the tasks are solved during the preparation for the practice by using lecture notes, literature and/or electronic databases. The grade is determined by the achievement of the student during the practice and a test written at the end of the term measuring the problem-solving ability.

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

ATOMIC ABSORPTION SPECTROMETRY

Code: TKBE0505
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Analytical chemistry I. (TKBE0501)
Lecturer: Posta, József

Topics: The AAS method and its place among the instrumental methods of analysis. Theoretical aspects of the connection between light absorption and atomic structure. The basis of flame chemistry. Sample transformations in the flame, the space and time course of atomization, regulation of these processes. Characterization of flames of different composition, their analytical importance. Physical and chemical sample transformations in a heated graphite tube. Sample introduction methods and interferences in atomic absorption spectrometry. The parts of AAS instruments. The role of each unit in signal/noise rate improving. The theory and practice of background correction. Practical applications of AAS. Determination possibilities and conditions for elements, groups of elements from different types of samples. Sample demand, noise level, accuracy, reliability, limit of detection, analytical sensitivity. Practical aspects of analysis optimization. The influence of sample preparation on the determination of a given element.

Compulsory/Recommended Readings:
1. B. Welz, M. Sperling: Atomic Absorption Spectrometry, Wiley-VCH, New York, 1999

BASIC CHEMICAL INFORMATICS

Code: TKBL0901
Classes/week: 2 hours of computer practice
ECTS Credit Points: 2
Prerequisites: None
Lecturer: Kéki, Sándor; Nagy, István; Póta, György; Zékány, László

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.

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
1. Mark G. Sobell: A Practical Guide to Linux(R) Commands, Editors, and Shell Programming, Prentice Hall PTR, 2005

BASIC ECONOMICS AND MANAGEMENT

Code: TTBE0010
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: None
Lecturer: Országh, István

Topics: History and basic theoretical foundations of management science. Development of different management techniques, preparation for understaning and use of specific management techniques (project management, change managamenet, marketing management, innovation management, crisis management, financial management). Tools of management, conditions in technics, informatics and human resources.

BASIC RADIOCHEMICAL MEASUREMENTS

Code: TKBL0414
Classes/week: 2 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: Nuclear chemistry (TKBE0405 co-requisite)
Lecturer: Nagy, Noémi; Komlósi, Andrea; Nemes, Zoltán

Topics: Adjustment and calibration of a basic radiation detector. Gamma spectrometry. Isotope dilution analysis. Radiometric titration. Determination of short and long half life. Backscattering of beta radiation. Self-adsorption of beta radiation.

Compulsory/Recommended Readings:

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

BIOCHEMISTRY I.

Code: TBBE0302
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Organic chemistry III. (TKBE0303)
Lecturer: Kerékgyártó, János

Topics: Protein structure and function; Oxygen-transporting proteins; Enzymes and mechanisms of enzyme action; Structure and function of biological membranes; Carbohydrate metabolism: glycolysis and glyconeogenesis, glycogen metabolism, the pentose phosphate pathway; The citric acid cycle. Electron transport and oxidative phosphorylation; Fatty acid metabolism; Amino acid metabolism; Nucleotide metabolism.

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)

BIOCHEMISTRY II.

Code: TBBL0303
Classes/week: 1 hour of problem-solving seminar, 3 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Biochemistry I. (TBBE0302 co-requisite)
Lecturer: Gyémánt, Gyöngyi

Topics: Enzymes and mechanisms of enzyme action. Stability of enzymes, the influence of the reaction conditions on enzymatic activity. The Michaelis-Menten model for the kinetic properties of enzymes. Definition, significance and determination of K_M and v_{max}. Specific inhibition of enzymes and determination of the type of inhibition. Regulation of enzymes with allosteric interaction or covalent modification.
Preparation, activity measurement and kinetic investigation of some oxidoreductases and hydrolases.

Compulsory/Recommended Readings:
1. J. M. Berg, J. L. Tymoczko, L. Stryer: *Biochemistry* 5th ed. (W. H. Freeman and Co. 2002.)

BIOCHEMISTRY III.

Code: TBBE0304
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Biochemistry I. (TBBE0302)
Lecturer: Harangi, János; Kiss, László

Topics: Protein conformation, dynamics and function. Oxygen-transporting proteins, molecular pathology of haemoglobin. Blood clotting cascade. Proteins of immuno protection system: immunoglobulins. Proteins of mechanical support and coordinated motion: collagen, miozin. Structure and function of biological membranes. Glycoproteines, lipoproteines.

Membrane transport system. Enzymes and mechanisms of enzyme regulation. Synthesis of membrane lipids and steroid hormones. Metabolism of amino acids and nitrogen containing biomolecules. Viruses and oncogenes. Hormone action.

Compulsory/Recommended Readings:
1. J. M. Berg, J. L. Tymoczko, L. Stryer: *Biochemistry* 5th ed. (W. H. Freeman and Co. 2002)
2. C. K. Mathews, K. E van Holde, K. G. Ahern: *Biochemistry* 3rd ed. (Addison Wesley Longman 2000)
3. A. L. Lehninger, D. L. Nelson: *Principles of biochemistry* 3. ed (Worth 2000)

BIOINORGANIC CHEMISTRY

Code: TKBE0203
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Inorganic chemistry II. (TKBE0202)
Lecturer: Sóvágó, Imre; Várnagy, Katalin

Topics: Elementary composition and classification of the elements in biological systems. Essential, beneficial and toxic elements and their role in biochemical processes. Coordination chemistry of the most common bioligands including amino acids, peptides, proteins, carbohydrates, nucleotides and porphyrins. Characterization of the metalloproteins and metalloenzymes. The involvement of alkaline and alkaline earth metal ions biological processes: cation distribution and membrane transport processes. Binding, transport and activation of dioxygen molecule. The participation of iron and copper in the biological oxidation reactions. The structure and properties of iron and copper proteins. Biochemistry of zinc: zinc containing enzymes and zinc finger proteins. The involvement of other essential elements in biological processes: the enzymes/coenzymes of manganese, cobalt, nickel, molybdenum, vanadium and selenium. The use of inorganic compounds in therapy and diagnosis. The environmental aspects of inorganic substances.

Compulsory/Recommended Readings:
1. S. J. Lippard, J. M. Berg: Principles of bioinorganic chemistry, University Science books, Mill Valley, California, 1994.

BIOLOGICAL MACROMOLECULES

Code: TKBE0610
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Colloid chemistry I. (TKBE0404)
Lecturer: Borbély, János

Topics: Biological macromolecules, basic principles, type and sources, applications in the material science. Their importance in the protection of environment as renewable materials. Their role in the sustainable development. Polypeptides, proteins, polyelectrolytes. Natural amino acids, structure of proteins, rheological properties. Structural proteins, fibrous proteins, keratin, fibroin, silk, elastine. Polysaccharides, hydrocolloids. Cellulose, starch, chitin, chitozan, alginates, hyaluronic acid, carrageenan. Importance in medicine and nutrition. Rheological modifiers.

Compulsory/Recommended Readings:

2. „Chemistry of Natural Products" ***Bhat***, Sujata V., ***Nagasampagi***, Bhimsen A., ***Sivakumar***, Meenakshi, 2005, ISBN: 978-3-540-40669-3
3. „Plant Biopolymer Science · Food and Non-Food Applications", Renard, D., Valle, D., Popineau, Y. (Eds.), 2002, ISBN 978-0-85404-856-4

BSc Thesis

Code: TKBL0003
Classes/week: 15 hours of laboratory work
ECTS Credit Points: 10
Prerequisites: at least 150 credits, at least 21 credits basic scientific, general subjects, at least 80 credits core courses
Lecturer: Somsák, László; individually assigned supervisors

Topics: Individual laboratory research in one of the research groups of the Chemistry Institute with the guidance of a supervisor. Students are expected to carry out novel research 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.

Chemical Concepts and Misconceptions

Code: TKBG0103
Classes/week: 2 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: None
Lecturer: Tóth, Zoltán

Topics: Conceptual development and conceptual change. Specific nature of chemical concepts. Misconceptions and alternative theories. Exploring and discussing students misconceptions.

Compulsory/Recommended Readings:
1. selected articles from the last 2 decades published in the Journal of Chemical Education
2. J.McMurray, R.C. Fay, Chemistry, Pearson Education , Inc., New Yersey, 2004.
3. S.S. Zumdahl, Chemistry, D.C. Heath and company, Lexington MA, 1993.

Chemical Experiments

Code: TKBL0102
Classes/week: 2 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: None
Lecturer: Tóth, Zoltán

Topics: Microscale experiments on tile: diffusion, solubility, acid-base reactions. Electrochemical experiments: electrolysis, galvanic cells. Preparation and reactions of gases: hydrogen, oxygen, chlorine, hydrogen chloride, nitrogen dioxide, and acetylene. Reactions of

metals with water, acids, bases, and with metal ions. Experiments using simple apparatus by Obendrauf: evolution and reactions of oxygen, hydrogen, carbon dioxide, acetylene, ammonia, chlorine, nitric oxides, and carbon monoxide. Exciting experiments.

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.

CHEMICAL INFORMATICS

Code: TKBL0902
Classes/week: 2 hours of computer practice
ECTS Credit Points: 2
Prerequisites: Basic chemical informatics (TKBL0901)
Lecturer: Kéki, Sándor

Topics: Application of mathemathical(i.e.. Derive, Maple, Mathematica, Scilab, Octave, Mupad etc.) and table manager programs in chemistry. Instrument controlling and evaluating softwares. Chemistry on the internet, databases, papers, books. Softwares and hardwares needed for quality presentations: drawing chemical structures with coputer, 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

CHEMICAL PROGRAMMING

Code: TKBE0001
Classes/week: 2 hours of computer practice
ECTS Credit Points: 2
Prerequisites: Basic chemical informatics (TKBL0901)
Lecturer: Póta, György; Zékány, László

Topics: Elements of computer programming. The basic usage and application of the chosen programming language. Computer studies into different mathematical objects. Detailed investigation of the numerical algorithms for the solutions of equations and the principle of the least squares. Other numerical methods applied to the solutions of chemical problems (using library routines).

Compulsory/Recommended Readings:
1. Pauline Cushman, Ramon Mata-Toledo: Schaum's Outline of Introduction to Computer Science, McGraw-Hill 2000
2. S. Chapra: Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill, 2007
3. Mike McGrath: Linux in Easy Steps, Computer Step; 2Rev Ed edition, 2006

CHEMICAL TECHNOLOGY I.

Code: TKBE0601
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar, 5 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: General chemistry (TKBE0101)
Lecturer: Kéki, Sándor

Topics: Laboratory chemical reactors and large-scale industrial reactors: stirred-tank reactor, tubular reactor, fluidized bed reactor; catalytic reactors: tubular catalytic wall reactor, fixed bed catalytic reactor; kilns, furnaces, incinerators. Size reduction: grinding and cutting. Operations involving particulate solids. Sieves. Air classification, dense-medium separators, flotation cells, magnetic separators, electrostatic separators. Mechanical separations: sedimentation, decantation, clarification, filtration, centrifugation. Filters. Centrifuges and cyclones. Fluidization, fluidized beds. Agitation and Mixing. Homogenization. Mixing equipments: liquid mixers, powder and particle mixers, dough and paste mixers. Heat transfer and its applications. Heating and cooling. Flow of heat: conduction, convection, radiation. Heat-exchangers. Mass transfer and its applications. Azeotropes. Batch distillation. Continuous distillation. Vacuum distillation. Steam distillation. Extractive distillation. Azeotropic distillation. Distillation columns. Extraction (liquid-liquid and solid-liquid extraction). Evaporators. Drying. Crystallizers. Membrane separation processes: microfiltration, ultrafiltration, reverse osmosis (= hyperfiltration), pervaporation.

Compulsory/Recommended Readings:

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Federal Republic of Germany, VCH, Weinheim, Volumes: B1-B8, 1990-1995.
2. W. L. McCabe; J. C. Smith, and P. Harriott: Chemical Engineering Unit Operations, 7th Ed., McGraw Hill, New York, 2004.
3. W. F. Smith: Foundation of Materials Science and Engineering, 2nd Ed., McGraw-Hill, New York, 1993.

CHEMICAL TECHNOLOGY SEMINAR I.

Code: TKBG0601
Classes/week: 1 hour of problem-solving seminar
ECTS Credit Points: 1
Prerequisites: General chemistry (TKBE0101)
Lecturer: Nemes, Sándor

Topics: Laboratory chemical reactors and large-scale industrial reactors: stirred-tank reactor, tubular reactor, fluidized bed reactor; catalytic reactors: tubular catalytic wall reactor, fixed bed catalytic reactor; kilns, furnaces, incinerators. Size reduction: grinding and cutting. Operations involving particulate solids. Sieves. Air classification, dense-medium separators, flotation cells, magnetic separators, electrostatic separators. Mechanical separations: sedimentation, decantation, clarification, filtration, centrifugation. Filters. Centrifuges and cyclones. Fluidization, fluidized beds. Agitation and Mixing. Homogenization. Mixing equipments: liquid mixers, powder and particle mixers, dough and paste mixers. Heat transfer and its applications. Heating and cooling. Flow of heat: conduction, convection, radiation. Heat-exchangers. Mass transfer and its applications. Azeotropes. Batch distillation. Continuous distillation. Vacuum distillation. Steam distillation. Extractive distillation.

Azeotropic distillation. Distillation columns. Extraction (liquid-liquid and solid-liquid extraction). Evaporators. Drying. Crystallizers. Membrane separation processes: microfiltration, ultrafiltration, reverse osmosis (= hyperfiltration), pervaporation.

Compulsory/Recommended Readings:

1. Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., Federal Republic of Germany, VCH, Weinheim, Volumes: B1-B8, 1990-1995.
2. W. L. McCabe; J. C. Smith, and P. Harriott: Chemical Engineering Unit Operations, 7th Ed., McGraw Hill, New York, 2004.
3. W. F. Smith: Foundation of Materials Science and Engineering, 2nd Ed., McGraw-Hill, New York, 1993.

CHEMICAL TECHNOLOGY II.

Code: TKBE0602
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Chemical technology I. (TKBE0601), Chemical technology seminar I. (TKBG0601)
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. Corrosion, protection against corrosion. Process of silicates: ceramics, glass and enamel, cement and concrete. Coal. Process of natural gas and crude oil. Petrochemical processes and products. Plastics. Fermentation technologies: production of yeast, ethanol, beer, vinegar. Agricultural technologies: production of saccharose, starch, cellulose. Safety and environmental protection in the chemical industry.

Compulsory/Recommended Readings:

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

CHEMICAL TECHNOLOGY SEMINAR II.

Code: TKBG0602
Classes/week: 1 hour of problem-solving seminar
ECTS Credit Points: 1
Prerequisites: Chemical technology I. (TKBE0601), Chemical technology seminar I. (TKBG0601)
Lecturer: Zsuga, Miklós

Topics: Exploration of the terms, laws of lecture topics. Problem solving and calculations based on technologies. Overview of flowcharts and processes.

Compulsory/Recommended Readings:

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

COLLOID CHEMISTRY I.

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

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

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

COLLOID CHEMISTRY II.

Code: TKBE0415
Classes/week: 2 hours of lecture, 2 hours of laboratory work
ECTS Credit Points: 2
Prerequisites: Colloid chemistry I. (TKBE0404), Colloid chemistry laboratory (TKBL0404)
Lecturer: Bányai, István

Topics: *Lecture:* Colloid and interfacial chemistry of environmental phenomena. Interfacial phenomena in the atmosphere: gas-solid, gas-liquid systems. Formation of smog. Colloid and interfacial phenomena in surface water, liquid-liquid, liquid-solid interactions. Transport processes in the environment. Migration of pollutants in the atmosphere, hydrosphere and lithosphere. Environmental colloid techniques: flocculation, ion exchange, membrane filtration.
Laboraotory practice: Study of colloid and interfacial phenomena. Adsorption on solid-liquid interface (analog of surface water). Adsorption on solid-gas interface (analog of atmospheric conditions). Determination of particle size in dispersions (sediments from water, air). Rheological phenomena (oil products, gels). Macromolecular colloids (artificial and biological macromolecules). Separation on membrane surfaces (decontamination by ultrafiltration, inverse osmosis.)

Compulsory/Recommended Readings:
1. Richard Pashley, Marilyn Karaman, Applied Colloid and Surface Chemistry, Wiley 2004,
2. H. Yildirim Elbir, Surface Chemistry of Solid and Liquid Interfaces, Blackwell Publishing Ltd. 2006

COLLOID CHEMISTRY LABORATORY

Code: TKBL0404
Classes/week: 2 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: Introductory Physical Chemistry Laboratory Practice (TKBL0401), Colloid chemistry (TKBE0404 co-requisite)
Lecturer: Bányai, István

Topics: Adsorption on solid-liquid interface. Surface tension of solutions. Separation of dyes by paper electrophoresis. Effect of macromolecules on the sol stability. Determination of average mol mass of polymers by viscosimetry. Study of solubility. Sedimentation analysis. Determination of critical micelle concentration of association colloid by electric conductivity.

Compulsory/Recommended Readings:
1. M. Berka: Manual for Colloid Chemistry practical course (2006), handouts

CRYSTALLOGRAPHY

Code: TGBE1124
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: None
Lecturer: Papp, István

Topics: The crystal lattice and unit cells. Symmetry of crystals. The laws of crystal morphology and the morphological system of crystals. Crystal forms, combinations, twinning. Basic laws of crystal chemistry. Ionic, covalent, metallic and molecular crystal lattices; discussion of their most important types. Relationship between physical (cohesional and optical) properties and lattice structure. The polarization microscope.

Compulsory/Recommended Readings:
1. Buerger, Martin Julian Introduction to crystal geometry / [by] Martin J. Buerger [1971]
2. Cartmell, Edward Principles of crystal chemistry / [by] E. Cartmell 1971
3. Massa, Werner Crystal structure determination / Werner Massa ; translated into English by Robert O. Gould 2000
4. Chemical crystallography / edited by J. M. Robertson [1975]
5. International tables for crystallography. Brief teaching edition of volume A, Space-group symmetry / edited by Theo Hahn [1999]

ENVIRONMENTAL CHEMISTRY AND TECHNOLOGY

Code: TKBE0606
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: Chemical technology II. (TKBE0602), Chemical technology seminar II. (TKBG0602)
Lecturer: Borbély, János; Borda, Jenő; Török, János

Topics: The status of the ecosystem. Environment changes from natural and anthropogenic activities. Environmental pollution caused by different materials. Air pollution, reactions in the air. Ozone degradation and its mechanism. Air pollution from energy production and traffic. Climate change and its effects. The status of the hydrosphere. Water-pollutant materials. The chemistry of water cleaning. The chemical basis of the environmental protection. The environmental effects of production processes. Reduced waste technologies. Types and characterization of wastes. Principles and solutions of modern waste management. Gas (vapor), liquid and solid industrial wastes and operational techniques for their handling. The additional protection of environment, the integrated protection of environment to the production processes and product. The environmental pollution of the most important branches of industry. Principles of their handling. Dangerous wastes and their handling. Communal wastes and possibilities for their handling. Waste burning, storing and recycling.

Compulsory/Recommended Readings:

1. G. W. van Loon, S. J. Duffy: Environmental Chemistry, 2000.
2. R. P. Wayne: Chemistry of Atmospheres, 2000.
3. A. Boyce: Introduction to Environmental Technology (John Wiley & Sons Inc 1997)
4. G. Burke, B. Ramnarine Singh, L. Theodore: Handbook of Environmental Management and Technology (John Wiley & Sons Inc

ENVIRONMENTAL SCIENCE

Code: TTBE0040
Classes/week: 1 hour of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: None
Lecturer: Lakatos, Gyula

Topics: Environmental sciences and ecological principles. Terminological system of our environment. Environmental sciences and their interdisciplinary nature. Challenge for science. The principle of precaution. Environmental problems. Natural environment. The surface of the Earth. Soil, the hydrosphere, the atmosphere. The history of natural conservation and environmental protection; sustainable development. The economics of human populations and environmental resources. Growth limits. Human demography. The future of human populations. Resources and reserves. Soil as a natural resource and sustainable agriculture. Biological resources. The effect of human activity on the natural environment. Pollution of the atmosphere. Water pollution. Environmental pollution from industries. Technological forecasts and the environment. Sustainable development as a challenge.

Compulsory/Recommended Readings:

1. Brundtland, G.H. (Chair) 1987: Our common future. Oxford: Oxford University Press.

2. Cunningham, W.P. & Saigo, B.W. 1995: Environmental Science. A global concern. Dubuque: Wm.C. Brown Publishers.
3. Jackson, A,R.W., Jackson, J.M. 1996: Environmental Science. The natural environment and human impact. Longman, Singapore.

GENERAL CHEMISTRY

Code: TKBE0101
Classes/week: 3 hours of lecture
ECTS Credit Points: 5
Prerequisites: None
Lecturer: Sóvágó, Imre

Topics: Subject, history and development of chemistry and its relation to other natural sciences. Structure of atoms and molecules, electron configurations, atomic orbitals and periodicity. Different forms of chemical bonding: ionic and metallic bonds, and structure of ionic solids and metals. Covalent bonds and molecular structure. Basic concepts of stoichiometry. Gases, liquids, solids and phases changes. Solutions and their properties. Basic laws of thermochemistry, chemical kinetics, and their applications. Chemical equilibrium and its application in various fields of chemistry. The classification of chemical reactions: acid-base concepts and redox reactions. Basic concepts of electrochemistry and its applications.

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.

GENERAL CHEMISTRY LABORATORY

Code: TKBL0101
Classes/week: 3 hours of laboratory work
ECTS Credit Points: 2
Prerequisites: General chemistry (TKBE0101 co-requisite)
Lecturer: Sóvágó, Imre; Várnagy, Katalin

Topics: Students acquire the handling of laboratory equipment (glass-, metal- and wood-equipment), learn the basic measuring procedures (mass, volume, temperature, density) and other manual laboratory techniques (heating, cooling, preparation of solution, diluting, crystallization, decanting, filtration, titration, producing gases in the laboratory, handling of gas-cylinders). Students are expected to prepare certain simple chemicals and run various basic experiments to familiarize themselves with chemical laboratory work.

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.

GENERAL CHEMISTRY PROBLEMS

Code: TKBG0101
Classes/week: 2 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: General chemistry (TKBE0101 co-requisite)
Lecturer: Sóvágó, Imre; Várnagy, Katalin

Topics: Basic concepts (chemical symbol, formula, amount of substance, atomic weight, molecular weight) and their application in stoichiometric calculations. Concentration units (percent compositions, molar concentration, molality, etc.) and their application in exercises connected to the concentration calculations. Principles of oxidation number and balancing of reactions, calculations based on reactions. Gas laws and their application in different type of exercises connected to evolution of gases. Definition of pH, calculation of pH for monoprotic acids and bases.

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.

GREEN CHEMISTRY

Code: TKBE0002
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physical chemistry II. (TKBE0402), Organic chemistry II. (TKBE0302)
Lecturer: Joó, Ferenc; Patonay, Tamás; Somsák, László

Topics: Relationship between chemistry and the environment. Definition of green chemistry, quantitative description of the green character of chemical procedures: atom efficiency, the E-factor, complex evaluation of the environmental, health and safety (EHS) characteristics. Life cycle analysis. The twelve principles of green chemistry (according to Anastas and Warner). Devising green procedures and products, elimination of toxic and environmentally harmful components. Syntheses without the use of chlorine. Alternative, renewable energy sources and raw materials. Chemical syntheses using biological raw materials. Alternative solvents instead of volatile organic solvents: water, ionic liquids, fluorous solvents, supercritical fluids. Syntheses with no solvents. Replacement of toxic stoichiometric reagents with environmentally friendly ones – oxidations with air and hydrogen peroxide. Selective homogeneous, heterogeneous and biocatalytic processes and their role in green chemistry. Catalytic syntheses in biphasic or multiphasic liquid systems. Relation of green chemistry and energy consumption. Photochemical and microwave promoted syntheses. Industrial and social impact of green chemistry. National and international organizations supporting the development and spreading of green chemical investigations and green industrial developments.

Compulsory/Recommended Readings:
1. P. T. Anastas, J. C. Warner: *Green Chemistry, Theory and Practice*, Oxford University Press, 1998.
2. S. Matlack: *Introduction to Green Chemistry*, Marcel Dekker, 2001.

HISTORY AND STRUCTURE OF THE EUROPEAN UNION

Code: TTBE0030
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: None
Lecturer: Teperics, Károly

Topics: Institutional system of the EU. Reform processes in EU integration. General questions of EU enlargement. Specific properties of the fifth stage of EU enlargement and the EU membership of Hungary.

Compulsory/Recommended Readings:

1. The European Union: A Very Short Introduction. by John Pinder (Oxford, 2001) ISBN 978-0-19-285375-2
2. The Institutions of the European Union. edited by John Peterson, Michael Shackleton, 2nd edition (Oxford University Press, 2006) ISBN 0198700520

INDUSTRIAL PLACEMENT

Code: TKBX0607
Classes: 4 weeks of practice in the summer after semester 4
ECTS Credit Points: 0
Prerequisites: Chemical technology I. (TKBE0601), Chemical technology seminar I. (TKBG0601)
Lecturer: Borda, Jenő; Nemes, Sándor (organizers)

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.

INORGANIC CHEMISTRY I.

Code: TKBE0201
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: General chemistry (TKBE0101)
Lecturer: Sóvágó, Imre; Lázár, István

Topics: Physical and chemical properties of hydrogen, the nonmetals and metallic elements of the p-group, their occurrence in nature, basic methods of their laboratory scale preparation

and industrial production. Most important structural classes, chemical reactions, thermal and hydrolytic stabilities, acid-base and redox properties of their compounds, with an emphasis on the detailed description of their hydrides, hydroxides, oxides, oxoacids and sulfides. Biological and toxicological properties of the elements and their compounds. Laboratory scale and industrial production methods of the most important compounds. Review of the compounds and ions with an emphasis on their coordination chemistry properties. Analytical chemistry of the related elements and compounds. Practical applications of the elements and compounds in the everyday life, in the laboratory and in the industry.

Compulsory/Recommended Readings:
1. N.N. Greenwood, A. Earnshaw: Chemistry of the Elements, Butterworth-Heinemann, Pergamon Press, 1997.

INORGANIC CHEMISTRY II.

Code: TKBE0202
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Inorganic chemistry I. (TKBE0201)
Lecturer: Sóvágó, Imre

Topics: Alkaline and alkaline earth metals: general characterization, properties, occurrence and preparation, applications and most important compounds. The general characterization and preparation of transition elements. Hydrides, halides, oxides and other binary compounds of transition elements and their applications. Introduction to coordination chemistry: types of ligands and complexes. The properties of lanthanides and actinides. Introduction to bioinorganic chemistry, the environmental aspects of inorganic substances. Classification and properties of organometallic compounds.

Compulsory/Recommended Readings:
N.N. Greenwood, A. Earnshaw: Chemistry of the Elements, Butterworth-Heinemann, Pergamon Press, 1997.

INORGANIC CHEMISTRY LABORATORY

Code: TKBL0201
Classes/week: 6 hours of laboratory work
ECTS Credit Points: 4
Prerequisites: General chemistry (TKBE0101), General chemistry laboratory (TKBL0101), Inorganic chemistry I. (TKBE0201 co-requisite)
Lecturer: Sóvágó, Imre; Buglyó, Péter

Topics: Hydrogen and its most important compounds. The most significant **p**-block elements and their compounds. The metals of the **s**-block and their important compounds. Transition metals and their more important compounds. Preparation of basic compounds using inorganic chemical reactions and using common measuring instruments.

Compulsory/Recommended Readings:
N.N. Greenwood, A. Earnshaw: Chemistry of the Elements, Butterworth-Heinemann, Pergamon Press, 1997.

INTRODUCTION TO CHEMICAL CALCULATIONS

Code: TKBG0102
Classes/week: 2 hours problem-solving seminar
ECTS Credit Points: 2
Prerequisites: None
Lecturer: Tóth, Zoltán

Topics: Units and unit conversions. Significant figures. Calculation with formula or proportional method. Explicit and implicit data. Pathway from given to objective and vice versa. Metacognitive aspects of problem-solving. Problem-solving strategies in the following main topics: composition of solutions; diluting and concentrating solutions; the empirical and the molecular formula; balancing chemical equations; stoichiometry; limiting reagent; chemical equilibrium.

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.

INTRODUCTORY PHYSICAL CHEMISTRY LABORATORY PRACTICE

Code: TKBL0401
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: General chemistry (TKBE0101), General chemistry laboratory (TKBL0101), General chemistry problems (TKBG0101)
Lecturer: Kathó, Ágnes, Horváth-Csajbók, Éva

Topics: Conductometry, pH-potentiometry, gas-volumetric measurements, spectrophotometry, polarimetry, electrolysis (coulombmetry), colligative properties of solutions (freezing point depression by dissolved material), basic calorimetry, effect of changing molarity on density of two-component liquid mixtures.

Compulsory/Recommended Readings:
1. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

MACROMOLECULAR CHEMISTRY I.

Code: TKBE0603
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Zsuga, Miklós

Topics: Classification of polymers. Structure, chemical structure and fine structure of the polimer chain. Polymolecularity. Molecular weight averages, molecular weight distribution and their determination. Size exclusion Chromatography. MALDI TOF Mass Spectrometry.

Physical states of polymers, glass transition temperature. Characterization of amorph polymers. Crystallization of polymers, polymer solutions. Synthesis of macromolecules. Radical polymerization. Basic steps of radical polymerization. Radical initiation, propagation, termination, chain transfer, inhibition and retardation. Kinetics of radical polymerization, radical copolymerization. Ionic polymerization. Stereospecific polymerization. Polycondensation. Poliaddition. Ring opening polymerization. Polymer analog reactions.

Compulsory/Recommended Readings:

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

MACROMOLECULAR CHEMISTRY SEMINAR I.

Code: TKBG0603
Classes/week: 1 hour of problem-solving seminar, 5 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Zsuga, Miklós

Topics: Calculations based on basic macrololecular properties like: molecular weight, molecular weight distribution, degree of polymerization... etc.

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).

MACROMOLECULAR CHEMISTRY II.

Code: TKBE0604
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Macromolecular chemistry I. (TKBE0603), Macromolecular chemistry seminar I. (TKBG0603)
Lecturer: Deák, György

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

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

MACROMOLECULAR CHEMISTRY SEMINAR II.

Code: TKBG0604
Classes/week: 1 hour of problem-solving seminar
ECTS Credit Points: 1
Prerequisites: Macromolecular chemistry I. (TKBE0603), Macromolecular chemistry seminar I. (TKBG0603)
Lecturer: Deák, György

Topics: Structure and properties of polymers as related to their chemical structure, composition and mechanical treatment. “Bear-hand” and “naked eye” analysis of 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).

MACROMOLECULAR COLLOIDS

Code: TKBE0609
Classes/week: 2 hours of lecture, 2 hours of laboratory work
ECTS Credit Points: 4
Prerequisites: Colloid chemistry I. (TKBE0404)
Lecturer: Borbély, János

Topics: *Lecture*: Structure and hierarhy of macromolecules. Macromolecular solutions as colloid systems, their shape, osmotic pressure, light scattering. Separation by fractionalization. Polyelectrolites. Stability. Donnan membrane equilibrium. Macromolecules and disperse systems. Paints and coatings. Film formation. Fillers and pigments. Rheological properties of linear and branched macromolecules. Ionic polymers. Copolymers and their structure. Reactivity of monomers. Industrial polymerization, homogeneous solution, emulsions. Solubility, crosslinked structures, swelling, degradation. Mechanical and thermal properties. Polymer based nanosystems.
Practice: Rheological properties of polymers in solution and in molten state. Food additives. Rheological modifiers in pharmacy. Characterization of size by light scattering. Synthesis of gels and microgels. Mechanical and swelling properties of hydrogels. Membrane filtration. Gel electrophoresis. Purification of biomacromolecules by ultrafiltration. Dialysis of proteins. Emulsion polymerizacion. Polymer dispersions and film formation.

Compulsory/Recommended Readings:
1. „Colloidal Polymers” ed. A. Elaissari, 2003, ISBN: 0-8247-4304-0
2. „Colloidal Biomolecules, Biomaterials, and Biomedical Applications” ed. A. Elaissari, 2003, ISBN: 0-8247-4779-8

MATHEMATICAL METHODS IN CHEMISTRY

Code: TKBL0904
Classes/week: 2 hours of computer practice
ECTS Credit Points: 2
Prerequisites: Mathematics II. (TMBE0607), Mathematics seminar II. (TMBG0607)
Lecturer: Póta, György; Zékány, László

Topics: Function transformations (Laplace, Fourier etc.) and their applications in the modern analytical devices and methods. Differential equations in reaction kinetics and quantum chemistry: analytical solutions, numerical treatment, software. Curve fitting, statistical applications. Experimental planning/design.

Compulsory/Recommended Readings:
1. Ramesh Kumari: Computers and Their Applications to Chemistry**,** Narosa, 2002

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

MATHEMATICS SEMINAR I.

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

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

MATHEMATICS SEMINAR II.

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

METHODS OF INORGANIC ENVIRONMENTAL ANALYTICAL CHEMISTRY

Code: TKBE0205
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: Analytical chemistry I. (TKBE0501), Inorganic chemistry II. (TKBE0202)
Lecturer: Fábián, István; Braun, Mihály

Topics: The main parts of the design of environmental analytical research will be illustrated by case studies. The special instrumental analytical methods will be introduced in detail. The Hungarian and ISO standards connected with the determination of the major inorganic components and pollutants in superficial and drinking water, soil, air will be discussed. The methods used for field measurements will be explained in full. Theoretical matter needed for the laboratory practice is taught in the first part of the semester.

Compulsory/Recommended Readings:
1. Reeve, R.N., Environmental Analysis, John Wiley and Sons, Chichester, 1994

METHODS OF INORGANIC ENVIRONMENTAL ANALYTICAL CHEMISTRY LABORATORY

Code: TKBL0202
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Analytical chemistry I. (TKBL0501), Methods of Inorganic Environmental Analytical Chemistry (TKBE0205)
Lecturer: Fábián, István; Braun, Mihály

Topics: The analytical methods of inorganic components in the most common types of environmental samples (soil, superficial-, drinking water, air) will be introduced on the laboratory practices. The evaluation and report of results and the validation of measuring methods will be discussed. The practices will be done by groups of 4-5 students. They have to determine the chemical components of unknown environmental samples. The results of measurements will be summarized and the most frequent analytical problems will be discussed at the end of the semester.

Compulsory/Recommended Readings:
1. Reeve, R.N., Environmental Analysis, John Wiley and Sons, Chichester, 1994

NUCLEAR CHEMISTRY

Code: TKBE0001
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: General chemistry (TKBE0101)
Lecturer: M. Nagy, Noémi

Topics: 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. Radioactive isotopes in the environment.

Compulsory/Recommended Readings:

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

ORGANIC CHEMISTRY I.

Code: TKBE0301
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: General chemistry (TKBE0101)
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:

E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994

ORGANIC CHEMISTRY II.

Code: TKBE0302
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: Organic chemistry I. (TKBE0301)
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. Compounds containing sulfur and nitrogen, oxo compounds, carboxylic acids and their derivatives, carbonic acid derivatives, substituted carboxylic acids, nomenclature, preparation and chemical properties of important heterocyclic compounds. Evaluation of their physical and chemical properties according to their structure. Presenting the main properties of fundamental natural products such as carbohydrates, peptides, proteins and nucleic acids.

Compulsory/Recommended Readings:
E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994

ORGANIC CHEMISTRY III.

Code: TKBE0303
Classes/week: 2 hours of lecturek
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302)
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. Natural organic compounds are discussed in the frame of “biological chemistry”.
The chemistry of biologically important natural products such as amino acids (peptides, proteins), carbohydrates, nucleic acids, flavonoids, alkaloids, antibiotics and compounds with isoprene and porphine skeleton. Elucidation of the composition and structure of organic compounds, presenting the applicability and theory of spectroscopic methods.

Compulsory/Recommended Readings:
1. E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994

ORGANIC CHEMISTRY IV.

Code: TKBL0301
Classes/week: 1 hour of problem-solving seminar, 3 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302), General chemistry laboratory (TKBL0101)
Lecturer: Juhász-Tóth, Éva; Gulácsi, Katalin; Illyés, Tünde Zita

Topics: Seminar: Explaining the mechanism of test tube reactions suitable for the identification of organic compounds such as hydrocarbons, alcohols, phenols, alkyl halides, amines, aldehydes and ketones. Synthetic procedures for the preparation of carbonyl derivatives. Condensation reactions. Theoretical background of destillation methods. Heating, cooling and drying. Principles of purification methods (filtration, recrystallization, extraction, column and flash chromatography). Methods for the characterization and identification of the product. Laboratory practice: Application of the test tube reaction acquired during the seminar, identification of an unknown sample, learning basic organic synthetic procedures, performing simple reactions. Isolation of a natural product from plant source.

Compulsory/Recommended Readings:
1. E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994
2. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, Blackie Academic & Professional, Glasgow, U.K., 1993

ORGANIC CHEMISTRY V.

Code: TKBL0302
Classes/week: 2 hours of problem-solving seminar, 3 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Organic chemistry IV. (TKBL0301)
Lecturer: Juhász-Tóth, Éva; Gulácsi, Katalin; Illyés, Tünde Zita

Topics: *Seminar*: C-C bond formation in acid- and base-catalyzed reactions. Addition to C=C, C≡C and C=O bonds. Formation of C-N and C-O bonds. Aromatic electrophilic and nucleophilic substitution, reactions of arene diazonium salts. Interconversion of functional groups. Oxidation and reduction methods. Three-, five- and six-membered heterocyclic compounds. Application of organometallic reagents in organic chemistry. Enzyme-catalyzed chemical transformations. Enantioselective synthetic methods. Principles of retrosynthetic analysis.
Laboratory practice: Students prepare ten compounds independently, whose synthesis belongs to different topics such as nucleophilic substitution, electrophilic and nucleophilic addition, elimination, introduction of functinal groups to aromatic compounds, preparation of heterocycles, C-C bond formation, phase- transfer reactions.

Compulsory/Recommended Readings:
1. E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994
2. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, Blackie Academic & Professional, Glasgow, U.K., 1993

ORGANIC CHEMISTRY VI.

Code: TKBL0303
Classes/week: 2 hours problem-solving seminar, 6 hours of laboratory work
ECTS Credit Points: 5
Prerequisites: Organic chemistry IV. (TKBL0301)
Lecturer: Juhász-Tóth, Éva; Gulácsi, Katalin; Illyés, Tünde Zita

Topics: *Seminar*: C-C bond formation in acid- and base-catalyzed reactions. Addition to C=C, C≡C and C=O bonds. Formation of C-N and C-O bonds. Aromatic electrophilic and nucleophilic substitution, reactions of arene diazonium salts. Interconversion of functional groups. Oxidation and reduction methods. Three-, five- and six-membered heterocyclic compounds. Application of organometallic reagents in organic chemistry. Enzyme-catalyzed chemical transformations. Enantioselective synthetic methods. Principles of retrosynthetic analysis.
Laboratory Practice: Students prepare sixteen compounds independently. A literature survey and a task modelling the structure elucidation of an unknown compound are also included.

Compulsory/Recommended Readings:
1. E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solved problems in Organic Chemistry, McGraww-Hill INC, 1994
2. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, Blackie Academic & Professional, Glasgow, U.K., 1993

ORGANIC STEREOCHEMISTRY AND REACTION MECHANISMS

Code: TKBE0304
Classes/week: 3 hours of lecture
ECTS Credit Points: 4
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Patonay, Tamás; Somsák, László

Topics: Configurational and conformational isomers, chirality and its connection to biological effects. Properties of diastereomers and enantiomers. Enantiomeric excess and its determination. Racemization and resolvation. Basic principles of asymmetric synthesis, kinetic resolution and enzyme-catalyzed methods. Understanding the mechanism of organic reactions, methods for the determination of reaction mechanisms. Reactive intermediates, solvent effects and their classification and characterization. Fundamental ionic substitution, addition, elimination and aldol mechanisms.

Compulsory/Recommended Readings:
1. E.L. Eliel – S.H. Wilen: Stereochemistry of Organic Compounds, Wiley, 1994.
2. Aitken – A.S. Kilényi: Asymmetric Synthesis, Blackie, 1992.
3. Laszlo, P. – Organic Reactions, Simplicity and Logic, Wiley, 1995.

PHYSICAL CHEMISTRY I.

Code: TKBE0401
Classes/week: 2 hours of lecture, 2 hours of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: General chemistry (TKBE0101), Mathematics I. (TMBE0606), Mathematics semainar I. (TMBG0606), Basic chemical informatics (TKBL0901), Physics I. (TFBE2101)
Lecturer: Gáspár, Vilmos

Topics: The perfect gas; the kinetic theory of gases; non-ideal gases; fundamentals of thermodynamics (first law: internal energy, heat and work; enthalpy and thermochemistry; second law: entropy and change; heat engines; third law; potential functions and free energy); phase equilibria and phase transitions: evaporation, boiling and melting; ideal and non-ideal mixtures and solutions; colligative properties; chemical potential and fundamentals of chemical equilibria; response to changes: Le Chatelier's Principle.

Compulsory/Recommended Readings:
1. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

PHYSICAL CHEMISTRY II.

Code: TKBE0402
Classes/week: 3 hours of lecture, 2 hours of problem-solving seminar
ECTS Credit Points: 5
Prerequisites: Physical chemistry I. (TKBE0401)
Lecturer: Bányai, István

Topics: *Lecture*: Equlibiria in electrolyte solutions. Electrodes, galvanic cells, electrode and cell potentials. Nernst equation. Molecular motion in gases and liquids. Transport properties. Electrolytic conductivities. Diffusion equation. Rate, empirical rate laws and mechanism of chemical reactions. Activation and catalysis. Rate theories. Heterogeneous reactions, dynamic electrochemistry. Production of current, batteries, electrolysis, corrosion.
Problem-solving seminar: Calculations equilibrium concentrations, activity and equilibrium constant from experimental data. Calculations of electrode and cell potentials. Nernst equation. Application of electrochemical data for gaining molecular information. Methods for determination of empirical rate laws and mechanism of chemical reactions. Calculations on production of current, batteries, electrolysis, corrosion.

Compulsory/Recommended Readings:
1. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

PHYSICAL CHEMISTRY LABORATORY PRACTICE

Code: TKBL0402
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: None
Lecturer: Kathó, Ágnes; Nagy, István; Rábai, Gyula

Topics: Experiments from the field of thermochemistry, phase equilibria, electrochemistry, chemical kinetics and molecular structures.

Compulsory/Recommended Readings:
1. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

PHYSICS I.

Code: TFBE2101
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: None
Lecturer: Erdélyi, Gábor

Topics: Physical quantities, dimensions, systems of units. Kinematics: velocity, acceleration, motion in three dimensions. Mass, linear momentum, forces and Newton's laws, centre of mass, conservation of linear momentum. Elementary applications, projectile motion, vibrations. Rotation, angular momentum, moment of inertia, torques, planetary orbits. Motion and equilibrium of a rigid body. Work and energy, potential energy, conservation of mechanical energy. Principle of Galilean relativity, non-inertial forces. Elasticity, stresses, strain, Hook's law, elastic modulus. Gases and liquids, hydrostatics, phenomena of capillarity. Introduction to transverse and longitudinal waves. Superposition and interference of harmonic waves. Standing waves. The Doppler effect. Temperature scales, equations of state, the first law of thermodynamics, specific heat. Reversible and irreversible processes. Carnot-cycle, heat-pump and refrigerator. The second law of thermodynamics. Entropy, Helmholtz- and Gibbs-free energy functions. Chemical potential, phase transformations, transport phenomena.

Compulsory/Recommended Readings:
1. Halliday, Resnick, Walker: Fundamentals of Physics., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company

PHYSICS II.

Code: TFBE2104
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physics I. (TFBE2101)
Lecturer: Erdélyi, Gábor

Topics: Phenomena and physical quantities of electrostatics. Electric intensity, Gauss's law, electric potential, electric dipoles. Conductors and isolators in electric fields: influence, capacitors, polarization. Current, resistivity, Ohm's law, simple electric circuits. Electric currents in metals, semiconductors, liquids and gases. Magnetic field, flux density. Induction, Faraday's law, Lenz's law. Alternating currents and electromagnetic vibrations and waves. Light as electromagnetic waves, interference, diffraction, polarization, absorption and scattering. Thermal radiation, photoelectric effect. The Rutherford experiment, the Bohr model, the Franck-Hertz experiment. Particle-wave dualism, de Broglie's relation, wave function, Schrödinger-equation. The Heisenberg uncertainty principle. Atomic structure, Pauli's principle. Band model of solids, conduction phenomena in semiconductors, lasers, superconductivity. Radioactivity, radiations. Nuclear structure, properties of nuclei. Fission and fusion. Elementary particles, fundamental interactions, basic terms of cosmology.

Compulsory/Recommended Readings:
1. Halliday, Resnick, Walker: Fundamentals of Physics., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company

PHYSICS II. (ALTERNATIVE)

Code: TFBE2103
Classes/week: 2 hours of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 4
Prerequisites: Physics I. (TFBE2101)
Lecturer: Erdélyi, Gábor

Topics: Phenomena and physical quantities of electrostatics. Electric intensity, Gauss's law, electric potential, electric dipoles. Conductors and isolators in electric fields: influence, capacitors, polarization. Current, resistivity, Ohm's law, simple electric circuits. Electric currents in metals, semiconductors, liquids and gases. Magnetic field, flux density. Induction, Faraday's law, Lenz's law. Alternating currents and electromagnetic vibrations and waves. Light as electromagnetic waves, interference, diffraction, polarization, absorption and scattering. Thermal radiation, photoelectric effect. The Rutherford experiment, the Bohr model, the Franck-Hertz experiment. Particle-wave dualism, de Broglie's relation, wave function, Schrödinger-equation. The Heisenberg uncertainty principle. Atomic structure, Pauli's principle. Band model of solids, conduction phenomena in semiconductors, lasers, superconductivity. Radioactivity, radiations. Nuclear structure, properties of nuclei. Fission and fusion. Elementary particles, fundamental interactions, basic terms of cosmology.

Compulsory/Recommended Readings:
1. Halliday, Resnick, Walker: Fundamentals of Physics., John Wiley & Sons Inc.
2. Sears, Zemansky, Young: University Physics, Addison-Wesley Publishing Company

PHYSICAL METHODS

Code: TFBG2501
Classes/week: 1 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: Physics I. (TFBE2101)
Lecturer: Szabó, Sándor

Topics: Calculation of errors: different types of errors they learn statistical methods, use of graphs. Electronic measurements: electronic resistance and use of electronic resistive elements with a Wheatstone-bridge. Temperature dependence of resistance. Parallel and serial oscillating circuits, RLC systems, resonance, and resonance coefficient. Characterization of diodes and transistors.
Optical measurements: concentration measurement by polarimeter. Prisms, optical gratings. Abbe-refractometer, optical microscope and binoculars. The most important parameters of optical lenses.
Thermodynamic measurements: Heat capacity, specific heat, heat and temperature of fusion. The coefficients of heat conduction and heat dilatation.

Compulsory/Recommended Readings:
Study aid for electronic measurements, Dept. of Solid State Physics, Debrecen University.

PRINCIPLES OF MEDICINAL CHEMISTRY

Code: TKBE0305
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Gulácsi, Katalin

Topics: Classification of the discussed drugs is carried out according to their chemical structures. This ensures the discussion of general synthetic methods and deepens the knowledge of organic chemistry. From the specified structures, only the synthesis of a few will be detailed. The selection is made by putting an emphasis on the knowledge that is important from organic chemistry point of view.

Compulsory/Recommended Readings:
1. Patrick, G. L. – An Introduction to Medicinal Chemistry, Oxford University Press, 2005.

PROJECT

Code: TKBL0002
Classes/week: 7 hours of laboratory and/or library work
ECTS Credit Points: 5
Prerequisites: at least 100 credits, at least 21 credits basic scientific, general subjects, as specified by the supervisor
Lecturer: Somsák, László; individually assigned supervisors

Topics: Individually assigned tasks for every student with the guidance of a supervisor resulting in a written report of intermediate length.

Compulsory/Recommended Readings:
Assigned by the supervisors depending on the individual research projects with emphasis on finding the primary sources of chemical information.

PROPERTIES OF PLASTICS

Code: TKBL0605
Classes/week: 4 hours of laboratory work
ECTS Credit Points: 3
Prerequisites: Macromolecular chemistry I. (TKBE0603), Macromolecular chemistry seminar I. (TKBG0603)
Lecturer: Deák, György

Topics: Solubility test of polymers. Measurement of density. Hardness testing: Shore-, Rockwell- and Brinell- methods. Tensile and flexural testing of polymers – determination of Young and flexural modulus, stress at yield and stress at break, elongation at yield and elongation at break. Determination of impact strength by Izod pendulum. Impact strength measurement of foils by Darts method. Determination of melt flow rate of polymers. The environmental stress cracking test of polyethylene. Preparation of polymer composites by a laboratory scale extruder.

Compulsory/Recommended Readings:
1. D. Braun: Simple methods for identification of plastics, Hanser, Darmstadt (1986).
2. E. Schröder, G. Müller, K.F. Arndt: Polymer characterization, Akademie-Verlag, Berlin (1989).

QUALITY MANAGEMENT

Code: TTBE0020
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: None
Lecturer: Török, János; Borda, Jenő

Topics: The history of quality management. The development of the ISO standard system, advantages. The essence of the TQM and EFQM. The ISO 9000:2000 standard system; the idea of the quality and quality management, the customer in the centre, respect for the law, the process management and control, the PDCA ring, the continuous developing, the ISO 9004:2000. The presentation of the ISO 9000:2000 standard; the system (handbook, documents), responsibility of the management (quality policy, quality aims, sources of power, communication, revision), production and supply in the ISO, customer service, measurement and control, correction and prevention.

Compulsory/Recommended Readings:
1. ISO 9001:2000 Standard
2. ISO 9004:2000 Standard
3. Quality Management (5th Edition) by David L. Goetsch, Stanley B. Davis, Prentice Hall
4. Quality Management: Introduction to Total Quality Management for Production, Processing, and Services (4th Edition) by David L. Goetsch, Stanley B. Davis Prentice Hall

REACTION KINETICS AND CATALYSIS

Code: TKBE0413
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physical chemistry II. (TKBE0402)
Lecturer: Gáspár, Vilmos; Joó, Ferenc

Topics: Chemical kinetics and reaction mechanisms: analysis of experimental data and deduction of reaction mechanisms; reactions in solutions; complex mechanism; surface reactions; theory of chain reactions; free radical polymerization; thermal explosions; oscillating reactions; reactions in open systems (flow-through reactors); photochemistry; homogeneous catalysis; catalytic application of transition metal complexes in liquid phase reactions; heterogeneous catalysis; preparation and characterization of heterogeneous catalysts; enzyme kinetics.

Compulsory/Recommended Readings:
1. James H. Espenson: Chemical Kinetics and Reaction Mechanisms, 2nd. Ed., McGraw Hill, 1995.
2. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

REACTION KINETICS AND CATALYSIS LABORATORY

Code: TKBL0413
Classes/week: 2 hours of laboratory work
ECTS Credit Points: 1
Prerequisites: Reaction Kinetics and Catalysis (TKBE0413 co-requisite)
Lecturer: Gáspár, Vilmos; Nagy, István

Topics: Chemical kinetics and reaction mechanisms: analysis of experimental data and deduction of reaction mechanisms; reactions in solutions; complex mechanism; surface reactions; theory of chain reactions; free radical polymerization; thermal explosions; oscillating reactions; reactions in open systems (flow-through reactors); photochemistry; homogeneous catalysis; catalytic application of transition metal complexes in liquid phase reactions; heterogeneous catalysis; preparation and characterization of heterogeneous catalysts; enzyme kinetics.

Compulsory/Recommended Readings:
1. James H. Espenson: Chemical Kinetics and Reaction Mechanisms, 2nd. Ed., McGraw Hill, 1995.
2. B.C. Gates: Catalytic Chemistry, Wiley, 1991.
3. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

SEPARATION TECHNIQUES

Code: TKBE0502
Classes/week: 1 hour of lecture
ECTS Credit Points: 1
Prerequisites: Analytical chemistry I. (TKBE0501 co-requisite)
Lecturer: Fábián, István; Lázár, István

Topics: Basic concepts of the most important chromatographic techniques including adsorption, distribution, size exclusion, normal and reversed phase, gel, ion exchange, affinity and ion mobility chromatographies. Structures and working concepts of the modern analytical instruments, theoretical and practical aspects of their use. Autosamplers and automatic fraction collectors, laboratory automation. Modern sample preparation techniques, solid-liquid and liquid-liquid extraction, solid phase extraction. Application of supercritical fluids in analytical chemistry. Ultrafiltration and nanofiltration, dialysis techniques. Separation techniques used in solid phase syntheses. Analytical and preparative scale layer and column chromatographic techniques. Preparative normal and reversed phase liquid chromatography, affinity chromatography, ion chromatography. Separation and analytical techniques based on electromigration of charged particles. Electrodeposition methods used for the analysis of extremely dilute solutions.

Compulsory/Recommended Readings:
1. F. J. Dechow: Separation and Purification Techniques in Biotechnology, William Andrews Publishing, 2001
2. F. Rouessac, A. Rouessac: Chemical Analysis, Modern Intsrumentation Methods and Techniques, John Wiley and Sons, 2007

SEPARATION TECHNIQUES LABORATORY

Code: TKBL0502
Classes/week: 3 hours of laboratory work
ECTS Credit Points: 2
Prerequisites: Separation techniques (TKBE0502 co-requisite)
Lecturer: Fábián, István; Lázár, István

Topics: Basic concepts of gas chromatography, the most important types of GC measurements, structure of a GC instrument, types and applications of capillary and filled columns, practical aspects of chromatographic indices, qualitative and quantitative analysis by a GC. Basic concepts of intensive liquid chromatography, general structure of a HPLC instrument, types and applications of LC columns, sample preparation techniques, qualitative and quantitative analysis by a HPLC. Basic concepts of ion mobility chromatographic techniques, most important CE chromatographic techniques, sample preparation, qualitative and quantitative analysis with CE. Basic concepts of gel chromatography, the most important types of gels, column filling in the practice, sample preparation, qualitative and quantitative analysis with gel chromatography. Basic concepts of layer chromatographies, the most important techniques, sorbents for preparation of layers, practical separations with thin layer chromatography. Qualitative and quantitative analysis by TLC. Enrichment techniques used in radiochemistry, separation of radioisotopes with electrochemical enrichment, quantitative analysis of a very dilute isotope solution.

Compulsory/Recommended Readings:
1. F. J. Dechow: Separation and Purification Techniques in Biotechnology, William Andrews Publishing, 2001
2. F. Rouessac, A. Rouessac: Chemical Analysis, Modern Intsrumentation Methods and Techniques, John Wiley and Sons, 2007

SPECIAL AND DANGEROUS MATERIALS

Code: TKBE0204
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: None
Lecturer: Lázár, István

Topics: General properties of illicit drugs, special issues of drug addictology, development of dependency. Drugs and the law. Detailed description of the physical, chemical and biological properties of the most widely used illicit drugs. Multimedia demonstration of the danger of drug abuse. General human rights, environmental and legal issues of the use of toxic chemicals as weapons during the history. Classification of toxic substances (chemical weapons) based on their toxicological profile. Detailed description of the most widely known classic and modern toxic chemicals, their analysis and methods of decomposition. Physical chemistry basics of different kind of rapid reactions leading to explosion. Classification of explosive materials. Low and high explosives, their most important physical, chemical and explosive properties. Synthesis, handling and decomposition of explosive materials. Civilian use of explosive materials in the industry. Special measurement techniques associated with the characterization of explosives. Basic materials, structure, preparation, handling and storing of pyrotechnic devices. The lawful use of pyrotechnic devices. Supertoxins of biological origin. Their history, occurrence in the nature, toxins of exotic species. Pheromones, their chemical structures, role in the biology and in the social behavior of people. Practical and ecological applications of pheromones.

Compulsory/Recommended Readings:
I. Lázár: Special and Dangerous Materials, edited lecture notes

SPECTROSCOPY

Code: TKBE0503
Classes/week: 1 hour of lecture, 1 hour of problem-solving seminar
ECTS Credit Points: 3
Prerequisites: Organic chemistry II. (TKBE0302)
Lecturer: Szilágyi, László; Kurtán, Tibor; Kiss, Attila

Topics: Zeeman interaction, principles of NMR ans ESR spectroscopy. NMR chemical shift and its measurement. Structure and operation of NMR spectrometers. Proton chemical shifts and their applications in structure elucidation. Nuclear spin-spin coupling. NMR multiplets and rules of spectrum analysis. Nuclear spin-spin coupling constants and their application in structure elucidation. Chemical shifs of ^{13}C and other nuclei and its application. ESR spectroscopy to study chemical reactivity and structure. Absorption spectra (UV, IR, Raman). Beer's law and its analytical applications. Conjugation in absorption spectra. Structure and operation of spectrophotometers. Inter- and intramolecular effects in IR spectra. Basic

principles of mass spectrometry: ionization of molecules, methods of ionization and mass-to-charge ratio analysis. Structure and operation of mass spectrometers. Fragmentation rules in mass spetrometry. Combined methods of mass spectrometry (GC-LC-CE-MS): applications in analytical chemistry and structure elucidation. Tandem mass spectrometry. Strategy for the application of spectroscopic methods. Spectrum analysis, quality ensuring parameters.

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

STRUCTURAL CHEMISTRY

Code: TKBE0411
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: Physical chemistry II. (TKBE0402)
Lecturer: Joó, Ferenc; Póta, György; Gáspár, Vilmos, Bányai, István

Topics: Application of molecular symmetry and group theory in the description of molecular structure. Introduction of the quantum chemical description of molecular structure. Energetics of many electron systems. Molecular spectroscopy (rotational and vibrational spectra). Excitation of electronic states and the fate of excited states. Lasers. Methods of electron spectroscopy. Spectroscopy of transition metal complexes. Dielectric and magnetic properties. Diffraction methods of structure determination. Structure of solids, liquids and solutions.

Compulsory/Recommended Readings:
1. P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

STRUCTURAL CHEMISTRY PROBLEM-SOLVING SEMINAR

Code: TKBG0411
Classes/week: 2 hours of problem-solving seminar
ECTS Credit Points: 2
Prerequisites: Structural Chemistry (TKBE0411 co-requisite)
Lecturer: Póta, György; Gáspár Vilmos; Bányai István

Topics: Elements of the quantum mechanical theory of chemical bonding. Relations between the structure of matter and biological impact. Applications of some quantum chemical programs and evaluation of the results.

Compulsory/Recommended Readings:
P. W. Atkins, J. de Paula: Physical Chemistry, 7th ed.; Oxford University Press: Oxford, 2002.

THEORETICAL CHEMISTRY

Code: TKBE0412
Classes/week: 1 hour of lecture
ECTS Credit Points: 2
Prerequisites: Structural Chemistry (TKBE0411 co-requisite)
Lecturer: Póta, György; Kovács, Gábor

Topics: Elements of the quantum mechanical theory of chemical bonding. Relations between the structure of matter and biological impact. Applications of some quantum chemical programs and evaluation of the results.

Compulsory/Recommended Readings:
1. Levine, I. N.: Quantum Chemistry, Allyn and Bacon, Boston-London-Sydney-Toronto 1983.

TOPICS IN MODERN CHEMISTRY

Code: TKBE0001
Classes/week: 2 hours of lecture
ECTS Credit Points: 3
Prerequisites: None
Lecturer: Bányai, István

Topics: A frequently updated selection of topics, which are of special current interest and possibly get some coverage in the media as well e.g. hydrogen economy, nuclear accidents, enzyme technology, the chemistry of wine, colorful and tasteful flavonoids, professional and lay opinion in chemistry, green chemitsry, plastics, carbohydrates, modern synthetic chemistry, precious stones and noble metals, chemistry in the kitchen.

Compulsory/Recommended Readings:
1. http://www.howstuffworks.com
2. http://www.whfreeman.com/chemcom/

VISITS AT CHEMICAL COMPANIES

Code: TKBX0608
Classes: 5 full days in semester 6
ECTS Credit Points: 0
Prerequisites: Chemical technology II. (TKBE0602), Chemical technology seminar II. (TKBG0602)
Lecturer: Borda, Jenő; Nemes, Sándor (organizers)

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