University of Debrecen
Faculty of Science and Technology
Institute of Chemistry

CHEMISTRY BSC PROGRAM

2022

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DEAN`S WELCOME

Welcome to the Faculty of Science and Technology!

This is an exciting time for you, and I encourage you to take advantage of all that the Faculty of Science and Technology UD offers you during your bachelor's or master's studies. I hope that your time here will be both academically productive and personally rewarding

Being a regional centre for research, development and innovation, our Faculty has always regarded training highly qualified professionals as a priority. Since the establishment of the Faculty in 1949, we have traditionally been teaching and working in all aspects of Science and have been preparing students for the challenges of teaching. Our internationally renowned research teams guarantee that all students gain a high quality of expertise and knowledge. Students can also take part in research and development work, guided by professors with vast international experience.

While proud of our traditions, we seek continuous improvement, keeping in tune with the challenges of the modern age. To meet the demand of the job market for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Based on the fruitful collaboration with our industrial partners, recently, we successfully introduced dual-track training programmes in our constantly evolving engineering courses.

We are committed to providing our students with valuable knowledge and professional work experience, so that they can enter the job market with competitive degrees. To ensure this, we maintain a close relationship with the most important national and international companies. The basis for our network of industrial relationships are in our off-site departments at various different companies, through which market participants - future employers - are also included in the development and training of our students.

Prof. dr. Ferenc Kun
Dean

UNIVERSITY OF DEBRECEN

Date of foundation: 1912 Hungarian Royal University of Sciences, 2000 University of Debrecen

Legal predecessors: Debrecen University of Agricultural Sciences; Debrecen Medical University; WarghaIstván College of Education, Hajdúböszörmény; Kossuth Lajos University of Arts and Sciences

Legal status of the University of Debrecen: state university

Founder of the University of Debrecen: Hungarian State Parliament

Supervisory body of the University of Debrecen: Ministry of Education

Number of Faculties at the University of Debrecen: 14

Faculty of Agricultural and Food Sciences and Environmental Management

Faculty of Child and Special Needs Education

Faculty of Dentistry

Faculty of Economics and Business

Faculty of Engineering

Faculty of Health

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Public Health

Faculty of Science and Technology

Number of students at the University of Debrecen: 29,954

Fulltime teachers of the University of Debrecen: 1,557

197 full university professors and 1,224 lecturers with a PhD.

FACULTY OF SCIENCE AND TECHNOLOGY

The Faculty of Science and Technology is currently one of the largest faculties of the University of Debrecen with about 3000 students and more than 200 staff members. The Faculty has got 6 institutes: Institute of Biology and Ecology, Institute of Biotechnology, Institute of Chemistry, Institute of Earth Sciences, Institute of Physics and Institute of Mathematics. The Faculty has a very wide scope of education dominated by science and technology (11 Bachelor programs and 13 Master programs), additionally it has a significant variety of teachers' training programs. Our teaching activities are based on a strong academic and industrial background, where highly qualified teachers with a scientific degree involve student in research and development projects as part of their curriculum. We are proud of our scientific excellence and of the application-oriented teaching programs with a strong industrial support. The number of international students of our faculty is continuously growing (currently ~ 770 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

THE ORGANIZATIONAL STRUCTURE OF THE FACULTY

Dean: Prof. Dr. Ferenc Kun, Full Professor
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Head of Dean's Office: Mrs. Katalin Kozma-Tóth
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DEPARTMENTS OF THE INSTITUTE OF CHEMISTRY

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ACADEMIC CALENDAR

General structure of the academic semester (2 semesters/year):

Study period	1st week	Registration*	1 week
	2nd – 15th week	Teaching period	14 weeks
Exam period	directly after the study period	Exams	7 weeks

*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

For further information please check the following link:

https://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2022_23/University_calendar_2022-2023-Faculty_of_Science_and_Technology.pdf

THE CHEMISTRY BACHELOR PROGRAM

Information about the Program

Name of BSc Program:	Chemistry BSc Program
Specialization available:	-
Field, branch:	Science
Qualification:	Chemist
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Chemistry
Program supervisor	Dr. László Somsák, DSc, University professor
Program coordinator:	Dr. Éva Juhászné Tóth PhD, Assistant Professor
Duration:	6 semesters
ECTS Credits:	180

Objectives of the BSc program:

The aim of this study programme 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 Chemistry Bachelor 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.

Professional competences to be acquired

A Chemist
a) Knowledge:
- He/She knows the basic qualitative and quantitative chemical principles and methods.
- He/She knows the main models and theories of chemical bonds and molecular structure based on scientific findings.
- He/She has a basic chemical knowledge for describing basic chemical processes as well as for recognizing and organizing these in practice.
- He/She knows and can apply the most important chemicals, laboratory equipment and basic laboratory processes. He/She can follow and recognize the requirements of safety instructions.

- He/She has the knowledge to solve problems in the field of natural processes and natural sources, and to understand the chemical background of living and non-living systems.
- He/She has the knowledge that (under supervision) enables him/her to test or measure chemical processes and systems by accepted scientific methods, including computational evaluation of the results.
- He/She understands the progress and future trends in chemistry and chemical industries.

b) Abilities:
- He/She is able to understand the natural and anthropogenic chemical reactions, and is capable to collect as well as evaluate data in these fields including data mining from literature.
- He/She is able to solve practical problems by using the previously obtained knowledge of laws in the field of natural and anthropogenic chemical processes.
- He/She is able to apply in practice the previously learned scientific theories, paradigms, and principles (especially in the field of chemistry) to plan, execute and evaluate laboratory investigations.
- Using his/her chemical knowledge and experiences, He/She is able to execute experiments under laboratory conditions to demonstrate and prove basic chemical phenomena.
- He/She is able to evaluate, interpret and report the results of measurements.
- He/She is able to apply the acquired chemical knowledge for problem solving in chemical, industrial and environmental fields including corroboration of the results by calculations.
- He/she is able to collect and interpret relevant data in the field of chemistry that enables him/her to form well-founded opinions on problems regarding social, scientific or ethical affairs.
- He/She is able to argue about scientific problems based on his/her knowledge.

c) Attitudes:
- He/She seeks to use his/her knowledge to understand and describe the laws of nature-man relationships especially chemical processes related to human life.
- He/She is environmentally conscious in the laboratory work, strives to apply procedures of low environmental load.
- He/She is ready to discuss problems with professionals in chemical and related scientific fields.
- He/She is able to collaborate with other groups and capable of getting insight into the chemical aspects of economy and environmental safety.
- He/She is able to represent his/her own personal scientific ideology toward professional and unprofessional groups.
- He/She is open toward scientific and other post gradual education.
- He/She is committed to learning or obtaining insights into new competences and broadening his/her world view.
- He/She is consciously undertaking the profession’s ethical norms.
- He/she is well aware of his/her professional statements and its consequences.

d) Autonomy and responsibility:
- During laboratory work He/She is capable of pondering over basic chemical problems on his/her own, is able to prepare reports to principals that might come up as bases for solutions or decisions.
- He/She is able to operate the most important technological instruments of chemical industries.
- He/She stands for his/her scientific opinion or ideology in professional discussions.
- Under supervision He/She is collaborating responsibly with other professionals (especially in the fields of environmental economy and safety).
- He/She can make reasonable evaluations about his/her own work by comparison with that of others in the same field.

- He/She shows responsibility to gain enough experience before participating in decision making for laboratories or industrial plants.
- He/She can evaluate his/her dependent co-worker's work responsibly in either laboratory or industrial environment, and report it to his/her chief.
- He/She takes part in scientific project(s) under continuous supervision.

Completion of the BSc Program

The Credit System

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes: statements of what students know and can do on completing their degrees. In describing the cycles, the framework uses the European Credit Transfer and Accumulation System (ECTS).
ECTS was developed as an instrument of improving academic recognition throughout the European Universities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programs and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programs.
Regarding each major the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

During the program students have to complete a total amount of 180 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the prerequisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Model Curriculum of the Chemistry BSc Program”.

Model Curriculum of the Chemistry BSc Program

CompulsoryCourses							
Modul *Blocks of courses (suggestedcredits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; type of examination: e:exam, p:practice, t: termgrade, s: signature)						**Prerequisites**
	1.	2.	3.	4.	5.	6.	
Science							
Mathematics							
Mathematics I. **TTMBE0808_EN** – 5 cr **TTMBG0808_EN** – 2 cr *Zoltán Muzsnay*	4e+3p+0						None
Mathematics II. **TTMBE0809_EN** – 3 cr **TTMBG0809_EN** – 2 cr *Zoltán Muzsnay*		2e+3p+0					TTMBE0808_EN TTMBG0808_EN Mathematics I. (lecture and seminar)
Physics							
Physics fo rEngineers I. **TTFBE2111_EN** – 3 cr *Balázs Ujvári*	(2+1)e+0						None
Physics for Engineers II. **TTFBE2113_EN** – 3 cr *Balázs Ujvári*		(2+1)e+0					TTFBE2111_EN Physics for Engineers I.
Informatics							
Basic Chemical Informatics **TTKBG0901_EN** – 2 cr *Attila Mándi*	0+2p+0						None
Chemical Informatics **TTKBG0902_EN** – 2 cr *Ákos Kuki*		0+2p+0					TTKBG0901_EN Basic Chemical Informatics
General subjects							
Basic Economics and Management **TTTBE0010 _EN** – 1 cr *Mária Újhelyi*	1e+0+0						None
Quality Management **TTTBE0020 _EN** – 1 cr *Zsolt Radics*	1e+0+0						None
History and Structure of the EU **TTTBE0030 _EN** – 1 cr *Károly Teperics*	1e+0+0						None
Environmental Science **TTTBE0040_EN** – 1 cr *István Gyulai*	1e+0+0						None

Core Subjects							
General Chemistry							
General Chemistry I. (lectureand seminar) **TTKBE0101_EN** – 4 cr *József Kalmár* **TTKBG0101_EN** – 3 cr *Linda Bíró Földi*	3e+3p+0						None Paralel registration for both courses is required
General Chemistry II. (laboratorypractice) **TTKBL0101_EN** – 3 cr *Linda Bíró Földi*		0+0+3p					TTKBE0101_EN and TTKBG0101_EN General Chemistry I.

CompulsoryCourses							
Modul *Blocks of courses (suggestedcredits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; type of examination: e:exam, p:practice, t: termgrade, s: signature)						**Prerequisites**
	1.	2.	3.	4.	5.	6.	
InorganicChemistry							
Inorganic Chemistry I. **TTKBE0201_EN** – 3 cr *István Lázár*		2e+0+0					TTKBE0101_EN General Chemistry I.
Inorganic Chemistry II. **TTKBE0202_EN** – 3 cr *Péter Buglyó*			2e+0+0				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN PhysChem. I.
Inorganic Chemistry III. **TTKBL0201_EN** – 5 cr *Péter Buglyó*			0+(1+4)p				TTKBL0101_EN Gen. Chem. II. TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN PhysChem. I.
Inorganic Chemistry IV. **TTKBL0202_EN –** 4 cr *Norbert Lihi*				0+(1+3)p			TTKBE0202_EN Inorg. Chem. II. TTKBL0201_EN Inorg. Chem. III.

PhysicalChemistry							
Physical Chemistry I. (lecture and seminar) **TTKBE0401_EN** – 3 cr **TTKBG0401_EN** – 2 cr *Attila Bényei*		2e+2p+0					TTKBE0101_EN Gen. Chem. I. TTMBE0808_EN Mathematics I. TTFBE2111_EN Phys. forEng. I.
Physical Chemistry II. (lecture and seminar) **TTKBE0402_EN** – 3 cr **TTKBG0402_EN** – 2 cr *Attila Bényei*			2e+2p+0				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
Introduction to Physical Chemistry Measurements **TTKBL0401_EN** – 4 cr *Ferenc Krisztián Kálmán*			0+0+4p				TTKBL0101_EN Gen. Chem. II. TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN PhysChem. I.
Physical Chemistry III. **TTKBE0403_EN** – 3 cr *Noémi Nagy*				2e+0+0			TTKBE0402_EN Phys. Chem. II.
Physical Chemistry IV. **TTKBE0404_EN** – 5 cr *Attila Bényei, Oldamur Hollóczki*					(2+2)e+0		TTKBE0402_EN Phys. Chem. II.
Physical Chemistry V. **TTKBL0402_EN** – 5 cr *Ferenc Krisztián Kálmán*					0+0+4p		TTKBE0402_EN Phys. Chem. II. TTKBL0401_EN Intr. Phys. Chem. Meas.

CompulsoryCourses							
Modul *Blocks of courses* *(suggestedcredits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; type of examination: e:exam, p:practice, t: termgrade, s: signature) 1.	2.	3.	4.	5.	6.	**Prerequisites**
OrganicChemistry							
Organic Chemistry I. **TTKBE0301_EN** – 4 cr *Tibor Kurtán*		(2+1)e+0					TTKBE0101_EN Gen. Chem. I.
Organic Chemistry II. **TTKBE0302_EN** – 4 cr *Tibor Kurtán*			(2+1)e+0				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN PhysChem. I.
Organic Chemistry III. **TTKBE0303_EN** – 3 cr *László Somsák*				2e+0+0			TTKBE0302_EN Org. Chem. II.
Organic Chemistry IV. **TTKBG0301_EN** – 1 cr *Attila Mándi* **TTKBL0301_EN** – 4 cr *Marietta Vágvölgyiné Tóth*				0+1p+4p			TTKBL0101_EN Gen. Chem. II. TTKBE0302_EN Org. Chem. II.
Organic Chemistry V. **TTKBL0302_EN** – 7 cr *Marietta Vágvölgyi Tóth*					0+(2+4)p		TTKBL0301_EN Org. Chem. IV.
Biochemistry I. **TTBBE2035_EN** – 3 cr *János Kerékgyártó*					2e+0+0		TTKBE0303_EN Org. Chem. III.
Biochemistry II. (laboratory practice) **TTKBL0303_EN** – 3 cr *Gyöngyi Gyémánt*						0+(1+2)p	TTBBE2035_EN Biochemistry I.

AnalyticalChemistry							
Analytica lChemistry I. **TTKBE0501_EN** – 3 cr *Péter Buglyó*			2e+2p+4p				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN PhysChem. I.
TTKBG0501_EN – 2 cr *Csilla Kállay*							TTKBG0101_EN Gen. Chem. I. and paralel registrationto TTKBE0501_EN Anal. Chem. I.
TTKBL0501_EN – 4 cr *Csilla Kállay*							TTKBL0101_EN Gen. Chem. II. and paralel registrationto TTKBE0501_EN Anal. Chem. I.
SeparationTechniques I. **TTKBE0502_EN** – 1 cr *István Lázár*			1e+0+0				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
SeparationTechniques II. **TTKBL0502_EN** – 3 cr *Attila Gáspár*				0+0+3p			TTKBL0201_EN Inorg. Chem. III. TTKBE0502_EN Separ. Tech. I.

CompulsoryCourses							
Modul *Blocks of courses (suggestedcredits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; type of examination: e:exam, p:practice, t: termgrade, s: signature) 1.	2.	3.	4.	5.	6.	**Prerequisites**
Analytical Chemistry II. **TTKBL0503_EN** – 6 cr *Attila Gáspár*				0+0+6p			TTKBE0501_EN Anal. Chem. I. TTKBL0501_EN Anal. kém. I. (lab)
Spectroscopic Methods I. **TTKBE0503_EN** – 3 cr *Gyula Batta*				2e+0+0			TTKBE0302_EN Org. Chem. II. TTFBE2113_EN Phys. forEng. II.
Spectroscopic Methods II. **TTKBL0504_EN** – 4 cr *Tünde Zita Tóthné Illyés*						0+3p+0	TTKBE0503_EN Spectr. Meth. I.
Applied Chemistry (≥12)							
Chemical Technology I. **TTKBE0601_EN** – 3 cr **TTKBG0601_EN** – 1 cr *Lajos Nagy*				2e+1p+0			TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
Chemical Technology II. **TTKBE0602_EN** – 4 cr **TTKBG0602_EN** – 2 cr *Lajos Nagy*					3e+2p+0		TTKBE0601_EN TTKBG0601_EN Chem. Tech. I.
Macromolecular Chemistry **TTKBE0611_EN** – 3 cr **TTKBG0611_EN** – 1 cr *Sándor Kéki*						2e+1p+0	TTKBE0302_EN Org. Chem. II.
Environmental Technology **TTKBE1114_EN**– 3 cr *Katalin Margit Illyésné Czifrák*						2e+0+0	TTKBE0602_EN TTKBG0602_EN Chem. Tech. II.
Special courses							
Practical courses							
Visit in Chemical Industries **TTKBX0607_EN** *Ákos Kuki*				1 week(s)			Parallel registration to TTKBE0601_EN Chem. Tech. I.
Closing Block							
BScThesis I. **TTKBL0001_EN** – 5 cr *László Somsák*					0+(2+3)p		Minimum of 110 fulfilled credits + courses determined by the supervisor
BScThesis II. **TTKBL0002_EN** – 10 cr *László Somsák*						0+0+10p	TTKBL0001_EN BScThesis I.

OptionalChemistryCourses (6 credits)							
Modul *Blocks of courses* *(suggested credits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; typeof examination: e:exam, p:practice, t: termgrade, s: signature)						**Prerequisites**
	1.	2.	3.	4.	5.	6.	
Crystallography **TTGBE5104_EN** – 3 cr *Gábor Dobosi*	2e+0+0 fallsemester						None
History of Chemistry **TTKBE0007_EN** – 3 cr *Ágnes Dávid*		2e+0+0 springsemester					TTKBE0101_EN Gen. Chem. I.
Special and Dangeorus Materials **TTKBE0204_EN** – 3 cr *István Lázár*			2e+0+0 fallsemester				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
Environmental Chemistry I. **TTKBE0417_EN** – 3 cr *Mónika Kéri*			2e+0+0 fallsemester				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
The Basics of Liquid Chromatography – Pharmaceutical Application **TTKBE0310_EN** – 3 cr *László Krusper*					2e+0+0		TTKBE0501 _EN Anal. Chem. I.
Computational Quantum Chemistry **TTKBG0903_EN –** 3 cr *Oldamur Hollóczki*				0+2p+0 springsemester			TTMBE0809_EN TTMBG0809 _ENMathematics II. (lect.+ sem.) TTKBG0901_EN Basic. Chem. Inf.
Process Control I. **TTKBG0612_EN** – 4 cr *Lajos Nagy*				(2+1)t+0 springsemester			TTKBG0902_EN Chem. Informatics
Unit Operations I. **TTKBG0614_EN** – 6 cr *Sándor Kéki*			(2+3)t+0 fallsemester				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
Unit Operations II. **TTKBG0615_EN** – 6 cr *Katalin Margit Illyésné Czifrák*				(2+3)t+0 springsemester			TTKBG0614_EN Unit Operations I.
Unit Operations III. **TTKBG0616_EN** – 6 cr *Katalin Margit Illyésné Czifrák*					(2+3)e+0		TTKBG0615_EN Unit operations II.
Applied Radiochemistry **TTKBE0504_EN** – 3 cr *Noémi Nagy*					2e+0+0		TTKBE0403 _EN Phys. Chem. III.
NMR Operator Training I. **TTKBL0004_EN** – 2 cr *Gyula Batta*					0+0+2p		TTKBE0503_EN Spectr. Meth. I.
Biochemistry III. **TTBBE0304_EN** – 3 cr *Teréz Barna*						2k+0+0	TTBBE2035_EN Biokémia I.
Biocolloids **TTKBE0405_EN** – 3 cr *Levente Novák*				2e+0+0 springsemester			TTKBE0402 _EN Phys. Chem. II.
Colloid Chemistry **TTKBE0415_EN** – 3 cr *Levente Novák*						2e+0+0	TTKBE0403_EN Phys. Chem. III.

OptionalChemistryCourses (6 credits)							
Modul *Blocks of courses* *(suggested credits)* Courses **Codes**– credits (cr) *Lecturer*	Semester (teachinghours: lectures + seminars + (laboratory) practice; typeof examination: e:exam, p:practice, t: termgrade, s: signature)						**Prerequisites**
	1.	2.	3.	4.	5.	6.	
Plastics and Processing II. **TTKBE1213_EN** – 2 cr *Sándor Kéki*						0+2p+0	TTKBE0611_EN Macromol. Chem.
OrganicChemistrySeminar I. **TTKBG0311_EN -**1 cr *László Juhász*		0+1p+0					TTKBE0101_EN Gen. Chem. I.
Organic Chemistry Seminar II. **TTKBG0312_EN**-1 cr *László Juhász*			0+1p+0				TTKBE0201_EN Inorg. Chem. I. TTKBE0301_EN Org. Chem. I. TTKBE0401_EN Phys. Chem. I.
Advanced Organic Chemistry Seminar **TTKBG0313_EN -**2 cr *László Juhász*				0+2p+0			TTKBE0302_EN Org. Chem. II.

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation.
Registration in the Neptun system by the subject: MUNKAVEDELEM
Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on webpage of the Faculty.

Physical Education

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in two semesters during his/her Bachelor's training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: http://sportsci.unideb.hu.

Pre-degree Certification

A pre-degree certificate (absolutorium) is issued by the Faculty after completion of the bachelor's (BSc) program. The pre-degree certificate can be issued if the student has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education as set out in Section 10 in Rules and Regulations – with the exception of preparing thesis – and gained the necessary credit points (180). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the requirements for Physical Education. Students who obtained the pre-degree certificate can submit the thesis and take the final exam.

Thesis

Students have to write a thesis in the 5th and 6th semester. Writing this is the precondition of the entrance to the final exam.
The bachelor thesis that terminates the studies is based on independent work of the student supervised by a staff member of the Institute of Chemistry (IC) and appears as a written description of the activities done and results achieved in an extent of 20-30 pages. The aim of the thesis is to prove that the student is able to collect and critically evaluate information, to set an aim and solve tasks to reach it, evaluate observations and results obtained in a branch of chemistry or chemistry related research field. The thesis work must be done in a research group of the IC or with a supervisor outside of the institute approved by the IC. The thesis should be discussed in a department's seminar before submission and must be presented and defended at the final exam.
Formal requirements of the thesis as well as the evaluation of the thesis by the supervisor are detailed in a manual available from the homepage of the IC.

Final Exam

The final examination is an oral exam of ~30 min to be absolved in front of a Final Examination Board appointed by the dean of the faculty. The supervisor of the student is member of the committee.

Preconditions to start the final exam:

Acquired absolutorium
Submitted thesis
Submitted evaluation sheet for the thesis by the supervisor, with
a minimum grade of pass (2).

Parts and evaluation of the Final Exam

1. Presentation of the thesis (~5 min) – mark on the 1-5 scale
2. Defence of the thesis based on questions raised by the members of the FEC (~5 min) – mark on the 1-5 scale
3. Presentation of a topic related to the thesis work (a list of 4-6 items is provided by the supervisor and one of them is selected by a member of the FEC, ~5 min) – mark on the 1-5 scale
4. Demonstration of the knowledge of chemistry by presenting a topic from the basic chemical subjects (list of items available in the homepage of the IC, ~15 min) – mark on the 1-5 scale

The final exam evaluation mark comprises of two marks obtained as averages of part 1. and 2. as well as of 3. and 4.

Final Exam Board

Board chair and its members are selected from the acknowledged internal and external experts of the professional field. Traditionally, it is the chair and in case of his/her absence or indisposition the vice-chair who will be called upon, as well. The board consists of – besides the chair – at least two members (one of them is an external expert), and questioners as required. The mandate of a Final Examination Board lasts for one year.

Repeating a failed Final Exam

If any part of the final exam is failed it can be repeated according to the rules and regulations. A final exam can be retaken in the forthcoming final exam period. If the Board qualified the Thesis unsatisfactory a student cannot take the final exam and he has to make a new thesis. A repeated final exam can be taken twice on each subject.

Diploma

The diploma is an official document decorated with the coat of arms of Hungary which verifies the successful completion of studies in the Chemistry Bachelor Program. It contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialization; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the rector’s (or vice-rector’s) original signature and the seal of HEI. The University keeps a record of the diplomas issued.

In Chemistry Bachelor Program the diploma grade is calculated as the average grade of the results of the followings:

- Weighted average of the overall studies at the program (A)
- Average of grades of the thesis and its defense given by the Final Exam Board (B)
- Average of the grades received at the Final Exam for the two subjects (C)

Diploma grade = (A + B + C)/3

Classification of the award on the bases of the calculated average:

Excellent	4.81 – 5.00
Very good	4.51 – 4.80
Good	3.51 – 4.50
Satisfactory	2.51 – 3.50
Pass	2.00 – 2.50

The Chemistry BSc program at the University of Debrecen has beenawarded the „Eurobachelor” qualification label by the European Chemistry Thematic Network.

Course Descriptions of the Chemistry BSc Program

Title of course: Mathematics I. **Code**: TTMBE0808	**ECTS Credit points: 5**
Type of teaching, contact hours - lecture: 4 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 56 hours - practice: - - laboratory: - - home assignment: 44 hours - preparation for the exam: 50 hours Total: 150 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTMBE0809_EN, TTMBG0809_EN	

Topics of course

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improprius integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature

Compulsory: -
Recommended:

Thomas, Weir& Hass: Thomas' Calculus,
K. A. Stroud: Calculus and MathematicalAnalysis,
K. A. Stroud: Engineering Mathematics,
E. Mendelson: Schaum's 3000 SolvedProblems in Calculus,

1st week
Operations with sets, set algebra. Descartes product, relations, functions. Special functions: injectivity, surjectivity, bijectivity. The inverse of a function. Real numbers. Exact lower and upper bounds. Open and closed sets. Bolzano-Weierstrass theorem.
2nd week

Complex numbers. The algebraic structure of the set of complex numbers. The complex plane. Trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week

Sequences. Convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Cauchy's convergence criteria. Algebraic operations with convergent sequences. Squeezing theorem. The generalization of the notion of limit.

4th week

Series. The convergence of series. Arithmetic series and geometric series. The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week

Limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week

Differentiation. The geometric meaning of the derivative. Rules of differentiation. Derivative of a function of a function: the chain rule. The derivative of the inverse function. Relationship of monotonicity and the derivative. Roll’s theorem and Lagrange’s theorem. Conditions for the existence of extreme values. Derivative of elemental functions.

7th week

Higher order derivatives. Convexity and the derivatives. Approximating with polynomials, Taylor formula. Conditions for the existence of extreme value.

8th week

Test.

Primitive functions, the indefinite integral. Integration methods. Definite integral. Basic properties of the definite integrals. Integration of a continuous functions. The Newton-Leibniz formula.

9th week

Improper integrals. Applications.

10th week

Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

Vector space. Linear dependent and independent system of vectors. Base, dimension. Subspace. Vector space generated by a set of vectors. Rank of a system. Linear maps.

12th week

Matrices, matrix algebra. Determinants and their calculation. The rank of a matrix. The inverse of a matrix. Matrix representation of linear maps.

13th week

System of linear equations. Homogeneous and inhomogeneous systems. Gauss elimination, Cramer rule. Applications.

14th week

Test.

Requirements:

Only students who have the grade from the practical part can take part of the exam. The exam is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)

50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course:Mathematics I. **Code**: TTMBG0808_EN	**ECTS Credit points: 2**
Type of teaching, contact hours - lecture: - - practice: 3 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 42 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: Total: 60 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTMBE0809_EN, TTMBG0809_EN	

Topics of course

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and impróprius integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature

Compulsory: -
Recommended:

Thomas, Weir& Hass: Thomas' Calculus,
K. A. Stroud: Calculus and MathematicalAnalysis,
K. A. Stroud: EngineeringMathematics,
E. Mendelson: Schaum's 3000 SolvedProblems in Calculus,

Schedule:

1st week

Operations with sets, set algebra. Descartes product, relations, functions. Special functions: injectivity, surjectivity, bijectivity. The inverse of a function. Real numbers. Exact lower and upper bounds. Open and closed sets. Bolzano-Weierstrass theorem.

2nd week

Complex numbers. The algebraic structure of the set of complex numbers. The complex plane. Trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week

sequences. Convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Cauchy's convergence criteria. Algebraic operations with convergent sequences. Squeezing theorem. The generalization of the notion of limit.

4th week

Series. The convergence of series. Arithmetic series and geometric series. The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week

Limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week

Differentiation. The geometric meaning of the derivative. Rules of differentiation. Derivative of a function of a function: the chain rule. The derivative of the inverse function. Relationship of monotonicity and the derivative. Roll’s theorem and Lagrange’s theorem. Conditions for the existence of extreme values. Derivative of elemental functions.

7th week

Higher order derivatives. Convexity and the derivatives. Approximating with polynomials, Taylor formula. Conditions for the existence of extreme value.

8th week

Test.

Primitive functions, the indefinite integral. Integration methods. Definite integral. Basic properties of the definite integrals. Integration of a continuous functions. The Newton-Leibniz formula.

9th week

Improper integrals. Applications.

10th week

Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

Vector space. Linear dependent and independent system of vectors. Base, dimension. Subspace. Vector space generated by a set of vectors. Rank of a system. Linear maps.

12th week

Matrices, matrix algebra. Determinants and their calculation. The rank of a matrix. The inverse of a matrix. Matrix representation of linear maps.

13th week

System of linear equations. Homogeneous and inhomogeneous systems. Gauss elimination, Cramer rule. Applications.

14th week

Test.

Requirements:

- for a signature

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.

- for a grade

During the semester one test is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

Students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics II. **Code**: TTMBE0809_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 22 hours - preparation for the exam: 40 hours Total: 90 hours	
Year, semester: 1st year, 2st semester	
Its prerequisite(s): TTMBE0808_EN, TTMBG0808_EN	
Further courses built on it:	

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -

Recommended:

Thomas, Weir& Hass: Thomas' Calculus,

P. Sahoo: Probability and MathematicalStatistics

E. Mendelson: Schaum's 3000 SolvedProblems in Calculus,

Schedule:

1st week

Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.

2nd week

Limit and continuity of multivariable functions.

3rd week

Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse funciton theorem. The implicit function theorem.

4^{th} week

Directional derivative. Gradient and its application. Extreme values of real functions of several variables.

5^{th} week

Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.

6^{th} week

Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.

7^{th} week

Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.

8^{th} week

Line integral. Basic properties. Applications.

9^{th} week

Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.

10^{th} week

Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.

11^{th} week

Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hypergeometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.

12^{th} week

Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.

13^{th} week

Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.

14^{th} week

Element of statistics.

Requirements:

Only students who have the grade from the practical part can take part of the exam. The exam is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics II. Code: TTMBG0809_EN	ECTS Credit points: 2

Type of teaching, contact hours
- lecture: -
- practice: 3 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 42 hours
- laboratory: -
- home assignment: 18 hours
- preparation for the exam:

Total: 60 hours

Year, semester: 1st year, 2st semester

Its prerequisite(s): TTMBE0808_EN, TTMBG0808_EN

Further courses built on it:

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -

Recommended:

Thomas, Weir& Hass: Thomas' Calculus,

P. Sahoo: Probability and MathematicalStatistics

E. Mendelson: Schaum's 3000 SolvedProblems in Calculus,

Schedule:

1st week

Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.

2nd week

Limit and continuity of multivariable functions.

3rd week

Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse funciton theorem. The implicit function theorem.

4th week
Directional derivative. Gradient and its application. Extreme values of real functions of several variables.
5th week
Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.
6th week
Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.
7th week
Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.
8th week
Line integral. Basic properties. Applications.
9th week
Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.
10th week
Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.
11th week
Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hypergeometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.
12th week
Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.
13th week
Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.
14th week
Test. Element of statistics.

Requirements:
- *for a signature*
Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.
- *for a grade*
During the semester one test is written. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

Students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD
Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course:Physics for Engineers I **Code**: TTFBE2111_EN	**ECTS Credit points: 3**

Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -
Evaluation: exam
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 24 hours - preparation for the exam: 24 hours Total: 90 hours
Year, semester: 1st year, 1st semester
Its prerequisite(s): –
Further courses built on it: TTFBE2113_EN, TTKBE0401_EN, TTKBG0401_EN,

Topics of course
Physical quantities, standards, units. Kinematics in one dimension. Kinematics in three dimensions. Dynamics. Force laws. Ballistic motions. Center of mass, constrained motion. Collisions. Work and energy. Oscillations. Elasticity. Wave motion. Temperature.
Literature
J.W. JewettJr, R.A. Serway: PhysicsforScientists and Engineers

Schedule:

1st week

Physical quantities, standards, units: definition of length, equivalence relations and classes, scales, standards of length, time and mass, basic and derived physical quantities, units and prefixes in SI, physical dimensions, dimensional analysis

2nd week

Kinematics in one dimension: Cartesian, spherical and cylindrical coordinate systems, vectors,operations with vectors, position vector, position function, average and instantaneous speed, average and instantaneous acceleration in one dimension

3rd week

Kinematics in three dimensions: displacement vector and path, average and instantaneous velocity, average and instantaneous acceleration in three dimensions, circular motion, tangential and normal acceleration, angular velocity, angular acceleration, relative motions, Galilean transformation, Coriolis acceleration

4th week

Dynamics: Newton's first law, inertial frames, experimental laws of two-body interactions, inertial mass, momentum, conservation of momentum, Newton's second law, Newton's third law

5th week
Force laws: basic interactions in nature, the role of force laws in equations of motion, force law of gravitation, force law of electrostatic interaction between two point charges, force law of a charged particle moving in magnetic field, force law of an idealized spring, force law of friction, force law of drag forces
6th week
Ballistic motions: analytic solution of the equation of motion near the surface of the Earth, describing the path, calculating the parameters of the special points of the path, numerical solution of the equation of motion near the surface of the Earth
7th week
Center of mass, constrained motion: center of mass defined in the discreet and in the continuum limit, density, internal and external forces, constrained motion on a slope, constrained motion of a pendulum
8th week
Collisions: describing collisions in the center-of-mass and in the laboratory frame, elastic and inelastic collisions, kinetic energy, collisions in one dimension, special cases of one-dimensional collisions
9th week
Work and energy: work, work-energy theorem, work of the gravitational pull of the Earth, work of an idealized spring, power, potential energy, conservation of total mechanical energy, conservative and dissipative forces, potential energy of a body under the influence of an idealized spring, potential energy of a body under the influence of gravitation
10th week
Oscillations: analyzing the motion of a pendulum, simple harmonic oscillations, addition of two simple harmonic oscillations, Lissajous figures, damped oscillations, forced oscillations, coupled oscillations
11th week
Elasticity: tensile stress, shearing stress, uniform compression, relative deformation, Young's modulus, shear modulus, compression modulus, Hooke's law, elastic energy, elastic energy density
12th week
Wave motion: mechanical waves, transverse and longitudinal waves, one-dimensional wave motion in a streched string, wave speed, wave function, wave equation, harmonic waves, wavelength, wave number, time period, energy transports in wave motion, kinetic and potential energy density of an elastic medium, energy density current, intensity
13th week
Wave motion: multi-dimensional wave motion, wavefronts, spherical waves, plane waves, principle of linear superposition, interference, coherent waves, standing waves, sound waves, intensity, pitch and tone, fundamental frequency and overtones, diffraction, Huygens' principle, Huygens–Fresnel principle
14th week
Temperature: extensive and intensive quantities, thermal equilibrium, zeroth law of thermodynamics, empirical measuring scales, Celsius scale, Kelvin scale, triple-point temperature, Gay-Lussac's law, constant-volume gas scales, ideal gas

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading: *0–49 % → 1,* *50–62 % → 2,* *63–75 % → 3,* *76–88 % → 4,* *89–100 % → 5*
Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD
Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Physics for Engineers II **Code**: TTFBE2113_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 24 hours - preparation for the exam: 24 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTFBE2111_EN	
Further courses built on it: TTKBE0503_EN	

Topics of course

Geometrical optics. Wave properties of light. Electrostatics. Gauss' law. Electric potential. Capacitors. Electric current. Direct current circuits. Magnetic field. Sources of magnetic field. Solenoids, displacement current. Induction. LC and RLC circuits. Electromagnetic waves.

Literature

J.W. JewettJr, R.A. Serway: PhysicsforScientists and Engineers

Schedule:

1st week

Geometrical optics: law of reflection, law of refraction, total reflection, imaging by concave and convex mirrors, imaging by a single spherical refractive surface, imaging by converging and diverging thin lenses, lense distortions

2nd week

Wave properties of light: coherent light waves, interference, diffration, Young’s double-slit experiment, thin-film interference, single-slit diffraction, diffraction gratings

3rd week

Electrostatics: electric charge, insulators, conductors and semi-conductors, Coulomb's law, electric field, field vector, field lines, electric field of a point charge, electric dipoles, linear, surface and volume charge distributions

4th week

Gauss' law: electric flux through open and closed surfaces, Gauss' law and its applications, electric field of a uniformly charged infinite line, electric field of a uniformly charged infinite plane, electric charge of a uniformly charged spherical volume

5th week

Electric potential: comparison of the force laws of gravitational and electrostatical interactions, work done by electric field, potential energy, potential energy of two-body and many-body systems, potential, potential due to a single point charge and charge distributions *6th week* Capacitors: parallel-plate, cylindrical and spherical capacitors, capacitance, energy and energy density stored by the electrostatic field, capacitors with dielectrics, equivalent capacitance of capacitors connected in parallel and series *7th week* Electric current: electric current, electric current density, resistance, resistivity, conductivity, differential and integral form of Ohm's law, temperature dependence of resistivity, electric power *8th week* Direct current circuits: equivalent resistance of resistors connected in parallel and series, ideal and non-ideal batteries, electromotive force, Kirchhoff's junction law, Kirchhoff's loop law, transient phenomena in RC circuits *9th week* Magnetic field: magnetic field, field vector, field lines, electric charge moving in magnetic field, Lorentz's force, cyclotron, magnetic force acting on a current-carrying conductor *10th week* Sources of magnetic field: Biot–Savart law, magnetic field of a current-carrying straight wire, magnetic force between two parallel conductors, definition of the unit of electric current, Ampere's law *11th week* Solenoids, displacement current: magnetic field of a solenoid, magnetic flux through open and closed surfaces, Gauss' law of magnetism, displacement current, Ampere–Maxwell law *12th week* Induction: induced electormotive force, Faraday's law of induction, Lenz's law, eddy currents, self-induction, inductance, transient phenomena in RL circuits *13th week* LC and RLC circuits: energy conditions in LC circuits, analogy to free harmonic oscillations of a mechanical system, energy conditions in RLC circuits, analogy to damped oscillations of a mechanical system *14th week* Electromagnetic waves: differential and integral form of Maxwell's equations, linearly polarized plane electromagnetic waves
Requirements: *The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:* *0–49 % → 1,* *50–62 % → 2,* *63–75 % → 3,* *76–88 % → 4,* *89–100 % → 5*
Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD
Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Basic Chemical Informatics Code: TTKBG0901_EN	ECTS Credit points: 2

Type of teaching, contacthours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: mid-semestergrade

Workload (estimated), dividedintocontacthours:
- lecture: -
- practice: 28 hours
- laboratory: -
- homeassignment: 16 hours
- preparationfortheexam: 16 hours

Total: 60 hours

Year, semester: 1st year, 1st semester

Itsprerequisite(s): -

Furthercoursesbuiltonit: TTKBG0902_EN

Topics of course

- Basic knowledgeabout Microsoft Office program packages
- Preparing documents and presentations
- Using Instant JChem and Marvin program packagesfordrawingmolecularstructures
- Learningbasic Linux commands
- UsingWinSCPCommander and Puttyprograms

Literature

Compulsory:
https://support.office.com/

Recommended:
https://chemaxon.com/products/instant-jchem
https://www.opensuse.org/

Schedule:

1st week
MS Word. Professional wordprocessing I. Formatting, symbols, formula.Formatting and editingdocuments: subscripts and superscripts, Greekletters. Reproducingchemical formula and reactionsby MS Word.

2nd week
2Professional wordprocessing II. Tables, title, table of contents, coverpage, margins, orientation, bullets and numbering, page/sectionbreaks

3rd week
Professional wordprocessing III. Equations, figures, literature, remarks, header and

footer: letterhead, pagenumberedform
4th week
Professional wordprocessing IV. Chemistry add in Word
5th week
PowerPointPresentation 1.
6th week
PowerPointPresentation 2.
7th week
Spreadsheet I. Formatting, data management
8th week
Spreadsheet II. *xy* diagrams, linear fitting
9th week
Spreadsheet III. *xy* diagrams, non-linearcurves
10th week
Drawing programs. MarvinSketch
11th week
Data base. Instant JChem
12th week
Simulating programs. GaussView
13th week
Linux commands.
14th week
Exam

Requirements:
- for a signature
Attendance is recommended, maximum 3 absences are accepted.
- for a grade
MS Word document and presentation prepared during the semester. (50%)
Exam of MS Excel and Linux commands. (50%)
The finalgrade is based on the sum of the exam and the MS Office document and presentation.
The finalgrade is given according to the following table:

Score (%)	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of the finalgrade is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Attila Mándi, assistant professor, PhD

Lecturer: Dr. Attila Mándi, assistant professor, PhD

Title of course: Chemical Informatics **Code**: TTKBG0902_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice:2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours Total: 60 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBG0901_EN	
Further courses built on it: TTKBG0612_EN	
Topics of course	
Application of spreadsheets: mathematical operations, equations, charts, curve fitting, least-squares fitting, numerical integration, numerical derivation, solving of nonlinear equations, solving of set of equations, linear regression, matrix operations, introductions to statistics.	
Literature	
Recommended: 1. Joan Preppernau, Joyce Cox and Curtis Frye. Microsoft® Office Home and Student 2007 StepbyStep, Microsoft Press, 2007 2. Robert de Levi. Advanced Excel® forscientificdataanalysis, Oxford University Press, New York, 2004 3. Robert de Levi. HowtoUse Excel® in AnalyticalChemistry: And in General Scientific Data Analysis, Cambridge University Press, Cambridge, 2004	

Schedule:

1st week

Implementation of mathematical functions in the spreadsheet software. Plotting the result in *xy* scatter graphs.

2nd week

Solving calculation problems in chemistry by implemented mathematical functions.

3rd week

Numerical differentiation by spreadsheet software and its application for problem-solving in chemistry.

4th week

Numerical integration by spreadsheet software and its application for problem-solving in chemistry.

5th week

Regression, curve fitting
6th week
The application of interpolation for problem-solving in chemistry.
7th week
Solving nonlinear equations by spreadsheet software and its application for problem-solving in chemistry.
8th week
Solving nonlinear set of equations by spreadsheet software and its application for problem-solving in chemistry.
9th week
Matrix operations
10th week
Solvingsets of linearequationsby matrix operations.
11th week
Application of spreadsheets in combinatorics and probability.
12th week
Application of spreadsheets in statistics. Probability distributions.
13th week
Maxwell–Boltzmann molecular speed distribution for gases. Typical speeds.
14th week
Application of t-tests for problem-solving in chemistry.

Requirements:
- for a signature
Participation at the classes is compulsory. A student must attend the classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at the classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.
- for the practice grade
The course ends with a test in the 14th week. The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

The students are allowed to retake the test once to improve their scores. Further improvement is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Ákos Kuki, associate professor, PhD

Lecturer: Dr. Tibor Nagy, Assistant Professor, PhD

Title of course: Basic Economics and Business **Code**: TTTBE0010-K1_EN	**ECTS Credit points: 1**
Type of teaching, contact hours - lecture: 1 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

The course reviews the main areas that are essential to understand the operation of a business organization. In addition to reviewing the basic concepts of economics and management, it focuses on strategic management and planning, marketing, asset management, quality management, project management, organizational behaviour, human resource management and finance.

Literature

Compulsory:

Robbins, Stephen P. – Judge, Timothy A. (2016): Essentials of OrganizationalBehavior, thirteenthedition, Global edition. Pearson Education Limited, Essex, England

Foster, S. Thomas – Ganguly, Kunal K. (2007): ManagingQuality. IntegratingtheSupplyChain. Pearson, Prentice Hall

Hill, Charles W. L. – Jones, Gareth R. – Schilling, Melissa A. (2015): Strategic Management Theory. 11th edition, CengageLearning

Lecturenotesprovidedbythelecturers

Schedule:

1st week (two hour)

Fundamental management terms, theories. Organizations. Key elements and common organizational designs.

2nd week -

3rd week (two hour)

Organizational behaviour and leadership

4th week - *5th week (two hour)* Fundamental economics and business terms. Quality assurance, maintenance, project management, innovation management. *6th week -* *7th week (two hour)* Strategic management, business planning and marketing. *8th week -* *9th week (two hour)* The most important elements of production and process management, the basic concepts of logistics. *10th week -* *11th week (two hour)* Human resources management. *12th week -* *13th week (two hour)* Fundamental terms of corporate finance *14th week* Final test
Requirements: Attendance at lecturesis recommended, but not compulsory. Those students who write a successful final test on the 14th week can get an offered grade, based on the test. Those who do not participate, or fail, have to take a written exam during the examination period.
Person responsible for course: Dr. Mária Ujhelyi, associate professor, PhD
Lecturers: Dr. Mária Ujhelyi, associate professor, PhD Dr. András István Kun, associate professor, PhD Dr. Krisztina Dajnoki, associate professor, PhD Dr. Ferenc Ede Buzás, scientific assistant Dr. Andrea Szabó, assistant professor, PhD

Title of course: Quality Management **Code**: TTTBE0020_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

History of quality management. Standards, standardization methods. ISO standard system and related standards. Basic principles of quality management. The EN ISO 9001:2015 standard. Application of TQM (Total Quality Management). The EN ISO 14001:2015 standard.

Literature

Compulsory:

- The EN ISO 9001:2015, 14001:2015 and BS OHSAS 18001:2007 standards.
- John Jeston, Johan Nelis: Business Process Management – Practical Guidelines to Successful Implementations (Elsevier, 2008) ISBN: 978-0-75-068656-3
- D. H. Stamatis: FailureMode and EffectAnalysis - FMEA fromTheorytoExecution (American Society forQuality, Quality Press, 2003) ISBN: 0-87389-598-3

Recommended:

- Carl L. Pritchard: Risk Management Concepts and Guidance (CRC Press, Taylor & Francis Group, 2015) ISBN: 978-1-4822-5846-2

Schedule:

1st week

The history of quality management.

2nd week

Overview of the quality management systems used in the world. US and EU standards.

3rd week

ISO 9001:2015: Customer focus and customer satisfaction, leadership

4th week

ISO 9001:2015: Involvement of people, process approach.

5th week

ISO 9001:2015: Systematic approach to management, continual improvement

6th week

ISO 9001:2015: Factual approach to decision making, mutually beneficial supplier relationship

7th week

Using the Cycle of PDCA (Plan-Do-Check-Act) For Quality Management.

8th week

ISO 14001:2015: Context of the organization, Leadership.

9th week

ISO 14001:2015: Planning, Support, Operation.

10th week

ISO 14001:2015: Performance evaluation, Improvement

11th week

Integrating ISO 9001 and ISO 14001.

12th week

TQM: Quality and team organization. Teams' thinking and communication.

13th week

TQM: Problem solving and decision making process. Leadership and Empowerment. Benchmarking.

14th week

TQM: Achieving quality by planning: QFD, Hoshin planning. Quality through improvement and control: SPC. Quality through design: Robust design.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Active participation is rewarded by the teacher in every class.

During the semester there is one end-term test in the 15th week for an offered grade (optional). Students have to sit for the tests.

- for a grade

The course ends in an **examination**.

The minimum requirement for the end-term test and the examination respectively is 50%. Based on the score of the test, the grade for the test and the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-61	pass (2)
62-74	satisfactory (3)
75-87	good (4)
88-100	excellent (5)

If the score the test is below 50, students can take a retake test in conformity with the Education and Examination Rules and Regulations.

-an offered grade:

it may be offered for students if the grade of both the essay and the end-term test is at least satisfactory (3). The offered grade is the average of them.
Person responsible for course: Dr Zsolt Radics, Assistant Professor, PhD
Lecturer: Dr Zsolt Radics, Assistant Professor, PhD

Title of course:History and Structure of the EU **Code**: TTTBE0030-K1	**ECTS Credit points: 1**
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: -	

Topics of course

The aim of the course is togivean overall picture for the students of the history of the development of the Community and the operation of its institutional system. It also aims at introducing the students to the enlargement process and the most important cooperation areas. On the level of EU policies, the issues of agriculture, regional policy, Economic and Monetary Union and the Schengen Area are discussed. The primary goal is that the future diploma holders have realistic knowledge about the functioning of the European Union, and of the international background of the Hungarian EU membership.

Literature

Bergmann, Julian – Niemann, Arne (2013): Theories of European Integration and their Contribution to the Study of European Foreign Policy, Paper prepared forthe 8th Pan-European Conferenceon International Relations, Warsaw 2013. p22.
Ott, Andrea – Vos, Ellen (eds.) (2009): FiftyYears of European Integration: Foundations and Perspectives. T.M.C. Asser Press, Springer. 480pp. ISBN: 978-90-6704-254-3
Official website: https://europa.eu/european-union/about-eu_en

Schedule:

1st week

History of the Integration. Integration theories, stages of integration around the world. Specific features of the European integration process before the Second World War. Impacts of the Second World War on the history of the cooperation. Predecessors, impacts of the European Coal and Steel Community (ECSC) on the foundation of the European Economic Community. Steps towards the European Union.

2nd week

Process of the enlargement of the organisation. Preconditions of the enrolment of new members. Events of the period prior to the First Enlargement (1973). Steps, principles, causes and consequences of the Enlargements. Relationships between the decision-making mechanism and the Enlargement.
3rd week
Specific features of the enlargements after the turn of the millennium. Transformation of East Central Europe, and the unique features of its membership. Copenhagen criteria, pre-accession funds, prolonged negotiation process. Brexit.
4th week
History and principles of the creation of the institutional system. Taking-over the institutional system of the European Coal and Steel Community. Tasks of the most important institutions, operational mechanism, democratic deficit. Reform process of the institutional system, concepts laid down in the Constitutional Treaty. Decision-making in the EU.
5th week
Agricultural policy. History of the development of the CAP. The most important tools and sources of the funds. Horizontal measures. Current state of the common agricultural policy and its expected future. Reform attempts in agriculture. Hungary and common agricultural policy. Sharing the fish stocks of the seas.
6th week
Regional policy in the European Union. History of the regional policy. Regionalism – regionalisation in the EU Member States. General features of the regional policy. NUTS nomenclature. Regional disparities in the Community. Funds and main objectives. Decision-making in regional policy. Hungary and the regional policy.
7th week
Economic and Monetary Union (EMU). History of the European monetary co-operation. The European Monetary System (EMS). Role of the Maastricht Treaty in the monetary co-operation. Stages on the development of the Monetary Union. Convergence criteria. The euro and the currency market. Hungary and the Monetary Union.
8th week
Judicial co-operation in the Community. Legal order in the European Union. Role of the primary EU legislation in the European Community. European Community justice. Institutions serving the needs of judicial co-operation.
9th week
History of co-operations in home affairs. Schengen Convention. Regulations related to crossing state borders. Border checks. Checks between state borders, migration policy.
10th week
External relations. Principles of the common foreign trade policy. Autonomous import and export regulation. Issues related to the impediment to trade. External relations: African, Caribbean and Pacific Group of States (ACP), Global Mediterranean Policy, associated countries.
11th week
EU Budget: revenue side. Components of the EU budget and recent changes in the proportions. History of the EU budget. Budget revenues: duties, value-added tax (VAT), gross national product (GNP) sources.
12th week
Expenditures: agricultural policy, structural funds, external aid, research and development, pre-accession assistances, administrative expenditures. Economic characteristics. Budget procedure.

13th week **Migration and the European Union.** Theoretical background to the migration crisis in 2015and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation. *14th week* **Common vision for the European co-operation.** Possible development paths in the future of the European Union. Federal Europe or Europe of Nations? Reform options. Problem-solving attempts. Brexit.
Requirements: - *for a signature* Attendance at **lectures** is recommended, but not compulsory. - *for a grade* The course ends in a **written examination**.
Person responsible for course: Dr. Károly Teperics, associate professor, PhD
Lecturer: Dr. Klára Czimre, assistant professor, PhD

Title of course: General Chemistry I. **Code**: TTKBE0101_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: 3 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 42 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 78 hours Total: 120 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTKBL0101_EN. TTKBE0201_EN, TTKBE0007_EN	

Topics of course

History and development of chemistry and its relation to other natural sciences. Development of atomic and molecular theory. The structure of atom. Basics of radioactivity. Discovery of the periodic table and periodically changing properties. Introduction to quantum chemistry. Primary and secondary chemical bonds. Description of gaseous, liquid and solid states of matter. Phase changes. Chemical equilibrium. Acid-base theories. Basics of thermochemistry, reaction kinetics and electrochemistry.

Literature

Compulsory:

- John McMurry, Robert C. Fay: Chemistry, 7th ed., Prentice Hall ISBN: 0321943171.
- Darrell D. Ebbing: General Chemistry, 9th ed. Belmont, CA, ISBN: 1439049829
- James E. Brady, Gerard E. Humiston: General chemistry: principles and structure, 3rd ed., New York, Wiley, ISBN: 0471808164

Schedule:

1st week

Classification of natural sciences, history and development of chemistry. The concept of chemical change. The SI system of units, the most important physical quantities and units. Conservation of mass and energy. The law of definite proportions, the law of multiple proportions, law of combining gas volumes, Avogadro’s law. Dalton’s atomic theory. Relative atomic and molecular weights. Amount of substance and the definition of mole. Notations for elements and compounds, symbol, empirical formula, molecular formula, structure, isomerism.

2nd week

Valency and oxidation number. Oxidation number in inorganic compounds. Types of chemical reactions. Latin names of compounds. Experimental background of the atomic theory, discovery of the nucleus. Discovery and basic properties of subatomic particles (electron, proton, neutron). Isotopes.

3rd week

Types and properties of radioactive radiation. Laws of radioactive decay, decay series. Medical and other practical importance of radioactive isotopes. The mass defect. Einstein's equation on mass-energy equivalence. Nuclear energy, nuclear fission and fusion. Quantized changes in the energy states of atoms. The photon hypothesis. The Bohr model of the atom. Characteristics of electromagnetic radiation, atomic line spectra, X-ray radiation.

4th week

The dual nature of matter. Heisenberg's uncertainty principle. Schrödinger's equation and its application for the hydrogen atom. Quantum numbers and their importance. The shape of atomic orbitals. Characterization of polyelectronic atoms. Principles of the periodic table.

5th week

Electronegativity, ionization energy, electronaffinity, atomic and ionic radii and their change across the periodic table. The ionic bond. Calculation of the lattice energy. Metallic bonding.

6th week

The covalent bond. Basic characteristics of the molecular orbital (MO) theory and its application for diatomic molecules. The valence shell electron pair repulsion (VSEPR) model. The shape of molecules, bond angles, bond orders, hybridization. Polarity of covalent bonds, polar and nonpolar molecules.

7th week

Intermolecular forces. London forces, dipole-dipole interaction. Hydrogen bond and its importance in inorganic and organic chemistry. General characterization of molecular, ionic, metallic, and network atomic solids.

8th week

Classification and structure of chemical systems. General characterization of different states of matter. The kinetic molecular theory of gases, ideal and real gases. Gas laws: Boyle's law, Charles's law, the ideal gas law. Gas mixtures, partial pressure. General characterization of liquids, surface tension, viscosity. General characterization and classification of solids. Changes of state: melting, freezing, evaporation, condensation, sublimation.

9th week

Classification of multicomponent systems, properties of solutions and mixtures. Solubility and units of concentration. Vapor pressure, freezing and boiling point of solutions. Osmosis pressure. Determination of molecular weight. Phase diagrams, critical temperature and pressure. Thermodynamic temperature.

10th week

Basics of thermochemistry. Heat of reaction, Hess's law. The importance of heat of formation. Heat of reaction and bond energies. The direction of spontaneous chemical reactions: internal energy, enthalpy, free energy and entropy.

11th week

Dependence of reaction rates on concentrations and the temperature. Order of reactions. Activation energy. Catalysts, homogeneous and heterogeneous catalytic reactions. Enzymes. Photochemical processes. The equilibrium condition and the equilibrium constant. Possibilities to shift the composition of equilibria. Dependence of the equilibrium constant on temperature and pressure. Le Chatelier's principle.

12th week
Solubility equilibria, solubility product. Temperature dependence of solubility. Gas-liquid and liquid-liquid equilibria. Extraction. Different theories of acid-base reactions (Arrhenius, Brønsted, Lewis). Characterization of aqueous solutions, electrolytic dissociation. Strength of acids and bases. Super acids. Dissociation constant and degree of dissocation.
13th week
Self-ionization of water. Ionic product of water. The definition and calculation of pH. Amphoteric substances. Buffer solutions and acid-base indicators. Acid-base properties of salts. Complex ion equilibria. Pearson's hard-soft theory.
14th week
Basics of electrochemistry. Galvanic cells and the concept of electrode potential. Standard electrode potentials, oxidizing and reducing agents. Water as a redox system. Electrolysis, voltage needed in electrolytic cells, overvoltage. Quantitative laws of electrolysis. Galvanic cells and batteries.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**. The result of the examination determines the final grade. The minimum requirement for the examination is 50%. Based on the score of the exam, the grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-87	good (4)
88-100	excellent (5)

If the case of failure, students can take retake exam(s) in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Jőzsef Kalmár Assistant Professor, PhD, habil

Lecturer: Dr. József Kalmár Assistant Professor, PhD, habil

Title of course:General Chemistry I. (seminar) **Code**: TTKBG0101_EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: -
- practice: 3 hours/week
- laboratory: -

Evaluation:mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 42 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 1^{st} year, 1^{st} semester

Its prerequisite(s): -

Furthercoursesbuiltonit: TTKBL0101_EN, TTKBG0501_EN

Topics of course

The main objective of the seminar is to give the basic knowledge and background for students to solve general calculation problems strictly connected to the general chemistry laboratory practice: calculations connected to mass and volume measurements, concentration and its units, crystallization, acid-base and redox equilibria, balancing chemical equations.

Literature

Compulsory:
The collection of calculation problems will be available at the Department's homepage (inorg.unideb.hu)
Recommended:
DarrellEbbing, Steven D. Gammon: General Chemistry 10th edition
DarrellEbbing, Steven D. Gammon: General Chemistry – Standalonebook

Schedule: The seminar will be held in 11 weeks.

1^{st} week
Determination of atomic weight, molecular weight, empirical formula, molecular formula, amount of substance. Determination of empirical formula based on weight percent composition and on elemental analysis.

2^{nd} week
General introduction to the units of concentration. Interconversion of units. Calculation problems connected to solution preparation. Introduction of the SI system. Mass concentration, molarity, mass percent composition, molar percent composition.

3^{rd} week
Review exercises concerning on the first two weeks. Interconversion of concentration units. Density measurements. Mixing equations. Theoretical background of crystallization. Exercises calculation problems of crystallization.

4th week Theoretical backgrounds of gas and solids. Composition of solid and gas mixtures. Introduction to basic chemical equations. Stoichiometric calculations based on chemical equations. Preparation of salts, calculation of theoretical and percent yield. Dissolving of metal mixtures in acids. *5th week* Acid-base equilibria. Theory of acid-base reactions and titrations. Exercises based on acid-base titrations. Stoichiometric calculations based on chemical equations. Determination of molar weight based on titration results. *6th week* Review exercises in stoichiometry and concentration calculations. *7th week* Introduction to basic gas laws. Laboratory preparation of gases. Calculation problems connected to evolution of gases based on chemical equations. *8th week* Theory of redox reactions. Balancing of redox reactions. Calculations based on redox reactions. Preparation of salts from its metal. Review exercises in balancing of redox and acid-base reactions. *9th week* Definition of pH. Theoretical background of pH calculation. Introduction to water ionisation constants. Relationship between the Kw and H+. Calculation of pH of strong acids and strong bases. *10th week* Calculation of pH of weak acids and weak bases. Determination of dissociation rate. Theoretical background of buffer systems, buffer capacity. Calculation problems regarding the pH of buffer systems. *11th week* Electrochemical exercises. Fundamental of galvanic cells (Daniell cell). The concept of electromotive force, redox potential, standard redox potential. Nernst equation. Review exercises of pH calculations.
Requirements: Students are required to write two general tests (after week 6 and after week 11) which are based on the course material for weeks 1-5 and 7-11, respectively. Each general test is worth 50 points. Grading is based on a five-level scale: 1 (fail), 2 (pass), 3 (average), 4 (good), 5 (excellent). The final course grade is given based on the results of these tests. The score from the general tests must be above 50 % to avoid a 'fail' final course grade. In order to pass the seminar, a student should collect minimum 50 points from the general tests. Students with 'fail' final course grade due to low test results can re-take once a comprehensive test exam in the examination period. It is not allowed to miss any seminars. If a student misses two seminars even for any medical reasons, the student's lecture book won't be signed and she or he has to retake the course next year.
Person responsible for course: Dr. Linda Földi Bíró Assistant Professor, PhD
Lecturer: Dr. Linda Földi Bíró Assistant Professor, PhD

Title of course:General Chemistry II. (laboratory practice) **Code**: TTKBL0101_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 3 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 42 hours - home assignment: 34 hours - preparation for the exam: 14 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN, TTKBG0101_EN	
Furthercoursesbuiltonit: TTKBL0201_EN, TTKBL0501_EN	

Topics of course
The objective of the laboratory practice is to introduce firs-year students of different background to laboratory work, the use of basic laboratory equipment, simple laboratory operations and measurements. In addition, students are expected to prepare certain simple chemicals and run various basic experiments to familiarize themselves with chemical laboratory work.
Literature
Compulsory: General chemistry laboratory practice (laboratory manual) *Recommended:* Darrell Ebbing, Steven D. Gammon: General Chemistry 10th edition Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book

Schedule: The laboratory practice will be held in 11 weeks.

1st week

General introduction to the laboratory rules and laboratory work. Safety training. Introduction to laboratory pieces of equipment. The use of gas burners. Overview of pieces of the received laboratory equipment.

2nd week

Mass and volume measurements: weighing on analytical and standard laboratory balances; introduction to volume measurement devices (pipette, burette, volumetric flask). Calibration of volumetric measuring equipment (pipette or volumetric flask). Calculation the standard error between the measured and nominal values.

3rd week

Introduction to solution preparation: grinding, use of mortal, pestle, volumetric flask. Preparation of a standard solution from a crystalline salt. Introduction to a density measurement. The use of the pycnometer. Determination of the density of the prepared solution by the help of the pycnometer. Calculating the weight percent composition of the prepared solution.

4th week

Introduction to separation methods: decantation, centrifuging, filtration. Purification of solids. Theoretical background heating, cooling and the use of hot water bath. Purification of a benzoic acid sample contaminated with sodium chloride. Preparation of a double salt from simple salts and basic laboratory procedures.

5th week

Writing the general mid-term test based on the studied material of the laboratory practice and seminar until week 4. Determination of the composition of mixture of potassium chloride and potassium chlorate. Review of different methods used to temperature measurements. Introduction to the measurements of melting point of the solid substances. Determination of the melting point of the purified benzoic acid sample. Determination of the contamination percentage of the purified benzoic acid sample.

6th week

Demonstration of acid-base titration. Preparation of a standard solution of NaOH. Concentration determination of the standard NaOH solution by acid-base titration. Determination of the molar weight of the recrystallized sample of benzoic acid by acid-base titration. Comparing the result with the literature value and calculating the standard error between the given and measured data. Purified benzoic acid due in.

7th week

Laboratory work with gases: introduction to the use of gas cylinders, simple gas generator, Kipp's apparatus. Studying the chemical and physical properties of gases. Demonstration of hydrogen preparation. The hydrogen explosion test. Preparation of oxygen in a laboratory gas generator and burning of sulphur in oxygen. Study of the observations during the reaction (oxidation product of sulphur). Determination of molecular weight based on the ideal gas law.

8th week

Practice the basic laboratory techniques considering the preparation of a salt. Preparation of salts from its metal. Studies of reactions involving gas formation and precipitation.

9th week

Quantitative study of a precipitation reactions to determine the stoichiometric composition of water insoluble precipitates using the method of continuous variation. Dependence of reaction rate of concentration of reactants. Studying the factor affecting the reaction rates. Determination of the reaction rate and the rate law of the studied reaction. Metal salts preparations due in.

10th week

Theoretical background of liquid-liquid extractions and demonstration of the separation techniques. Introduction to buffer systems, buffer capacity by studying a particular buffer system (acetic acid/acetate ion buffer; ammonium ion/ammonia buffer). Hydrolysis of salts to study the acid-base properties of ionic and covalent compounds in aqueous solutions or in reactions with water. Writing of the ionic equations based on the observed chemical reactions.

11th week

General test from week 5 to week 10. General introduction to electrochemistry. Study of redox reactions. Prediction of the direction of spontaneous processes based on standard potentials. Factors affecting the order of the deposition of different metals during electrolysis (study of Daniell cell). Return of the received pieces of laboratory equipment.

Requirements:
Each week the laboratory session begins with a short test (not more than 20 minutes) based exclusively on the preparatory material of that week and the previous week and the results of the experiments carried out the previous week. With each short test a student can collect 25 points. Altogether there are eight short tests during the semester. Students are also required to write two general tests (week 5 and week 11) which are based on the course material for weeks 1-4 and 5-10, respectively. Each general test is worth 50 points. Grading is based on a five-level scale: 1 (fail), 2 (pass), 3 (average), 4 (good), 5 (excellent). The final course grade is given based on the results of these tests, the quality of the laboratory notes and the quality of laboratory work. The average score from both the short tests and the general tests must be above 50 % to avoid a 'fail' final course grade. In order to pass the laboratory practice, a student should collect minimum 100 points from the short tests and minimum 50 points from the general tests. Students with 'fail' final course grade due to inadequate laboratory work have to retake the course the next year. Students with 'fail' final course grade due to low test results can re-take a comprehensive test exam in the examination period.
Those students, whose results are lower than 25% either from the short test or from the general test, cannot write a final exam, they will receive a 'fail' final course grade.
It is not allowed to miss any laboratory practices/seminars. If a student misses one or two lab practices, medical certification is needed. If a student misses three lab practices/seminars even for any medical reasons, the student's lecture book won't be signed and she or he has to retake the course next year. It is not possible to miss short tests at the beginning of the laboratory practice. If a student misses more than two short tests, the laboratory practice will not be accepted for him or her. The students cannot miss either of the general tests, otherwise no signature and final grade is given to the student.

Person responsible for course: Dr. Linda Földi Bíró Assistant Professor, PhD

Lecturer: Dr. Linda Földi Bíró Assistant Professor, PhD

Title of course: Inorganic Chemistry I **Code**: TTKBE0201_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN	
Further courses built on it: TTKBE0202_EN, TTKBL0201_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBL0502_EN, TTKBE0204_EN	

Topics of course

Literature

Compulsory:

N. N. Greenwood, A. Earnshaw: Chemistry of the Elements, 2nd Edition, 1997 (or later ed.)

Recommended:

Geoff Rayner-Canham, Tina Overton: Descriptive Inorganic Chemistry (5th Edition), W. H. Freeman and Company, New York, 2010, ISBN-13: 978-1-4292-2434-5 (or later edition)

Glen E. Rodgers, Descriptive Inorganic, Coordination and Solid-Phase Chemistry, (3rd Edition), Brooks/Cole, 2012, ISBN-13: 978-0-8400-6846-0 (or later edition)

Schedule:

1st week

Origin of the elements in the periodic table. Abundances of the elements in the Universe and on the Earth. Energy production by nuclear reactions. Development of atmosphere on Earth. Major chemical forms of elements, grouping elements by their oxidation state. Production and exploitation methods of the chemical elements.

2nd week

Chemical, physical and atomic properties of the element hydrogen. Solubility of hydrogen in different materials. Hydrogen isotopes, their nuclear properties, nuclear spin isomers, practical application of isotopes and nuclear isomers. Electronic structure, oxidation number, and chemical reactivity, and major reactions of hydrogen. Laboratory and industrial production of hydrogen. Hydrogen as an environment-friendly fuel. Binary hydrides, their most important groups, properties. Hydrogen bonding and its role in the structure and properties of the materials.The most important hydrogen compounds and their use in the practice.

3rd week

Noble gases. General characterization, special physical and chemical properties. Electronic structure of noble gases. Correlatio between electronic structure and chemical reactions. Noble gas compounds. The history of xenon compounds, structure, electronic structure, characteristic reactions. Xenon oxides and oxoacids and their salts. Preparation and practical use. Separtion of noble gases from natural sources.

General properties of the halogens. Physical properties, electronic structure, chemical reactivity, possible oxidation numbers. Interaction of the halogens with different solvents. Hydrate formation, chemical hydrolysis.

4th week

Characteristic chemical reactions of the halogens, interhalogen compounds, polyhalogenium ions, polyhalide anions. Structural aspects of interhalogen compounds, VSEPR theory to describe geometric structures. Halogen-containing minerals, natural resources. Biological role of halides. Laboratory scale and industrial production of the halogen elements. Most important groups of halides regarding their chemical bondings and lattices, physical properties.

5th week

Halogen-oxygen compounds, physical and chemical properties of halogen oxides, and methods of their synthesis, and practical uses. Halogen oxyacids and their salts. Oxidation numbers of the component atoms, laboratory scale and industrial productions. Chemical reactions of halogen oxides and oxoacids. Sterilization, drinking water treatment with halogen oxides and oxoacids.

6th week

Elements of the oxygen group. Electronic structure, physical and chemical properties, characteristic oxidation numbers. Allotropic forms of dioxygen. Structure of dioxygen, explanation of the magnetic properties. Solubility of oxygen in water ant its biological role, solubility in water.

Ozone, physical and chemical properties, formation of ozone in the high atmosphere. Ozone depletion, ozone whole in the arctic region. The role of ozone shield. Ozone precursors, chemicals that can destroy the ozone shield. Chemical reactions of ozone. Practical applications.

Sulfur, selenium, tellurium, allotropic forms, physical properties, oxidation numbers, electronic structures. Chemical reactivity of the elements. Acid-base properties of the sulfides. Laboratory scale and industrial production techniques of the elements. Biological role of the oxygen group elements andtheir compounds. Oxygen and sulfur cycles in the biosphere.

7th week

Binary hydrides of the oxygen group elements. Water, physical and chemical properties, its role in the life and the environment. Types of water in the nature. Gas hydrates. Water purification techniques, water hardness and water treatment. Water wars.

Hydrogen peroxide. Structure, electronic structure, characteristic physical and chemical properties, appearence and role in the living organisms. Sythesis of hydrogen peroxide, in the laboratory and in the industry. Practical uses of hydrogen peroxide.

Binary hydrides of sulfur, selenium, tellurium and lead. Stabilities, chemical properties, synthesis, toxicity, practical uses. Analytical system based on hydrogen sulfide.

8th week

Halides of the calcogenic elements. Synthesis of sulfur chlorides, their properties, reactivities and practical uses. Sulfur oxides, their structure, synthesis, physical and chemical properties, production in the industry. Sulfur-containing oxoacids and their salts: structure, properties,

reactivities, practical uses. Peroxi sulfuric acids and S-S bond-conatiningsulfur oxoacids and their salts: structure, reactivity, preparation, practical uses.
Environmental concerns reagarding the concentration of atmospheric sulfur dioxide: formacion and effect of acid rain.
9th week
Elements of the nitrogen group: appearence, electronic structure, physical properties, allotrops, chemical properties, oxidation states, hybridization. Synthesis and isolation of the elements. Industrial production, air liquifaction and fractionated distillation. Physical methods of nitrogen generation. Practical uses of the elements.
10th week
Hydrides of the nitrogen-group elements. Ammonia and hydrazine: composition, structure, electronic properties, molecular movements. Physical and chemical properties, reactivities, acid-base properties, redox states, characteristic chemical reactions. Synthesis of ammonia and hydrazine in the laboratory and in the industry. Haber-Bosch and Raschig processes. Practical uses of ammonia and hydrazine.
Halides and halogeno-complexes of the nitrogen-group elements. Composition, formation, structure, characteristic physical and chemical properties, reactivities. Practical uses.
Oxides and oxo-compounds of the nitrogen-group elements. Structure, formation, composition, physical and chemical properties. Electronic structure, spectral and magnetic properties. Laboratory-scale and industrial production, Ostwald synthesis. Acid-base properties. Environmental and health issues of nitrogen oxides, role of NO in the human body.
11th week
Nitrogen and phopsphorus oxoacids. Chemical composition, oxidation states, stabilities, physical properties, characteristic reactions, most important salts. Practical uses of nitric and phosphoric acids. Other oxides, oxoacids and oxoanions of other elements of the nitrogen group. Compounds with sulfur: sulfur nitrides, phosphorus sulfides, molecular structures, stabilities, physical and chemical properties, practical uses.
Elements of the carbon group. Electronic structure, oxidation states, hybridization, types of chemical bondings. Stereochemistry of carbon. Comparision of the structure of analogous carbon and silicon compounds.
12th week
Carbon allotrops, structural properties, characteristic physical and chemical properties. Natural carbon sources. Synthesis of carbon allotropes. Isotopes of carbon, stability, properties, practical uses, radiocarbon method. Silicon and other elements: natural sources, properties, synthesis, practical uses. Production and purification of semiconductor grade silicon and germanium. Tin and lead: allotropes, preparation/production, properties, toxicity, practical uses.
Comparision of the structure and stability, hydrolytic properties of the binary hydrides of the carbon group elements. Preaparation of the hydrides, practical uses in hte analytical chemistry.
Halides of the carbon group elements: Composition, hydrolysis, complex formation, geometry, nature of the bonds, redoxi properties and stabilities of the halides.
13th week
Oxides and oxoacids of carbon and silicon. Composotion and electronic structure of carbon oxides and oxoacids. Binding modes and coordination chemistry of carbon monoxide, the most important carbonyl complexes. Properties, toxicity and environmental issues of carbon dioxide. Carbonic acid and their salts, carbonates in the nature. Greenhouse effect, increase of atmospheric carbon dioxide, climate changes, global warming, and the role of technical civilization. Silicic acids and silicates. Types of natural and synhetic silicates. Polymeric and 3D

structures, basic types, appearence in the nature. Special silicon oxides and silicates, silica gels and aerogels. Oxides of tin and lead.
Carbon-nitrogen bond containing inorganic compounds: Cyanic acid and isocyanic acid and their salts. Thiocyanic acid and isothiocyanic acid and their salts. Properties, practical uses.
Carbon and silicon sulfides. Comparision of oxo and thio compounds. Thio-bases and thio-acids. Types of carbides, ionic, covalent and intersticial carbides. Properties, practical uses.
14th week
Elements of the boron group. Appearence, natural resources, most important minerals. Electronic structure, Lewis-acidity, physical and chemical properties, most important chemical reactions. Hybridization. Halides of the boron group elements. Properties, hydrolysis, complex formation, structure, practical uses. Industrial production of aluminum.
Binary and complex hydrides of boron group elements. Special structural characteristics and bonding mode of diborane: 2-electron-3-center binding mode. Synthesis, physical and chemical properties of hydrides and complex hydrides. Comparison of hydrolytic and thermal stabilities. Practical uses of the complex hydrides. Reduction, hydroboration. Polyhedral boron hydrides, structure, stability, carboranes. Boron oxides, boric acid, aluminum oxide and hydroxide. Practical use of aluminum oxide and hidh surface area alumina.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**.
The examination starts with a qualification test. The minimum requirement to qualify for the examination is: 60 score. Below score 60 Grade 1 (Fail) is given.

Score	Grade
0-59	fail (1)
60-100	qualified to the exam

The minimum requirement for the examination is 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-88	good (4)
89-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. István Lázár, associate professor, PhD

Lecturer: Dr. István Lázár, associate professor, PhD

Title of course: Inorganic Chemistry II **Code**: TTKBE0202_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2^{nd} year, 1^{st} semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Furthercoursesbuiltonit: TTKBL0201_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBL0502_EN, TTKBE0204_EN	

Topics of course

Literature

Compulsory:

N. N. Greenwood, A. Earnshaw: Chemistry of the Elements, 2nd Edition, 1997 (or later ed.*)*

Recommended:

Geoff Rayner-Canham, Tina Overton: Descriptive Inorganic Chemistry (5th Edition), W. H. Freeman and Company, New York, 2010, ISBN-13: 978-1-4292-2434-5 (or later edition)

Glen E. Rodgers, Descriptive Inorganic, Coordination and Solid-Phase Chemistry, (3rd Edition), Brooks/Cole, 2012, ISBN-13: 978-0-8400-6846-0 (or later edition)

Schedule:

1^{st} week

General characterization of the metals, structure of the metals, metallic bond. Principles of band theory, conductors, semiconductors and insulators. Characteristic physical and chemical properties of the metals.

2^{nd} week

Alkali metals: general characterization, physical and chemical properties, abundance, preparation and use. Hydrides, halogenides, oxides, hydroxides of alkali metals, salts formed with the most important oxoanions. Complexes of alkali metal ions, crown ethers and cryptands. Covalent compounds of the alkali metals.

3^{rd} week

Alkali earth metals: general characterization, physical and chemical properties, abundance, preparation and use. Role of the alkali earth metals in the nature, biological effect of the metals and their ions. Special features of beryllium and its compounds. Hydrides, halogenides, oxides, hydroxides of alkali earth metals, salts formed with the most important oxoanions. Covalent compounds and complexes of the alkali metals.

4th week

General characterization of the transition (d-block) metals. Important trends in the change of electronic configuration, electronegativity, atomic and ionic radii for the elements in the d-block. Physical and chemical properties of the transition metals, their similarity. Abundance of d-block metals and general methods for the preparation of transition metals. Theoretical and practical aspects of the selection of reducing agents.

5th week

Basic terms in coordination chemistry, coordination number, geometry of complexes. Isomerism and nomenclature of complex compounds. Factors influencing the stability of complexes. Fundamentals of the Hard-Soft Acid-Base (HSAB) theory. Classification of complex compounds and ligands, mono- and multidentate ligands, σ-donor and π-acceptor ligands. Chelate- and macrocycle effect, their importance. Inert and labile complexes.

6th week

Fundamentals of the crystal field theory, interpretation of the colors and magnetic behaviour of the complex compounds. High and low spin complexes. Definition and importance of crystal field stabilization energy (CFSE). Types of transition metal hydrides and their practical importance. Classification of transition metal halogenides based on their composition, structure and binding types. Some important halogenides of the transition metals.

7th week

Oxides, hydroxides and oxoacids of transition metals. Classification of oxides based on their composition and binding types. Physical and chemical properties of the oxides, their acid-base and redox reactions. Methods for the preparation of oxides. Transition metal sulphides, their importance in the environment and analitycal chemistry. Carbides. Simple complexes of the transition metals: hydroxido, halogenido and cyano complexes.

8th week

Metals of the titanium and vanadium group and their most important compounds. General characterization, trends in oxidation numbers, physical and chemical properties, occurrence, preparation and use. Industrial preparation of titanium, practical importance of the metal. Properties of titanium-dioxide and –tetrachloride, their derivatives. Properties of vanadium oxides and their derivatives.

9th week

Members of the chromium group, some important compounds. General characterization, trends in oxidation numbers, physical and chemical properties, occurrence, preparation and use. Halogenides and coordination chemistry of chromium, molybdenum and tungsten. Oxides and their derivatives. Thermal stability, acid-base and redox reactions of the oxides. Formation trends and structure of the iso- and heteropolyacids.

10th week

Members of the manganese and iron groups, some important compounds. General characterization, trends in oxidation numbers, physical and chemical properties, occurrence, preparation and use. Manganese oxides, their derivatives and redox reactions of them. Industrial preparation of iron and steel. Oxides, halogenides and important complex compounds of iron, cobalt and nickel.

11th week
General characterization of the platinum group metals, trends in oxidation numbers, physical and chemical properties. Theoretical aspects of their preparation, some important practical use. Oxides and halogenides. Coordination chemistry of platinum group metal ions: oxidation states and practical use.
12th week
Members and the most important compounds of the copper and zinc groups. General characterization, trends in oxidation numbers, physical and chemical properties, occurrence, preparation and use. Practical importance of the metals, alloys. Oxides and halogenides. Chemical background of black and white photography. Important complex compounds. Environmental and biological role of the metals and their cations.
13th week
General characterization of the lanthanoides and actinoides, electronic configuration, oxidation numbers, physical and chemical properties, occurrence, preparation and use. Oxides and halogenides, important complex compounds. Physical and chemical properties of thorium and uranium, important compounds. Theoretical aspects of the use of nuclear power.
14th week
Fundamentals of bioinorganic chemistry. Classification of the elements based on their biological role. Metalloenzymes and their role. Fundamentals of the medicinal and environmental use of metal ions and their complexes. Classifiction of organometallic compounds. Definition of hapticity. Covalent organometallic compounds. Carbonyls, alkenes and cylopentadiene compounds of the transition metals.

Requirements:
- *for a signature*
Attendance at **lectures** is recommended, but not compulsory.
- *for a grade*
The course ends in an **examination**.
The minimum requirement for the examination is 40 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-39	fail (1)
40-55	pass (2)
56-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

If the score of any test is below 40, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Péter Buglyó, associate professor, PhD

Lecturer: Dr. Péter Buglyó, associate professor, PhD

Title of course: Inorganic Chemistry III. Code: TTKBL0201_EN	ECTS Credit points: 5
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 56 hours - home assignment: 94 hours - preparation for the exam: - Total: 150 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBL0101_EN, TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Furthercoursesbuiltonit:	

Topics of course
Physical and chemical properties, laboratory preparation, use, biological role, identification of hydrogen and the most important p-block elements. The most important compounds of hydrogen and the p-block non-metals: chemical reactions, reactivity, preparation and use. Qualitative analysis of the most important related (oxo)anions with classical analysis. Synthesis and purification of compounds of the p-block elements.
Literature
1. Syllabus provided by the tutor 2. Willard, L.L. Inorganic Chemistry, Wadsworth Publ. Co., Belmont, 1998. 3. Vogel's Qualitative Inorganic Analysis, (ed. Gy. Svehla), Longmann, 2007.

Schedule:

1st week: Introductory guidance, safety regulations

2nd week: Hydrogen: preparation, physical and chemical properties, reactions with non-metals

3rd week: Group 17 elements: preparation, physical and chemical properties, reaction of chlorine with metals. Identification of the halide ions

4th week: Unknown sample with halide ions. Group 16 elements: oxygen and sulfur. Laboratory reparation, physical and chemical properties, reactions of non-metals and metals with oxygen. Ozone.

5th week: Important compounds of group 16 elements: preparation, physical and chemical properties, redox properties of hydrogen-peroxide. Sulfur oxides and oxoacids. Identification of sulphite and sulphate ions.

6th week: Unknown sample with group 17 and 16 anions. Group 15 elements: preparation, physical and chemical properties of nitrogen and phosphorus. Allotropic modifications of phosphorus. Ammonia, dissolution of alkaline metals in liquid ammonia. Identification of ammonia and ammonium ion.

7th week: Synthesis of various compounds consisting p-block elements. Group 15 halogenides and related compounds.

8th week: Nitrogen oxides and the appropriate oxoacids and salts. Preparation and reactivity of nitrogen-dioxide. Properties of nitric acid. Identification of nitrite and nitrate ion.

9th week: Phosphorous oxides and the appropriate oxoacids and salts. Properties of phosphoric acid. Formation, reactivity, redox features and identification of nitrite and nitrate ion.

10th week: Unknown sample with group 17-15 anions. Group 15 sulphides, their acid-base properties and analytical importance.

11th week: Group 14 elements: physical and chemical properties. Reactivity of lead and tin. Formation of silane. Carbon oxides: synthesis, their properties and important reactions. Cyanide and thiocyanate ions and their analytical importance.

12th week: Preparation of various compounds consisting p-block elements. The most important properties of tin and lead: oxides and sulphides.

13th week: Complex unknown sample with the most important anions. Group 13 elements: physical and chemical properties.

14th week: The most important aluminium and boron compounds. Acid-base character of boric acid. Identification of aluminium(III) and borate ions. Complex hydrides and their practical use.

Requirements:
- *for a signature*
Participation at practices is compulsory. Students must attend each practice during the semester. In case of absence(s), a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.
- *for a grade*
Grading is given by considering the following grades:
- the average grade of the short tests written at the beginning of the practices (an average of at least 2.0 is necessary to avoid a ‘fail’ final grade) (70 %)
- the average grade of the unknown samples (20 %)
- the average grade of evaluation of the quality and quantity of the prepared compounds and the laboratory notebook prepared by the student (10 %)
A final ‘fail’ mark can only be improved once if it is due theoretical insufficiency during the short tests.

Person responsible for course: Dr.Péter Buglyó, associate professor, PhD

Tutor: Dr.Péter Buglyó, associate professor, PhD

Title of course: Inorganic Chemistry IV. **Code**: TTKBL0202_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 3 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - laboratory: 42 hours - home assignment: 84 hours - preparation for the exam: - Total: 120 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBE0202_EN, TTKBL0201_EN	
Furthercoursesbuiltonit:	

Topics of course

Physical and chemical properties, laboratory preparation, use, biological role, identification of p-, s- and d-block metals. The most important compounds and complexes of the metals: chemical reactions, reactivity, preparation and use. Qualitative analysis of the most important metal ions with classical analysis. Synthesis and purification of various metal compounds.

Literature

1. Syllabus provided by the tutor
2. Willard, L.L. Inorganic Chemistry, Wadsworth Publ. Co., Belmont, 1998.
3. Vogel's Qualitative Inorganic Analysis, (ed. Gy. Svehla), Longmann, 2007.

Schedule:
2 h introduction + 8 x 5 h practice

1st week: Introductory guidance, safety regulations (2 h)

2nd week: Group I metals: preparation, physical and chemical properties, reactions with non-metals. Formation of (per)oxides, hydroxides, chemical reactions. Crown ether complexes. Synthesis of calcium-hydride.

3rd week: Group II metals and important compounds: oxides, hydroxides, carbonates. Poorly soluble compounds of Group I and II metals. Unknown sample with Group I and II metal ions.

4th week: D-block metals: laboratory preparation, chemical properties. Formation and stability of various oxidation states of transition metal ions. General characterization of complexes: basic terms, stability and kinetic behaviour.

5^{th} week: Important compounds of transition metals: preparation, physical and chemical properties. Halogenides, oxides and their derivatives. Acid-base character of the oxides. Iso- and heteropoyacids and the analytical use. 6^{th} week: Preparation of various compounds consisting s-block and transition elements. Hard-soft classification of the metal ions and ligands. 7^{th} week: Halogeno, amino and hydroxo complexes. Cyano and thiocyanato complexes and their analytical significance. 8^{th} week: The Fresenius system and its practical use in the qualitative analysis of metal ions. Cation groups I-V. 9^{th} week: Analysis of an unknown sample with selected p- and d-block metal ions.
Requirements: *- for a signature* Participation at practices is compulsory. Students must attend each practice during the semester. In case of absence(s), a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. *- for a grade* Grading is given by considering the following grades: - the average grade of the short tests written at the beginning of the practices (an average of at least 2.0 is necessary to avoid a 'fail' final grade) (70 %) - the average grade of the unknown sample(s), evaluation of the quality and quantity of the prepared compound(s) and the laboratory notebook (30 %) A final 'fail' mark can only be improved once if it is due theoretical insufficiency during the short tests.
Person responsible for course: Dr. Norbert Lihi Research Fellow, PhD
Tutor: Dr. Norbert Assistant Professor, PhD

Title of course:Physical Chemistry I **Code**: TTKBE0401_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN, TTFBE2111_EN, TTMBE0808_EN	
Further courses built on it: TTKBE0402_EN, TTKBE0202_EN, TTKBL0201_EN, TTKBG0402_EN, TTKBL0401_EN, TTKBE0302_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBE0601_EN, TTKBG0601_EN, TTKBE0204_EN, TTKBE0417_EN, TTKBG0614_EN, TTKBG0312_EN	

Topics of course

The series of lectures are based on the topics of chemical thermodynamics and equilibrium studies. It reviews the fundamental relations of physical chemistry. The course help to build and strengthen the concepts of physical chemistry in the students' scientific view. In this way the basic concepts and phenomena learned, especially in the General Chemistry course (prerequisite) will be placed into more exact and mathematically well-established surrounding. Application of the approach of physical chemistry in chemical engineering is discussed through examples. The main chapters include: Description of gases. Laws of thermodynamics. Thermochemistry. Description of one component and multicomponent systems. Equilibrium.

Literature

Compulsory:

- P.W: Atkins, J. de Paula (2006): Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8.
- J. M. Smith, H. C. van Ness, M. M. Abbott (2003): Introduction to Chemical Engineering Thermodynamics 6th Edition, McGraw-Hill, ISBN 0-07-240296-2 ISBN:978-0070494862.
- Lecture notes and teaching material available via the e-learning system.
- Leo Lue (2009): Chemical Thermodynamics, Leo Lue and Ventus Publishing, ISBN: 9788776814977. Can be downloaded from bookboon.com

Recommended:

- A. J. Fletcher (2012): Chemistry for Chemical Engineers, ISBN: 9788740302493. Can be downloaded from bookboon.com
- Other corresponding books from bookboon.com

Schedule:

1st week Ideal and real gases

Concepts: Ideal gas and the state equation. Isotherm, isobar and isochor changes. Pressure of gases and its statistical interpretation. Mixture of ideal gases, molar fraction and partial pressure Dalton's law. Real gases, isotherms. Compressibility factor. Real gases and van der Waals equation. Molecular explanation of the pressure and volume correction. The virial equation. List of mathematical tools used during the course. Phenomenological and statistical approach. SI system and units. Dimension analysis. The 0th law of thermodynamics

2nd week The 1st law of thermodynamics

Concepts: Description and formulation of 1st law of thermodynamics. Internal energy and molecular explanation. Work and energy. Volume and other work. Heat. Enthalpy. Internal energy of ideal gases. Joule expansion experiment. Enthalpy and internal energy of real gases. Joule-Thomson experiment and Joule-Thomson coefficient. Liquefaction of gases. . Conservative force fields in physics. Exact differential.

3rd week Thermochemistry

Concepts: Thermochemical equations. Standard state. Reaction heat and its thermodynamic definition. Hess' law. Enthalpy of formation and enthalpy of combustion. Experimental determination of reaction enthalpy. Heat capacity. Temperature dependence of heat capacity. Kirchoff's law.

4th week 2nd law of thermodynamics

Concepts: Description and formulation of the 2nd law. Definition of entropy in thermodynamics and statistical definition. The entropy change of the system and the surrounding during reversible and irreversible isotherm, expansion of ideal gases. Entropy change of adiabatic processes. Transformation of heat into work. Efficiency. Heat engines, refrigerators, heat pumps. Temperature as integral dividend.

5th week 3rd law of thermodynamics

Concepts: Entropy and molar heat capacity. Heat capacity at extreme low temperatures. Absolute zero degree. Description and formulation of the 3rd law. Temperature dependence of entropy. Absolute and standard entropy. Standard reaction entropy. Comparison of phenomenological and statistical approach.

6th week Potential functions in thermodynamics

Concepts: Unification of the 1st and 2nd laws. Maximum useful work and its molecular explanation Free energy (Helmholtz) and free enthalpy (Gibbs) Potential function and their properties. Direction of spontaneous processes. Equilibrium in closed and open systems. Equilibrium and steady state.

7th week Chemical potential

Concepts: Chemical potential and its calculation one component and multicomponent systems. Gibbs–Duhem equation. Chemical potential in two component gas and liquid mixtures, ideal and real solutions Raoult's law and Henry's law. Fugacity and activity and its thermodynamic importance. Choice of standard state. The fundamental equation.

8th week Thermodynamics of one component systems

Concepts: Phase and component. Types of phase transitions. Application of chemical potential in the description of equilibrium of multiple phase one component systems. Phase stability and phase transition. Clapeyron's and Clausius–Clapeyron equation. Liquid-vapour systems, evaporation, boiling, enthalpy of evaporation, boiling point, saturated vapour pressure, entropy of evaporation. Trouton's law and phase diagram. Phase diagram of CO2 and water.

9th week Thermodynamics of two component mixtures and dilute solutions
Concepts: Ideal and real mixtures. Partial molar quantities. Partial molar volume and its determination. Thermodynamics of mixing. Excess functions of mixing, enthalpy and entropy of mixing. Colligative properties: melting point depression, boiling point elevation and osmosis. Practical importance and applications of colligative properties.
10th week Mixture of volatile components
Concepts: Vapour pressure of liquid mixtures. Vapour pressure and composition, boiling point-composition equilibrium plots for ideal and real mixtures. Distillation, azeotropic mixtures. Distribution equilibrium, Vapour pressure of non-miscible liquids. Steam distillation.
11th week Phase rule
Concepts: component, phase, degree of freedom. Phase rule. Phase diagram of partially miscible liquids. Eutectics, phase diagram of two component solids. Cooling of two component mixtures. Three component systems and their presentation in triangle diagram.
12th week Thermodynamic equilibrium in reactive systems.
Concepts: Chemical equilibrium. Reaction free energy. Exergonic and endergonic processes. Equilibrium constant. Standard reaction enthalpy and its relation to equilibrium constant and chemical potentials. Determination of equilibrium constant from thermodynamic data. Types of equilibrium constant: Kp, Kx, Ka. Reaction quotient and equilibrium constant.
13th week Effect of parameters on chemical equilibrium
Concepts: Dynamic nature of equilibrium, La-Chatalier principle. Effect of pressure and temperature on the equilibrium constant, van't Hoff equation. Effect of addition of reactants and products. Practical applications.
14th week Chemical equilibrium in various systems.
Concepts: Types of equilibria: one step, multiple step, parallel, consecutive equilibrium. Equilibrium in homogeneous systems: acid-base, redoxy and stepwise equilibrium. Dissociation in solution and gas phase, equilibrium of reaction systems. Thermodynamics of ATP. Heterogeneous equilibrium, solubility product, decomposition of solids, adsorption of gases on solids. Buffers. pH scale and calculation of pH. Haber process.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
During the semester there is a written end-term test in the 14th week. Students have to sit for the tests. The material of the test is the same as the exam. All questions cover several parts of the topics of the lectures and the sub-questions are scored according to the given points.
- for a grade
The course ends in a **written or oral examination**. Based on the result of the examination questions scored according to pre-set maximum points for each sub-questions. The type of the examination (written or oral) is the choice of the student.
The minimum requirement for the examination is 60%. Based on the score of the tests separately, the grade for the tests and/or the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS. *-an offered grade:* It may be offered for students on the basis of the result of the end-term test if the grade is at least satisfactory (3).
Person responsible for course: Dr. Attila Bényei, associate professor, PhD
Lecturer: Dr. Attila Bényei, associate professor, PhD

Title of course: Physical Chemistry I. **Code**: TTKBG0401_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: - Total: 60 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN, TTFBE2111_EN, TTMBE0808_EN, parallel registration to TTKBE0401_EN	
Further courses built on it: -	

Topics of course

The problem solving classes are based on the topics of the lectures in the field of chemical thermodynamics and equilibrium studies. Calculations are made for better understanding the fundamental relations of physical chemistry. The course help to build and strengthen the concepts of physical chemistry in the students' scientific view. In this way the basic concepts and phenomena learned, especially in the General Chemistry course (prerequisite) will be placed into more exact and mathematically well-established surrounding. Application of the approach of physical chemistry in chemical engineering is discussed through examples. The main chapters include: Description of gases. Laws of thermodynamics. Thermochemistry. Description of one component and multicomponent systems. Equilibrium.

Literature

Compulsory:

- P.W. Atkins, J. de Paula (2006): Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8.
- J. M. Smith, H. C. van Ness, M. M. Abbott (2003): Introduction to Chemical Engineering Thermodynamics 6th Edition, McGraw-Hill, ISBN 0-07-240296-2 ISBN:978-0070494862.
- List of problems, their solutions and other teaching material available via the e-learning system.
- L. Lue (2009): Chemical Thermodynamics, Leo Lue and Ventus Publishing, ISBN: 9788776814977. Can be downloaded from bookboon.com

Recommended:

- A. J. Fletcher (2012): Chemistry for Chemical Engineers, ISBN: 9788740302493. Can be downloaded from bookboon.com
- Other corresponding books from bookboon.com

Schedule:
1st week Ideal and real gases
Problem solving and calculations in the following topics: Ideal gas and the state equation. Isotherm, isobar and isochor changes. Pressure of gases and its statistical interpretation. Mixture of ideal gases, molar fraction and partial pressure Dalton’s law. Real gases, isotherms. Compressibility factor. Real gases and van der Waals equation. Molecular explanation of the pressure and volume correction. The virial equation. List of mathematical tools used during the course. Phenomenological and statistical approach. SI system and units. Dimension analysis. The 0th law of thermodynamics
2nd week The 1st law of thermodynamics
Problem solving and calculations in the following topics: Description and formulation of 1st law of thermodynamics. Internal energy and molecular explanation. Work and energy. Volume and other work. Heat. Enthalpy. Internal energy of ideal gases. Joule expansion experiment. Enthalpy and internal energy of real gases. Joule-Thomson experiment and Joule-Thomson coefficient. Liquefaction of gases. . Conservative force fields in physics. Exact differential.
3rd week Thermochemistry
Problem solving and calculations in the following topics: Thermochemical equations. Standard state. Reaction heat and its thermodynamic definition. Hess’ law. Enthalpy of formation and enthalpy of combustion. Experimental determination of reaction enthalpy. Heat capacity. Temperature dependence of heat capacity. Kirchoff’s law.
4th week 2nd law of thermodynamics
Problem solving and calculations in the following topics: Description and formulation of the 2nd law. Definition of entropy in thermodynamics and statistical definition. The entropy change of the system and the surrounding during reversible and irreversible isotherm, expansion of ideal gases. Entropy change of adiabatic processes. Transformation of heat into work. Efficiency. Heat engines, refrigerators, heat pumps. Temperature as integral dividend.
5th week 3rd law of thermodynamics
Problem solving and calculations in the following topics: Entropy and molar heat capacity. Heat capacity at extreme low temperatures. Absolute zero degree. Description and formulation of the 3rd law. Temperature dependence of entropy. Absolute and standard entropy. Standard reaction entropy. Comparison of phenomenological and statistical approach.
6th week Potential functions in thermodynamics
Problem solving and calculations in the following topics: Unification of the 1st and 2nd laws. Maximum useful work and its molecular explanation Free energy (Helmholtz) and free enthalpy (Gibbs) Potential function and their properties. Direction of spontaneous processes. Equilibrium in closed and open systems. Equilibrium and steady state.
7th week Chemical potential
Problem solving and calculations in the following topics: Chemical potential and its calculation one component and multicomponent systems. Gibbs–Duhem equation. Chemical potential in two component gas and liquid mixtures, ideal and real solutions Raoult’s law and Henry’s law. Fugacity and activity and its thermodynamic importance. Choice of standard state. The fundamental equation.
8th week Thermodynamics of one component systems
Problem solving and calculations in the following topics: Phase and component. Types of phase transitions. Application of chemical potential in the description of equilibrium of multiple phase one component systems. Phase stability and phase transition. Clapeyron and Clausius–Clapeyron equation. Liquid-vapour systems, evaporation, boiling, enthalpy of evaporation, boiling point, saturated vapour pressure, entropy of evaporation. Trouton’s law and phase diagram. Phase diagram of CO_2 and water.

9th week Thermodynamics of two component mixtures and dilute solutions
Problem solving and calculations in the following topics: Ideal and real mixtures. Partial molar quantities. Partial molar volume and its determination. Thermodynamics of mixing. Excess functions of mixing, enthalpy and entropy of mixing. Colligative properties: melting point depression, boiling point elevation and osmosis. Practical importance and applications of colligative properties.
10th week Mixture of volatile components
Problem solving and calculations in the following topics: Vapour pressure of liquid mixtures. Vapour pressure and composition, boiling point-composition equilibrium plots for ideal and real mixtures. Distillation, azeotropic mixtures. Distribution equilibrium, Vapour pressure of non-miscible liquids. Steam distillation.
11th week Phase rule
Problem solving and calculations in the following topics: component, phase, degree of freedom. Phase rule. Phase diagram of partially miscible liquids. Eutectics, phase diagram of two component solids. Cooling of two component mixtures. Three component systems and their presentation in triangle diagram.
12th week Thermodynamic equilibrium in reactive systems.
Problem solving and calculations in the following topics: Chemical equilibrium. Reaction free energy. Exergonic and endergonic processes. Equilibrium constant. Standard reaction enthalpy and its relation to equilibrium constant and chemical potentials. Determination of equilibrium constant from thermodynamic data. Types of equilibrium constant: K_p, K_x, K_a. Reaction quotient and equilibrium constant.
13th week Effect of parameters on chemical equilibrium
Problem solving and calculations in the following topics: Dynamic nature of equilibrium, La-Chatelier principle. Effect of pressure and temperature on the equilibrium constant, van't Hoff equation. Effect of addition of reactants and products. Practical applications.
14th week Chemical equilibrium in various systems.
Problem solving and calculations in the following topics: Types of equilibria: one step, multiple step, parallel, consecutive equilibrium. Equilibrium in homogeneous systems: acid-base, redox and stepwise equilibrium. Dissociation in solution and gas phase, equilibrium of reaction systems. Thermodynamics of ATP. Heterogeneous equilibrium, solubility product, decomposition of solids, adsorption of gases on solids. Buffers. pH scale and calculation of pH. Haber process.

Requirements:
- for a signature
Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring calculators or computers pencil and ruler to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.
During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests. The problems to be solved and calculated are highly analogous with the ones made available in e-learning system. Scoring system is also provided, i.e. possible maximum points for the given problem.

- for a grade
The course ends with signature and mark. The mark is based on the result of the two tests scored according to pre-set maximum points for each sub-problems.
The minimum requirement for the mark is 60%, based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Attila Bényei, associate professor, PhD

Lecturer: Dr. Attila Bényei, associate professor, PhD

Title of course:Physical Chemistry II. **Code**: TTKBE0402_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0401_EN, TTKBE0201_EN, TTKBE0301_EN	
Further courses built on it: TTKBE0403_EN, TTKBE0404_EN, TTKBL0402_EN, TTKBE0405_EN	
Topics of course	
The series of lectures are based on the topics of electrochemistry and reaction kinetics It reviews the fundamental relations of physical chemistry. The course help to build and strengthen the concepts of physical chemistry in the students' scientific view. Application of the approach of physical chemistry in chemical engineering is discussed through examples. The main chapters include: Homogeneous and heterogeneous equilibrium electrochemistry. Transport processes. Kinetics of homogeneous and heterogeneous reactions.	
Literature	
Compulsory: - P.W: Atkins, J. de Paula (2006): Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8. - H. S. Fogler (2011): Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, ISBN: 0-13-047394-4. ISBN: 9780130473943. - R.M. Pashley, M. E. Karaman:Applied Colloid and Surface Chemistry. ISBN 13 978-0-470-86882-9(HB) Teaching material is available via the e-learning system - R. Kandiyoti (2009): Fundamentals of Chemical Reaction Engineering, R. Kandiyoti and Ventus Publishing, ISBN: 9788776815103. Can be downloaded from bookboon.com *Recommended:* -R. Kandiyoti (2009): Fundamentals of Chemical Reaction Engineering- Examples, R. Kandiyoti and Ventus Publishing, ISBN: 9788776815127. Can be downloaded from bookboon.com	

Schedule:	
1st week	Homogeneous equilibrium electrochemistry. Thermodynamics of electrolyte solutions

Concepts: Thermodynamic functions of ions. Standard state of ions. Activity in electrolyte solutions. Mean activity coefficient and its experimental determination. Debye-Hückel limiting law. Ionic strength. Solubility equilibria of salts and effect of ionic strength on the solubility. Calculation of solubility from thermodynamic tables Ostwald's law of dilution.

2nd week Heterogeneous equilibrium electrochemistry. Thermodynamics of electrodes.

Concepts: Processes on electrodes. Main types of electrodes, gas electrodes, first and second kind electrodes, redoxy electrodes. Dependence of electrode potential on concentrations. Nernst equation. Standard electrode potential. Measurement of pH, glass electrode. Redoxy potentials and their application. Half reactions. Electrochemical series. Electrolysis, industrial applications.

3rd week Thermodynamics of galvanic cells

Concepts: Electrodes and galvanic cells. Diffusion potential and its elimination. Types of batteries. Chemistry of various batteries. Thermodynamics of batteries. The connection between electromotive force and reaction free enthalpy. Thermodynamic parameters from electrochemistry measurement.

4th week Transport processes

Concepts: Flux. Diffusion. Fick I and Fick II law. Stokes-Einstein equation. Diffusion equation and their solutions. Convection, diffusion and chemical reaction. Heat conductance. Viscosity. Uniform discussion of transport processes.

5th week Movement of ions in electrolyte solutions. Conductance of electrolytes

Concepts: Measurement of conductivity and conductance. Molar conductivity and its dependence on concentration. Conductivity of weak and strong electrolytes. Kohlrausch's law. Independent migration of ions. Transference number and its determination. Interaction among moving ions. -

6th week Reaction kinetics. Rate of chemical reactions. Rate law of chemical reactions

Concepts: Definition of reaction rate. Experimental methods to determine reaction rates. Fast reaction kinetics. Flow, relaxation and other techniques. Types of reactors. Rate equation, rate coefficient and order of reaction. Experimental methods to determine rate equation. Methods to evaluate experimental results.

7th week Kinetics of simple reactions

Concepts: Formal kinetics. Rate equation of first and second order reactions. Integral forms. Third order reactions. Formal kinetics of equilibrium. Consecutive reactions. Rate determining step. Half-life methods.

8th week Complex reaction systems

Concepts: Elementary reactions and molecularity. Simplification of reaction rate determination, flooding or isolation. Steady state and pre-equilibrium. Unimolecular reactions and their Lindemann–Hinshelwood-mechanism. Enzyme reactions, Michaelis–Menten mechanism.

9th week Reaction encounters

Concepts: Basic steps of chain reactions: initiation, propagation, branching, termination. Formation of hydrogen halogenides. Thermal and chain explosion, explosion limits. The Hinshelwood–Semenov mechanism. Catalysis, formal kinetic description and energetics of catalysis. Homogeneous and heterogeneous catalytic systems Autocatalysis and chemical feedback. Continuous and open reactors.

10th week Collision theory of chemical reactions

Concepts: Temperature dependence of rate coefficient, Arrhenius equation. Activation energy. Collision theory, its basic assumptions. Interpretation and calculation of pre-exponential factor. Steric factor, the anchoring mechanisms, Diffusion driven and activation energy driven reactions.

11th week The activated complex theory of chemical reactions

Concepts: The history of development of activated complex theory and the basic assumptions of the theory. Activated complex and its concentration, experimental evidences. Statistical mechanics in the activated complex theory. Thermodynamic approach in the activated complex theory. Activation free enthalpy activation enthalpy and entropy. Determination of activation parameters Non-thermal activation. Basics of photochemistry, industrial applications.

12th week Processes on solid surfaces

Concepts: Structure of solids and surfaces. Physisorption and chemisorption, their properties and differentiation. Isotherms, Langmuir- and BET-isotherms, basic assumptions of the models. Adsorption enthalpy. Basic steps of surface processes, possible rate determining step. Heterogeneous catalysis, the Langmuir–Hinshelwood- and Eley–Rideal mechanisms. Heterogeneous catalytic processes in the chemical industry. Solid-liquid interface in electrochemistry. Basics od dynamic electrochemistry.

13th week Physical chemistry of colloid

Concepts: Introduction to the nature of colloidal systems, types of colloidal systems. The concept of surface tension. Wetting and spreading. Curved surfaces. Electric double layer, electrokinetic potential. The colloid stability.

14th week Application of colloids, nanoparticles

Concepts: Coherent incoherent systems. The basics of rheology. Liophobic colloids: aerosols, liosols, xerosols. Applications of colloids: nanoparticles, emulsions, suspebsions foams. Liophilic colloids: association and macromolecular systems. The theory of surfactants and cleaning

Requirements:

- for a signature

Attendance at **lectures** is highly recommended, but not compulsory.

During the semester there is a written end-term test in the 14th week. Students have to sit for the tests. The material of the test is the same as the exam. All questions cover several parts of the topics of the lectures and the sub-questions are scored according to the given points.

- for a grade

The course ends in a **written or oralexamination**. Based on the result of the examination questions scored according to pre-set maximum points for each sub-questions. The type of the examination (written or oral) is the choice of the student.

The minimum requirement for the examination is 60%. Based on the score of the tests separately, the grade for the tests and/or the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

It may be offered for students on the basis of the result of the end-term test if the grade is at least satisfactory (3).

Person responsible for course: Dr. Attila Bényei, associate professor, PhD

Lecturer: Dr. Attila Bényei, associate professor, PhD

Title of course:Physical Chemistry II. **Code**: TTKBG0402_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: - Total: 60 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0401_EN, TTKBE0201_EN, TTKBE0301_EN, parallel registration to TTKBE0402_EN	
Further courses built on it: -	

Topics of course

The problem solving classes are based on the topics of the lectures in the field of electrochemistry, reaction kinetics, and colloid chemistry Calculations are made for better understanding the fundamental relations of physical chemistry. The course help to build and strengthen the concepts of physical chemistry in the students' scientific view. In this way the basic concepts and phenomena learned, especially in the General Chemistry course (prerequisite) will be placed into more exact and mathematically well-established surrounding. Application of the approach of physical chemistry in chemical engineering and industry is discussed through examples. The main chapters include: Homogeneous and heterogeneous equilibrium electrochemistry. Transport processes. Kinetics of homogeneous and heterogeneous reactions. Physical chemistry of colloids.

Literature

Compulsory:

- P.W. Atkins, J. de Paula (2006): Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8.
- H. S. Fogler (2011): Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, ISBN: 0-13-047394-4. ISBN: 9780130473943.
- R. M. Pashley, M. E. Karaman: Applied Colloid and Surface Chemistry. ISBN 13 978-0-470-86882-9(HB)
- List of problems, their solutions and other teaching material available via the e-learning system.
- R. Kandiyoti (2009): Fundamentals of Chemical Reaction Engineering, R. Kandiyoti and Ventus Publishing, ISBN: 9788776815103. Can be downloaded from bookboon.com

Recommended:

-R. Kandiyoti (2009): Fundamentals of Chemical Reaction Engineering- Examples, R. Kandiyoti and Ventus Publishing, ISBN: 9788776815127. Can be downloaded from bookboon.com

Schedule:

1st week Homogeneous equilibrium electrochemistry. Thermodynamics of electrolyte solutions
Problem solving and calculations in the following topics: Thermodynamic functions of ions. Standard state of ions. Activity in electrolyte solutions. Mean activity coefficient and its experimental determination. Debye-Hückel limiting law. Ionic strength. Solubility equilibria of salts and effect of ionic strength on the solubility. Calculation of solubility from thermodynamic tables Ostwald's law of dilution.

2nd week Heterogeneous equilibrium electrochemistry. Thermodynamics of electrodes.
Problem solving and calculations in the following topics: Processes on electrodes. Main types of electrodes, gas electrodes, first and second kind electrodes, redoxy electrodes. Dependence of electrode potential on concentrations. Nernst equation. Standard electrode potential. Measurement of pH, glass electrode. Redoxy potentials and their application. Half reactions. Electrochemical series. Electrolysis, industrial applications.

3rd week Thermodynamics of galvanic cells
Problem solving and calculations in the following topics: Electrodes and galvanic cells. Diffusion potential and its elimination. Types of batteries. Chemistry of various batteries. Thermodynamics of batteries. The connection between electromotive force and reaction free enthalpy. Thermodynamic parameters from electrochemistry measurement.

4th week Transport processes
Problem solving and calculations in the following topics: Flux. Diffusion. Fick I. and Fick II. law. Stokes-Einstein equation. Diffusion equation and their solutions. Convection, diffusion and chemical reaction. Heat conductance. Viscosity. Uniform discussion of transport processes.

5th week Movement of ions in electrolyte solutions. Conductance of electrolytes
Problem solving and calculations in the following topics: Measurement of conductivity and conductance. Molar conductivity and its dependence on concentration. Conductivity of weak and strong electrolytes. Kohlrausch's law. Independent migration of ions. Transference number and its determination. Interaction among moving ions.

6th week Reaction kinetics. Rate of chemical reactions. Rate law of chemical reactions
Problem solving and calculations in the following topics: Definition of reaction rate. Experimental methods to determine reaction rates. Fast reaction kinetics. Flow, relaxation and other techniques. Types of reactors. Rate equation, rate coefficient and order of reaction. Experimental methods to determine rate equation. Methods to evaluate experimental results.

7th week Kinetics of simple reactions
Problem solving and calculations in the following topics: Formal kinetics. Rate equation of first and second order reactions. Integral forms. Third order reactions. Formal kinetics of equilibrium. Consecutive reactions. Rate determining step. Half-life methods.

8th week Complex reaction systems
Problem solving and calculations in the following topics: Elementary reactions and molecularity. Simplification of reaction rate determination, flooding or isolation. Steady state and pre-equilibrium. Unimolecular reactions and their Lindemann–Hinshelwood mechanism. Enzyme reactions, Michaelis–Menten mechanism.

9th week Reaction encounters

Problem solving and calculations in the following topics: Basic steps of chain reactions: initiation, propagation, branching, termination. Formation of hydrogen halogenides. Thermal and chain explosion, explosion limits. The Hinshelwood–Semenov mechanism. Catalysis, formal kinetic description and energetics of catalysis. Homogeneous and heterogeneous catalytic systems Autocatalysis and chemical feedback. Continuous and open reactors.

10th week Collision theory of chemical reactions

Problem solving and calculations in the following topics: Temperature dependence of rate coefficient, Arrhenius equation. Activation energy. Collision theory, its basic assumptions. Interpretation and calculation of pre-exponential factor.

Steric factor, the anchoring mechanisms, Diffusion driven and activation energy driven reactions.

11th week The activated complex theory of chemical reactions

Problem solving and calculations in the following topics: The history of development of activated complex theory and the basic assumptions of the theory. Activated complex and its concentration, experimental evidences. Statistical mechanics in the activated complex theory. Thermodynamic approach in the activated complex theory. Activation free enthalpy activation enthalpy and entropy. Determination of activation parameters Non-thermal activation. Basics of photochemistry, industrial applications.

12th week Processes on solid surfaces

Problem solving and calculations in the following topics: Structure of solids and surfaces. Physisorption and chemisorption, their properties and differentiation. Isotherms, Langmuir and BET isotherms, basic assumptions of the models. Adsorption enthalpy. Basic steps of surface processes, possible rate determining step. Heterogeneous catalysis, the Langmuir–Hinshelwood and Eley–Rideal mechanisms. Heterogeneous catalytic processes in the chemical industry. Solid-liquid interface in electrochemistry. Basics of dynamic electrochemistry.

13th week Physical chemistry of colloid

Problem solving and calculations in the following topics: Introduction to the nature of colloidal systems, types of colloidal systems. The concept of surface tension. Wetting and spreading. Curved surfaces. Electric double layer, electrokinetic potential. The colloid stability.

14th week Application of colloids, nanoparticles

Problem solving and calculations in the following topics: Coherent incoherent systems. The basics of rheology. Liophobic colloids: aerosols, liosols, xerosols. Applications of colloids: nanoparticles, emulsions, suspensions, foams.

Liophilic colloids: association and macromolecular systems. The theory of surfactants and cleaning

Requirements:

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring calculators or computers pencil and ruler to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests. The problems to be solved and calculated are highly analogous with the ones made available in e-learning system. Scoring system is also provided, i.e. possible maximum points for the given problem.

- for a grade

The course ends with signature and mark. The mark is based on the result of the two tests scored according to pre-set maximum points for each sub-problems.

The minimum requirement for the mark is 60%, based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Attila Bényei, associate professor, PhD

Lecturer: Dr. Attila Bényei, associate professor, PhD

Title of course:Introduction to Physical Chemistry Measurements **Code**: TTKBL0401_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 56 hours - home assignment: 64 hours - preparation for the exam: - Total: 120 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBL0101_EN, TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBL0402_EN	

Topics of course

This course is intended to teach students how to perform basic physical chemistry measurements and to get familiar with measurement planning, data processing and report writing. The tasks detailed here contain mainly spectrophotometry, pH-potentiometry, gas-volumetric measurements, polarimetry, electrolysis, conductometry etc.

Set of measurements:
101. Measuring densities by pycnometer, composition of a binary mixture
102. Measuring the heat capacities of metals by calorimetry
103. Measuring electrical conductivity of solutions
104. Measuring the concentration of a coloured solute by spectrophotometry
105. Determination of $NaHCO_3$ content of a solid sample by gas volumetry
106. pH-metric titration curves of hydrochloric and acetic acids
107. Study of Cooling Curve
108. Study of electrolysis
109. Mutarotation of glucose measured by polarimetry
110. Measuring electromotive force of a galvanic cell
111. Refractometry and viscosimetry
112. Determination of enthalpy of dissolution
113. Investigation of redox electrodes
114. Conductometry
115. Reaction rate of decomposition of H_2O_2 measured by gas volumetry
116. Investigation of buffers
117. Electrochemical investigation of corrosion
118. Distillation of an alcohol-water mixture

Literature

- Laboratory notes and additional teaching materials available via the e-learning system.
- P.W. Atkins, J. de Paula: Atkins, Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8, 2006
- K. Ősz, A. Bényei: Physical Chemistry Laboratory Measurements (for students of Pharmacy, Chemistry and Chemical Engineering). DebreceniEgyetemiKiadó, ISBN: 978-963-318-143-0, 2011

Schedule: One of the measurements listed above (**Topics of course**) per week except the 1st practice (introduction, general information and safety training).

Requirements:
Participation on the laboratory practice is compulsory. The measurements and knowledge of the associated theory are marked and an overall mark will be given. Safety training (1st week) is mandatory before the first lab practice (2nd week). Everybody should work individually according to the pre-set schedule (which will be provided on the 1st week). Lab practices are 4 hours long every week (from the 2nd until the 14th weeks). Being late or failed mark on the written test from the appropriate measurement is equivalent with an absence. In accordance with the regulations of University of Debrecen, attendance is compulsory with the exception of health or family problems (the reason of absence should be certified). In this case, the students should agree with the teacher on replacement dates for the missed experiments.

Requirements for the grade:
The measurements (regularly) and written tests (occasionally) according to the knowledge of the associated theory are marked and the overall mark will be given based on these.
- At least 11 notebooks of the measurements (from the 13) have to be marked as “pass (2)” or better for the successful completion.
- The minimum requirement for the written tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the average of written tests is below 60% the best grade for the course can be only “pass (2)” in any other cases the final mark is given with weighted average by means of the mark of the written tests and notebooks in 1 to 2 ratio.

Person responsible for course: Dr. Ferenc K. Kálmán, assistant professor, PhD

Lecturer: Dr. Ferenc K. Kálmán, assistant professor, PhD

Title of course: Physical chemistry III. **Code**: TTKBE0403_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 22 hours - preparation for the exam: 40 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBE0402_EN	
Further courses built on it: TTKBE0504_EN, TTKBE0415_EN	

Topics of course

- Basic properties of interfaces.
- Adsorption.
- Electric double layer.
- Kinetics of heterogeneous reactions.
- Heterogeneous catalysis.
- Dynamic electrochemistry.
- Practical applications of electrochemistry.
- Definition, discovery, application of radioactivity.
- Parts, structure of atomicnucleus, stable and radioactive nuclei.
- Kinetics of radioactive decay.
- Mechanism and type of radioactive decay.
- Interaction of radiation with matter.
- Nuclearreactions, nuclear energy production.
- Chemical and biologicaleffects of radiation.
- Detection and measurement of radiation.
- Environmenta lradioactivity.

Literature

Compulsory:

- Atkins, P.W. 1990. Physical Chemistry, Oxford University Press, Oxford.
- Kónya, J., Nagy N.M., 2012, 2018. Nuclear and Radiochemistry, Elsevier, Oxford.
- Choppin, G.R., Liljenzin, J-O., Rydberg, J. Ekberg, C., 2013. Radiochemistry and Nuclear Chemistry, 4th Edition, Elsevier, Amsterdam.

Schedule:

1st week

Formation and properties of interfaces, methods for studying interfaces. Interfacial microscopic and macroscopic properties, surface analytical methods

2nd week

Interfacial thermodynamics: adsorption of gases on solid surface, adsorption isotherms, determination of surface area. Decrease of surface energy by adsorption, quantitative description of the process

3rd week

Solid/liquid interfaces, electric double layer. Surface excess concentration on solid/liquid interfaces, the role of interfacial electric properties

4th week

Kinetics of interfacial reactions. Heterogeneous catalysis. Steps of heterogeneous reactions, rate-determining step. Applications of heterogeneous catalysis

5th week

Dynamic electrochemistry. Rate of charge transport, activation free energy, relations of current and voltage (Erdey-Grúz and Volmer theory), exchange current, overpotential, polarization. Definitions and relations on electrode reactions.

6th week

Effects determining the rate of charge transfer, the influence of transport on kinetics of electrode reaction: diffusion, migration, and convection. Diffusion current, diffusion limit. Effects determining the electron transfer, selection of potential determining process

7th week

Electrochemistry in practice, electrolysis, voltage sources, industrial electrochemical processes, corrosion and passivity. Application of electrochemistry

8th week

Discovery of radioactivity, consequences. Properties and constituents of nucleus. Stable and radioactive nuclei. Isobar nuclei. Cause and result of radioactive decay. Radioactivity is a natural process. Scientific and practical consequences of the discovery of radioactivity. Stability/radioactivity of atomic nuclei, decay type are determined by the ratio of protons to neutrons.

9th week

Kinetics of radioactive decay. Simple radioactive decay. Branching decay. Successive decay. Radioactive equilibria: secular and transient equilibria. Natural decay series. Formulas expressing the kinetics of radioactive decay. Radioactive equilibria in nature.

10th week

Radioactive nuclei. Types of radioactive decay. Alpha, beta decays, electron capture, isomeric transition (gamma radiation). Spontaneous fission. Interaction of radiation with matter. Probability, of the interactions. Interaction of alpha radiation with matter. Types of radioactive decay, emitted particles and photons. Energy release. General aspects of radiation-matter interactions.

11th week

Interaction of beta radiation with matter: ionization, Brehmsstrahlung, Cherenkov radiation, annihilation (positron emission tomography), back-scattering, absorption, self-absorption. Interaction of gamma and X-ray radiation with matter: Compton scattering, photoelectric effect, pair formation. General aspects of the interaction of beta radiation and high energy electromagnetic radiation, respectively, with matter.

12th week

Nuclear reactions, Conservation rules, kinetics. Nuclear reactions with neutrons. Nuclear reactions with charged particles. Nuclear energy production. Fission reaction with thermal neutrons. Main parts of nuclear reactors. Breeder reactors. Transformation of atomic nuclei. Basic reaction of nuclear energy production. Structure of nuclear reactors.

13th week

Environmental aspects of nuclear energy production, disposal of nuclear waste.

Detection and measurement of nuclear radiation. Detectors, electric units. Ionization, scintillation, semiconductor detectors. Imaging of radiation. Positive and negative impacts of nuclear energy production. Detection and measurement of radiation.

14th week

Dosimetry. Irradiation, absorbed, effective doses. The effect of nuclear radiation on living organisms: physical, chemical, biological effects, Radiolysis of water. Dose limits. Natural and artificial radionuclide in the environment. Effect of radiation on living organisms. Sources and quantity of environmental radioactivity.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**. Based on the examination, the exam grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of the examination is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if they write a test on the 14th week and the score of it is at least 60%. The offered grade is calculated as the exam grade (see above).

Person responsible for course: Prof. Dr. Noémi Nagy, university professor, DSc

Lecturer: Prof. Dr. Noémi Nagy, university professor, DSc

Title of course: Physical Chemistry IV. **Code**: TTKBE0404_EN	**ECTS Credit points:** 5
Type of teaching, contact hours - lecture: 2 hours/week - practice: 2 hours/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 28 hours - laboratory: - - home assignment: 44 hours - preparation for the exam: 50 hours Total: 150 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBE0402_EN	
Further courses built on it: -	

Topics of course
The series of lectures are based on the topics of computational chemistry. Both theoretical outlook on the basics of quantum mechanics and their application in simple computational problems are discussed. The main topics include Symmetry properties and their description by group theory. Basics of wave mechanics, wave functions and operators. The different formulations of Schrödinger's equation and methods to solve them. Importance of rotational, vibrational and electron-energies in chemistry. Electronic and magnetic properties of particles. Diffraction methods as information sources from the structure of particles. Schrödinger equation: wavefunction. Hartree-Fock Theory. Density Functional Theory: electron density. Structural analysis. Understanding chemical bond theories In the seminars computational practices help the deeper understanding the theory. Simple quantum chemical calculations are made.
Literature
Compulsory: - P.W. Atkins, J. de Paula (2006): Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8. - Lecture notes and teaching material available via the e-learning system - http://employees.oneonta.edu/viningwj/Chem111/Chapters9-10.pdf -https://fns.uniba.sk/fileadmin/prif/chem/kag/Bakalar/vch_noga/GEN_INORG_CHEM03-04.pdf *Recommended:* -http://folk.uio.no/helgaker/talks/la.pdf -https://www.chem.uci.edu/~lawm/9-28.pdf

Schedule:

1st week Properties of symmetries and point groups

Concepts: Symmetry elements and their operators. Symmetry calculation at operator level Symmetry properties and point group of a body. Character tables and their use. Physical quantities, operators and eigenvalues.

Calculations: Interactive learning of symmetry elements.

2nd week Schrödinger equation: operators and eigenvalues

Concepts: Basics of quantum mechanics. Physical definitions and operators. Operators of energy, and momentum. The concept and use of eigenvalues and equations.

Calculations: Computational possibilities, the role of supercomputers.

3rd week Electronstructure of hydrogen atom, quantumnumbers

Concepts: Polar coordinates. New forms of Schrödinger equation. Radial and angular part of the solution. Quantum numbers.

Calculations: Particle in the box. Solution of the Schrödinger equation for hydrogen atoms

4th week Hartree-Fock theory: approximations

Concepts: Approximations in computational chemistry. Pauli principle. Born-Oppenheimer approximation. Hierarchy of approximations. Hartree-Fock model. One nucleus and multiple electron systems. Term symbols and their information contend and use.

Calculations: Hartree-Fock method in practice. Limitations.

5th week Geometry and structural parameters of molecules: VSPER theory

Concepts: VSPER theory. Structure of covalent molecules. Hybridization. Molecule geometry and hybridization.

Calculations: Use of symmetry considerations in VSPER theory.

6th week MolecularOrbitals: LCAO-MO theory

Concepts: Molecular orbitals. Linear combination of atomic orbitals. Use of symmetry and point groups in description of molecular orbitals.

Calculations: Software resources based on LCAO-MO theory.

7th week DensityFunctionalTheory: electrondensityanalysis

Concepts : Density functional theory and its use in understanding material properties. Meaning of abbreviations for the level of theory.

Calculations: DFT calculation basics.

8th week Frequency and rotation

Concepts: Microwave and infraredspectra. Rotational and vibrationalenergies of simplemolecules.

Calculation: Use of charactertables in vibrational and Ramanspectroscopy.

9th week Dipolemoment, magneticproperties

Concepts: Dipolemoment, polarizability, refractive index, dispersion and theirinterconnection. Magneticproperties of materials, paramagnetic, diamagnetic and ferromagneticsystemsMagneticsusceptibility. Basics of NMR and EPR. MRI, biological and medicalapplications.

Calculations: Simplequantumchemicalcalculations. Use of softwares.

10th week Excitationstates: spectroscopy

Concepts: Excitation methods and excitons as particles. Quenching. Practical applications

Calculations: Simplequantumchemicalcalculations. Use of softwares.

11th week Diffraction methods I

Concepts: Symmetry in the solid state. Space groups. Basics of electron, neutron and X-ray diffraction. The limitations of the methods and their application in solving chemical structural problems
Calculations: Interactive learning of space group notation and symmetry elements in the solid states.
12th week Diffraction methods II
Concepts: The information content of diffraction studies. Possibilities for the experimental determination of electron density
Calculations: Use of crystallographic databases.
13th week Spectroscopic method
Concepts: General description of spectroscopic methods. Applicability of the methods in structure determination. Oscillator strength and experimental consequences.
Calculations: Spectroscopy of iodine.
14th week Secondary interactions
Concepts: List and energetics of secondary interactions. The possibility to predict solid state structures.
Calculations: Simple quantumchemical calculations. Use of softwares.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

- for a grade
The course ends in an **examination**. The exam can be **written or oral**, choice of the student. In any case one more comprehensive and 3 smaller questions should be answered from the topics of the course. Scoring system is provided and percentage is calculated.

The minimum requirement for the examination is 60%. The grade of the examination is given according to the following table:

Score(%)	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade: It may be offered for students on the basis of a written test (not compulsory) sit at the last week of the semester. Students can perform literature search and can submit a written report of that. Possible topics are given during the semester. The report should be at least 10 A4 pages and graded by the lecturers. The offered grade should be at least satisfactory (3).
Person responsible for course: Dr. Attila Bényei, associate professor, PhD
Lecturer: Dr. Attila Bényei, associate professor, PhD Dr.Olldamur Hollóczki, Senior research fellow, PhD

Title of course: Physical Chemistry V. **Code**: TTKBL0402_EN	**ECTS Credit points:** 5
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 56 hours - home assignment: 94 hours - preparation for the exam: - Total: 150 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBL0401_EN, TTKBE0402_EN	
Further courses built on it: -	

Topics of course

The main goal of this laboratory measurement is to get more detailed knowledge in the field of basic methodology of physical chemistry and perform basic laboratory practices. It gives the chance for the students to prove theories of physical and colloidal chemistry by their own hands and to determine physical and colloidal chemical quantities.

Topics of measurements:

- determination of material characteristic data
- determination of thermodynamic parameters
- study of ampholites and complex ions
- electrochemical measurements
- reaction kinetics measurements
- investigation of photochemical reaction
- adsorption on a solid-liquid interface, determination and analysis of an isotherm
- critical micelle concentration of association colloids
- solubilization capacity of surfactants
- determination of surface tension and the Gibbs isotherm
- rheological investigation of different samples
- determination of the isoelectric point of isolabile proteins
- isotope dilution analysis
- backscattering of β radiation
- measurement of γ spectra

Set of measurements:

201. Determination of heat of combustion by using a bomb calorimeter
202. Thermodynamic quantities by measuring the temperature dependent EMF
203. Determination of partial molar volumes by measuring densities

204. Determination of theenthalpy and entropy of vaporization of liquids
205. Redox potentials from potentiometric titrations
206. Investigation of Kohlrausch's law
207. Determination of activity coefficient for concentration galvanic cell
208. Determination of diffusion coefficient by layered ("schlieren") method
209. Study of the photochemical degradation of tris(oxalato)iron(III) complex
210. Determination of protonation constants of an indicator
211. Study of the iodine-iodide equilibrium
212. Dissociation constant of weak acids measured by conductometry
213. Dissociation equilibria of ampholites, determination of isoelectric pH
214. Study of stepwise complex formation
215. Decomposition kinetics of Kalmopyrin
216. Acid catalysed hydrolysis of saccharose
217. Kinetics of a second order reaction: hydrolysis of esters
218. Determination of activation energy
219. Initial rates and activation energy of the iodine clock
220. Adsorption at solid-liquid interfaces, construction and analysis of an isotherm
221. Solubilization capacity of surfactants
222. Determination of surface tension, the Gibbs isotherm.
223. Rheological investigation of different samples.
224. Determination of the CMC value of association colloids
225. Determination of the isoelectric point of isolabile proteins
226. Isotope dilution analysis: quantitative determination of a stable isotope by a radioactive isotope
227. Backscattering of β radiation by backscattering media of different thickness, composition and concentration
228. Gamma spectrometry: measurement and interpretation of γ spectra

Literature

- Laboratory notes and additional teaching materials available via the e-learning system.
- P. W. Atkins, J. de Paula: Atkins' Physical Chemistry 8th Edition, W.H. Freeman and Company, New York, ISBN: 0-7167-8759-8, 2006

Schedule: One of the measurements listed above (**Topics of course**) per week except the 1st practice (introduction, general information and safety training).

Requirements:
Participation on the laboratory practice is compulsory. The measurements and knowledge of the associated theory are marked and an overall mark will be given. Safety training (1st week) is mandatory before the first lab practice (2nd week). Everybody should work individually according to the pre-set schedule (which will be provided on the 1st week). Lab practices are 4 hours long every week (from the 2nd until the 14th weeks). Being late or failed mark on the written test from the appropriate measurement is equivalent with an absence. In accordance with the regulations of University of Debrecen, attendance is compulsory with the exception of health or family problems (the reason of absence should be certified). In this case, the students should agree with the teacher on replacement dates for the missed experiments.

Requirements for the grade:
The measurements (regularly) and written tests (occasionally) according to the knowledge of the associated theory are marked and the overall mark will be given based on these.
- At least 11 notebooks of the measurements (from the 13) have to be marked as “pass (2)” or better for the successful completion.
- The minimum requirement for the written tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the average of written tests is below 60% the best grade for the course can be only “pass (2)” in any other cases the final mark is given with weighted average by means of the mark of the written tests and notebooks in 1 to 2 ratio.

Person responsible for course: Dr. Ferenc K. Kálmán, assistant professor, PhD

Lecturer: Dr. Ferenc K. Kálmán, assistant professor, PhD

Title of course: OrganicChemistry I. **Code**: TTKBE0301_EN	**ECTS Credit points:** 4

Type of teaching
- lecture: 2 hours/week
- practice: 1 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated)
- lecture: 28 hours
- practice: 14 hours
- laboratory: -
- home assignment: 18 hours
- preparation for the exam: 60 hours

Total: 120 hours

Year, semester: 1^{st} year, 2^{nd} semester

Its prerequisite(s): General Chemistry I. TTKBE0101_EN

Further courses built on it: TTKBE0202_EN, TTKBL0201_EN, TTKBE0402_EN, TTKBG0402_EN, TTKBL0401_EN, TTKBE0302_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBE0601_EN, TTKBG0601_EN, TTKBE0204_EN, TTKBE0417_EN, TTKBG0614_EN, TTKBG0312_EN, MFVGE31V03_EN, TTKBE1111_EN

Topics of course

- Types and theories of chemical bonds
- Acid-base theories
- Basic concepts of isomerism and stereochemistry.
- Classification of organic reactions.
- Structure, nomenclature, preparation and reactivity of aliphatic compounds
- Aromatic compounds, benzene and its derivatives, polycyclic aromatic compounds and heteroarenes.

Literature

Compulsory:
1. Lecture material and seminars available in the e-learning system.

Recommended:
2. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder; OrganicChemistry, 12^{th}edition, John Wiley&Sons, Inc., 2016.
3. John McMurry: Organic Chemistry (8^{th} Edition), 2012, Brooks/Cole
4. Herbert Meislich, Estelle Meislich, Jacob Sharefkin - 3000 Solved Problem in Organic Chemistry (1994)

Schedule:

1st week

The definition and brief history of organic chemistry. Overview of the basic general chemical concepts needed for this subject. A brief summary of the theories of the chemical bond: the shared electron pair model, the valence bond model.Covalent and ionic bonds. The basics of LCAO-MO theories, types of atomic and molecular orbitals. Bi- and polycentric molecular orbitals, delocalization.

2nd week

VB theory, resonance structures and rules of their writing. Hybridization. Electron shift phenomena, inductive and mesomeric effects, conjugation and hyperconjugation. Secondary bonds, intermolecular interactions, hydrogen bond, dipole−dipole, dipole-induced dipole interactions.

3rd week

Description of functional groups in organic compounds. An overview of the most important organic compound groups based on their functional groups. The effect of functional groups on the electron structure of compounds.

4th week

The basic nomenclatutre systems in organic chemistry: common or trivial names and systematic nomenculture. Basic rules to generate systematic names of organic compounds; substitutive and functional class nomenclature. The rules to generate the names the groups derived from hydrocarbons. The rules to generate the name of unbranched and branched (saturated and unsaturated) hydrocarbons. Elemental reactions. Definitions of transition state, intermediates, Gibbs energy, kinetical and termodinamical parameters of chemical reactions.

5th week

Multi-step reactions (consecutive reactions), intermediates. Hammond postulate. Parallel (competitive) reactions. Thermodynamic and kinetic control. Reactivity and selectivity. Reagents and reactive intermediates. Classification of organic chemical reactions based on attack agent and type of the reaction. Brönsted and Lewis acid-base theory, "hard" and "soft" acids and bases.

6th week

Basics of stereochemistry: characterization of constitutional, conformational and configuration isomers. Chirality, types of chiral molecules. The concept of enantiomers and diastereomers, general comparison of their chemical and physical properties. Absolute and relative configuration. Optical activity. The representation of organic molecules. The absolute configuration of chiral compounds, Fischer and Cahn-Ingold-Prelog convention. The role of chirality in drug chemistry.

7th week

Characterization of the structures of alkanes and cycloalkanes. Review their conformational and physical properties. Chemical properties of alkanes, radical substitution, chain reaction. Statistical and regioselective halogenation and interpretation based on radical stability in alkane halogenation.

8th week

Sulphonation, sulphochlorination, nitration and oxidation of alkanes. The basic petrochemical processes (pyrolysis, cracking, isomerization) and their industrial significance. The most important natural sources and the synthetic methods of alkanes.

9th week

The characterization of the structure of alkenes, cycloalkenes, di- and polyenes. The hindered rotation: characterization of E / Z isomers. Synthesis of alkenes, cycloalkenes. Physical and chemical properties of alkenes and cycloalkenes. Electrophilic and radical addition reactions and practical significance. Interpretation of the regioselectivity of the addition reactions; the Markovnikov rule.

10th week

Types of polymerization. Substitution in allylic position, interpretation of the stability of allylic intermediates. Oxidation of alkenes. Addition of conjugated dienes, partial and complete addition. 1,2 and 1,4 addition and its interpretation based on kinetic and thermodynamic control. Diels-Alder cycloaddition.

11th week

Characterization of the structure of alkynes and their physical properties. The stability and synthesis of alkynes. Chemical transformations of alkynes: C-H acidity, addition reactions and their significance. The role of acetylene in the chemical industry, coal-based chemical industry.

12th week

The concept and the interpretation of aromaticity. Neutral and charged homo and heteroaromatic systems. The type and mechanism of the most important aromatic electrophilic substitution reactions (halogenation, nitration, sulphonation, Friedel-Crafts acylation and alkylation).

13th week

The S_{EAr} reactions of substituted benzene derivatives –the reactivity and regioselectivity. Classification of substituents and interpretation of their effect on reactivity and regioselectivity.

14th week

Electrophilic substitution reactions of five- and six-membered heteroaromatic base compounds. Addition reactions of monocyclic aromatic hydrocarbons. Reactions of aromatic hydrocarbons containing alkyl substituents, the stability of benzyl-type reactive intermediates. Most important representatives of polycyclic aromatic hydrocarbons.

Requirements:

- for a signature

Attendance of **lectures** is highly recommended and lecturer may make it compulsory for one-third of the lectures.

Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester or the semester is not approved, and the student must repeat the course.

- for a grade

The course ends in an **examination**.

The exam grade is the result of a written exam.

The minimum requirement for achieving the courseis 50%. The grade for the written exam is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

If the score of any test is below 50%, the student may repeat the exam in accordance with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Tibor Kurtán, university professor, DSc

Lecturer: Dr. Tibor Kurtán, university professor, DSc

Title of course: Organic chemistry II. **Code**: TTKBE0302_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
Evaluation: term mark	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 18 hours - preparation for the exam: 60 hours Total: 120 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBE0303_EN, TTKBE0611_EN, TTKBE1212_EN, TTKBL1212_EN, TTKBE0503_EN, TTKGB0313_EN	

Topics of course

Systematical overview the structure, physical, chemical properties of hydrocarbons possessing heteroatoms as halogenated hydrocarbons, organometallic derivatives, alcohols, phenols, ethers and their thio analogues; amines, nitro derivatives, diazonium salts, aldehyde, ketones, carboxylic acids and their derivatives, derivatives of carbonic acid.

Literature

Compulsory:

1. Lecture material and seminars are available in the e-learning system.

Recommended:

2. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder; OrganicChemistry, 12thedition, John Wiley&Sons, Inc., 2016.
3. John McMurry: Organic Chemistry (8th Edition), 2012, Brooks/Cole
4. Herbert Meislich, Estelle Meislich, Jacob Sharefkin - 3000 Solved Problem in Organic Chemistry (1994)

Schedule:

1st week

Classification of halogenated hydrocarbons, characterization of their structure and physical properties. The effect of the structure of the hydrocarbon skeleton, and the quality of the halogen on the strength of the C-Hlg bond and reactivity. Synthesis of halogenated hydrocarbons.

2nd week

Reactions of halogenated hydrocarbons. Interpretation of decreased, normal and high reactivity of halogenated hydrocarbons. Nucleophilic substitution and elimination of halogenated hydrocarbons. Interpretation of the mechanism of these reaction (S_N1, S_N2; α- and β-elimination; E1, E2 and E1cB). Reaction of halogenated compounds with metals.

3rd week

The basics of chemistry of organometallic compounds. Their bonding system, the term "umpolung". Synthesis and reactivity of organometallic compounds. Organimetallic compounds as nucleophiles and carbanion equivalents. C-C bond formation with organometallic reagents: Grignard compounds and their application. Synthesis and interconversion of organometallic compounds, transmetallation.

4th week

Classification and characterization of hydroxyl derivatives of hydrocarbons (alcohols, phenols) and their thio analogues. Interpretation of their physical properties derived from their bonding system. The acid-base properties of alcohols, phenols and thio analogues. Preparation of alcohols, ethers, phenols and thio analogues.

5th week

Alcohols and phenol es nucleophiles: alkylation, acylation, formation of sulphonate and inorganic esters; acid catalyzed transformations of alcohols (conversion of alcohols to halogenated derivatives, elimination reactions). Oxidation of alcohols and phenols. The characterization of ethers; synthesis and cleavage of ethers. Characterization of the special ether derivatives: epoxides, semi-acetals, acetals and enoleters. Cumene-based phenol synthesis.

6th week

Overview of the organic compounds possessing C-N single bond. Classification of amines and characterization of their bonding systems. Interpretation of their physical derived from their bonding system. Synthesis of aliphatic and aromatic amines; industrial methods.

7th week

Review and interpretation of basicity of amines. Chemical transformation of amines: alkylation, acylation of amino group. Synthesis of sulfonamide and reaction with nitric acid. Oxidation of the amines. S_EAr reactions of anilines.

8th week

Characterization of nitro compounds: the bonding system, interpretation of electron-withdrawing effect and C-H acidity. Synthesis of nitro compounds. Preparation of diazonium salts, reactions of diazonium salts and their practical significance. Azo compounds and their industrial significance.

9th week

Classification and characterization of oxo compounds: the bonding system and stability of carbonyl group. Physical properties of oxo compounds. Acid-base properties of aldehydes and ketones: acidity of the α-hydrogen, keto-enol tautomerism. Synthesis of aldehydes and ketones.

10th week

Reactions of aldehydes and ketones. Nucleophilic addition with O-, S-, N- and C-nucleophiles, the reversibility of the additions. Condensation reactions. Oxidation and reduction. Reactions on α-carbon; aldol dimerization, α-halogenation. Nucleophilic addition reactions of α,β-unsaturated oxo compounds.

11th week
Classification of carboxylic acids and their derivatives, description and comparison of their bonding systems. Stability and reactivity of the carboxylic acid derivatives. Physical properties and synthesis of carboxylic acids.

12th week
Review and interpretation of the acid-base properties of carboxylic acids and their derivatives (O-H, N-H and C-H acidity). Interconversion of the carboxylic acid derivatives, acyl nucleophilic substitution. Reductive transformations of carboxylic acid derivatives, transformation of their carbon skeleton.

13th week
β-Dicarbonyl and β-oxo-carboxylic acid derivatives, C-H acidity and basic of enolate chemistry: formation of carbon-carbon bond, malonic ester, acetoacetic ester and cyanoacetic ester syntheses.

14th week
Substituted (halogenated, hydroxy and oxo) carboxylic acid derivatives and their interconversion. Synthesis and interconversion of carbonic acid derivatives and their major representatives. Practical significance of carbonic acid derivatives.

- for a signature
Attendance of **lectures** is highly recommended and the lecturer may make it compulsory for one-third of the lectures.
Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester or the semester is not approved, and the student must repeat the course.
- for a grade
The course ends in an **examination**.
The exam grade is the result of a written exam.
The minimum requirement for achieving the courseis 50%. The grade for the written exam is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

If the score of any test is below 50%, the student may repeat the exam in accordance with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Tibor Kurtán, university professor, DSc

Lecturer: Dr. Tibor Kurtán, university professor, DSc

Title of course: Organic chemistry III. **Code**: TTKBE0303_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: term mark	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 12 hours - preparation for the exam: 50 Total: 90 hours	
Year, semester: 2nd year, 2st semester	
Its prerequisite(s): TTKBE0302_EN	
Further courses built on it: TTBBE2035_EN	

Topics of course
Characterization of the building blocks of biomacromolecules (peptides and proteins, carbohydrates, nucleic acids, lipids) that form biological structures. Description and characterization of the most important biochemical reactions. Characterization of the structure of the biomacromolecules. Overview of the chemical and instrumental methods which can be used for the structure elucidation of these type of compounds. Review the basic of their information storage and storage capacity, the relationship between structure and function. Chemical properties of their monomers and synthesis of biopolymers. The structure and biological effect/function of some other significant natural compounds (isoprenoids, flavonoids, alkaloids, antibiotics, vitamins, porphinase compounds).
Literature
Compulsory: Coursematerial, concept and taskcollectionforlectures, seminars in the e-learningsystem**.** *Recommended:* J. G. Smith: OrganicChemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725 C. Stan Tsai: Biomacromolecules, John Wiley&Sons, New Jersey (2007) A. Miller-J. Tanner: Essentials of ChemicalBiology, John Wiley&Sons, Chichester (2008) P. M. Dewick: MedicinalNatural Products: A BiosyntheticApproach, 3rd Edition. John Wiley&Sons, Chichester (2009)

Schedule:
1st week
Primary and secondary metabolism. Classification of natural compounds. Types of biological structural materials, general characterization. Common features of the synthesis of biopolymers: group protection, activation, coupling reactions, requirements for protective groups, orthogonality
2nd week
Structure, synthesis and chemical properties of amino acids. Characterization of α-amino acids which are forming protein/peptides. Structure and determinations of peptides. Determination of amino acid sequence by chemical and enzymatic methods, possibility of automation.
3rd week
Synthesis of peptides. The basic protecting groups and activation methods for peptide synthesis. Solid phase synthesis, automation. The occurrence, classification and functions of proteins. Levels of protein structure: primary, secondary, tertiary and quaternary structures, structure formation. Structure and function relationship.
4th week
Classification, structure and nomenclature of carbohydrates. Basic configuration and conformational conditions of monosaccharides. Most important chemical properties of monosaccharides: mutarotation, transformation of oxo group and hydroxyl groups, synthesis of glycosides.
5th week
Most important representatives of di- and oligosaccharides (sucrose, maltose, cellobiose, lactose, cyclodextrins), factors determining their structure. Synthesis of di- and oligosaccharides, basic protecting groups and activation methods.
6th week
Derivatives of Peptides / proteins and low molecular weight carbohydrates: peptidoglycans, glycoproteins, their biological significance. The carbohydrate code.
7th week
Polysaccharides (cellulose, chitin, starch, glycogen, pectin, mucopolysaccharides). Polysaccharides as structural materials and reserve nutrients. Derivatives of polysaccharides and proteins (proteoglycans). The industrial significance of polysaccharides.
8th week
Classification and characterization of nucleic acids, their building blocks. Synthesis of nucleosides and nucleotides. Primary, secondary and tertiary structure and biological function of DNA and RNA. The genetic code. Information content of the nucleotide, amino acid and carbohydrate code and their correlation. Nucleotide coenzymes.
9th week
Classification and characterization of lipids, their structure, their biological role. Basics of the biosynthesis of fats, phospho- and glycolipids.
10th week
Isoprenes, terpenoids and carotenoids. The basics of their biosynthesis, and most important representatives of terpenoids. The chemical background of vision. Structure, classification of steroids, basics of their biosynthesis, their major representatives and their biological function.
11th week
Classification and structure of phenylpropanoids. The chemical synthesis of their basic skeletones. Structure and biological significance of flavonoids.
12th week

Classification of alkaloids and structure and function of their most important representatives. Alkaloids as drugs and medicines. *13th week* Definition of symbiosis, antibiosis. Definition and classification of antibiotics: β-lactam, amino acid or peptide, glycoside type antibiotics, polycyclic antibiotics. Preparation of antibiotics: fermentation, semi-synthetic and synthetic derivatives. The most important mode of action of antibiotics. *14th week* The structure, biosynthesis and biological role of porphyrins. Structure, biological role and metabolism of chlorophyll and hemoglobin. Classification of vitamins, their structure, their natural sources and their biological functions.
Requirements: - *for a signature* Attendance at **lectures** is recommended, but not compulsory. A student may not miss the lecture more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed and the student must repeat the course. - *for a grade* The course ends in an oral exam in the exam period.
Person responsible for course: Dr. László Somsák, university professor PhD, habil, DSc
Lecturer: Dr. László Somsák, university professor PhD, habil, DSc

Title of course: **Organic Chemistry IV (seminar)** **Code**: TTKBG0301_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: 1 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: - - preparation for the mid-term tests: 16 hours Total: 30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): **TTKBE0302_EN**	
Further courses built on it: -	

Topics of course
- Basic stereochemical concepts (constitution, conformation, configuration, relative configuration, absolute configuration, enantiomers, diastereomers, epimers) - Constitutional isomerism - Conformational isomerism - *Cis* / *trans*, *E* / *Z*isomers - Projectiveformulas - D / L markers - CIP convention - Axial chirality, allene isomerism, atropisomerism
Literature
Compulsory: Slides of the lectures by László Juhász: or Tibor Kurtán OrganicChemisty I. and OrganicChemisty II. *Recommended:* IUPAC stereochemistry recommendations: http://old.iupac.org/reports/provisional/abstract04/BB-prs310305/Chapter9.pdf J. P. Riehl: Mirror-Image Asymmetry - An IntroductiontotheOrigin and Consequences of Chirality, John Wiley&Sons, 2010, Hoboken, New Jersey. E. L. Eliel, S. H. Wilen: Stereochemisty of OrganicCompounds, Wiley, New York, 1994.

Schedule: *1st week*

Review of stereochemical concepts. Constitution, conformation, configuration (relative and absolute), enantiomers, diastereomers, epimers.
Examples of constitutional isomers.

2nd week
Conformational isomers. Conformation of ethane, butane, open-chain compounds. Cyclohexane ring conformation. Conformation of cyclic compounds with examples.

3rd week
Cis / *trans*, *E* / *Z* isomery with examples.

4th week
Projective formulas, Fischer projection. Examples.

5th week
Mid-term test 1.

6th week
D / *L* markers for amino acids, open chain and ring forms of sugars. Examples.

7th week
CIP convention in simpler (with one chirality center) cases with examples.

8th week
CIP convention in more complicated cases (in larger systems, with more chirality centers). Examples.

9th week
Practice.

10th week
Mid-term test 2.

11th week
CIP convention in special cases. Phantom atoms, E / Z isomers and CIP convention, bridged ring systems. Examples.

12th week
Axial chirality. Allen-isomerism. Atrop isomerism. Examples.

13th week
Practice.

14th week
Mid-term test 3.

Requirements:

- *for a signature*
Attendance of all practical classes.
- *for a grade*
Class performance (33%)
Mid-term tests (67%)
Based on the sum of the 3 tests and the class performance the practical grade is calculated.
The final grade is given according to the following table:

Score (%)	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of the final grade is below 50%, students can not take a retake the tests in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-*an offered grade:*
-

Person responsible for course: Dr. Attila Mándi, assistant professor, PhD

Lecturer: Dr. Attila Mándi, assistant professor, PhD

Title of course: Organic chemistry IV. **Code**: TTKBL0301_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 56 hours - home assignment: 64 hours - preparation for the exam: - Total: 120 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBL0101_EN, TTKBE0302_EN	
Further courses built on it: TTKBL0302_EN	

Topics of course
The aim of the course is to enable students to become familiar with the theoretical background of basic organic chemistry laboratory techniques and to learn how to apply them in practice, to deepen the theoretical knowledge gained in organic chemistry lectures and to understand the reactivity of functional groups by synthesizing simple preparations on a semi-micro scale and by carrying out test tube reactions. The other goal is to provide students with the right material knowledge and to understand and apply cleaning and identification techniques as typical organic chemistry activities.
Literature
Compulsory: L. Juhász: OrganicLaboratoryTechniques and ManualsforPharmacistStudents, Debrecen, 2009 J. R. Mohrig, D. G. Alberg, G. E. Hofmeister, P. F. Schatz, C. Noring Hammond: LaboratoryTechniques in OrganicChemistry (SupportingInquiry-DrivenExperiments), 4th edition, W. H. Freeman and Company. ISBN-13: 978-1-4641-3422-7. Recommended: H. Meislich, E. K. Meislich, J. Sharefkin: 3000 SolvedProblems in OrganicChemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244 R. O. C. Norman, J. M. Coxon: Principles of OrganicSynthesis, 3rd Edition, 1993, BlackieAcademic& Professional, Glasgow, UK; ISBN-13: 9780751401264 J. McMurry: OrganicChemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449 J. Clayden, N. Greeves, S. Warren: OrganicChemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293 F. A. Carey: OrganicChemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-10: 0072905018 J. G. Smith: OrganicChemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725

Schedule:

1st week

Introduction: Timetable and requirements. Receiving of laboratory equipment and list of tasks. Safety education.

Presentation of the device for recrystallization.

Presentation of gravity and vacuum filtration equipment.

Description of the operation of the rotary vacuum evaporator.

Recrystallization of acetanilide from water.

2nd week

Short written test.

Presentation of thin layer chromatography (TLC).

Presentation of determination of melting point.

Check of the purity of the compound recrystallized in previous practice by melting point and TLC.

Calculation of the yield of recrystallization.

Recrystallization of benzanilide from methanol.

Check of the purity of the recrystallized benzanilide by TLC.

3rd week

Short written test.

Description of liquid-liquid extraction.

Control the purity of the compound recrystallized in previous practice by melting point. Calculation of the yield of recrystallization.

Use of liquid-liquid extraction to separate m-dinitrobenzene and m-nitroaniline. Checking the success of the separation using TLC.

4th week

Short written test.

Presentation of equipment used for distillation at atmospheric and reduced pressure.

Distillation of acetone from $KMnO_4$ at atmospheric pressure.

Distillation of water in vacuum.

5th week

Short written test.

Presentation of steam distillation.

Isolation of S-(+)-Carvone from caraway and preparation of its 2,4-dinitrophenylhydrazone derivative.

6th week

Short written test.

Preparation of 4-chlorobenzoic acid and 4-chlorobenzyl alcohol. Check of the purity of the products using TLC and melting point measurement.

7th week

Short written test.

Presentation of a device used in reaction with three-necked round bottom flasks.

Preparation of benzamide and recrystallization of the product from water.

Preparation of iodoform.

8th week
Short written test.
Description of column chromatography.
Determination of melting point of iodoform, and calculation of the yield.
Check of the purity of benzamide by TLC and melting point measurement.
Separation of the mixture of acetanilide and m-dinitrobenzene by column chromatography.

9th week
Short written test.
Preparation of acetylsalicylic acid and purification of the product by recrystallization.
Check of the purity of the product by TLC and melting point measurement.
Calculation of the yield.

10th week
Short written test.
Identification of hydrocarbons and organic halides using test tube reactions.
Reaction of hydrocarbons with bromine.
Reaction of hydrocarbons with bromine in the presence of UV light.
Friedel-Crafts test of aromatic hydrocarbons.
Baeyer test of unsaturated hydrocarbons.
Beilstein and alcoholic silver nitrate test of organic halides.
Identification of unknown compounds.
Preparation of 2,6-dibenzylidene-cyclohexanone (test tube variant). Check of the purity of the products by TLC and melting point measurement. Calculation of the yield.

11th week
Short written test.
Identification of hydroxyl derivatives of hydrocarbons using test tube reactions.
Solubility of alcohols and phenols.
Determination of order of substitution of the carbon carrying the OH group by Lucas probe.
Oxidation of alcohols with Jones reagent.
Reaction of diols or poliols with copper(II) ions.
Reaction of phenols and enols with iron(III) ions.
Iodoform test of 2-alkanols.
Identification of unknown compounds.
Preparation of benzoic acid (test tube reaction).

12th week
Short written test.
Identification of amino derivatives of hydrocarbons using test tube reactions.
The Hinsberg test.
Reactions of amines with nitrous acid.
The Rimini reaction of aliphatic primary amines
Complex formation of amine with Cu(II) ions.
Identification of unknown compounds.
Preparation of benzotriazole (test tube variant)

13th week
Short written test.
Identification of oxo compounds using test tube reactions.
Detection of aldehydes with 2,4-dinitrophenylhydrazine test.
Oxidation of aldehydes by neutral potassium permanganate solution.
Oxidation of oxo compounds by Jones reagent.
Reaction of oxo compounds with Tollens reagent.
Iodoform test of oxo compounds.
Identification of unknown compounds.
Preparation of cyclohexanone (test tube variant)

14th week
Short written test.
Performing missed identification tasks (melting point measurement, TLC), yield calculation.
Cleaning and handovering of equipments.
Present the synthesized products to the instructor.
Evaluation.

Requirements:
Attendance at laboratory practice is mandatory.
Before starting the laboratory work, students must write a short written test on their theoretical organic chemistry and practical knowledge as well as on the safety rules about the previous laboratory practice (15-20 minutes).

On the one hand, the term mark consists of the marks obtained for the identification of the unknowns and on the other hand the marks written before the practice, which are closely related to the laboratory exercises carried out the week before (15-20 minutes). Of course, a prerequisite for successful laboratory practice is the synthesis of all preparations.
The final grade will be determined based on the average of the grades of tasks. A weighted average of the grades of subtasks will be calculated in the following manner:

- Short written test (70%)
- *Activity in laboratory practice (15%)*
- Identification of unknown compounds (15%)

Final grade: excellent (5): 85%; good (4): 75%; satisfactory (3): 60%; pass (2): 50%; fail (1): below 50%.

Person responsible for course: Dr.Marietta VágvölgyinéDr.Tóth, associate professor, PhD

Lecturer: Dr.Marietta VágvölgyinéTóth, associate professor, PhD

Title of course: Organic chemistry V. **Code**: TTKBL0302_EN	**ECTS Credit points:** 7
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: 56 hours - home assignment: 126 hours - preparation for the exam: - Total: 210 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBL0301_EN	
Further courses built on it: -	

Topics of course

The aim of the course is to enable students to learn new methods of organic chemical synthesis, learn their practical implementation and master the use of literature.

Students will get an individual list of tasks including ten organic compounds to be synthetized and a literature search. The execution of the tasks and the order of their implementation are planned by the students.

Literature

Compulsory:
J. R. Mohrig, D. G. Alberg, G. E. Hofmeister, P. F. Schatz, C. Noring Hammond: LaboratoryTechniques in OrganicChemistry (SupportingInquiry-DrivenExperiments), 4th edition, W. H. Freeman and Company. ISBN-13: 978-1-4641-3422-7.
Recommended:
E. K. Meislich, H. Meislich, J. Sharefkin: 3000 Solvedproblems in OrganicChemistry, McGraww-Hill INC, 1994.
P. Wyatt, S. Warren: OrganicSynthesis: Wiley: Chischester, 2007
M. B. Smith: OrganicSynthesis, 3rd Ed., McGraw-Hill: New York, 2008
F. A. Carey, R. J. Sundberg: Advanced OrganicChemistry, 3rd Ed., Part B,
Plenum Press: New York-London, 1990
M. B. Smith, J. March: Advanced OrganicChemistry, 6th Ed., Wiley: New Jersey, 2007
R. C. Larock: ComprehensiveOrganicTransformations, 2nd Ed., Wiley: New York, 1999
R. O. C. Norman, J. M. Coxon: Principles of OrganicSynthesis, 3rd Ed., BlackieAcademic& Professional: London, 1994

Schedule:
1st week
Introduction:
Timetable and requirements. Receiving of laboratory equipment and list of tasks. Safety education.
Preparative work:
Preparation and purification of a selected organic compound from the individual list. Determination of physical properties (melting point or boiling point) and purity (TLC, R_f). Calculation of yield.

2nd week
Short written test:
Topics: Substitution reactions (SN, SR) and their synthetic applications. Nomenclature. Safet yrules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list. Determination of physical properties (melting point or boiling point) and purity (TLC, R_f). Calculation of yield.

3rd week
Shor twritten test:
Topics: Synthetic applications of electrophilic addition reactions. Nomenclature. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list. Determination of physical properties (melting point or boiling point) and purity (TLC, R_f). Calculation of yield.

4th week
Short written test:
Topics: Elimination reactions, Hofmann rule. Nomenclature. Basic laboratory techniques: heating, cooling. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list. Determination of physical properties (melting point or boiling point) and purity (TLC, R_f). Calculation of yield.

5th week
Short written test:
Topics: Diazotization, reactions of diazoniumsalts. Filtration techniques. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list. Determination of physical properties (melting point or boiling point) and purity (TLC, R_f). Calculation of yield.

6th week
Short written test:
Topics: Formation of functional groups on aromati ccore. Nomenclature. Crystallization. Safetyrules.

Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

7th week
Short written test:
Topics: Preparation and reaction of organometallic compounds. Nomenclature. Chromatography (TLC, column chromatography). Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

8th week
Short written test:
Topics: Nucleophilic addition reactions. Nomenclature. Extraction methods. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

9th week
Short written test:
Topics:β-Dicarbonylcompounds and their synthetic applications. Nomenclature. Distillation at atmospheric pressure. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

10th week
Short written test:
Topics: Phasetransfer catalysis. Vacuumdistillation. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

11th week
Short written test:
Topics: Complex organic chemical problem solving (test). Nomenclature. Steam distillation. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

12th week
Short written test:
Topics: Complex organic chemical problem solving (test). Nomenclature. Grouping of solvents and their effects on organic chemical reactions. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

13th week
Shortwritten test:
Topics: Complex organic chemical problem solving (test). Nomenclature. Safety rules.
Preparative work:
Preparation and purification of a selected organic compound from the individual list.
Determination of physical properties (melting point or boiling point) and purity (TLC, R_f).
Calculation of yield.

14th week
Performing missed identification tasks (meltingpoint measurement, TLC), yield calculation.
Last occasion to present the synthesized products to the instructor.
Cleaning and handovering of equipments.
Evaluation.

Requirements:
Attendance at laboratory practice is mandatory.
Before starting to prepare a selected compound, students must give an oral report on their theoretical organic chemistry and practical knowledge as well as on the safety rules.
The synthetic work can only be started after a successful discussion.
Minimum requirements for signing the course:

- Syntheses and characterizations of the selected 10 organic compounds.
- Sufficient level of the discussion (pass, (2)) for each preparation.
- Minimum level of the written test: at least 50% of the overall score.
- Presentation of the result of the literature search within the given time.

In case of failure of anysubtask, thepracticeendswith a poor (1) grade.

The final grade will be determined based on the average of the grades of tasks. A weighted average of the grades of subtasks will be calculated in the following manner:

- Activity in laboratory practice, discussion (40%)
- Short written test (50%)
- Literature search (10%)

Final grade: excellent (5): 90%; good (4): 75%; satisfactory (3): 60%; pass (2): 50%; fail (1): below 50%.

Person responsible for course: Dr. Marietta VágvölgyinéTóth, associate professor, PhD

Lecturer: Dr. Marietta VágvölgyinéTóth, associate professor, PhD

Title of course: Biochemistry I. **Code**: TTBBE2035_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - seminar: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 28 hours - preparation for the exam: 34 hours Total: 90 hours	
Year, semester: 3st year, 1st semester	
Its prerequisite(s): TTKBE0303_EN	
Further courses built on it: TTKBL0303_EN, TTBE0304_EN	

Topics of course
Molecular design of life. Protein structure and function. Oxigen-transporting proteins: Myoglobin and Hemoglobin. Carbohydrates. Glycoconjugates. Glycobiology. Introduction to biological membranes. Enzymes. Metabolism: basic concepts and design. Glycolysis. Gluconeogenesis. Cori cycle. Citric acid cycle. Oxidative phosphorylation. The pentose phosphate pathway. Glycogen metabolism. The coordinated control of synthesis and breakdown. Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Synthesis of ketone bodies. Biosynthesis of fatty acids. Digestion of proteins. Amino acid degradation. The urea cycle. The link between the urea and the citric acid cycle. The fates of the carbon skeletons of amino acids.
Literature
Compulsory: ***- LubertStryer, Biochemistry, W. H. Freeman and Company, New York, 2002, ISBN 1-7167-4684-0.*** *Recommended:* ***- Glycoscience-Chemistry and Chemical Biology, (Eds: B. Fraser-Reid, K. Tatsua, J. Thiem) 2001, Springer-Verlag, Berlin*** ***- Essentials of glycobiology (Eds: A.Varki, R. Cummings, J. Esko, H. Freeze, G. Hart, J. Marth, 1999, Cold Spring Harbor, New York, ISBN 0-87969-559-5)***

Schedule:
1st week: Introduction to Biochemistry. Molecular design of life. Amino acids. Peptides. Primary, secondary, tertiary, quaternary structures.

2nd week: Determination of peptide structures. Protein structure and function. Oxigen-transporting
proteins: Myoglobin and Hemoglobin.

3rd week: Carbohydrates. Biological role of carbohydrates. Monosaccharides, disaccharides. polysaccharides. Glycoconjugates. Glycobiology.

4th week: Introduction to biological membranes. Lipids. Classification and functions of lipids. Neutral fats, oils and waxes. The major classes of membrane lipids. Membrane models.

5th week: Enzymes. Classification. Coenzymes. Mechanism of enzyme action. Control of enzyme activity.

6th week: The kinetic properties of enzymes. The Michaelis-Menten model. Graphic evaluation of the kinetic parameters. Inhibition of enzyme activity. Diagnostic importance of enzymes.

7th week: Metabolism: basic concepts and design. Purine and pyrimidine bases, nucleosides and nucleotides. cAMP, ATP. Nucleotide coenzymes. Metabolism of carbohydrates. Glycolysis. The fate of pyruvate. Entry of fructose and galactose into glycolysis.

8th week: Gluconeogenesis. Cori cycle. The pentose phosphate pathway.

9th week: Citric acid cycle. Pyruvate dehydrogenase complex. The citric acid cycle is a source of biosynthetic precursors. Control of the citric acid cycle.

10th week: Oxidative phosphorylation. The four enzyme complexes of the respiratory chain. Synthesis of ATP. The ATP yield of the complete oxidation of glucose.

11th week: Glycogen metabolism. Glycogen degradation and synthesis. The coordinated control of synthesis and breakdown.

12th week: Fatty acid metabolism. Oxidation of fatty acids and unsaturated fatty acids. Energetics of fatty acid oxidation. Synthesis of ketone bodies.

13th week: Biosynthesis of fatty acids. The elongation cycle. Biosynthesis of cholesterol.

14th week: Digestion of proteins. Amino acid degradation. Transamination and oxidative deamination. The urea cycle. The link between the urea and the citric acid cycle. The fates of the carbon skeletons of amino acids.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. János Kerékgyártó, senior research fellow, PhD

Lecturer: Dr. János Kerékgyártó, senior research fellow, PhD

Title of course: Biochemistry II. **Code**: TTKBL0303_EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: -
- practice: 1 hours/week
- laboratory: 2 hours/week

Theoretical seminar (2 h), solving independent tasks (use of database, use of simulation program), practical laboratory work (4 h), evaluation and interpretation of results.

Evaluation:
Assessment methods:
An assessment carried out with written examinations at the end of semester.
Written examinations are used during the semester from the theoretical and practical part.

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 14 hours
- laboratory: 28 hours
- home assignment: 48 hours
- preparation for the exam: -

Total: 90 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): TTKBE2035_EN

Further courses built on it: -

Topics of course

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.

Literature

Compulsory:
- Syllabus for biochemical practice
Recommended:
- J. M. Berg, J. L. Tymoczko, L. Stryer: Biochemistry V. edition (W. H. Freeman and Co. 2002. ISBN 0-7167-4684-0)
- A. Cornish-Bowden: Fundamentals of enzyme kinetics, 3. reprint (Portland Press, 2002, ISBN 1 85578 072 0)

Schedule: practices - 2 hours/week, laboratory - 5 hours/week, two independent tasks
1st week

Labor safety education. Semester schedule. Theory: The concept, structure and grouping of enzymes. Parameters influencing the speed of enzyme reactions. Occurrence, function, structure and activity of lipase enzyme.

2nd week

Laboratory practice: Extraction of lipase enzyme and determination of its activity.

3rd week

Enzyme activity measurement, reaction rate measurement for enzyme reactions. Enzyme structure and function relationship. Coenzymes, prosthetic groups. Enzyme regulation. The occurrence, function and structure of the catalase enzyme. Hem is a prosthetic group. Generation of hydrogen peroxide in living organisms, $FADH_2$ coenzyme, superoxide dismutase. Enzyme databases, molecular modelling.

4th week

Laboratory practice: Extraction of catalase enzyme from plant tissue, measurement of activity.

5th week

The mechanism of enzyme activity. Structural analysis of proteins. How can we develop an enzyme activity measurement method? The function and significance of the amylase enzyme, its mechanism of action and its activity. Definition and calculation of the subsite map.

6th week

Laboratory practice: Study of starch and oligosaccharide hydrolysis catalysed by amylase enzyme

7th week

Overview of the virtual laboratory program. Enzyme assays to investigate the effects of pH, time, amount of enzyme, incubation temperature and substrate concentration on the activity of different enzymes. Students can also investigate the effects of adding different inhibitors, as well. The students carry out the tasks independently at home.

8th week

Kinetics of enzymatic reactions, inhibition types. Methods for determining kinetic constants. Computer evaluation of enzyme kinetic measurements. Function of emulsion beta-glucosidase, method of measuring activity.

9th week

Laboratory practice: Determination of kinetic parameters of almond emulsin beta-glucosidase. Enzyme and substrate concentration dependence of reaction rate. Determination of enzyme kinetic parameters K_M and v_{max} and inhibition assay.

10th week

Presentation and discussion of results obtained from a search for a given enzyme in the protein and enzyme databases.

11th week

End term test

Requirements:

- for a signature

Participation at practice and laboratory classes is compulsory. A student must attend the practice classes and may not miss more than one times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.

During the semester there are tests in every second week as a part of the practice, whicharemandatory.
Students have to submit all the two tasks (database search and virtual laboratory) as a minimum on a sufficient level.
- for a grade
The course is evaluated based on the tests, designing tasks and the lab notbooks. The grade is calculated as an average.
The minimum requirement is 60%. The grade for the practice is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Gyöngyi Gyémánt, associate professor, PhD

Lecturer: Dr. Gyöngyi Gyémánt, associate professor, PhD

Title of course: Analytical Chemistry I. **Code**: TTKBE0501_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Furthercoursesbuiltonit: TTKBL0512_EN	

Topics of course

Literature

Compulsory:

1) Syllabus provided by the tutor

2) Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and Co.

3) Vogel's Qualitative Inorganic Analysis, (ed. Gy. Svehla), Longmann, 2007

Schedule:

1st week

Introduction to analytical chemistry. Measurements. Basic equations of equilibrium calculations.

2nd week

Acids and bases, acid-basetheories. The Broenstedequation. Buffers.

3rd week

Basic termsrelatedtotitrations. Practice of acid-basetitrations.

4th week

Basics of complexometry. Complexometrictitrations.

5th week

Solubility equilibria. Precipitation titrations, argentometry.

6th week

Redoxiequilibria. Permanganometry.

7th week

Chromatometry. Bromatometry. Iodometry.

8th week

Simple separation techniques I. Gravimetry.
9th week
Simple separation techniques II. Extraction.
10th week
Chromatographicseparations and techniques.
11th week
Classification of instrumental analytical methods. Evaluation of analytical chemical results.
12th week
Spectroscopy I. Atomicspectroscopy.
13th week
Spectroscopy II. UV-Visspectroscopy.
14th week
Potentiometry and conductometry.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**.
The minimum requirement for the examination is 40 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-39	fail (1)
40-55	pass (2)
56-70	satisfactory (3)
71-85	good (4)
86-100	excellent (5)

If the score of any test is below 40, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Péter Buglyó, associate professor, PhD

Lecturer: Dr. Péter Buglyó, associate professor, PhD

Title of course: Analytical Chemistry I (seminar) **Code**: TTKBG0501_EN	**ECTS Credit points:** 2

Type of teaching, contacthours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: mid-semestergradegrade

Workload (estimated), dividedintocontacthours:
- lecture: -
- practice: 28 hours
- laboratory: -
- homeassignment: 32 hours
- preparationfortheexam: -

Total: 60 hours

Year, semester: 2nd year, 1st semester

Itsprerequisite(s): TTKBG0101_EN, and parallel registrationto TTKBE0501_EN

Furthercoursesbuiltonit: -

Topics of course

Calculations involved acid-base, redox, argentometric and complexometric equilibrium and titrations

Literature

Compulsory:
Study Aids on the website
Recommended:
Daniel C. Harris: Quantitative Chemical Analysis
R. Kellner, J.-M. Mermet, M. Otto, H. M. Widner: Analytical Chemistry, Wiley, 1997

Schedule:
Schedule:

1st week
Calculations in acid-base systems: Simple problems about pH calculations (revision). Quantitative description of solutions containing monobasic acids and bases.

2nd week
Buffers in acid-base chemistry. Titration curves, calculation of final results from experimental data.

3rd week
Di- and polybasic acids and bases, ampholytes (illustration with evaluating the titration curve of a sample of phosphoric acid). Problems based on acid-base titrations.

4th week
Problems based on acid-base titrations. Calculation of equivalence points, indicator selection. Calculations for planning titration-based methods, and of distribution curves of species.

5th week
Practice, consultation.
6th week
Test I.
7th week
Complex formation equilibria. The concept and calculation of conditional stability constants.
8th week
Calculations connected to complexometric titration methods.
9th week
Quantitative description of redox equilibria.
10th week
Calculations based on redox titration methods.
11th week
Quantitative description of precipitation equilibria. Solubility product and solubility.
12th week
Effects of pH and the excess of precipitating ion on solubility. Problems based on precipitation reactions and precipitation-based titrimetric methods.
13th week
Practice, consultation.
14th week
Test II.

- for a signature
Attendance at **seminars** is recommended, but not compulsory.
During the semester there are two tests: the mid-term test in the 6th week and the end-term test in the 14th week. Students have to sit for the tests.
- for a grade
If the score of any test is below 10 points of the maximal 50 points, the grade is fail (1).
The grade is calculated from the results of the tests.

%	Grade
0-49	fail (1)
50-61	pass (2)
62-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

Students with fail (1) final course grade due to low test results can take once a comprehensive test exam during the examination period, where pass (2) can be obtained.

Person responsible for course: Dr. Csilla Kállay, associate professor, PhD

Lecturer: Dr. Csilla Kállay, associate professor, PhD

Title of course: Analytical Chemistry I (seminar) **Code**: TTKBL0501_EN	**ECTS Credit points:** 2
Type of teaching, contacthours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semestergrade	
Workload (estimated), dividedintocontacthours: - lecture: - - practice: - - laboratory: 56 hours - homeassignment: 64 hours - preparationfortheexam: - Total: 120 hours	
Year, semester: 2nd year, 1st semester	
Itsprerequisite(s): TTKBL0101_EN, and parallel registrationto TTKBE0501_EN	
Furthercoursesbuiltonit: -	

Topics of course
Acid-base, redox, argentometric and complexometric titrations
Literature
Compulsory: ***Study Aids on the website*** *Recommended:* ***Daniel C. Harris: Quantitative Chemical Analysis*** ***R. Kellner, J.-M. Mermet, M. Otto, H. M. Widner: Analytical Chemistry, Wiley, 1997***

Schedule:

1st week

Introduction to the Quantitave Analytical Chemistry Laboratory.

Laboratory Safety Information.

Review of lab equipment.

2nd week

Preparation of ~0.1 M HCl titrant (250 ml).

Determination of the exact concentration of the HCl titrant solution using potassium hydrogen carbonate stock solution.

Preparation of ~0.1 M NaOH titrant by the Sörensen (500 ml) and determination of its exact concentration.

3rd week

Determination of borax content of a solid sample (unknown sample).

Simultaneous determination of sulfuric acid and boric acid in a mixture (unknown sample).

4th week

Determination of oxalic acid (unknown sample).
Determination of $Na_2S_2O_3$ by measuring the acid formed in the oxidation reaction of $Na_2S_2O_3$ with bromine.
5th week
Determination of ascorbic acid active ingredient content of vitamin C tablet (unknown sample).
Determination of the composition of KCl-KBr mixture using 0.05 M silver nitrate stock solution (unknown sample).
Preparation of 0.02 M potassium bromate titrant (250.00 ml).
6th week
Determination of the exact concentration of the potassium permanganate titrant solution using sodium oxalate stock solution.
Determination of ferrous oxalate by permanganometric titration (unknown sample).
Determination of hydrogen peroxide (unknown sample).
7th week
Preparation of 0.02 M sodium thiosulfate titrant (250 ml) and determination of its exact concentration using 0.003 M potassium iodate stock solution.
Determination of iodide ion (unknown sample).
8th week
Redetermination of the exact concentration of the prepared 0.02 M sodium thiosulfate titrant
Determination of copper(II) (unknown sample).
9th week
Preparation of 0.01 M Na_2EDTA titrant solution (250.00 ml).
Simultaneous determination of calcium(II) and magnesium(II) ions (unknown sample).
Determination of Bi(III) (unknown sample).
10th week
Simultaneous determination of copper(II) and zinc(II) ions (unknown sample).
11th week
Quantitative description of precipitation equilibria. Solubility product and solubility.
12th week
Determination of Al(III) (unknown sample).
13th week
Lab equipment return.
14th week
Evaluation

Requirements:
Requirements:
- for a signature
Participation at practice classes is compulsory. A student must attend the practice classes and may not miss more than one during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Being late is equivalent with an absence. In case of absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.
Each week the laboratory session begins with a short test (not more than 15 minutes) based exclusively on the preparatory material and calculations of that week.
Students are required to determine “unknown samples”.
- for a grade

The grade is calculated from the results of the tests (50%) and the unknown samples (50%). Both averages have to be to be minimum 2.00 in order to successfully complete the course. Otherwise the final grade will be fail (1). Students with fail (1) final course grades thanks to unacceptable test results can take once a comprehensive test exam during the examination period.
Person responsible for course: Dr. Csilla Kállay, assistant professor, PhD
Lecturer: Dr. Csilla Kállay, associate professor, PhD

Title of course: Separation Techniques I **Code**: TTKBE0502_EN	**ECTS Credit points: 1**
Type of teaching, contact hours - lecture: 1 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN,TTKBE0401_EN	
Furthercoursesbuiltonit: TTKBL0502_EN	

Topics of course
Basic concepts, theoretical and practical aspects, carry-out and use of fundamental laboratory and industrial scale separation processes. Set-up, major components and basic operation principles of modern analytical instruments using separation methods in their working methods.
Literature
Compulsory: ***1) Separation process principles: chemical and biochemical operations / J. D. Seader, Ernest J. Henley, D. Keith Roper.—3rd ed. 2011, ISBN 978-0-470-48183-7, John Wiley & Sons, Inc.*** ***2) Modern analytical chemistry / David Harvey. — 1st ed., 2000, ISBN 0–07–237547–7, The McGraw-Hill Companies, Inc.*** *Recommended:* ***3) Modern HPLC for practicing scientists / by Michael W. Dong., 2006, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN-13: 978-0-471-72789-7*** ***4) Modern size-exclusion liquid chromatography / André M. Striegel et al., 2nd ed., 2009 by John Wiley & Sons, Inc., ISBN 978-0-471-20172-4*** ***5) Modern practice of gas chromatography., 4th ed. / edited by Robert L. Grob, Eugene F. Barry. 2004 by John Wiley & Sons, Inc., ISBN 0-471-22983-0*** ***6) Affinity Chromatography Methods and Protocols, 2nd Ed., Ed. by Michael Zachariou, 2008, Humana Press, a part of Springer Science+Business Media, LLC, ISBN: 978-1-58829-659-7*** ***7) Gel Electrophoresis of Proteins A Practical Approach, 3rd Edition, B. D. Hames, Oxford University Press, 1998, ISBN 0-19-963641-9***
Schedule: *1st week*

Basic concepts of separation processes. Removal of solvents from a mixture by different techniques: partial evaporation, batch and continuous mode thin film evaporators and concentrators. Partial evaporation by a rotating and circulating gas flow. Centrifugal evaporators.
2nd week
Partial freezing, removal of frozen solvent crystals, increase of concentration. Spray drying, freeze drying. Instruments of spray drying, practical use of spray dryin for the production of drugs, and foods. Instruments of freeze drying, laboratory scale to industrial production. Freeze-dried food production and use.
3rd week
Separation of solid mixtures by physical methods: air flow sedimentation, selective dissolution, magnetic separation, flotation. Separation by solubilities, fractionated crystallization, crystallization. Stoke's law. Removal of solids from liquids and gases: sedimentation, centrifugation, cyclons, ultracentrifugation. Separation of emulsions by special centrifuges. Gas separation and isotopes enrichments with gas centrifuges.
4th week
Filtration: basic concepts, formation and role of filter cakes. The good laboratory practice of filtration. Removal of dust from gas streams, industrial sack-type filteres, filter candles, electrostatic dust collectors. Types of filter media, filter papers, filter membranes. Filtration apparatuses. Vacuum filtration, pressure filtration. Tangential filtration.
5th week
Extraction: liquid-liquid liquid-solid and liquid-gas processes. From laboratory scale to undustrial liquid-liquid extractors, the role of density, practical uses. Basic rules of extraction, disribution coefficients, selectivites, design of an extraction scheme. Soxhlet extractors, heated and non-heated types. Solid phase extraction (SPE) and solid phase microextraction (SPME), use of SPME in sample preparation. Osmosis, dialysis, reverse osmosis instruments and their use in drinking water production. Membrane dialysis, separation of molecules by size, medical application, hemodialysis.
6th week
General aspects and types of different chromatographic techniques. Grouping of techniques by the dimension of the separating medium. Layer chromatographies: paper chromatography (PC), thin layer chromatography (TLC). Basics of TLC: tools, chambers, separation modes, geometry, types of layers, calculations, visualization and evaluation methods. Computer aided analysis of TLC and HPTLC plates. Two-dimensional TLC.
7th week
Gas chromatography 1: Definition, basics of intruments. Sample preparation for chromatographic analysis: concentration, dissolution, filtration, extraction, head-space sampling, SPME, derivatization, adsorption. General setup, gas supply system, rotating and robot arm sample holders, injectors. The inlet: the key role of rapid sample evaporation.
8th week
Gas chromatography 2: Types of inlets, oven, temperature control, gas chromatography detectors (FID, ECD, MS). Types of analytes that can be measured by the given detectors. Working principles of FID? ECD and MS detectors. Preparative gas chromatography. Web communication within and outside of laboratories. 2D-gas chromatography (2D-GCxGC).
9th week
High pressure liquid chromatography (HPLC) 1. Basic principles, structure, potential fields of applications. Separation mechanisms and separation modes. Most important structural units and components of the HPLC instrument. Solvent supply system, degass station. Role of degassing,

different degassing modes. Graadient formation unit. HPLC pumps, workin g principles, types, role of depulser. Major types of HPLC columns. Stationary phases, normal phase and reversed phase.

10th week

HPLC detectors, their working principles, structure, mode of use. (UV-Vis, scanning UV-Vis, dioade array, refractive index, fluorescence, evaporative light scattering, and mass spectrometry detectors). Isocratic and gradient elutions. Characterization of the chromatograms. Preparative HPLC.

11th week

Low pressure chromatography. Traditional, classic column chromatography, dry column chromatography, flash chromatography. Basic operating techniques, limits of separations, hardware requirements, manual mode and instrumentation.

12th week

Affinity chromatography. General principles, hardware requirements, special interaction between the stationary phase and the analytes. Elution of the analytes. Operation in column mode and in the batch mode.

13th week

Gel chromatography. Basic principles, working concepts. Dead volume, gel volume, exclusion limit, penetration. Measurement of the bed volume, separation of large molecules. Bed making, conditioning. Separtion of smaller molecules in organic solvent gel system. Characterization of the gel chromatograms, calculation of the molar mass.

14th week

Gel electrophoresis. Basic principles, translation of ions within a gel by the external electric potential. Types of gel materials, their use in the separation of proteins and nucleic acids. Vertical and horizontal electrophoresis chamber, gel casting, use of the comb. Loading of samples. Development of the gel. Visualization of the gel electroferograms, blotting. Computer aided evaluation and documentation.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**.

The minimum requirement for the examination is 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-88	good (4)
89-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. István Lázár, associate professor, PhD

Lecturer: Dr. István Lázár, associate professor, PhD

Title of course: Separation Techniques II **Code**: TTKBL0502_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 3 hours/week, organized in six blocks in the semester	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 42 hours - home assignment: 48 hours - preparation for the exam: - Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBL0201_EN, TTKBE0502_EN	
Furthercoursesbuiltonit:	

Topics of course
Basic concepts, theoretical and practical aspects, carry-out and use of fundamental laboratory analytical separation and identification processes. Basic operation principles of modern analytical instruments using separation methods in their working methods. Use of analytical instruments and techniques to separate and identify components of complex samples.
Literature
Compulsory: *1) Specific handouts, each provided for the given laboratory practice.* *2) Separation process principles: chemical and biochemical operations / J. D. Seader, Ernest J. Henley, D. Keith Roper.—3rd ed. 2011, ISBN 978-0-470-48183-7, John Wiley & Sons, Inc.* *3) Modern analytical chemistry / David Harvey. — 1st ed., 2000, ISBN 0–07–237547–7, The McGraw-Hill Companies, Inc.* *Recommended:* *4) Modern HPLC for practicing scientists / by Michael W. Dong., 2006, John Wiley & Sons, Inc., Hoboken, New Jersey, ISBN-13: 978-0-471-72789-7* *5) Modern size-exclusion liquid chromatography / André M. Striegel et al., 2nd ed., 2009 by John Wiley & Sons, Inc., ISBN 978-0-471-20172-4* *6) Modern practice of gas chromatography., 4th ed. / edited by Robert L. Grob, Eugene F. Barry. 2004 by John Wiley & Sons, Inc., ISBN 0-471-22983-0* *7) Affinity Chromatography Methods and Protocols, 2nd Ed., Ed. by Michael Zachariou, 2008, Humana Press, a part of Springer Science+Business Media, LLC, ISBN: 978-1-58829-659-7* *8) Gel Electrophoresis of Proteins A Practical Approach, 3rd Edition, B. D. Hames, Oxford University Press, 1998, ISBN 0-19-963641-9* *9) Thin-Layer Chromatography, 4th Edition, by Joseph Sherma, Bernard Fried, 1999, Marcel Dekker Inc., New York, Basel, ISBN: 0-8247-0222-0*

Schedule:
1st block
Gas chromatography.
2nd block
High pressure liquid chromatography.
3rd block
Thin layer chromatography.
4th block
Gel permeation chromatography.
5th block
Low pressure liquid chromatography.
6th block
Radioisotopes separation.

Requirements:
- for a signature
Attendance at all of the laboratory practice blocks and fulfilment of the required experiments/tasks, preparing and presenting a valid lab report.
- for a grade
The course ends in a **term mark**.
Each block of practice ends in a mark. A mean value of all marks received in the course are calculated. The minimum requirement for the examination is a mean value of 2.00. Based on the mean value, the grade for the term mark is given according to the following table:

Mean value	Grade
0-1.99	fail (1)
2.00-2.74	pass (2)
2.75-3.49	satisfactory (3)
3.50-4.24	good (4)
4.25-5.00	excellent (5)

If the mean value is below 2.00, students retake the laboratory practice in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr.Attila Gáspár University Professor Head of Department, PhD,habil DSc

Lecturer: Dr.Attila Gáspár University Professor Head of Department, PhD,habil DSc

Title of course: Instrumental analysis II **Code**: TTKBL0503_EN	**ECTS Credit points:** 6
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 6-8 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - laboratory: 78 hours - home assignment: 102 hours - preparation for the exam: - Total: 180 hours	
Year, semester: 2nd year, 2st semester	
Its prerequisite(s): TTKBE0501, TTKBL0501	
Furthercoursesbuiltonit:	

Topics of course

The series of laboratory practices are based on the topics of different intsrumental analysis like electrophoresis, atomic spectrometry, electroanalysis, validation, spectroscopic methods (IR, UV/vis, X-ray). The instrumental laboratories are connected to the topics of the Instrumental Analysis lecture and the Separation Techniques lecture and laboratory practice.

Literature

1. Daniel C. Harris: Quantitative Chemical Analysis, 7th Ed., 2007, Freeman and CoH.H.
2. Willard, L.L. Merritt, J.A. Dean, F.A. Settle: Instrumental methods of Analysis, Wadsworth Publ. Co., Belmont, 1988.
3. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch: Fundamentals of Analytical Chemistry, 8th. ed., 2004, Brooks/Cole
4. Syllabuses provided by the tutor.

Schedule:

1st week: Introductory guidance, accident protection (2h)

2nd week: Gel electrophoresis (DNA analysis) (6h)

3rd week: Chromatographic purification methods for proteins (6h)

4th week: High Performance Liquid Chromatography II (8h)

5th week: Mass spectrometry (ESI, MALDI, CE-MS) (8h)

6th week: Evaluation of chromatograms (8h)

7th week: Gas chromatography – mass spectroscopy (6h)

8th week: IR spectroscopy (6h)

9th week: Atomic spectroscopy (8h)

10th week: UV-vis spectroscopy (6h)

11th week: pH-metry (6h)

12th week: Final test (2h)

Requirements:
- for a signature
Participation at practices is compulsory. A student must attend every practices during the semester. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.
- for a grade
Grading is given by the average of 3 separate grades:
- the average grade of the short tests written at the beginning of the instrumental analysis lab practices (an average of at least 2.0 is necessary to avoid a 'fail' final grade)
- the average grade of evaluation of the analytical data measured by the instrument, the laboratory notebook prepared by the student and final discussion/conclusion made between the student and the supervisor at the end of the lab practice (an average of at least 2.0 is necessary to avoid a 'fail' final grade)
- the grade of the final test

The grade of the final test is calculated according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course: Prof. Dr. Attila Gáspár, university professor, DSc

Lecturer: Prof.Dr. Attila Gáspár, university professor, DSc

Title of course: Spectroscopic methods I. **Code**: TTKBE0503_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 22 hours - preparation for the exam: 40 hours Total: 90 hours:	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0302_EN, TTFBE2113_EN	
Furthercoursesbuiltonit: TTKBL0504_EN, TTKBL0004_EN	

Topics of course

Modern chemical analytics is based on different branches of spectroscopy. The series of lecture are based on the topics of Nuclear Magnetic Resonance, Mass Spectrometry (MS), Infrared Spectroscopy (IR) and Ultraviolet/Visible Spectroscopy (UV).
It reviews: the fundamental relations of the angular momentum and nuclear magnetism, the connections between magnetic field and nuclear magnetisation, the selection rule for NMR and the resonance condition. After that it deals with connections between electron density shielding and chemical shifts; scalar spin-spin coupling, Karplus relationship, first order spectrum (week coupling), first order rules, second-order spectrum ("strong" coupling), ^{13}C NMR. In addition, theory and practice of optical and mass-spectroscopy is covered.

Literature:

1. Andrew Derome, Modern NMR Techniques for Chemistry Research, Pergamon, ISBN-10: 0080325149
2. Timothy D.W. Claridge, High-Resolution NMR Techniques in Organic Chemistry, Elsevier, ISBN: 9780080999869
3. Neil Jacobsen, NMR Spectroscopy Explained,Wiley, ISBN-10: 0471730963
4. R.M.Silverstein, F.X.Webster:"Spectrometric Identification of Organic Compounds", Wiley, 1998.
5. F.W.McLafferty: „Interpretation of mass spectra", W.A.Benjamin, INC, New York, 1967
6. J.R.Chapman: „Practical Organic Mass Spectrometry", Wiley, 1995
7. E.Pretsch, J.T.Clerc: „Interpretation of Organic Compounds", VCH, 1997

Schedule:

1st week **Basics of NMR:** Magnetic dipoles in external B_o field, nuclear Zeeman effect, selection rules, transition frequency, populations, Boltzmann distribution, bulk magnetisation, vector model. B_1 radiofrequency excitation, CW and pulse-Fourier spectrometer schemes. NMR active nuclei. Fields of applications: solid-state NMR, MRI, tomography in material science, relaxation for drug quality control and oil research.

*2ndweek***NMR parameters:** Spin-lattice (T_1) and spin-spin (T_2) relaxation. The nuclear Overhauser effect. Chemical shielding, chemical shift, ppm scale. Factors influencing chemical shifts. Indirect scalar spin-spin couplings. Splitting patterns of multiplets, multiplicity rules. Karplus curves for determining dihedral angles.

3[rd] week **Analysis of high resolution NMR spectra 1.** :^{1}H spin system labelling rules based on molecular structure. First order analysis of ^{1}H NMR spectra. Strong couplings and their impact. Integration of ^{1}H NMR spectra, rules for quantitative NMR.

4[th] week **Analysis of high resolution NMR spectra 2.** : Interpretation of homo-and heteronuclear NOE data. Basic types of ^{13}C NMR spectra: broadband ^{1}H-decoupled, j-modulated attached proton test, gated decoupling for heteronuclear couplings, and inverse-gated decoupling for quantitative ^{13}C NMR.

5[th] week **Practicing organic molecule structure elucidation by NMR 1.:**^{1}H NMR: Major factors influencing proton chemical shifts: electronegative substituents, neighboring anisotropic shielding, H-bonds. Acids, aldehydes, aromatics, alkenes, aliphatics. Analyzing aromatic ring substitution patterns. Alcohols, ketones.

6[th] week **Practicing organic molecule structure elucidation by NMR 2.:**^{13}C NMR: Signal multiplicities in undecoupled spectra. Predicting the number of carbons from decoupled spectra. The carbon NMR chemical shift correlation chart. Assigning the ^{13}C NMR spectra of aromatics, alcohols, ketones and aliphatics. Interpreting signal intensities in usual, decoupled and in "quantitative" ^{13}C NMR.

7[th] week **NMR written TEST**

8th week Electromagnetic radiation, ranges and energy of electromagnetic radiation. Conditions for generating infrared spectra. Rotational and vibrational spectra. Characteristic group frequencies, characteristic vibrational frequencies. Overtone frequencies. Typical ranges of chemical vibrations and their dependence on binding energy and binding stability.
9th week IR spectra of alkanes, alkenes, alkines and aromatic compounds. Alcohol identification, the effect of hydrogen bond on the IR spectrum of alcohols. Intra- and intermolecular effects affecting the C-O vibration of the carbonyl group. IR spectra of carboxylic acids and carboxylic acid derivatives.

10th week Absorption spectra (UV, IR, Raman) of molecules. The Bauger-Lambert-Beer Law and its Analytical Applications. Electron excitation transitions. Maximum places and Ɛ values of the UV transitions of chromophores. Selection rules. The Jablonski diagram. Frank-Condon principle, batochromic, hypsochromic, hypochromic and hyperchromic shifts. The effect of conjugation, steric hindrance on chromophores.

11th week Conformation and geometry of polyene systems. Effect of solvent polarity on UV spectra. The basic concepts of mass spectrometry. The main ionization techniques of organic mass spectrometry. Ionization of molecules.
12th week General fragmentation and fragmentation of the molecular ion: mass spectrum. The advantages and disadvantages of ionization methods. Main parts of mass spectrometer. Optimal technical requirements for sample input aspects and multicomponent samples. Ion sources, EI ion source, CI ion source.
13th week Molecular ionization: ESI ion source, APCI ion source. The types of Mass analyzers. The Resolution. Signal Processing: detectors.
14th week Basic concepts of organic mass spectrometry, mol peak, molecular ion. The nitrogen rule, natural isotopes. General aspects of the interpretation of mass spectra. Main fragmentation processes: α-, benzyl, allyl cleavage. The McLafferty rearrangement. Generic mass spectrometry of different class of organic compounds
15[th] week **MS & IRwritten TEST**

Requirements:
- for a signature

Attendance at **lectures** is highly recommended (not compulsory) since interactive evaluation of test problems are parts of the lectures.
Students have to **submit all the two designing tasks** as scheduled minimum on a sufficient level.
During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students have to sit for the tests
- for a grade
The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- or the result of the oral examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-an offered grade:
it may be offered for students if the average grade of the two designing tasks is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Prof. Dr. Gyula Batta, university professor, DSc

Lecturers: Prof. Dr. Gyula Batta, university professor, DSc
Dr. Attila Kiss, associate professor, PhD

Title of course:Spectroscopy methods II. **Code**: **TTKBL0504_EN**	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: - - practice: 3 hours/week - laboratory: -	
Evaluation: mid-semestergrade	
Workload (estimated), divided into contact hours: - lecture: - practice: 42 hours - laboratory: - - home assignment: 78 hours - preparation for the exam: - Total: 120 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0503	
Further courses built on it: -	

Topics of course

- Spectroscopic characterization of alkanes, alkenes and alkenes.
- Spectroscopic characterization of aromatic compounds.
- Spectroscopic characterization of halogen-containing compounds.
- Spectroscopic characterization of alcohols, phenols and ethers.
- Spectroscopic characterization of amino, nitro and azide derivatives
- Spectroscopic characterization of oxo compounds.
- Spectroscopic characterization of sulfur-containing compounds.
- Spectroscopic characterization of oxo compounds.
- Spectroscopic characterization of carboxylic acids and carboxylic acid derivatives.

Literature

Compulsory:

1. *L D Field, S Sternhell, J R Kalman, Organic Structures from Spectra, 5th edition, Wiley, 2013*
2. *E. Pretsch,P. Bühlmann M. Badertscher, Structure Determination of Organic Compounds; 4th edition, Springer-Verlag, 2009*
3. *R. M. Silverstein, F. X. Webster, D. J. Kiemle, D. L. Bryce, Spectrometric Identification of Organic Compounds, 8th edition, Wiley, 2014*

Schedule:

1st week

Repeat the theoretical background of spectroscopic methods and review the general information content of each spectrum.

2nd week

Spectroscopic characterization of alkanes, alkenes and alkenes, identification of their constitutional and configuration isomers.

3rd week

Spectroscopic characterization of aromatic compounds and identification of their substitution pattern.

4th week

Spectroscopic characterization of halogenated derivatives.

5th week

Spectroscopic characterization of alcohols, phenols and ether derivatives.

6th week

Spectroscopic characterization of amino, nitro and azido derivatives.

7th week

Mid-term test.

8th week

Spectroscopic characterization of oxo compounds.

9th week

Spectroscopic characterization of thiols, sulphoxides, sulfones and sulfonic acids.

10th week

Spectroscopic characterization of carboxylic acids and esters.

11th week

Spectroscopic characterization of carboxylic amides and acid anhydrides and substituted carboxylic acids.

12th week

Complex structure identification of organic compounds I.

13th week

Complex structure identification of organic compounds II.

14th week

End-term test.

Requirements:

- for a signature

Attendance at **practice** is compulsory.

A student must attend the practice classes and may not miss more than two times during the semester (but not at the week of 7th and 14th), and a medical certificate needs to be presented. In case a student does so, the subject will not be signed, and the student must repeat the course. A student can’t make up any practice with another group. Being late is equivalent with an absence. If the student does not write the tests (at the week of 7th and 14th), they must to write at the 1st week of the exam session otherwise fail the course.

- for a grade

The term mark is based on the average of the grades of written tests.

The minimum requirement for the mid-term and end-term tests respectively is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-80	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
Person responsible for course: Dr.László Juhász, associate professor, PhD
Lecturer: Dr.László Juhász, associate professor, PhD Dr.Tünde Zita Illyés, senior lecturer, PhD

Title of course: Chemical Technology I. **Code**: TTKBE0601_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBE0602_EN, TTKBG0602_EN, Parallel registration to TTKBX0607_EN	

Topics of course
Theory and equipments of basic unit operations. Transportation of fluids, mixing, filtering, fluidization. Heat transfer, mass transfer. Reactors.
Literature
Recommended: ***1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill, New York, 2005.*** ***2. Peter Atkins, Physical Chemistry, Oxford University Press, Oxford, 2009.*** ***3. Louis Theodore, R. Ryan Dupont, Kumar Ganesan, Unit Operations in Environmental Engineering, Scrivener Publishing LLC, Beverly, MA, 2017***

Schedule:

1st week

Classification of unit operations

2nd week

Hydrostatics, hydrodynamics, Navier-Stokes equation, Pascal-rule. Industrial applications.

3rd week

Fluid flow types, Bernoulli equation, principle, pressure drop in pipes.

4th week

Pumps in chemical engineering, cavitation, pump characteristics.

5th week

Mixing, filtering

6th week

Fluidization

7th week
Heat transfer, Fourier equations, heat exchangers.
8th week
Vapor-liquid equilibrium, batch distillation.
9th week
Flash distillation.
10th week
Multi stage distillation, McCabe, Thiele method.
11th week
Extraction
12th week
Absorption
13th week
Adsorption
14th week
Chemical reactors

Requirements:
Attendance at lecturesis recommended, but not compulsory.
The course ends with an exam. The minimum requirement for the exam is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

The students can retake the exam in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Lajos Nagy, associate professor, PhD

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: Chemical Technology I. **Code**: TTKBG0601_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: 1 hour/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBE0602_EN, TTKBG0602_EN, Parallel registration to TTKBX0607_EN	

Topics of course
Calculations of basic unit operations. Transportation of fluids, mixing, filtering, fluidization. Heat transfer, mass transfer. Reactors.
Literature
Recommended: ***1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill, New York, 2005.*** ***2. Peter Atkins, Physical Chemistry, Oxford University Press, Oxford, 2009.*** ***3. Louis Theodore, R. Ryan Dupont, Kumar Ganesan, Unit Operations in Environmental Engineering, Scrivener Publishing LLC, Beverly, MA, 2017***

Schedule:

1st week

Calculations in the field of hydrostatics, Pascal-rule.

2nd week

Fluid flow types, Reynolds number.

3rd week

Bernoulli equation

4th week

Pressure drop in pipes.

5th week

Pump power calculations

6th week

Pump duty point calculation

7th week
Calculations in the field of filtering, mixing.
8th week
Calculations in the field of fluidization.
9th week
Calculation of heat exchangers
10th week
Calculation of *flash* distillation.
11th week
Distillation, operating lines, *Short-cut* method.
12th week
Distillation, McCabe, Thiele method.
13th week
Calculations in the field of extraction.
14th week
Calculations in the field of absorption and adsorption.

Requirements:
- for a signature
Participation at the classes is compulsory. A student must attend the classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at the classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented.
- for the practice grade
The course ends with a test in the 14th week. The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

The students are allowed to retake the test once to improve their scores. Further improvement is in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Lajos Nagy, associate professor, PhD

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: Chemical Technology II. **Code**: TTKBE0602_EN	**ECTS Credit points: 4**
Type of teaching, contact hours - lecture: 3 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 42 hours - practice: - - laboratory: - - home assignment: 38 hours - preparation for the exam: 40 hours Total: 120 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: -	

Topics of course

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.
Crude oil and natural gas: genesis (organic and inorganic theories), types, ingredients, mining. Engine fuels, destructive methods (thermic-, catalitic- and hydrocrackig), reforming of gasoline.

Literature

Compulsory:
- Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA., 2002, ISBN: 9783527306732
- J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press, 1983.
- G N Pandey: Textbook of Chemical Technology Vol-1, 2, 2006.
Recommended:
- Muhlynov I.: Chemical Technology I-II.

Schedule:
1st week
Laws and description of Chemical Technology
2nd week
Purification of water, water treatment

3rd week
Water softening, hardness scales
4th week
Nitrogen industry, steam processing
5th week
Synthesis of ammonia
6th week
Nitric acid production, nitrogen containing fertilizers
7th week
Sulphur industry, sulphuric acid production
8th week
Superphosphate production
9th week
Brine electrolysis, products
10th week
Alumina industry, electrolysis of alumina
11th week
Manufacturing iron, processes in the blast furnace
12th week
Atmospheric distillation of natural oil
13th week
Vacuum distillation of atmospheric residue
14th week
Processing of natural gas

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
During the semester there is one test: the end-term test in the 15th week. Students have to sit for the test
- for a grade
The exam grade is calculated by the result of end-term test.
The minimum requirement for end-term test is 50%. Based on the score of the test separately, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of the test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-an offered grade:
It may be offered for students if the grade is at least pass (2).

Person responsible for course: Dr. Lajos Nagy, associate professor, PhD

Lecturer: Dr. Lajos Nagy, associate professor, PhD

Title of course: Chemical Technology II. **Code**: TTKBG0602_EN	**ECTS Credit points: 2**

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 12 hours
- preparation for the exam: 20 hours

Total: 60 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN

Further courses built on it: -

Topics of course

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.
Crude oil and natural gas: genesis (organic and inorganic theories), types, ingredients, mining. Engine fuels, destructive methods (thermic-, catalitic- and hydrocrackig), reforming of gasoline.

Literature

Compulsory:
- Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA., 2002, ISBN: 9783527306732
- J.M. Coulson, J.F. Richardson and R.K. Sinnot: Chemical Engineering, Volume 6., Pergamon Press, 1983.
- G N Pandey: Textbook of Chemical Technology Vol-1, 2, 2006.
Recommended:
- Muhlynov I.: Chemical Technology I-II.

Schedule:
1st week
Laws and description of Chemical Technology
2nd week
Purification of water, water treatment

3rd week
Water softening, hardness scales
4th week
Nitrogen industry, steam processing
5th week
Synthesis of ammonia
6th week
Nitric acid production, nitrogen containing fertilizers
7th week
Sulphur industry, sulphuric acid production
8th week
Superphosphate production
9th week
Brine electrolysis, products
10th week
Alumina industry, electrolysis of alumina
11th week
Manufacturing iron, processes in the blast furnace
12th week
Atmospheric distillation of natural oil
13th week
Vacuum distillation of atmospheric residue
14th week
Processing of natural gas

Requirements:
- *for a signature*

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.
During the semester there is one test: the end-term test in the 15th week. Students have to sit for the test

- *for a grade*

The exam grade is calculated by the result of end-term test.
The minimum requirement for end-term test is 50%. Based on the score of the test separately, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of the test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS. *-an offered grade:* It may be offered for students if the grade is at least pass (2).
Person responsible for course: Dr. Lajos Nagy, associate professor, PhD
Lecturer: Dr. Lajos Nagy, associate professor, PhD

Title of course: Macromolecular Chemistry **Code**: TTKBE0611_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice:- - laboratory: - - home assignment: 12 hours - preparation for the exam: 50 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0302_EN	
Further courses built on it: TTKBE1213_EN	

Topics of course

Principal definitions. Classification of polymers. The most important synthetic polymers. Methods for characterizing polymers. Polymolecularity. Correlation between the structure and properties of polymers. Physical states of polymers. Preparation methods of synthetic polymers and copolymers: radical polymerization and copolymerization, anionic, cationic, living cationic polymerization. Step polymerization: polycondensation and polyaddition.

Literature

Compulsory:

- George Odian: Principles of Polymerization (Wiley, 2004) ISBN: 978-0-471-27400-1

- Leslie H. Sperling: Introduction to Physical Polymer Science (Wiley, 2006) ISBN: 978-0-471-70606-9

Recommended:

- Krzysztof Matyjaszewski, Thomas P. Davis: Handbook of Radical Polymerization (Wiley, 2002) ISBN: 978-0-471-39274-3

Schedule:

1st week

Principal definitions. Classification of polymers.

2nd week

Chemical structure, shape and fine structure of polymers.

3rd week

Polymolecularity. Average molecular weights, molecular weight distribution.

4th week

Determination methods for the molecular weight of polymers.
5th week
Physical states of polymers, I.: glass transition temperature, description of amorphous polymers.
6th week
Physical states of polymers, II.: crystallinity of polymers.
7th week
Synthesis of polymers: Radical polymerization I.
8th week
Synthesis of polymers: Radical polymerization II.
9th week
Synthesis of polymers: Types of copolymers, radical copolymerization.
10th week
Synthesis of polymers: Cationic, living cationic polymerization.
11th week
Synthesis of polymers: Anionic polymerization.
12th week
Synthesis of polymers: Coordination polymerization.
13th week
Synthesis of polymers: Step polymerization I.: Polycondensation.
14th week
Synthesis of polymers: Step polymerization II.: Polyaddition.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory. Active participation is rewarded by the teacher in every class.
During the semester there is one end-term test in the 15th week for an offered grade (optional). Students have to sit for the tests.
- for a grade
The course ends in an **examination**.
The minimum requirement for the end-term test and the examination respectively is 50%. Based on the score of the test, the grade for the test and the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-61	pass (2)
62-74	satisfactory (3)
75-87	good (4)
88-100	excellent (5)

If the score the test is below 50, students can take a retake test in conformity with the Education and Examination Rules and Regulations.
-an offered grade:
it may be offered for students if the grade of the end-term test is at least satisfactory (3).

Person responsible for course: Prof. Dr. Sándor Kéki, university professor, DSc

Lecturer: Prof. Dr. Sándor Kéki, university professor, DSc

Title of course: Macromolecular Chemistry **Code**: TTKBG0611_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: 1 hour/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: 6 hours - preparation for the exam: 10 hours Total: 30 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0302_EN	
Further courses built on it: TTKBE1213_EN	

Topics of course

Review of the principal definitions, the classification of polymers. Overview of the most important synthetic polymers, methods for characterizing polymers. Calculation of polymolecularity. Examples for the correlation between the structure and properties of polymers, the physical states of polymers. Overview of the preparation methods of synthetic polymers and copolymers: radical polymerization and copolymerization, anionic, cationic, living cationic polymerization. Step polymerization: polycondensation and polyaddition. Calculation examples for different polymerization methods.

Literature

Compulsory:

- George Odian: Principles of Polymerization (Wiley, 2004) ISBN: 978-0-471-27400-1

- Leslie H. Sperling: Introduction to Physical Polymer Science (Wiley, 2006) ISBN: 978-0-471-70606-9

Recommended:

- Krzysztof Matyjaszewski, Thomas P. Davis: Handbook of Radical Polymerization (Wiley, 2002) ISBN: 978-0-471-39274-3

Schedule:

1st week

Review of the principal definitions, the classification of polymers.

2nd week

Chemical structure, shape and fine structure of polymers.

3rd week

Calculation of polymolecularity, average molecular weights, molecular weight distribution.

4th week
Determination methods for the molecular weight of polymers.
5th week
Discussion of the physical states of polymers, I.: glass transition temperature, description of amorphous polymers.
6th week
Discussion of the physical states of polymers, II.: crystallinity of polymers.
7th week
Synthesis of polymers: Radical polymerization I. Discussion, examples.
8th week
Synthesis of polymers: Radical polymerization II. Discussion, examples, calculation.
9th week
Synthesis of polymers: Types of copolymers, radical copolymerization. Determination of the reactivity ratio, distribution of monomers in a copolymer.
10th week
Synthesis of polymers: Cationic, living cationic polymerization. Discussion, examples.
11th week
Synthesis of polymers: Anionic polymerization. Discussion, examples.
12th week
Synthesis of polymers: Coordination polymerization. Discussion, examples.
13th week
Synthesis of polymers: Step polymerization I.: Polycondensation. Discussion, examples, calculation.
14th week
Synthesis of polymers: Step polymerization II.: Polyaddition. Discussion, examples.

Requirements:
- for a signature
Participation at **practice classes** is compulsory. Active participation is rewarded by the teacher in every class. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.
During the semester there is one end-term test in the 15th week for a practice grade. Students have to sit for the tests.
- for a grade
The course ends in an **end-term test**.
The minimum requirement for the end-term test is 50%. Based on the score of the test, the grade for the test is given according to the following table:

Score	Grade
0-49	fail (1)
50-61	pass (2)
62-74	satisfactory (3)
75-87	good (4)
88-100	excellent (5)

If the score the test is below 50, students can take a retake test in conformity with the Education and Examination Rules and Regulations. *-an offered grade:* it may be offered for students if the grade of the end-term test is at least satisfactory (3).
Person responsible for course: Prof. Dr. Sándor Kéki, university professor, DSc
Lecturer: Prof. Dr. Sándor Kéki, university professor, DSc

Title of course: Environmental Technology **Code**: TTKBE1114_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 32 hours - preparation for the exam: 30 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE1111_EN	
Further courses built on it: -	

Topics of course

Relationship between the humanity and the nature. Sustainable development. Types of municipal and industrial wastes, prevention of their formation. Basics of waste management: landfilling, incineration and other physical and chemical methods. Additive and integrated environmental protection strategies. Treatment technologies of wastes at different states. Pollutants of air, water, and soil, their treatment. Municipal and industrial wastewater treatment. Noise and vibration protection. Renewable energy sources.

Literature

Compulsory:

- D.A. Vallero: Fundamentals of Air Pollution (Academic Press, 2007) ISBN: 9780123736154

- N.L. Nemerow: Industrial Waste Treatment (Butterworth-Heinemann, 2007) ISBN: 9780123724939

Recommended:

- A. Malik, E. Grohmann: Environmental Protection Strategies for Sustainable Development (Springer, 2011), ISBN: 9789400715912

Schedule:

1st week

Relationship between the humanity and the nature. Sustainable development in the industry.

2nd week

Types of industrial wastes, reduction and treatment.

3rd week

Additive and integrated environmental protection strategies. Closed-loop technologies.

4th week

Technologies and methods for the treatment of gaseous wastes.
5th week
Technologies and methods for the treatment of liquid wastes.
6th week
Technologies and methods for the treatment of solid wastes.
7th week
Air pollutants, their effects, prevention, treatment options.
8th week
Water pollutant chemical substances, their effects on the hydrosphere, prevention, treatment options.
9th week
Organic substances as water pollutants, their analytical problems, effects on the living organisms.
10th week
Physical and chemical methods of wastewater treatment.
11th week
Biological methods of wastewater treatment. Sludge treatment.
12th week
Soil pollution, treatment options of different pollutants.
13th week
Renewable energy sources: solar, wind, water, geothermal.
14th week
Noise and vibration protection. Effects of noise on the environment and human health.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory. Active participation is rewarded by the teacher in every class.
Students have to **submit an essay** about a given topic as scheduled minimum on a sufficient level.
During the semester there is one end-term test in the 15th week for an offered grade (optional). Students have to sit for the tests.
- for a grade
The course ends in an **examination**. Based on the average of the grades of the essay and the examination, the exam grade is calculated as an average of them:
The minimum requirement for the end-term test and the examination respectively is 50%. Based on the score of the test, the grade for the test and the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-61	pass (2)
62-74	satisfactory (3)
75-87	good (4)
88-100	excellent (5)

If the score the test is below 50, students can take a retake test in conformity with the Education and Examination Rules and Regulations.
-an offered grade:
it may be offered for students if the grade of both the essay and the end-term test is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Katalin Margit Illyésné Czifrák, assistant professor, PhD
Lecturer: Dr. Katalin Margit Illyésné Czifrák, assistant professor, PhD

Title of course: Visit in Chemical Industries **Code**: TTKBX0607_EN	**ECTS Credit points:** 0
Type of teaching, contact hours 5 days	
Evaluation: signature	
Workload (estimated), divided into contact hours: Total: 40 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Parallel registration toTTKBE0601_EN	
Further courses built on it: -	

Topics of course
5 days visit at various factories and companies in the chemical engineering field. The technology processes and equipments are explained to the students by experts. Visited companies are in the field: plastic industry, oil industry, pharmaceutics, water treatment, waste treatment, power plants, etc.
Literature
-

Requirements: Attendance at the visits is compulsory.
Person responsible for course: Dr. Ákos Kuki, associate professor, PhD

Title of course: Bachelor thesis I. **Code**: TTKBL0001_EN	**ECTS Credit points:** 5

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: 3 hours/week

Evaluation: practical grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28
- laboratory: 42 hours
- home assignment: 80 hours
- preparation for the exam: -

Total: 150 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): Completion of 110 credits + special requirements by the supervisor

Further courses built on it: TTKBL0002

Topics of course

The course aims at the preparation to solve a problem that can be approached by chemical methods. The student is expected to get the following competences: planning, time management, handling of information (gain and analysis from various sources, such as traditional library, electronic databases, search engines), ability to work alone or in a team, practical application of acquired knowledge, communication in native language both in oral and written ways. The student gets deeper knowledge in methods and procedures of a particular field of chemistry. With the help of the supervisor he/she starts to plan and execute the literature search and experimental work related to the topic of the thesis.

Literature

Provided by the supervisor.

Schedule:
The student works by following the instructions of the supervisor.

Requirements:
- *for a signature*

The student have to take part in the research project coordinated by the supervisor.
- *for a grade*

The work of the student is evaluated by the supervisor considering many aspects, e.g. the quality of the work in the laboratory or industry, the ability to work alone or in a team, the competence for process the literature about the given topic, the problem solving ability and the presentation of the results.

Person responsible for course: Prof. Dr. László Somsák, university professor, DSc
Lecturer: supervisors are staff members of the Institute of Chemistry, UD

Title of course: Bachelor thesis II. **Code**: TTKBL0001_EN	**ECTS Credit points:** 10
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 10 hours/week	
Evaluation: mid-semester gradegrade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 140 hours - home assignment: 160 hours - preparation for the exam: - Total: 300 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBL0001_EN	
Further courses built on it:	
Topics of course	
The student will complete the task of the previous semester by critically evaluating the literature, studying and applying the experimental method(s) to solve the given problem, carrying out the necessary practical work, and summarizing the results in a thesis of 20-30 printed pages. Special and detailed reqirements are available at the homepage of the Institute of Chemistry. All these must be realized in a research group of the Institute of Chemistry. Work in an external group is only possible with the consent of the Institute of Chemistry and with a supervisor acknowledged by the Institute of Chemistry.	
Literature	
Provided by the supervisor.	

Schedule: *The student works by following the instructions of the supervisor.*
Requirements: - *for a signature* The student have to take part in the research project coordinated by the supervisor. - *for a grade* The work of the student is evaluated by the supervisor considering many aspects, e.g. the quality of the work in the laboratory or industry, the ability to work alone or in a team, the competence for process the literature about the given topic, the problem solving ability and the presentation of the results.
Person responsible for course: Prof. Dr. László Somsák, university professor, DSc
Lecturer: supervisors are staff members of the Institute of Chemistry, UD

Optional Courses

Title of course: Crystallography **Code**: TTGBE5104_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: 2 hours/week - practice:- - laboratory: -	
Evaluation:exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice:- - laboratory: - - home assignment: 10 hours - preparation for the exam: 52 hours Total: 90	
Year, semester: 1st year, 1st semester	
Its prerequisite(s):	
Further courses built on it:-	

Topics of course

Position of crystallography among other fields of science. The definition of space latice, unit cell and crystallographic axes. Bravais lattices. Unit cells and crystallographic axes in crystal systems. Calculation of Miller indices. Symmetry elements, crystal classes, point groups and space groups. Fundamentals of crystal chemistry and the different types of lattices. Rules of coordination and packing. Lattice defects and element substitutions in the lattice. Physical properties of crystals and their explanation through stuctural differences.
The understanding of constitution of unit cells and symmetry elements will be supported by the in-class study of three dimensional crystal models.

Literature

Compulsory:
W. D. Nesse: Introduction to Mineralogy. Oxford University Press. Oxford-New York, 2012 (2nd edition)

Schedule:

1st week
Subject of crystallography. Properties of crystalline substances, definition of space lattice. Principles of morphology and crystallography.

2nd week

Bravais-type unit cells and crystal systems. Crystal cross in crystallography. Definition of directions, lattice planes and crystal faces. The Miller index.

3rd week
The visible symmetry elements of crystals, simple and combined symmetry elements. The stereographic projection. The translational symmetry.

4th week
Practicing of identification of symmetry elements

5th week
Point groups and the 32 crystal classes. Holohedral, hemihedral and tetrahedral crystal classes.

6th week
Mid-term test. Definition of crystal form. Crytal forms and symmetry elements in triclinic, monoclinic and orthorhombic systems.

7th week
Crystal forms and symmetry elements in trigonal, tetragonal and hexagonal crystal systems

8th week
Crystal forms and symmetry elements in cubic crystal system

9th week
Basics of crystal chemistry. X-ray diffraction and Bragg equation. Types of crystal lattices (atomic, inoic, metallic, molecular lattice).Coordination number, atomic, ionic radii.

10th week
Types of atomic lattices. Metallic lattice and the close packing. Molecular lattices. Properies of ionic lattice substances.

11th week
Isodesmic, anisodesmic and mesodesmic ionic lattices. Stucture of silicates. Ortho, ring, chain, sheet and framework silicates.

12th week
Isomorphism and polymorphism. Real lattice structures, lattice defects. Rules of element substitutions. Crystal growth.

13th week
Crystal physics. Cohesion properties. Cleavage and sliding. Mohs-type hardness scale. Thermoelectric and piezoelectric properties. Structural interpretation of physical properties.

14th week
Crystal optics. Isotropic and anisotropic crystals. Birefrigency and optical activity. Summary

Requirements:

- *for a signature*
Participation at **lecture classes** is not compulsory but highly advised.
During the semester there will be be two tests, the mid-term test in week 6, and theend-term test in week 15. Students have to sit for the tests.
- for a grade
The course ends with a **writing examination** in the exam period, covering the whole material of the semester. The final grade for the course will be determined according to the followings: it is based on the average grade of the mid-term test and end-term test in 10 %, and based on the result of written exam in 90 %.
The minimum requirement for the average grade of end-term test and mid-term test and final exam is 50%, respectively. The examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-72	satisfactory (3)
73-87	good (4)
88-100	excellent (5)

If the score of the test is below 49, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:
it may be offered for students if the average grade of mid-term test and end-term test is at least satisfactory (3).

Person responsible for course: Prof. Dr. Gábor Dobosi, university professor, DSc

Lecturer: Dr. Dávid Nagy, assistant lecturer, PhD

Title of course: History of chemistry **Code**: TTKBE0007_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 0 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: 30 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN	
Further courses built on it: - The course is connected to other courses of chemistry teachers (Basics of chemistry teaching, Methods and devices of chemistry teaching)	

Topics of course

The topic of this course is the history of chemical thinking, the philosophical foundations of the science, the thinking systems and the history of discovery and inventions. It also concerns the impact of the development of chemistry on culture, history, the world view and the lifestyle of mankind. The lecture covers the ancient and medieval chemistry (metal processing, cleaning, cosmetics, chemistry of medicines) as well, namely, the age of alchemy. We analyse the conditions of the discovery of gases, the development of the interpretation of chemical reactions, the history of the formation of organic chemical concepts, the formation of a modern chemical industry and the age of modern atom theory, the age of electrochemistry and radiochemistry, and the history of medication development. The historical interpretations help to understand the complex relation between the chemistry and the human culture.

Literature

Compulsory:
- L. Balázs: History of chemistry I-II. (1996), National Textbook Publisher (Budapest), 1996, p.1-1075. (editors: Oláh Zsuzsa, lector: I. Pais, E. Szilágyi)
Recommended:
- K. Simonyi (1981): Cultural history of physics, Publisher: "Gondolat Kiadó", Budapest
- L. Kovács, D. Csupor, G. Lente, T. Gunda (2011): 100 chemical myths. Publisher: "Akadémiai Kiadó"

Schedule:

1st week: The review of the requirement. Science philosophy. Chemistry knowledge in the prehistoric age. *2nd week: The history of the chemistry in the antiquity (Syria, Arabia, Mezopotámia, Egypt, Asia)* *3rd week: Chemistry knowledges in the Greek and a Roman age. The appearance of the alchemy.* *4th week: Age of alchemy.* *5th week: Develeopment of jatro-chemistry.* *6th week: The age of discovery of gases.* *7th week: Mixtures, compounds, elements, separation, qualitative analysis, chemical symbols, formules, nominations.* *8th week: Development of electrochemistry.* *9th week: Development of organic chemistry.* *10th week: Development of terminology and language of chemistry* *11th week: Chemistry and the turn of the century.* *12th week: The history of the discovery of medicines. The history is famous poisons and poisoning.* *13th week: Test.* *14th week: Evaluation. Declaring of results.*
Requirements: *- for a signature* Attendance at **lectures** is recommended, but not compulsory. *- for a offered grade* - During the semester there is an end-term test (70% of the total scores) in the 13th week. - *“work at lecture”:* at the beginning of the weekly lecture they can write a test (four questions from the previous lecture) and obtain 4 points, the lecturer will add these point to the end points of term test (10% of the total scores) - *“individual collecting work”:* If the students write and send an excellent collecting work (in themes of the lectures) for the lecturer, she/he can obtain further points (20% of the total scores) Students can obtain an offered mark, if he/she accept this mark, the examination is not necessary for him/her. If he/she do not accept the offered mark, the course ends in an writing or oral **examination**. The minimum requirement for end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table: Score Grade

0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Ágnes Dávid, assistant lecturer, PhD

Lecturer: Dr. Ágnes Fejesné Dávid, assistant professor, PhD

Title of course: Special and dangerous materials. **Code**: TTKBE0204_EN	**ECTS Credit points: 3**
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2^{nd}–4^{th} year, 1^{st} semesters	
Its prerequisite(s):TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it:	

Topics of course

Structure, composition, properties and handling/safe use of special materials, which may represent a personal, social or environmental risk or even a life-threatening danger in case of accidents, war, or illicit use.

Literature

Compulsory:

1) Chemical Warfare Agents Chemistry, Pharmacology, Toxicology, and Therapeutics, Edited by
James A. Romano, Jr. Brian J. Lukey, Harry Salem, CRC Press, ISBN-13 978-1-4200-4661-8

2) High Energy Materials. Propellants, Explosives and Pyrotechnics, Jai Prakash Agrawal, 2010, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

Recommended:

3) Chemistry of Pyrotechnics, Basic Principles and Theory, 2nd Edition, 2010, CRC Press, ISBN-13: 978-1-4200-1809-7

4) The Pleasure Instinct Why We Crave Adventure, Chocolate, Pheromones, and Music, Gene Wallenstein, 2009, John Wiley & Sons, Inc., ISBN 978-0-471-61915-4

Schedule:

1^{st} week

Narcotics, hard and soft drugs 1. General properties, groups, addiction, legal state. Treatment of addiction. Cannabis.

2^{nd} week

Narcotics, hard and soft drugs 2. Opium, morphine, heroine, opioids. Treatment of addiction, withdrawal syndroms.

3rd week
Narcotics, hard and soft drugs 3. LSD, mescaline, and related derivatives.
4th week
Narcotics, hard and soft drugs 4. Natural materials: Catinone, harmine, harmaline, bufotenine, ibogaine, ephedrine, LSA, safrole, iso-safrole, myristicyne.
5th week
Narcotics, hard and soft drugs 5. Synthetics 1. Amphetamine and derivatives, Extasy, etc..
6th week
Narcotics, hard and soft drugs 6. Synthetics 2. DON, DOB, STP, designer drugs.
7th week
Chemical weapons 1. Major groups, target organs, toxicity. Tear gases, lachrymators.
8th week
Chemical weapons 2. Blood poisons, lung poisons, vesicants..
9th week
Chemical weapons 3. Nerve gases. Floroorganic poisons.
10th week
Chemical weapons 4. Binary chemical weapons. Incendiaries, flame materials, heat source materials.
11th week
Explosives, pyrotechnics 1. Basic concepts, definitions, modes of action. Deflagration: gun powder. Energetic materials, propellants, high energy polymers.
12th week
Explosives, pyrotechnics 2. Initiators, shock and spark sensitive materials. Blasting caps, detonators. High energy explosives, binary explosives, and their civilian and military uses.
13th week
Explosives, pyrotechnics 3. Basic experimental techniques to determine explosive characteristics and stability of explosives and gun powders. Pyrotechnical materials and devices. Civilian pyrotechnics, fireworks.
14th week
Pheromones. Basic properties, mode of action, role in the behavior control and in the physiological signaling processes. Use of pheromones in the agriculture, and in the animal life. Pheromone-like materials, the Dirty 12.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**.
The minimum requirement for the examination is 50 score. Based on the score, the grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-88	good (4)
89-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. István Lázár, associate professor, PhD
Lecturer: Dr. István Lázár, associate professor, PhD

Title of course: Environmental chemistry I. **Code**: TTKBE0417_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd/3rd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: -	

Topics of course

The series of lectures are based on the topics of the chemistry of the environment. First the course reviews the definitions, formation, researching method and relations of environmental chemistry with the other fields of science and economy. Than it deals with the formation of our surroundings (formation of the elements, nuclear processes, nuclear fusion and fission, nuclear energy, formation of the stars, planets and the Earth. After that it deals with the chemistry of the atmosphere (structure and characterization, stratospheric ozone, greenhouse effect, aerosols, types of smog, carbon, oxygen, nitrogen and sulphur cycle). The chemistry of the hydrosphere includes the role of the surface waters and oceans in the geochemical cycle, the comparison of the composition and features of sea water and fresh water, industrial and drinking water, water treatment. At the end the course reviews the chemical processes of the pedosphere and the soil, the role of humus materials, as well as the bio-geochemical cycle of phosphorous and other essential elements.

Literature

Compulsory:

- I. Pulford, H. Flowers (2006): Environmental Chemistry at a Glance, Blackwell Publishing. ISBN 978-1405135320

- P. Brimblecombe, J. E. Andrews, T. D. Jickells, P. Liss, B. Reid (2003): An Introduction to Environmental Chemistry, Blackwell Publishing. ISBN 0-632-05905-2

- T. G. Spiro, K. L. Purvis-Roberts, W. M. Stigliani (2011): Chemistry of the Environment, Univ. Sci. Books. ISBN 978-1-891389-70-2

- Recommended:

- G. W. van Loon, S. J. Duffy (2010): Environmental Chemistry: A global perspective, Oxford Univ. Press. ISBN 9780199228867

Schedule:

1st week

Definitions, development, researching methods and relations of environmental chemistry to the other fields of science and economy. The evolution of the natural environment: the Big Bang theory.

2nd week

The formation of the elements. The possible nuclear chemical processes of the synthesis of nuclei. Hydrogen as an energy source. The formation and geochemical development of the Earth.

3rd week

Energy balance of the Earth. The principles of energy production of atomic fission. The structure of a reactor and a power-plant. Advantages and problems of the nuclear energy-production. The basics of isotope dating.

4th week

Chemical evolution: principles, formation of essential mono- and polimers. The development of the atmosphere and hydrosphere. The hypothesis of the origin of life.

5th week

Composition and regions of the Earth's atmosphere. The chemistry and role of the stratospheric ozone. Environmental problems of ultraviolet radiation.

6th week

Chemical reactions in the atmosphere: formation and reaction of O-, C-, S-, N-containing compounds.

7th week

The most frequent gas and solid air pollutants, their health hazarding effects, elimination possibilities. Natural and social causes and consequences of the greenhouse effect.

8th week

Types of smog, conditions required for their formation. The self-purification of the atmosphere, generation of acidity in rains.

9th week

The composition of the hydrosphere. Physical and chemical properties of water. The chemistry of aqueous solutions: acid-base and redox equilibriums. Solubility of gases, liquids and solids in water.

10th week

Water pollutions and water quality. Waste water and its treatment.

11th week

Lithosphere: structure and components (rocks and minerals), soil formation, organic and inorganic components of soil.

12th week

Characterization and main functions of soil. Environmental problems associated with soils (acidification, alkalinity, metal contamination, etc.).

13th week

Biogeochemical cycles: carbon, oxygen, nitrogen.

14th week

Biogeochemical cycles: sulphur, phosphorous and metal ions. Treatment of wastes.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**, which means a written test.
The minimum requirement for the examination is 50%. Based on the score of the test (60), the grade is given according to the following table:

Score	Grade
0-29	fail (1)
30-37	pass (2)
38-45	satisfactory (3)
46-53	good (4)
54-60	excellent (5)

If the score of any test is below 30, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Mónika Kéri, assistant professor, PhD

Lecturer: Dr. Mónika Kéri, assistant professor, PhD

Title of course: Computational Quantum Chemistry **Code**: TTKBG0903_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: 30 hours Total: 90 hours	
Year, semester: 2nd / 3rd year, 2nd semester	
Its prerequisite(s): TTMBE0809_EN, TTMBG0809_EN, TTKBG0911_EN	
Further courses built on it: -	

Topics of course

Hartree-Fock Theory. DensityFunctionalTheory. Basissets. Solventeffect, Polarizable. ContinuumModel. Geometryoptimization. Structuralanalysis. Calculatingenergies of chemical reactions

Literature

Compulsory:
https://maker.pro/linux/tutorial/basic-linux-commands-for-beginners
http://gaussian.com/keywords/
Recommended:
http://barrett-group.mcgill.ca/tutorials/Gaussian%20tutorial.pdf

Schedule:

1st week
Basic theory of the Hartree-Fock method: approximations, LCAO-MO theory. Building structures by the GaussView program.

2nd week
Basic Linux commands, using the WinSCP and Putty programs, connecting by SFTP. Using the Gaussian program package, optimizing simple molecules.

3rd week
Geometry optimizations by different basis sets, comparing and calibrating the methods by structural parameters.

4th week

Frequency analysis, calculating Gibbs free energies of simple reactions. Scanning a reaction pathway, finding the transition state, identifying the stationary points of the Potential Energy Surface.

5th week

Basic theory of the post-Hatree-Fock theories. Recalculating the previously studied systems and comparing them to the HF results.

6th week

Solvent effect, using Polarizable Continuum Models to refine the energies.

7th week

Basic theory of the Density Functional Theory. Recalculating the previously studied systems and comparing them to the (post-)HF results.

8th week

Systems with explicit solvent molecules.

9th week

Calculation on more difficult systems: metal complexes and relativistic effects.

10th week

Mid-term exam about calculations by using Gaussian.

11th week

Conformation analysis, more Linux commands.

12th week

Writing simple scripts in b shell.

13th week

Generating input files by scripts.

14th week

Exam of writing scripts in b shell.

Requirements:

- for a signature

Attendance is recommended, maximum 3 absences are accepted.

- for a grade

Class performance (33%)

Final examination (67%)

Based on the sum of the final practical exam of performing calculations and the class performance the practical grade is calculated.

The final grade is given according to the following table:

Score (%)	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of the final grade is below 50%, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Oldamur Hollóczki, assistant professor, PhD

Lecturer: Dr. Oldamur Hollóczki, assistant professor, PhD

Dr. Attila Mándi, assistant professor, PhD

Title of course: Unit Operations I **Code**: **TTKBG0614_EN**	**ECTS Credit points:** 6
Type of teaching, contact hours - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 50 - preparation for the exam: 60 hours Total: 180 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBG0615_EN	

Topics of course

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

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transport processes and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Definition and classification of unit operations. batch and continuous processes. Flowsheets.

2nd week

Physical quantities, units, dimensions. The SI system. Extensive and intensivequantities. Dimensional and tensorial homogenity. Scalar-vector-tensor quantities.

3rd week

The fundamental equation of thermodynamics. Conditions of equilibrium, driving force, rate of processes. Degrees of freedom of a chemical system.

4th week

Flows and fluxes. Scalar and vector fields and their derivatives. The Nabla vector, gardient and divergence.

5th week

The general transport equation. Differential and integral form of balance equations valid for one and two phase unit operations. The Damköhler equations. The Onsager theory.

6th week

The mathematical model. Initial and boundary conditions. Balance equations for simple systems: Fourier-I and Fick-I laws.

7th week

Similitude and modelling. Dimensional analysis, dimensionless numbers.

8th week

Mass and energy balances for simple and complex unit operations.

9th week

Flow in unpacked pipes and in pipelines: Fluids in rest, Pascal's law. Navier-Stokes equations. Bernoulli equation. Cavitation. Newtonian and non-Newtonian fluids. Newton's law of viscosity.

10th week

Basic types of fluid flow. Reynolds' experiment. Hagen-Poisseuille equation. Modified Bernoulli equation. Fanning equation. Moody diagram. Energy requirement of fluid transport. Types of pumps.

11th week

Flow near solids, in packed columns: Flow around immersed objects. Interpretation of Reynolds number. Types of flow around spherical particles. Stokes' law for the frictional force. Drag coefficient for laminar, transitional and turbulent regions. Ergun equation. Packed columns, characteristics and types of packings. Methods of flow measurement.

12th week

Basics of filtration. Darcy's law of filtration. Batch filtration using constant pressure, continuous filtration using constant flow rate. Filtration units. Filtration using centrifugal force. Types of centrifuges. Basics of membrane filtration. Concentration polarization.

13th week
Mixing of solids, apparatus. Mixing of fluids. Momentum balance for the agitator. Power requirement of agitation. Fluid mixers.

14th week
Terminal velocity of sedimentation. Stokes' law. Drag coefficient as a function of Reynolds number. Apparat us for settling, dust removers, cyclones.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.
- for a grade
The course ends in an **examination**.
The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.
-an offered grade:
it may be offered for students if the average grade of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Sándor Kéki university professor, DSc

Lecturer:

Title of course: Unit Operations II. **Code**: TTKBG0615_EN	**ECTS Credit points:** 6
Type of teaching, contact hours - lecture: 2 hours/week - practice: 3 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 42 hours - laboratory: - - home assignment: 40 hours - preparation for the exam: 40 hours Total: 150 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Unit operations I. (TTKBG0614_EN)	
Further courses built on it: Unit operations III. (TTKBG0616_EN)	

Topics of course

Heat transfer. General characterization of heat transfer. Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Heating and cooling. Heat transfer at standard- and changeable temperature difference. Unsteady- and steady state transfer of heat. The logarithmic mean temperature difference. Heat exchangers. Evaporation and evaporators. Cooling and coolers. Classification of reactors and choice of reactor type in the industry. Chemical kinetics. Residence time and distribution of residence time. Batch reactors and continuous reactors. Influence of heat of reaction on reactor type. Isothermal, adiabatic polytrophic reactors. Mechanical operations. Size reduction of solids. Methods of operating crushers: coarse-, intermediate-, fine crushers and colloid mills. Classification of solid particles and settling. Blending of solid particles.

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of Chemical Engineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transport phenomena and unit operations: a combined approach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transport processes and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Heat transfer. General characterization of heat transfer.

2nd week

Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat-transfer by convection. Analogies between momentum and heat transfer. Chilton-Colburn analogy. *3rd week* The heat equation. Types and calculation of heat transport. Steady state heat conduction in plane pipe walls. Fourier-I equation and thermal insulation. *4th week* Unsteady state heat conduction. Fourier-II equation. Dimensionless numbers for transient heat conduction: Fourier, Biot number and dimensionless temperature. Interpretation of the Heissler chart. *5th week* Boundary layer theory of heat transfer. The Nusselt and Prandtl number. Forced convection heat transfer. Natural convection heat transfer. Radiation heat transfer and solution of complex heat transfer problems *6th week* Heat exchanngers. Stationary heat transmission with constant temperature difference through flat and cylindrical wall. Determination of heat flow and thermal resistances. *7th week* Direct and indirect heat exchange. Determination of the power requirement for a stationary recuperative heat exchanger. Temperature-space function of co-current and counter current heat exchangers. Logarithmic mean temperature difference. Types and apparatus of heat exchangers. *th week* Boiling of liquids. Boiling curves. Critical heat flux of boiling. Leidenfrost effect. *9th week* The aim of evaporation, Calandria, falling film and Robert-type evaporator. Multistage evaporators and their connections. *10th week* Cooling and coolers. *11th week* Introduction to chemical reactors. Classification of reactors based on flow, operation mode, component stream and heat. Operation time, residence time. Concentration-time and concentration-space functions of batch and continuous reactors. *12th week* Heat balance of a reactor. Stability of reactors. *13th week* Methods of feed preparation and surface increase: size reduction, sieving, vaporization, homogenization: Crushers and grinders. Energy requirement of size reduction. Screening and classification. Sieve analysis. *14th week* Practice.
Person responsible for course: Katalin Illyésné Dr. Czifrák, assistant professor, PhD
Lecturer:

Title of course: Unit Operations III. **Code**: TTKBG0616_EN	**ECTS Credit points:** 6

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: 3 hours/week
- laboratory: -

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 42 hours
- laboratory: -
- home assignment: 50
- preparation for the exam: 60 hours

Total: 180 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTKBG0615_EN

Further courses built on it: -

Topics of course

Mass transfer processes. Mass transfer across a phase boundary, the two-film theory. Common interpretation of the operating line and the equilibrium curve. Mass transfer in the columns, the transfer units. Mass transfer in the cascades, the equilibrium units. Absorption, Adsorption. Evaporation. Distillation. Rectification. Extraction. Crystallization. Humidification. Drying.

Literature

Compulsory:

McCabe, W.L.; Smith, J.C.; Harriot, P. (1993) Unit Operations Of ChemicalEngineering (7th Ed) - McGraw-Hill

Richard G. Griskey:Transportphenomena and unit operations: a combinedapproach, (2002), Wiley, ISBN 0-47 1-43819-7

Christie J Geankoplis: Transportprocesses and unit operations (1993), 3rd edition, Prentice-Hall, ISBN 0-13-045253-X

J. M. Coulson, J. F. Richardson: ChemicalEngineering. Volume 1-6. Third Edition. Pergamon Press. Oxford

Schedule:

1st week

Mass transfer theories. Two-film and boundary layer theory of component transfer.

2nd week

Absorption-desorption: Concentration-space diagram of a continuous counter current absorption unit operation. Equation of operating line.

3rd week

Transfer unit and its graphical determination. Chemisorption. Types of absorption-desorption apparatus.

4th week

Adsorption-desorption. Physical and chemical adsorption. Isotherms.

5th week

Types of absorption-desorption apparatus. The PSA adsorption.

6th week

Thermal separation operations: distillation: Batch and continuous distillation.

7th week

Rectification. Operating point. Types and parts of a continuous rectification apparatus.

8th week

Operating lines of a rectifier. The q-line. Equilibrium stage, its determination using McCabe-Thiele diagram.

9th week

Liquid-liquid extraction. Ternary phase diagram. Distributional diagram of the key component. Batch and continuous extraction. Continuous one-stage mixer-settler extractor.

10th week

Liquid-solid extraction and its apparatus.

11th week

Crystallization and its phase diagram. Apparatus for crystallization.

12th week

Humidification.

13th week

Drying. Types of moisture binding. Rate of drying. Enthalpy of moist air. Types, material-and energy balance of drying apparatus

14th week

Practice.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

- for a grade

The course ends in an **examination**.

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

- Score Grade
- 0-59 fail (1)
- 60-69 pass (2)
- 70-79 satisfactory (3)
- 80-89 good (4)

- 90-100 excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-*an offered grade:*

it may be offered for students if the average grade of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. Katalin Margit Illyésné Czifrák, associate professor, PhD

Lecturer:

Title of course:Applied Radiochemistry **Code**: TTKBE0504_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 22 hours - preparation for the exam: 40 hours Total: 90 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBE0403_EN	
Further courses built on it: -	

Topics of course

- Interaction of radiation with matter and its practical aspects.
- Radioactive labeling.
- Production of radionuclides.
- Chemical, biological, medical applications
- Nuclear energy production.
- Tools and facilities of isotope laboratories.

Literature

Compulsory:

- ***Kónya, J., Nagy N.M., 2012, 2018. Nuclear and Radiochemistry, Elsevier, Oxford.***
- ***Choppin, G.R., Liljenzin, J-O., Rydberg, J. Ekberg, C., 2013. Radiochemistry and Nuclear Chemistry, 4th Edition, Elsevier, Amsterdam.***
- ***Kratz, J.-V., Lieser, K.H., 2013. Nuclear and Radiochemistry: Fundamentals and Applications, 3rd Edition, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany,***

Schedule:

1st week and 2nd week

Interaction of radiation with matter, general sketch of the applications.

3rd week and 4th week

Applications of natural radioactive and stable isotopes

5th week

Production of radionuclides

6th week and 7th week

Radiotracers, physical chemistry of carrier-free concentrations.
Basic rules of tracer studies.

8th week

Tracer studies in chemistry, nuclear medicine and chemical industry.

9th -12th week

Nuclear and radioanalytical methods based on radiation-matter interactions.

13th week

New trends in nuclear energy production.

14th week

Operation, tools, and facilities of isotope laboratories.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory.

- for a grade

The course ends in an **examination**. Based on the examination, the exam grade is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of the examination is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade:

it may be offered for students if they write a test on the 14th week and the score of it is at least 60%. The offered grade is calculated as the exam grade (see above).

Person responsible for course: Prof. Dr.Noémi Nagy, university professor, DSc

Lecturer: Prof. Dr.Noémi Nagy, university professor, DSc

Title of course:NMR Operator Training Practice I. **Code**: TTKML0004_EN, TTKBL0004_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - home assignment: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home.assignment:- - preparation for the exam: 32 hours Total: 60 hours:	
Year, semester: 2nd year, 2nd semester or 3rd year, 1st or 2nd semester	
Its prerequisite(s): Spectroscopic methods I.TTKBE0503_EN	
Further courses built on it: Advanced NMR practical course TTKMG0530_EN	

Topics of course: practical laboratory course with aim that students would be able to pick up ^{1}H and ^{13}C NMR spectra on the 360MHz high field NMR spectrometer without external help

Literature

Compulsory:

P.J. Hore, Nuclear Magnetic Resonance, ISBN 963 19 4426 3

Bruker Topspin 3.x manuals (free download)

Recommended:James Keeler, "Understanding NMR Spectroscopy" , 2009, ISBN 0-470-01787-2

Schedule:

1st week Safety rules in NMR labs. with supercon magnets. Dangers for magnets and human beings. Pulse Fourier measurement principle. Hardware of 360 MHz spectrometer: magnet, probeheads, RF preamplifier, electronic control unit, control PC, manual controls.

2nd week Sample preparation: use of deuterated solvents, quality and cleaning of NMR sample tubes, sample amount and dissolving rules. Positioning the samples before measurement, pneumatic transfer of samples into the magnet. Use of deuterium lock in automatic or manual mode. Lock power, field, phase, gain, finding the lock signal. Optimizing lock parameters avoiding saturation of the deuterium signal.

3rd week Homogenisation of the main magnetic field up to 10^{-9}-10^{-10} accuracy, using the lock signal amplitude. Sample spinning, use of z-shim coils. Non-spinning shims (x,y) combinations.

Changing lock phase. Reading and writing shim files (rsh/wsh). Signs of bad shimming. Indicators of good shims in TMS signal.

4th week Recording proton NMR spectra. Measurement principles: pulse program zg and it's visualisation. Acqusition parameters in eda and ased starting windows. Explanation of important parameters: digital sampling and connection between td, sw, aq parameters. Choice of p1 pulse and d1 relaxation delay for quantitative 1H-NMR. Real-time FID shimming in gs mode.

5th week Processing proton NMR spectra. Math rules of Fourier transformation with FFT. TD and SI, zero filling. Window functions for S/N enhancement (em) or resolution (gm) enhancement. Phase correction to pure absorption phase - automatic or manual. Baseline correction for accurate integrals. Integration routine and calibration, correction of integrals.

6th week Recording carbon NMR spectra. Pulse programs zgdc and jmod. Explaining the double impact of proton decoupling: removing splittings caused by proton-carbon spin-spin couplings and heteronuclear NOE that improves carbon sensitivity. Explaining the proton channel power and dB scale, and heating effect danger. Exponential line broadening is a must (em) before FT. Explaining and running the jmod spin-echo sequence.

7th week Recording more carbon NMR spectra with gated (zggd) and inverse gated (zgig) sequences. The former for measuring heteronuclear couplings with better sensitivity, the latter for quantitative ^{13}C-NMR. Adjusting optimal parameters for carbon NMR. Explaining signal multiplicity of deuterated organic solvents. Peak picking (ppm) of spectra.

8th week Excercising ^{1}H NMR signal acquisition and processing one by one.

9th week Excercising ^{13}C NMR signal acquisition and processing one by one.

10th week Excercising ^{1}H NMR signal acquisition and processing one by one.

11th week Excercising ^{13}C NMR signal acquisition and processing one by one.

12th week Excercising ^{1}H NMR and ^{13}C NMR signal acquisition and processing one by one.

13th week Excercising ^{1}H NMR and ^{13}C NMR signal acquisition and processing one by one.

14th week Excercising ^{1}H NMR and ^{13}C NMR signal acquisition and processing one by one.

Requirements:
- *for a signature*
Attendance of laboratory excercises is compulsory.
A student must attend the practice classes and may not miss more than two times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can’t make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student’s behaviour or conduct doesn’t meet the requirements of

active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class. - *for a grade* The course ends in an **examination**. The student must produce an 1H NMR spectrum with quantitative integrals and a 13C NMR spectrum with peak list within one hour time limit, without external help. They may ask for tutor help, however this may result in lowering their mark. - the result of the practical examination may be 1 (failed) 2,3,4,5 (passed)
Person responsible for course: Prof. Dr.Gyula Batta, university professor, DSc
Lecturer: Prof. Dr.Gyula Batta, university professor, DSc

Title of course: Biochemistry III **Code**: TTBBE0304_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment : - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Biochemistry I	
Further courses built on it: -	

Topics of course

The lectures cover the main features of the protein structures including fibrous proteins and the membrane proteins with their role in transport. There is an insight into the photosynthesis: the light reactions and the carbon-assimilation reactions. The nucleotide metabolism is summarized. The biosynthesis of macromolecules such as DNA, RNA and protein will also be described. Post-translational modification: N-glycosylation is also mentioned.

Literature

Compulsory: ***The lecture notes***

Recommended:

Nelson D.L., Cox M.M.: Lehninger Principles of Biochemistry (W. H. Freeman Sixth edition, 2012) ISBN-13: 978-14234146.

Berg J.M., Tymoczky J.L., Gatto G.J. and Styer L.: Biochemistry (W. H. Freeman; Eighth edition, 2015), ISBN-13: 978-1464126109.

Albert B., Bray D. Essential Cell Biology (Fouth edition, Garland Science, 2014) ISBN: 978-0-8153-4454-4.

Schedule:

1st week

The different structural level or proteins. Protein folding and chaperons. Protein misfolding. Structural classification of proteins.

2nd week

Fibrous proteins: α-keratin, fibroin and the structure of collagen fibrils. Structural feature of membrane protein.

3rd week

The role of membrane proteins in transport processes of the cell. Facilitated diffusion by transport proteins. Primary and secondary active transport. The ion selective channels.
4th week
The role, the location and the components of photosynthesis. The light driven electron flow in Photosystem I and II. The function and structure of Cythocrome b_6f complex.
5th week
The synthesis of ATP and NADPH in the light reactions of photosynthesis. The cyclic photophosphorylation. The water splitting complex. Comparing the light reactions of the photosynthesis with the oxidative phosphorylation taking place at the mitochondria.
6th week
Photosynthetic assimilation of carbon dioxide. The function, structure and regulation of Rubisco. The three stages of the Calvin cycle. Photorespiratory reactions and the C_4 pathway.
7th week
Nucleotide Metabolism. The biological function of nucleotides. The pyrimidin *de novo* biosynthesis. The interconversion of nucleoside mono- di- and triphosphates.
8th week
The purin *de novo* biosynthesis. The role of tetrahydrofolate in the nucleotide biosynthesis. The Salvage pathway. The function of ribonucleotide reductase in the generation of deoxyribonucleotides. Degradation of purin and pyrimidine nucleotides.
9th week
The biosynthesis of deoxyribonucleic acid. The helical structure of DNA. The Meselson-Stahl experiment. The stages of replication in prokaryotes. The replication forks. DNA synthesis on the leading and lagging strands.
10th week
The function of the protein factors and enzymes involved in the the processes of replication including primase, DNA polymerases I and III, DNA ligase. Termination of chromosome replication in bacterial cell.
11th week
The biosynthesis of ribonucleic acids in prokaryotes. The function and characteristics of the DNA -dependent RNA polymerase. Transcription initiation, elongation and termination.
12th week
The biosynthesis of ribonucleic acids in eukaryotes. The function of the different RNA polymerases. Assembly of the Initiation Complex. RNA processing: 5' capping and 3' Poly(A) Tail. RNA splicing.
13th week
The biosynthesis of proteins. The genetic code. The structure and the function of tRNA. The components of the ribosome. The stages of the protein biosynthesis. Proofreading on the ribosome. Antibiotics inhibit translation.
14th week
Signal sequences and protein targeting.Protein translocation into the ER. Post-translational modification: N-glycosylation and its function.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade
The course ends in an **examination**.
The grade for the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of examination is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Teréz Barna, assistant professor, PhD

Lecturer: Dr. Teréz Barna, assistant professor, PhD

Title of course:Biocolloids **Code**: TTKBE0405_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 20 hours - preparation for the exam: 42 hours Total: 90 hours	
Year, semester: 2rd/3rd year, 2nd semester	
Its prerequisite(s): TTKBE0402_EN	
Further courses built on it: -	

Topics of course

The goal of this series of lectures is to give knowledge about the relationship between biological sciences and colloid/surface phenomena. A further goal is to deepen colloid chemical knowledge of students about biological phenomena related to colloids. It makes them able to approach biological problems from a colloid chemical perspective and to solve possible problems and tasks in this context.

Literature

Compulsory:
- Lecture slides downloadable from the Department's homepage (http://fizkem.unideb.hu)

Recommended:
- D. Fennell Evans, Hakan Wennerstrom: The Colloidal Domain: Where Physics, Chemistry and Biology Meet, 2nd Ed. ,Wiley, 1999
- Pashley, R. M.: Applied Colloid & Surface Chemistry. Wiley&Sons, ISBN 0-a470-a86883-aX, 2004
- Cosgrove T.: Colloid science. Blackwell Publishing ISBN:978-a14051-a2673-a1, 2005

Schedule:

1st week

Importance of colloidal state in biology. Hypotheses about the origin of life in the past and nowadays. Occurrence of organic matter in space. Hyperresistant organisms and survival under the conditions found in space. Shadow biosphere and "artificial life".

2nd week

Formation of interfaces. Films and membranes. Langmuir-Blodgett films and liquid crystals. Membrane models, structure of the cell membrane.

3rd week
Diffusion and transport phenomena through membranes, osmosis and dialysis. Transport phenomena in living organisms. Function of the kidneys, artificial kidney.

4th week
Adsorption phenomena in biological systems, processes in biotechnology and separation sciences.

5th week
Surface tension and its importance in nature. Motion of striders on the surface of water. Reproduction using surface tension: ballistospores of fungi. Wetting, contact angle, influencing the surface tension. Capillarity, water transport in plants and the transpiration-adhesion-tension-cohesion hypothesis. The importance of capillarity under arid climates. Adhesion to smooth surfaces. Atherosclerosis and interfacial influences leading to atherosclerosis.

6th week
Association colloids, micelles and inverse micelles. Critical micelle concentration and its importance. Detergents and their uses. Biological detergents in the digestion: bile acids. Solubilization with polar molecules. Lung surfactants and their role in breathing.

7th week
Modern instrumental methods in the study of biomacromolecules (ultracentrifugation, electrophoresis, size exclusion chromatography, scanning confocal microscopy, electron microscopy, scanning probe microscopy, surface plasmon resonance, X-ray diffraction, NMR).

8th week
Macromolecules, types and importance of macromolecules. Characterization and importance of dispersity, shape, and conformation.

9th week
Important and interesting biomacromolecules, their properties, importance and uses (*polysaccharides*: cellulose, starch, chitin, etc.; *proteins*: collagen, silk, green fluorescent protein, etc.; *others*: lignin, chlorophylls, haemoglobin, etc.).

10th week
Dispersion colloids in nature. Bioaerosols and smokes. Importance of foams, emulsions, sols and their biological relevance. Making and breaking of dispersions in different biological, medical, pharmaceutical, etc. processes.

11th week
Coherent systems and lyogels. The eye as a natural lyogel system. Biocomposites: structure and formation of bones. A complex disperse system: the soil.

12th week

Electrokinetic effects, precipitation from liquids. Epitaxis. Kidney and bile stones, processes of their formation.

13th week
Flow properties. Biorheology. Rheology of blood and its importance in blood coagulation.

14th week
Nanotechnology and its development. Nanostructures from non-living matter. Natural nanostructures: diatoms and the fine structure of butterfly scales. Nanodevices. Natural nanomotors: kinesins, dyneins, the actomyosin complex. DNS machines, active molecular tweezers.

Requirements:
- *for a signature*
Attendance at **lectures** is recommended, but not compulsory.
- *for a grade*
The course ends in an **examination**. The minimum requirement for the examination is 50%. The grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, students can make a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Levente Novák, assistant professor, PhD

Lecturer: Dr. Levente Novák, assistant professor, PhD

Title of course: Colloid Chemistry **Code**: TTKBE0415_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 20 hours - preparation for the exam: 42 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0402_EN	
Further courses built on it: -	

Topics of course

The goal of this series of lectures is to give knowledge to the students about the relation between size and physico-chemical properties. Students are expected to get acquainted with the behaviour of nanosized particles, the role of the interfaces and their possible applications.

Literature

Compulsory:

- Lecture slides downloadable from the Department's homepage (http://fizkem.unideb.hu)

- Barnes, GT, Gentle, IR: Interfacial Science. Oxford UP. ISBN 0-a19-a927882-a2, 2005

- Pashley, R. M.: Applied Colloid & Surface Chemistry. Wiley&Sons, ISBN 0-a470-a86883-aX, 2004

- Cosgrove T.: Colloid science. Blackwell Publishing ISBN:978-a14051-a2673-a1, 2005

Schedule:

1st week

Introduction. The notion of colloids and the classification of colloid systems. Synthesis of colloids. Relation between colloids and nanotechnology. Average and types of average.

2nd week

Molecular interactions. Quantitative description of electrostatic and van der Waals interactions, their role in the synthesis of colloids. Lennard-Jones potential. Hydrophilic and hydrophobic interactions.

3rd week

Notion and characterization of interfaces. Fluid interfaces. Interfacial phenomena, the concept of surface tension. The Eötvös rule. Laplace pressure, importance of curved surfaces.

4th week
Nonfluid interfaces. Contact angle, wetting and spreading. Adhesion and cohesion. Adsorption at fluid interfaces, the Gibbs isotherm. Langmuir and Langmuir-Blodgett layers.

5th week
Adsorption at solid-liquid interfaces. Adsorption isotherms. Formation of charged interfaces and their significance. Chromatographies.

6th week
Formation of the electrostatic double layer, its structure and description. Comparison of the Helmholtz, Gouy-Chapman and Stern models. Potentials. Zeta potential.

7th week
Electrokinetic phenomena. Electrophoretic mobility. The phenomenon of electroosmosis and its practical use in capillary electrophoresis.

8th week
Stabilization and destabilization of lyophobic colloids. The Hamaker model. The DLVO theory. Sterical stabilization. Salting out. Destabilization of lyophilic colloids. The technology of butter- and cheese-making.

9th week
Gas-liquid disperse systems. Stability, preparation and importance of aerosols. Stability, preparation and practical use of foams.

10th week
Liquid-liquid disperse systems. Preparation and breaking of emulsions. Emulsifiers, the HLB value.

11th week
Solid-liquid disperse systems. Their preparation, stabilization, kinetic description of their formation.

12th week
Association colloids. Surface activity. Amphiphilic molecules and micelles. Micelle formation, the critical micelle concentration. Surfactants, detergents.

13th week
Types of macromolecular colloids. Macromolecules and plastics. Drug transport and targeted delivery.

14th week
Basics of rheology. Viscosity and its measurement. Viscosity- and flow curves. Basic rheological types. Applications.

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
- for a grade

The course ends in an **examination**. The minimum requirement for the examination is 50%. The grade for the examination is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-89	good (4)
90-100	excellent (5)

If the score of any test is below 50%, students can make a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Levente Novák, assistant professor, PhD

Lecturer: Dr. Levente Novák, assistant professor, PhD

Title of course: Plastics and Processing II. **Code**: TTKBE1213_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours Total: 60 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0611_EN	
Further courses built on it: -	

Topics of course

The current situation and future prospects of world and domestic plastics production and use. Production of polyethylene I. (high pressure). Production of polyethylene II. (high pressure tube reactor and medium pressure processes) and its applications. Production of polypropylene, newer technology development. Domestic technologies for production of polypropylene (bulk polymerization and gas phase processes), use of polypropylene. Production of polystyrene (high impact strength and expandable polystyrene) and its use. Possibilities of manufacturing PVC. Home production and use of PVC. Possibilities for producing polyamides. Production and use of polyamide-6. Production and use of polyacrylonitrile. Manufacture and use of polyester fabrics. Additives used in the plastics industry.

Literature

Recommended:

1. Website of MOL Petrochemicals

2. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA (2002)

3. George Odian: Principles of Polymerization, McGraw-Hill, New York (1983)

Schedule:

1st week

The current situation and future prospects of world and domestic plastics production and use.

2nd week

Production of polyethylene I. (high pressure).

3rd week

Production of polyethylene II. (high pressure tube reactor and medium pressure processes) and its applications.

4th week
Production of polypropylene, newer technology development.
5th week
Domestic technologies for production of polypropylene (bulk polymerization and gas phase processes), use of polypropylene.
6th week
Production of polystyrene (high impact strength and expandable polystyrene) and its use.
7th week
Possibilities of manufacturing PVC
8th week
Home production and use of PVC.
9th week
Possibilities for producing polyamides. Production and use of polyamide-6.
10th week
R Production and use of polyacrylonitrile.
11th week
Manufacture and use of polyester fabrics.
12th week
Additives used in the plastics industry.
13th week
Consultation and PPT presentations.
14th week
Test and PPT presentations.

Requirements:
Attendance at seminars is compulsory.
The course ends with test for a partial grade. (This test is compulsory!) The minimum requirement for the test is 50%. The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-80	satisfactory (3)
81-90	good (4)
91-100	excellent (5)

All the students will deliver a ppt presentation on a subject. They will get a second partial grade. The term grade will be calculated by the following way: 60% of the test result, 40% of the ppt presentation

Person responsible for course: Dr. Sándor Kéki University professor, DSc

Lecturer: Dr. Sándor Kéki University professor, DSc

Title of course: Seminar in Organic Chemistry I. **Code**: TTKBG0311_EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: 1 hour/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
Year, semester: 1^{st} year, 2^{nd} semester	
Its prerequisite(s): General Chemistry I. (lecture) TTKBE0101_EN	
Further courses built on it: -	

Topics of course

- Review the basic of organic chemistry basics
- Types and theories of chemical bonds
- Review the acid-base theories
- Basic concepts of isomerism and stereochemistry.
- Classification of organic chemical reactions.
- Functional groups and the basics of organic nomenclature.
- The structure, nomenclature, synthesis and reactions of alkanes, alkenes, alkenes, alkynes, mono- and polycyclic, homo- and heteroaromatic hydrocarbons.

Literature

Compulsory:

1. ***Course material, concept and task collection for lectures, seminars in the e-learning system.***

Recommended:

2. ***J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725***
3. ***J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449***
4. ***J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293***
5. ***F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014***
6. ***L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148***

7. ***T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595***
8. ***H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244***

Schedule:

1st week
Comparison and exercise of representation of organic compounds. Determination of the order (primary, secondary, tertiary, quaternary) of carbon atoms in compounds.

2nd week
The use of resonance structures and hybridization in the interpretation of the structure of organic compounds. Interpretation of electron shift or delocalization phenomena (inductive and mesomeric effect, conjugation and hyperconjugation).

3rd week
Exercise the recognition of organic compounds and functional groups.

4th week
Use of the substitutive and functional class nomenclature in naming hydrocarbons. Practice the names of alkyl groups.

5th week
Exercise of the most important types of organic chemical reactions, recognition of reactive particles (electrophile, nucleophile, radical).

6th week
Exercise the concept of constitution, conformation and configuration. Recognition and differentiation of enantiomers and diastereomers.

7th week
Practice the representation and projection of the organic molecules. The absolute configuration of chiral compounds, Fischer and Cahn-Ingold-Prelog convention.

8th week
Interpretation of radical transformations of alkanes. Statistical and regioselective halogenation of alkanes. Synthesis of alkanes.

9th week
Methods for the synthesis of alkenes, cycloalkenes. Addition reactions of alkenes, regioselectivity and its interpretation in addition reactions.

10th week
Addition reactions of conjugated dienes, partial and complete addition. 1,2- and 1,4- addition and its interpretation based on kinetic and thermodynamic control. Diels-Alder cycloaddition.

11th week
Synthesis of alkynes. Chemical transformations of alkynes: C-H acidity, addition reactions and their significance. The role of acetylene in the chemical industry, coal-based chemical industry.

12th week
Exercise the criteria of aromaticity. Interpretation of aromatic electrophilic substitution reactions.

13th week
The S_{EAr} reactions of substituted benzene derivatives –the reactivity and regioselectivity. Classification of substituents and interpretation of their effect on reactivity and regioselectivity.

14th week

Reactions of aromatic hydrocarbons containing alkyl residues, interpretation of the stability of benzyl-type reactive intermediates. Most important representatives of polycyclic aromatic hydrocarbons.

Requirements:
The course is recommended in parallel with the lecture Organic Chemistry I. (TTKBE0301_EN).
Evaluation:
- *for a signature*
Attendance at seminars is **compulsory**. A student may not miss the seminar more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed, and the student must repeat the course.
The performance of the students in the seminar is verified 4 times in the form of written tests.

- *for a grade*
The term mark is based on the average of the grades of written tests.
The minimum requirement for the written tests respectively is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-80	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course: Dr.László Juhász, associate professor, PhD

Lecturer: Dr.László Juhász, associate professor, PhD

Title of course: Seminar in Organic Chemistry II. **Code**: TTKBG0312_EN	**ECTS Credit points: 1**
Type of teaching, contact hours - lecture: - - practice: 1 hour/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: 16 hours - preparation for the exam: - Total: 30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Inorganic Chemistry I. (lecture) TTKBE0201_EN, Organic Chemistry I. (lect .and sem.) TTKBE0301_EN, Physical Chemistry I. (lecture) TTKBE0401_EN	
Further courses built on it: -	

Topics of course

Overview and exercising of the structure, physical, chemical properties of hydrocarbons possessing heteroatoms as halogenated hydrocarbons, organometallic derivatives, alcohols, phenols, ethers and their thio analogues; amines, nitro derivatives, diazonium salts, aldehyde, ketones, carboxylic acids and their derivatives, derivatives of carbonic acid

Literature

Compulsory:

1. ***Course material, concept and task collection for lectures, seminars in the e-learning system.***

Recommended:

2. ***J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725***
3. ***J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449***
4. ***J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293***
5. ***F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014***
6. ***L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148***
7. ***T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595***
8. ***H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244***

Schedule:

1st week

Practice the classification and synthesis of halogenated hydrocarbons.

2nd week

Practice the elimination and substitution reactions of halogenated hydrocarbons.

3rd week

Practice the preparation of Grignard compounds and their application.

4th week

Preparation of alcohols, ethers, phenols and their thioanalogues. The acid-base properties of alcohols, phenols and their thioanalogues

5th week

Practice the chemical properties of alcohols and phenols, ethers and their thioanalogues.

6th week

Practice the classification of amines and characterization of their bonding systems. Practice the synthetic methodologies of aliphatic and aromatic amines, industrial methods.

7th week

Practice the basicity and chemical transformations of the amines (alkylation, acylation, sulfonamide formation, reaction with nitric acid). Reactions of aromatic rings of anilines.

8th week

Practice the preparation of nitro compounds, diazonium salts. Reactions and practical significance of aromatic diazonium salts.

9th week

Practice the synthetic possibilities of aldehydes and ketones and an overview of their acid-base properties.

10th week

Practice the transformations of aldehydes and ketones. Reactions of the carbonyl group (nucleophilic addition reactions with O-, S-, N- and C-nucleophiles) and reactions on the α-carbon atoms.

11th week

Practice the classification and preparation of carboxylic acids and their derivatives.

12th week

Practice the acid-base properties of carboxylic acids and its derivatives. The acyl nucleophilic substitution and the reductive transformations of carboxylic acid derivatives, transformation of their carbon skeleton.

13th week

Chemical properties of β-dicarboxylic acids, malonester synthesis.

14th week

Chemical properties of β-oxocarboxylic acid derivatives, acetoacetic ester and cyanoacetic ester syntheses.

Requirements:

The course is recommended in parallel with the lecture Organic Chemistry II. (TTKBE0302_EN).

Evaluation:

- *for a signature*

Attendance at seminars is **compulsory**. A student may not miss the seminar more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed, and the student must repeat the course.
The performance of the students in the seminar is verified 4 times in the form of written tests.

- *for a grade*
The term mark is based on the average of the grades of written tests.
The minimum requirement for the written tests respectively is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score	Grade
0-49	fail (1)
50-65	pass (2)
66-80	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

Person responsible for course: Dr.László Juhász, associate professor, PhD

Lecturer: Dr.László Juhász, associate professor, PhD

Title of course: Advanced seminar in organic chemistry **Code**: TTKBG0313_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 32 hours - preparation for the exam: - Total: 60 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): Organic Chemistry II. (lect .and sem.) TTKBE0302_EN	
Further courses built on it: -	

Topics of course

The aim of the course is to enable students to master the complex organic chemistry problem solving skills, and to be able to apply the knowledge acquired in basic courses in solving complex synthetic tasks and designing syntheses.

Literature

Compulsory:

1. ***Course material, concept and task collection for lectures, seminars in the e-learning system.***

Recommended:

1. ***J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725***
2. ***J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449***
3. ***J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293***
4. ***F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014***
5. ***L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148***
6. ***T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595***
7. ***H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244***

Schedule:

1st week
The basics of retrosynthetic analysis, the concept of synthones and retrones. Types of disconnections. Interconversion of functional groups. The use of the method in the exploration of simple synthetic possibilities for compounds.
2nd week
Retrosynthetic analysis of aromatic compounds. Use of the directing and activating/deactivating effects to form the appropriate substituent pattern.
3rd week
Methods for forming C-C bond I. Base catalyzed conversions I. (aldol condensation and its variants).
4th week
Methods for forming C-C bond II. Base catalyzed conversions II. (malonic ester and acetoacetic ester syntheses).
5th week
Methods for forming C-C bond III. Acid catalyzed transformations.
6th week
Methods for forming C-C bond IV. Possibilities for the formation and use of Grignard compounds.
7th week
Methods for forming C-C bond V. Transition metal (Pd, Pt, Ru, Cu, etc.) catalyzed conversions.
8th week
Methods for forming carbon-oxygen and carbon-sulfur bonds.
9th week
Possibilities for forming carbon-nitrogen bonds.
10th week
Reactions suitable for the synthesis of oxo compounds.
11th week
Reactions for the preparation of carboxylic acids and their derivatives.
12th week
Preparation and reactions of amino acids. Peptide synthesis.
13th week
The basic chemical properties of monosaccharides. Protecting Groups. Essential questions of synthesis of di- and oligosaccharides.
14th week
The synthesis of basic heterocycles and their chemical properties.

Requirements:
The course is recommended in parallel with the lecture Organic Chemistry III. (TTKBE0303_EN).
- for a signature
Attendance at **lectures** is recommended, but not compulsory.
Attendance at seminars is compulsory. A student may not miss the seminar more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed, and the student must repeat the course.
- for a grade
The course ends in an **examination**.
The exam grade is the result of the written exam.
The minimum requirement for the examination respectively is 50%. The grade for the written exam is given according to the following table:

Score	Grade

0-49	fail (1)
50-62	pass (2)
63-75	satisfactory (3)
76-87	good (4)
88-100	excellent (5)

If the score of any test below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course:. Dr.László Juhász, associate professor, PhD

Lecturer: Dr.László Juhász, associate professor, PhD