University of Debrecen
Faculty of Science and Technology
Institute of Chemistry

CHEMICAL ENGINEERING BSC PROGRAM

2019

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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 our region's demand for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Recently, we successfully re-introduced dual 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 companies in our extended region. 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; Wargha István 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: 26938

Full time teachers of the University of Debrecen: 1542

207 full university professors and 1159 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 (10 Bachelor programs and 12 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 570 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

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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:
http://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2019_20/1920_Science.pdf

THE CHEMICAL ENGINEERING BACHELOR PROGRAM

Information about the Program

Name of BSc Program:	Chemical Engineering BSc Program
Specialization available:	-
Field, branch:	Science
Qualification:	Chemical Engineer
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Chemistry
Program coordinator:	Prof. Dr. Sándor Kéki, University Professor
Duration:	7 semesters
ECTS Credits:	210

Objectives of the BSc program:

The aim of the Chemical Engineering BSc program is to train professional chemical engineers, who have deep insight into spatial processes. Relying on strong chemistry-, engineer and process control base graduates of the program they are able to understand the natural, environmental, technical and social phenomena and to develop applied science-based solutions

Professional competences to be acquired

A Chemical Engineer:
a) Knowledge:
- He/she has a mathematical and scientific background to understand processes in chemical and chemistry related industries.
- He/she knows the properties of the most important chemicals, their productions and applications.
- He/she knows the basic principles, the planning and controlling options in the technology of chemical processes and industrial tasks.
- He/she knows the principles of instruments in chemical industries and technologies, and their operative parts, and their connections.
- He/she knows the chemical methods for measurements or analysis, their principles and instrumental background, and their applicabilities.
- He/she knows the chemistry and chemical technology related economic, management environmental safety, quality assurance (QC/QA), informatics and intellectual property rules and laws.
- He/she knows has a knowledge on the data mining, relevant literature and the ethical concerns of chemical engineering.

b) Ability:

- He/she able to apply the learned methods, models and plannings of chemical technology and chemical processes through calculations.
- He/she understands and is able to describe the elements of industrial and technological units, their operations including the connectivity options.
- He/she is able to apply those directives that are necessary to operate instruments and control processes in a safe, cost effective way as well as avoid any problems causing health issues.
- He/she is able to follow and control chemical processes and other technological steps concerning quality management and quality control.
- He/she is able to recognize the possible error symptoms, run diagnostic routines and offer solution based on the results.
- He/she is able to use documentation (either online or printed) related to the current field, including the scientific literature both in his/her native language and English.
- He/she is able to treat new or unknown systems based on the previous studies and experiences, learn and install new technologies and recognize mechanisms related to human health.
- He/she is able to run measurements both on laboratory and scaled up systems, and evaluate the derived data at all steps in the development.
- He/she is capable on conducting basic chemical engineering tasks.
- He/she is able to collect, organize, and understand information about health prevention, keeping track of new results, and apply them to make cost and environmentally effective, healthy working areas.

c) Attitude:

- He/she makes effort to keep his/her chemical engineering knowledge updated related to his/her professional goals.
- He/she is open to accept environmentally efficient technologies, and for the application of new, innovative and advanced methods in economy.
- During everyday work and installation of new technologies He/she is always concerned about sustainable development.
- He/she makes an effort to improve and apply the practical methods with new results and experiences.
- During his/her work He/she is committed to apply the quality concerns including the new assurances.
- He/she can collaborate with other people and discuss their opinions in problem-solving processes before making new decisions.
- In each technological or laboratory step He/she is always concerned about the current rules/laws of health prevention, safety and environmental questions.

d) Autonomy and responsibility:

- Following directions He/she can work without supervision considering all quality and safety rules.
- He/she tends to establish new solutions and technologies.
- He/she can manage work and worker resources, follow and control the instruments and measuring units.
- He/she can evaluate the work of other persons and make decisions based on the outcome.
- He/she works towards personal improvements and helps others to achieve their professional goals.
- He/she shares experiences with others to help them.
- He/she makes decisions according to his/her positions, makes suggestions to qualify his/her colleagues involving their promotions.

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 120 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 Environmental Engineering BSc Program”.

Model Curriculum of Chemical Engineering BSc Program

	semesters								ECTS credit points	evaluation
	1.	2.	3.	4.	5.	6.	7			
	contact hours, types of teaching (l – lecture, p – practice), credit points									
Science subject group										
Mathematics modul										
1.Mathematics I. *Zoltán Muzsnay*	56 l / 5cr 42 p / 2cr								7	exam
2.Mathematics II. *Zoltán Muzsnay*		28 l /3cr 42 p /2cr							5	exam
Physics modul										
1. Physics for Engineers I. *Balázs Ujvári*	42 l /3cr								3	exam
2. Physics for Engineers II *Balázs Ujvári*		42 l /3cr							3	exam
Chemistry modul										
1.General Chemistry I (lect and sem) *Gábor Bellér,Norbert Lihi*	42 l /4cr. 42 p /3cr								7	exam
2. General Chemistry (lab) II. *Norbert Lihi*		42 p /3cr.							3	mid-semester grade
3. Inorganic Chemistry I. *István Lázár*		28 l /3cr.							*3*	exam
4. Inorganic Chemistry II. *Péter Buglyó*	.		28 l /3cr.						3	exam
5. Organic Chemistry I. (lect and sem) *László Juhász*		28 l /3cr. 14 p /1cr.							4	exam
6. Organic Chemistry II. *László Juhász, Marietta Vágvölgyiné Tóth*			42 l/4cr. 42 p/2cr.						6	exam
7. Organic Chemistry III. *László Juhász*				28 l/3cr./					3	exam
8. Biochemistry I. *János Kerékgyártó*					28 l/3cr				3	exam

Economic and Human Sciences subject group										
Micro- and Macroeconomic modul										
1. Introduction to Economics *Judit Kapás*	28 l/3cr.		.						3	exam
Management and Business modul										
1. Introduction to Business *András Nábrádi*	28 l/3cr								3	exam
Business Law modul										
1. Basics of Civil Law I. *Tamás Fézer*		28 l /2cr.							2	exam
2. Basics of Civil Law II. *Tamás Fézer*		.	28 l /2cr						2	exam
3. History and Structure of Europian Union *Károly Teperics*	14 l /1cr		.						1	exam
Economic and Human Sciences module										
1. Engineering Ethics *Zsolt Tiba*	28 l /3cr.								3	mid-semester grade
2. Management of Value Creating Processes *Miklós Pakurár*		28 l /3cr.							3	exam
Basics of Professional Knowledge subject group										
Physical, Analytical Chemistry and Material Science modul										
Analytical Field										
1. Analytical Chemistry I. *Péter Buglyó*			28 l /3cr		.				3	exam
2. Inorganic and Qualitative Analytical Chemistry *József Kalmár*			56 p /4cr.						4	mid-semester exam
3. Application of Instrumental Analysis (lect.) *István Lázár*					14 l /1cr.				1	exam
4 Application of Instrumental Analysis (lab.) *Attila Gáspár*						42 p /3cr.			1	mid-semester exam
Physical Chemistry and Material Science Field										

1. Physical Chemistry I. (lect. and sem.) *Attila Bényei*		28 l /3cr. 28 p/2cr.							5	exam, mid-semester grade
2. Physical Chemistry II. (lect. and sem.) *Attila Bényei*			28 l /3cr. 28 p/2cr	.					5	exam, mid-semester grade
3. Physical Chemistry II. (lab.) *Ferenc Krisztián Kálmán*				28 p /2cr.					2	mid-semester grade
4 Physical Chemistry III. *Noémi Nagy*				28 l /3cr	.				3	exam
5.Macromolecular Chemsitry *Sándor Kéki*				28 l /3cr					3	exam
6.Materials of Construction *Bence Vadkerti*					28 l /3cr				3	exam
7.Plastics and Processing I *Sándor Kéki*						28 l /2cr 28 p/2cr.			4	exam, mid-semester grade
Measurement and Processing modul										
Informatics Field										
1. Informatics for Engineers *Ákos Kuki*			28 l /2cr						2	mid-semester grade
Processing Field										
1. Process Control I. *István Árpád*				42 l /4cr.					4	mid-semester grade
2. Process Control II. *István Árpád*			.		42 p /3cr.				3	mid-semester grade
Mechanics and Unit Operation modul										
Mechanics Field										
1. Mechanics for Chemical Engineers I. *Zsolt Tiba*			42 l /3cr.						3	mid-semester grade
2. Mechanics for Chemical Engineers II. *Ákos Kuki*				42 l /3cr.					3	mid-semester grade

3. Mechanics for Chemical Engineers III. *Gábor Balogh*					42 l /3cr.				3	mid-semester grade
Unit Operation Field										
1. Unit Operation I. *Miklós Nagy*			70 l /6cr.		.				6	mid-semester grade
2. Unit Operation II *Miklós Nagy*				70 l /6cr.					6	mid-semester grade
3. Unit Operation III. *Miklós Nagy*					70 l /6cr.				6	mid-semester grade
Technology Module										
Planing Field										
1. Computer Modeling of Chemical Technology Systems I *Ákos Kuki*						28 p/ 2cr.			2	mid-semester grade
2. Computer Modeling of Chemical Technology Systems II Ákos Kuki							28 p/2cr.		2	mid-semester grade
Chemical Technology Field										
1. Chemical Technology I. *Lajos Nagy*				28 l/3cr. 56 p/4cr.	.				7	exam, mid-semester grade
2. Chemical Technology II. *Lajos Nagy*.					28 l/3cr. 56 p/4cr.	r			7	exam, mid-semester grade
3. Environmental Technology *Katalin Illyésné Czifrák*						28 l/3cr 28 l/2cr.			5	exam
4. Pilot Plant Work *Miklós Nagy*						70 p/5c			5	mid-semester grade
Safety Field										
1.Safety *Sándor Kéki*							28 l/3cr.		3	exam
Special Courses										
1.Basics of Petrolchemistry *Lajos Nagy*					28 l/3cr.				3	exam

2.Waste Management *Sándor Kéki*						28 l/3cr			3	exam
3.Spectroscopic Methods I. *Gyula Batta*						28 l/3cr.			3	exam
4.Quality Management *Ágnes Kotsis*							28 l/3cr.		3	exam
5. Design of Experiments *Ákos Kuki*						28 l/3cr.			3	mid-semester grade
BSc Thesis I.					.	**2cr.**			*2*	mid-semester grade
BSc Thesis II.							**13cr.**		*13*	mid-semester grade
optional chemistry courses (10cr.)										
1.Crystallography *Gábor Dobosi*	28 l/3cr. fall semester								3	exam
2.Basics of Environmental Science *István Gyulai*	14 l/1cr. fall semester								1	exam
3.History of Chemsitry *Ágnes Dávid*		28 l/3cr. spring semester							3	exam
4.Macroeconomics *Pál Czeglédi*			28 l/3cr fall semester						3	exam
5.Special and Dangerous Materials *István Lázár*			28 l/3cr fall semester						3	exam
6.Computational Quantum Chemistry *Mihály Purgel*				28 p/3cr. spring semester					3	mid-semester grade
7.Applied Radiochemistry *Noémi Nagy*					28 l/3cr. spring semester				3	exam
8.Plastics and Processing II. *Sándor Kéki*						28 p/2cr.			2	mid-semester grade
9.Colloid Chemistry *Levente Novák*						28 l/3cr.			3	exam
10.Biochemistry III. *Teréz Barna*						28 l/3cr.			3	exam
11.Biocolloids *Levente Novák*				28 l/3cr. spring semester					3	exam

12.NMR Operator Training I. *Gulya Batta*							28 p/2cr.		2	mid-semester grade
13. Plastics and Processing III. *Sándor Kéki*							42 p/3cr.		3	mid-semester grade
14. Chemical Technology III. *Lajos Nagy*							28 l/3cr		3	exam
15.Organic Chemistry Seminar I. *László Juhász*		14 p/1cr.							1	mid-semester grade
16. Organic Chemistry Seminar II. *László Juhász*			14 p/1cr						1	mid-semester grade
17.Advanced Organic Chemistry seminar *László Juhász*				28 p/2cr.					2	mid-semester grade
internship										
internship									*6 weeks*	signature

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.

Internship

Students majoring in the Chemical Engineering BSc Program have to carry out a 6 weeks internship involved in the model curriculum. The internship course must be signed up for previously via the NEPTUN study registration system in the spring semester (4th semester). Its execution is the criteria requirement of getting the pre-degree certificate (absolutorium).

Objective of the internship, competences
Students get acquainted with professional work in conformity with their major at the company or institution and join in the daily working process. They have to resolve tasks independently assigned by their supervisor and gain experiences may be utilized later in the labour market. During the internship common and professional competences may be acquired. Common competences: precise working on schedule either individually or in team, talk shop applying correct technical terms. Professional competences: applying the professional skill gained during the training and acquiring new knowledge.

Places suitable for internship
All the organizations, institutions and companies in Hungary or abroad, provide students with the opportunity to acquire proficiency in accordance with their specialization in the field of operation, repairing technology, installation, management and development of different machines and vehicles, may be a suitable place.

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 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, internship (mandatory) – with the exception of preparing thesis – and gained the necessary credit points (210). 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 6th and 7th semester. Writing this is the precondition of the entrance to the final exam.
The thesis is the solution of a chemical engineering task which the student should solve relying on previous studies and secondary literature under the guidance of a tutor in one semester. The thesis must prove that the author can apply the acquired theoretical knowledge.

The student can choose any topic for a thesis suggested by the faculty or in occasional cases individual topics acknowledged by the head of the department. Only those tasks can be given as thesis that can be accomplished within the allowed time limit relying on the skills acquired during the years of study. The topics of the thesis should be given in completely uniform manner and based on the system of requirements set up by the head of the institute and the head of the department responsible for the specialization. Students must be informed of the thesis topics in the first academic week of the first semester the latest. The thesises are written with the close collaboration of the candidate and the supervisor.
The formal requirements of the thesis are detailed in the "manual for writing thesises" which is handed out to every candidate when they decide upon their topic. The thesises must be handed into the department responsible minimum ten days before the beginning of the final exam period. The thesis paper is evaluated by the supervisor who gives a grade as well as a short written comment on it. The head of the department makes a proposal for the final evaluation of the thesis based on the comments. The thesis receives a grade from the final exam committee. In case the thesis is not accepted he/she cannot carry on with the exam.

Final Exam

Students of the major receive an absolutorium after they have been satisfied every aspect of their educational and examinational requirements. The student can only register on the final exam if the thesis is already submitted, it is accepted and evaluated by the supervisor. The final exam is essential for anyone who wants to get a Chemical Engineer BSc diploma. The final exam must be taken in front of the Final Exam Board.

Subjects of the Final Exam:

- Physical Chemistry
- Chemical Technology
- Unit Operation

Procedure of the Final Exam

Conditions on taking part of the final exam:

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

Parts of the Final Exam

- Drawing a question card of each topic, preparation (30 minutes)
- Brief presentation of the results of the thesis (6 minutes)
- Answering the questions about the thesis (6 minutes)
- Answering the questions about the 3 subjects (3x6 minutes)

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 Chemical Engineering 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 Chemical Engineering 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

Course Descriptions of Chemical Engineering 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 Mathematical Analysis,
K. A. Stroud: Engineering Mathematics,
E. Mendelson: Schaum's 3000 Solved Problems 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
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
Euclidean spaces. Inner product, standard, angle, distance. Schwarz and Minkowski inequality. Orthogonality. Orthogona projection. Symmetrical and orthogonal transformations.

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: 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, 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 Mathematical Analysis,
K. A. Stroud: Engineering Mathematics,
E. Mendelson: Schaum's 3000 Solved Problems 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 Mathematical Statistics
E. Mendelson: Schaum's 3000 Solved Problems 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
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 Mathematical Statistics
E. Mendelson: Schaum's 3000 Solved Problems 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

Test.

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, Hyper-geometric, 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, MFVGE31V03_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. Jewett Jr, R.A. Serway: Physics for Scientists 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. Jewett Jr, R.A. Serway: Physics for Scientists 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: 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. Gábor Bellér, assistant professor, PhD

Lecturer: Dr. Gábor Bellér, assistant professor, PhD

Title of course: General Chemistry I. (seminar) **Code**: TTKBG0101_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: - - practice: 4 hours/week - laboratory: -	
Evaluation: middle-term and final exams	
Workload (estimated), divided into contact hours: - lecture: - - practice: 44 hours - laboratory: - - home assignment: 26 hours - preparation for the exam: 20 hours Total: 90 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTKBL0101_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 home page (inorg.unideb.hu) *Recommended:* - Darrell Ebbing, Steven D. Gammon: General Chemistry 10th edition - Darrell Ebbing, Steven D. Gammon: General Chemistry – Standalone book
Schedule: The seminar will be held in 11 weeks. *1st 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. *2nd 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. *3rd 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. Norbert Lihi, assistant research fellow, PhD

Lecturer: Dr. Norbert Lihi, assistant research fellow, PhD

Title of course: General Chemistry II. (laboratory practice) **Code**: TTKBL0101_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 44 hours - home assignment: 32 hours - preparation for the exam: 14 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTKBE0101_EN, TTKBG0101_EN	
Further courses built on it: TTKBL0511_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. Norbert Lihi, assistant research fellow, PhD
Lecturer: Dr. Norbert Lihi, assistant research fellow, 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: 1^{st} year, 2^{nd} 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: 1) N. N. Greenwood, A. Earnshaw: Chemistry of the Elements, 2nd Edition, 1997 (or later ed.) *Recommended:* 2) 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) 3) 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* 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. *2^{nd} 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 roleaz oxigéncsoport elemeinek előfordulása, általános jellemzése, 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-conatining sulfur 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.

14^{th} 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: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBL0201_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBL0502_EN, TTKBE0204_EN	

Topics of course
Literature
Compulsory: 1) N. N. Greenwood, A. Earnshaw: Chemistry of the Elements, 2nd Edition, 1997 (or later ed.) *Recommended:* 2) 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) 3) 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* 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. *2nd 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. *3rd 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: Organic Chemistry 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: 28 hours - preparation for the exam: 50 hours Total: 120 hours	
Year, semester: 1st year, 2nd 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	
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. John McMurry: Organic Chemistry (8th Edition), ISBN-10: 0840054440 ISBN-13: 9780840054449, 2012, Brooks/Cole 3. Jonathan Clayden, Nick Greeves, and Stuart Warren: Organic Chemistry (Second Edition), ISBN: 978-0-19-927029-3; 2012, Oxford University Press 4. Francis A. Carey: Organic Chemistry (4th Edition), ISBN 0-07-290501-8; 2000, The McGraw-Hill Companies, Inc. 5. Leroy G. Wade: Organic Chemistry (8th Edition), ISBN-10: 0321768140; 2012, Pearson 6. T. W. Graham Solomons, Craig Fryhle, Organic Chemistry (10th Edition), ISBN-10: 0470556595; 2009, Wiley & Sons 7. 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 a 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 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. Éva Juhászné Tóth, assistant professor, PhD;
Dr. Krisztina Kónya, assistant professor, PhD

Title of course: Organic chemistry II. **Code**: TTKBE0302_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: 18 hours - preparation for the exam: 60 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. 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

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.

Requirements:
- 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. Éva Juhászné Tóth, assistant professor, PhD
Dr. Krisztina Kónya, assistant professor, PhD

Title of course: Organic chemistry II. **Code**: TTKBL0311_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 3 hours/week	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 42 hours - home assignment: 18 hours - preparation for the exam: - Total: 60 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBL0101_EN, TTKBE0301_EN, TTKBE0401_EN, TTKBE0201_EN	
Further courses built on it: -	

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:

1. L. Juhász: Organic Laboratory Techniques and Manuals for Pharmacist Students, Debrecen, 2009
2. J. R. Mohrig, D. G. Alberg, G. E. Hofmeister, P. F. Schatz, C. Noring Hammond: Laboratory Techniques in Organic Chemistry (Supporting Inquiry-Driven Experiments), 4th edition, W. H. Freeman and Company. ISBN-13: 978-1-4641-3422-7.

Recommended:

1. H. Meislich, E. K. Meislich, J. Sharefkin: 3000 Solved Problems in Organic Chemistry, 1st Edition, 1994, McGraww-Hill Companies; ISBN-13: 978-0070564244
2. R. O. C. Norman, J. M. Coxon: Principles of Organic Synthesis, 3rd Edition, 1993, Blackie Academic & Professional, Glasgow, UK; ISBN-13: 9780751401264
3. J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449
4. J. Clayden, N. Greeves, 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-10: 0072905018

6. J. G. Smith: Organic Chemistry, 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.
Description of column chromatography. Separation of the mixture of acetanilide and m-dinitrobenzene by column chromatography.

7th 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.

8th 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.

9th week
Short written test.
Check of the purity of benzamide by TLC and melting point measurement.
Calculation of the yield.
Preparation of cyclohexanone and cyclohexanone 2,4-dinitrophenyl-hydrazone (test tube variant).
Preparation of benzotriazole (test tube variant).

10th 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.

11th week
Short written test.
Preparation of 4-chlorobenzoic acid and 4-chlorobenzyl alcohol. Check the purity of the product using TLC and melting point measurement.

12th 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.

13th 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.

14th week
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): 90%; good (4): 75%; satisfactory (3): 60%; pass (2): 50%; fail (1): below 50%.

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

Lecturer: Dr. Marietta Vágvölgyiné Tóth, associate professor, PhD

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: 14 hours - preparation for the exam: 48 hours 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:

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. C. Stan Tsai: Biomacromolecules, John Wiley & Sons, New Jersey (2007)
4. A. Miller-J. Tanner: Essentials of Chemical Biology, John Wiley & Sons, Chichester (2008)
5. P. M. Dewick: Medicinal Natural Products: A Biosynthetic Approach, 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 Juhász, associate professor, PhD

Lecturer: Dr. László Juhász, 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: 22 hours - preparation for the exam: 40 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:

- Lubert Stryer, 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: Introduction to economics **Code**: **TTBEBVVM-KT1-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, 1st semester (or any later fall semester)	
Its prerequisite(s): -	
Further courses built on it: TTBEBVM-KT3_EN	

Topics of course

10 principles of economics, how markets work: demand and supply analysis, the effects of governmental interventions, cost of production, profit-maximizing behaviour of firms, analysis of perfect competition and monopoly

Literature

Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009.
Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010.

Schedule:

1st week
Introduction: Basic concepts and fundamental questions of economics
SR: Understanding the basic concepts and the economic way of thinking

2nd week
Human needs, scarcity, inputs, trade and its benefits
SR: Knowing the concept of scarcity and how free-will trade makes everyone better off

3rd week
Principles of economics
SR: Understanding the meaning of the 10 main principles

4th week
Production possibilities frontier, opportunity cost

SR: Knowing the role of opportunity cost in the model of PPF curve

5th week
Demand and Supply
SR: Understanding the model of market, able to derive the changes of variables

6th week
Market allocation
SR:Able to characterize the equilibrium and disequilibrium

7th week
Welfare economics
SR: Concept of consumer and producer surplus and Dead Weight Loss

8th week
Application: Governmental interventions
SR: Able to identify the effects of government's interventions on market and the welfare of the society

9th week
Cost of production
SR: The main types of cost and their relationship

10th week
Competitive industry I.
SR: Criteria of perfect competition, and profit-maximization

11th week
Competitive industry II.
SR: Welfare effects and industry in the long run

12th week
Monopoly I.
SR: Criteria of monopoly, and profit-maximization

13th week
Monopoly II.
SR: Understanding the welfare effects of monopoly

14th week
Summary, discussion of questions emerging during the semester.
SR: --

Requirements:
- for a signature
There is no requirement for a signature.
- for a grade

Assessment is based on a written exam which will be evaluated according to the following grading schedule: 0 -50% – fail (1) 50%+1 point -63% – pass (2) 64% -75% – satisfactory (3) 76% -86% – good (4) 87% -100% – excellent (5)
Person responsible for course: Prof**.** Dr. Judit Kapás, university professor, DSc
Lecturer: Dr. István Kovács, assistant professor

Title of course: Introduction to Business **Code**: TTBEBVVM-KT2_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: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:)	

Topics of course

The course explores the question 'what is a business'; and investigates the business functions of human resource management, marketing, operations management, accounting and finance. Different internal and external elements of a business are introduced, and the context in which a business operates explained. Students will explore the common aims and characteristics of business – investigating what makes them different. Business structures, cultures and functions are identified and the political, social, economic, and technological considerations affecting business are introduced. Students get an insight into the international competition, too.

Literature

Compulsory:
- Nickels, William G. – McHugh, James M. – McHugh, Susan M. (2008): Understanding Business. Eighth edition, McGraw-Hill/Irwin, New York, pp.1-87, 116-147, 180-319, 348-543, ISBN 978-0-07-310597-0

Recommended:
- Ferrell, O. C. – Hirt, Geoffrey (1993): Business – A Changing World. Irwin, Homewood, pp.1-29, 80-471, 502-633, ISBN 0-256-11683-0
- Skinner, Steven J. – Ivancevich, John M. (1992): Business for the 21st Century. Irwin, Homewood, pp.1-121, 188-701, 736-771, ISBN 0-256-09222-2

Schedule:

1st week

Introduction. Managing within the Dynamic Business Environment

2nd week

How Economics Affects Business

3rd week
Competing in Global Markets
4th week
Choosing a Form of Business Ownership
5th week
Management, Leadership and Employee Empowerment
6th week
Adapting Organizations to Today's Markets
7th week
Producing Word-Class Goods and Services
8th week
Motivating Employees and Building Self-Managed Teams
9th week
Human Resource Management: Finding and Keeping the Best Employees
10th week
Marketing: Building Customer Relationships; Developing and Pricing Product and Services
11th week
Distributing Products Quickly and Efficiently Using Effective Propotional Techniques
12th week
Understanding Financial Information and Accounting; Financial Management
13th week
Security Markets: Financing and Investing Opportunities
14th week
Summary

Requirements:
- for a signature
Attendance at **lectures** is compulsory.
Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- for a grade
The course ends in a written **examination**.
The minimum requirement for the written exam is 60%. Based on the score of the exam, the 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 exam is below 60, students can retake it in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Prof. Dr. András Nábrádi, university professor, DSc

Lecturer: Prof. Dr. András Nábrádi, university professor, DSc

Title of course: Basics of Civil Law I **Code**: TTBEBVVM-JA1_EN	**ECTS Credit points:** 2
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: 20 hours Total: 60 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): -	
Further courses built on it: Basics of Civil Law II. (TTBEBVVM-JA2)	

Topics of course

The course introduces students to the basic principles of civil law in order to provide up to date knowledge on the most important institutions of private law to engineers. During the course, the following topics of civil law are discussed:
- law of natural persons (legal capacity, capacity to act);
- personality rights and their protection;
- company laws in the EU (formation, structure);
- consumer protection laws in the EU;
- general rules on contracts and obligations;
- proprietary rights.

Literature

Compulsory:
- Trstenjak, V. – Weingeri, P. (2016): The Influence of Human Rights and Basic Rights in Private Law, Springer, ISBN 978-3319253350
- Twigg-Flesner, C. (2010): The Cambridge Companion to European Union Private Law, Cambridge University Press, ISBN 978-0521736152
- Sauter, W. – Schepel, H. (2009): State and Market in European Union Law: The Public and Private Spheres of the Internal Market Before the EU Courts, Cambridge University Press, ISBN 978-0521674478

Schedule:

1st week
Distinction between private and public laws.

2nd week
General principles of civil law: good faith, fault-based liability

3rd week
Law of natural persons: legal capacity and capacity to act
4th week
Law of legal entities (company law) I.: Formation
5th week
Law of legal entities (company law) I.: Structure
6th week
Personality rights and privacy laws
7th week
Consumer rights in the EU
8th week
Distance selling, e-commerce laws
9th week
Contract formation
10th week
Breach of the contract
11th week
Remedies to a breach scenario
12th week
Calculation of damages
13th week
Rights to property
14th week
Summary

Requirements:
- for a signature
Attendance at **lectures** is compulsory.
Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- for a grade
The course ends in a written **examination**.
The minimum requirement for the written exam is 60%. Based on the score of the exam, the 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 exam is below 60, students can retake it in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Tamás Fézer, associate professor, PhD

Lecturer: Dr. Tamás Fézer, associate professor, PhD

Title of course: Basics of Civil Law II **Code**: TTBEBVVM-JA2_EN	**ECTS Credit points:** 2
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: 20 hours Total: 60 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): Basics of Civil Law I. (TTBEBVVM-JA1)	
Further courses built on it: -	

Topics of course

The course introduces students to intellectual property laws and their protection in a European and international level. The rules of international sales law, dispute settlement mechanisms and transportation are also discussed in order to grant better understanding on the legal background of technological inventions and commercial activities related to them..

Literature

Compulsory:

- Pila, J. – Wadlow, C. (2015): The Unitary EU Patent System, Hart Publishing, ISBN 978-1849466196
- Stamatoudi, I. – Torremans, P. (2014): EU Copyright Law, Edard Elgar, ISBN 978-1781952429
- Sauter, W. – Schepel, H. (2009): State and Market in European Union Law: The Public and Private Spheres of the Internal Market Before the EU Courts, Cambridge University Press, ISBN 978-0521674478

Schedule:

1st week

The nature of IP laws in Europe.

2nd week

Copyright law in the EU I.

3rd week

Copyright law in the EU II.

4th week

Patent rights.

5th week

Patent restrictions and commercial chains.
6th week
Trademark protection.
7th week
Contractual relations to IP law.
8th week
Insurance Laws.
9th week
Dispute settlement mechanisms.
10th week
International commercial arbitration.
11th week
International Sales Law I.
12th week
International Sales Law II.
13th week
Transportation laws.
14th week
Summary

Requirements:
- *for a signature*
Attendance at **lectures** is compulsory.
Students have to **submit their solutions to two hypotheticals as home work assignments during the semester**.

- *for a grade*
The course ends in a written **examination**.
The minimum requirement for the written exam is 60%. Based on the score of the exam, the 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 exam is below 60, students can retake it in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Tamás Fézer, associate professor, PhD

Lecturer: Dr. Tamás Fézer, associate 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 to give an 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

1. Bergmann, Julian – Niemann, Arne (2013): Theories of European Integration and their Contribution to the Study of European Foreign Policy, *Paper prepared for the 8th Pan-European Conference on International Relations, Warsaw 2013. p22.*
2. Ott, Andrea – Vos, Ellen (eds.) (2009): Fifty Years 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: **Engineering Ethics** **Code**: TTBEVEM-MK1_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: 42 hours - preparation for the exam: 20 hours Total: 90 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:	

Topics of course

The course is intended to introduce the study of ethics, the branch of philosophy that aims to understand what actions are right and wrong, what states of affairs are good and bad, and what traits of personality are desirable and undesirable. Our central question will be "What should I (morally) do?" Similarly, although it is impossible to separate discussion of ethical theory from its application to particular moral problems, this course will emphasize the former. The most well-developed and carefully formulated ethical theory that addresses our central question is utilitarianism: what I should do is to make the world a better place. In the second half we review of the growth and development of the profession, engineering ethics, obligations to employers and peers, limits of professional responsibility, codes of ethics and enforcement. Traditional function of engineering societies. Ethical engineers and the low, the public interest. Case studies.

Literature

Compulsory:

- Charles E. Harris, Michael S. Pritchard, Michael J. Rabins: Engineering Ethics: Concepts and Cases, 2008 - 313 pages
- Keith Goore: Ethics in the Workplace. Thompson Learning, 2007
- R. Paul, L. Elder: Critical thinking. Prentice Hall, 2002

Recommended:

Schedule:

1st week

Lecture: Code of engineering ethics. Right to engineering service.

2nd week

Lecture The engineer's obligations to society. Obligations to the profession, employers and client.

3rd week
Lecture: Roles of engineering societies in ethics.
4th week
Lecture: Ethical behavior versus management. Internal and external procedures for considering dissenting views.
5th week - 14th week:
Lecture: Case studies. Discussing and analysing the case studies in terms of engineering ethics.

Requirements:
- for a signature

Participation at **lecture** is compulsory. Student must attend the lecture and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a lecture with another group. The attendance on lecture will be recorded by the lecturer. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed lecture should be made up for at a later date, to be discussed with the tutor. Active participation is evaluated by the lecture in every lecture. If student's behavior or conduct doesn't meet the requirements of active participation, the lecturer may evaluate their participation as an absence due to the lack of active participation in class.

Each student must give one small **presentation about a case study** during the semester. The presenter has to show his or her ability to present the case study clearly, focus on the most important parts in a concise manner and answer the questions raised by the audience or the lecture. Student has to analyse his or her case study in terms of ethical behavior, obligation to the profession, to the society, to the employer and client.

- for a grade
The course ends in **mid-semester grade**.
Based on the marks of the presentation and the activity of the student during the lecture, the mid-semester grade is determined.

Person responsible for course: Dr. Zsolt Tiba, college professor, PhD

Lecturer: Dr. Zsolt Tiba, college professor, PhD

Title of course: Management of Value Creating Processes **Code**: TTBEBVM-KT4_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 - preparation for the exam: 40 hours Total: 90 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): -	
Further courses built on it: TTBEBVM-KT6_EN	

Topics of course

Introduction to operations management. Strategy. Decision analysis support tools. Quality management. Process capability and statistical process control. Acceptance sampling. Designing products. Designing services. Process design. Capacity and facility planning. Facility location. HR management, Work measurement. Project management.

Literature

Compulsory:

– Russell, R. S. - Taylor, B. W. : Operations Management, 8th Edition, Wiley & Suns, INC., ISBN10 1118808908 ISBN13 9781118808900, 2014
– Heizer, J. - Barry R. - Chuck M.: Operations Management: Sustainability and Supply Chain Management (12th Edition), Pearson, ISBN-13: 978-0134130422, ISBN-10: 0134130421, 2016

Recommended:

– Lee J. Krajewski, L. J. - Malhotra, M. K. - Larry P. Ritzman, L. P.: Operations Management: Processes and Supply Chains, 11th Edition, ISBN-13: 9780133872132, Pearson, 2016

Schedule:

1st week

Introduction. The structure of value creating processes. Production processes. Service processes. The role of the operations manager. The evolution of operations management. Supply chain management. Globalisation. Productivity and competitiveness.

TE: Should know the basic functions and features of the value creating processes. Should understand the process of the evolution of management.

2nd week

Strategy. The steps of strategy formulation: primary task, core competencies, order winners and order qualifiers, positioning the firm, and strategy deployment. Hoshin kanri and balance scorecard as methods of strategy deployment. Operations strategy.

TE: Should know the steps of strategy formulation. Should understand the relationships between strategy deployment and business development.

3rd week

Decision analysis support tools and processes. Optimist and pessimist decision maker. The meaning and usage of coefficient of optimism. Decision making criteria: maximax, maximin, equal likelihood, and Hurwitz.

TE: Should use the decision criteria to mitigate the risk. Should know the difference between pessimistic and optimistic decisions.

4th week

Quality and quality management. The TQM and quality management systems. Quality tools. The focus of quality management: the customer. Quality improvement. Lean six sigma. ISO 9000.

TE: Should know the methods of quality measurement and the techniques of quality improvements. Should be able to conform to the changing demand of the customer.

5th week

Process capability and statistical process control. The role of process control in the quality management. Attribute data and variable data. Construction and usage of process control charts: p, c, x mean and R diagrams. Tolerances and process capability.

TE: Should know how to control production and service processes using process control charts. Should understand the importance of preventing production and service processes from defects.

6th week

Acceptance sampling as decision support analysis. Single-sample attribute plan. The risk of producer and consumer. The operating characteristic curve. Average outgoing quality. Double- and multiple-sampling plans.

TE: Should know the risk of product acceptance and the techniques of sample taking as well as should be able to deduce the features of the base population from the analysis of the samples.

7th week

Product design. The product design process, idea generation, feasibility study, form design, functional design, reliability, maintainability, usability, and production design. Design for environment, and design for robustness.

TE: Should know the steps and interrelations of the product design. Should understand the importance of product development to adapt to the continuously changing demand of customers.

8th week

Service design. The service economy. The service design process. Tools for service design. Waiting line analysis for service improvement. Operating characteristics of the queueing system, traditional cost relationships in waiting line analysis. Psychology of waiting, queuing models.

TE: Should know the characteristics of services and the tools for service design. Should able to understand the effect of waiting lines on the service provider and can improve the queueing system.

9th week

Process design and technology. Outsourcing, process selection wit break even analysis. Process analysis, using process flowcharts, process development. Technology decisions: financial justification and technology primer.

TE: Should know the steps of process design. Should know how to select the best production or service process using adequate methods. Should understand the interrelations between the importance of process plan, process selection and business competitiveness.

10th week

Capacity and facilities planning. The basics of facility layouts. Basic layouts: process layouts, product layouts, and fix position layouts. Planning of process layouts, service layouts, product layouts, and hybrid layouts.

TE: Should know the main types of facility layouts and the means of their designs. Should understand the relationship between the facility layout and the capacity utilization.

11th week

Facility location decision support tools. The types of facilities. Site selection. The factors of the global supply chain. Location analysis techniques: location factor rating, center-of-gravity technique, and load-distance technique.

TE: Should know the types of facilities, the factors that influence facility locations and the techniques of facility locations. Should understand the relationship between geographic location of facilities and efficient operation of facilities.

12th week

Human resources in the operations management. HR and quality management. The changing nature of HR management. Contemporary trends in HR management. Management of diversities in HR. Job design, job analysis and the learning curve.

TE: Should know the characteristics of modern HR management and the methods of work design and work analysis. Should understand the role of human resources as the primary resource in business operations.

13th week

Work measurement decision analysis support Tools. Time studies: stopwatch study, normal time, number of cycles, elemental time files, and predetermined motion times. Work sampling.

TE: Should know the traditional work measurement methods, stopwatch study and work sampling. Should understand that the traditional methods are needed presently mainly in services.

14th week

Project management. The elements of a project plan. Global differences in project management. The control of projects: time, cost, performance, and communication. Project planning with Gannt chart and CPM/PERT. Microsoft Project. Project crashing, time-cost analysis.

TE: Should know the characteristics of projects, the procedure of project planning and the methods (Gannt diagram, CPM/PERT, Microsoft Project). Can control the project implementation. Should understand the importance of project management in the areas of production, services and researches.
Requirements: - *For a signature* Attendance at lectures is recommended, but not compulsory. -*For a grade* The course ends in an examination in the exam period. The minimum requirement for the examination is 60%. 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) -*An offered grade:* It may be offered to students if they solves problems at lectures and attend lectures on a regular basis (do not miss more than 1/3 of the lectures). The grade is the average of the papers filed in the semester, the grade is in accordance with the table above.
Person responsible for course: Dr. Miklós Pakurár, associate professor, PhD
Lecturer: Dr. Miklós Pakurár, 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	
Evaluation: examination	
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	
Further courses built on it: 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-base theories. The Broensted equation. Buffers.

3rd week

Basic terms related to titrations. Practice of acid-base titrations.

4th week

Basics of complexometry. Complexometric titrations.

5th week

Solubility equilibria. Precipitation titrations, argentometry.

6th week

Redoxi equilibria. Permanganometry.

7th week

Chromatometry. Bromatometry. Iodometry.

8th week

Simple separation techniques I. Gravimetry.

9th week

Simple separation techniques II. Extraction.

10th week
Chromatographic separations and techniques.
11th week
Classification of instrumental analytical methods. Evaluation of analytical chemical results.
12th week
Spectroscopy I. Atomic spectroscopy.
13th week
Spectroscopy II. UV-Vis spectroscopy.
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: Inorganic and qualitative analytical chemistry laboratory practice **Code**: TTKBL0511-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: 26 hours - preparation for the exam: 38 hours Total: 120 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN, TTKBL0101_EN	
Further courses built on it: TTKBL0512_EN	

Topics of course
This practice trains the students in qualitative and quantitative inorganic analytical chemistry laboratory operations. In the first 5 practices some experiments and test tube reactions will be performed with inorganic materials. Until Practice 5 the sequence of the analytical topics follows the classical Fresenius system. In the first part of the practices it is required to obtain experience in the identification and separation of inorganic anions and cations. This work is followed by the analysis of "unknown samples". From Practice 6 the students will perform quantitative analytical measurements using classical titration methods. Acid-base titrations, redox titrations and complexometric titrations will be performed. In each practice the students have to analyse an unknown sample and hand in the results for evaluation.
Literature
Compulsory: 1) Róbert Király and Gábor Lente: Inorganic and Qualitative Analytical Chemistry: Supplementary material for laboratory course Department of Inorganic and Analytical Chemistry, University of Debrecen, Hungary, 2011. 2) G. Svehla (reviser): Vogel's Qualitative Inorganic Analysis, 6th ed. Longman Scientific & Technical Copublished in the United States with John Wiley & Sons, Inc., New York, 1994. 3) N. N. Greenwood and A. Earnshaw: Chemistry of the Elements Butterworth-Heinemann, Reed Educational and Professional Publishing Ltd, 2nd ed. 1997.
Schedule: *1st week*

Safety training. General laboratory procedures.
2nd week
Anion group I and II. Qualitative analysis of an unknown sample.
3rd week
Anion group I, II, III and IV. Qualitative analysis of an unknown sample.
4th week
Cation group I and III. Qualitative analysis of an unknown sample.
5th week
Cation group I, III, IV and V. Qualitative analysis of an unknown sample.
6th week
Acid-base titrations. Quantitative analysis of a borax sample.
7th week
Acid-base titrations. Quantitative analysis of an oxalic acid sample.
8th week
Titrations with $AgNO_3$. Quantitative analysis of a KCl + KBr sample.
9th week
Redox titrations with $KMnO_4$. Quantitative analysis of a H_2O_2 sample.
10th week
Iodometric titrations. Quantitative analysis of a Cu(II) sample.
11th week
Iodometric titrations. Quantitative analysis of a NaI sample.
12th week
Complexometric titrations with EDTA. Quantitative analysis of a Bi(III) sample.
13th week
Complexometric titrations with EDTA. Quantitative analysis of a Zn(II) + Cu(II) sample.

Requirements:
- for a signature
Participation at **practice classes** is compulsory.
- for a grade
At the beginning of every practice the students are required to write a short test related to the theoretical background and practical questions of the current experiments. For these tests and for the analysis of samples, scores are given. The results of the qualitative analytical tasks are also scored. Based on the average score of the above, the grade is given according to the following table

Score	Grade
0-50	fail (1)
51-60	pass (2)
61-70	satisfactory (3)
71-80	good (4)
81-100	excellent (5)

If the score of the oral exam is below 51%, students can take a retake the exam in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. József Kalmár, assistant professor, PhD

Lecturer: Dr. József Kalmár, assistant professor, PhD

Title of course: Application of Instrumental Analysis I. **Code**: TTKBE0512_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: 3rd year, 1st semester	
Its prerequisite(s): TTKBE0501_EN .	
Further courses built on it: TTKBL0512_EN	

Topics of course
Basic concepts, theoretical and practical aspects, carry-out and use of fundamental laboratory and industrial scale separation processes related to the instrumental analytical chemistry. 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: Instrumental analysis II **Code**: TTKBL0512_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: 48 hours - preparation for the exam: - Total: 90 hours	
Year, semester: 3rd year, 2st semester	
Its prerequisite(s): TTKBE0501, TTKBL0501	
Further courses built on it:	

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 (atomic spectrometry, UV/vis, HPLC). The instrumental laboratories are connected to the topics of the Instrumental Analysis lecture.

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: Evaluation of chromatograms (8h)

3rd week: UV-vis spectroscopy (6h)

4th week: High Performance Liquid Chromatography II (6h)

5th week: Atomic spectroscopy (6h)

6th week: pH-metry (6h)

7th week: Thin layer chromatography (6h)

8th 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: 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, MFVGE31V03_EN, TTKBG0402_EN, TTKBE0302_EN, TTKBE0501_EN, TTKBE1111_EN, TTKBL1111_EN, TTKBE0204_EN, TTKBG0614_EN, TTKBG0312_EN, TTKBL0311_EN, TTKBL0511_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, TTKBL0411_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 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 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: 30 hours - preparation for the exam: - Total: 58 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: Physical Chemistry II. (lab.) **Code**: TTKBL0411_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 2 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 28 hours - home assignment: 32 hours - preparation for the exam: - Total: 60 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBL0101_EN, TTKBE0402_EN	
Further courses built on it: -	

Topics of course

The aim of this course is to help students to get a deeper understanding of the complex physico-chemical theories by performing experiments with basic techniques. To teach them how to use laboratory equipments, how to carry out experiments and how to interpret experimental results. The tasks of this course are mainly based on kinetics, thermodynamics, phase equilibria, electrochemistry.

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

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 the enthalpy 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

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). Debreceni Egyetemi Kiadó, 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 7th week). 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.
- All of the notebooks of the measurements 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, TTKBE0617_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 atomic nucleus, stable and radioactive nuclei.
- Kinetics of radioactive decay.
- Mechanism and type of radioactive decay.
- Interaction of radiation with matter.
- Nuclear reactions, nuclear energy production.
- Chemical and biological effects of radiation.
- Detection and measurement of radiation.
- Environmental radioactivity.

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
Prof. Dr. István Bányai, university professor, DSc

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: Materials of Construction **Code**: TTKBE1211_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, 1st semester	
Its prerequisite(s): TTKBE0611_EN	
Further courses built on it: -	

Topics of course

Atomic structure of metals, stuctural forms of their crystal lattice, the effect of the crystallization method on the properties of the metal. Single-phase metals and solid solutions. Properties of alloys. The effect of deformation by forming on the mechanical properties. Basics of heat treatment methods (annealing, tempering, quenching, hardening). Types of iron-based alloys, their properties and applications. Properties and applications of non-ferrous metals. Mechanical testing of materials, destructive and non-destructive methods. Types of corrosion, protection. Properties and applications of nonmetal materials.

Literature

Compulsory:
- A. Sauveur: The metallography of iron and steel (Nabu Press, 2010) ISBN 9781145880399
- J.M. Coulson, J.F. Richardson, R.K. Sinnot: Chemical Engineering, Volume 6 (Pergamon, 1983) ISBN 9780080229690
- B.L. Bramfitt, A.O. Benscoter: Metallographer's guide: practices and procedures for irons and steels (ASM International, 2002), ISBN: 0871707489

Recommended:
- K. Elayaperumal, V.S. Raja: Corrosion failures: theory, case studies, and solutions (Wiley, 2015) ISBN 9780470455647

Schedule:

1st week

Atomic structure of metals, stuctural forms of their crystal lattice. Pure metals.

2nd week

Explanation for the mechanical properties of single-phase metals by their crystal lattice.
Modification of the mechanical properties by forming – defects of the lattice.
3rd week
Types of solid solutions. Diffusion in solids. Annealing.
4th week
The effect of grain size on the mechanical properties. Polymorphic transformations.
5th week
Multi-phase metals, properties of alloys, their description by constitutional diagrams.
6th week
Types and properties of iron-carbon alloys.
7th week
Mechanical properties of unalloyed steels, physical basics of γ-α transformations, isothermic transformation of steels.
8th week
The effect of various alloying constituents. Types of cast iron.
9th week
Properties and applications of non-ferrous metals.
10th week
Basics of heat treatment methods, their effect on the mechanical properties. Surface heat treatment.
11th week
Mechanical testing of materials, destructive and non-destructive methods.
12th week
Types of corrosion, methods of protection.
13th week
Properties and applications of nonmetal materials: wood, glass, enamel, porcelain.
14th week
Properties and applications of nonmetal materials: ceramics, concrete, stones, plastics.

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

Title of course: Plastics and Processing I. **Code**: TTKBE1212_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 20 hours - practice: - - laboratory: - - home assignment: 15 hours - preparation for the exam: 25 hours Total: 60 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0302_EN	
Further courses built on it: -	

Topics of course

The polymer industry in the world and in the region, perspectives. Synthesis of polyethylene (high-, low- and mid-pressure method), applications. Production of polypropylene, development of the technology, applications. Production of polystyrene (including high impact and expanded PS), application. Production methods of PVC an other chlorine- and fluorine-containing polymers, applications. Synthesis of poly(vinylacetate), poly(vinylalcohol), poly(vinyl-pyrrolidone), polyamides. Production of Polyamide-6, applications. Synthesis and properties of the most importand polydienes, elasthomers. Synthesis and properties of polyacrylates, polyesters, polyethers, epoxy and alkyd resins, polyurethanes, silicones and their derivatives. Additives of the polymer industry.

Literature

Compulsory:
- J. Brandup, E.H. Immergut, E.A. Grulke (Wiley, 1999) ISBN: 0-471-16628-6
- J.E. Mark: Polymer Data Handbook (Oxford University Press, 1999) ISBN: 9780195107890

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

Schedule:

1st week

Definition of polymers and plastics. Classification, types and aims of additives.

2nd week

Synthesis, properties and application of polyethylene and polypropylene, their copolymers.

3rd week

Polyisobutylene, butyl rubber and thermoplastical elastomers.
4th week
Polystyrene, polybutadiene, poly(acrylonitrile) and their copolymers (SAN, SBR, NBR, ABS).
5th week
Chlorine- and fluorine-containing polymers (PVC, chlorinated PVC, PVdC, PTFE, PTFCE).
6th week
Poly(vinylacetate), poly(vinylalcohol) and their derivatives.
7th week
Poly(vinyl-pyrrolidone) and related polymers.
8th week
Synthesis and properties of the most importand polydienes, elasthomers (PB, polyisoprene, polychloroprene). Vulcanization.
9th week
Synthesis and properties of polyacrylates and their derivatives.
10th week
Synthesis, properties and application of saturated and non-saturated polyesters, polycarbonates. Alkyd resins
11th week
Polyethers (aromatic and aliphatic types). Epoxy resins and their crosslinking.
12th week
Polyamides and polyimides. Synthesis and properties of phenol formaldehyde and aminoplast resins.
13th week
Polyurethanes, silicones, cellulose derivatives.
14th week
Test writing for an offered grade.

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 14th 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: Plastics and Processing I. **Code**: TTKBL1212_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 2 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 28 hours - 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

Identification of plastics by simple methods. Molding of plastic sheets. Shore hardness determination. Determination of mechanical properties of plastics based on tensile test. Impact testing of polypropylenes. Determination of Ball Indentation and Rockwell Hardness of polymers.

Literature

Recommended:

1. ISO standards (one copy can be found in the laboratory)
2. Syllabus provided by the Department of Applied Chemistry
3. George Odian: Principles of Polymerization, McGraw-Hill, New York (1983)

Schedule:

1st week

Identification of plastics by simple methods.

2nd week

Molding of plastic sheets. Shore hardness determination.

3rd week

Determination of mechanical properties of plastics based on tensile test.

4th week

Impact testing of polypropylenes.

5th week

Determination of Ball Indentation and Rockwell Hardness of polymers.
6th week
Determination of Ball Indentation and Rockwell Hardness of polymers.
7th week
Test writing.

Requirements:
The laboratory practices will be done in blocks (4 hours a week, 7 weeks).Attendance at laboratory practices are compulsory.
All measuring groups will prepare a laboratory notebook (laboratory record) after every practice.
The practice ends with a test for a partial grade. The test will cover the theoretical and the practical part of the laboratory practices. (The test is also 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)
60-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

The practice grade will be calculated as a weighted average by the following way: 60% of the test result, 40% of the laboratory notebook.

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

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

Title of course: Informatics for Engineers **Code**: TTKBG0911_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: practice grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - preparation for the tests: 32 hours Total: 60 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTKBG0912_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 Step by Step, Microsoft Press, 2007 2. Robert de Levi. Advanced Excel® for scientific data analysis, Oxford University Press, New York, 2004 3. Robert de Levi. How to Use Excel® in Analytical Chemistry: 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 chemical engineering by implemented mathematical functions. *3rd week* Numerical differentiation by spreadsheet software and its application for problem-solving in chemical engineering. *4th week* Numerical integration by spreadsheet software and its application for problem-solving in chemical engineering. *5th week* Regression, curve fitting	

6th week
The application of interpolation for problem-solving in chemical engineering.
7th week
Solving nonlinear equations by spreadsheet software and its application for problem-solving in chemical engineering.
8th week
Solving nonlinear set of equations by spreadsheet software and its application for problem-solving in chemical engineering.
9th week
Matrix operations
10th week
Solving sets of linear equations by 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 chemical engineering.

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. Ákos Kuki, associate professor, PhD

Title of course: Process Control I. **Code**: TTKBG0612_EN	**ECTS Credit points:** 4
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 56 hours - preparation for the exam: 22 hours Total: 120 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBL0911_EN	
Further courses built on it: TTKBG0613_EN	

Topics of course

Simple process control systems. Steady state and dynamic behaviour of chemical equipment. Determination of signal transmission of chemical equipments and control systems. Writing the balance/conservation equations. Basics of mathematical modelling.

Literature

Compulsory:

1) Seborg D. E., Edgar T.F., Mellichamp D. A., Doyle III F. J.: Process Dynamics and Control., Third Edition, published by John Wiley & Sons, Inc., 2011

Recommended:

2) Ingham J., Dunn I.J., Heinzle E., Prenosil J.E., Snape J.B.: Chemical Engineering Dynamics. An Introduction to Modelling and Computer Simulation., Third completely revised ed., WILEY-VCH Verlag GmbH, Weinheim, 2007
3) Smith A.C, Corripio A.B.: Principles and Practice of Automatic Process Control. Second ed., 2007
4) Luyben W.L.: Process Modeling, Simulation, and Control for Chemical Engineers. McGraw-Hill, International Edition, 1996.
5) Stephanopoulos G.: Chemical Process Control. An Introduction to Theory and Practice., published by Prentice Hall PTR, Englewood Cliffs, New Jersey, 1984
6) Bequette B. W.: Process Dynamics. Modeling, Analysis, and Simulation., Prentice Hall International Series in the Physical and Chemical Engineering Sciences, Prentice Hall PTR, 1998
7) Elnashaie S. S. E. M., Garhyan P.: Conversation Equations and Modelling of Chemical and Biochemical Processes., published by Marcel Dekker, Inc., 2003

Schedule:

1st week

Introduction. Determination of scope of Process Control. Classification of industrial automation.

2nd week

Single input and single output systems (SISOs). Feed-back Control (FBC) system and Feed-forward Control system (FFC). Symbols of process control and P&I diagrams. Signals and hardware elements of process control systems. Operations of signals. Block diagram and schematic structure/diagram.

3rd week

Industrial examples for process control. Comparison of FBC and FFC.

4th week

Industrial examples for process control. Comparison of FBC and FFC.

5th week

Enhanced control strategies. Ratio control. Cascade control. Inferential control.
Selective control.

6th week

Proportional signal transmission. Block diagram algebra. Block diagram reduction rules. Determination of equivalent summation amplification factor of FBC systems. Regulatory and servo operational mode of FBC systems.

7th week

Signal transmission. Basics of mathematical modelling. Total mass, component, energy and momentum conservation equations of chemical equipments and describe these balance equations for CSTR with exothermic first order chemical reaction. Solutions of different examples.

8th week

Solutions of different examples for CSTR.

9th week

Signal transmission. The basics of dynamic behaviour. The basics of transient behaviour. The signal transmission of hardware elements of process control which can be describe with ordinary linear differential equations (ODEs). The general equation of signal transmission in the time domain. Forcing functions, typical test signals.

10th week

Standard dynamic behaviours of hardware elements and processes. Proportional (P), integrative (I), derivative (D), first order process (PT_1), second order process (PT_1T_2) and n-order process ($PT_1...T_n$).

11th week

Forcing functions' indicated respons functions of different behaviour of hardware elements and processes. Practical examples.

12th week

Difference between steady-state behaviour and dynamic behaviour of chemical equipments. Operational point and operational line. Characteristic curves and diagrams of time domain. Transient operational mode of chemical equipments.

13th week

Self regulating and unstable systems. Practical examples for self regulating systems and them operational point.

14th week

exam

Requirements:

- for a signature

Participation in lectures and seminars. *The total number of absences for the semester does not exceed three (3).*

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* At the end of the course based on the result of written exam (100%). 0 % - 40 % mark: 1 (fail), > 40 % - 60 % mark: 2 (pass, sufficient), > 60 % - 77 % mark: 3 (satisfactory or average), > 77 % - 90 % mark: 4 (good), > 90 % mark: 5 (excellent). In the case of failure to perform of first exam, it is possible to write a second written exam.
Person responsible for course: Dr. István Árpád, assistant professor, PhD
Lecturer: Dr. István Árpád, assistant professor, PhD

Title of course: Process Control II. **Code**: TTKBG0613_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: 56 hours - preparation for the exam: 22 hours Total: 120 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBG0612_EN	
Further courses built on it: -	

Topics of course

Process control systems with hardware elements which are described with ODE. Determination of equivalent summation function in time domain of these FBC systems used Laplace transformation. Frequency response analysis and the Bose and Nyquist diagrams. Stability requirements for process control systems. Basics of selection, adjustment and tuning of different controller (P, PI, PID).

Literature

Compulsory:

1) Seborg D. E., Edgar T.F., Mellichamp D. A., Doyle III F. J.: Process Dynamics and Control., Third Edition, published by John Wiley & Sons, Inc., 2011

Recommended:

2) Ingham J., Dunn I.J., Heinzle E., Prenosil J.E., Snape J.B.: Chemical Engineering Dynamics. An Introduction to Modelling and Computer Simulation., Third completely revised ed., WILEY-VCH Verlag GmbH, Weinheim, 2007
3) Smith A.C, Corripio A.B.: Principles and Practice of Automatic Process Control. Second ed., 2007
4) Luyben W.L.: Process Modeling, Simulation, and Control for Chemical Engineers. McGraw-Hill, International Edition, 1996.
5) Stephanopoulos G.: Chemical Process Control. An Introduction to Theory and Practice., published by Prentice Hall PTR, Englewood Cliffs, New Jersey, 1984
6) Bequette B. W.: Process Dynamics. Modeling, Analysis, and Simulation., Prentice Hall International Series in the Physical and Chemical Engineering Sciences, Prentice Hall PTR, 1998
7) Elnashaie S. S. E. M., Garhyan P.: Conversation Equations and Modelling of Chemical and Biochemical Processes., published by Marcel Dekker, Inc., 2003

Schedule:
1st week
Introduction. Repeat of standard dynamic behaviours chemical equipments and process control systems. Dead time.
2nd week
Oscillating second order process (PξT). Examples for PξT.
3rd week
The Laplace Transform. Example for solution of ordinary linear differential equations.
4th week
Definition of transfer function. Transfer functions of different dynamic behaviour elements.
5th week
Examples for determination of response function in time domain used Laplace transformation.
6th week
Transfer function of FBC with proportional (P) controller. Comparison the behaviour of process with controller and without controller. Residual control discrepancy. Transfer function of FBC with integral (I) controller.
7th week
Stability of dynamical systems. Stability condition according to Lyapunov. Stability in the Laplace-domain. Determination of stability on the basis of the locations of roots of characteristic polynomial equation (root-locus analysis).
8th week
Routh-Hurwitz criterion.
9th week
Periodical (cosine) function as a typical test signal. Frequency response analysis. Nyquist and Bode diagrams.
10th week
Nyquist and Bode diagrams of different behaviour elements.
11th week
Geometrical conditions of stability, Nyquist and Bode criteria. Impact of dead time.
12th week
Basics of selection, adjustment and tuning of different controller (P, PI, PID). Ziegler-Nichols tuning technique.
13th week
Introduction to using of Matlab Control System Toolbox and Simulink software systems.
14th week
exam

Requirements:
- for a signature
Participation in lectures and seminars. *The total number of absences for the semester does not exceed three (3).*
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
At the end of the course based on the result of written exam (100%).

0 % - 40 % mark: 1 (fail), > 40 % - 60 % mark: 2 (pass, sufficient), > 60 % - 77 % mark: 3 (satisfactory or average), > 77 % - 90 % mark: 4 (good), > 90 % mark: 5 (excellent). In the case of failure to perform of first exam, it is possible to write a second written exam.
Person responsible for course: Dr. István Árpád, assistant professor, PhD
Lecturer: Dr. István Árpád, assistant professor, PhD

Title of course: Mechanics for Chemical Engineers I. **Code**: MFVGE31V03_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 hours - laboratory: - - home assignment: 28 hours - preparation for the exam: 20 hours Total: 90 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTFBE2111_EN, TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: MFVGE32V03_EN	

Topics of course

It reviews the fundamental rules of the formal requirements of the technical drawing, representing components by views and sectional views. After that it deals with the drawing of standardized machine elements and the concept of manufacturing tolerance and fitting, dimensional specification, geometrical and positioning tolerance, surface irregularity. Contact among machine elements. Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipe fittings, tanks etc. Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis. Alloy steel and non-ferrous metals. Modification of material properties by heat treatment. Non-destruction tests. Notation of steel. Formation of welded bound by smelting processes. Destruction tests and non-destruction tests of welded bounds. Works of chemical machines: determination of machine, grouping. Types of energy, energy sources. Efficiency.
In seminar there are four tasks to elaborate: to elaborate the workshop drawing of different machine elements and components.

Literature

Compulsory:

- Zsolt Tiba (2010): Machine Drawing, Debrecen University Press, ISBN 978-963-318-066-2
- A. Ugural (2004): Mechanical Design: An Integrated Approach, CRC Press, ISBN 13 9780072921854
- William D. Callister, David G. Rethwisch: Fundamentals of materials science and engineering : SI version, John Wiley and Sons, 2013., ISBN 978 1 118 32269 7

Recommended:

Schedule:
1st week
Lecture: Drawing standards, formal requirements of machine drawings. Drawing sheet dimensions, title block, defining the line types and thickness groups. Standardized letter and figure shape and sizes, scales, full size, reduction scales, enlarged scales.
Practice: issuing the task 1: Lettering
2nd week
Lecture: Defining the surfaces of a part. Presentation method in machine drawing, views, auxiliary view, local view, breaking, sectional views and sections.
Practice: issuing the task 2: Drawing Machine Parts. Practicing the presentation methods.
3rd week
Lecture: Complex sectional views, removed element, removed sections, specific sectional views and sections, conventional practice in machine drawing.
Practice: submitting the task 1: Lettering, elaborating the task 2. Practicing the presentation methods.
4th week
Lecture: General prescriptions for dimensioning, choosing basis surfaces. Conventional dimensioning methods.
Practice: elaborating the task 2. Practicing the presentation methods.
5th week
Lecture: ISO Tolerance system. Basic size, actual size, limits, deviations, fundamental deviation
Practice: Applying the dimensioning methods to dimensioning parts. Submitting the task 2. Issuing the task 3: Shaft drawing.
6th week
Lecture: ISO Tolerance system. Defining fits: clearance, transition and interference fit.
Practice: elaborating the task 3.
7th week
Lecture: Defining the surface roughness. Feasible roughness with different processing methods. Correlation between the surface roughness and the IT grade of dimension.
Practice: submitting the task 3, issuing the task 4: Screw Fastening and Joints.
8th week
Mid-term test
Lecture: Standardized Thread forms and its main features. Threads and thread symbols in drawing. Threaded joints: bolted joint, studded joint, screw fastening.
Practice: elaborating the task 4.
9th week
Lecture: springs: standardized representation of helical spring, keyed joints with saddle keys, sunk keys, parallel keys and woodruff keys. Splined shaft joint. Gears and toothed parts. Spur and helical gears.
Practice: elaborating the task 4.
10th week
Lecture: Contact among machine elements. Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipe fittings, tanks etc.
Practice: study drive train components in the lab.
11th week

Lecture: equation of energy equilibrium. Defining and calculating stresses in different load situations. Works of chemical machines: determination of machine, grouping. Types of energy, energy sources. Efficiency.
Practice: submitting the task 4.
12th week
Lecture: Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis.
Practice: Destructive test methods.
13th week
Lecture: Alloy steel and non-ferrous metals. Modification of material properties by heat treatment. Non-destructive tests. Notation of steel.
Practice: Non-destructive test methods.
14th week
Mid-term test
Lecture: Formation of welded bound by smelting processes. Destruction tests and non-destruction tests of welded bounds.
Practice: Conducting destructive and non-destructive tests.

Requirements:
- for a signature
Attendance on the **lectures** is recommended, but not compulsory.
Participation at **practice** is compulsory. Student must attend the practices and my not miss more than three practice during the semester. In case a student misses more than three, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. The attendance on practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices 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 for the course with them to each practice. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence due to the lack of active participation in class.
Students have to **submit all the four drawing tasks** as scheduled minimum on a sufficient level. During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 14th week. Students have to sit for the tests.
- for a grade
The course ends in **mid-semester grade**. Based on the average of the marks of the drawings and the average of the test results, the mid-semester grade is calculated as an average of them:

- average grade of the four drawing tasks
- average grade of the two tests

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 four 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. Zsolt Tiba, college professor, PhD
Lecturer: Dr. Zsolt Tiba, college professor, PhD

Title of course: Mechanics for Chemical Engineers II. **Code**: MFVGE32V03_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hour/week - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: 14 - laboratory: - - home assignment: 10 hours - preparation for the tests: 38 hours Total: 90 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): MFVGE31V03_EN	
Further courses built on it: MFVGE33V03_EN	

Topics of course
Transportation of fluids: Pascal's law, Bernoulli-equation, flow measurement, pressure drop and friction losses in pipes, pumps, head, pump power calculations, maximum suction height, cavitation, net positive suction head (NPSH), characteristic curves for centrifugal pump, duty point calculation. Electric motors: Lorentz force, categorization of electric motors, DC motors, synchronous AC motors, single phase induction motors, three phase AC induction motors, basic calculations. Heat engines: four-stroke engines (Otto cycle), two-stroke engines (Otto cycle), diesel engines, thermodynamics (Otto cycle), engine efficiency of thermal engines, octane and cetane values, Wankel engine, gas turbines, jet engines.
Literature
Recommended: 1. J. ML Coulson, J. F. Richardson, J. H. Marker, J. R. Backhurst, Chemical engineering, Volume 1, Butter worth –Heinemann, Oxford, 1999. 2. J. F. Richardson, J. R. Backhurst, J. H. Harker, Solutions to the Problems in Chemical Engineering Volume 1, Butter worth –Heinemann, Oxford, 2001. 3. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill, New York, 2005.
Schedule: *1st week* Transportation of fluids: Pascal's law, Bernoulli-equation. *2nd week* Flow measurement, pressure drop and friction losses in pipes. *3rd week*

Pump types used in the chemical industry.
4th week
Head and pump power calculations.
5th week
Maximum suction height, cavitation.
6th week
Net positive suction head (NPSH)
7th week
Characteristic curves for centrifugal pump, duty point calculation.
8th week
Lorentz force, force on current carrying wires.
9th week
Categorization of electric motors, DC motors.
10th week
Synchronous AC motors, single phase induction motors.
11th week
Three phase AC induction motors, basic calculations related to electric motor.
12th week
Heat engines, four-stroke engines (Otto cycle), two-stroke engines (Otto cycle).
13th week
Diesel engines, thermodynamics (Otto cycle), engine efficiency of thermal engines.
14th week
Octane and cetane values, Wankel engine, gas turbines, jet engines.

Requirements:
- for a signature
Attendance at lectures is recommended, but not compulsory.
Participation at the practice 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 term grade
The course ends with test for the term grade. 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 solution of the home assignments is counted into the score of the test by 5%.
The students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Sándor Pálinkás, senior lecturer, PhD

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: Mechanics for chemical engineers III. **Code**: MFVGE33V03-EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: 1 hours/week - laboratory: -	
Evaluation: mid-semester grade	
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: 3rd year, 1st semester	
Its prerequisite(s): MFVGE31V03, MFVGE32V03	
Further courses built on it: -	

Topics of course
Heat exchangers and reactors. Thermal conductivity. Thermal convection, heat transfer and basic concepts of heat exchangers. Overview and basic equations of heat exchangers. THE moderate temperature difference. The heat coefficient k. Heat transfer without phase change. heat transfer with convection. Heat transfer with free convention. Heat transfer during phase change. Heat transfer of ribbed tubes.Heat transfer in a mixer. Dimensional principles. Heat radiation. Applications and Types of Tubular Heat Exchangers.Other heat exchangers. Condenser. Cooling towers.Chemical reactors.Models of reactor model ideal for flow. Descriptive quantities and equations.Examples of industrial reactors. Devices of high temperature homogeneous gas reactions. Stability and selection of reactors.Intermittent reactors. Furnaces. Rotary, rotary, fluidizing furnaces. Breakdown of water. Water electrolysisers. Industrial applications.Refrigerators.The chemical application of cooling. Compressor refrigerators. Carnot refrigeration cycle. Cold-running cycles.Refrigerants, media. The machines, devices and components of the refrigeration equipment. absorption refrigeration equipment. Steam jet cooling equipment. Heat pumps.
Literature
Compulsory: - James O Wilkes - Fluid Mechanics for Chemical Engineers Second Edition with Microfluidics and CFD - Reactor Design for Chemical Engineers, J. M. Winterbottom, Michael King - EFFECTIVE THERMAL DESIGN OF COOLING TOWERS, By Jonny Goyal Air Liquide Engineering and Construction, Lurgi India | February 1, 2012 - Coulson and Richardson's Chemical Engineering (Seventh Edition) Volume 1b: Heat and Mass Transfer: Fundamentals and Applications 2018, Pages 471-528 Coulson and Richardson's Chemical Engineering Chapter 5 - Applications in Humidification and Water Cooling

Schedule:
1st week
The basics of technical heat. Heat transfer is theoretical
Fundamentals. Thermal conductivity, Convective heat transfer,
thermal transmittance. Logarithmic medium temperature
difference Heat transfer coefficient k.
2nd week
Heat convection without phase change is free and
forced flow.
3rd week
Heat transfer during phase change. fin
heat transfer Heat transfer in mixer.
4th week
Applications and Types of Tubular Heat Exchangers.
Dimensional principles.
thermal radiation
5th week
Other heat exchangers.
6th week
Direct heat exchanger heat exchangers Condensation condensers.
7th week
Cooling towers.
8th week
Refrigerators. The chemical application of cooling.
Compressor refrigerators. Carnot Cooling Circuit.
Cold-running cycles.
9th week
Chillers are machines, devices, structural
elements. Absorption chillers. Steam Radiation-
refrigerators. Heat pumps.
10th week
Chemical reactors. Heat and component balance equations
interpretation. Descriptive quantities and
equations. Models of reactor model ideal for flow. Seamless and continuous cavity reactors,
continuous cascade and tube reactors.
11th week
Isothermal and Adiabatic Reactors. The reactors
thermal stability
12th week
Examples of industrial reactors. Stability of reactors
and selection.
13th week
Intermittent reactors. Furnaces. Rotary,
rotary, fluidizing furnaces.
Water electrolysis. Breakdown of water. water electrolysis
devices. Industrial applications
14th week

Systematic repetition of thermal operations.

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.
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 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: Mr. Gábor Balogh, instructor

Lecturer: Mr. Gábor Balogh, instructor

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. Miklós Nagy, associate professor, PhD

Lecturer: Dr. Miklós Nagy, associate professor, PhD

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: 50 - preparation for the exam: 60 hours Total: 180 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBG0614_EN	
Further courses built on it: TTKBG0616_EN	

Topics of course

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

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

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. Packed columns, characteristics and types of packings. Methods of flow measurement.

2nd week
Fluidization and pneumatic transport. Ergun equation. Geldart classification of powders.

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.

6th week
Forced convection heat transfer.

7th week
Natural convection heat transfer.

8th week
Radiation heat transfer and solution of complex heat transfer problems

9th week
Heat exchanngers. Stationary heat transmission with constant temperature difference through flat and cylindrical wall. Determination of heat flow and thermal resistances.

10th 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.

11th week
Boiling of liquids. Boiling curves. Critical heat flux of boiling. Leidenfrost effect.

12th week
The aim of evaporation, Calandria, falling film and Robert-type evaporator. Multistage evaporators and their connections.

13th week
Analogies between momentum and heat transfer. Chilton-Colburn analogy.

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. Miklós Nagy, associate professor, PhD
Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Unit Operations III **Code**: TTKBE0616_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: 3nd year, 1st semester	
Its prerequisite(s): TTKBG0615_EN	
Further courses built on it: -	

Topics of course

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

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

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
Thermal separation operations: distillation: Batch and continuous distillation, rectification. The aim of evaporation.

5th week
Operating point. Types and parts of a continuous rectification apparatus. Operating lines of a rectifier. The q-line. Equilibrium stage, its determination using McCabe-Thiele diagram.

6th week
Liquid-liquid extraction. Ternary phase diagram. Distributional diagram of the key component. Batch and continuous extraction. Continuous one-stage mixer-settler extractor. Liquid-solid extraction and its apparatus.

7th week
Crystallization and its phase diagram. Apparatus for crystallization.

8th week
Drying. Types of moisture binding. Rate of drying. Enthalpy of moist air. Types, material-and energy balance of drying apparatus

9th week
Humidification.

10th 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

11th week
Introduction to chemical reactors.

12th week
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.

13th week
Heat balance of a reactor. Stability of reactors.

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. Miklós Nagy, associate professor, PhD
Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Computer Modeling of Chemical Technology Systems I. **Code**: TTKBG0912_EN	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: practice 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): TTKBG0911_EN	
Further courses built on it: TTKBG0913_EN	

Topics of course
Application of a chemical process simulation software for the simulation of industrial processes. Drawing the flowcharts. Creating a simulation step by step. Simulation of simple reactions, evaluation of the results, creating reports, exporting data. Study of vapor-liquid equilibrium. Modeling of flash distillation and three phase flash distillation. Application of sensitivity study. Applications of the controller module. Modeling of heat exchangers.
Literature
Recommended: 1. J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt 2. ChemCAD tutorial file 3. J.H. Perry: Chemical Engineers Handbook, McGraw-Hill, New York (2007) 4. Warren L. McCabe, Julian Smith, Peter Harriott: Unit Operations of Chemical Engineering McGraw-Hill, New York (2007)
Schedule: *1st week* The main features of a process simulation software. The steps of the simulations. Drawing process flow diagrams. *2nd week* Simulation of simple reactions, evaluation of the results. *3rd week* Simulation of reactions with more feeds and unit operations, evaluation of the results. *4th week* Study of vapor-liquid equilibrium.

5th week
Modeling of flash distillation and three phase flash distillation.
6th week
Application of sensitivity study.
7th week
Introduction into the use of the *controller*.
8th week
Application of *controller* for problem-solving in chemical engineering.
9th week
Modeling of heat exchangers.
10th week
Various reactor models.
11th week
Simulation of chemical processes with reactors and separators
12th week
Simulation of chemical processes with recycling.
13th week
Simulation of more complex chemical processes.
14th week
Simulation of more complex chemical processes.

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. Ákos Kuki, associate professor, PhD

Title of course: Computer Modeling of Chemical Technology Systems II. **Code**: TTKBG0913_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: 30 hours Total: 58 hours	
Year, semester: 4th year, 1st semester	
Its prerequisite(s): TTKBG0912_EN	
Further courses built on it: -	

Topics of course

Application of a process simulation software for design and simulation of mass transfer operations (distillation, rectification, extraction, absorption, adsorption, drying). Pipe system sizing, pumps. Economic calculations.
By using the software the students can broaden their knowledge in the field of industrial devices and processes, besides they can learn novel, up to date industrial and environmental technologies.

Literature

Recommended:

1. J. M. Coulson, J. F. Richardson: Chemical Engineering. Volume 1-6. Pergamon Press. Oxford, New-York, Toronto, Sydney, Paris, Frankfurt
2. ChemCAD tutorial file
3. J.H. Perry: Chemical Engineers Handbook, McGraw-Hill, New York (2007)
4. Warren L. McCabe, Julian Smith, Peter Harriott: Unit Operations of Chemical Engineering McGraw-Hill, New York (2007)

Schedule:

1st week
Fluid transportation. Pressure drop calculations in piping systems.
2nd week
Simulation and sizing of pumps.
3rd week
Simulation of piping systems, cost calculations.
4th week
Pump duty point calculation.
5th week

Modeling of distillation, *Short Cut* method.
6th week
Modeling of distillation, *SCDS* model.
7th week
Multi step distillation, *Tower* model.
8th week
Application of stuffed columns.
9th week
Simulation of absorption.
10th week
Simulation of extraction.
11th week
Simulation of more complex chemical processes.
12th week
Simulation of more complex chemical processes.
13th week
Simulation of more complex chemical processes.
14th week
Simulation of more complex chemical processes.

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. Ákos Kuki, associate professor, PhD

Title of course: Chemical Technology I. **Code**: TTKBE1111_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): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBE1112_EN, TTKBL1112_EN	

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 I. **Code**: TTKBL1111_EN	**ECTS Credit points: 4**
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: 2 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: 28 hours - home assignment: 40 hours - preparation for the exam: 24 hours Total: 120 hours	
Year, semester: 2nd year, 2nd semester	
Its prerequisite(s): TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN	
Further courses built on it: TTKBE1112_EN, TTKBL1112_EN	

Topics of course

Calculations related to the Chemical Technology I topics. 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. Knowing of the technologically important unit operation processes such as filtration, mixing, water softening, rectification and distillation, drying, sedimentation, sieve analysis.

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

Safety regulations

2nd week

Determination of hardness of unknown water samples
3rd week
Water softening with ion exchange resin
4th week
Sieve analysis
5th week
Distillation
6th week
Rectification, separation of ethanol-water mixture
7th week
Mixing
8th week
Determination of critical power of mixer
9th week
Sieve analysis of ground limestone
10th week
Drying, determination of moisture in unknown samples
11th week
Filtration
12th week
Sedimentation
13th week
Application of Stokes's law for sedimenting particles
14th week
Repeating of failed practices

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. 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. Furthermore, the students make reports about their laboratory practice results.
- for a grade
The exam grade is calculated by the results of end-term test and the laboratory reports.
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**: TTKBE1112_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): TTKBE1111_EN, TTKBL1111_EN	
Further courses built on it: -	

Topics of course

Polyolefins. Properties of different polyethylene (PE) and polypropylene (PP) polymers. Typical industrial reactors for the production of LDPE, HDPE (LLDPE) and PP. Uses of polyolefins.
Biotechnology. Phases and types of the industrial fermentation. Requirements of the mixed tank reactors in the biotechnology.
Industrial production and types of solid dosage forms. Advantage, disadvantage and types of capsule dosage forms. Typical examination methods of the solid dosage forms.

Literature

Compulsory:
- H. A. Modi, Fermentation Technology (Vol: I and II), 2009
- J Joao B. P. Soares, Timothy F. L. McKenna, Polyolefin Reaction Engineering, 2012, ISBN: 978-3-527-31710-3
- Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, 2016

Recommended:
- Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA., 2002, ISBN: 9783527306732

Schedule:

1st week
Processing and refining crude oil
2nd week
Catalytic cracking
3rd week

Pyrolysis in the industry
4th week
Production of olefins, its products and side products
5th week
Uses of ethylene and propylene
6th week
Classification and uses of polyethylene and polypropylene
7th week
Properties of the polyethylene and polypropylene polymers
8th week
Production of LDPE in the industry
9th week
Production of HDPE in the industry
10th week
Production of polypropylene in the industry
11th week
Basics of biotechnology
12th week
Industrial fermentation
13th week
Extraction of the pharmaceutically important components from the fermentation broth
14th week
Industrial production and types of solid dosage forms

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**: TTKBL1112_EN	**ECTS Credit points: 4**

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: 28 hours
- home assignment: 40 hours
- preparation for the exam: 24 hours

Total: 120 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTKBE1111_EN, TTKBL1111_EN

Further courses built on it: -

Topics of course

Study the steps of fermentation processes. Manufacturing and qualifying of biofuels. Qualifying of lubricants. Study of catalytic processes such as dehydrogenation. Study of corrosion processes

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

Manufacturing biodiesel

2nd week

Qualifying of biodiesel

3rd week

Study the corrosion of different metals

4th week

Production of alcohol by fermentation

5th week

Distillation of crude oil fractions

6th week

Determination of flash point and firing point of crude oil fractions
7th week
Bioconversion by yeast
8th week
Dehydrogenation of isopropanol on copper catalyst
9th week
Glyptal resin production
10th week
Study the viscosity of paraffin and lubricant oils
11th week
Determination of methane content in unknown gas sample
12th week
Study the cascade reactor hydrodynamic properties
13th week
Study the plug flow reactor hydrodynamic properties
14th week
Repeating of failed practices

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. 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. Furthermore, the students make reports about their laboratory practise results.
- for a grade
The exam grade is calculated by the results of end-term test and the laboratory reports.
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: 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: 6 hours - preparation for the exam: 56 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBL0101_EN	
Further courses built on it: -	

Topics of course

The Relationship Between Nature and Man (the Technosphere). Sustainable Development. Types of Industrial Waste, Possibilities to Prevent Their Formation. Additive, Environmentally Integrated Production and Product. Technological Methods for the Treatment of Different Types of Waste. Air and Water Pollutants, Wastewater Treatment. Soil Contamination and Management. Noise and Vibration Protection. Radioactivity. Renewable Energy Sources. Case Histories.

Literature

Compulsory:
- D.A. Vallero: Fundamentals of Air Pollution (Academic Press, 2007) ISBN: 780123736154
- 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
- J.E. Andrews, P. Brimblecombe,T.D. Jickells, P.S. Liss and B. Reid: An Introduction to Environmental Chemistry, 2nd edition, 2004 by Blackwell Science Ltd, ISBN 0-632-05905-2

Schedule:

1st week

Overpopulation (problems, effects and solutions). Causes of Environmental Pollution. Effects of Environmental Pollution (Greenhouse Effect, Global Warming, Climate Change).

2nd week

The Areas of the Environmental Protection. The Theory of the Sustainable Development.

3rd week

The Type and Composition of Waste.The Technology Sytem of the Waste Management (Selective Collection, Transportation, Pre-Treatment, Utilization, Disposal and Landfilling).

4th week

The Principles of the Product and Production Integrated Environmental Protection.

5th week

Waste processing technologies. Description of Major Waste Treatment Equipments (Shredders, Mills, Comminutors…).

6th week

Description of the Waste Collection, Separation and Sorting Equipments and Technologies.

7th week

The Type of Air Pollutants. Descripition of Technologies to Remove Air Pollutants.

8th week

The Different Type of Water Pollutants (Oil, Detergents, Pesticides, Organic Substances). Determining the Organic Pollution of Waters (BOD, COD, TOC)

9th week

Main Soil Components. Type of Soil Pollution. Treatments Technologies of Contaminated Soil.

10th week

Description of a Sewage Treatment Plant. Near-Natural Wastewater Treatment Technologies

11th week

Noise and Vibrations. Effects and Noise Abatement.

12th week

Effect of Radioactivity on the Human Body. Application of Radioactivity (Medicine, Energy Production).

13th week

Renewable Energy Sources (Solar Energy, Hydropower Wind Energy, Sea Energy, Geothermal Energy)

14th week

Case Histories About Great Environmental Pollutions and Their Effects.

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: Prof. Dr. Kéki Sándor, university professor, DSc
Lecturer: Illyésné Dr. Czifrák, Katalin, assistant professor, PhD

Title of course: Environmental Technology Lab **Code**: TTKBL1114_EN	**ECTS Credit points: 2**
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 2 hours/week/blocked by quarter semester	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 24 hours - home assignment: 36 - preparation for the exam: - Total: 60 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE1114_EN parallel recording	
Further courses built on it: -	

Topics of course

Determination Organic Solvent Content of Water. Determination of Soft PVC Softener Content. Examination of Desalination on a Strongly Acid Cation Exchange Column. Removing Contaminated and Surface Water Suspended Solids by Sedimentation. Identification and Binding of Hydrocarbon Air Pollutants on Activated Carbon. Identifying plastics with Simple, Quick Methods.

Literature

Compulsory:

- Silabus made by the Department of Applied Chemistry.

Recommended:

- J.E. Andrews, P. Brimblecombe,T.D. Jickells, P.S. Liss and B. Reid: An Introduction to Environmental Chemistry, 2nd edition, 2004 by Blackwell Science Ltd, ISBN 0-632-05905-2

Schedule:

1st week

Determination Organic Solvent Content of Water.

2nd week

Determination of Soft PVC Softener Content.

3rd week

Examination of Desalination on a Strongly Acid Cation Exchange Column.

4th week

Removing Contaminated and Surface Water Suspended Solids by Sedimentation.

5th week

Identification and Binding of Hydrocarbon Air Pollutants on Activated Carbon.

6th week

Identifying plastics with Simple, Quick Methods.

7th week Written Test.
Requirements: - *for a signature* Attendance at **lectures** is recommended, but not compulsory. During the semester there is a written end-term test in the 7th 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 exam**. 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) 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: Prof. Dr. Kéki Sándor, university professor, DSc
Lecturer: Illyésné Dr Czifrák, Katalin, assistant professor, PhD

Title of course: Pilot Plant practice **Code**: TKBL1115_EN	**ECTS Credit points:** 5
Type of teaching, contact hours - lecture: - practice: 1 hours/week - laboratory: 4 hours/week	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: - practice: 14 hours - laboratory: 56 hours- - home assignment: 80 hours - preparation for the exam: Total: 150 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): **Chemical technology I. (TKBE1111)**	
Further courses built on it: **-**	

Topics of course

During the laboratory practice the students can learn the manual and computerized operation of pilot plant sized unit operations. The will record and calculate mass and energy balances for different processes such as: evaporations. absorbtion. grinding-size distribution, liquid- liquid extraction, distillation, fluidization and membrane separation.

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

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

Muhlynov I.: Chemical Technology I-II.

Schedule:

1st week

Safety instructions. The basic requirements of laboratory work.

2nd week

Fluidization

3rd week

Grinding and sieve analysis. Comparison of grinding efficiencies.

4th week
Batch distillation.

5th week
PLC controlled reactor I.

6th week
PLC controlled reactor I.

7th week
Absorption.
8th week
Liquid-liquid extraction.
9th week
Heat exchange.
10th week
Falling film evaporator
11th week
Membrane separation. RO.
12th week
Vacuum evaporation.
13th week
Gas separation
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. 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.

- for a grade
The course is graded based on lab reports created individually. The reports should be prepared after the practices.

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

Lecturer: Dr. Miklós Nagy, associate professor, PhD

Title of course: Safety **Code**: TTKBE0711_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 tests: 62 hours Total: 90 hours	
Year, semester: 4th year, 1th semester	
Its prerequisite(s): TTKBE1112_EN	
Further courses built on it: -	

Topics of course

General safety rules. Describing major accidents and causes. Poisoning, noise. Inerting of chemical vessels. Hazards of electricity (Static electricity, Direct current and alternating current). Dangers of chemical reactions. Safety valves, regulation of pressure, solutions in case of emergency.

Literature

Recommended:

1. D. A. Crowl, J.F. Louvar: Chemical Process Safety, Pearson, Boston, USA (2011)
2. Roger L. Bauer: Safety and Health for Engineers, Wiley Interscience, New York (2005)
3. Richard J. Lewis ed.: Sax1s Dangerous properties of Industrial Materials, John Wiley (2005)
4. C. D. Classen, Caserett and Doull's Toxicology, McGraw-Hill, New York (2008)

Schedule:

1st week

General and basic security rules. Definition of accident, near-miss (quasi-accident) and first aid. Can we learn from accidents that have not happened?

2nd week

Accident statistics, industry comparison. Conclusions from the figures.

3rd week

Some major accidents are described, for example: in Bhopal, India (1984), Seveso, Italy (1976), Red Sludge (Red Mud) Disaster, Kolontar, Hungary (2010). Discussion of the possible causes of accidents.

4th week

Intoxications. Exposure and elimination of toxic substances to the body. Basic principles of toxicology. Definition of LD50. Cross effects of toxic substances, antidotes. Methanol poisoning.

5th week

Definition and classification of noise. Effect of the frequency and power of the noise. Dangers and diseases caused by noise. Work in a noisy workplace.

6th week

Purpose and implementation of inerting. Nitrogen-Purging, Vacuum, Pressure, Combination and Siphon Method. Advantages disadvantages. Simplification of a simple oxygen concentration calculation method..

7th week

Dangers of static electricity. Prevention of the formation of static electricity. The dust explosion. Electrical hazards. The role of insulation, earthing, residual current device (fi-relay) and fuse in the prevention of accidents

8th week

Dangers of chemical reaction. Run-away reaction and possible causes. Exothermic and/or gas producing reactions. Pyrophoric, peroxide-forming, reacting with water, highly oxidizing, self-reactive, impact-sensitive, heat-decomposing materials and their dangers.

9th week

Types of safety valves and their operation. Multiple protection. Comparison of safety valves, advantages and disadvantages.

10th week

Removal of excess pressure in case of danger. Technical solutions. Protective devices and their use.

11th week

Identification of hazards (environmental and safety). Solution options. Explosion limits of gas mixtures. Options for security protection.

12th week

Watching educational videos on safety. Learn the GHS pictograms and safety signs.

13th week

Consultation.

14th week

Test for a recommended grade.

Requirements:

Attendance at lectures is recommended, but not compulsory.

The course ends with test for a recommended grade. (This test is not 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)

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

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

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

Title of course: Basics of Petrochemistry **Code**: TTKBE1113_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 tests: 62 hours Total: 90 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTKBE1111_EN	
Further courses built on it: -	

Topics of course

- Possible application of distilled fractions.
- Processes of fuel fractions.
- Basic thermal and catalytic cracking procedures
- Role of isomerization and oligomerization in the petroleum industry .
- Chemicals as product of crude oil
- Main technology of oil based monomers
- Production of biofuels.

Literature

Recommended:

1. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim, Volumes: 1-40, (2002)
2. Fundamentals of Petroleum Refining, Mohamed A. Fahim, Taher A. Alsahhaf, Amal Elkilani, Elsevier, (2010)
3. Chemistry of Petrochemical Processes, Sami Matar, Lewis F. Hatch. Elsevier (2001)
4. Fundamentals of petroleum and Petrochemical Engineering, Uttam Ray Chaudhuri, CRC Press (2010)

Schedule:

1st week

Topic of petrochemistry, classification of procedures, first step of oil process

2nd week

Thermal cracking processes, visbreaking and delayed cooking.

3rd week

Basics of catalytic cracking, role of these processes in the petroleum refining.

4th week

Fluid catalytic cracking and hydrocracking.
5th week
Catalytic reforming, aims and main reactions.
6th week
Aim of isomerization, classification based on the feeds.
7th week
Technology of alkylation and oligomerization. Production of ethylbenzene.
8th week
Production, separation and purification of benzene, toluene and xylene (BTX fraction) and their main products.
9th week
Aim of steam cracking, main reactions and possible feeds.
10th week
The main part of the steam cracker furnaces. comparison of different technologies and the applied furnaces. Procedure of the product.
11th week
Second generation monomers: vinyl chloride, .ethylene- and propylene oxide. Production of the monomers and product of ethylene, propylene and butadiene.
12th week
Hydrogen production, aim of steam reforming. Application of synthesis gas.
13th week
Production of biodiesel, classification of procedures based on the catalyst.
14th week
Production of bioethanol, possible. Possible sources and pretreatment of the feeds. Production of ethyl tert-butyl ether.

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

Score	Grade
0-49	fail (1)
50-64	pass (2)
65-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

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

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

Lecturer: Dr. Tibor Nagy, associate professor, PhD

Title of course: Waste Management **Code**: TTKBE1116_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

Basic definitions of waste management. Classification of wastes. Waste management strategies, reduction of waste amount. 4R: reduction-reuse-recycle-recover. Landfilling and incineration of solid wastes. Advanced thermal processing technologies, aerobic and anaerobic digestion, composting. Mechanical–biological treatment. Integrated solid waste management.

Literature

Compulsory:
- Stephen Burnley: Solid Wastes Management (Wiley, 2014) ISBN 9781118863923
- John Pichtel: Waste management practices: municipal, hazardous, and industrial (Taylor and Francis, 2005) ISBN 9781466585188
- Nicholas P. Cheremisinoff: Handbook of solid waste management (Butterworth-Heinemann, 2003) ISBN 9780750675079

Recommended:
- Nicholas P. Cheremisinoff, Paul N. Haber: Hazardous materials and waste management (Elsevier Science & Technology, 1996) ISBN 9786612769269
- Alireza Bahadori: Waste Management in the Chemical and Petroleum Industries (Wiley, 2013) ISBN 9781118731758

Schedule:

1st week
Basic definitions of waste management. Classification of wastes.

2nd week
Waste management strategies, waste reduction.

3rd week
Landfilling – cell method

4th week
Landfilling – leachate control and gas collection
5th week
Landfilling – site restoration
6th week
Incineration – conventional incinerators
7th week
Incineration – rotary kiln, fluidised bed incineration
8th week
Incineration – Emissions abatement technologies
9th week
Advanced thermal processing technologies – gasification and pyrolysis
10th week
Anaerobic digestion
11th week
Composting
12th week
Materials recycling – MRF, SRF
13th week
Materials recycling – MBT
14th week
Integrated solid waste management and waste strategies

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: Prof. Dr. Sándor Kéki, university professor, DSc
Lecturer: Dr. Tibor Nagy, assistant professor, PhD

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	
Further courses built on it: 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.

2^{nd} *week* **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
15th week **MS & IR written 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: Quality Management **Code**: TTBEBVM-KT6-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: 3rd year, 1st semester	
Its prerequisite(s): TTBEBVM-KT4_EN	
Further courses built on it: -	

Topics of course
The series of lectures are based on the topics of Quality Managment. This course introduces the participants into the philosophy, the theories and the basic calculations of quality management. Lectures give opportunity to discuss the topics and to get practice in basics techniques of measuring quality, quality improvement, statistical process control, quality management, international standards of quality.
Literature
Compulsory: - Foster S. Thomas (2017): *Managing Quality: Integrating the Supply Chain.* 6th edition. Pearson Prentice-Hall, New-Jersey, ISBN-13: 978-0133798258 *Recommended:* -Joel E. Ross – Susan Perry (2004): Total Quality Management, Text, Cases and Readings. 3rd Edition, Vanity Books International. -David L. Goetsch - Stanley Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality. 8th Edition. Pearson Prentice-Hall, New-Jersey,ISBN-13: 978-0133791853
Schedule: *1st week: Basic issues of quality: quality of products,KANO-model* *2nd week :Basic issues of quality: quality of services, SERVQUAL model* *3rd week: Product Design – Paired comparison*

4th week: Quality theories- Taguchi method (Design of Experiments) *5th week: Tools of quality - 7 basic tools of quality (Ishikawa)* *6th week: Statistical Process Control I – Charts for Variables* *7th week: Statistical Process Control II – Charts for Attributes* *8th week: Process Capability* *9th week: Quality management: International Quality standards (ISO, TQM, EFQM model)* *10th week: LEAN Manufacturing and Quality* *11th week: Six Sigma System* *12th week:Product Design – Quality Function Deployment* *13th week: Risk Evalutaion: Failure Mode and Effects Analysis* *14th week: Practicing Case Studies*
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 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. Agnes Kotsis, assistant professor, PhD
Lecturer: Dr. Agnes Kotsis, assistant professor, PhD

Title of course: Design of Experiments **Code**: TTKBE0617_EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: mid-semester grade	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - preparation for the tests: 62 hours Total: 90 hours	
Year, semester: 3rd year, 2nd semester	
Its prerequisite(s): TTKBE0403_EN	
Further courses built on it: -	

Topics of course

The basic data processing methods in the field of engineering. Introduction to statistics for engineers: distributions, statistical estimation, statistical hypothesis tests. Regression analysis, analysis of variance (ANOVA), factorial experiment design.

Literature

Recommended:

1. Zivorad R. Lazic, Design of Experiments in Chemical Engineering, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.
2. R. Mead, S. G. Gilmour, A. Mead, Statistical Principles for the Design of Experiments: Applications to Real Experiments, Cambridge University Press, Cambridge, 2012
3. Robert de Levi. How to Use Excel® in Analytical Chemistry: And in General Scientific Data Analysis, Cambridge University Press, Cambridge, 2004

Schedule:

1st week

Uncertain phenomena, population, sample, probability variable, probability density function, cumulative distribution function.

2nd week

Expected value, sample mean, variance, standard deviation.

3rd week

Gaussian distribution, z-distribution.

4th week

T-distribution, f-distribution.

5th week

Estimations, confidence intervals.

6th week
Hypothesis tests.
7th week
T-test
8th week
Two sample t-test.
9th week
Paired t-test.
10th week
Correlation analysis.
11th week
Regression analysis.
12th week
Analysis of variance (ANOVA).
13th week
Factorial experiment design. 2^p plans.
14th week
Factorial experiment design, significance of the estimated model parameters.

Requirements:
Attendance at lectures is recommended, but not compulsory.
The course ends with test for the term grade. 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 can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

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

Lecturer: Dr. Ákos Kuki, associate professor, PhD

Title of course: BSc thesis I. **Code**: TTKBG2011_EN	**ECTS Credit points:** 2

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 32 hours
- preparation for the exam: -

Total: 60 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): Completion of 140 credits

Further courses built on it: TTKBG2012_EN

Topics of course

The aim of the course is to solve a problem that can be approached by chemical or chemical engineering methods. The student is expected to get the following competences: planning, time management, handling of information (acquiring and analysing them from various sources, such as traditional library, electronic databases, search engines), ability to work alone or in a team, practical application of the 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 or chemical industry. 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. Sándor Kéki, university professor, DSc

Lecturer: supervisors are staff members of the Institute of Chemistry, UD or specialists at the cooperating industrial partners (e.g. MOL Petrochemistry, TEVA Pharmaceutical, BorsodChem), however in this case a co-supervisor from the Institute of Chemistry continously verifies the work.

Title of course: BSc thesis II. **Code**: TTKBG2012_EN	**ECTS Credit points:** 13
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 13 hours/week	
Evaluation: practice grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: - - laboratory: 182 hours - home assignment: 208 hours - preparation for the exam: - Total: 390 hours	
Year, semester: 4th year, 1st semester	
Its prerequisite(s): TTKBG2011_EN	
Further courses built on it: -	

Topics of course
The student will complete the task started in 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. Detailed requirements of the thesis is described in the first part of this bulletin and in the Education and Examination Rules and Regulations, which can be found at the homepage of the insitute.
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. Sándor Kéki, university professor, DSc
Lecturer: supervisors are staff members of the Institute of Chemistry, UD or specialists at the cooperating industrial partners (e.g. MOL Petrochemistry, TEVA Pharmaceutical, BorsodChem),

however in this case a co-supervisor from the Institute of Chemistry continously verifies the work.

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 hours	
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)

Recommended:

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 professor, 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: - - laboratory: - - home assignment: 32 hours - preparation for the exam: 30 hours Total: 90 hours	
Year, semester: 3nd 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 Dávid, assistant lecturer, PhD

Title of course: Macroeconomics **Code**: TTBEBVM-KT3_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 (or any later fall semester)	
Its prerequisite(s): TTBEBVVM-KT1_EN	
Further courses built on it: -	

Topics of course

The course is aimed at making students familiar with the basic issues of macroeconomics, and make them able to use those fundamental analytical tools which are needed to think about macroeconomic questions. By the end of the course the students have to be able to use a model of a closed economy in analysing macroeconomic phenomena will have some basic insights about an open economy, too. The topics of the course cover the basic principles of macroeconomics, measuring GDP, inflation, and unemployment, the basics of the financial system, labour market processes, and economic policy.

Literature

Compulsory:
Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009.
Recommended:
Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010.
Mankiw, Gregory: Macroeconomics. Sixth Edition. Worth Publisher, New York, 2007.

Schedule:

1st week
The fundamental questions of macroeconomics.
LO: The students are aware of the main questions of macroeconomics and some of the connections between them.

2nd week

Aggregates in macroeconomics.
LO: The students understand the meaning of aggregation and the aggregates that are used most often.

3rd week
Measuring income: nominal and real GDP.
LO: The students understand the different approaches to measuring GDP and the relationships between these approaches.

4th week
Measuring the costs of living.
LO: The students understand the steps through which the consumer price index is calculated, and the meaning of that index.

5th week
Money, monetary system, money supply, demand for money, and inflation I
LO: The students know the functions of money and have a birds-eye view of the money creation process.

6th week
Money, monetary system, money supply, demand for money, and inflation II
LO: The students understand the role and structure of the banking sector in the economy, are aware of the basic roles of the central bank, are able to explain some of the social costs, and cause, of inflation.

7th week
The time value of money
LO: The students are aware of the methods of comparing future income flows with different timing.

8th week
Saving, investment, and the financial system.
LO: The students understand the function of savings, and that of the market for loanable funds in the economy. They know the basic types of financial assets such as stocks and bonds.

9th week
Labour market and unemployment.
LO: The students know the main measures to describe the labour market with, the main reasons, and the types of, unemployment.

10th week
Short-run economic fluctuations I.
LO: The students re familiar with the notion of aggregate demand and supply.

11th week
Short-run aggregate fluctuations II.

LO: The students are familiar with the possibilities and limitations of fiscal and monetary policy in countervailing recessions. *12th week* The economy in the long run. LO: Students are familiar with the factors that determine aggregate income in the long run. *13th week* International economic relations. LO: Students are familiar with the basic welfare implications of international trade, and the effects of protectionism. *14th week* Summary. LO: Students have a birds-eye view of the relationships of the topics that will have been discussed.
Requirements: *- for a signature* There is no requirement for a signature. *- for a grade* Assessment is based on a written exam which will be evaluated according to the following grading schedule: 0 -50% – fail (1) 50%+1 point -63% – pass (2) 64% -75% – satisfactory (3) 76% -86% – good (4) 87% -100% – excellent (5)
Person responsible for course: Dr. Pál Czeglédi, associate professor, PhD
Lecturer: Dr. István Kovács, 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: 2nd–4th year, 1st 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:

1st week

Narcotics, hard and soft drugs 1. General properties, groups, addiction, legal state. Treatment of addiction. Cannabis.

2nd 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: Computational Quantum Chemistry **Code**: TTKBG0903_EN	**ECTS Credit points:** 3
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: 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 - Density Functional Theory - Basis sets - Solvent effect, Polarizable Continuum Model - Geometry optimization - Structural analysis - Calculating energies 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. Mihály Purgel, assistant professor, PhD
Lecturer: Dr. Mihály Purgel, assistant professor, PhD Dr. Attila Mándi, assistant professor, PhD

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

Interaction of radiation with matter, general sketch of the applications.

2nd week

Radiotracers, physical chemistry of carrier-free concentrations.

3rd week

Basic rules of tracer studies.

4th week

Selection of radiotracers.

5th week

Preparation of frequently used radiotracers, general methods.
6th week
Preparation of frequently used radiotracers, examples.
7th week
Classification of tracer methods, the role of mixing entropy.
8th week
Tracer studies in physical chemistry: kinetics of exchange reactions, coprecipitation, determination of solubility, diffusion studies, surface area determination.
9th week
Analytical applications: isotope dilution, radiometric titration, activation analysis.
10th week
Nuclear and radioanalytical methods based on radiation-matter interactions.
11th week
Applications of isotopes in chemical industry.
12th week
Tracer studies in medicine.
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: Dr. Noémi Nagy, professor, DSc

Lecturer: Dr. Noémi Nagy, professor, DSc

Title of course: Plastics and Processing II. **Code**: TTKBE0711_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: Prof. Dr. Sándor Kéki, university professor, DSc

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

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: - - preparation for the exam: 62 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: 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: 22 hours
- preparation for the exam: 40 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: NMR Operator Training Practice I. **Code**: TTKML0004_EN, TTKBL0004_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: - - 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. Batta Gyula, university professor, DSc
Lecturer: Prof. Dr. Batta Gyula, university professor, DSc

Title of course: Plastics and Processing III. **Code**: TTKBE1214_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: 22 hours - preparation for the exam: 28 hours Total: 90 hours	
Year, semester: 4th year, 1st semester	
Its prerequisite(s): TTKBE0611_EN	
Further courses built on it: -	

Topics of course

The basics of the processing of different plastics. Classification of plastic types. Mixing and homogenization of plastics. Theory of extrusion, technological aspects. Extrusion of different product types (rod, tube, sheet, hollow bodies). Calendering, tube blowing, dry melt and wet spinning. Technology of injection molding. Compression molding. Thermoforming technologies (stretching, deep-drawing, pressure and vacuum forming). Forming methods without pressure (casting, die casting, centrifugal casting, rotational molding, dip-coating). Plastic coatings. Plastic foams, foaming. Basics of composites. Fixation of plastic components: adhesive bonding, screwing, welding, clamp joint. Liquid resin processes. Decorating and finishing.

Literature

Compulsory:
- A.B. Strong: Plastics: Materials and Processing (Prentice Hall, 2006) ISBN: 9780131145580
- C.A. Harper: Handbook of Plastic Processes (Wiley, 2005) ISBN: 9780471662556

Recommended:
- Z. Tadmor, C.G. Gogos: Principles of Polymer Processing (Wiley, 2006), ISBN: 0471387703

Schedule:

1st week
The basics of the processing of different plastics. Classification of plastic types.

2nd week
Mixing and homogenization of plastics.

3rd week
Theory of extrusion, technological aspects. Extrusion of different product types (rod, tube, sheet, hollow bodies).

4th week

Calandering, tube blowing, dry melt and wet spinning.
5th week
Technology of injection molding. Available plastics, formed products.
6th week
Compression molding with pressure or vacuum. Available plastics, formed products.
7th week
Thermoforming technologies (stretching, deep-drawing, pressure and vacuum forming).
8th week
Forming methods without pressure (casting, die casting, centrifugal casting, rotational molding, dip-coating).
9th week
Plastic coatings on different materials: metals, glass, plastics.
10th week
Plastic foams, foaming. Foaming agents and methods.
11th week
Basics of composites. Reinforcing fiber types, physico-chemical background.
12th week
Fixation of plastic components: adhesive bonding, screwing, welding, clamp joint.
13th week
Liquid resin processes.
14th week
Decorating and finishing.

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

Title of course: Chemical Technology III. **Code**: TTKBE1117_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: 4th year, 1st semester	
Its prerequisite(s): TTKBE1112_EN, TTKBL1112_EN	
Further courses built on it: -	

Topics of course

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

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
Biofuels, bioethanol production in the industry

2nd week
Biofuels, biodiesel production in the industry

3rd week
Yeast and acetic acid production

4th week
Manufacturing beer

5th week

Uses of renewable energy sources
6th week
Manufacturing sugar
7th week
Paper industry
8th week
Classification of explosive materials
9th week
Nanotechnology
10th week
Polyurethanes
11th week
Nuclear energy
12th week
Manufacturing wine and champagne
13th week
Silicate industry, production of cement
14th week
Ceramic industry

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: 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: 1st year, 2nd 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: Course material, concept and task collection for lectures, seminars in the e-learning system. *Recommended:* J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725 J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449 J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293 F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014 L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148 T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595 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: László Dr. Juhász, associate professor, PhD

Lecturer: László Dr. 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:

Course material, concept and task collection for lectures, seminars in the e-learning system.

Recommended:

J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725

J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449

J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293

F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014

L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148

T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595

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, dr. habil

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:

Course material, concept and task collection for lectures, seminars in the e-learning system.

Recommended:

J. G. Smith: Organic Chemistry, 5th Edition, 2016, McGrow Hill; ISBN-13: 9780077354725

J. McMurry: Organic Chemistry, 8th Edition, 2012, Brooks/Cole; ISBN-13: 9780840054449

J. Clayden, N. Greeves, and S. Warren: Organic Chemistry, 2nd Edition, 2012, Oxford University Press; ISBN-13: 9780199270293

F. A. Carey: Organic Chemistry, 4th Edition, 2000, The McGraw-Hill Companies; ISBN-13: 9780072905014

L. G. Wade: Organic Chemistry, 8th Edition, 2012, Pearson; ISBN-13: 9780321768148

T. W. G. Solomons, C. Fryhle, Organic Chemistry, 10th Edition, 2009, Wiley & Sons; ISBN-10: 0470556595

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