CHEMICAL ENGINEERING BSC PROGRAM
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Welcome to the Faculty of Science and Technology!

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

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

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

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

Prof. dr. Ferenc Kun
Dean
UNIVERSITY OF DEBRECEN

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

Legal predecessors: Debrecen University of Agricultural Sciences; Debrecen Medical University; Wargha István College of Education, Hajdúbőszörmény; Kossuth Lajos University of Arts and Sciences

Number of Faculties at the University of Debrecen: 14
Faculty of Agricultural and Food Sciences and Environmental Management
Faculty of Child and Special Needs Education
Faculty of Dentistry
Faculty of Economics and Business
Faculty of Engineering
Faculty of Health
Faculty of Humanities
Faculty of Informatics
Faculty of Law
Faculty of Medicine
Faculty of Music
Faculty of Pharmacy
Faculty of Public Health
Faculty of Science and Technology

Number of students at the University of Debrecen: 29,045

Full time teachers of the University of Debrecen: 1,541
200 full university professors and 1,205 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 ~650 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

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<td><a href="mailto:purgel.mihaly@science.unideb.hu">purgel.mihaly@science.unideb.hu</a></td>
<td>D617</td>
</tr>
<tr>
<td>Mrs. Dr. Szilvia Bunda, PhD</td>
<td>Assistant Research Fellow</td>
<td><a href="mailto:bunda.szilvia@science.unideb.hu">bunda.szilvia@science.unideb.hu</a></td>
<td>D607</td>
</tr>
<tr>
<td>Mr. Dr. Tibor Csupasz, PhD</td>
<td>Assistant Lecturer</td>
<td><a href="mailto:csupasz.tibor@science.unideb.hu">csupasz.tibor@science.unideb.hu</a></td>
<td>D520</td>
</tr>
<tr>
<td>Mr. Dr. Imre Tóth, PhD, DSc</td>
<td>Professor Emeritus</td>
<td><a href="mailto:imre.toth@science.unideb.hu">imre.toth@science.unideb.hu</a></td>
<td>D520</td>
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<tr>
<td>Mrs. Dr. EnikőTóth-Molnár, PhD</td>
<td>Assistant Research Fellow</td>
<td><a href="mailto:molnar.eniko@science.unideb.hu">molnar.eniko@science.unideb.hu</a></td>
<td>D507</td>
</tr>
<tr>
<td>Mr. Dr. Antal Udvardy, PhD</td>
<td>Assistant Professor</td>
<td><a href="mailto:udvardya@science.unideb.hu">udvardya@science.unideb.hu</a></td>
<td>D603</td>
</tr>
</tbody>
</table>
ACADEMIC CALENDAR

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

<table>
<thead>
<tr>
<th>Study period</th>
<th>1(^{\text{st}}) week</th>
<th>Registration*</th>
<th>1 week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2(^{\text{nd}}) – 15(^{\text{th}}) week</td>
<td>Teaching period</td>
<td>14 weeks</td>
</tr>
<tr>
<td>Exam period</td>
<td>directly after the study period</td>
<td>Exams</td>
<td>7 weeks</td>
</tr>
</tbody>
</table>

*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:
THE CHEMICAL ENGINEERING BACHELOR PROGRAM

Information about the Program

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

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 180 credit points. It means approximately 30 credits per semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the prerequisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Model Curriculum of Chemical Engineering BSc Program”.
Model Curriculum of Chemical Engineering BSc Program

<table>
<thead>
<tr>
<th>Science subject group</th>
<th>semesters</th>
<th>ECTS credit points</th>
<th>evaluation</th>
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</thead>
<tbody>
<tr>
<td><strong>Mathematics modul</strong></td>
<td>1.</td>
<td></td>
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<tr>
<td>1. Mathematics I.</td>
<td>56 l / 5cr</td>
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<td>7</td>
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<tr>
<td>Zoltán Muzsnay</td>
<td>42 p / 2cr</td>
<td></td>
<td>exam</td>
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<tr>
<td>2. Mathematics II.</td>
<td>28 l /3cr</td>
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<td>5</td>
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<tr>
<td>Zoltán Muzsnay</td>
<td>42 p /2cr</td>
<td></td>
<td>exam</td>
</tr>
<tr>
<td><strong>Physics modul</strong></td>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Physics for Engineers I.</td>
<td>42 l /3cr</td>
<td>3</td>
<td>exam</td>
</tr>
<tr>
<td>Balázs Ujvári</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Physics for Engineers II</td>
<td>42 l /3cr</td>
<td>3</td>
<td>exam</td>
</tr>
<tr>
<td>Balázs Ujvári</td>
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<tr>
<td><strong>Chemistry modul</strong></td>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>1. General Chemistry I. (lect and sem)</td>
<td>42 l /4cr, 42 p /3cr</td>
<td>7</td>
<td>exam</td>
</tr>
<tr>
<td>József Kalnár, Linda Biró-Földi</td>
<td></td>
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<tr>
<td>2. General Chemistry (lab) II.</td>
<td>42 p /3cr.</td>
<td>3</td>
<td>mid-semestre grade</td>
</tr>
<tr>
<td>Linda Biró-Földi</td>
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<tr>
<td>3. Inorganic Chemistry I.</td>
<td>28 l /3cr.</td>
<td>3</td>
<td>exam</td>
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<tr>
<td>István Lázár</td>
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<tr>
<td>4. Inorganic Chemistry II.</td>
<td>28 l /3cr.</td>
<td>3</td>
<td>exam</td>
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<tr>
<td>Péter Buglyó</td>
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<tr>
<td>5. Organic Chemistry I. (lect and sem)</td>
<td>28 l /3cr. 14 p /1cr.</td>
<td>4</td>
<td>exam</td>
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<td>Tibor Kurtán</td>
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<td>Course</td>
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<td>Credits</td>
<td>Exams</td>
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<tr>
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<tr>
<td><strong>Organic Chemistry II.</strong></td>
<td>Tibor Kurtán, Marietta Vágvölgyiné Tóth</td>
<td>42 l/4cr. 42 p/2cr.</td>
<td>6</td>
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<tr>
<td><strong>Organic Chemistry III.</strong></td>
<td>László Somsák</td>
<td>28 l/3cr./</td>
<td>3</td>
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<tr>
<td><strong>Biochemistry I.</strong></td>
<td>János Kerékgyártó</td>
<td>28 l/3cr</td>
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**Economic and Human Sciences subject group**

**Micro- and Macroeconomic modul**

<table>
<thead>
<tr>
<th>Course</th>
<th>Name</th>
<th>Credits</th>
<th>Exams</th>
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</thead>
<tbody>
<tr>
<td>1. Introduction to Economics</td>
<td>Levente Sándor Nádasdi</td>
<td>28 l/3cr.</td>
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</table>

**Management and Business modul**

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<thead>
<tr>
<th>Course</th>
<th>Name</th>
<th>Credits</th>
<th>Exams</th>
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</thead>
<tbody>
<tr>
<td>1. Introduction to Business</td>
<td>András Nábrádi</td>
<td>28 l/3cr</td>
<td>3</td>
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</tbody>
</table>

**Business Law modul**

<table>
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<tr>
<th>Course</th>
<th>Name</th>
<th>Credits</th>
<th>Exams</th>
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</thead>
<tbody>
<tr>
<td>1. Basics of Civil Law I.</td>
<td>Tamás Fézer</td>
<td>28 l/2cr.</td>
<td>2</td>
</tr>
<tr>
<td>2. Basics of Civil Law II.</td>
<td>Tamás Fézer</td>
<td>.</td>
<td>2</td>
</tr>
<tr>
<td>3. History and Structure of European Union</td>
<td>Károly Teperics</td>
<td>14 l/1cr</td>
<td>1</td>
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**Economic and Human Sciences module**

<table>
<thead>
<tr>
<th>Course</th>
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<th>Credits</th>
<th>Exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Engineering Ethics</td>
<td>Zsolt Tiba</td>
<td>28 l/3cr.</td>
<td>3 mid-semestre grade</td>
</tr>
<tr>
<td>2. Management of Value Creating Processes</td>
<td>Miklós Pakurár</td>
<td>28 l/3cr.</td>
<td>3</td>
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**Basics of Professional Knowledge subject group**

**Physical, Analytical Chemistry and Material Science modul**

**Analytical Field**

<table>
<thead>
<tr>
<th>Course</th>
<th>Name</th>
<th>Credits</th>
<th>Exams</th>
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</thead>
<tbody>
<tr>
<td>1. Analytical Chemistry I.</td>
<td>Péter Buglyó</td>
<td>28 l/3cr.</td>
<td>3</td>
</tr>
<tr>
<td>Course</td>
<td>Instructor</td>
<td>Credits</td>
<td>Type</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
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<tr>
<td>2. Inorganic and Qualitative Analytical Chemistry</td>
<td>Csilla Kállay</td>
<td>56 p</td>
<td>4 cr.</td>
</tr>
<tr>
<td>3. Application of Instrumental Analysis (lect.)</td>
<td>István Lázár</td>
<td>14 l</td>
<td>1 cr.</td>
</tr>
<tr>
<td>4. Application of Instrumental Analysis (lab.)</td>
<td>Attila Gáspár</td>
<td>42 p</td>
<td>3 cr.</td>
</tr>
<tr>
<td>Physical Chemistry and Material Science Field</td>
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<tr>
<td>1. Physical Chemistry I. (lect. and sem.)</td>
<td>Attila Bényei</td>
<td>28 l</td>
<td>3 cr.</td>
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<tr>
<td>2. Physical Chemistry II. (lect. and sem.)</td>
<td>Attila Bényei</td>
<td>28 p</td>
<td>2 cr.</td>
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<tr>
<td>3. Physical Chemistry II. (lab.)</td>
<td>Ferenc KrisztiánKálmán</td>
<td>28 p</td>
<td>2 cr.</td>
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<tr>
<td>4. Physical Chemistry III.</td>
<td>Noémi Nagy</td>
<td>28 l</td>
<td>3 cr.</td>
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<tr>
<td>5. Macromolecular Chemistry</td>
<td>Sándor Kéki</td>
<td>28 l</td>
<td>3 cr.</td>
</tr>
<tr>
<td>6. Materials of Construction</td>
<td>Sándor Kéki</td>
<td>28 l</td>
<td>3 cr.</td>
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<tr>
<td>7. Plastics and Processing I</td>
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<td>2 cr.</td>
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<tr>
<td>Measurement and Processing modul</td>
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<td>Informatics Field</td>
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<td>1. Informatics for Engineers</td>
<td>Ákos Kuki</td>
<td>28 l</td>
<td>2 cr.</td>
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<td>Processing Field</td>
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<td><strong>Process Control I.</strong></td>
<td>Lajos Nagy</td>
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<tr>
<td><strong>Mechanics and Unit Operation module</strong></td>
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<td>1. Mechanics for Chemical Engineers I.</td>
<td>Zsolt Tibó</td>
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<tr>
<td>2. Mechanics for Chemical Engineers II.</td>
<td>Ákos Kuki</td>
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<tr>
<td>3. Mechanics for Chemical Engineers III.</td>
<td>Gábor Balogh</td>
<td>42</td>
<td>3</td>
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<tr>
<td>Unit Operation Field</td>
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<tr>
<td>1. Unit Operation I.</td>
<td>Sándor Kéki</td>
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<td>6</td>
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<tr>
<td>2. Unit Operation II</td>
<td>Katalin Margit Illésné Czifrák</td>
<td>70</td>
<td>6</td>
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<tr>
<td>3. Unit Operation III.</td>
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<tr>
<td><strong>Technology Module</strong></td>
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<tr>
<td>Planing Field</td>
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<tr>
<td>2. Computer Modeling of Chemical Technology Systems II</td>
<td>Ákos Kuki</td>
<td>28</td>
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<tr>
<td>1. Chemical Technology I.</td>
<td>Lajos Nagy</td>
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</table>

*mid-semester grade*
<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
<th>Credits</th>
<th>Examination</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Technology II.</td>
<td>Lajos Nagy</td>
<td>28 l/3cr.</td>
<td>exam</td>
<td>mid-semester grade</td>
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<tr>
<td>Environmental Technology</td>
<td>Katalin Margit IllyésnéCzifrák</td>
<td>28 l/3cr, 28 l/2cr.</td>
<td>exam, mid-semester grade</td>
<td></td>
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<tr>
<td>Pilot Plant Work</td>
<td>Tibor Nagy</td>
<td>70 p/5c</td>
<td>mid-semester grade</td>
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<td>Safety Field</td>
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<td>Safety</td>
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<td>exam</td>
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<td>Special Courses</td>
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<td>Basics of Petrolchemistry</td>
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<td>exam</td>
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<td>Waste Management</td>
<td>Sándor Kéki</td>
<td>28 l/3cr.</td>
<td>exam</td>
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<tr>
<td>Spectroscopic Methods I.</td>
<td>Gyula Batta</td>
<td>28 l/3cr.</td>
<td>exam</td>
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<tr>
<td>Quality Management</td>
<td>Ágnes Kotsis</td>
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<td>exam</td>
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<tr>
<td>Design of Experiments</td>
<td>Akos Kuki</td>
<td>28 l/3cr.</td>
<td>mid-semester grade</td>
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<tr>
<td>Crystallography</td>
<td>Gábor Dobosi</td>
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<td>István Gyulai</td>
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Note: Credits and exams are approximate and subject to change.
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<tr>
<th>Course Number</th>
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<th>Hours</th>
<th>Exam/Grade</th>
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<tr>
<td>3</td>
<td>History of Chemistry</td>
<td>Ágnes Dávid</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
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<tr>
<td>4</td>
<td>Macroeconomics</td>
<td>Pál Czeglédi</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>5</td>
<td>Applied Radiochemistry</td>
<td>Noémi Nagy</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>fall semester</td>
<td>exam</td>
</tr>
<tr>
<td>6</td>
<td>Plastics and Processing II</td>
<td>Sándor Kéki</td>
<td>28 p/2 cr.</td>
<td>28 p/2 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>7</td>
<td>Colloid Chemistry</td>
<td>Levente Novák</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>fall semester</td>
<td>exam</td>
</tr>
<tr>
<td>8</td>
<td>Biochemistry III</td>
<td>Teréz Barna</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>9</td>
<td>Biocolloids</td>
<td>Levente Novák</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>10</td>
<td>NMR Operator Training I</td>
<td>Gyulya Batta</td>
<td>28 p/2 cr.</td>
<td>28 p/2 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>11</td>
<td>Plastics and Processing III</td>
<td>Sándor Kéki</td>
<td>42 p/3 cr.</td>
<td>42 p/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>12</td>
<td>Chemical Technology III</td>
<td>Lajos Nagy</td>
<td>28 l/3 cr.</td>
<td>28 l/3 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>13</td>
<td>Organic Chemistry Seminar I</td>
<td>László Juhász</td>
<td>14 p/1 cr.</td>
<td>14 p/1 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>14</td>
<td>Organic Chemistry Seminar II</td>
<td>László Juhász</td>
<td>14 p/1 cr.</td>
<td>14 p/1 cr.</td>
<td>spring semester</td>
<td>exam</td>
</tr>
<tr>
<td>15</td>
<td>Visitsat Chemical Companies</td>
<td>Akos Kuki</td>
<td>28 p</td>
<td>28 p</td>
<td></td>
<td>Paralel registration to TTKBE11 11_EN</td>
</tr>
<tr>
<td>Industrial Placement</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>---</td>
</tr>
<tr>
<td><em>Internship</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ákos Kuki</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 weeks</td>
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</tr>
<tr>
<td>signature</td>
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<td></td>
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</tr>
</tbody>
</table>
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 (Industrial Placement:TTKBG1119_EN) in the spring semester (6th 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.
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 theses” which is handed out to every candidate when they decide upon their topic. The theses 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)

\[
\text{Diploma grade} = \frac{(A + B + C)}{3}
\]

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

<table>
<thead>
<tr>
<th>Title of course: Mathematics I.</th>
<th>ECTS Credit points: 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTMBE0808</td>
<td></td>
</tr>
</tbody>
</table>

### 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

### Literature

#### Compulsory:
-

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

### Schedule:

#### 1st week

#### 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

4th week

5th week

6th week

7th week

8th week

9th week
Improper integrals. Applications.

10th week
Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

12th week

13th week

14th week

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>Score Range</td>
<td>Grade</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>75-86</td>
<td>good</td>
</tr>
<tr>
<td>87-100</td>
<td>excellent</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: 3 hours/week</td>
<td></td>
</tr>
<tr>
<td>- laboratory: -</td>
<td></td>
</tr>
</tbody>
</table>

| Evaluation:                     | exam |

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
</tr>
<tr>
<td>- practice: 42 hours</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
<tr>
<td>- home assignment: 18 hours</td>
</tr>
<tr>
<td>- preparation for the exam:</td>
</tr>
</tbody>
</table>

Total: 60 hours

| Year, semester: | 1st year, 1st semester |

| Its prerequisite(s): | - |

| Further courses built on it: | TTMBE0809_EN, TTMBG0809_EN |

<table>
<thead>
<tr>
<th>Topics of course</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory: -</td>
</tr>
<tr>
<td>Recommended:</td>
</tr>
<tr>
<td>Thomas, Weir&amp; Hass: Thomas' Calculus,</td>
</tr>
<tr>
<td>K. A. Stroud: Calculus and MathematicalAnalysis,</td>
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<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Schedule:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
</tr>
<tr>
<td>2nd week</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>3rd week</td>
</tr>
</tbody>
</table>

| 28 |

4th week

5th week

6th week

7th week

8th week
Test.

9th week
Improper integrals. Applications.

10th week
Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

12th week

13th week

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:
<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-84</td>
<td>good (4)</td>
</tr>
<tr>
<td>85-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th><strong>Title of course:</strong> Mathematics II.</th>
<th><strong>ECTS Credit points:</strong> 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code:</strong> TTMBE0809_EN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Evaluation:</strong> exam</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
<tr>
<td>- home assignment: 22 hours</td>
</tr>
<tr>
<td>- preparation for the exam: 40 hours</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Total:</strong> 90 hours</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Year, semester:</strong> 1&lt;sup&gt;st&lt;/sup&gt; year, 2&lt;sup&gt;nd&lt;/sup&gt; semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Its prerequisite(s):</strong> TTMBE0808_EN, TTMBG0808_EN</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Further courses built on it:</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Compulsory:</strong> -</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Recommended:</strong></th>
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<tbody>
<tr>
<td>Thomas, Weir&amp; Hass: Thomas' Calculus,</td>
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<tr>
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</table>

<table>
<thead>
<tr>
<th><strong>Schedule:</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>1&lt;sup&gt;st&lt;/sup&gt; week</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>2&lt;sup&gt;nd&lt;/sup&gt; week</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit and continuity of multivariable functions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>3&lt;sup&gt;rd&lt;/sup&gt; week</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse function theorem. The implicit function theorem.</td>
</tr>
</tbody>
</table>
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

8th week

9th week

10th week
Element of the probability theory. Conditional probability. Total probability theorem, Bayes’ theorem. Independence of events.

11th week

12th week
Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.

13th week

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:

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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 |
<table>
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<tr>
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<tbody>
<tr>
<td><strong>Type of teaching, contact hours</strong></td>
<td></td>
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<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: 3 hours/week</td>
<td></td>
</tr>
<tr>
<td>- laboratory: -</td>
<td></td>
</tr>
<tr>
<td><strong>Evaluation:</strong> exam</td>
<td></td>
</tr>
<tr>
<td><strong>Workload (estimated), divided into contact hours:</strong></td>
<td></td>
</tr>
<tr>
<td>- lecture: -</td>
<td></td>
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<td>- laboratory: -</td>
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<td>- preparation for the exam:</td>
<td></td>
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<td>Total: 60 hours</td>
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</tr>
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<td><strong>Year, semester:</strong> 1st year, 2nd semester</td>
<td></td>
</tr>
<tr>
<td><strong>Its prerequisite(s):</strong> TTMBE0808_EN, TTMBG0808_EN</td>
<td></td>
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<tr>
<td><strong>Further courses built on it:</strong></td>
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**Topics of course**


**Literature**

*Compulsory:* -  
*Recommended:*  
  - Thomas, Weir & Hass: Thomas’ Calculus,  
  - P. Sahoo: Probability and Mathematical Statistics  
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5th week

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6th week

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

7th week

Test.


8th week


9th week


10th week

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

11th week


12th week

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

13th week


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.

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<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-84</td>
<td>good (4)</td>
</tr>
<tr>
<td>85-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>
Students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

<table>
<thead>
<tr>
<th>Person responsible for course:</th>
<th>Dr. Zoltán Muzsnay, associate professor, PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer:</td>
<td>Dr. Zoltán Muzsnay, associate professor, PhD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title of course:</th>
<th>Physics for Engineers I</th>
<th>ECTS Credit points: 3</th>
</tr>
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<tbody>
<tr>
<td>Code:</td>
<td>TTFBE2111_EN</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
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<tr>
<td>- practice: 1 hours/week</td>
</tr>
<tr>
<td>- laboratory:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>exam</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
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</tr>
<tr>
<td>- laboratory:</td>
</tr>
<tr>
<td>- home assignment: 24 hours</td>
</tr>
<tr>
<td>- preparation for the exam: 24 hours</td>
</tr>
<tr>
<td>Total: 90 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year, semester:</th>
<th>1st year, 1st semester</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Its prerequisite(s):</th>
<th>–</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Further courses built on it:</th>
<th>TTFBE2113_EN, TTKBE0401_EN, TTKBG0401_EN, MFVGE31V03_EN</th>
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</table>

<table>
<thead>
<tr>
<th>Topics of course</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>J.W. Jewett Jr, R.A. Serway: Physics for Scientists and Engineers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Schedule:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
</tr>
<tr>
<td>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</td>
</tr>
</tbody>
</table>

<p>| 2nd 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 |</p>
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd</td>
<td>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</td>
</tr>
<tr>
<td>4th</td>
<td>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</td>
</tr>
<tr>
<td>5th</td>
<td>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</td>
</tr>
<tr>
<td>6th</td>
<td>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</td>
</tr>
<tr>
<td>7th</td>
<td>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</td>
</tr>
<tr>
<td>8th</td>
<td>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</td>
</tr>
<tr>
<td>9th</td>
<td>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</td>
</tr>
<tr>
<td>10th</td>
<td>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</td>
</tr>
<tr>
<td>11th</td>
<td>Oscillations: analyzing the motion of a pendulum, simple harmonic oscillations, addition of two simple harmonic oscillations, Lissajous figures, damped oscillations, forced oscillations, coupled oscillations</td>
</tr>
<tr>
<td>12th</td>
<td>Elasticity: tensile stress, shearing stress, uniform compression, relative deformation, Young's modulus, shear modulus, compression modulus, Hooke’s law, elastic energy, elastic energy density</td>
</tr>
<tr>
<td>13th</td>
<td>Wave motion: mechanical waves, transverse and longitudinal waves, one-dimensional wave motion in a stretched 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</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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:</td>
</tr>
<tr>
<td>0–49 % → 1,</td>
</tr>
<tr>
<td>50–62 % → 2,</td>
</tr>
<tr>
<td>63–75 % → 3,</td>
</tr>
<tr>
<td>76–88 % → 4,</td>
</tr>
<tr>
<td>89–100 % → 5</td>
</tr>
</tbody>
</table>

| 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 |

<p>| Further courses built on it: |
| TTKBE0503_EN |</p>
<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
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<tr>
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<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong>&lt;sup&gt;st&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>2</strong>&lt;sup&gt;nd&lt;/sup&gt; week</td>
</tr>
<tr>
<td>Wave properties of light: coherent light waves, interference, diffraction, Young’s double-slit experiment, thin-film interference, single-slit diffraction, diffraction gratings</td>
</tr>
<tr>
<td><strong>3</strong>&lt;sup&gt;rd&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>4</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>5</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>6</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>7</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>Electric current: electric current, electric current density, resistance, resistivity, conductivity, differential and integral form of Ohm's law, temperature dependence of resistivity, electric power</td>
</tr>
<tr>
<td><strong>8</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>9</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td><strong>10</strong>&lt;sup&gt;th&lt;/sup&gt; week</td>
</tr>
<tr>
<td>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</td>
</tr>
</tbody>
</table>
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

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

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Schedule:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st week</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>2nd week</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>3rd week</strong></td>
</tr>
<tr>
<td><strong>4th week</strong></td>
</tr>
<tr>
<td><strong>5th week</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>6th week</strong></td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>7th week</strong></td>
</tr>
</tbody>
</table>

**8th week**

**9th week**

**10th week**

**11th week**

**12th week**

**13th week**

**14th week**

**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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-75</td>
<td>satisfactory (3)</td>
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<tr>
<td>76-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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. József Kalmár, associate professor, PhD,habil

**Lecturer:** Dr. József Kalmár, associate professor, PhD,habil

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**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

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**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.

<table>
<thead>
<tr>
<th>Week</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>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.</td>
</tr>
<tr>
<td>6th week</td>
<td>Review exercises in stoichiometry and concentration calculations.</td>
</tr>
<tr>
<td>7th week</td>
<td>Introduction to basic gas laws. Laboratory preparation of gases. Calculation problems connected to evolution of gases based on chemical equations.</td>
</tr>
<tr>
<td>9th week</td>
<td>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.</td>
</tr>
<tr>
<td>10th week</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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).
final course grade is given based on the results of these tests. The score from the general tests must be above 50% to avoid a ‘fail’ final course grade. In order to pass the seminar, a student should collect minimum 50 points from the general tests. Students with ‘fail’ final course grade due to low test results can re-take once a comprehensive test exam in the examination period. It is not allowed to miss any seminars. If a student misses two seminars even for any medical reasons, the student’s lecture book won’t be signed and she or he has to retake the course next year.

**Person responsible for course:** Dr. Linda Földi-Biró Assistant Professor, PhD

**Lecturer:** Dr. Linda Földi-Biró Assistant Professor, PhD

<table>
<thead>
<tr>
<th><strong>Title of course:</strong> General Chemistry II. (laboratory practice)</th>
<th><strong>ECTS Credit points:</strong> 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code:</strong> TTKBL0101_EN</td>
<td></td>
</tr>
</tbody>
</table>

**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 first-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. 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

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.

7th week

8th week
Practice the basic laboratory techniques considering the preparation of a salt. Preparation of salts from its metal. Studies of reactions involving gas formation and precipitation.

9th week
Quantitative study of a precipitation reactions to determine the stoichiometric composition of water insoluble precipitates using the method of continuous variation. Dependence of reaction rate of concentration of reactants. Studying the factor affecting the reaction rates. Determination of the reaction rate and the rate law of the studied reaction. Metal salts preparations due in.

10th week
Theoretical background of liquid-liquid extractions and demonstration of the separation techniques. Introduction to buffer systems, buffer capacity by studying a particular buffer system (acetic acid/acetate ion buffer; ammonium ion/ammonia buffer). Hydrolysis of salts to study the acid-base properties of ionic and covalent compounds in aqueous solutions or in reactions with water. Writing of the ionic equations based on the observed chemical reactions.

11th week
General test from week 5 to week 10. General introduction to electrochemistry. Study of redox reactions. Prediction of the direction of spontaneous processes based on standard potentials. Factors affecting the order of the deposition of different metals during electrolysis (study of Daniell cell). Return of the received pieces of laboratory equipment.

Requirements:
Each week the laboratory session begins with a short test (not more than 20 minutes) based exclusively on the preparatory material of that week and the previous week and the results of the experiments carried out the previous week. With each short test a student can collect 25 points. Altogether there are eight short tests during the semester. Students are also required to write two general tests (week 5 and week 11) which are based on the course material for weeks 1-4 and 5-10, respectively. Each general test is worth 50 points. Grading is based on a five-level scale: 1 (fail), 2 (pass), 3 (average), 4 (good), 5 (excellent). The final course grade is given based on the results of these tests, the quality of the laboratory notes and the quality of laboratory work. The average score from both the short tests and the general tests must be above 50% to avoid a ‘fail’ final course grade. In order to pass the laboratory practice, a student should collect minimum 100 points from the short tests and minimum 50 points from the general tests. Students with ‘fail’ final course grade due to inadequate laboratory work have to retake the course the next year. Students with ‘fail’ final course grade due to low test results can re-take a comprehensive test exam in the examination period.

Those students, whose results are lower than 25% either from the short test or from the general test, cannot write a final exam, they will receive a ‘fail’ final course grade.

It is not allowed to miss any laboratory practices/seminars. If a student misses one or two lab practices, medical certification is needed. If a student misses three lab practices/seminars even for any medical reasons, the student’s lecture book won’t be signed and she or he has to retake the course next year. It is not possible to miss short tests at the beginning of the laboratory practice. If a student misses more than two short tests, the laboratory practice will not be accepted for him or her. The students cannot miss either of the general tests, otherwise no signature and final grade is given to the student.

Person responsible for course: Dr. Linda Földi-Biró Assistant Professor, PhD
Lecturer: Dr. Linda Földi-Biró Assistant Professor, PhD
<table>
<thead>
<tr>
<th>Title of course: Inorganic Chemistry I</th>
<th>ECTS Credit points: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBE0201_EN</td>
<td></td>
</tr>
</tbody>
</table>

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

**Evaluation:** exam

**Workload (estimated), divided into contact hours:**
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 62 hours
Total: 90 hours

**Year, semester:** 1st year, 2nd semester

**Its prerequisite(s):** TTKBE0101_EN

**Further courses built on it:** TTKBE0202_EN, TTKBL0201_EN, TTKBE0501_EN, TTKBE0502_EN, TTKBL0502_EN, TTKBE0204_EN

**Topics of course**

**Literature**

*Compulsory:*

*Recommended:*

**Schedule:**

1st week

2nd week
Chemical, physical and atomic properties of the element hydrogen. Solubility of hydrogen in different materials. Hydrogen isotopes, their nuclear properties, nuclear spin isomers, practical application of isotopes and nuclear isomers. Electronic structure, oxidation number, and chemical reactivity, and major reactions of hydrogen. Laboratory and industrial production of hydrogen. Hydrogen as an environment-friendly fuel. Binary hydrides, their most important groups,
properties. Hydrogen bonding and its role in the structure and properties of the materials. The most important hydrogen compounds and their use in the practice.

3rd week
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

7th week

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,

Environmental concerns regarding the concentration of atmospheric sulfur dioxide: formation and effect of acid rain.

9th week


10th week


Halides and halogeno-complexes of the nitrogen-group elements. Composition, formation, structure, characteristic physical and chemical properties, reactivities. Practical uses.


11th week

Nitrogen and phosphorus 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.


12th week


Comparison of the structure and stability, hydrolytic properties of the binary hydrides of the carbon group elements. Preparation of the hydrides, practical uses in the 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 o xoacids of carbon and silicon. Composition and electronic structure of carbon oxides and o xoacids. 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 synthetic silicates. Polymeric and 3D structures, basic types, appearance 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. Comparison of oxo and thio compounds. Thio-bases and thio-acids.
Types of carbides, ionic, covalent and interstitial carbides. Properties, practical uses.

14th week
Elements of the boron group. Appearance, natural resources, most important minerals. Electronic structure, Lewis-acidity, physical and chemical properties, most important chemical reactions.
Practical use of aluminum oxide and high 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.

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-100</td>
<td>qualified to the exam</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-75</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>76-88</td>
<td>good (4)</td>
</tr>
<tr>
<td>89-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:*

*Recommended:*

**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

5th week

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

8th week

9th week

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

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-39</td>
<td>fail (1)</td>
</tr>
<tr>
<td>40-55</td>
<td>pass (2)</td>
</tr>
<tr>
<td>56-70</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>71-85</td>
<td>good (4)</td>
</tr>
<tr>
<td>86-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course: OrganicChemistry I.</th>
<th>ECTS Credit points: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBE0301_EN</td>
<td></td>
</tr>
</tbody>
</table>

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

**Literature**

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

*Recommended:*
**Schedule:**

**1st week**
The definition and brief history of organic chemistry. Theories of the chemical bond, Lewis-Kössel theory, covalent and ionic bonds, LCAO-MO theory, types of atomic and molecular orbitals. Resonance contributors.

**2nd week**

**3rd week**
Description of functional groups in organic compounds. Classification of organic reactions based on the reagent and type of the reaction.

**4th week**
The basic nomenclature systems in organic chemistry: common or trivial names and systematic nomenclature. 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 thermodynamical parameters of chemical reactions.

**5th week**

**6th week**
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. Preparation, conformation and physical properties. Reactions of alkanes, combustion, radical substitution with different halogens, chain reaction. Statistical and regioselective halogenation.

**8th week**
Sulphonation, sulphotchlorination, 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**

**10th week**
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 $\text{S}_{\text{EAr}}$ reactions of substituted benzene derivatives—the reactivity and regioselectivity. Classification of substituents and interpretation of their effect on reactivity and regioselectivity.

**14th week**

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

**Requirements:**

- **for a signature**

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

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

- **for a grade**

  The course ends in an **examination**.

  The exam grade is the result of a written exam.

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

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-84</td>
<td>good (4)</td>
</tr>
<tr>
<td>85-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

**Person responsible for course:** Dr. Tibor Kurtán, associate professor, PhD,

**Lecturer:** Dr. Tibor Kurtán, associate 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

Structure, physical and chemical properties of organic derivative containing heteroatoms such as halogenated hydrocarbons, organometallic derivatives, alcohols, phenols, ethers, sulfur analogues; amines, nitro derivatives, diazonium salts, aldehydes, ketones, carboxylic acids and their derivatives, derivatives of carbonic acid.

Literature

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

Recommended:  

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). 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. Organometallic 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

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

8th week

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 $\alpha$-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 $\alpha$-carbon; aldol dimerization, $\alpha$-halogenation. Nucleophilic addition reactions of $\alpha,\beta$-unsaturated oxo compounds.

11th week

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**

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

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-84</td>
<td>good (4)</td>
</tr>
<tr>
<td>85-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

**Person responsible for course:** Dr. Tibor Kurtán, University professor, PhD

**Lecturer:** Dr. Tibor Kurtán, University professor, PhD
**Title of course:** Organic chemistry II  
**Code:** TTKBL0311_EN  
**ECTS Credit points:** 2

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: -</td>
<td></td>
</tr>
<tr>
<td>- laboratory: 3 hours/week</td>
<td></td>
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<table>
<thead>
<tr>
<th><strong>Evaluation:</strong></th>
<th>exam</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: -</td>
<td></td>
</tr>
<tr>
<td>- laboratory: 42 hours</td>
<td></td>
</tr>
<tr>
<td>- home assignment: 18 hours</td>
<td></td>
</tr>
<tr>
<td>- preparation for the exam: -</td>
<td></td>
</tr>
<tr>
<td>Total: 60 hours</td>
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<table>
<thead>
<tr>
<th><strong>Year, semester:</strong></th>
<th>2nd year, 1st semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Its prerequisite(s):</strong></th>
<th>TTKBL0101_EN, TTKBE0301_EN, TTKBE0401_EN, TTKBE0201_EN</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Further courses built on it:</strong></th>
<th>-</th>
</tr>
</thead>
</table>

**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

**Recommended:**

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 KMnO4 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.
<table>
<thead>
<tr>
<th>Week</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Short written test. Presentation of a device used in reaction with three-necked round bottom flasks. Preparation of 3-nitroaniline and recrystallization of the product from water.</td>
</tr>
<tr>
<td>9&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Short written test. Check of the purity of 3-nitroaniline 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).</td>
</tr>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>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.</td>
</tr>
<tr>
<td>11&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Short written test. Preparation of 4-chlorobenzoic acid and 4-chlorobenzyl alcohol. Check the purity of the product using TLC and melting point measurement.</td>
</tr>
<tr>
<td>13&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Short written test. Identification of amino derivatives of hydrocarbons using test tube reactions. The Hinsberg test.</td>
</tr>
</tbody>
</table>
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): 85%; 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, 2nd 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. Courseresonal, concept and taskcollectionforlectures, seminars in the e-learningsystem.
- Recommended:

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
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>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.</td>
</tr>
<tr>
<td>4th</td>
<td>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.</td>
</tr>
<tr>
<td>5th</td>
<td>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.</td>
</tr>
<tr>
<td>6th</td>
<td>Derivatives of Peptides / proteins and low molecular weight carbohydrates: peptidoglycans, glycoproteins, their biological significance. The carbohydrate code.</td>
</tr>
<tr>
<td>7th</td>
<td>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.</td>
</tr>
<tr>
<td>8th</td>
<td>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.</td>
</tr>
<tr>
<td>9th</td>
<td>Classification and characterization of lipids, their structure, their biological role. Basics of the biosynthesis of fats, phospho- and glycolipids.</td>
</tr>
<tr>
<td>10th</td>
<td>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.</td>
</tr>
<tr>
<td>11th</td>
<td>Classification and structure of phenylpropanoids. The chemical synthesis of their basic skeletones. Structure and biological significance of flavonoids.</td>
</tr>
<tr>
<td>12th</td>
<td>Classification of alkaloids and structure and function of their most important representatives. Alkaloids as drugs and medicines.</td>
</tr>
<tr>
<td>13th</td>
<td>Definition of symbiosis, antibiosis. Definition and classification of antibiotics: β-lactam, amino acid or peptide, glycoside type antibiotics, polycyclic antibiotics. Preparation of antibiotics:</td>
</tr>
</tbody>
</table>
fermentation, semi-synthetic and synthetic derivatives. The most important mode of action of antibiotics.

14th week

The structure, biosynthesis and biological role of porphyrins. Structure, biological role and metabolism of chlorophyll and hemoglobin. Classification of vitamins, their structure, their natural sources and their biological functions.

| Requirements: |
| - for a signature |
| Attendance at lectures is recommended, but not compulsory. A student may not miss the lecture more than three times during the semester. In case of further absences, a medical certificate needs to be presented. In case a student does not do this, the subject will not be signed and the student must repeat the course. |
| - for a grade |
| The course ends in an oral exam in the exam period. |

| Person responsible for course: | Dr. László Somsák, university professor PhD, habil, DSc |
| Lecturer: | Dr. László Somsák, university professor PhD, habil, DSc |
**Title of course:** 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:** 3\textsuperscript{rd} year, 1\textsuperscript{st} semester

**Its prerequisite(s):** TTKBE0303_EN

**Further courses built on it:** TTKBL0303_EN, TTBE0304_EN

**Topics of course**

**Literature**

*Compulsory:*

*Recommended:*

**Schedule:**


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.


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


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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
<td>70-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course: Introduction to economics</th>
<th>ECTS Credit points: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTBEBVVM-KT1-EN</td>
<td></td>
</tr>
</tbody>
</table>

### 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

### 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:** Dr. Levente Sándor Nádasi, Assistant Professor, PhD

**Lecturer:** Dr. Levente Sándor Nádasi, Assistant Professor, PhD
**Title of course:** Introduction to Business  
**Code:** TTBEBVVM-KT2_EN  
**ECTS Credit points:** 3

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture: 2 hours/week</td>
<td></td>
</tr>
<tr>
<td>practice: -</td>
<td></td>
</tr>
<tr>
<td>laboratory: -</td>
<td></td>
</tr>
</tbody>
</table>

| **Evaluation:** | exam |

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture: 28 hours</td>
<td></td>
</tr>
<tr>
<td>practice: -</td>
<td></td>
</tr>
<tr>
<td>laboratory: -</td>
<td></td>
</tr>
<tr>
<td>home assignment: 12 hours</td>
<td></td>
</tr>
<tr>
<td>preparation for the exam: 50 hours</td>
<td></td>
</tr>
</tbody>
</table>

**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:**

**Recommended:**

### Schedule:

**1st week**
Introduction. Managing within the Dynamic Business Environment

**2nd week**

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### 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:

<table>
<thead>
<tr>
<th>Score</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
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<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course: Basics of Civil Law I</th>
<th>ECTS Credit points: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTBEBVVM-JA1_EN</td>
<td></td>
</tr>
</tbody>
</table>

**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:*

**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 homework 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:

<table>
<thead>
<tr>
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</tr>
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<tbody>
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</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:  

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:

<table>
<thead>
<tr>
<th>Score</th>
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</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 1 hour/week</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
<th>exam</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 14 hours</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
<tr>
<td>- home assignment: -</td>
</tr>
<tr>
<td>- preparation for the exam: 16 hours</td>
</tr>
<tr>
<td>Total: 30 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year, semester:</th>
<th>1st year, 1st semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Its prerequisite(s):</th>
<th>-</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Further courses built on it:</th>
<th>-</th>
</tr>
</thead>
</table>

### 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


### Schedule:

<table>
<thead>
<tr>
<th>1st week</th>
</tr>
</thead>
</table>


<table>
<thead>
<tr>
<th>2nd week</th>
</tr>
</thead>
</table>

79
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th</td>
<td>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.</td>
</tr>
<tr>
<td>5th</td>
<td>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.</td>
</tr>
<tr>
<td>9th</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Expenditures: agricultural policy, structural funds, external aid, research and development, pre-accession assistances, administrative expenditures. Economic characteristics. Budget procedure.</td>
</tr>
</tbody>
</table>
### 13th week

**Migration and the European Union.** Theoretical background to the migration crisis in 2015 and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation.

### 14th week


**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

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 may 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**  

**Literature**  
*Compulsory:*  

*Recommended:*  

**Schedule:**  

1st week  

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

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

4th week

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

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

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

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 Gantt 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 (Gantt 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
<td>70-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

- *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:** 2\textsuperscript{nd} year, 1\textsuperscript{st} 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
3) Vogel's Qualitative Inorganic Analysis, (ed. Gy. Svehla), Longmann, 2007

**Schedule:**

1\textsuperscript{st} week
Introduction to analytical chemistry. Measurements. Basic equations of equilibrium calculations.

2\textsuperscript{nd} week

3\textsuperscript{rd} week
Basic terms related to titrations. Practice of acid-base titrations.

4\textsuperscript{th} week
Basics of complexometry. Complexometric titrations.

5\textsuperscript{th} week
Solubility equilibria. Precipitation titrations, argentometry.

6\textsuperscript{th} week
Redoxi equilibria. Permanganometry.

7\textsuperscript{th} week

8\textsuperscript{th} week
Simple separation techniques I. Gravimetry.

9\textsuperscript{th} 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:
<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-39</td>
<td>fail (1)</td>
</tr>
<tr>
<td>40-55</td>
<td>pass (2)</td>
</tr>
<tr>
<td>56-70</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>71-85</td>
<td>good (4)</td>
</tr>
<tr>
<td>86-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>
  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 | **ECTS Credit points:** | 4 |
|----------------------|-------------------------------------------------|--------------------------|
| **Code:**            | TTKBL0511-EN                                    |                          |    |

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: –</td>
</tr>
<tr>
<td>- practice: –</td>
</tr>
<tr>
<td>- laboratory: 4 hours /week</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Evaluation:</strong></th>
<th>mid-semester grade</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: –</td>
</tr>
<tr>
<td>- practice: –</td>
</tr>
<tr>
<td>- laboratory: 56 hours</td>
</tr>
<tr>
<td>- home assignment: 26 hours</td>
</tr>
<tr>
<td>- preparation for the exam: 38 hours</td>
</tr>
<tr>
<td><strong>Total:</strong> 120 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Year, semester:</strong></th>
<th>2nd year, 1st semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Its prerequisite(s):</strong></th>
<th>TTKBE0201_EN, TTKBE0301_EN, TTKBE0401_EN, TTKBL0101_EN</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Further courses built on it:</strong></th>
<th>TTKBL0512_EN</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>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 &quot;unknown samples&quot;. 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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory:</strong></td>
</tr>
</tbody>
</table>
**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 AgNO₃. Quantitative analysis of a KCl + KBr sample.

9th week  
Redox titrations with KMnO₄. Quantitative analysis of a H₂O₂ 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.

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50</td>
<td>fail (1)</td>
</tr>
<tr>
<td>51-60</td>
<td>pass (2)</td>
</tr>
<tr>
<td>61-70</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>71-80</td>
<td>good (4)</td>
</tr>
<tr>
<td>81-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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. Csilla Kállay, associata professor, PhD, habil

**Lecturer:** Dr. Csilla Kállay, associate professor, PhD, habil
Title of course: Application of Instrumental Analysis I.
Code: TTKBE0512_EN
ECTS Credit points: 1

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

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- 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:

Recommended:

Schedule:
1st week

2nd week

3rd week

4th week

5th week
Extraction: liquid-liquid liquid-solid and liquid-gas processes. From laboratory scale to industrial liquid-liquid extractors, the role of density, practical uses. Basic rules of extraction, distribution coefficients, selectivities, 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 instruments. 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. Gradient formation unit. HPLC pumps, working 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, diode 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

14th week

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-75</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>76-88</td>
<td>good (4)</td>
</tr>
<tr>
<td>89-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course: Instrumental analysis II</th>
<th>ECTS Credit points: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBL0512_EN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: 3 hours/week</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation: mid-semester grade</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: 42 hours</td>
</tr>
<tr>
<td>- home assignment: 48 hours</td>
</tr>
<tr>
<td>- preparation for the exam: -</td>
</tr>
<tr>
<td>Total: 90 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year, semester: 3rd year, 2nd semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Its prerequisite(s): TTKBE0501, TTKBL0501</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Further courses built on it</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Topics of course</th>
</tr>
</thead>
<tbody>
<tr>
<td>The series of laboratory practices are based on the topics of different instrumental 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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Syllabuses provided by the tutor.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Schedule:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week: Introductory guidance, accident protection (2h)</td>
</tr>
<tr>
<td>2nd week: Evaluation of chromatograms (8h)</td>
</tr>
<tr>
<td>3rd week: UV-vis spectroscopy (6h)</td>
</tr>
<tr>
<td>4th week: High Performance Liquid Chromatography II (6h)</td>
</tr>
<tr>
<td>5th week: Atomic spectroscopy (6h)</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
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<tr>
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<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:**
- Lecture notes and teaching material available via the e-learning system.

**Recommended:**
- Other corresponding books from bookboon.com

**Schedule:**

1st week
Ideal and real gases

2nd week
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>The 1st law of thermodynamics</td>
</tr>
<tr>
<td>3rd</td>
<td>Thermochemistry</td>
</tr>
<tr>
<td>4th</td>
<td>2nd law of thermodynamics</td>
</tr>
<tr>
<td>5th</td>
<td>3rd law of thermodynamics</td>
</tr>
<tr>
<td>6th</td>
<td>Potential functions in thermodynamics</td>
</tr>
<tr>
<td>7th</td>
<td>Chemical potential</td>
</tr>
<tr>
<td>8th</td>
<td>Thermodynamics of one component systems</td>
</tr>
<tr>
<td>9th</td>
<td>Thermodynamics of two component mixtures and dilute solutions</td>
</tr>
</tbody>
</table>

10th week
Mixture of volatile components

11th week
Phase rule

12th week
Thermodynamic equilibrium in reactive systems.

13th week
Effect of parameters on chemical equilibrium

14th week
Chemical equilibrium in various systems.

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 oralexamination. Based on the result of the examination questions scored according to pre-set maximum points for each sub-questions. The type of the examination (written or oral) is the choice of the student.
  The minimum requirement for the examination is 60%. Based on the score of the tests separately, the grade for the tests and/or the examination is given according to the following table:

<table>
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</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
</tbody>
</table>
- 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

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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

100
include: Description of gases. Laws of thermodynamics. Thermochemistry. Description of one component and multicomponent systems. Equilibrium.

**Literature**

**Compulsory:**
- List of problems, their solutions and other teaching material available via the e-learning system.

**Recommended:**
- Other corresponding books from bookboon.com

**Schedule:**

<table>
<thead>
<tr>
<th>Week</th>
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</tr>
</thead>
</table>
| 1st week | Ideal and real gases  
Problem solving and calculations in the following topics: Ideal gas and the state equation. Isoterm, 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  
| 3rd week | Thermochemistry  
| 4th week | 2nd law of thermodynamics  
| 5th week | 3rd law of thermodynamics  
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
</table>
| 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  
| 8th week | Thermodynamics of one component systems  
| 9th week | Thermodynamics of two component mixtures and dilute solutions  
| 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_c, 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 |

**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:

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<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:**
- 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

**Recommended:**

**Schedule:**

1st week  Homogeneous equilibrium electrochemistry. Thermodynamics of electrolyte solutions

2nd week  Heterogeneous equilibrium electrochemistry. Thermodynamics of electrodes.

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
Uniform discussion of transport processes.

5th week  Movement of ions in electrolyte solutions. Conductance of electrolytes
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
Third order reactions. Formal kinetics of equilibrium. Consecutive reactions. Rate determining 

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
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 
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

14th week Application of colloids, nanoparticles

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:

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<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Title of course: Physical Chemistry II.</th>
<th>ECTS Credit points: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBG0402_EN</td>
<td></td>
</tr>
<tr>
<td>Type of teaching, contact hours</td>
<td></td>
</tr>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: 2 hours/week</td>
<td></td>
</tr>
<tr>
<td>- laboratory: -</td>
<td></td>
</tr>
<tr>
<td>Evaluation: mid-semester grade</td>
<td></td>
</tr>
<tr>
<td>Workload (estimated), divided into contact hours:</td>
<td></td>
</tr>
</tbody>
</table>
- 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 helps 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:**
- List of problems, their solutions and other teaching material available via the e-learning system.

**Recommended:**

### Schedule:

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, redox electrodes. Dependence of electrode potential on concentrations. Nernst equation. Standard electrode potential.


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


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


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


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


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.
The activated complex theory of chemical reactions


Processes on solid surfaces


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.

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:

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</tbody>
</table>
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

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<table>
<thead>
<tr>
<th>Score Range</th>
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</tr>
</thead>
<tbody>
<tr>
<td>60-69</td>
<td>pass  (2)</td>
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<tr>
<td>70-79</td>
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<td>good  (4)</td>
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<tr>
<td>90-100</td>
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</tr>
</tbody>
</table>

---

**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 NaHCO₃ 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 H₂O₂ 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.

**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:

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<td>excellent (5)</td>
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</table>

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:*

### 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

10th week

11th week
Interaction of beta radiation with matter: ionization, Brehms strahlung, Cherenkov radiation, annihilation (positron emission tomography), back-scattering, absorption, self-absorption. Interaction of gamma and X-rayradiation 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

13th week

14th week

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

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
<td>70-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

**an offered grade:**

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

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

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

---

**Title of course:** 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**

and copolymers: radical polymerization and copolymerization, anionic, cationic, living cationic polymerization. Step polymerization: polycondensation and polyaddition.

**Literature**

*Compulsory:*

*Recommended:*

**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

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-61</td>
<td>pass (2)</td>
</tr>
<tr>
<td>62-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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...

**Literature**

**Compulsory:**

**Recommended:**

**Schedule:**

1st week
Atomic structure of metals, structural 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

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 $\gamma$-$\alpha$ 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

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:

<table>
<thead>
<tr>
<th>Score</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
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<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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(vinylpyrrolidone), polyamides. Production of Polyamide-6, applications. Synthesis and properties of the most importandpolydienes, elastomers. Synthesis and properties of polycrylates, polyesters, polyethers, epoxy and alkyd resins, polyurethanes, silicones and their derivatives. Additives of the polymer industry.

---

### Literature

**Compulsory:**

**Recommended:**

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### 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 importandpolydienes, elastomers (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:

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<tr>
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<tbody>
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<tr>
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</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course: Plastics and Processing I.</th>
<th>ECTS Credit points: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBL1212_EN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture:</td>
<td></td>
</tr>
<tr>
<td>- practice:</td>
<td></td>
</tr>
<tr>
<td>- laboratory: 2 hours/week</td>
<td></td>
</tr>
</tbody>
</table>

| Evaluation:                             | mid-semester grade  |

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture:</td>
<td></td>
</tr>
<tr>
<td>- practice:</td>
<td></td>
</tr>
<tr>
<td>- laboratory: 28 hours</td>
<td></td>
</tr>
<tr>
<td>- preparation for the tests: 32 hours</td>
<td></td>
</tr>
<tr>
<td>Total: 60 hours</td>
<td></td>
</tr>
</tbody>
</table>

| Year, semester:                               | 3rd year, 2nd semester |

| Its prerequisite(s):                          | TTKBE0611_EN          |

| Further courses built on it:                  | -                   |

### Topics of course

### Literature

*Recommended:*
1. ISO standards (one copy can be found in the laboratory)
2. Syllabus provided by the Department of Applied Chemistry

### Schedule:

1. **1st week**
   Identification of plastics by simple methods.

2. **2nd week**
   Molding of plastic sheets. Shore hardness determination.

3. **3rd week**
   Determination of mechanical properties of plastics based on tensile test.

4. **4th week**
   Impact testing of polypropylenes.

5. **5th week**
   Determination of Ball Indentation and Rockwell Hardness of polymers.

6. **6th week**
   Determination of Ball Indentation and Rockwell Hardness of polymers.

7. **7th week**
   Test writing.
Requirements:
The laboratory practices will be done in blocks (4 hours a week, 7 weeks). Attendance at laboratory practices is 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
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</tr>
<tr>
<td>50-59</td>
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</tr>
<tr>
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</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:*

**Schedule:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>Implementation of mathematical functions in the spreadsheet software. Plotting the result in $xy$ scatter graphs.</td>
</tr>
<tr>
<td>2nd week</td>
<td>Solving calculation problems in chemical engineering by implemented mathematical functions.</td>
</tr>
<tr>
<td>3rd week</td>
<td>Numerical differentiation by spreadsheet software and its application for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td>4th week</td>
<td>Numerical integration by spreadsheet software and its application for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td>5th week</td>
<td>Regression, curve fitting</td>
</tr>
<tr>
<td>6th week</td>
<td>The application of interpolation for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td>7th week</td>
<td>Solving nonlinear equations by spreadsheet software and its application for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td>8th week</td>
<td>Solving nonlinear set of equations by spreadsheet software and its application for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td>9th week</td>
<td>Matrix operations</td>
</tr>
<tr>
<td>10th week</td>
<td>Solving sets of linear equations by matrix operations.</td>
</tr>
<tr>
<td>11th week</td>
<td>Application of spreadsheets in combinatorics and probability.</td>
</tr>
<tr>
<td>12th week</td>
<td>Application of spreadsheets in statistics. Probability distributions.</td>
</tr>
<tr>
<td>13th week</td>
<td>Maxwell–Boltzmann molecular speed distribution for gases. Typical speeds.</td>
</tr>
<tr>
<td>14th week</td>
<td>Application of t-tests for problem-solving in chemical engineering.</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
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<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Title of course: Process Control I.</th>
<th>ECTS Credit points: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBG0612_EN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
</tr>
<tr>
<td>- practice: 1 hours/week</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation: mid-semester grade</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
</tr>
<tr>
<td>- practice: 14 hours</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
<tr>
<td>- home assignment: 56 hours</td>
</tr>
<tr>
<td>- preparation for the exam: 22 hours</td>
</tr>
<tr>
<td>Total: 120 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year, semester: 2nd year, 2nd semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Its prerequisite(s): TTKBG0911_EN</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Further courses built on it: TTKBG0613_EN</th>
</tr>
</thead>
</table>
**Topics of course**

Simple process control systems. Steady state and dynamic behaviour of chemical equipment.

**Literature**

**Compulsory:**

**Recommended:**

**Schedule:**

1st week

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

6th week

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 (PT₁), second order process (PT₁T₂) and n-order process (PT₁...Tₙ).

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. Lajos Nagy, associate professor, PhD
Lecturer: Professor Dr. Péter Mizsey, PhD
<table>
<thead>
<tr>
<th><strong>Title of course:</strong> Process Control II.</th>
<th><strong>ECTS Credit points:</strong> 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code:</strong> TTKBG0613_EN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: 3 hours/week</td>
<td></td>
</tr>
<tr>
<td>- laboratory: -</td>
<td></td>
</tr>
</tbody>
</table>

| **Evaluation:** mid-semester grade  |                          |

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td></td>
</tr>
<tr>
<td>- practice: 42 hours</td>
<td></td>
</tr>
<tr>
<td>- laboratory: -</td>
<td></td>
</tr>
<tr>
<td>- home assignment: 56 hours</td>
<td></td>
</tr>
<tr>
<td>- preparation for the exam: 22 hours</td>
<td></td>
</tr>
<tr>
<td>Total: 120 hours</td>
<td></td>
</tr>
</tbody>
</table>

| **Year, semester:** 3rd year, 1st semester            |                          |

| **Its prerequisite(s):** TTKBG0612_EN                 |                          |

| **Further courses built on it:** -                   |                          |

<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>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).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory:</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Recommended:</strong></th>
<th></th>
</tr>
</thead>
</table>
### Schedule:

**1\textsuperscript{st} week**  
Introduction. Repeat of standard dynamic behaviours chemical equipments and process control systems. Dead time.

**2\textsuperscript{nd} week**  
Oscillating second order process (P\(\zeta\)T). Examples for P\(\zeta\)T.

**3\textsuperscript{rd} week**  
The Laplace Transform. Example for solution of ordinary linear differential equations.

**4\textsuperscript{th} week**  
Definition of transfer function. Transfer functions of different dynamic behaviour elements.

**5\textsuperscript{th} week**  
Examples for determination of response function in time domain used Laplace transformation.

**6\textsuperscript{th} 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.

**7\textsuperscript{th} week**  

**8\textsuperscript{th} week**  
Routh-Hurwitz criterion.

**9\textsuperscript{th} week**  

**10\textsuperscript{th} week**  
Nyquist and Bode diagrams of different behaviour elements.

**11\textsuperscript{th} week**  
Geometrical conditions of stability, Nyquist and Bode criteria. Impact of dead time.

**12\textsuperscript{th} week**  

**13\textsuperscript{th} week**  
Introduction to using of Matlab Control System Toolbox and Simulink software systems.

**14\textsuperscript{th} 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 8\textsuperscript{th} week and the end-term test in the 15\textsuperscript{th} 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%).
Person responsible for course: Dr. Lajos Nagy, associate professor, PhD

Lecturer: Professor Dr. Péter Mizsey, PhD

Title of course: Mechanics for Chemical Engineers I.

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 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

In seminar there are four tasks to elaborate: to elaborate the workshop drawing of different machine elements and components.
**Literature**

*Compulsory:*

*Recommended:*

**Schedule:**

1*st* 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

2*nd* 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.

3*rd* 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.

4*th* week  
**Lecture:** General prescriptions for dimensioning, choosing basis surfaces. Conventional dimensioning methods.  
**Practice:** elaborating the task 2. Practicing the presentation methods.

5*th* 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.

6*th* week  
**Lecture:** ISO Tolerance system. Defining fits: clearance, transition and interference fit.  
**Practice:** elaborating the task 3.

7*th* 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.

8*th* week  
**Mid-term test**  
**Lecture:** Standardized Thread forms and its main features. Threads and threads symbols in drawing. Threaded joints: bolted joint, studded joint, screw fastening.  
**Practice:** elaborating the task 4.
<table>
<thead>
<tr>
<th>Lecture</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lecture:</strong> 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.</td>
<td><strong>Practice:</strong> elaborating the task 4.</td>
</tr>
<tr>
<td><strong>10th week</strong></td>
<td><strong>11th week</strong></td>
</tr>
<tr>
<td><strong>Lecture:</strong> Contact among machine elements. Elements for energy process in machine systems. Elements for material flow in machine systems: pipes, pipefittings, tanks etc.</td>
<td><strong>Practice:</strong> study drive train components in the lab.</td>
</tr>
<tr>
<td><strong>12th week</strong></td>
<td><strong>13th week</strong></td>
</tr>
<tr>
<td><strong>Lecture:</strong> 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.</td>
<td><strong>Practice:</strong> submitting the task 4.</td>
</tr>
<tr>
<td><strong>14th week</strong></td>
<td><strong>Mid-term test</strong></td>
</tr>
<tr>
<td><strong>Lecture:</strong> Structural materials. Structure of non-ferrous metals. Iron-carbon double phased systems, crystallization and metamorphosis.</td>
<td><strong>Practice:</strong> Conucting destructive and non-destructive tests.</td>
</tr>
<tr>
<td><strong>Requirements:</strong></td>
<td><strong>- for a signature</strong></td>
</tr>
<tr>
<td>Attendance on the <strong>lectures</strong> is recommended, but not compulsory. Participation at <strong>practice</strong> is compulsory. Student must attend the practices and may 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 makeup 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 <strong>submit all the four drawing tasks</strong> 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. <strong>- for a grade</strong> The course ends in <strong>mid-semester grade</strong>. 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:</td>
<td></td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
<td>70-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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, pressuredrop and frictionlosses in pipes, pumps, head, pumppowercalculations, maximum suctionheight, cavitation, net positivesuctionhead (NPSH), characteristiccurvesforcentrifugalpump, dutypointcalculation.
**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:*


**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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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. Ákos Kuki, associate professor, PhD

**Lecturer:** Dr. Sándor Pálinkás, senior lecturer, 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

### 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.

9th week 

10th week 

11th week 
Isothermal and Adiabatic Reactors. The reactors thermal stability

12th week 
Examples of industrial reactors. Stability of reactors and selection.

13th week 

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
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<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Title of course: Unit Operations I</th>
<th>ECTS Credit points: 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBG0614_EN</td>
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</tr>
</tbody>
</table>

**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**

**Literature**
**Compulsory:**

**Schedule:**

1<sup>st</sup> week
Definition and classification of unit operations. batch and continuous processes. Flowsheets.

2<sup>nd</sup> week

3<sup>rd</sup> week
The fundamental equation of thermodynamics. Conditions of equilibrium, driving force, rate of processes. Degrees of freedom of a chemical system.

4<sup>th</sup> week

5<sup>th</sup> 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.

6<sup>th</sup> week

7<sup>th</sup> week
Similitude and modelling. Dimensional analysis, dimensionless numbers.

8<sup>th</sup> week
Mass and energy balances for simple and complex unit operations.

9<sup>th</sup> week

10<sup>th</sup> week

11th week

12th week

13th week

14th week
Terminal velocity of sedimentation. Stokes' law. Drag coefficient as a function of Reynolds number. Apparatus for settling, dust removers, cyclones.

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

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

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

  - Score Grade
  - 0-59 fail (1)
  - 60-69 pass (2)
  - 70-79 satisfactory (3)
  - 80-89 good (4)
  - 90-100 excellent (5)
If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

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

**Person responsible for course:** Dr. Sándor Kéki University professor, PhD

**Lecturer:**

**Title of course:** Unit Operations II  
**Code:** TTKBG0615_EN  
**ECTS Credit points:** 6

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

**Evaluation:** mid-semester grade

**Workload (estimated), divided into contact hours:**
- lecture: 28 hours  
- practice: 42 hours  
- laboratory: -  
- home assignment: 40 hours  
- preparation for the exam: 40 hours  
**Total:** 150 hours

**Year, semester:** 2nd year, 2nd semester

**Its prerequisite(s):** Unit operations I. (TTKBG0614_EN)

**Further courses built on it:** Unit operations III. (TTKBG0616_EN)

**Topics of course**


**Literature**

Schedule:

1st week
Heat transfer. General characterization of heat transfer.

2nd week
Heat transfer by convection, conduction and radiation. Application of dimensional analysis to heat transfer by convection. Analogies between momentum and heat transfer. Chilton-Colburn analogy.

3rd week

4th week

5th week

6th week
Heat exchangers. Stationary heat transmission with constant temperature difference through flat and cylindrical wall. Determination of heat flow and thermal resistances.

7th week

8th week

9th week
The aim of evaporation, Calandria, falling film and Robert-type evaporator. Multistage evaporators and their connections.

10th week
Cooling and coolers.

11th week
Introduction to chemical reactors. Classification of reactors based on flow, operation mode, component stream and heat. Operation time, residence time. Concentration-time and concentration-space functions of batch and continuous reactors.

12th week

13th week

14th week
Practice.
**Person responsible for course:** Katalin Illyésné Dr. Czifrák, assistant professor, PhD

**Lecturer:**

<table>
<thead>
<tr>
<th>Title of course: Unit Operations III.</th>
<th>ECTS Credit points: 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code: TTKBG0616_EN</td>
<td></td>
</tr>
</tbody>
</table>

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

| 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:** 3\(^{rd}\) year, 1\(^{st}\) semester

**Its prerequisite(s):** TTKBG0615_EN

**Further courses built on it:** -

**Topics of course**

**Literature**

*Compulsory:*

**Schedule:**
1\(^{st}\) 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

4th week

5th week
Types of absorption-desorption apparatus. The PSA adsorption.

6th week
Thermal separation operations: distillation: Batch and continuous distillation.

7th week
Rectification. Operating point. Types and parts of a continuous rectification apparatus.

8th week
Operating lines of a rectifier. The q-line. Equilibrium stage, its determination using McCabe-Thiele diagram.

9th week
Liquid-liquid extraction. Ternary phase diagram. Distributional diagram of the key component. Batch and continuous extraction. Continuous one-stage mixer-settler extractor.

10th week
Liquid-solid extraction and its apparatus.

11th week
Crystallization and its phase diagram. Apparatus for crystallization.

12th week
Humidification.

13th week
Drying. Types of moisture binding. Rate of drying. Enthalpy of moist air. Types, material-and energy balance of drying apparatus

14th week
Practice.

Requirements:
- for a signature

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

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.
- for a grade
The course ends in an examination.
The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
<td>70-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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.

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

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

Lecturer:

---

**Title of course:** Computer Modeling of Chemical Technology Systems I.  
**Code:** TTKBG0912_EN  
**ECTS Credit points:** 2

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
</tr>
<tr>
<td>- practice: 2 hours/week</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
</tbody>
</table>

**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 flow charts. Creating a simulation step by step. Simulation of simple reactions,

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended:</strong></td>
</tr>
<tr>
<td>2. ChemCAD tutorial file</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Schedule:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st week</strong></td>
</tr>
<tr>
<td>The main features of a process simulation software. The steps of the simulations. Drawing process flow diagrams.</td>
</tr>
<tr>
<td><strong>2nd week</strong></td>
</tr>
<tr>
<td>Simulation of simple reactions, evaluation of the results.</td>
</tr>
<tr>
<td><strong>3rd week</strong></td>
</tr>
<tr>
<td>Simulation of reactions with more feeds and unit operations, evaluation of the results.</td>
</tr>
<tr>
<td><strong>4th week</strong></td>
</tr>
<tr>
<td>Study of vapor-liquid equilibrium.</td>
</tr>
<tr>
<td><strong>5th week</strong></td>
</tr>
<tr>
<td>Modeling of flash distillation and three phase flash distillation.</td>
</tr>
<tr>
<td><strong>6th week</strong></td>
</tr>
<tr>
<td>Application of sensitivity study.</td>
</tr>
<tr>
<td><strong>7th week</strong></td>
</tr>
<tr>
<td>Introduction into the use of the controller.</td>
</tr>
<tr>
<td><strong>8th week</strong></td>
</tr>
<tr>
<td>Application of controller for problem-solving in chemical engineering.</td>
</tr>
<tr>
<td><strong>9th week</strong></td>
</tr>
<tr>
<td>Modeling of heat exchangers.</td>
</tr>
<tr>
<td><strong>10th week</strong></td>
</tr>
<tr>
<td>Various reactor models.</td>
</tr>
<tr>
<td><strong>11th week</strong></td>
</tr>
<tr>
<td>Simulation of chemical processes with reactors and separators</td>
</tr>
<tr>
<td><strong>12th week</strong></td>
</tr>
<tr>
<td>Simulation of chemical processes with recycling.</td>
</tr>
<tr>
<td><strong>13th week</strong></td>
</tr>
<tr>
<td>Simulation of more complex chemical processes.</td>
</tr>
<tr>
<td><strong>14th week</strong></td>
</tr>
<tr>
<td>Simulation of more complex chemical processes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirements:</th>
</tr>
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<tr>
<td>- for a signature</td>
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| 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
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</tr>
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</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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). Pipesystem 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:*

2. ChemCADtutorial file

**Schedule:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Fluid transportation. Pressure drop calculations in piping systems.</td>
</tr>
<tr>
<td>2nd</td>
<td>Simulation and sizing of pumps.</td>
</tr>
<tr>
<td>3rd</td>
<td>Simulation of piping systems, cost calculations.</td>
</tr>
<tr>
<td>4th</td>
<td>Pump duty point calculation.</td>
</tr>
<tr>
<td>6th</td>
<td>Modeling of distillation, <em>SCDS</em> model.</td>
</tr>
<tr>
<td>7th</td>
<td>Multi step distillation, <em>Tower</em> model.</td>
</tr>
<tr>
<td>8th</td>
<td>Application of stuffed columns.</td>
</tr>
<tr>
<td>9th</td>
<td>Simulation of absorption.</td>
</tr>
<tr>
<td>10th</td>
<td>Simulation of extraction.</td>
</tr>
<tr>
<td>11th</td>
<td>Simulation of more complex chemical processes.</td>
</tr>
<tr>
<td>12th</td>
<td>Simulation of more complex chemical processes.</td>
</tr>
<tr>
<td>13th</td>
<td>Simulation of more complex chemical processes.</td>
</tr>
<tr>
<td>14th</td>
<td>Simulation of more complex chemical processes.</td>
</tr>
</tbody>
</table>

**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:

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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


### Literature

**Compulsory:**

**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
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:

<table>
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</table>

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

<table>
<thead>
<tr>
<th>Topics of course</th>
</tr>
</thead>
</table>

**Literature**

*Compulsory:*

*Recommended:*
- Muhlyov I.: Chemical Technology I-II.

**Schedule:**

1*st* week  
Safety regulations  
2*nd* week  
Determination of hardness of unknown water samples  
3*rd* week  
Water softening with ion exchange resin  
4*th* week  
Sieve analysis  
5*th* week  
Distillation  
6*th* week  
Rectification, separation of ethanol-water mixture  
7*th* week  
Mixing  
8*th* week  
Determination of critical power of mixer  
9*th* week  
Sieve analysis of ground limestone  
10*th* 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:

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</table>

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
- Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, 2016

Recommended:

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

<table>
<thead>
<tr>
<th>Requirements:</th>
<th></th>
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<tbody>
<tr>
<td>- for a signature</td>
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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:*

*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:

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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

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
<td></td>
</tr>
<tr>
<td>- practice:</td>
<td>-</td>
</tr>
<tr>
<td>- laboratory:</td>
<td>-</td>
</tr>
</tbody>
</table>

| **Evaluation:**  | exam |

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
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</tr>
<tr>
<td>- practice:</td>
<td>-</td>
</tr>
<tr>
<td>- laboratory:</td>
<td>-</td>
</tr>
<tr>
<td>- home assignment: 6 hours</td>
<td></td>
</tr>
<tr>
<td>- preparation for the exam: 56 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>90 hours</td>
</tr>
</tbody>
</table>

| **Year, semester:**  | 3rd year, 2nd semester |

| **Its prerequisite(s):** | TTKBL1111_EN |

| **Further courses built on it:** | - |

**Topics of course**


**Literature**

*Compulsory:*

*Recommended:*

**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 System 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. Description 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


14th week

Case Histories About Great Environmental Pollutions and Their Effects.

<table>
<thead>
<tr>
<th>Requirements: - for a signature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attendance at lectures</strong> is recommended, but not compulsory.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>- for a grade</td>
</tr>
<tr>
<td>The course ends in a <strong>written or oral examination</strong>. 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.</td>
</tr>
<tr>
<td>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:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
</tr>
<tr>
<td>60-69</td>
<td>pass (2)</td>
</tr>
<tr>
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<td>satisfactory (3)</td>
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<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>
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. Katalin Margit Illyésné Czifrák assistant professor, PhD

**Lecturer:** Dr. Katalin Margit Illyésné Czifrák 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

**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):** TTKBE1114_EN parallel recording

**Further courses built on it:** -

**Topics of course**

**Literature**

*Recommended:*
1. Syllabus provided by the Department of Applied Chemistry

**Schedule:**

8th week
Identification of plastic wastes using simple physical and chemical methods.
9th week
Desalination of waste water on ion exchange column.

10th week
Removal of floating particles from waste water by sedimentation.

11th week
Determination of the solvent content of waste water by GC method.

12th week
Measurement of extractable matter content (plasticizer content) from (qualitative and quantitative) waste plastics. Carry out the extraction, prepare the sample.

13th week
Measurement of plasticizer content (qualitative and quantitative) from waste materials.

14th 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-79</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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: Katalin Illyésné Dr. Czifrák, assistant professor, PhD

Lecturer: Katalin Illyésné Dr. Czifrák, assistant professor, PhD

Title of course: Pilot Plant Work
Code: TTKBL1115_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

<table>
<thead>
<tr>
<th>Year, semester</th>
<th>3rd year, 2nd semester</th>
</tr>
</thead>
</table>
| Its prerequisite(s) | Chemical technology I (TTKBE1111_EN) and (TTKBL1111_EN)  
Unit Operation I (TTKBG0614_EN) |
| 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. They will record and calculate mass and energy balances for different processes such as: evaporations, absorption, grinding-size distribution, liquid-liquid extraction, distillation, fluidization and membrane separation.

**Literature**

*Compulsory:*  
- McGraw-Hill  
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. Tibor Nagy, Assistant Professor, PhD

Lecturer: Dr. Tibor Nagy, Assistant 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:** 4\(^{th}\) year, 1\(^{st}\) semester

**Its prerequisite(s):** TTKBE1112_EN

**Further courses built on it:** -

### Topics of course

### Literature

*Recommended:*

### Schedule:

**1\(^{st}\) week**
General and basic security rules. Definition of accident, near-miss (quasi-accident) and firstaid. Can we learn from accidents that have not happened?

**2\(^{nd}\) week**
Accident statistics, industry comparison. Conclusions from the figures.

**3\(^{rd}\) 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.

**4\(^{th}\) week**

**5\(^{th}\) 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.

**6\(^{th}\) week**

**7\(^{th}\) 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

**8\(^{th}\) 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

11th week

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:

<table>
<thead>
<tr>
<th>Score</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-80</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>81-90</td>
<td>good (4)</td>
</tr>
<tr>
<td>91-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

Person responsible for course: Dr. Tibor Nagy, Assistant Professor, PhD

Lecturer: Dr. Tibor Nagy, Assistant Professor, PhD

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:*

### 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: vinylchloride, 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 ethyltert-butylether.

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-64</td>
<td>pass (2)</td>
</tr>
<tr>
<td>65-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-84</td>
<td>good (4)</td>
</tr>
<tr>
<td>85-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

Person responsible for course: Dr. Tibor Nagy, Assistant Professor, PhD

Lecturer: Dr. Tibor Nagy, Assistant 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
<table>
<thead>
<tr>
<th>Total: 90 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year, semester:</strong> 3rd year, 2nd semester</td>
</tr>
<tr>
<td><strong>Its prerequisite(s):</strong> TTKBE1111_EN</td>
</tr>
<tr>
<td><strong>Further courses built on it:</strong> -</td>
</tr>
</tbody>
</table>

**Topics of course**


**Literature**

**Compulsory:**

**Recommended:**

**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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-61</td>
<td>pass (2)</td>
</tr>
<tr>
<td>62-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th><strong>Title of course:</strong> Spectroscopic methods I.</th>
<th><strong>ECTS Credit points:</strong> 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code:</strong> TTKBE0503_EN</td>
<td></td>
</tr>
</tbody>
</table>

**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 upon 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:**
5. F.W. McLafferty: „Interpretation of mass spectra”, W.A. Benjamin, INC, New York, 1967

**Schedule:**
1st week Basics of NMR: Magnetic dipoles in external B₀ field, nuclear Zeeman effect, selection rules, transition frequency, populations, Boltzmann distribution, bulk magnetisation, vector model. B₁: 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.


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

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


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

7th week NMR written TEST


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.

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 & IRwritten TEST

Requirements:
- for a signature

Attendance at lectures is highly recommended (not compulsory) since interactive evaluation of test problems are parts of the lectures.

Students have to submit all the two designing tasks as scheduled minimum on a sufficient level. During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students have to sit for the tests

- for a grade

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

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

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
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<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Title of course:</th>
<th>Quality Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code:</td>
<td>TTBEBVM-KT6-EN</td>
</tr>
<tr>
<td>ECTS Credit points:</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of teaching, contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
</tbody>
</table>

| Evaluation: | exam |

<table>
<thead>
<tr>
<th>Workload (estimated), divided into contact hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
</tr>
<tr>
<td>- practice: -</td>
</tr>
<tr>
<td>- laboratory: -</td>
</tr>
<tr>
<td>- home assignment: -</td>
</tr>
<tr>
<td>- preparation for the exam: 62 hours</td>
</tr>
<tr>
<td>Total: 90 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year, semester:</th>
<th>3rd year, 1st semester</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Its prerequisite(s):</th>
<th>TTBEBVM-KT4_EN</th>
</tr>
</thead>
</table>

| Further courses built on it: | - |

## Topics of course

The series of lectures are based on the topics of Quality Management. 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:**

**Recommended:**

## 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 Evaluation: 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
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</table>

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:  

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

175
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. 2pplans.
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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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. Tibor Nagy, Assistant Professor, PhD
**Title of course:** BSc thesis I. 
**Code:** TTKBG2011_EN  
**ECTS Credit points:** 2

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td>-</td>
</tr>
<tr>
<td>- practice: -</td>
<td>-</td>
</tr>
<tr>
<td>- laboratory: 2 hours/week</td>
<td></td>
</tr>
</tbody>
</table>

| **Evaluation:** | mid-semester grade |

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: -</td>
<td>-</td>
</tr>
<tr>
<td>- practice: -</td>
<td>-</td>
</tr>
<tr>
<td>- laboratory: 28 hours</td>
<td></td>
</tr>
<tr>
<td>- home assignment: 32 hours</td>
<td></td>
</tr>
<tr>
<td>- preparation for the exam: -</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total:</strong> 60 hours</td>
<td></td>
</tr>
</tbody>
</table>

| **Year, semester:** | 3rd year, 2nd semester |

| **Its prerequisite(s):** | Completion of 140 credits |

| **Further courses built on it:** | TTKBG2012_EN  |

<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided by the supervisor.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Schedule:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The student works by following the instructions of the supervisor.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Requirements:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- for a signature</td>
<td></td>
</tr>
<tr>
<td>The student have to take part in the research project coordinated by the supervisor.</td>
<td></td>
</tr>
<tr>
<td>- for a grade</td>
<td></td>
</tr>
<tr>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>
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 continuously verifies the work.

<table>
<thead>
<tr>
<th><strong>Title of course:</strong> BSc thesis II.</th>
<th><strong>ECTS Credit points:</strong> 13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code:</strong> TTKBG2012_EN</td>
<td></td>
</tr>
</tbody>
</table>

**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 institute.

**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 continuously verifies the work.

<table>
<thead>
<tr>
<th><strong>Title of course</strong></th>
<th>Crystallography</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code</strong></td>
<td>TTGBE5104_EN</td>
</tr>
</tbody>
</table>

| **ECTS Credit points** | 3 |

<table>
<thead>
<tr>
<th><strong>Type of teaching, contact hours</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 2 hours/week</td>
</tr>
<tr>
<td>- practice:</td>
</tr>
<tr>
<td>- laboratory:</td>
</tr>
</tbody>
</table>

| **Evaluation** | exam |

<table>
<thead>
<tr>
<th><strong>Workload (estimated), divided into contact hours:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- lecture: 28 hours</td>
</tr>
<tr>
<td>- practice:</td>
</tr>
<tr>
<td>- laboratory:</td>
</tr>
<tr>
<td>- home assignment: 10 hours</td>
</tr>
<tr>
<td>- preparation for the exam: 52 hours</td>
</tr>
<tr>
<td>Total: 90 hours</td>
</tr>
</tbody>
</table>

| **Year, semester** | 1st year, 1st semester |

<table>
<thead>
<tr>
<th><strong>Its prerequisite(s):</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Further courses built on it:</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Topics of course</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of crystallography among other fields of science. The definition of space lattice, 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 structural differences. The understanding of constitution of unit cells and symmetry elements will be supported by the in-class study of three dimensional crystal models.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Literature</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Compulsory:</strong></th>
</tr>
</thead>
</table>
Schedule:

1st week

2nd week
Bravais-type unit cells and crystals systems. Crystalcross in crystallography. Definition of directions, latticeplanes and crystalfaces. 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 crystalform. Crystalforms and symmetry elements in triclinic, monoclinic and orthorhombic systems.

7th week
Crystalforms and symmetry elements in trigonal, tetragonal and hexagonal crystalsystems

8th week
Crystalforms and symmetry elements in cubic crystalsystem

9th week
Basics of crystal chemistry. X-ray diffraction and Bragg equation. Types of crystal lattices (atomic, inoic, metallic, molecularlattice).Coordination number, atomic, ionic radii.

10th week

11th week

12th week

13th week

14th week
Crystaloptics. Isotropic and anisotropiccrystals. Birefrigency and opticalactivity. Summary

**Requirements:**
- **for a signature**
  Participation at lecture classes is not compulsory but highly advised. During the semester therewill be be two tests, the mid-term test in week 6, and the end-term test in week 15. Students have to sit for he 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-72</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>73-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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: 3rd year, 2nd semester

Its prerequisite(s): TTKBE0101_EN

Further courses built on it: The course is connected to other courses of chemistry teachers (Basics of chemistry teaching, Methods and devices of chemistry teaching)

Topics of course
The topic of this course is the history of chemical thinking, the philosophical foundations of the science, the thinking systems and the history of discovery and inventions. It also concerns the impact of the development of chemistry on culture, history, the worldview 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:

Recommended:
**Schedule:**

1\(^{st}\) week: The review of the requirement. Science philosophy. Chemistry knowledge in the prehistoric age.

2\(^{nd}\) week: The history of the chemistry in the antiquity (Syria, Arabia, Mezopotámia, Egypt, Asia)

3\(^{rd}\) week: Chemistry knowledges in the Greek and a Roman age. The appearance of the alchemy.

4\(^{th}\) week: Age of alchemy.

5\(^{th}\) week: Development of jatro-chemistry.

6\(^{th}\) week: The age of discovery of gases.

7\(^{th}\) week: Mixtures, compounds, elements, separation, qualitative analysis, chemicals symbols, formules, nominations.

8\(^{th}\) week: Development of electrochemistry.

9\(^{th}\) week: Development of organic chemistry.

10\(^{th}\) week: Development of terminology and language of chemistry

11\(^{th}\) week: Chemistry and the turn of the century.

12\(^{th}\) week: The history of the discovery of medicines. The history is famous poisons and poisoning.

13\(^{th}\) week: Test.

14\(^{th}\) 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 13\(^{th}\) 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 points 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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 Fejesné Dávid, Assistant Professor, PhD

**Lecturer:** Dr. Ágnes Fejesné Dávid, Assistant Professor, PhD

---

**Title of course:** Macroeconomics

**Code:** TTBEBVVM-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:*

*Recommended:*

**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)
Person responsible for course: Dr. Pál Czeglédi, associate professor, PhD
Lecturer: Dr. Levente Sándor Nádasí, 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:

Recommended:


**Schedule:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th</td>
<td>Narcotics, hard and softdrugs 5. Synthetics 1. Amphetamine and derivatives, Extasy, etc.</td>
</tr>
<tr>
<td>7th</td>
<td>Chemical weapons 1. Major groups, target organs, toxicity. Teargas, lachrymators.</td>
</tr>
<tr>
<td>8th</td>
<td>Chemical weapons 2. Blood poisons, lung poisons, vesicants.</td>
</tr>
<tr>
<td>14th</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Requirements:**

- *for a signature*

Attendance at lectures is recommended, but not compulsory.
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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-75</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>76-88</td>
<td>good (4)</td>
</tr>
<tr>
<td>89-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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-semestergrade

**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:** 2\textsuperscript{nd} / 3\textsuperscript{rd} year, 2\textsuperscript{nd} semester

**Its prerequisite(s):** TTMBE0809_EN, TTMBG0809_EN, TTKBG0911_EN

**Further courses built on it:** -

**Topics of course**

**Literature**
*Compulsory:*
https://maker.pro/linux/tutorial/basic-linux-commands-for-beginners
http://gaussian.com/keywords/

**Recommended:**

**Schedule:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>Basic theory of the Hartree-Fock method: approximations, LCAO-MO theory. Building structures by the GaussView program.</td>
</tr>
<tr>
<td>2nd week</td>
<td>Basic Linux commands, using the WinSCP and Putty programs, connecting by SFTP. Using the Gaussian program package, optimizing simple molecules.</td>
</tr>
<tr>
<td>3rd week</td>
<td>Geometry optimizations by different basis sets, comparing and calibrating the methods by structural parameters.</td>
</tr>
<tr>
<td>4th week</td>
<td>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.</td>
</tr>
<tr>
<td>5th week</td>
<td>Basic theory of the post-Hartree-Fock theories. Recalculating the previously studied systems and comparing them to the HF results.</td>
</tr>
<tr>
<td>6th week</td>
<td>Solvent effect, using Polarizable Continuum Models to refine the energies.</td>
</tr>
<tr>
<td>7th week</td>
<td>Basic theory of the Density Functional Theory. Recalculating the previously studied systems and comparing them to the (post-)HF results.</td>
</tr>
<tr>
<td>8th week</td>
<td>Systems with explicit solvent molecules.</td>
</tr>
<tr>
<td>9th week</td>
<td>Calculation on more difficult systems: metal complexes and relativistic effects.</td>
</tr>
<tr>
<td>10th week</td>
<td>Mid-term exam about calculations by using Gaussian.</td>
</tr>
<tr>
<td>11th week</td>
<td>Conformation analysis, more Linux commands.</td>
</tr>
<tr>
<td>12th week</td>
<td>Writing simple scripts in b shell.</td>
</tr>
<tr>
<td>13th week</td>
<td>Generating input files by scripts.</td>
</tr>
<tr>
<td>14th week</td>
<td>Exam of writing scripts in b shell.</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>Score (%)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
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<tr>
<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

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**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:** -
- 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:*

**Schedule:**

1st week
Interaction of radiation with matter, general sketch of the applications.

2nd week
Radiotracers, physicalchemistry of carrier-free concentrations.

3rd week
Basic rules of tracerstudies.

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
Tracerstudies in physicalchemistry: 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 radioanalytica Imethods 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>fail (1)</td>
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<tr>
<td>60-69</td>
<td>pass (2)</td>
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<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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 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**

Determination the density of plastics. Molding of plastic sheets. Shore hardness determination. Determination of mechanical properties of plastics based on tensile test. Impact testing of...

**Literature**

*Recommended:*
1. ISO standards (one copy can be found in the laboratory)
2. Syllabus provided by the Department of Applied Chemistry

**Schedule:**

1st week
Determination the density of plastics.

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 MFI value of plastics.

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 group 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
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<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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:** Katalin Illyésné Dr. Czifrák, assistant professor, PhD

**Title of course:** Plastics and Processing II.  
**Code:** TTKBE1213_EN  
**ECTS Credit points:** 2
**Type of teaching, contact hours**
- lecture: -
- practice: 2 hours/week
- laboratory: -

**Evaluation:** mid-semester grade

**Workload (estimated), divided into contact hours:**
- lecture: -
- practice: 28 hours
- laboratory: -
- preparation for the tests: 32 hours
Total: 60 hours

**Year, semester:** 3rd year, 2nd semester

**Its prerequisite(s):** TTKBE0611_EN

**Further courses built on it:** -

**Topics of course**

**Literature**
*Recommended:*
1. Website of MOL Petrochemicals

**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

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:

<table>
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<tr>
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<tbody>
<tr>
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<tr>
<td>60-80</td>
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</tr>
<tr>
<td>81-90</td>
<td>good (4)</td>
</tr>
<tr>
<td>91-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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)

### 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

#### 5th week
6th week

7th week

8th week

9th week

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

14th week

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:

<table>
<thead>
<tr>
<th>Score</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail  (1)</td>
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</tr>
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<td>Score Range</td>
<td>Grade</td>
</tr>
<tr>
<td>-------------</td>
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</tr>
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</tbody>
</table>

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

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**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:*  
Schedule:

1st week
The different structural level or proteins. Protein folding and chaperons. Protein misfolding. Structural classification of proteins.

2nd week

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 b6f 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 C4 pathway.

7th week
Nucleotide Metabolism. The biological function of nucleotides. The pyrimidin de novo biosynthesis. The interconversion of nucleoside mono-diprophosphates.

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

**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:

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<tr>
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</tr>
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</tr>
</tbody>
</table>

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

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**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:** 2nd/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:**

### 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**

**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

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

12th week
Electrokinetic effects, precipitation from liquids. Epitaxis. Kidney and bile stones, processes of their formation.

13th week

14th week

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:

<table>
<thead>
<tr>
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<tbody>
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</table>

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 1H and 13C NMR spectra on the 360MHz high field NMR spectrometer without external help

**Literature**

- Bruker Topspin 3.x manuals (free download)

**Schedule:**

---

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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. Lockpower, field, phase, gain, findingthelocksignal. Optimizinglockparametersavoidingsaturation of thedeuteriumsignal.

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. Acquisition 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 13C-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 $^1$H NMR spectrum with quantitative integrals and a $^{13}$C NMR spectrum with peak list within one hour time limit, without external help. They may ask for tutor help, however this may result in lowering their mark.
  - the result of the practical examination may be 1 (failed) 2,3,4,5 (passed)

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

**Lecturer:** Prof. Dr. Gyula Batta, university professor, DSc

| **Title of course:** Plastics and Processing III. | **ECTS Credit points:** 3 |
| **Code:** TTKBE1214_EN | |

**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


### Literature

**Compulsory:**

**Recommended:**

### 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
Calendering, tube blowing, dry melt and wet spinning.

5th week

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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-61</td>
<td>pass (2)</td>
</tr>
<tr>
<td>62-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

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**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:**_

_**Recommended:**_
- Muhlynov I.: Chemical Technology I-II.

**Schedule:**

1<sup>st</sup> week
Biofuels, bioethanol production in the industry

2<sup>nd</sup> week
Biofuels, biodiesel production in the industry

3<sup>rd</sup> week
Yeast and acetic acid production

4<sup>th</sup> week
Manufacturing beer

5<sup>th</sup> week
Uses of renewable energy sources

6<sup>th</sup> week
Manufacturing sugar

7<sup>th</sup> week
Paper industry

8<sup>th</sup> week
Classification of explosive materials

9<sup>th</sup> week
Nanotechnology

10<sup>th</sup> week
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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-59</td>
<td>pass (2)</td>
</tr>
<tr>
<td>60-74</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>75-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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: Organic Chemistry Seminar I.
Code: TTKBG0311_EN
ECTS Credit points: 1

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

Evaluation: mid-semester grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 14 hours
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: -
Total: 30 hours

**Year, semester:** 1<sup>st</sup> year, 2<sup>nd</sup> semester

**Its prerequisite(s):** General Chemistry I. (lecture) TTKBE0101_EN

**Further courses built on it:** -

## Topics of course

Review the basic of organic chemistry. Types and theories of chemical bonds. Review the acid-base the ories. 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-learningsystem.

**Recommended:**


## Schedule:

**1<sup>st</sup> week**
Comparison and exercise of representation of organic compounds. Determination of the order (primary, secondary, tertiary, quaternary) of carbon atoms in compounds.

**2<sup>nd</sup> 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).

**3<sup>rd</sup> week**
Exercise the recognition of organic compounds and functional groups.

**4<sup>th</sup> 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

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 $SE_{Ar}$ 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-65</td>
<td>pass (2)</td>
</tr>
<tr>
<td>66-80</td>
<td>satisfactory (3)</td>
</tr>
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<td>80-89</td>
<td>good (4)</td>
</tr>
<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

Person responsible for course: László Dr.Juhász, associate professor, PhD

Lecturer: László Dr.Juhász, associate professor, PhD

Title of course: OrganicChemistry Seminar 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


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:

213
<table>
<thead>
<tr>
<th>Week</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; week</td>
<td>Practice the classification and synthesis of halogenated hydrocarbons.</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; week</td>
<td>Practice the elimination and substitution reactions of halogenated hydrocarbons.</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; week</td>
<td>Practice the preparation of Grignard compounds and their application.</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Preparation of alcohols, ethers, phenols and their thioanalogues. The acid-base properties of alcohols, phenols and their thioanalogues</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the chemical properties of alcohols and phenols, ethers and their thioanalogues.</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the classification of amines and characterization of their bonding systems. Practice the synthetic methodologies of aliphatic and aromatic amines, industrial methods.</td>
</tr>
<tr>
<td>7&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the basicity and chemical transformations of the amines (alkylation, acylation, sulfonamide formation, reaction with nitric acid). Reactions of aromatic rings of anilines.</td>
</tr>
<tr>
<td>8&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the preparation of nitro compounds, diazonium salts. Reactions and practical significance of aromatic diazonium salts.</td>
</tr>
<tr>
<td>9&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the synthetic possibilities of aldehydes and ketones and an overview of their acid-base properties.</td>
</tr>
<tr>
<td>10&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>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.</td>
</tr>
<tr>
<td>11&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>Practice the classification and preparation of carboxylic acids and their derivatives.</td>
</tr>
<tr>
<td>12&lt;sup&gt;th&lt;/sup&gt; week</td>
<td>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.</td>
</tr>
</tbody>
</table>
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:

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<tr>
<td>0-49</td>
<td>fail (1)</td>
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<td>pass (2)</td>
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<td>80-89</td>
<td>good (4)</td>
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<tr>
<td>90-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

Person responsible for course: Dr. László Juhász, associate professor, PhD

Lecturer: Dr. László Juhász, associate professor, PhD, dr.habil

<table>
<thead>
<tr>
<th>Title of course:</th>
<th>Advanced Organic Chemistry Seminar</th>
<th>ECTS Credit points: 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code:</td>
<td>TTKBG0313_EN</td>
<td></td>
</tr>
</tbody>
</table>

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):** OrganicChemistry II. (lect. and sem.) TTKBE0302_EN

**Further courses built on it:** -

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**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:*

**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

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. 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>fail (1)</td>
</tr>
<tr>
<td>50-62</td>
<td>pass (2)</td>
</tr>
<tr>
<td>63-75</td>
<td>satisfactory (3)</td>
</tr>
<tr>
<td>76-87</td>
<td>good (4)</td>
</tr>
<tr>
<td>88-100</td>
<td>excellent (5)</td>
</tr>
</tbody>
</table>

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

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