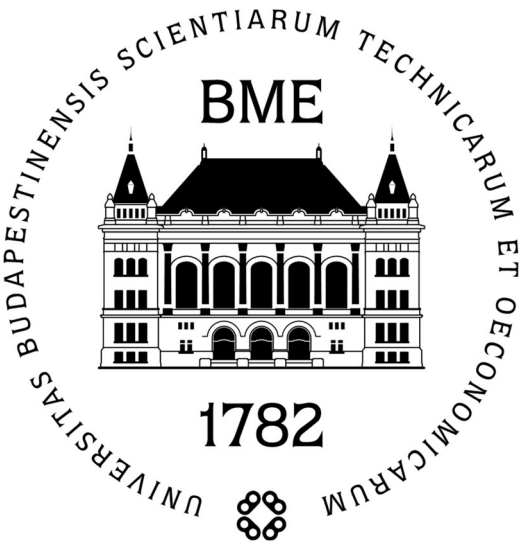

Chemical Engineering Bachelor's Programme
Study mode: Full-time
Language of instruction: English

EDUCATIONAL PROGRAMME

Effective from 01 September 2014

Applies to students starting their studies from term I of the academic year 2014/15 till term 2025/26

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1. Basic details of the educational programme

1.1. The study programme and the professional qualification

Title of the study programme

In Hungarian: vegyészmérnöki alapképzés

In English: Chemical Engineering Bachelor's Programme

Title of professsional qualification

In Hungarian: vegyészmérnök

In English: Chemical Engineer

Level of qualification

In Hungarian: alapfokozat

In English: Bachelor of Science, BSc

1.2. Profile of the educational programme

Level of the educational programme: Bachelor's

The educational programme

Classification according to the European Qualifications Framework (EQF): 6

Classification according to the Hungarian Qualifications Framework (HuQF): 6

Classification according to ISCED 2011: 6

Classification according to ISCED-F 2013: 0711

Classification by educational programme: engineering

Orientation: balanced (40-60 percent)

FIRgráf[1] availability: https://firgraf.oh.gov.hu/felsooktatasi-kepzesek/kepzes/BSZKVEM/

1.3. Dual, cooperative educational programme

N/A

1.4. Duration and credit value of the programme

Duration of the programme: 7 terms

Number of credits to be earned: 210 credits

[1] On the Educational Authority's central educational programme registration platform (https://firgraf.oh.gov.hu/felsooktatasi-kepzesek/) the data sheet of the given educational programme (e.g. for a bachelor's programme in chemical engineering https://firgraf.oh.gov.hu/felsooktatasi-kepzesek/kepzes/BSZKVEM/)

1.5. Study mode and organisation of the educational programme

Study mode of the educational programme: full-time

A detailed description of how the educational programme is organised: full-time. 100% of classes are delivered in an in-person format; approximately 10% are also available in a distance-learning format. The timetable is organised from Monday to Friday, within the time slots defined by the current regulations of BME.

1.6. Language of the educational programme

Language of the educational programme: English

Specificities of the educational programme taught in Hungarian: N/A; general rules apply, see Section 2.5.2.

Specificities of the educational programme taught in a language other than Hungarian: N/A

1.7. The persons responsible for the educational programme

The faculty responsible for educational programme: Faculty of Chemical Technology and Biotechnology

Programme leader: Dr Edit Székely, university professor

1.8. Conditions for admission

The conditions set out in the legislation, the Admission Regulation and the Higher Education Admission Guide as follows:

The main rules set out in the ministerial publication on programme and outcome requirements are described in detail in Section 2.8.1.

In addition to the requirements defined by law and the BME Admission Regulation, the programme does not prescribe any further specific admission requirements.

2. Content, characteristics and requirements of the educational programme

2.1. The aim of the educational programme, quality assurance system

The aim of the educational programme is to train chemical engineers who are capable of operating and maintaining chemical processes and equipment; introducing and applying chemical technologies; organising and managing work; and performing tasks of average complexity in technical development, research and design. Graduates are able to ensure the safe operation of technological systems without endangering health, to recognise their potential effects on human health, and to apply the necessary tools of preventive activities. They are prepared to continue their studies at master's level.

General Chemical and Process Engineering Specialisation

The objective of the specialisation: The two main areas are process control and chemical management. Both require strong mathematical knowledge. The specialisation has

relatively little laboratory practice, preparing mainly for production management and only to a lesser extent for laboratory work. Engineers who graduate from the specialisation can be employed mainly as production managers, development engineers, or in the engineering management department of a company.

Analytical and Structural Chemistry Specialisation

The objective of the specialisation: The specialisation prepares the students for two main areas. One is mostly research work, such as structural analysis research on a given compound. The other area is applied analytics, where they can deal with the quantitative and qualitative determination of compounds and quality control. There are many laboratory exercises, which primarily involve precise instrumental measurements.

Pharmaceutical Industry Specialisation

The objective of the specialisation: The specialisation provides knowledge in basic and applied organic chemistry, as well as in pharmaceutical technology. During the organic synthetic laboratory practice, students acquire preparative basic techniques and apply the learned analytical and separation methods. There is also an opportunity to gain knowledge in the field of formulation technology, building on materials science and analytical knowledge.

Plastics, textile and materials science specialisation

The objective of the specialisation: The specialisation prepares the students for three areas. Accordingly, the aim of the educational programme is, building on the common subject Materials Science Testing Methods, to provide basic chemical and physical knowledge of plastics, fibres and textiles, as well as of those areas of materials science dealing with plastics, metals and ceramics. The specialisation familiarises students with the most important technologies and qualification methods applied during the production and processing of different materials and products, and presents possible fields of application.

The defining subjects of the **polymer processing technology sub-specialisation** are the physics of plastics, plastics processing, and plastics processing machines and tools. Graduates may work in traditional chemical industry fields, but in addition they also possess supplementary knowledge related to the processing and application of plastics.

The defining subjects of the **textile technology sub-specialisation** address the physical and chemical structure of fibres, the chemical structure of dyes and auxiliaries, as well as the basic technologies of textile finishing. In addition to traditional chemical and textile industry fields, graduates may find employment in other industries processing fibres, as well as in the clothing industry and textile trade. This sub-specialisation is not launched.

7

The defining subjects of the **materials science sub-specialisation** present plastics, metals and metal alloys, ceramics and composite systems. Graduates are employed primarily in the related industries, as well as in technical fields applying complex technologies, and in research.

Elements of quality assurance in educational programme according to the ESG

Compliance with the ESG 1.1 [Quality Assurance Policy] standard:

The educational programme aims are in line with the institution's quality assurance policy and contribute to the continuous development of the educational programme offer, along strategic priorities.

Compliance with ESG 1.2 [Design and approval of educational programmes]:

The educational programme was designed through a consultative process that took into account relevant professional and societal needs, involving academics, labour market actors and student delegates. The aims are set through clearly defined learning outcomes. The curriculum was developed with broad participation of academic lecturers and students, and was approved by the Programme Committee, the Faculty Council and the Senate.

Compliance with the ESG 1.3 [Student-centred learning, teaching and assessment] standard:

The educational programme aims and organisation support active learning and student autonomy, professional responsibility and competence-based development. The curriculum includes a high proportion of elective subjects and opportunities for topic selection within subjects, and places strong emphasis on project-based education.

Compliance with ESG 1.4 [Student progress, recognition and awarding of degrees]:

The aims and curriculum structure ensure transparent progression rules, recognition of prior learning and consistent and fair awarding of diplomas.

Compliance with ESG 1.9 [Continuous monitoring and periodic review of programmes]:

The aims of the educational programme and the field orientation are regularly reviewed on the basis of student feedback, follow-up of graduates and employer consultations.

Compliance with the ESG 1.10 [Cyclical external quality assurance] standard:

The definition and periodic review of educational programme objectives is integrated into the system of institutional accreditation and external quality assurance procedures.

2.2. General competences

Subjects providing for the acquisition of general competences as defined in Section 11(2), Section 114/P(2)(b) of the Nftv. and the KKK:

General competence	Subjects [subject code, subject name]
digital competences (digital competences and occupation-specific digital skills, media literacy, safe use of the internet, and knowledge of digital solutions for effective use of digital technology to achieve learning objectives)	BMEVESAA103 Computing
artificial intelligence (AI-based tools and procedures, and their knowledge and application in relation to educational programme)	BMEVExxA999 Thesis
developing financial and entrepreneurial skills related to the knowledge-based economy	BMEGT20A001 Management and Business Economics BMEGT30A001 Micro- and macroeconomics
health promotion knowledge, physical education [*Section 11(2) of the Higher Education Act: The higher education institution shall ensure physical and mental health promotion, including the organisation of regular physical exercise and sports activities, in accordance with its core activities (...)*]	BMEGT70BS1X Physical Education BSc - 1/X BMEGT70BS2X Physical Education BSc - 2/X X:A/B/C
basic knowledge for sustainable development (*knowledge and skills to achieve the SDGs*[2])	BMEVEKFA403 Environmental Chemistry and Technology BMEVEKFA506 Hydrocarbon Industry Technology BMEVEVMA607 Environmentally Friendly Processes BMEVESTA411 Organic Chemical Industry Technologies BMEVESTA508 Organic Chemical Industry Basic Processes
knowledge of environmental, accident and consumer protection, and occupational safety	BMEVESZA101 Safety Engineering and Occupational Safety BMEVEKFA403 Environmental Chemistry and Technology
basic knowledge on corruption prevention	BMEGT55A001 Business Law
Knowledge of Industry 4.0-based operations and technological knowledge, cyber-physical systems, self-organising mechanisms, and the consequences of digitisation and automation inducing structural changes in the labour market (*only in bachelor's and master's degree programmes in the fields of engineering and IT, business programmes in the field of economics, and programmes in the field of natural sciences*)	BMEVEVMA504 Process Control

2.3. Professional competences

2.3.1. Programme and outcome requirements

Competences of the student completing the educational programme (according to the programme and outcome requirements):

Knowledge

[2] **See details:** https://sdgs.un.org/goals

1. Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors.
2. Has knowledge of the materials most commonly used in the chemical industry, the basics of their production and the conditions of their application.
3. Has knowledge of the fundamental principles, design approaches and control technologies related to chemical and chemical engineering processes.
4. Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories.
5. Has knowledge of the measurement and analytical methods, instruments and measuring equipment used in the chemical industry and in chemical processes in general, as well as the conditions of their applicability.
6. Has knowledge of the safety, health protection and environmental protection requirements related to the field.
7. Has knowledge of the fundamentals of economic, management, environmental protection, quality assurance (QC/QA), information technology, intellectual property protection and other laws and procedures closely related to the chemical industry and chemical technologies.
8. Has knowledge of the methods of knowledge acquisition and data collection in the field of chemical engineering, as well as their ethical limitations.

Skills

1. Is able to apply the calculation and modelling principles and methods of analysis and design related to chemical processes and chemical technologies.
2. Is able to interpret and describe the structure and operation of the structural units and elements of chemical industry and chemical technology systems, as well as the design and interrelations of the applied system components.
3. Is able to apply the technical and safety regulations related to the safe operation of chemical industry and chemical technology systems, and understands the principles and economic aspects of setting up and operating processes and equipment.
4. Is able to manage and supervise chemical production and other technological processes, taking into account quality assurance and quality control aspects.
5. Is able to diagnose malfunctions and technological problems and to select corrective operations.

6. Is able to understand and use the characteristic online and printed technical documentation and professional literature of the field in Hungarian and in at least one foreign language.
7. Is able to become familiar with previously unknown new processes, products and systems, to acquire and introduce new methods, and to recognise their mechanisms of impact on human health.
8. Is able to carry out and evaluate measurements at laboratory, pilot plant and plant scale, and to perform sub-tasks of development.
9. Is able to perform basic chemical engineering managerial tasks.
10. Is able to interpret and utilise information related to health preservation, and to apply modern managerial knowledge and skills in order to create a workplace environment that supports health and efficiency.

Attitude

1. Strives to ensure that self-development in the field of chemical engineering is continuous and aligned with professional objectives.
2. Is open and receptive to the application of new, modern and innovative procedures and methods related to environmentally conscious technologies and management.
3. Always takes sustainability aspects into account in professional work and in the introduction of new technological processes and procedures.
4. Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field.
5. Consistently applies a quality-oriented approach in work and uses modern quality management procedures.
6. Strives to solve tasks and make managerial decisions by taking into account the opinions of supervised colleagues, preferably through cooperation.
7. Applies safety, health protection and environmental protection requirements and considerations in the performance and planning of technological and laboratory tasks.

Autonomy and responsibility

1. Performs professional work independently, in compliance with quality and safety requirements, based on the guidance of the workplace supervisor.
2. Initiates the development and introduction of new professional solutions when necessary or possible.
3. Directs the work of assigned staff and supervises the operation of technological equipment and measuring instruments based on the guidance of the workplace supervisor.
4. Regularly evaluates the efficiency, effectiveness and safety of subordinates' work, and assigns further tasks based on the results of these evaluations.

5. Monitors and evaluates the professional development of subordinates, encouraging and supporting such efforts.
6. Shares experience with colleagues, thereby supporting their development.
7. Makes decisions or submits proposals, within the scope of authority, regarding the evaluation, recognition and promotion of colleagues.

2.3.2. Specific competences of the educational programme

The programme-specific competences listed below reflect the characteristics specific to the implementation of the Bachelor's Programme in Chemical Engineering at the University. These competences go beyond the basic requirements defined in the programme and outcome requirements (KKK) and are the results of an educational environment aligned with the traditionally research and development-oriented approach of the BME VBK.

The aim of these competences is to ensure that graduates of the educational programme not only meet the requirements of the general qualification levels, but also possess specific knowledge, skills and attitudes, as well as a strong willingness to engage in problem solving, through which they may become outstanding contributors to the chemical industry and to research and development within their sub-specialisation, possibly following further studies.

Area of competence	*Programme-specific competence*
Knowledge	*1. Possesses advanced theoretical and practical knowledge in chemistry, with particular emphasis on organic synthetic chemistry, physical chemistry and analytical chemistry.*
	2. Has fundamental comprehensive knowledge in the fields of materials science, surface chemistry and colloid chemistry.
	3. Is familiar with the theoretical background of factorial experimental design and data evaluation.
	4. Has sufficient theoretical background knowledge to understand the effects of chemical substances on human health and the environment.
Skills	*1. Is able to understand the operation of complex chemical industry technologies and systems and, by applying theoretical knowledge, actively participate in solving complex tasks.*
	2. Routinely applies systems of equations and the digital tools necessary for their solution where these support the completion of the task.
	3. Has good laboratory practice and is capable of independent chemical laboratory work.
	4. Is capable of efficiently designing and carrying out experiments, taking into account both practical (laboratory) and evaluation (mathematical) aspects simultaneously.
Attitude	*1. Recognises the importance of research and development for the future of the chemical industry.*
	2. Acknowledges possible mistakes and takes active steps to correct them.
	3. Is aware of the importance of scientific literature.
	4. Strives not only for self-education but also to understand and explore the background underlying practical experience.
Independence and responsibility	*1. Is capable of independently and reliably following descriptions, work instructions and protocols.*
	2. Is able to assume both individual and group responsibility, and understands personal responsibility within a group.

Area of competence	*Programme-specific competence*
	3. Recognising the significant environmental and climate impact of chemical industry processes and their personal risks, is committed to chemical safety in everyday activities.

2.4. Basic structural components of the educational programme

2.4.1. Traineeship

Traineeship is a non-credit criterion requirement.

The recommended term for completing the traineeship: 7

Duration of the traineeship: 6 weeks

2.4.2. Thesis, diploma project

Credits allocated to the thesis to be prepared in the programme: 15

2.4.3. Elective subjects

Credits allocated to elective subjects: 10

2.4.4. Area of knowledge

The areas of knowledge defined in the KKK and the classification of each subject into areas of knowledge, and the person responsible for the area of knowledge:

The name of the knowledge area; (credit range according to the KKK)	Subjects, Codes, Credit values	Total credit value of the subject	The person responsible for the knowledge area
Natural Sciences subjects [Mathematics (at least 12 credits), Chemistry (at least 15 credits), Physics, Biochemistry)] 40-50 credits	BMEVESAA101 General Chemistry BMEVESAA104 General Chemistry Practice BMETE90AX00 Mathematics A1a - Analysis BMETE14AX15 Physics 1 - Mechanics BMETE90AX17 Mathematics A2c BMEVESAA208 Inorganic Chemistry BMETE14AX04 Physics 1 - Electrodynamics BMETE14AX05 Physics laboratory practice BMETE90AX18 Mathematics A3c for Chemical and Bioengineers BMEVESZA301 Organic chemistry 1 BMEVESZA401 Organic chemistry 2 BMEVEVMA606 Design and Evaluation of Experiments	48 credits	Dr József Kupai
Economics and Humanities subjects (Economics, Entrepreneurship and Management Studies, Quality Assurance, Public Administration and Professional Legal Studies,	BMEVESZA101 Safety Engineering and Occupational Safety BMEGT30A001 Micro- and macroeconomics BMEGT55A001 Business Law BMEGT20A001 Management and Business Economics BMEVEKFA615 Quality Management Elective GH subject (from the subject group)	20 credits	Dr Kinga Lak, née Komka

The name of the knowledge area; (credit range according to the KKK)	Subjects, Codes, Credit values	Total credit value of the subject	The person responsible for the knowledge area
Human Studies) 14-30 credits			
Chemical Engineering specialised subjects (General Engineering and Information Technology Studies, Physical Chemistry, Analytical Chemistry, Materials Science, Chemical and Chemical Industry Measurement Techniques, Chemical Industry Machinery and Operations, Technology, Process Control and Control Engineering Studies, Design of Chemical Technological Operations and Processes) 70-105 credits	BMEVESAA103 Computing BMEVESAA209 General Chemistry Laboratory BMEVEFKA304 Physical Chemistry 1 BMEVEKFA203 Chemical Technology BMEGEVGAV03 Chemical Industry Machinery BMEGEVGAV04 Chemical Industry Machinery Practice BMEVESAA302 Analytical Chemistry 1 BMEVEFAA405 Physical Chemistry 2 BMEVEFAA306 Plastics for Chemical Engineers BMEVESAA301 Inorganic Chemistry Laboratory BMEVEFAA409 Colloid Chemistry Foundations of Nanotechnology BMEVESAA403 Analytical Chemistry Laboratory BMEVESZA403 Pharmaceuticals BMEVESZA402 Organic Synthesis Laboratory BMEVESTA411 Organic Chemical Industry Technologies BMEVESZA412 Organic Chemical Industry Technologies Laboratory BMEVEKFA410 Chemical Industry Operations 1 BMEVEBEA301 Biochemistry BMEVEFAA506 Physical Chemistry Laboratory BMEVEKFA506 Hydrocarbon Industry Technology BMEVEKFA512 Chemical Industry Operations 2 BMEVEVMA504 Process Control BMEVEKFA403 Environmental Chemistry and Technology BMEVEKFA613 Chemical Industry Operations Laboratory BMEVEKFA777 Design	94 credits	Dr Alfréd Kállay-Menyhárd

2.4.5. Specialisations

The list of specialisations available within the programme is provided in the following table. The credit value is the total number of credits assigned to the subjects belonging to the given specialisation. The specialisation is also one of the modules of the programme (see: *0).* Specialisations are launched only if they are chosen by a predetermined minimum number of students, and they may limit the number of students admitted. Students are informed about these requirements and limitations prior to the specialisation selection period.

Specialisation name	Specialisation credit value	Organisational unit responsible for the specialisation	Specialisation leader
General Chemical and Process Engineering Specialisation	41 credits	Department of Chemical and Environmental Process Engineering	Dr Edit Székely
Analytical and Structural Chemistry Specialisation	41 credits	Department of Inorganic and Analytical Chemistry	Dr Lajos Höfler
Pharmaceutical Industry Specialisation	41 credits	Department of Organic Chemistry and Technology	Dr László Hegedűs
Plastics, textile and materials science specialisation	41 credits	Department of Physical Chemistry and Materials Science	Dr János Móczó

2.5. Assessment methods

Only the assessment methods specified in this educational programme may be used in each subject. With regard to each subject, the assessment methods, procedures and rules are set out in detail in the subject descriptions (subject datasheets), in accordance with the applicable Study and Exams Regulations and the present educational programme.

General description and objectives of the assessment methods (how they comply with ESG 1.3):

- they must be designed in a way that makes it possible to measure the extent to which the learning outcomes have been achieved, including knowledge, skills and attitudes;
- a variety of assessment methods must be applied, adapted to the nature of the subject and the teaching and learning activities (e.g. written examination, project work, oral examination, portfolio, presentation, group work, project assignment, coursework);
- they must support active student participation and responsibility, promoting in-depth learning and continuous development instead of mere memorisation;
- they must provide timely and constructive feedback that helps the student understand their own performance and identify opportunities for development;
- they must be conducted in a transparent and fair manner, and students must be clearly informed in advance about the criteria, procedures and weighting of the assessment;
- they must take diversity and inclusivity into account, allowing reasonable adjustments for students with special needs;
  they must support academic integrity and ethical conduct, with clear rules and procedures for the prevention and handling of plagiarism or other forms of misconduct.

2.5.1. Methods for the assessment of student performance

The following table provides a detailed description of the types of assessment methods used during the programme. The assessment methods of the subjects should not differ substantially from these and should be applied uniformly and consistently throughout the programme.

Assessment method	Methodological description, typical forms of implementation	Average time taken to complete the assessment, or typical time frame, minutes or hours	Average time students spend preparing for the assessment, hours
oral exam following a written test	An oral examination following the successful completion of a maximum 20-minute written test assessing predefined basic concepts and fundamental knowledge issued in advance of the oral examination. The description of the oral exam part is provided under the relevant point.	15–20 minutes + 20–60 minutes	45 hours
oral exam	Oral assessment conducted before a committee of at least two members, with preparation time (3–5 minutes) provided; may be partly or wholly dialogue-based. It may be based on responses to structured questions (set topics, list of topics) in the form of a coherent exposition, or on an unstructured series of questions and answers (e.g. solving application problems).	20-60 minutes	45 hours
written exam	Written exam, paper-based or online; may be test-based, essay-based, calculation-based or a combination of these. The student provides written answers to the questions set, on the basis of which the achievement of the expected learning outcomes assigned to the assessment in the given subject can be measured. Only aids explicitly authorised by the instructor may be used during the assessment.	45-90 minutes	45 hours

Assessment method	Methodological description, typical forms of implementation	Average time taken to complete the assessment, or typical time frame, minutes or hours	Average time students spend preparing for the assessment, hours
summative assessment of student performance	summative assessment of student performance, paper-based or online; may be test-based, essay-based, calculation-based or a combination of these. The student independently provides written answers to the questions set, on the basis of which the achievement of the expected learning outcomes assigned to the assessment in the given subject can be measured. Only aids explicitly authorised by the instructor may be used during the assessment.	30-90 minutes	20-60 hours
assessment of partial performance	broken down into subtypes (e.g. homework, mini-projects, essays, analyses and their specificities) – regular homework (with a deadline of no more than one week): solving tasks, preparing reports – complex homework (with a deadline of two to three weeks): processing literature, preparing a presentation/report, writing an essay – comprehensive homework (with a deadline of at least one month): completing a project assignment, processing literature, preparing a presentation/report, writing an essay – termly, quasi-project type homework: solution of the project assignment, development of the design	15-60 minutes (duration of the presentation, report) 15-60 minutes (duration of the presentation, report) 15-60 minutes (duration of the presentation, report)	2-6 hours 5-10 hours 20-36 hours 25-72 hours

Assessment method	Methodological description, typical forms of implementation	Average time taken to complete the assessment, or typical time frame, minutes or hours	Average time students spend preparing for the assessment, hours
	task, processing literature, preparing a presentation/report, writing an essay, production of a video – a brief paper-based or online partial performance assessment – group discussions during course hours – solving mini project assignments in class	5-30 minutes 15-60 minutes 15-60 minutes	2-10 hours 2-10 hours 2-10 hours
termly project assignment (in project subject)	Project assignments develop individual or group problem-solving skills, independence and responsibility. In the case of group assignments, the objective is to develop the ability to work in a team in addition to professional skills.	15-60 minutes (duration of the presentation, report)	in accordance with the credit value of the subject
diagnostic assessment (quiz)	typically laboratory entry test	2-15 minutes	5 hours

2.5.2. Specialised language competence

A condition for obtaining the final certificate (absolutorium) is that the student – in accordance with the provisions of the Studies and Exams Regulation – must obtain 12 language credits. Language credits may be earned as part of the curriculum of the programme as follows:

1. Subjects offered by the Centre for Modern Languages that develop professional language competences and carry credits must be recognised with their full credit value.

2. Subjects completed entirely in a foreign language must be recognised with their full credit value, regardless of their role in the curriculum (compulsory, compulsory elective, elective).

3. Within a subject taught in Hungarian, partial language credit (recognised as language credit from the total credit value of the subject) may be earned, in particular in the following ways:

   a. processing professional literature in a foreign language;

   b. completing part of the performance assessments within the subject in a foreign language;

   c. completing a project assignment in a foreign language;

4. The following subjects must be recognised with partial credit value:

Subject name	Subject Neptun code	Subject credit value	Language credit point
Organic Synthesis Laboratory	BMEVESZA402	4	1
Organic Chemistry Laboratory II	BMEVESKA605	5	1
Environmentally Friendly Procedures	BMEVEVMA607	4	1
Chemical Industry Operations 2	BMEVEKFA512	6	1
Thesis	BMEVE__A999	15	7
Process Engineering	BMEVEVMA605	5	2
Computer-Based Process Control	BMEVEVMA709	3	1
Design	BMEVE__A777	3	1

2.5.3. Traineeship

1. Requirements relating to traineeship:
   a) Prerequisites (e.g. credits obtained, subjects completed): none; however, it is recommended to complete the traineeship after the 6th term of the recommended curriculum.
   b) Requirements for the traineeship host: the traineeship host must have a co-operation agreement in place for the organisation of traineeships in the Bachelor's programme in Chemical Engineering.
   a) Responsible organisational unit: the department responsible for the given specialisation.
   b) Rules of contact: matters related to the organisation and administration of traineeships are handled by the departmental traineeship coordinators. In 2025, the lecturers responsible for organising traineeships are: Dr Benjámin Gyarmati (Department of Physical Chemistry and Materials Science, Materials Science Specialisation), Dr András Simon (Department of Inorganic and Analytical Chemistry, Analytical and Structural Investigation Specialisation), Dr Éva Pusztai (Department of Chemical and Environmental Process Engineering, Chemical Industry and Process Engineering Specialisation), Dr Zoltán Hell (Department of Organic Chemistry and Technology, Pharmaceutical Industry Specialisation). Any change in the person responsible for traineeships must be published on the Faculty website: https://www.ch.bme.hu/oktatas/oktatoi-gyik/szakmaigyak/
2. Reporting obligations
   a) Content and formal requirements of the report: submission of the evaluation form completed and signed by the traineeship host. The template of the evaluation form can be downloaded from the Faculty website: https://www.ch.bme.hu/oktatas/oktatoi-gyik/szakmaigyak/
   b) Method of submission of the report: electronically or in person, as announced by the traineeship coordinator.
   c) Deadline for submission: the last day of the study period.

3. Method and criteria of evaluation of the traineeship
   a) Conditions for completion: at least a "pass" grade in every category of the evaluation form; a minimum of 120 working hours (which may be completed at more than one traineeship host); the completed activity must be professionally relevant to the expected job role (FEOR 2117).
   b) Correction of a rejected report: by submitting a new evaluation form by the end of the late completion period.
   c) Repetition of a rejected traineeship: by completing a new traineeship at a different host.

Relevant professional experience (FEOR 2117), organised individually and even completed prior to the start of the programme, may be accredited. For accreditation, the following must be submitted as an attachment to the appropriate Neptun request: an employment contract (with financial data redacted), an evaluation form (see point 3a), and a professional report of at least two pages, endorsed by the traineeship host.

2.5.4. Criteria requirements

Criteria to be fulfilled during the programme, the fulfilment of which is a prerequisite for obtaining the final certificate:

1. Physical education 2 terms (2 subjects), without restriction as to the type of sport.
2. Specific language requirements: none
3. Health fitness requirement(s): none.
4. Participation in occupational safety, accident prevention, environmental protection and fire safety study programme: not relevant; in this programme, mandatory instruction is provided in every laboratory in every term.
5. Traineeship: see Subsection 2.5.3.

2.5.5. Preparation of the thesis

1. Prerequisites for registering for the subject serving thesis preparation:

   In the Bachelor's programme, the thesis is completed in one part (Thesis subject in the 7th term of the recommended curriculum). The Thesis subject may be registered for by a student who has passed the comprehensive examination, or has registered for it concurrently, and who lacks no more than 20 credits in addition to the thesis for obtaining the Bachelor's degree.

2. Content and Formal Requirements of the thesis:

   The preparation of the thesis is an independent task concluding the Bachelor's programme. The purpose of the thesis is for the student to acquire the skills necessary for independent professional work and for documenting it to a high standard, and to demonstrate that they meet the requirements set for graduates of the programme.

In solving an engineering task appropriate to the level of the Bachelor's degree, the student is guided and supported by a supervisor and, where applicable, a thesis advisor. The student expands and deepens the knowledge acquired during their studies in the chosen topic, summarises the available information, formulates the problem, prepares a plan for its solution, evaluates the results of the work, analyses the findings and provides a summary.

The thesis may be based on experiments, computer-based tasks, preparation of a study, or a combination of these. A thesis based solely on literature review is not supported at the Faculty of Chemical Technology and Biotechnology. As a written work, the thesis is similar to scientific publications or engineering studies. Unless otherwise specified by the supervisor, the following structure is recommended:

Table of contents

Introduction (a brief overview of the topic and the task)

Literature review (summary of literature directly related to the topic; formulation of the problem and objective of the work based on the literature)

Experiments, methods (materials used, their main characteristics, safety regulations, analytical methods, applied computer programs, etc.)

Results and their evaluation

Summary

Bibliography

Appendix (details of measurement and/or calculation results, data)

The length of the thesis, including figures, is 20–40 pages (typically 30 pages), excluding references and appendices, with one-and-a-half line spacing.

The thesis may only be submitted if it contains, duly completed and signed and bound into the thesis, the declarations available on the Faculty website:

a.) the supervisor's declaration (and, if applicable, jointly with the thesis advisor or external supervisor) on the admissibility of submission;

b.) the student's declaration.

In the absence of these, the lecturer responsible for the final examination shall refuse to accept the thesis and to admit the student to the final examination.

The department responsible for the final examination informs the student about the exact procedure for electronic submission (submission by email or upload to the departmental server). The department may also request a printed copy.

3. Rules for writing a thesis in a language other than the language of the educational programme:

The thesis may be prepared not only in Hungarian but also in one of the foreign languages of instruction at BME (English or German), subject to the approval of the departmental supervisor and the head of department.

4. Process of thesis preparation:

   The Thesis subject must be registered for in the Neptun system. Application for a topic is made electronically. The student may choose a thesis topic from any department of the Faculty and may also propose a topic (e.g. a workplace-related topic). The thesis may be prepared at any department of BME. The department responsible for the thesis is the department of the supervisor. If the (internal) supervisor is employed at another faculty of BME, the opinion of the programme leader must be sought in advance as to whether the chosen topic is acceptable as a thesis topic in the programme. Requesting this opinion is the student's responsibility. If the student cannot find a suitable thesis topic, they may contact the head of the department responsible for the specialisation, no later than Tuesday of the second teaching week. If this deadline is missed, the head of department is not obliged to provide a thesis topic.

   Monitoring progress: during the study period, the internal supervisor consults with the student at least once every two weeks. At the end of the study period, the student reports on the progress of the thesis before the professional community in which the thesis work was carried out.

   Review: the completed and submitted thesis must be reviewed. The reviewer must hold an MSc degree or equivalent or higher qualification, or hold a BSc degree with at least five years of professional experience. The external reviewer (independent reviewer) must be legally and academically independent of both the student and the supervisor. The external reviewer is appointed by the head of the department responsible for the specialisation. An independent reviewer may be an employee of BME VBK only if the thesis was prepared at another faculty of BME. Efforts must be made to appoint an independent reviewer from industry, a research institute or another university (independent of BME). The supervisor also prepares a separate evaluation (internal review). The reviews must be made available to the candidate no later than five days before the thesis defence. The reviewer and the supervisor each make a proposal for the grade of the thesis.

   The review is approximately one page of free-text evaluation, typically addressing the relevance of the topic, the quality of processing available literature and technical documentation, the quantity and quality of the student's own work, the validity or possible shortcomings of the conclusions, and the structure and standard of the thesis as a written work. The specialisation coordinators may prescribe the use of a review template.

   Defence: the submitted and reviewed thesis is defended by the student at the final examination. At the beginning of the defence, the student presents the essence of the thesis in a 10-minute oral presentation with appropriate visual aids, and then answers the questions of the Final Examination Committee. The grade of the thesis is determined by the Final Examination Committee on the basis of

the performance at the defence, taking into account the proposals of the reviewers.

5. Criteria for the assessment of the thesis preparation:
   The internal supervisor – with the involvement of the external supervisor and consultant, if any – evaluates the student's work. The Thesis subject is assessed in the same way as subjects concluding with a semester grade. For the assessment of the subject, the existence of the completed thesis as a written work is not a prerequisite; however, when awarding a grade other than fail, the lecturer/head of department certifies that the student possesses sufficient experimental/calculation results and experience to be able to complete the thesis without further departmental assistance. In the case of negligent work, the subject is assessed as fail; if the work has not been commenced, it is assessed as "Not completed". An objection to the assessment may be raised only in the case of deficiencies on the part of the thesis advisor or supervisor. The student has the right and obligation to turn to the head of the department announcing the topic in the event of deficiencies on the part of the thesis advisor or supervisor, and must do so as soon as necessary. If the matter cannot be resolved at departmental level, the student may contact the Vice-Dean for Education.
6. Criteria for assessment of the (professional) content of the thesis:

   The grade of the thesis is determined by the final examination committee, taking into account the opinions of the reviewers, after reviewing the submitted thesis and hearing the oral defence, including the discussion. A particularly important part of the defence is the student's answers to the questions posed by the committee.

   In the assessment, the committee pays particular attention to whether

   the candidate

   - has sufficient knowledge in the field related to the thesis;
   - has completed the assigned tasks to an appropriate standard;
   - is capable of independently expanding their professional knowledge;
   - compares and evaluates their results with similar findings and measurements in the literature and other sources;
   - is capable of conducting a meaningful professional discussion and defending their standpoint;
   - has independent ideas regarding the topic;
   - is capable of documenting their work and presenting it to a professional audience;
   - has achieved, in the submitted and presented professional work, a standard and quality appropriate to the end of a Bachelor's programme.

2.5.6. Final Examination

Structure of the final examination, its components and their description:

1. Thesis defence, within the framework of which the candidate delivers a 10-minute oral presentation, in which they present in detail the objective of the work, the methods applied during the work, the results obtained and their evaluation. They highlight their independent contribution and provide substantive answers to the questions posed by the members of the Final Examination Committee.
2. During the oral examination taken at the same time as the defence, the candidate is examined in two subjects or two subject groups corresponding to their specialisation.

Subject groups for the final examination

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)	Specialisation (subspecialisation)
ZVEVETOA211	Process Dynamics + Hydrocarbon Industry Technology	Process Dynamics, BMEVEVMA605 Hydrocarbon Industry Technology, BMEVEKFA506	General Chemical and Process Engineering Specialisation
ZVEVETOA212	Environmentally Friendly Technologies + Computer-Based Process Control	Environmentally Friendly Technologies, BMEVEVMA607 Computer-Based Process Control, BMEVEVMA709	General Chemical and Process Engineering Specialisation
ZVEVETOA221	Analytical Chemistry	Analytical Chemistry 1, BMEVESAA302 Analytical Chemistry Laboratory, BMEVESAA403	Analytical and Structural Chemistry Specialisation
ZVEVETOA222	Elemental Analysis + Chromatography	Elemental Analysis, BMEVESAA701 Chromatography, BMEVEAAA611	Analytical and Structural Chemistry Specialisation
ZVEVETOA231	Organic Chemical Industry Technologies + Pharmaceutical Industry Technology	Organic Chemical Industry Technologies, BMEVESTA411 Organic Chemical Industry Technologies Laboratory, BMEVESTA412 Pharmaceutical Industry Technology, BMEVESTA704	Pharmaceutical Industry Specialisation
ZVEVETOA232	Basic Organic Chemical Industry Processes + Basic Pharmaceutical Chemistry Processes	Basic Organic Chemical Industry Processes, BMEVESTA508 Basic Pharmaceutical Chemistry Processes, BMEVESTA606	Pharmaceutical Industry Specialisation

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)	Specialisation (sub-specialisation)
		Basic Pharmaceutical Chemistry Processes Laboratory, BMEVESTA705	
ZVEVETOA241	Plastics Processing + Plastics Processing Machines and Tools	Plastics Processing, BMEVEMGA608 Plastics Processing Machines and Tools, BMEVEFAA705	Plastics, Textile and Materials Science Specialisation (Plastics Technology Sub-specialisation)
ZVEVETOA242	Physics of Polymers	Physics of Polymers, BMEVEMGA511	Plastics, Textile and Materials Science Specialisation (Plastics Technology Sub-specialisation)
ZVEVETOA243	Textile Technology	Textile Chemical Technology 1, BMEVEMGA617 Textile Chemical Technology 2, BMEVEFAA718	Plastics, Textile and Materials Science Specialisation (Textile Technology Sub-specialisation)
ZVEVETOA244	Fibre-Forming Polymers + Dye and Surfactant Chemistry	Fibre-Forming Polymers, BMEVEMGA512 Dye and Surfactant Chemistry, BMEVESTA510	Plastics, Textile and Materials Science Specialisation (Textile Technology Sub-specialisation)
ZVEVETOA245	Metals, Ceramics and their Associated Systems + Plastics for Chemical Engineers	Metals and Metal Matrix Composites, BMEGEMTBVFM Advanced Engineering Ceramics, BMEVEFAA601 Plastics for Chemical Engineers, BMEVEFAA306	Plastics, Textile and Materials Science Specialisation (Materials Science Sub-specialisation)
ZVEVETOA246	Materials Science Testing Methods	Materials Science Testing Methods, BMEVEFAA708	Plastics, Textile and Materials Science Specialisation (Materials Science Sub-specialisation)

Detailed requirements of the individual final examination subject groups (list of topics, competence list)

1. Process Dynamics + Hydrocarbon Industry Technology [ZVEVETOA211]

1. Concept of heat integration; presentation of the significant variables and considerations in the design of heat exchanger networks; possible stream matches. Pinch design using composite curves and heat cascade calculation.
2. Pinch design: identification of matches in the vicinity of the pinch temperature and away from it; hidden pinch; essential presentation of the rapid algorithm.
3. Presentation of the grand composite curve; integration of a distillation column and a heat pump into the heat cascade; determination of utility temperatures using the reduced grand composite curve.

4. Cost of heat exchanger networks: relationship between energy recovery and heat exchanger area; supertargeting; cost changes during modification of an existing heat exchanger network (retrofit targeting).
5. Design of component recovery systems (mass exchange networks) in comparison with the design of energy recovery systems (heat exchanger networks). Main steps of the design; similarities and differences.
6. Water-using networks. Determination of minimum water consumption without regeneration. Regeneration with recycle and without recycle (reuse).
7. Comparison of Block Flow Diagram, Process Flow Diagram and Piping & Instrumentation Diagram: their application, characteristics and content.
8. Crude oils, origin, transport, pretreatment, fundamentals of distillation, crude oil distillation.
9. Quality improvement technologies: heteroatom removal, dearomatisation, dewaxing.
10. Production of motor gasoline blending components: alkylation, production of oxygenates, isomerisation, reforming.
11. Physical separation operations: supercritical extraction, extraction and distillation of aromatics, solvent dewaxing of base oils.
12. Conversion processes: fluid catalytic cracking and hydrocracking of vacuum gas oils; thermal cracking of vacuum residues by visbreaking and delayed coking.
13. Classification of petroleum industry products, product blending: motor fuel blending components and additives, properties.
14. Petrochemical technologies: implementation of steam pyrolysis, product separation, production of PE and PP, their main properties.

2. Environmentally Friendly Technologies + Computer-Based Process Control [ZVEVETOA212]

1. What is meant by a PID controller? What PID algorithms are known? How can the parameters of the P, I and D terms be characterised? In what form can the P and I parameters be determined? Specifically, to which PID algorithm and to which parameters can the IMC/Lambda and the Cohen-Coon methods be applied?
2. Briefly present the problem of integral windup, as well as the low-pass filters frequently applied in derivative terms, and their importance for control quality.
3. What special hardware elements are used in computer-based process control? Block diagram and explanation of a DDC loop. Present the DCS systems widely used today.
4. Explain the importance of Laplace and Z transforms in control engineering and their relationship with sampling time. How would you select the sampling frequency for sampled systems?
5. In an industrial DCS system, the parameters of a PID controller remained at their default values. How would you tune this controller? What would you pay attention to when entering the tuned parameters? 6. Control of MIMO systems:

how would you pair MV and PV values? Present the main steps of applying RGA, including its practical determination.
7. What are MIMO systems? Why is degrees-of-freedom (DoF) analysis important for MIMO systems? Present any method for degrees-of-freedom analysis.
8. Wastewater treatment: Principles for selecting applicable methods based on the quality and concentration of pollutants.
9. Wet air oxidation: technological implementation, typical applications. Comparison of supercritical water oxidation (SCWO) and wet air oxidation (WAO).
10. Sublimation: operating principles of vacuum and inert gas sublimation, 1–2 typical application examples. Engineering aspects of continuous process design (process flow diagram and explanation). Basic principles and applications of freeze-drying.
11. The role of residence time distribution (RTD) in the concentration of heat-sensitive solutions. Comparison of atmospheric and vacuum distillation operations. Presentation of short-path distillation and molecular distillation in comparison with wiped film evaporation (WFE). Applications, technical challenges.
12. Classification of membrane operations according to driving force (name, driving force, operating principle, typical application). Balance equations, typical membrane configurations, process flow diagrams of batch, semi-continuous and continuous membrane operations.
13. High-pressure distillation: reasons for applying pressure and its consequences. Pressure-swing distillation (PSD) for the separation of azeotropes. Column configurations based on knowledge of phase equilibrium data.
14. Biofuels. Comparison of bioethanol, biodiesel and biogas (raw materials, production technology, applications).

3. Analytical Chemistry [ZVEVETOA221]

Main aspects of the topics related to measurement techniques: possibilities and process of qualitative and quantitative analysis; principles of the methods and their theoretical background; main units of measuring instruments and their operating principles; analytical performance characteristics; typical practical applications/examples of analytical methods (primarily from the scope of laboratory practice).

1. Qualitative and quantitative analysis
Definitions; steps of analysis; classification of classical and instrumental methods of quantitative analysis; their fundamental principles and methodology (direct and indirect methods, calibration, standard addition, internal standard).
2. Reliability of analytical methods and analytical performance characteristics
Errors (systematic, random), recovery, limit of detection, limit of quantification, sensitivity, selectivity, measurement range.
3. Gravimetric analysis

Steps of analysis; factors influencing the solubility of precipitates; gravimetry with organic and inorganic precipitating agents; fields of application; practical examples.

4. Acid-base titrations

Basic concepts (strong and weak acids/bases, buffers, pH, equilibrium reactions and constants); steps and characteristics of analysis (acid-base reactions, volumetric equipment, standard solutions and indicators and criteria for their selection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); instrumental endpoint detection; applications/examples.

5. Complexometry

Basic concepts (complex formation reactions, complexing agents, chelate effect, stability constants of complexes, factors affecting complex stability); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators and endpoint detection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); applications/examples.

6. Precipitation titrations

Basic concepts (applied reactions, argentometry, solubility equilibrium); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators, chemical and instrumental endpoint detection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); applications/examples.

7. Redox titrations

Basic concepts (redox reactions/systems, galvanic cells, electromotive force, standard and formal potential, Nernst equation, redox electrodes); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators, chemical and instrumental endpoint detection); typical examples of oxidimetric and reductometric titrations (permanganometry, iodometry, determination of water by the Karl Fischer method).

8. Potentiometry

Basic concepts (definition, structure of the measuring system, electromotive force, reference and indicator electrodes, activity, ionic strength, Nernst equation, diffusion potential); direct potentiometry with ion-selective electrodes (derivation of the phase boundary potential as a function of ion activity, concentration dependence of cell potential, selectivity, typical measurement ranges); pH measurement with a glass electrode (combined glass electrode, pH meter, measurement procedure); fluoride ion-selective electrode.

9. Conductometry

Basic concepts (factors affecting the conductivity of solutions, resistance/conductance, specific resistance/conductance); conductometer (measuring cells, operating principle, determination of cell constant); applications.

10. Spectrophotometers, spectrofluorimeters and photometers

Definitions; main units and their operating principles (light sources, cuvettes, spectral resolving elements, photodetectors); configurations/types of spectrophotometers and spectrofluorimeters.

11. UV-Vis molecular spectroscopy

Energy transitions of molecules; absorption and emission spectra; principles of absorption and luminescence molecular spectroscopic methods; theoretical basis of quantitative and qualitative analysis; basic analytical performance characteristics (typical measurement ranges, detection limits); possibilities/applications and examples in practice.

12. Fundamentals of atomic spectroscopic methods

Fundamental Concepts (atomisation, atom sources, energy transitions of atoms, atomic spectra); basic principles of atomic spectroscopic measurements (atomic absorption, atomic emission, atomic fluorescence); fundamentals of quantitative and qualitative analysis.

13. Fundamentals of chromatographic methods

Principle, purpose and efficiency of separation; main characteristics and types of gas and liquid chromatography; measurement arrangements (main units and their operating principles); chromatogram; fundamentals of quantitative and qualitative analysis; applications/examples.

14. Mass spectrometry

Principle of mass spectrometry; structure of mass spectrometers; most commonly used ion sources (operating principle and selection criteria); mass analysers (operating principle, selection criteria); quantitative and qualitative analysis; applications.

15. Immunoanalytical methods

Basic concepts (antigen, antibody and antibody production, hapten, epitope); label-free methods based on antibody–antigen equivalence; labelled methods (labels, competitive and sandwich immunoassays). Applications/examples.

4. Elemental analysis + Chromatography [ZVEVETOA222]

Elemental analysis

1. Comparison of the main atomic spectroscopic methods from the perspective of applications and analytical performance characteristics.

2. Major processes occurring in atom sources and radiation sources.

3. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Principle of the method, analytical characteristics and applications. Structure of measurement systems, main units and their operating principles.

4. Flame Atomic Absorption Spectrometry (FAAS). Principle of the method, analytical characteristics and

applications. Structure of measurement systems, main units and their operating principles.

5. Graphite Furnace Atomic Absorption Spectrometry (GFAAS). Principle of the method, analytical characteristics

and applications. Structure of measurement systems, main units and their operating principles.
6. Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Principle of the method, analytical characteristics and applications. Structure of measurement systems, main units and their operating principles.

Chromatography

1. Causes of zone broadening in HPLC and possibilities for their reduction. Interpretation of the van Deemter equation.
2. Normal-phase liquid chromatography (NPLC). Stationary phases, mobile phases, separation mechanism.
3. Reversed-phase liquid chromatography. Stationary phases, mobile phases. Role of pH.
4. Reversed-phase ion-pair chromatography (IPC); Hydrophilic Interaction Chromatography (HILIC); non-aqueous reversed-phase liquid chromatography (NARP-LC).
5. Detection possibilities in liquid chromatography (UV-Vis, FL, MS, RI, ELSD, CAD) and detector characteristics.
6. Gradient elution. Computer-assisted method development (Pallas, DryLab).
7. Efficiency and selectivity characterising capillary (high-resolution) gas chromatography (CGC) and their role in separation. Factors influencing the analysis time of gas chromatographic analysis and their mechanisms of action.
8. Gas chromatographic columns: column types, stationary phases. Main analytical application areas of the principal types.
9. Gas chromatographic detectors, their operating principles and applications.
10. Methods of qualitative and quantitative analysis in gas chromatography.
11. Coupled gas chromatographic methods (Headspace-GC, Purge-and-Trap GC, GC-MS) and their analytical significance.
12. Criteria for the analytical application of gas chromatography; main application areas (gas analysis, environmental analysis, pharmaceutical analysis, agricultural and food industry applications, etc.).

5. Organic Chemical Industry Technologies + Pharmaceutical Industry Technology [ZVEVETOA231]

Organic chemical industry technologies

1. Types of reactors and their applications with examples; a typical production hall.
2. Criteria of batch and continuous technologies; examples.
3. Family trees of ethylene, propylene and aromatics.
4. The 12 principles of green chemistry; requirements related to products, starting materials and reactions; examples.
5. Heterogeneous and homogeneous catalytic transformations; examples; selectivity.

6. Criteria for solvent selection in the pharmaceutical and fine chemical industries.
7. Types of surfactants, their production, soaps and detergents.
8. Insecticides, fungicides and herbicides; synthesis of some typical active ingredients, such as carbofuran/carbaryl, parathion/fenitrothion, malathion, temephos, trichlorfon, DDVP, cypermethrin, fundazol/carbendazim, monolinuron, triazines, phenoxyacetic acid derivatives, glyphosate.
9. Pharmaceutical industrial processes illustrated by the examples of papaverine, barbiturates, Seduxen, Hibernal, amphetamine, Jumex, L-adrenaline, Aspirin, phenacetin, Rubophen, Deseptil, furosemide
10. Cellulose and paper production, wood pulping.
11. Natural and synthetic dyes.
12. Common types of plastics and their industrial production methods.

Pharmaceutical Industry Technology

1. Synthesis of Corontin (reagents, reaction conditions).
2. Synthesis of Selegiline (reagents, reaction conditions)
3. Synthesis of Ipriflavone (reagents, reaction conditions)
4. Synthesis of Dopegyt (reagents, reaction conditions)
5. Synthesis of Ibuprofen and Naproxen (reagents, reaction conditions)
6. Synthesis of Captopril (reagents, reaction conditions)
7. Synthesis of Tavegyl (reagents, reaction conditions)
8. Synthesis of Gabapentin (reagents, reaction conditions)
9. Synthesis of Tisercin (reagents, reaction conditions)
10. Synthesis of Imipramine (Melipramine) (reagents, reaction conditions)
11. Synthesis of Halidor (reagents, reaction conditions)
12. Synthesis of Norfloxacin (reagents, reaction conditions)
13. Synthesis of Vitamin C (reagents, reaction conditions)
14. Synthesis of Terbinafine (reagents, reaction conditions)
15. Synthesis of Diltiazem (reagents, reaction conditions)
16. Synthesis of Grandaxin (reagents, reaction conditions)
17. Synthesis of Trimethoprim (reagents, reaction conditions)
18. Synthesis of No-Spa (reagents, reaction conditions)
19. Synthesis of Duloxetine (reagents, reaction conditions)
20. Synthesis of Trimethoquinol (reagents, reaction conditions)
21. Synthesis of Verapamil (reagents, reaction conditions)
22. Synthesis of Dihydrochlorothiazide and Klorurit (reagents, reaction conditions)
23. Synthesis of Aspartame (reagents, reaction conditions)
24. Synthesis of Levamisole (reagents, reaction conditions)
25. Synthesis of Nitrofurantoin (reagents, reaction conditions)

26. Synthesis of Cetirizine (reagents, reaction conditions)
27. Synthesis of Rigenicid (reagents, reaction conditions)
28. Synthesis of Noxiron (reagents, reaction conditions)
29. Synthesis of Nalidixic Acid (reagents, reaction conditions)
30. Synthesis of Probon (reagents, reaction conditions)

6. Basic Organic Chemical Industry Processes + Basic Pharmaceutical Chemistry Processes [ZVEVETOA232]

Basic organic chemical processes

1. Alkylation: *O*- and *N*-alkylation; the role of pressure in alkylation; autoclave; alkylation of CH-acidic compounds; alkylation under phase-transfer conditions; Friedel–Crafts alkylation; application areas of zeolites; pharmaceutical industry examples of alkylation.
2. Acylation: *O*- and *N*-acylation; various cases of equilibrium shift; alcoholysis; acidolysis; transesterification; hydrolysis; phosgene and triphosgene as acylating agents; Claisen condensation; Friedel–Crafts acylation; formylation; pharmaceutical industry examples of acylation.
3. Halogenation: substitution and addition halogenation; radical and ionic halogenation; introduction of fluorine; industrial examples of halogenation.
4. Oxidation: vapour–gas–solid phase oxidation; handling of exothermic reactions; liquid–gas phase oxidation; liquid–liquid phase oxidation; reactor types; industrial examples of oxidation.
5. Reduction: reducible functional groups; heterogeneous catalytic hydrogenation (vapour–gas and gas–liquid phase); homogeneous catalytic hydrogenation; enantioselective hydrogenation; reactor types; industrial examples.
6. Hydroformylation processes: components of oxo synthesis; selectivity; industrial examples and utilisation of products.
7. Sulfonation: sulfochlorination and sulfoxidation of paraffins; sulfation and sulfonation of olefins; sulfonation of aromatic compounds; reactor types; pharmaceutical industry examples of sulfonation.
8. Nitration: nitration of aliphatic and aromatic compounds; nitration equipment; industrial examples.
9. Diazotisation and coupling; diazotisation of aromatic amines and utilisation of diazonium salts in coupling reactions.

Fundamental Processes in Pharmaceutical Chemistry

1. *O*-alkylation reactions.
2. *N*-alkylation, *N*-arylation.
3. *S*-alkylation of thio compounds.
4. *C*-alkylation reactions.
5. Special *C*-acylation reactions (Claisen condensation, Dieckmann condensation, Stobbe condensation).

6. Mannich reaction; Perkin–Knoevenagel condensation; preparation of nitrostyrenes.
7. Reactions of oxo compounds with acetoacetic ester derivatives and other CH-acidic compounds; Darzens reaction; Vilsmeier formylation.
8. Strecker synthesis; treatment of cyanide-containing wastewater.
9. Bischler–Napieralski ring closure (synthesis of intermediates of papaverine, drotaverine, vinpocetine).
10. Properties of formaldehyde; chloromethylation; hydroxymethylation.
11. Peptide synthesis (strategies, protecting and activating groups; industrial example).
12. Hydride reductions I (lithium aluminium hydride; sodium borohydride; Meerwein–Ponndorf–Verley reduction / Oppenauer oxidation).
13. Hydride reductions II (diisobutyl aluminium hydride; sodium cyanoborohydride; reductions with borane complexes; CBS catalyst).
14. Separation of optical isomers I (properties of enantiomers and diastereomers; resolution by induced crystallisation; kinetic resolution).
15. Separation of optical isomers II. Resolution by diastereomer formation (resolving agents; salt formation methods; efficiency of resolution; influencing parameters).
16. Racemisation methods; conversion of the total amount of racemic compounds into the useful isomer under kinetic and thermodynamic control.
17. Application of polar organometallic compounds in synthesis I (characteristics of the metal–carbon bond; aggregate formation; main activation methods).
18. Preparation of organometallic compounds by reductive substitution (preparation of alkali metal and magnesium compounds; industrial production and properties of butyllithium).
19. Preparation of organometallic compounds by exchange methods (starting from halogen compounds and hydrocarbons; regioselective metallation of aromatic and heteroaromatic compounds; benzylic metallation).
20. Reactions of polar organometallic compounds with electrophiles (carbon dioxide; acid derivatives; alkylating agents; etc.).
21. α-Metallation of oxo compounds and aliphatic carboxylate salts with lithium amides; practical implementation of organometallic reactions.
22. Carbon–carbon bond formation by cross-coupling reactions (Suzuki, Karasch, Negishi and Stille reactions).
23. Sonogashira and Heck reactions; Buchwald–Hartwig C–N coupling.
24. Decarboxylation; decarbonylation.

7. Plastics Processing + Plastics Processing Machines and Tools [ZVEVETOA241]

1. Elements of the extruder; their roles; elementary steps of extrusion; screw designs.

2. Melt transport in the extruder; throughput of single- and twin-screw extruders; operating point; technological problems.
3. Extrusion: aspects of shaping; flow in the die; main aspects of profile die design.
4. Pipe production dies; calibration possibilities.
5. Production of flat and blown films.
6. Structure of the injection moulding machine; the injection moulding process; clamping units.
7. Injection moulding cycle; starting conditions of the cycle; mould filling process.
8. Classification of injection moulds; description of mould structures.
9. Design aspects of runner systems; gate designs; flow path in the injection mould.
10. Structure of injection-moulded products; factors determining product properties.
11. Designs of hot runner moulds.
12. Product removal solutions in injection moulding; possibilities of robot application.
13. Tools for multi-component injection moulding; applications.
14. Elementary steps of extrusion blow moulding; factors determining product properties; solutions for synchronising continuous and batch technologies.
15. Injection blow moulding; stretch blow moulding; rotational moulding.
16. Thermoforming.
17. Welding
18. Processing of thermosetting and fibre-reinforced resins.
19. Fibre production; membrane technology.
20. Foams.
21. Rubber production.

8. **Physics of Polymers [ZVEVETOA242]**

1. Freely jointed chain model; statistical segment; conformational distribution.
2. Interactions; cohesive energy density; solubility parameter.
3. Solubility and dissolution; Flory–Huggins lattice model.
4. Principle and main methods of molar mass determination.
5. States (aggregate, phase, physical); thermomechanical curve; molecular deformation mechanisms.
6. Characteristics and thermodynamics of large elastic deformation.
7. Theory of polymer networks; real networks.
8. Relaxation phenomena (relaxation; retardation; hysteresis; periodic loading).
9. Dynamic modulus.
10. Time–temperature superposition principle.
11. Phenomenological models.
12. Determination and use of the thermomechanical curve; information obtained.
13. Flow of polymer melts; mechanism; characteristics.
14. Factors determining viscosity.
15. Elastic effects during flow.

16. Capillary viscometry; Melt Flow Index (MFI).
17. Rotational viscometry.
18. Glass transition; determination of Tg; factors determining Tg.
19. Deformation of glassy polymers; embrittlement.
20. Fracture.
21. Conditions of crystallisation; hierarchical structure.
22. Supermolecular structure of crystalline polymers.
23. Nuclei; nucleation; nucleating agents.
23. Crystal growth; primary and secondary crystallisation.
24. Equilibrium temperature and lamellar thickness.
25. Melting of crystalline polymers; melting curve.
26. Relationship between properties and structure in crystalline polymers.

9. Textile Technology [ZVEVETOA243]

Not relevant; this sub-specialisation has not been launched in the past 10 years.

10. Fibre-Forming Polymers + Dye and Surfactant Chemistry [ZVEVETOA244]

Not relevant; this sub-specialisation has not been launched in the past 10 years.

11. Metals, Ceramics and Their Associated Systems + Plastics for Chemical Engineers [ZVEVETOA245]

1. Crystal structures, lattice defects, fundamentals of plastic deformation of metals.
2. Tensile test; E, Re, Rp0.2, Rm, σu, ε, A5, A10, Z, Wc.
3. Hardness tests; HBW, HV, HK, HRC, HRB; scleroscope; duroscope; Poldi hammer.
4. State variables and their effect on the brittle/ductile behaviour of metals; stress intensity factor αk.
5. Transition temperature; Charpy impact test; KV, TTKV.
6. Types of binary phase diagrams; calculations; Fe–Fe3C metastable phase diagram.
7. Non-equilibrium transformations; isothermal and continuous C-curves (TTT); hardenable section diameter; heat treatments.
8. Creep, rupture strength, fatigue, fatigue limit.
9. Pig iron production; ore preparation; blast furnace structure; mass balance; direct and indirect reduction; dephosphorisation; composition of pig iron.
10. Steelmaking; refining (blowing); desulphurisation; deoxidation (killing); finishing/refining processes.
11. Alloying elements in steels and their effect on steel properties.
12. Classification of steels; designation systems; applications; according to chemical composition, mechanical properties, etc.
13. Foundry technology: sand casting; investment casting; centrifugal casting; permanent mould casting; pressure casting.
14. Powder metallurgy: steps; products.

15. Plastic forming, bulk forming technologies: open-die forging; closed-die forging; ring forging; rotary forging; forward extrusion; backward extrusion; extrusion, etc.
16. Sheet metal forming technologies: rolling; bending; blanking; punching; deep drawing; metal spinning, etc.
17. Deformation processes; types of forming machines.
18. Welding, fusion processes: manual metal arc welding with coated electrodes; consumable-electrode arc welding; submerged arc welding; electroslag welding; oxy-acetylene gas welding; flame cutting; argon-shielded arc welding; flash butt welding; plasma beam welding; and pressure welding processes.
19. Upset butt welding; resistance spot welding; resistance projection welding; friction welding; explosive welding; ultrasonic welding; diffusion welding.
20. Types, properties and application areas of advanced engineering ceramics.
21. Materials science fundamentals of advanced engineering ceramics: bonding; crystal structure; phase relationships; structure–property relationships.
22. Production of raw materials for advanced engineering ceramics: oxides, nitrides, carbides.
23. Special powder production methods: thermal decomposition of organometallic compounds; hydrothermal synthesis.
24. Preparation of ceramic powders for shaping; shaping and drying processes.
25. Heat treatment of shaped green bodies: stages and mechanism of sintering; factors influencing mechanism and kinetics; methods of carrying out sintering.
26. Failure process of advanced engineering ceramics and determination of the cause of failure.
27. Methods for producing ceramic layers and coatings.
28. Functional ceramics: production, properties, applications.
29. Structural ceramics: production, properties, applications.
30. Composite ceramics: production, properties, applications.
31. Toughened ceramics by compositing: reinforcing effect of the toughening phases.
32. Radical polymerisation.
33. Other chain polymerisation methods (ionic, stereospecific, copolymerisation).
34. Step-growth polymerisation: characteristics, reactions, stoichiometry, crosslinking.
35. Differences between chain and step-growth polymerisation.
36. The individual chain; conformation; end-to-end distance; freely jointed chain model; statistical segment.
37. Polymer solutions; determination of molecular weight.
38. Aggregate state; phase; physical state; thermomechanical curve.
39. Flow of polymer melts; viscosity.
40. Entropy-elastic deformation; phenomenological models; molecular deformation mechanisms.
41. Deformation of glassy and crystalline materials; fracture; impact strength.

42. Conditions of crystallisation; crystalline formations.
43. Crystallisation; nucleation; melting.
44. Relationship between crystalline structure and properties.
45. Heterogeneous polymer systems; fillers; blends; composites.
46. Structure and operation of the extruder; processes occurring in the extruder; operating point.
47. Injection moulding machine; injection moulds; injection moulding cycle; mould filling.
48. Other processing methods (extrusion blow moulding; rotational moulding; thermoforming).
49. Fibre drawing; foams; membrane technology.
50. Elastomers; rubbers; tyre production.
51. Production of crosslinked resin products and fibre-reinforced composites.
52. Degradation; stabilisation.
53. Flame retardants and other additives (slip agents, plasticisers, impact modifiers, nucleating agents, etc.).
54. Applications of plastics.
55. Role of plastics in environmental pollution.

12. Materials Science Testing Methods [ZVEVETOA246]

1. Transmission electron microscopy.
2. Scanning electron microscopy.
3. Scanning tunnelling microscopy.
4. Atomic force microscopy.
5. Symmetry of molecules and crystals.
6. Fundamentals of molecular structure and spectroscopy; optical spectroscopy measurement arrangements.
7. Vibrational spectra: infrared and Raman spectroscopy.
8. Electronic excitation spectra: ultraviolet and visible absorption spectroscopy.
9. Electronic excitation spectra: fluorescence spectroscopy.
10. Photoelectron spectroscopy.
11. Mössbauer spectroscopy.
12. Electron spin resonance spectroscopy.
13. Nuclear magnetic resonance spectroscopy.
14. Basic crystallographic concepts.
15. Single-crystal X-ray diffraction and X-ray powder diffraction.

2.6. Labour market links

The educational programme is designed to develop the following labour market competences, according to the ESCO[3] categorisation:

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Chemical characteristics of sugar	The chemical characteristics and composition of sugar, enabling the appropriate modification of recipes and the achievement of the desired consumer experience.
Raises awareness of acquired knowledge within the team	Identification and documentation of knowledge acquired by team members and by oneself, in order to improve the quality of the work performed.
Equipment of manufacturing plants	Characteristics and operating conditions of equipment used in manufacturing plants, such as chemical reactors, auxiliary tanks, pumps, filters and mixers.
Prevention of environmental pollution	Processes for the prevention of environmental pollution: precautionary measures related to pollution, procedures and associated equipment for pollution control, as well as possible measures to protect the environment.
Content of products	The product range, its intended purpose and properties, as well as relevant legal and regulatory requirements.
Checks data	Analyses, transforms and models data in order to extract useful information and support decision-making.
Evaluates data, information and digital content	Analyses, compares and critically evaluates the credibility and reliability of sources of data, information and digital content. Analyses, interprets and critically evaluates data, information and digital content.
Basic chemicals	Production and properties of basic organic chemicals, such as ethanol, methanol and benzene, and basic inorganic chemicals, such as oxygen, nitrogen and hydrogen.
Alkylation	Understands the process in which an alkyl group is transferred from one molecule to another. This process is applied in oil refining, where alkylated isobutane becomes a premium blending component used in fuel production.
Develops component separation processes	Develops new processes through the application of controlled chemical operations in order to separate liquid or gaseous components or to generate electric current.
Tests materials	Examines the composition, properties and use of materials in order to develop new products and applications. Investigates them under normal and extreme conditions.

[3] The contact details for the ESCO database are: https://esco.ec.europa.eu/hu/classification/skill_main

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Develops material testing procedures	Develops testing protocols in cooperation with engineers and researchers to carry out various analyses, such as environmental, chemical, physical, thermal, structural, resistance or surface analyses, on a wide range of materials, including metals, ceramics and plastics.
Evaluates data quality	Identifies data-related issues using quality indicators, measures and metrics, in order to design data cleaning and data enrichment strategies according to data quality criteria.
Human factors in occupational safety	Considerations and implications relating to human safety.
Reports test results	Reports test results with a focus on findings and recommendations, distinguishing results according to their level of severity. Includes relevant information from the test plan and outlines the testing methodology, using indicators, tables and visual methods where necessary.
Prepares reports on professional activities	Provides reliable reporting of events and facts occurring in a professional environment.
Provides information on safety measures	Offers guidance on possible causes of accidents or hazards and explains the protective measures necessary to ensure health and safety.
Safety protective equipment	Procedures and materials used in the production of safety equipment, such as fire-fighting equipment, gas masks or protective headgear.
Safety, hygiene and health protection regulations	Requirements of safety, hygiene and health protection standards and legislation applicable in a given sub-specialisation.
Ensures proper document management	Ensures compliance with requirements and rules for tracking and recording document management, such as ensuring identification of changes, maintaining document legibility, and preventing the use of obsolete documents.
Reports to the team leader	Continuously informs the team leader about current and emerging issues.
Documents analysis results	Documents the procedure and the results of analyses performed on samples, either on paper or electronically.
Takes economic criteria into account in decision-making	Develops proposals and makes appropriate decisions while taking economic considerations into account.
Makes decisions	Selects from among several possible options.
Personal protective equipment	Types of protective materials and equipment prescribed for various tasks, such as general or specialised cleaning activities.
Cooperates with colleagues	Works together with colleagues to ensure effective completion of operations.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Electrochemistry	Branch of chemistry that studies chemical reactions occurring during the interaction between an electrolyte, which acts as an ion conductor, and an electrode or electrical conductor. Electrochemistry examines the movement of electrical charge between the electrolyte and electrodes, as well as the relationship between chemical changes and electrical energy. It is primarily applied in battery production.
Reports analysis results	Prepares research documents or presents reports on the results of conducted research and analysis, specifying the analytical procedures and methods that led to the results, as well as possible interpretations of the findings.
Accepts constructive criticism	Responds positively to valid and well-founded feedback regarding their work.
Accepts own accountability	Accepts accountability for their professional activities and recognises the limits of their own practice and competences.
Prepares chemical samples	Prepares specified samples, such as gas, liquid or solid samples, so that they are ready for analysis, labelling and storage in accordance with regulations.
Prepares chemical components	Prepares components according to the formulation by measuring and weighing chemical ingredients such as corrosive acids, solvents, emulsions and peroxides.
Develops forecasting models	Forecast modelling is the process of creating or selecting a model in order to predict as accurately as possible the likelihood of a given outcome.
Energy	Capacity to perform work in the form of mechanical, electrical, thermal, potential or other types of energy derived from chemical or physical sources, required to operate a physical system.
Evaluates the reliability of data	Applies procedures and techniques to determine the level of reliability of information in order to reduce risks and improve sound decision-making.
Interprets technical data sheets	Reads and understands technical specifications describing the characteristics and functioning of a product, component or machine, typically provided by the manufacturer.
Informs senior staff about problems	Notifies senior colleagues of problems or non-compliances and provides them with feedback.
Processes received instructions	Acknowledges, examines and acts upon operating instructions, usually provided verbally by supervisors, including guidelines on required actions. Takes note, examine the ordered requests, and takes action regarding them.
Monitors developments in the field	Keeps up to date with the latest research, regulations and other changes in the field related to the labour market or other relevant areas.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Gas chromatography	Principles of gas chromatography used for the analysis and separation of specific compounds that can be vaporised without decomposition.
Pharmaceutical products	Pharmaceutical products offered, their functions, properties, and applicable legal and regulatory requirements.
Good laboratory practice	Regulatory requirements and Good Laboratory Practice (GLP) applicable in the relevant manufacturing sub-specialisation.
Performs troubleshooting	Identifies operational problems, determines appropriate actions and reports accordingly.
Consults industry professionals	Communicates with engineers, designers, survey technicians and representatives involved in survey or project activities.
Interprets written communication	Seeks to understand and interpret live, email or text-based written communication. Requests confirmation from the recipient that the intended meaning corresponds to the sender's message.
Follows written instructions	Follows written instructions to complete a task or carry out a step-by-step procedure.
Reports	Provides information or reports on events orally.
Maintains contact with others	Maintains contact with others in various situations by applying strategies appropriate to the context and purpose.
Chemistry	Composition, structure and properties of substances, as well as the processes and transformations they undergo; use and interaction of different chemicals; technical production methods; risk factors; and disposal methods.
Improves chemical processes	Collects data required to develop or modify chemical processes. Develops new industrial processes, designs new processing plants or equipment, or modifies existing ones.
Performs chemical experiments	Conducts chemical experiments to test various products and materials in order to draw conclusions regarding product viability and reproducibility.
Demonstrates analytical thinking	Uses logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches.
Develops production processes based on formulations	Uses computer models and simulations to convert specific laboratory formulations and testing methods into production processes.
Manages production documentation	Manages reports and technical documentation, such as procedural standards or logbooks, by preparing and reviewing them and identifying and eliminating discrepancies and ambiguities.
Emission limit values	Knowledge of legal restrictions concerning the amount of pollutants that may be released into the environment.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Collects experimental data	Collects data derived from the application of scientific methods, such as testing methods, experimental design or measurements.
Analyses experimental laboratory data	Analyses experimental data and interprets results in order to prepare reports and summaries.
Uses communication techniques	Applies communication techniques that enable partners to understand each other better and to communicate messages accurately.
Calculates concentration	Measures and determines the concentration of a chemical element in a substance or preparation.
Petroleum	Various aspects of petroleum, including extraction, processing, composition, uses and environmental issues.
Thinks creatively	Develops new ideas or combines existing ones to create innovative solutions.
Approaches problems critically	Identifies the strengths and weaknesses of different options and reasonable concepts, such as issues, opinions and approaches, in order to develop solutions and alternative methods for handling a given problem situation.
Prepares coherent text from keywords	Drafts emails, letters and other written documents based on keywords or key concepts outlining the content. Selects the appropriate format and language style depending on the nature of the document.
Uses various communication channels	Uses different types of communication channels, such as verbal, handwritten, digital and telephone communication, to compile and share ideas or information.
Handles qualitative information	Compiles, codes, categorises, defines, examines or verifies qualitative information.
Laboratory-based sciences	Laboratory sciences such as biology, chemistry, physics, integrated science or advanced laboratory science.
Laboratory techniques	Techniques used in various fields of natural sciences to generate experimental data, such as gravimetric analysis, gas chromatography, electronic or thermal methods.
Performs laboratory tests	Carries out laboratory tests to provide reliable and accurate data supporting scientific research and product testing.
Performs laboratory examinations	Conducts manual, semi-automated and fully automated laboratory examinations. Performs specialised tests accurately and efficiently within the designated service area.
Reads pictograms	Interprets pictograms indicating properties and required handling measures through visual representations.
Tests alkalinity	Tests the alkalinity of sodium hydroxide, adjusting with sodium carbonate or water if necessary.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Estimates repair priority	Estimates the urgency of a specific repair or replacement based on the severity of the fault, the importance of the damaged or worn component, other planned repairs and the expected service life of the component.
Follows specified instructions	Follows instructions to achieve objectives and meet deadlines.
Determines technical requirements	Determines the technical characteristics of goods, materials, methods, processes, services, systems, software and functionalities by identifying and responding to specific needs in accordance with customer expectations.
Finds solutions to problems	Resolves problems arising in planning, prioritisation, organisation, management or facilitation of actions and performance evaluation. Applies systematic processes of information gathering, analysis and synthesis to evaluate current practice and develop new interpretations.
Eliminates equipment malfunctions	Identifies, reports and repairs damage and operational faults of equipment; liaises with on-site representatives and manufacturers to obtain repair and replacement parts.
Works with engineers	Collaborates closely and communicates with engineers regarding plans and new products.
Labels samples	Labels raw material or product samples for laboratory testing in accordance with the applied quality assurance system.
Performs sample testing	Carries out examinations and sample testing on prepared samples; avoids accidental or intentional contamination during testing. Operates sampling equipment in accordance with design parameters.
Complies with safety precautions in work	Applies principles, guidelines and institutional regulations aimed at ensuring a safe workplace for all employees.
Assists colleagues in their work	Guides or supports less experienced or less knowledgeable individuals in their work.
Maintains working relationships	Establishes effective working relationships among colleagues and maintains them over the long term.
Develops work methodology	Develops a system of methods applied in the field of activity or study.
Executes work instructions	Understands, interprets and appropriately applies workplace instructions related to various tasks.
Types of plastics	Types of plastics and their chemical composition, physical properties, possible problems and areas of application.
Uses technical documentation	Understands and uses technical documentation throughout the technical process.
Interprets technical requirements	Analyses, understands and applies information provided regarding technical conditions.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Develops preventive maintenance procedures for instruments	Develops and updates preventive maintenance procedures for components, equipment or systems.
High-performance liquid chromatography	Analytical chemistry method for identifying and quantifying the components of a mixture.
Tests oil samples	Analyses oil samples to determine characteristics such as consistency, texture, viscosity or concentration. Operates measuring instruments such as pH meters, densitometers and viscometers.
Optimises production process parameters	Optimises and maintains production process parameters such as flow, temperature or pressure.
Makes independent operational decisions	Makes immediate operational decisions as necessary, taking into account circumstances and applicable procedures and regulations. Independently determines the most appropriate option for a given situation.
Complex materials	Properties of various materials developed in the laboratory, their use according to product type and their production methods.
Measures pH	Measures pH, which indicates the degree of acidity or alkalinity.
Polymer chemistry	A subdiscipline of chemistry that studies the synthesis, properties and modification of natural and synthetic polymers, which are chemical substances composed of macromolecules.
Precision measuring instruments	Instruments used for precision measurement or manufacturing, such as micrometers, calipers, gauges, balances and microscopes.
Supports scientific research	Assists engineers and scientists in conducting experiments and analyses, developing new products or processes, formulating theories and performing quality control.
Conducts literature research	Systematically and comprehensively researches information and publications on a specific topic. Produces a comparative and evaluative literature review.
Builds a professional network	Engages with participants in a professional environment. Seeks common ground and establishes relationships for mutual benefit. Maintains and monitors contacts within the professional network and stays up to date with their activities.
Professional terminology	Language used in specific contexts that includes terms with particular meanings within a given group or field, such as industry, medicine or law.
Organic raw materials	Types and processing of organic materials used for the production of products or product components.
Organic chemistry	Chemistry of carbon-containing compounds and substances.
Inorganic chemistry	Chemistry of substances that do not contain hydrocarbon groups.
Follows verbal instructions	Follows verbal instructions received from colleagues. Strives to understand and clarify what is being requested.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Applies learning strategies	Applies various perceptual channels, learning styles, strategies and methods to acquire knowledge, know-how, skills and competences.
Applies technical communication skills	Explains technical details clearly and concisely to non-specialist clients, owners or other stakeholders.
Interprets technical texts	Reads and interprets technical texts that provide information on how to perform a task, usually described in step-by-step instructions.
Production processes	Materials and techniques required in production and distribution processes.
Optimises production	Analyses and identifies the strengths and weaknesses of solutions, conclusions or problem-solving approaches; develops and designs alternatives.
Performs test runs	Conducts tests by operating a system, machine, tool or other equipment under actual working conditions to assess reliability and suitability, and adjusts settings accordingly.
Delegates activities	Assigns activities and tasks to others based on their abilities, level of preparedness, competences and legal scope of responsibility. Ensures that individuals understand what needs to be done and when.
Flammable materials	Behaviour of liquids and gases posing serious fire and explosion hazards, including proper handling procedures and effective storage methods.
Executes instructions	Carries out written or verbal instructions.
Vacuum distillation procedures	Knowledge of the process of distilling liquid mixtures at very low pressure.
Develops vaccines	Creates medicinal products through research and laboratory testing that provide immunity against certain diseases.
Mixes chemicals	Safely mixes chemical substances in accordance with prescribed formulations.
Handles chemicals	Handles industrial chemicals safely and applies them effectively while avoiding environmental harm.
Uses chemical analytical equipment	Uses laboratory equipment such as atomic absorption instruments, pH meters, conductivity meters or salt spray chambers.
Supervises chemical process control	Supervises in-process chemical testing and ensures that control results are documented, procedures are properly defined and checklists are updated.
Chemical processes	Relevant chemical processes used in manufacturing, such as cleaning, separation, emulsification and dispersion.
Tests chemical samples	Performs testing procedures on prepared chemical samples using the required equipment and materials. Includes operations such as pipetting and dilution.

Short ESCO Competence Title	Detailed Description of the ESCO Competence
Tests chemical auxiliaries	Conducts tests to characterise the composition of chemical auxiliaries, including determination of water content, quantification of declared active substances and assessment of potential hazards.
Supervises chemical testing procedures	Directs chemical testing procedures by planning and ensuring proper execution of required analyses.
Chemical industry products	Offered chemical industry products, their functions, properties and relevant legal and regulatory requirements.
Develops chemical industry products	Researches and creates new chemical substances and plastics used in the manufacture of goods such as pharmaceuticals, textiles, construction materials and household products.
Consults with managers	Consults with managers of other organisational units to ensure effective service and communication in areas such as sales, planning, purchasing, trade, distribution and technical support.
Handles feedback	Provides feedback to others. Evaluates and responds to criticism from colleagues and customers constructively and professionally.
Testing procedures	Methods used to generate scientific or technical results, such as physical, chemical or statistical test results.
Develops testing procedures	Develops testing protocols to enable various analyses of products, systems and components.

2.7. Specialisation during the educational programme

2.7.1. Detailed rules for choosing between specialisations

1. Application and conditions

Students of the programme choose a specialisation at the end of the 4th term of the recommended curriculum, at the end of the summer examination period, provided that after completing the 3rd term they have obtained at least 70 credits. During the specialisation selection process, students may rank the specialisations in the manner announced in advance.

2. Calculation of scores, ranking

Ranking is based on academic performance. The launch of specialisations is not guaranteed; it depends on student interest and teaching capacity. The number of students in a specialisation in the bachelor's programme typically ranges between 10 and 30. Accordingly, the launch of a given specialisation in a particular year is only guaranteed if at least 10 students indicate it as their first choice. If the number of first-choice applications for a specialisation exceeds 30, a capacity limit may be imposed, and students may be admitted in order based on academic performance. The specific capacity limits applicable to each specialisation are announced publicly each year prior to the specialisation selection period.

3. Assignment to a specialisation

After the specialisation selection, the student is assigned to the appropriate specialisation in the academic system, and the fulfilment of study requirements for obtaining the final certificate is checked taking into account the requirements of the given specialisation.

4. Rules for changing specialisation

   A change of specialisation is possible at the student's request, with the joint approval of the leaders of both affected specialisations.

5. Participation of external partners in the specialisation through dual or cooperative educational programmes is

   not relevant. External partners may participate as invited lecturers, part-time instructors, or members of final examination boards.

2.7.2. General Chemical and Process Engineering Specialization

I. Basic data of the specialisation

1. Name of the specialisation
   a) in Hungarian: Általános vegyipari és folyamatmérnöki specializáció
   b) in English: Chemical and Process Engineering Specialization
2. Language of instruction: Hungarian
3. Credit value of the specialization: 41 credits
4. Organisational unit responsible for the specialization: Department of Chemical and Environmental Process Engineering
5. Lecturer in charge of specialisation: Dr Edit Székely

II. Conditions and method of entry to the specialisation

According to general rules

6. Detailed rules for the ranking of applicants for the specialisation

   According to general rules

III. Educational programme objective and content of the specialisation

7. The educational programme objective of the specialisation is:

The two main areas are process control and chemical management. Both require strong mathematical knowledge. The specialisation has relatively little laboratory practice, preparing mainly for production management and only to a lesser extent for laboratory work. Engineers who graduate from the specialisation can be employed mainly as production managers, development engineers, or in the engineering management department of a company.

8. Specific competences to be acquired in the specialisation
   a. Knowledge
      i. Has knowledge of the task of flowsheeting calculations, approaches to their solution, the main sub-problems arising within them, and some solution methods.
      ii. Has knowledge of the basics of designing control structures.
      iii. Knows and understands model-based process control.

iv. Is able to correctly select appropriate measuring instruments and transmitters.
v. Has an overview of the advantages and disadvantages of various renewable and non-renewable energy sources, as well as their methods of production.
vi. Understands the practical difficulties of implementing operations carried out at pressures different from atmospheric pressure.
vii. Has knowledge of the main membrane operations and their fields of application.
viii. Has knowledge of the main environmental regulations, the integrated pollution prevention and control directive, its availability and fields of application.
ix. Has knowledge of the basic principles of radiation protection and dosimetry, as well as their measurement and evaluation methods.
x. Has knowledge of the main approaches to cost estimation methods in the chemical industry.

b. Skills
i. Is able to use a process simulator appropriately, in particular to select suitable models, verify their correctness, fit model parameters to measurement data, achieve convergence, etc.
ii. Is able to select a large-scale separation operation suitable for a given task and to assemble a technological sequence.
iii. Is able to design control structures.
iv. Is able to appropriately select the material properties required for calculation tasks from online and printed handbooks.
v. Is able to select appropriate limit values and legal regulations for the environmental evaluation of simpler technologies.
vi. Is able to perform radiological and environmental calculations and estimations.
vii. Applies the basic rules of occupational safety, radiation protection and health protection.

c. Attitude
i. Shows interest in environmentally friendly technological solutions.
ii. Is able to use chemical engineering literature with understanding.
iii. Actively participates in teamwork and pays attention to the opinions of colleagues.
iv. Is motivated by lectures to gather further information (e.g. thorium-based reactors, treatment of radioactive waste).
v. Considers safety to be of primary importance during laboratory practices.

d. Autonomy and responsibility

i. Is able to work responsibly, professionally and independently in the field of computer-based process control.
ii. Actively participates in professional consultations.
iii. Performs assigned experimental or calculation tasks reliably and in a reproducible manner.
iv. Independently carries out assigned sub-tasks received verbally and/or in writing.
v. Understands the operation of assigned equipment/devices and recognises malfunction.
vi. Assists colleagues in their work.
vii. Reports on completed work in a manner that facilitates further work.

9. Specific, supplementary requirements of the traineeship

   According to general rules

10. Specific, supplementary requirements of the thesis

    According to general rules

11. Specific requirements of the final examination

    Subject groups of the final examination of the specialisation

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)
ZVEVETOA211	Process Dynamics + Hydrocarbon Industry Technology	Process Dynamics, BMEVEVMA605 Hydrocarbon Industry Technology, BMEVEKFA506
ZVEVETOA212	Environmentally Friendly Technologies + Computer-Based Process Control	Environmentally Friendly Technologies, BMEVEVMA607 Computer-Based Process Control, BMEVEVMA709

Detailed requirements of the individual final examination subject groups (list of topics, competence list)

1. Process Dynamics + Hydrocarbon Industry Technology [ZVEVETOA211]

List of exam topics:

1. Concept of heat integration; presentation of the significant variables and considerations in the design of heat exchanger networks; possible stream matches. Pinch design using composite curves and heat cascade calculation.

2. Pinch design: identification of matches in the vicinity of the pinch temperature and away from it; hidden pinch; essential presentation of the rapid algorithm.

3. Presentation of the grand composite curve; integration of a distillation column and a heat pump into the heat cascade; determination of utility temperatures using the reduced grand composite curve.

4. Cost of heat exchanger networks: relationship between energy recovery and heat exchanger area; supertargeting; cost changes during modification of an existing heat exchanger network (retrofit targeting).

5. Design of component recovery systems (mass exchange networks) in comparison with the design of energy recovery systems (heat exchanger networks). Main steps of the design; similarities and differences.

6. Water-using networks. Determination of minimum water consumption without regeneration. Regeneration with recycle and without recycle (reuse).

7. Comparison of Block Flow Diagram, Process Flow Diagram and Piping & Instrumentation Diagram: their application, characteristics and content.

8. Crude oils, origin, transport, pretreatment, fundamentals of distillation, crude oil distillation.

9. Quality improvement technologies: heteroatom removal, dearomatisation, dewaxing.

10. Production of motor gasoline blending components: alkylation, production of oxygenates, isomerisation, reforming.

11. Physical separation operations: supercritical extraction, extraction and distillation of aromatics, solvent dewaxing of base oils.

12. Conversion processes: fluid catalytic cracking and hydrocracking of vacuum gas oils; thermal cracking of vacuum residues by visbreaking and delayed coking.

13. Classification of petroleum industry products, product blending: motor fuel blending components and additives, properties.

14. Petrochemical technologies: implementation of steam pyrolysis, product separation, production of PE and PP, their main properties.

2. Environmentally Friendly Technologies + Computer-Based Process Control [ZVEVETOA212]

List of exam topics:

1. What is meant by a PID controller? What PID algorithms are known? How can the parameters of the P, I and D terms be characterised? In what form can the P and I parameters be determined? Specifically, to which PID algorithm and to which parameters can the IMC/Lambda and the Cohen-Coon methods be applied?

2. Briefly present the problem of integral windup, as well as the low-pass filters frequently applied in derivative terms, and their importance for control quality.

3. What special hardware elements are used in computer-based process control? Block diagram and explanation of a DDC loop. Present the DCS systems widely used today.

4. Explain the importance of Laplace and Z transforms in control engineering and their relationship with sampling time. How would you select the sampling frequency for sampled systems?

5. In an industrial DCS system, the parameters of a PID controller remained at their default values. How would you tune this controller? What would you pay attention to

when entering the tuned parameters? 6. Control of MIMO systems: how would you pair MV and PV values? Present the main steps of applying RGA, including its practical determination.

7. What are MIMO systems? Why is degrees-of-freedom (DoF) analysis important for MIMO systems? Present any method for degrees-of-freedom analysis.

8. Wastewater treatment: Principles for selecting applicable methods based on the quality and concentration of pollutants.

9. Wet air oxidation: technological implementation, typical applications. Comparison of supercritical water oxidation (SCWO) and wet air oxidation (WAO).

10. Sublimation: operating principles of vacuum and inert gas sublimation, 1–2 typical application examples. Engineering aspects of continuous process design (process flow diagram and explanation). Basic principles and applications of freeze-drying.

11. The role of residence time distribution (RTD) in the concentration of heat-sensitive solutions. Comparison of atmospheric and vacuum distillation operations. Presentation of short-path distillation and molecular distillation in comparison with wiped film evaporation (WFE). Applications, technical challenges.

12. Classification of membrane operations according to driving force (name, driving force, operating principle, typical application). Balance equations, typical membrane configurations, process flow diagrams of batch, semi-continuous and continuous membrane operations.

13. High-pressure distillation: reasons for applying pressure and its consequences. Pressure-swing distillation (PSD) for the separation of azeotropes. Column configurations based on knowledge of phase equilibrium data.

14. Biofuels. Comparison of bioethanol, biodiesel and biogas (raw materials, production technology, applications).

2.7.3. Analytical and Structural Chemistry Specialisation

I. Basic data of the specialisation

1. Name of the specialisation
   a) in Hungarian: Analitikai és szerkezetvizsgálati specializáció
   b) in English: Analytical and Structural Chemistry Specialisation
2. Language of instruction: Hungarian
3. Credit value of the specialization: 41 credits
4. Organisational unit responsible for the specialization: Department of Inorganic and Analytical Chemistry
5. Lecturer in charge of specialisation: Dr Lajos Höfler

II. Conditions and method of entry to the specialisation

According to general rules

6. Detailed rules for the ranking of applicants for the specialisation

   According to general rules

III. Educational programme objective and content of the specialisation

7. The educational programme objective of the specialisation is:

The objective of the specialisation is: The specialisation prepares the students for two main areas. One is mostly research work, such as structural analysis research on a given compound. The other area is applied analytics, where they can deal with the quantitative and qualitative determination of compounds and quality control. There are many laboratory exercises, which primarily involve precise instrumental measurements.

8. Specific competences to be acquired in the specialisation
    a. Knowledge
        i. Has knowledge of the basic operating principles and structure of chemical and biosensors, as well as the significance of continuous, online measurements.
        ii. Has knowledge of the main types of chemical and biosensors, their principal fields of application and their applicability criteria.
        iii. Has knowledge of the theoretical foundations of UV, IR, MS and NMR spectroscopic methods and the interpretation of the measured spectra.
        iv. Has knowledge of the theoretical foundations of elemental analytical spectroscopic methods, the methods of recording spectra and the interpretation of spectra.
        v. Has knowledge of the structure of instruments used in optical spectroscopy and the operation of their structural components. Has knowledge of the types, structure and operating principles of UV, IR, MS and NMR spectrometers.
        vi. Has knowledge of the methodological foundations of atomic absorption measurements applicable to element, trace element and ultra-trace element analysis, as well as the basics of developing individual measurement methods.
        vii. Has knowledge of the structure of instruments used in chromatography and the operation of their structural components. Has knowledge of the types, structure and operating principles of chromatographic instruments.
        viii. Has knowledge of the methodological foundations of procedures applicable in separation technology, as well as the basics of developing individual measurement methods.
    b. Skills
        i. Is able to perform basic-level processing and interpretation of signals from chemical and biosensors and to eliminate the most common sources of error.

ii. Is able to become familiar with previously unknown new processes, products and systems, to acquire and introduce new methods, and to recognise their mechanisms of impact on human health.
iii. Is able to evaluate UV, IR, MS and NMR spectra and to draw conclusions about the structure of an organic molecule based on the spectra.
iv. Is able to evaluate the results obtained during elemental analytical measurements.
v. Is able to select and operate the elemental analytical, molecular spectroscopic and structural analysis methods and instruments required for quality assurance.
vi. Is able to evaluate and compare different spectroscopic methods according to their applicability and analytical performance, and on this basis to select appropriate methods as part of a quality assurance system required to achieve production technology objectives.
vii.

c. Attitude
   i. Always takes sustainability aspects into account in professional work and in the introduction of new technological processes and procedures.
   ii. Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field. Strives to apply an integrated approach and to place the analysis to be carried out in a broader context.
   iii. When selecting spectroscopic methods and planning analyses, pays particular attention to sustainability.
   iv. In performing and planning technological and laboratory tasks, enforces the requirements and considerations of safety, health protection and environmental protection.
d. Autonomy and responsibility
   i. Based on the guidance of their workplace supervisor, performs professional tasks independently, in compliance with quality and safety requirements, directs the work of assigned staff and supervises the operation of technological equipment and measuring instruments.
   ii. Independently and with appropriate safety, is able to select sensors suitable for measuring technological parameters and, based on the results, to check the quality of the work of subordinates or their own work, as well as the correct use of sensors and to identify their malfunction.

iii. Independently and with a high degree of reliability, is able to assess, on the basis of spectra recorded during the monitoring of chemical reactions, the extent of reaction progress and the increase in the amount of end product, and on this basis may propose modifications to technological parameters. Based on the recorded spectra, checks the quality of the work of subordinates or their own work, as well as the correct or faulty operation of spectrometers.

9. Specific, supplementary requirements of the traineeship

   According to general rules

10. Specific, supplementary requirements of the thesis

    According to general rules

11. Specific requirements of the final examination

    Subject groups of the final examination of the specialisation

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)
ZVEVETOA221	Analytical Chemistry	Analytical Chemistry 1, BMEVESAA302 Analytical Chemistry Laboratory, BMEVESAA403
ZVEVETOA222	Elemental analysis + Chromatography	Elemental analysis, BMEVESAA701 Chromatography, BMEVEAAA611

Detailed requirements of the individual final examination subject groups (list of topics, competence list)

Analytical Chemistry [ZVEVETOA221]

Main aspects of the topics related to measurement techniques: possibilities and process of qualitative and quantitative analysis; principles of the methods and their theoretical background; main units of measuring instruments and their operating principles; analytical performance characteristics; typical practical applications/examples of analytical methods (primarily from the scope of laboratory practice).

1. Qualitative and quantitative analysis

Definitions; steps of analysis; classification of classical and instrumental methods of quantitative analysis; their fundamental principles and methodology (direct and indirect methods, calibration, standard addition, internal standard).

2. Reliability of analytical methods and analytical performance characteristics

Errors (systematic, random), recovery, limit of detection, limit of quantification, sensitivity, selectivity, measurement range.

3. Gravimetric analysis

Steps of analysis; factors influencing the solubility of precipitates; gravimetry with organic and inorganic precipitating agents; fields of application; practical examples.

4. Acid-base titrations

Basic concepts (strong and weak acids/bases, buffers, pH, equilibrium reactions and constants); steps and characteristics of analysis (acid-base reactions, volumetric equipment, standard solutions and indicators and criteria for their selection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); instrumental endpoint detection; applications/examples.

5. Complexometry

Basic concepts (complex formation reactions, complexing agents, chelate effect, stability constants of complexes, factors affecting complex stability); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators and endpoint detection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); applications/examples.

6. Precipitation titrations

Basic concepts (applied reactions, argentometry, solubility equilibrium); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators, chemical and instrumental endpoint detection); change in reactant concentrations during titration (calculation, logarithmic equilibrium diagram, titration curve); applications/examples.

7. Redox titrations

Basic concepts (redox reactions/systems, galvanic cells, electromotive force, standard and formal potential, Nernst equation, redox electrodes); steps and characteristics of analysis (titration reactions, volumetric equipment, indicators, chemical and instrumental endpoint detection); typical examples of oxidimetric and reductometric titrations (permanganometry, iodometry, determination of water by the Karl Fischer method).

8. Potentiometry

Basic concepts (definition, structure of the measuring system, electromotive force, reference and indicator electrodes, activity, ionic strength, Nernst equation, diffusion potential); direct potentiometry with ion-selective electrodes (derivation of the phase boundary potential as a function of ion activity, concentration dependence of cell potential, selectivity, typical measurement ranges); pH measurement with a glass electrode (combined glass electrode, pH meter, measurement procedure); fluoride ion-selective electrode.

9. Conductometry

Basic concepts (factors affecting the conductivity of solutions, resistance/conductance, specific resistance/conductance); conductometer (measuring cells, operating principle, determination of cell constant); applications.

10. Spectrophotometers, spectrofluorimeters and photometers

Definitions; main units and their operating principles (light sources, cuvettes, spectral resolving elements, photodetectors); configurations/types of spectrophotometers and spectrofluorimeters.

11. UV-Vis molecular spectroscopy

Energy transitions of molecules; absorption and emission spectra; principles of absorption and luminescence molecular spectroscopic methods; theoretical basis of quantitative and qualitative analysis; basic analytical performance characteristics (typical measurement ranges, detection limits); possibilities/applications and examples in practice.

12. Fundamentals of atomic spectroscopic methods

Fundamental Concepts (atomisation, atom sources, energy transitions of atoms, atomic spectra); basic principles of atomic spectroscopic measurements (atomic absorption, atomic emission, atomic fluorescence); fundamentals of quantitative and qualitative analysis.

13. Fundamentals of chromatographic methods

Principle, purpose and efficiency of separation; main characteristics and types of gas and liquid chromatography; measurement arrangements (main units and their operating principles); chromatogram; fundamentals of quantitative and qualitative analysis; applications/examples.

14. Mass spectrometry

Principle of mass spectrometry; structure of mass spectrometers; most commonly used ion sources (operating principle and selection criteria); mass analysers (operating principle, selection criteria); quantitative and qualitative analysis; applications.

15. Immunoanalytical methods

Basic concepts (antigen, antibody and antibody production, hapten, epitope); label-free methods based on antibody–antigen equivalence; labelled methods (labels, competitive and sandwich immunoassays). Applications/examples.

Elemental analysis + Chromatography [ZVEVETOA222]

Elemental analysis

1. Comparison of the main atomic spectroscopic methods from the perspective of applications and analytical performance characteristics.
2. Major processes occurring in atom sources and radiation sources.
3. Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Principle of the method, analytical characteristics and applications. Structure of measurement systems, main units and their operating principles.
4. Flame Atomic Absorption Spectrometry (FAAS). Principle of the method, analytical characteristics and
applications. Structure of measurement systems, main units and their operating principles.
5. Graphite Furnace Atomic Absorption Spectrometry (GFAAS). Principle of the method, analytical characteristics
and applications. Structure of measurement systems, main units and their operating principles.

6. Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Principle of the method, analytical characteristics and applications. Structure of measurement systems, main units and their operating principles.

Chromatography

1. Causes of zone broadening in HPLC and possibilities for their reduction. Interpretation of the van Deemter equation.
2. Normal-phase liquid chromatography (NPLC). Stationary phases, mobile phases, separation mechanism.
3. Reversed-phase liquid chromatography. Stationary phases, mobile phases. Role of pH.
4. Reversed-phase ion-pair chromatography (IPC); Hydrophilic Interaction Chromatography (HILIC); non-aqueous reversed-phase liquid chromatography (NARP-LC).
5. Detection possibilities in liquid chromatography (UV-Vis, FL, MS, RI, ELSD, CAD) and detector characteristics.
6. Gradient elution. Computer-assisted method development (Pallas, DryLab).
7. Efficiency and selectivity characterising capillary (high-resolution) gas chromatography (CGC) and their role in separation. Factors influencing the analysis time of gas chromatographic analysis and their mechanisms of action.
8. Gas chromatographic columns: column types, stationary phases. Main analytical application areas of the principal types.
9. Gas chromatographic detectors, their operating principles and applications.
10. Methods of qualitative and quantitative analysis in gas chromatography.
11. Coupled gas chromatographic methods (Headspace-GC, Purge-and-Trap GC, GC-MS) and their analytical significance.
12. Criteria for the analytical application of gas chromatography; main application areas (gas analysis, environmental analysis, pharmaceutical analysis, agricultural and food industry applications, etc.).

2.7.4. Pharmaceutical Industry Specialisation

I. Basic data of the specialisation

1. Name of the specialisation
   a) in Hungarian: Gyógyszeripari specializáció
   b) in English: Industrial Pharmaceutics Specialisation
2. Language of instruction: Hungarian
3. Credit value of the specialization: 41 credits
4. Organisational unit responsible for the specialization: Department of Organic Chemistry and Technology
5. Lecturer in charge of specialisation: Dr László Hegedűs

II. Conditions and method of entry to the specialisation

According to general rules

6. Detailed rules for the ranking of applicants for the specialisation

   According to general rules

III. Educational programme objective and content of the specialisation

7. The educational programme objective of the specialisation is:

   The specialisation provides knowledge in basic and applied organic chemistry, as well as in pharmaceutical technology. During the organic synthetic laboratory practice, students acquire preparative basic techniques and apply the learned analytical and separation methods. There is also an opportunity to gain knowledge in the field of formulation technology, building on materials science and analytical knowledge.

8. Specific competences to be acquired in the specialisation

   a. Knowledge

      i. Has knowledge of the characteristics of chemical reactions used in active pharmaceutical ingredient manufacturing technologies.
      ii. Has knowledge of the most important principles for developing an industrial-scale active pharmaceutical ingredient manufacturing technology.
      iii. Has knowledge of the basic methods of product separation and purification options.
      iv. Has knowledge of the environmental protection and safety aspects of the treatment of by-products and waste, as well as the possibilities for their reduction.
      v. Has knowledge of the reagents most commonly used in modern fine chemical syntheses, their production and the conditions of their application.
      vi. Has knowledge of the basic principles related to fundamental processes in medicinal chemistry, as well as basic methods of design and reaction control.
      vii. Has knowledge of the most important transformations occurring in the organic chemical industry, such as alkylation, acylation, esterification, halogenation, sulfonation, nitration, oxidation, reduction, CO reactions, diazotisation and coupling.
      viii. Has knowledge of the possibilities for conducting exothermic reactions and environmentally friendly solutions, as well as catalytic and phase-transfer implementations.
      ix. Has knowledge of the operating principles and structural design of equipment related to pharmaceutical formulation technologies and of the most important analytical instruments used for quality control.
      x. Has knowledge of the fundamental safety, health protection and environmental protection requirements related to pharmaceutical technology.

b. Skills
   i. Is able to perform a basic analysis and evaluation of an active pharmaceutical ingredient manufacturing technology.
   ii. Is able to develop proposals for modifying a technology when required for technical, safety or economic reasons.
   iii. Is able to identify the risky steps of a technological process based on manufacturing documentation.
   iv. Is able to implement fundamental pharmaceutical industrial reactions safely, in compliance with health and safety at work and economic regulations.
   v. Is able to identify errors occurring in the implementation of the most frequently used pharmaceutical and fine chemical basic reactions and to select appropriate corrective solutions.
   vi. Is able to understand and evaluate technical documentation related to organic chemical syntheses in their field.
   vii. Is able to manage the implementation of the most commonly applied organic synthetic reactions.
   viii. Is able to apply the latest technologies and methods. Strives for environmentally friendly and catalytic solutions.
   ix. Is able to apply the fundamental reactions of the organic chemical industry and to design a technological sequence by appropriately linking them.

c. Attitude
   i. When developing technological processes, takes into account the principles of environmental safety and economic efficiency.
   ii. Strives for the practical application of modern, highly selective and efficient organic synthetic reactions, contributing to the development of sustainable and cost-effective technologies.
   iii. In practical work, applies the acquired knowledge on health and environmental protection related to the use of hydrides, organometallic reagents and strong bases.
   iv. Strives to acquire new knowledge related to fundamental processes.
   v. Strives to apply environmentally friendly and catalytic methods.
   vi. Strives to acquire and apply new knowledge and methods related to fundamental processes in the organic chemical industry.
   vii. In work, keeps in mind the safety, health and environmental aspects related to the chemicals and reactions applied.
   viii. Is open to the application of new, innovative technologies and methods.
   ix. Introduces new technological solutions with consideration of sustainability aspects.

x. Strives to become familiar with and acquire new knowledge and methods in the field of pharmaceutical formulation technology.

d. Autonomy and responsibility

i. Strives for the continuous development and improvement of the technology under their supervision.

ii. Initiates the application of new, highly selective reactions usable in pharmaceutical and fine chemical syntheses in order to develop efficient procedures and technologies.

iii. During the industrial implementation of the fundamental processes most frequently used in pharmaceutical and fine chemical syntheses, directs the work of assigned staff and the operation of equipment, taking into account the guidance of their superior.

iv. Shares and discusses the results of organic synthetic development work with colleagues, supporting their professional development.

v. During the development of reaction steps, is open to elaborating new professional solutions.

vi. Directs and supervises the work of assigned colleagues in relation to the implementation of reaction steps.

vii. Promotes the development of colleagues by sharing professional experience and through consultations.

9. Specific, supplementary requirements of the traineeship

   According to general rules

10. Specific, supplementary requirements of the thesis

    According to general rules

11. Specific requirements of the final examination

    Subject groups of the final examination of the specialisation

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)
ZVEVETOA231	Organic Chemical Industry Technologies + Pharmaceutical Industry Technology	Organic Chemical Industry Technologies, BMEVESTA411 Organic Chemical Industry Technologies Laboratory, BMEVESTA412 Pharmaceutical Industry Technology, BMEVESTA704
ZVEVETOA232	Basic Organic Chemical Industry Processes + Basic Pharmaceutical Chemistry Processes	Basic Organic Chemical Industry Processes, BMEVESTA508 Basic Pharmaceutical Chemistry Processes, BMEVESTA606 Basic Pharmaceutical Chemistry Processes Laboratory, BMEVESTA705

1. Organic Chemical Industry Technologies + Pharmaceutical Industry Technology [ZVEVETOA231]

Organic chemical industry technologies

1. Types of reactors and their applications with examples; a typical production hall.
2. Criteria of batch and continuous technologies; examples.
3. Family trees of ethylene, propylene and aromatics.
4. The 12 principles of green chemistry; requirements related to products, starting materials and reactions; examples.
5. Heterogeneous and homogeneous catalytic transformations; examples; selectivity.
6. Criteria for solvent selection in the pharmaceutical and fine chemical industries.
7. Types of surfactants, their production, soaps and detergents.
8. Insecticides, fungicides and herbicides; synthesis of some typical active ingredients, such as carbofuran/carbaryl, parathion/fenitrothion, malathion, temephos, trichlorfon, DDVP, cypermethrin, fundazol/cipendazole, monolinuron, triazines, phenoxyacetic acid derivatives, glyphosate
9. Pharmaceutical industrial processes illustrated by the examples of papaverine, barbiturates, Seduxen, Hibernal, amphetamine, Jumex, L-adrenaline, Aspirin, phenacetin, Rubophen, Deseptil, furosemide
10. Cellulose and paper production, wood pulping.
11. Natural and synthetic dyes.
12. Common types of plastics and their industrial production methods.

Pharmaceutical Industry Technology

1. Synthesis of Corontin (reagents, reaction conditions).
2. Synthesis of Selegiline (reagents, reaction conditions)
3. Synthesis of Ipriflavone (reagents, reaction conditions)
4. Synthesis of Dopegyt (reagents, reaction conditions)
5. Synthesis of Ibuprofen and Naproxen (reagents, reaction conditions)
6. Synthesis of Captopril (reagents, reaction conditions)
7. Synthesis of Tavegyl (reagents, reaction conditions)
8. Synthesis of Gabapentin (reagents, reaction conditions)
9. Synthesis of Tisercin (reagents, reaction conditions)
10. Synthesis of Imipramine (Melipramine) (reagents, reaction conditions)
11. Synthesis of Halidor (reagents, reaction conditions)
12. Synthesis of Norfloxacin (reagents, reaction conditions)
13. Synthesis of Vitamin C (reagents, reaction conditions)
14. Synthesis of Terbinafine (reagents, reaction conditions)
15. Synthesis of Diltiazem (reagents, reaction conditions)
16. Synthesis of Grandaxin (reagents, reaction conditions)

17. Synthesis of Trimethoprim (reagents, reaction conditions)
18. Synthesis of No-Spa (reagents, reaction conditions)
19. Synthesis of Duloxetine (reagents, reaction conditions)
20. Synthesis of Trimethoquinol (reagents, reaction conditions)
21. Synthesis of Verapamil (reagents, reaction conditions)
22. Synthesis of Dihydrochlorothiazide and Klorurit (reagents, reaction conditions)
23. Synthesis of Aspartame (reagents, reaction conditions)
24. Synthesis of Levamisole (reagents, reaction conditions)
25. Synthesis of Nitrofurantoin (reagents, reaction conditions)
26. Synthesis of Cetirizine (reagents, reaction conditions)
27. Synthesis of Rigenicid (reagents, reaction conditions)
28. Synthesis of Noxiron (reagents, reaction conditions)
29. Synthesis of Nalidixic Acid (reagents, reaction conditions)
30. Synthesis of Probon (reagents, reaction conditions)

2. Basic Organic Chemical Industry Processes + Basic Pharmaceutical Chemistry Processes [ZVEVETOA232]

Basic organic chemical processes

1. Alkylation: *O*- and *N*-alkylation; the role of pressure in alkylation; autoclave; alkylation of CH-acidic compounds; alkylation under phase-transfer conditions; Friedel–Crafts alkylation; application areas of zeolites; pharmaceutical industry examples of alkylation.
2. Acylation: *O*- and *N*-acylation; various cases of equilibrium shift; alcoholysis; acidolysis; transesterification; hydrolysis; phosgene and triphosgene as acylating agents; Claisen condensation; Friedel–Crafts acylation; formylation; pharmaceutical industry examples of acylation.
3. Halogenation: substitution and addition halogenation; radical and ionic halogenation; introduction of fluorine; industrial examples of halogenation.
4. Oxidation: vapour–gas–solid phase oxidation; handling of exothermic reactions; liquid–gas phase oxidation; liquid–liquid phase oxidation; reactor types; industrial examples of oxidation.
5. Reduction: reducible functional groups; heterogeneous catalytic hydrogenation (vapour–gas and gas–liquid phase); homogeneous catalytic hydrogenation; enantioselective hydrogenation; reactor types; industrial examples.
6. Hydroformylation processes: components of oxo synthesis; selectivity; industrial examples and utilisation of products.
7. Sulfonation: sulfochlorination and sulfoxidation of paraffins; sulfation and sulfonation of olefins; sulfonation of aromatic compounds; reactor types; pharmaceutical industry examples of sulfonation.
8. Nitration: nitration of aliphatic and aromatic compounds; nitration equipment; industrial examples.

9. Diazotisation and coupling; diazotisation of aromatic amines and utilisation of diazonium salts in coupling reactions.

Fundamental Processes in Pharmaceutical Chemistry

1. *O*-alkylation reactions.
2. *N*-alkylation, *N*-arylation.
3. *S*-alkylation of thio compounds.
4. *C*-alkylation reactions.
5. Special *C*-acylation reactions (Claisen condensation, Dieckmann condensation, Stobbe condensation).
6. Mannich reaction; Perkin–Knoevenagel condensation; preparation of nitrostyrenes.
7. Reactions of oxo compounds with acetoacetic ester derivatives and other CH-acidic compounds; Darzens reaction; Vilsmeier formylation.
8. Strecker synthesis; treatment of cyanide-containing wastewater.
9. Bischler–Napieralski ring closure (synthesis of intermediates of papaverine, drotaverine, vinpocetine).
10. Properties of formaldehyde; chloromethylation; hydroxymethylation.
11. Peptide synthesis (strategies, protecting and activating groups; industrial example).
12. Hydride reductions I (lithium aluminium hydride; sodium borohydride; Meerwein–Ponndorf–Verley reduction / Oppenauer oxidation).
13. Hydride reductions II (diisobutyl aluminium hydride; sodium cyanoborohydride; reductions with borane complexes; CBS catalyst).
14. Separation of optical isomers I (properties of enantiomers and diastereomers; resolution by induced crystallisation; kinetic resolution).
15. Separation of optical isomers II. Resolution by diastereomer formation (resolving agents; salt formation methods; efficiency of resolution; influencing parameters).
16. Racemisation methods; conversion of the total amount of racemic compounds into the useful isomer under kinetic and thermodynamic control.
17. Application of polar organometallic compounds in synthesis I (characteristics of the metal–carbon bond; aggregate formation; main activation methods).
18. Preparation of organometallic compounds by reductive substitution (preparation of alkali metal and magnesium compounds; industrial production and properties of butyllithium).
19. Preparation of organometallic compounds by exchange methods (starting from halogen compounds and hydrocarbons; regioselective metallation of aromatic and heteroaromatic compounds; benzylic metallation).
20. Reactions of polar organometallic compounds with electrophiles (carbon dioxide; acid derivatives; alkylating agents; etc.).
21. α-Metallation of oxo compounds and aliphatic carboxylate salts with lithium amides; practical implementation of organometallic reactions.

22. Carbon–carbon bond formation by cross-coupling reactions (Suzuki, Karasch, Negishi and Stille reactions).
23. Sonogashira and Heck reactions; Buchwald–Hartwig C–N coupling.
24. Decarboxylation; decarbonylation.

2.7.5. Polymer Technology, Textile and Material Science Specialisation

I. Basic data of the specialisation

1. Name of the specialisation
   a) in Hungarian: Műanyag- textil- és anyagtudományi specializáció
   b) in English: Polymer Technology, Textile and Material Science Specialisation
2. Language of instruction: Hungarian
3. Credit value of the specialization: 41 credits
4. Organisational unit responsible for the specialization: Department of Physical Chemistry and Materials Science
5. Lecturer in charge of specialisation: Dr János Móczó

II. Conditions and method of entry to the specialisation

According to general rules

6. Detailed rules for the ranking of applicants for the specialisation

According to general rules

III. Educational programme objective and content of the specialisation

7. The educational programme objective of the specialisation is: The three sub-specialisations available within the specialisation are based on common subjects (chemistry of macromolecules, materials science testing methods). The defining subjects of the Plastics sub-specialisation are Physics of Plastics, Plastics Processing and Testing of Plastics. Graduates primarily work in the plastics industry. In the Textile sub-specialisation, knowledge related to the chemical and physical structure, colouring and other properties of fibres is taught. Particular emphasis is placed on knowledge related to natural polymers. In addition to the textile industry, employment is possible in other fibre-related fields (e.g. furniture industry, textile trade). In the Materials Science sub-specialisation, subjects presenting plastics, metals, alloys, ceramics and their applications build on physico-chemical and mathematical knowledge. Graduates are primarily employed in research fields and in technical areas applying complex technologies.

8. Specific competences to be acquired in the specialisation

Materials Science sub-specialisation

   a. Knowledge
      i. Has knowledge of the significance of interfaces in natural science processes.

ii. Has knowledge of methods suitable for monitoring surface processes, as well as their limitations and reliability.
iii. Has knowledge of the components, production methods and applications of the most commonly used metals and alloys.
iv. Has knowledge of the basics of the production, structure and properties of advanced ceramics used in the chemical industry.
v. Has knowledge of the physical background of basic characterisation methods of structural materials.
vi. Has knowledge of the basic equipment used for the production and processing of structural materials.
vii. Has knowledge of the safety and environmental protection aspects of basic processing procedures.
viii. Is expected to recognise the relationships between structure and properties in the case of the non-conventional materials studied and to generalise this knowledge.

b. Skills
i. Is able to perform laboratory-level material testing methods.
ii. Is able to evaluate measurement data related to interfacial phenomena on the basis of different models.
iii. Is expected to be able to apply previously learned mathematical relationships when interpreting relationships presented in lectures and when preparing laboratory reports.
iv. Is able to interpret failure processes of metals and to propose the elimination of faults.
v. Based on knowledge of structure–property relationships of advanced engineering ceramics, is able to identify the causes of ceramic failure and propose solutions to given problems.
vi. Is able to assess the safety risks of a complex production process and propose measures to avoid them.
vii. Is able to handle the online documentation of equipment used in material production and to take into account the safety data sheets of materials used during production.

c. Attitude
i. Is aware of the environmental aspects of interfacial phenomena.
ii. Is open to acquiring metal processing methods that are environmentally friendly.
iii. In laboratory work, enforces the requirements and considerations of safety, health and environmental protection.
iv. Strives to individually supplement the knowledge acquired in class in the given topic.
v. Evaluates the economic efficiency of the plant designed.
vi. Seeks to solve the design task using the most advanced techniques available in the literature.

d. Autonomy and responsibility
   i. Is able to independently assess the importance and significance of interfacial phenomena.
   ii. Carries out measurements independently based on the guidance of their workplace supervisor.
   iii. Is expected to prepare laboratory reports independently.
   iv. Performs laboratory work independently, following the guidance of their workplace supervisor, and to a high standard.
   v. Is expected to know and comply with occupational safety and fire protection regulations required for laboratory work.
   vi. Is expected to ask the lecturer or laboratory instructor if something is not understood during lectures or laboratory practices.

Plastics sub-specialisation

a Knowledge

i. Has knowledge of the mathematical and scientific background of polymer physical processes.
ii. Has knowledge of the measurement methods, instruments and equipment used to investigate polymer physical processes, as well as their conditions of application.
iii. Has knowledge of the chemical processes occurring during the degradation of polymers.
iv. Has knowledge of the materials used for the stabilisation of polymers and the conditions of their application.
v. Has knowledge of the health and environmental consequences of the use of stabilisers applied in the plastics industry.
vi. Has knowledge of the types, main properties and applicability of plastics used during plastics processing.
vii. Has knowledge of the design and process control procedures of the main plastics processing operations.
viii. Has knowledge of the operation, structure and main setting aspects of the most common plastics processing equipment (extruders, injection moulding machines, equipment suitable for thermoforming and hollow body production, and additive manufacturing machines).
ix. Has knowledge of possible faults in plastics product design and production, as well as the principles of manufacturing high-quality products.

b, Skills

i. Acquires basic control and operational knowledge of the main plastics processing technologies.
ii. Recognises the fundamental faults occurring in extrusion and injection moulding and knows general solutions to them.
iii. Is able to produce and interpret reports in Hungarian and in one additional foreign language.
iv. Acquires basic knowledge of the operation of production systems, which can be adapted and applied in individually installed systems.
v. Has knowledge of the chemical processes occurring during the degradation of polymers.
vi. Has knowledge of the materials used for the stabilisation of polymers and the conditions of their application.
vii. Has knowledge of the health and environmental consequences of the use of stabilisers applied in the plastics industry.
viii. Is able to assess the safety risks of a complex production process and propose measures to avoid them.
ix. Is able to handle the online documentation of equipment used in material production and to take into account the safety data sheets of materials used during production.

c, Attitude

i. Demonstrates a positive attitude towards new and challenging demands that can only be met through lifelong learning.
ii. Active participation in practices is required to complete the subject.
iii. During lectures and practices, becomes familiar with the environmental impact and energy requirements of equipment.
iv. On this basis, is able to take sustainability aspects into account.
v. Carries out design tasks independently and solves them by expanding their knowledge from additional sources.
vi. Seeks to solve the design task using the most advanced techniques available in the literature.

d, Autonomy and responsibility

i. Develops independent and critical thinking.
ii. During practices and plant visits, receives accident and fire protection instruction that provides an approach applicable in later professional practice.
iii. During group tasks in practices, shares results and experience with peers.

iv. Performs work in compliance with the safety instructions of the laboratory practice leader.

9. Specific, supplementary requirements of the traineeship

According to general rules

10. Specific, supplementary requirements of the thesis

According to general rules

11. Specific requirements of the final examination

Subject groups of the final examination of the specialisation

Final examination subject group code	Final examination subject group name	Recommended curriculum subjects in the final examination subject group (subject name, subject code)	Sub-specialisation / sub-specialisation
ZVEVETOA241	Plastics Processing + Plastics Processing Machines and Tools	Plastics Processing, BMEVEMGA608 Plastics Processing Machines and Tools, BMEVEFAA705	Plastics, Textile and Materials Science Specialisation (Plastics Technology Sub-specialisation)
ZVEVETOA242	Physics of Polymers	Physics of Polymers, BMEVEMGA511	Plastics, Textile and Materials Science Specialisation (Plastics Technology Sub-specialisation)
ZVEVETOA243	Textile Technology	Textile Chemical Technology 1, BMEVEMGA617 Textile Chemical Technology 2, BMEVEFAA718	Plastics, Textile and Materials Science Specialisation (Textile Technology Sub-specialisation)
ZVEVETOA244	Fibre-Forming Polymers + Dye and Surfactant Chemistry	Fibre-Forming Polymers, BMEVEMGA512 Dye and Surfactant Chemistry, BMEVESTA510	Plastics, Textile and Materials Science Specialisation (Textile Technology Sub-specialisation)
ZVEVETOA245	Metals, Ceramics and their Associated Systems + Plastics for Chemical Engineers	Metals and Metal Matrix Composites, BMEGEMTBVFM Advanced Engineering Ceramics, BMEVEFAA601 Plastics for Chemical Engineers, BMEVEFAA306	Plastics, Textile and Materials Science Specialisation (Materials Science Sub-specialisation)
ZVEVETOA246	Materials Science Testing Methods	Materials Science Testing Methods, BMEVEFAA708	Plastics, Textile and Materials Science Specialisation (Materials Science Sub-specialisation)

Plastics Processing + Plastics Processing Machines and Tools [ZVEVETOA241]

1. Elements of the extruder; their roles; elementary steps of extrusion; screw designs.
2. Melt transport in the extruder; throughput of single- and twin-screw extruders; operating point; technological problems.
3. Extrusion: aspects of shaping; flow in the die; main aspects of profile die design.
4. Pipe production dies; calibration possibilities.
5. Production of flat and blown films.

6. Structure of the injection moulding machine; the injection moulding process; clamping units.
7. Injection moulding cycle; starting conditions of the cycle; mould filling process.
8. Classification of injection moulds; description of mould structures.
9. Design aspects of runner systems; gate designs; flow path in the injection mould.
10. Structure of injection-moulded products; factors determining product properties.
11. Designs of hot runner moulds.
12. Product removal solutions in injection moulding; possibilities of robot application.
13. Tools for multi-component injection moulding; applications.
14. Elementary steps of extrusion blow moulding; factors determining product properties; solutions for synchronising continuous and batch technologies.
15. Injection blow moulding; stretch blow moulding; rotational moulding.
16. Thermoforming.
17. Welding
18. Processing of thermosetting and fibre-reinforced resins.
19. Fibre production; membrane technology.
20. Foams.
21. Rubber production.

Physics of Polymers [ZVEVETOA242]

1. Freely jointed chain model; statistical segment; conformational distribution.
2. Interactions; cohesive energy density; solubility parameter.
3. Solubility and dissolution; Flory–Huggins lattice model.
4. Principle and main methods of molar mass determination.
5. States (aggregate, phase, physical); thermomechanical curve; molecular deformation mechanisms.
6. Characteristics and thermodynamics of large elastic deformation.
7. Theory of polymer networks; real networks.
8. Relaxation phenomena (relaxation; retardation; hysteresis; periodic loading).
9. Dynamic modulus.
10. Time–temperature superposition principle.
11. Phenomenological models.
12. Determination and use of the thermomechanical curve; information obtained.
13. Flow of polymer melts; mechanism; characteristics.
14. Factors determining viscosity.
15. Elastic effects during flow.
16. Capillary viscometry; Melt Flow Index (MFI).
17. Rotational viscometry.
18. Glass transition; determination of Tg; factors determining Tg.
19. Deformation of glassy polymers; embrittlement.

20. Fracture.
21. Conditions of crystallisation; hierarchical structure.
22. Supermolecular structure of crystalline polymers.
23. Nuclei; nucleation; nucleating agents.
23. Crystal growth; primary and secondary crystallisation.
24. Equilibrium temperature and lamellar thickness.
25. Melting of crystalline polymers; melting curve.
26. Relationship between properties and structure in crystalline polymers.

Textile Technology [ZVEVETOA243]

Not relevant; this sub-specialisation has not been launched in the past 10 years.

Fibre-Forming Polymers + Dye and Surfactant Chemistry [ZVEVETOA244]

Not relevant; this sub-specialisation has not been launched in the past 10 years.

Metals, Ceramics and Their Associated Systems + Plastics for Chemical Engineers [ZVEVETOA245]

1. Crystal structures, lattice defects, fundamentals of plastic deformation of metals.
2. Tensile test; E, Re, Rp0.2, Rm, σu, ε, A5, A10, Z, Wc.
3. Hardness tests; HBW, HV, HK, HRC, HRB; scleroscope; duroscope; Poldi hammer.
4. State variables and their effect on the brittle/ductile behaviour of metals; stress intensity factor αk.
5. Transition temperature; Charpy impact test; KV, TTKV.
6. Types of binary phase diagrams; calculations; Fe–Fe3C metastable phase diagram.
7. Non-equilibrium transformations; isothermal and continuous C-curves (TTT); hardenable section diameter; heat treatments.
8. Creep, rupture strength, fatigue, fatigue limit.
9. Pig iron production; ore preparation; blast furnace structure; mass balance; direct and indirect reduction; dephosphorisation; composition of pig iron.
10. Steelmaking; refining (blowing); desulphurisation; deoxidation (killing); finishing/refining processes.
11. Alloying elements in steels and their effect on steel properties.
12. Classification of steels; designation systems; applications; according to chemical composition, mechanical properties, etc.
13. Foundry technology: sand casting; investment casting; centrifugal casting; permanent mould casting; pressure casting.
14. Powder metallurgy: steps; products.
15. Plastic forming, bulk forming technologies: open-die forging; closed-die forging; ring forging; rotary forging; forward extrusion; backward extrusion; extrusion, etc.

16. Sheet metal forming technologies: rolling; bending; blanking; punching; deep drawing; metal spinning, etc.
17. Deformation processes; types of forming machines.
18. Welding, fusion processes: manual metal arc welding with coated electrodes; consumable-electrode arc welding; submerged arc welding; electroslag welding; oxy-acetylene gas welding; flame cutting; argon-shielded arc welding; flash butt welding; plasma beam welding; and pressure welding processes.
19. Upset butt welding; resistance spot welding; resistance projection welding; friction welding; explosive welding; ultrasonic welding; diffusion welding.
20. Types, properties and application areas of advanced engineering ceramics.
21. Materials science fundamentals of advanced engineering ceramics: bonding; crystal structure; phase relationships; structure–property relationships.
22. Production of raw materials for advanced engineering ceramics: oxides, nitrides, carbides.
23. Special powder production methods: thermal decomposition of organometallic compounds; hydrothermal synthesis.
24. Preparation of ceramic powders for shaping; shaping and drying processes.
25. Heat treatment of shaped green bodies: stages and mechanism of sintering; factors influencing mechanism and kinetics; methods of carrying out sintering.
26. Failure process of advanced engineering ceramics and determination of the cause of failure.
27. Methods for producing ceramic layers and coatings.
28. Functional ceramics: production, properties, applications.
29. Structural ceramics: production, properties, applications.
30. Composite ceramics: production, properties, applications.
31. Toughened ceramics by compositing: reinforcing effect of the toughening phases.
32. Radical polymerisation.
33. Other chain polymerisation methods (ionic, stereospecific, copolymerisation).
34. Step-growth polymerisation: characteristics, reactions, stoichiometry, crosslinking.
35. Differences between chain and step-growth polymerisation.
36. The individual chain; conformation; end-to-end distance; freely jointed chain model; statistical segment.
37. Polymer solutions; determination of molecular weight.
38. Aggregate state; phase; physical state; thermomechanical curve.
39. Flow of polymer melts; viscosity.
40. Entropy-elastic deformation; phenomenological models; molecular deformation mechanisms.
41. Deformation of glassy and crystalline materials; fracture; impact strength.
42. Conditions of crystallisation; crystalline formations.
43. Crystallisation; nucleation; melting.
44. Relationship between crystalline structure and properties.

45. Heterogeneous polymer systems; fillers; blends; composites.
46. Structure and operation of the extruder; processes occurring in the extruder; operating point.
47. Injection moulding machine; injection moulds; injection moulding cycle; mould filling.
48. Other processing methods (extrusion blow moulding; rotational moulding; thermoforming).
49. Fibre drawing; foams; membrane technology.
50. Elastomers; rubbers; tyre production.
51. Production of crosslinked resin products and fibre-reinforced composites.
52. Degradation; stabilisation.
53. Flame retardants and other additives (slip agents, plasticisers, impact modifiers, nucleating agents, etc.).
54. Applications of plastics.
55. Role of plastics in environmental pollution.

13. Materials Science Testing Methods [ZVEVETOA246]

1. Transmission electron microscopy.
2. Scanning electron microscopy.
3. Scanning tunnelling microscopy.
4. Atomic force microscopy.
5. Symmetry of molecules and crystals.
6. Fundamentals of molecular structure and spectroscopy; optical spectroscopy measurement arrangements.
7. Vibrational spectra: infrared and Raman spectroscopy.
8. Electronic excitation spectra: ultraviolet and visible absorption spectroscopy.
9. Electronic excitation spectra: fluorescence spectroscopy.
10. Photoelectron spectroscopy.
11. Mössbauer spectroscopy.
12. Electron spin resonance spectroscopy.
13. Nuclear magnetic resonance spectroscopy.
14. Basic crystallographic concepts.
15. Single-crystal X-ray diffraction and X-ray powder diffraction.

3. Competence measurement

The purpose of competence measurements is to monitor students' progress throughout the educational programme. Chemical engineering students participate in the central competence measurements of BME; in this section only the programme-specific measurements are presented.

1. Knowledge

Measurement point	*Example competences to be measured*
Entry-level	*Knowledge of basic chemical concepts (e.g. elements, ions, bonds, molecules) at the level of the secondary school leaving examination in chemistry.*
Mid-term	*Knowledge of the thermodynamic and engineering fundamental concepts of the chemical engineering field.*
Outcome-level	*Knows the theoretical and calculation methods of the chosen field within chemical engineering (specialisation) and is able to present them.*

2. Skills

Measurement point	*Example competences to be measured*
Entry-level	*Reading comprehension and basic problem-solving skills: chemical calculations.*
Mid-term	*Is able to solve a complex chemical engineering design task in a group using professional literature and to report on the work.*
Outcome-level	*Ability to solve professional chemical engineering tasks, and ability to prepare documentation and present results.*

3. Attitude

Measurement point	*Example competences to be measured*
Entry-level	*Sense of responsibility towards tasks, motivation to learn.*
Mid-term	Performs assigned experimental or calculation tasks reliably and in a reproducible manner.
Outcome-level	*Responsible professional attitude, ethical awareness.*

4. Autonomy and responsibility

Measurement point	*Example competences to be measured*
Entry-level	*Basic study organisation skills and time management.*
Mid-term	*Task completion and taking responsibility in a group.*
Outcome-level	*Independent decision-making and presentation of one's own activities.*

Methodology

Measurement point	*Proposed methodology*
Entry-level	*Diagnostic test.*
Mid-term	*Small group project task, written paper and oral defence.*
Outcome-level	*During the final examination, in the form of an oral examination.*

3.1. Entry competence measurement

1. Objective of the entry competence measurement: to determine the chemistry competence level of incoming students at the beginning of their university studies and to orient them towards talent support and remedial opportunities.
2. Timing of the entry competence measurement: within the first month after the start of studies.
3. Description of the competences to be measured: chemical knowledge and calculation skills corresponding to the competences required for the secondary school leaving examination in chemistry, as well as a general assessment of cognitive competences (reading comprehension, time management, computer use).
4. Methodology of the competence measurement: diagnostic test.

3.2. Mid-term competence measurement(s)

1. Objective(s) of the mid-term competence measurement(s): to monitor the development of chemical engineering thinking and to map the development of chemical, calculation and problem-solving skills.
2. Timing of the mid-term competence measurement(s): during the 5th term of the recommended curriculum, within the framework of a group design task.
3. Description of the competences to be measured:
    a. Is able to divide a complex chemical engineering design task into subtasks and to cooperate with fellow students within the group in solving it.
    b. Uses professional literature sources and handbooks with understanding.
    c. Is able to report on their work in writing and orally and to justify decisions.
4. Methodology of the competence measurement: group design task followed by an oral defence after submission of written documentation.

3.3. Outcome competence measurement

1. Objective of the outcome competence measurement: to assess the level of fundamental general competences to be achieved during the educational programme.
2. Timing of the outcome competence measurement: during the final examination.
3. Description of the competences to be measured:
   Is able to prepare professional chemical engineering documentation.
   Is able to become familiar with and understand the professional background of their (thesis) task.
   Performs assigned experimental or calculation tasks reliably and in a reproducible manner.
   Compares results with previous experience and presents them in comparison.
   Is able to summarise and present their own work.
   During the execution of tasks, is able to make decisions with a level of independence appropriate to their competence.

Knows the theoretical and calculation methods of the chosen field and is able to present them.

4. Methodology of the competence measurement: during the final examination, in the form of an oral examination.

4. Mobility window

4.1. Term(s) of the mobility window

During the Chemical Engineering Bachelor's educational programme, students may participate in international mobility in any term. In order to ensure that completed performance can be recognised within the curriculum, a preliminary credit recognition procedure (VBK exceptional course schedule for students participating in a mobility term) is recommended. In order to support student international mobility, the educational programme provides a mobility window.

Term of the mobility window: 6th term

4.2. Recognition of subjects completed within the mobility window

Recognition of subjects completed within the mobility window is competence-based; recognition is carried out by the Faculty Credit Transfer Committee upon the student's request. Below, the list of competences and subjects to be recognised within the mobility window is presented by specialisation.

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Recognition of compulsory and compulsory elective subjects in the **General Chemical and Process Engineering Specialisation** is implemented as follows:

Subject code	Subject name	Credits	Method of equivalence recognition (credit recognition)
BMEGT20A001	Management and Business Economics	4	*Prior credit recognition pursuant to Section 57(5) of Government Decree 87/2015 (Vhr.), provided that the learning outcomes of the subject to be completed abroad include the following essential competences (the detailed description of the competences to be achieved is provided in the table below):* **Knowledge:** Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors. Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories. **Skills:** Is able to apply the calculation and modelling principles and methods of analysis and design related to chemical processes and chemical technologies. Is able to understand and use the characteristic online and printed technical documentation and professional literature of the field in Hungarian and in at least one foreign language.
BMEVEVMA504	Process control	5	
BMEVEKFA613	Chemical Industry Operations Laboratory	3	
BMEVEKFA403	Environmental Chemistry and Technology	4	
BMEVEKFA503	Hydrocarbon Industry Technology and Catalysis	5	
BMEVEVMA605	Process Engineering	5	
BMEVEVMA607	Environmentally Friendly Procedures	4	

Expected learning outcomes and possible partial competences required to achieve them, General Chemical and Process Engineering Specialisation, 6th term of the recommended curriculum:

Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors.

Has knowledge of the operation of chemical industry technologies in the petroleum industry, based on previously acquired mathematical, physical, mechanical engineering, organic and inorganic chemistry knowledge.

Has knowledge of the most important models used for phase equilibrium calculations, their derivation from equations of state or excess mixture models, as well as their applicability and limitations.

Has knowledge of the most commonly used numerical methods for solving equations, systems of equations, initial value problems and boundary value problems, as well as their fields of application and limitations.
Has knowledge of the basic principles and limitations of the most important equilibrium and distribution calculation procedures.
Has knowledge of the modelling framework and general solution methods for the detailed calculation of the steady state of multistage counter-current separation units.
Has knowledge of the task of flowsheeting calculations, approaches to their solution, the main sub-problems arising within them, and some solution methods.
Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories.
Has knowledge of basic equipment specifically used in the petroleum industry.
Understands the practical difficulties of implementing operations carried out at pressures different from atmospheric pressure.
Knows and understands several vacuum technologies used as separation operations.
Knows and understands several high-pressure technologies used as separation operations.
Has knowledge of the main membrane operations and their fields of application.
Is able to apply the calculation and modelling principles and methods of analysis and design related to chemical processes and chemical technologies.
Is able to use a process simulator appropriately, in particular to select suitable models, verify their correctness, fit model parameters to measurement data, achieve convergence, etc.
Applies, with understanding, indicators suitable for the environmental evaluation of synthesis routes and technological solutions.
Is able to select a technology suitable for the concentration or drying of heat-sensitive materials.
Is able to select an appropriate membrane operation for a given task.
Is able to understand and use the characteristic online and printed technical documentation and professional literature of the field in Hungarian and in at least one foreign language.
Has knowledge of the major databases applicable in chemical engineering technology design and their use.

Is able to search for measurement data and fitted parameters of modelled mixtures published in the literature and to select the appropriate data set.
Is able to appropriately select the material properties required for calculation tasks from online and printed handbooks.

The recognition of compulsory and compulsory elective subjects is implemented in the following manner in the **Analytical and Structural Examination Specialisation**:

Subject code	Subject name	Credits	Method of equivalence recognition (credit recognition)
BMEGT20A001	Management and Business Economics	4	*Prior credit recognition pursuant to Section 57(5) of Government Decree 87/2015 (Vhr.), provided that the learning outcomes of the subject to be completed abroad include the following essential competences (the detailed description of the competences to be achieved is provided in the table below):* **Knowledge:** Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors. Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories. Has knowledge of the safety, health protection and environmental protection requirements related to the field. **Skills:** Is able to perform basic chemical engineering managerial tasks. **Attitude:** Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field. **Autonomy and responsibility:** Directs the work of assigned staff and supervises the operation of technological equipment and measuring instruments based on the guidance of the workplace supervisor.
BMEVEVMA504	Process control	5	
BMEVEKFA613	Chemical Industry Operations Laboratory	3	
BMEVEKFA403	Environmental Chemistry and Technology	4	
BMEVESAA604	Analytical and Structural Analysis Laboratory	5	
BMEVESKA504	Organic Chemistry III	2	

Expected learning outcomes and possible partial competences required to achieve them, Analytical and structural analysis specialisation, 6th term of the recommended curriculum

Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors.
Has knowledge of the theoretical foundations of analytical methods and the evaluation of measurement results.
Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories.

Has knowledge of the operation and structure of equipment related to the analytical methods studied.
Has knowledge of the safety, health protection and environmental protection requirements related to the field.
Has knowledge of the safety, health protection and environmental protection requirements of the analytical methods studied.
Is able to perform basic chemical engineering managerial tasks.
Carries out measurements using the analytical methods studied in a group, learns the organisation and management of work.
Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field.
Has knowledge of the latest developments of the analytical methods studied.
Based on the guidance of their workplace supervisor, directs the work of assigned staff
and supervises the operation of technological equipment and measuring instruments.
Carries out measurements using the analytical methods studied in a group, learns the organisation and management of work. Knows and uses the measuring instruments related to analytical methods

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Recognition of compulsory and compulsory elective subjects in the **Pharmaceutical Industry Specialisation** is implemented as follows:

Subject code	Subject name	Credits	Method of equivalence recognition (credit recognition)
BMEGT20A001	Management and Business Economics	4	*Prior credit recognition pursuant to Section 57(5) of Government Decree 87/2015 (Vhr.), provided that the learning outcomes of the subject to be completed abroad include the following essential competences (the detailed description of the competences to be achieved is provided in the table below):* **Knowledge:** Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors. Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories. Has knowledge of the materials most commonly used in the chemical industry, the basics of their production and the conditions of their application. **Skills:** Is able to apply the calculation and modelling principles and methods of
BMEVEVMA504	Process control	5	
BMEVEKFA613	Chemical Industry Operations Laboratory	3	
BMEVEKFA403	Environmental Chemistry and Technology	4	
BMEVESTA606	Fundamental Processes in Pharmaceutical Chemistry	2	
BMEVESTA607	Pharmaceutical Formulation	3	
BMEVESKA504	Organic Chemistry III	2	

			analysis and design related to chemical processes and chemical technologies. **Attitude:** Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field.

Expected learning outcomes and possible partial competences required to achieve them, Pharmaceutical Industry Specialisation, 6th term of the recommended curriculum

Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors.
Has knowledge of the concepts related to organic compounds at microscopic (structure) and macroscopic (properties) levels and their interrelationships.
Has knowledge of the scalar and vector properties of organic compounds.
Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories.
Has knowledge of the operation of equipment related to pharmaceutical formulation technologies and the most important analytical instruments used for quality control.
Has knowledge of the materials most commonly used in the chemical industry, the basics of their production and the conditions of their application.
Has knowledge of the reagents most commonly used in modern fine chemical syntheses, their production and the conditions of their application.
Is able to apply the calculation and modelling principles and methods of analysis and design related to chemical processes and chemical technologies.
Is able to implement fundamental pharmaceutical industrial reactions safely, in compliance with health and safety at work and economic regulations.
Is able to identify errors occurring in the implementation of the most frequently used pharmaceutical and fine chemical basic reactions and to select appropriate corrective solutions.
Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field.

83	Strives to become familiar with and apply best practices and new professional knowledge related to the application of stereoisomers.
	Strives to apply best practices related to the development and application of stereoselective reactions.

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Recognition of compulsory and compulsory elective subjects in the **Plastics, Textile and Materials Science Specialisation** is implemented as follows:

Subject code	Subject name	Credits	Method of equivalence recognition (credit recognition)
BMEGT20A001	Management and Business Economics	4	*Prior credit recognition pursuant to Section 57(5) of Government Decree 87/2015 (Vhr.), provided that the learning outcomes of the subject to be completed abroad include the following essential competences (the detailed description of the competences to be achieved is provided in the table below):* **Knowledge:** Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors. Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories. Has knowledge of the materials most commonly used in the chemical industry, the basics of their production and the conditions of their application. Has knowledge of the measurement and analytical methods, instruments and measuring equipment used in the chemical industry and in chemical processes in general, as well as the conditions of their applicability. Has knowledge of the safety, health protection and environmental protection requirements related to the field. **Skills:** Is able to diagnose malfunctions and technological problems and to select corrective operations. Is able to carry out and evaluate measurements at laboratory, pilot plant and plant scale, and to perform sub-tasks of development. Is able to become familiar with previously unknown new processes, products and systems, to acquire and introduce new methods, and to recognise their mechanisms of impact on human health. **Attitude:** Applies safety, health protection and environmental protection requirements and considerations in the performance and planning of technological and laboratory tasks.
BMEVEVMA504	Process control	5	
BMEVEKFA613	Chemical Industry Operations Laboratory	3	
BMEVEKFA403	Environmental Chemistry and Technology	4	
BMEVEMGA608	Plastics Processing	7	
BMEVEMGA610	Polymer Additives	2	
BMEVEFAA601	Advanced Engineering Ceramics	2	
BMEVEMGA603	Materials Science Laboratory	3	
BMEVEFKA603	Physical Chemistry of Surfaces	3	
BMEGEMTBVFM	Metals and Metal Matrix Composites	2	

Expected learning outcomes and possible partial competences required to achieve them, Plastics, Textile and Materials Science Specialisation, 6th term of the recommended curriculum

Has knowledge of the mathematical and natural science (chemical and physical) background of processes applied in the chemical industry and related sectors.

Has knowledge of the physical background of basic characterisation methods of structural materials.
Has knowledge of the significance of interfaces in natural science processes.
Has knowledge of the chemical and physical background of processes related to plastics processing.
Has knowledge of the chemical processes occurring during the degradation of polymers.
Has knowledge of the operating principles, structural units and design fundamentals of equipment and instruments used in the chemical industry, chemical technologies and related laboratories.
Has knowledge of the basic equipment used for the production and processing of structural materials.
Has knowledge of the operating principles, structural units and design fundamentals of processing equipment and instruments used in the plastics industry.
Has knowledge of the materials most commonly used in the chemical industry, the basics of their production and the conditions of their application.
Has knowledge of the main characteristics, mechanical, thermal and surface properties of basic structural materials.
Has knowledge of the basics of the production, structure and properties of advanced ceramics used in the chemical industry.
Has knowledge of the components, production methods and applications of the most commonly used metals and alloys.
Has knowledge of the materials used for the stabilisation of polymers and the conditions of their application.
Has knowledge of the measurement and analytical methods, instruments and measuring equipment used in the chemical industry and generally in chemical processes, as well as their conditions of applicability.
Has knowledge of the techniques used to measure the basic mechanical, thermal and other properties of structural materials, their evaluation methods and conditions of applicability.
Has knowledge of the methods of specific surface area determination and is able to interpret their results and errors.
Has knowledge of the safety, health protection and environmental protection requirements related to the field.

Has knowledge of the health and environmental consequences of the use of stabilisers applied in the plastics industry.
Is able to diagnose malfunctions and technological problems and to select corrective operations.
Based on knowledge of structure–property relationships of advanced engineering ceramics, is able to identify the causes of ceramic failure and propose solutions to given problems.
Is able to interpret failure processes of metals and to propose the elimination of faults.
Is able to diagnose malfunctions and technological problems related to plastics processing and to select corrective operations.
Is able to identify and eliminate technological problems of plastics stabilisation.
Is able to carry out and evaluate measurements at laboratory, pilot plant and plant scale, and to perform sub-tasks of development.
Is able to perform laboratory-level material testing methods.
Is able to become familiar with previously unknown new processes, products and systems, to acquire and introduce new methods, and to recognise their mechanisms of impact on human health.
Is able to become familiar with stabiliser systems applied for plastics stabilisation, to develop new systems and to introduce them.
Applies safety, health protection and environmental protection requirements and considerations in the performance and planning of technological and laboratory tasks.
Is aware of the environmental aspects of interfacial phenomena.
Is open to acquiring metal processing methods that are environmentally friendly.

4.3. Special provisions related to the mobility window

In order to ensure the effective and targeted operation of the mobility window, the educational programme sets out the following recommendations and quality assurance principles:

1. Recommendations for selecting a partner institution

The partner institution must be an accredited higher education institution within the EHEA. Preference is given to partners where the programme offer is in line with the specific subject area thematically, methodologically or by profile.

2. Quality assurance for part-time studies abroad

The institution must ensure that the host's system of study requirements is transparent, that the learning outcomes of subjects are documented, and that credits are structured according to ECTS. The Learning Agreement is compulsory and must be approved and signed in advance.

3. Student satisfaction survey

After mobility, students' satisfaction and experiences are assessed using the mobility questionnaire for students of the programme as well, including experiences related to academic progress. The successful completion of academic progress is documented in the Study Administration System.

4. Guidelines for subjects to be completed abroad

Chemical engineering professional subjects are preferred; however, a clear one-to-one correspondence between foreign subjects and the subjects of the recommended curriculum is not required. It is recommended to make use of the **VBK exceptional course schedule for students participating in a mobility term**, which simultaneously ensures the achievement of the expected learning outcomes required for the term and takes into account individual interests and career goals, as well as maximising the orientation offered by the host institution:

Students participating in a mobility term may obtain the exceptional course schedule through an application. The application is two-stage (pre-application and application) and may be submitted on a rolling basis.

The aim of the application is to support high-quality studies abroad by integrating the subjects completed abroad as fully as possible into the student's educational programme. In addition to their positive effects on personal development and language skills, partial studies abroad provide an excellent opportunity for students to become involved in the international community of their chosen profession and field, and to acquire the knowledge and skills required for professional practice in a way that differs from their own curriculum but with the same outcome competences.

In line with the relevant provisions of the Studies and Exams Regulation, a condition for obtaining the exceptional course schedule is a minimum cumulative weighted grade point average of 4.00 in the bachelor's programme, or a bachelor's degree with at least "good" qualification. In evaluating the application, the evaluation committee takes the following aspects into account:

- the fit of the planned professional programme (the exceptional course schedule) with the outcome requirements of the educational programme,
- the applicant's academic performance and other additional professional achievements.

Stage 1: Pre-application

After obtaining the mobility term (typically ERASMUS) scholarship, before preparing the Learning Agreement, or at the same time, but at least 3 months before departure, a pre-application must be submitted. The Learning Agreement and the exceptional course schedule must be identical in content.

Compulsory elements of the pre-application:

- the student's personal data and key data related to the educational programme (name, Neptun code, educational programme, specialisation, location and duration of mobility term),
- the student's professional CV (1 page), publication list (if any),
- the number of credits completed in the bachelor's programme and the cumulative grade point average,
- the number of credits completed in the master's programme, cumulative grade point average and scholarship index (if any),
- the list of subjects required for the degree (minimum 120 credits), broken down as follows by completing the Excel file containing the subject list accordingly:
    - list of subjects already completed in the educational programme, indicating credits, term and grade,
    - list of subjects planned to be completed by term (with credit value indicated) – if the subject is not known, use the notation elective subject 1, compulsory elective GH 1, etc.,
    - list of subjects to be substituted, if any (with credit value indicated) – final examination subjects cannot be substituted,
    - list of subjects not included in the recommended curriculum (with credit value indicated),
    - the student's declaration and signature (the printed version of the Excel file is sufficient),
- the subject descriptions of subjects not included in the recommended curriculum (i.e. subjects planned to be completed during the mobility term),
- a copy of the Learning Agreement.

The committee evaluates the pre-application within three weeks of submission and notifies the applicant electronically of acceptance or rejection.

Stage 2: Final application

A final application may be submitted only if the pre-application has been accepted. It is recommended that the student submit the final application after departure, following the final enrolment in subjects abroad and the start of subjects; this also constitutes pre-accreditation. If the Learning Agreement needs to be modified, the final application should be submitted before sending the Learning Agreement for signature.

No request needs to be submitted in the Neptun system.

Compulsory elements of the final application:

- the student's personal data and key data related to the educational programme (name, Neptun code, educational programme, location and duration of mobility term, acceptance number and date of the pre-application),
- the student's declaration that the final application is identical to the pre-application, or
- submission of material corresponding to the professional content of the pre-application after providing a detailed description of differences, with a maximum 1-page written justification, as follows:
- the list of subjects required for the degree (minimum 120 credits), broken down as follows by completing the Excel file containing the subject list accordingly:
  - list of subjects already completed in the educational programme, indicating credits, term and grade,
  - list of subjects planned to be completed by term (with credit value indicated),
  - list of subjects to be substituted, if any (with credit value indicated),
  - list of subjects not included in the recommended curriculum (with credit value indicated),
- the subject descriptions of subjects not included in the recommended curriculum (i.e. subjects planned to be completed during the mobility term abroad),
- the student's declaration and signature (the printed version of the Excel file is sufficient).

The committee evaluates the final application within three weeks of submission and notifies the applicant electronically of acceptance or rejection.

Stage 3: Accreditation

If the application is rejected, the subjects must be accredited individually based on the general accreditation rules; however, in this case as well, VBK supports the acceptance of subjects to the greatest possible extent.

If the final application is accepted, after returning home accreditation must be completed by submitting the relevant Neptun request with reference to the application number. Acceptance of the request is automatic. Thus, if all subjects listed in the final application are completed in full, recognition takes place within 5 working days and constitutes full acceptance.

If not all subjects listed in the final application were completed or the student wishes to have fewer subjects accredited, then the final application is considered void and individual subject accreditation is required; individual matching of subjects is necessary.

5. Other information

N/A.

4.4. Special rules for traineeship completed within the mobility window

Not relevant, as the mobility window does not include a traineeship. A traineeship completed abroad may be carried out according to the general rules.

4.5. Special rules for thesis preparation within the mobility window

Not relevant, as the mobility window does not include thesis preparation. Thesis preparation during the mobility period (completion of the Thesis subject) is possible; however, it must fully comply with the rules detailed in Section 2.5.5 and with the BME Studies and Exams Regulation. The thesis must be submitted at BME and defended during the final examination.

5. Provisions and modules related to micro-credentials

5.1. Modules of the educational programme

5.1.1. General Chemical and Process Engineering module

1. The code of the module in the Study Administration System: 4N-A2-VAVF
2. Description, objective and specific features of the module

   The two main areas are process control and chemical management. Both require strong mathematical knowledge. The specialisation has relatively little laboratory practice, preparing mainly for production management and only to a lesser extent for laboratory work. Engineers who graduate from the specialisation can be employed mainly as production managers, development engineers, or in the engineering management department of a company.
3. Total credit value of the module: 26 credits
4. Subjects comprising the module

Subject code	Subject name	Credits
BMEVEKFA502	Radiochemistry and Nuclear Energetics	3
BMEVEKFA503	Hydrocarbon Technology and Catalysis	5
BMEVEVMA605	Process Engineering	5
BMEVEVMA607	Environmentally Friendly Procedures	4
BMEVEKTA888	Summer Traineeship	0
BMEVEKTA707	Chemical Production Management	3
BMEVEKFA777	Design	3
BMEVEVMA709	Computer-Based Process Control	4

5. Competencies covered by the module
   a. Knowledge
      i. Has knowledge of the task of flowsheeting calculations, approaches to their solution, the main sub-problems arising within them, and some solution methods.
      ii. Has knowledge of the basics of designing control structures.
      iii. Knows and understands model-based process control.
      iv. Is able to correctly select appropriate measuring instruments and transmitters.
      v. Has an overview of the advantages and disadvantages of various renewable and non-renewable energy sources, as well as their methods of production.
      vi. Understands the practical difficulties of implementing operations carried out at pressures different from atmospheric pressure.

vii. Has knowledge of the main membrane operations and their fields of application.
viii. Has knowledge of the main environmental regulations, the integrated pollution prevention and control directive, its availability and fields of application.
ix. Has knowledge of the basic principles of radiation protection and dosimetry, as well as their measurement and evaluation methods.
x. Has knowledge of the main approaches to cost estimation methods in the chemical industry.

b. Skills
i. Is able to use a process simulator appropriately, in particular to select suitable models, verify their correctness, fit model parameters to measurement data, achieve convergence, etc.
ii. Is able to select a large-scale separation operation suitable for a given task and to assemble a technological sequence.
iii. Is able to design control structures.
iv. Is able to appropriately select the material properties required for calculation tasks from online and printed handbooks.
v. Is able to select appropriate limit values and legal regulations for the environmental evaluation of simpler technologies.
vi. Is able to perform radiological and environmental calculations and estimations.
vii. Applies the basic rules of occupational safety, radiation protection and health protection.

c. Attitude
i. Shows interest in environmentally friendly technological solutions.
ii. Is able to use chemical engineering literature with understanding.
iii. Actively participates in teamwork and pays attention to the opinions of colleagues.
iv. Is motivated by lectures to gather further information (e.g. thorium-based reactors, treatment of radioactive waste).
v. Considers safety to be of primary importance during laboratory practices.

d. Autonomy and responsibility
i. Is able to work responsibly, professionally and independently in the field of computer-based process control.
ii. Actively participates in professional consultations.
iii. Performs assigned experimental or calculation tasks reliably and in a reproducible manner.
iv. Independently carries out assigned sub-tasks received verbally and/or in writing.

v. Understands the operation of assigned equipment/devices and recognises malfunction.
vi. Assists colleagues in their work.
vii. Reports on completed work in a manner that facilitates further work.

5.1.2. Analytical and structural chemistry module

1. The code of the module in the Study Administration System: 4N-A2-VAN
2. Description, objective and specific features of the module

   The module prepares the students for two main areas. One is mostly research work, such as structural analysis research on a given compound. The other area is applied analytics, where one can deal with the quantitative and qualitative determination of compounds and with quality control. There are many laboratory practices, which primarily involve precise instrumental measurements.
3. Total credit value of the module: 26 credits
4. Subjects comprising the module

Subject code	Subject name	Credits
BMEVESAA512	Elucidation of Organic Structures	3
BMEVEAAA708	Chemical and Biosensors	3
BMEVEAAA611	Chromatography	3
BMEVESAA604	Analytical and Structural Analysis Laboratory	5
BMEVESKA504	Organic Chemistry III	2
BMEVESAA888	Summer Traineeship	0
BMEVEFAA708	Materials Science Testing Methods	4
BMEVESAA701	Elemental analysis	3
BMEVESAA777	Design	3

5. Competencies covered by the module
   a. Knowledge
      i. Has knowledge of the basic operating principles and structure of chemical and biosensors, as well as the significance of continuous, online measurements.
      ii. Has knowledge of the main types of chemical and biosensors, their principal fields of application and their applicability criteria.
      iii. Has knowledge of the theoretical foundations of UV, IR, MS and NMR spectroscopic methods and the interpretation of the measured spectra.
      iv. Has knowledge of the theoretical foundations of elemental analytical spectroscopic methods, the methods of recording spectra and the interpretation of spectra.

v. Has knowledge of the structure of instruments used in optical spectroscopy and the operation of their structural components. Has knowledge of the types, structure and operating principles of UV, IR, MS and NMR spectrometers.
vi. Has knowledge of the methodological foundations of atomic absorption measurements applicable to element, trace element and ultra-trace element analysis, as well as the basics of developing individual measurement methods.
vii. Has knowledge of the structure of instruments used in chromatography and the operation of their structural components. Has knowledge of the types, structure and operating principles of chromatographic instruments.
viii. Has knowledge of the methodological foundations of procedures applicable in separation technology, as well as the basics of developing individual measurement methods.

b. Skills
i. Is able to perform basic-level processing and interpretation of signals from chemical and biosensors and to eliminate the most common sources of error.
ii. Is able to become familiar with previously unknown new processes, products and systems, to acquire and introduce new methods, and to recognise their mechanisms of impact on human health.
iii. Is able to evaluate UV, IR, MS and NMR spectra and to draw conclusions about the structure of an organic molecule based on the spectra.
iv. Is able to evaluate the results obtained during elemental analytical measurements.
v. Is able to select and operate the elemental analytical, molecular spectroscopic and structural analysis methods and instruments required for quality assurance.
vi. Is able to evaluate and compare different spectroscopic methods according to their applicability and analytical performance, and on this basis to select appropriate methods as part of a quality assurance system required to achieve production technology objectives.
vii.

c. Attitude
i. Always takes sustainability aspects into account in professional work and in the introduction of new technological processes and procedures.

ii. Strives to become familiar with and apply best practices, new professional knowledge and methods used in the field. Strives to apply an integrated approach and to place the analysis to be carried out in a broader context.
iii. When selecting spectroscopic methods and planning analyses, pays particular attention to sustainability.
iv. In performing and planning technological and laboratory tasks, enforces the requirements and considerations of safety, health protection and environmental protection.

d. Autonomy and responsibility
i. Based on the guidance of their workplace supervisor, performs professional tasks independently, in compliance with quality and safety requirements, directs the work of assigned staff and supervises the operation of technological equipment and measuring instruments.
ii. Independently and with appropriate safety, is able to select sensors suitable for measuring technological parameters and, based on the results, to check the quality of the work of subordinates or their own work, as well as the correct use of sensors and to identify their malfunction.
iii. Independently and with a high degree of reliability, is able to assess, on the basis of spectra recorded during the monitoring of chemical reactions, the extent of reaction progress and the increase in the amount of end product, and on this basis may propose modifications to technological parameters. Based on the recorded spectra, checks the quality of the work of subordinates or their own work, as well as the correct or faulty operation of spectrometers.

5.1.3. Industrial pharmaceutics module

1. The code of the module in the Study Administration System: 4N-A2-VGY
2. Description, objective and specific features of the module

   The module provides fundamental and applied knowledge in organic chemistry and pharmaceutical technology. During the organic synthetic laboratory practice, students acquire basic preparative techniques and apply the analytical and separation methods they have learned. There is also an opportunity to gain knowledge in the field of formulation technology, building on materials science and analytical knowledge.
3. Total credit value of the module: 26 credits
4. Subjects comprising the module

Subject code	Subject name	Credits
BMEVESAA512	Elucidation of Organic Structures	3

BMEVESKA605	Organic Chemistry Laboratory II	5
BMEVESTA508	Basic organic chemical processes	2
BMEVESTA606	Fundamental Processes in Pharmaceutical Chemistry	2
BMEVESTA607	Pharmaceutical Formulation	3
BMEVESKA504	Organic Chemistry III	2
BMEVESZA888	Summer Traineeship	0
BMEVESTA704	Pharmaceutical Industry Technology	2
BMEVESTA705	Pharmaceutical Chemical Fundamental Processes Laboratory	4
BMEVESZA777	Design	3

5. Competencies covered by the module
    a. Knowledge
        i. Has knowledge of the characteristics of chemical reactions used in active pharmaceutical ingredient manufacturing technologies.
        ii. Has knowledge of the most important principles for developing an industrial-scale active pharmaceutical ingredient manufacturing technology.
        iii. Has knowledge of the basic methods of product separation and purification options.
        iv. Has knowledge of the environmental protection and safety aspects of the treatment of by-products and waste, as well as the possibilities for their reduction.
        v. Has knowledge of the reagents most commonly used in modern fine chemical syntheses, their production and the conditions of their application.
        vi. Has knowledge of the basic principles related to fundamental processes in medicinal chemistry, as well as basic methods of design and reaction control.
        vii. Has knowledge of the most important transformations occurring in the organic chemical industry, such as alkylation, acylation, esterification, halogenation, sulfonation, nitration, oxidation, reduction, CO reactions, diazotisation and coupling.
        viii. Has knowledge of the possibilities for conducting exothermic reactions and environmentally friendly solutions, as well as catalytic and phase-transfer implementations.
        ix. Has knowledge of the operating principles and structural design of equipment related to pharmaceutical formulation technologies and of the most important analytical instruments used for quality control.

x. Has knowledge of the fundamental safety, health protection and environmental protection requirements related to pharmaceutical technology.

b. Skills
   i. Is able to perform a basic analysis and evaluation of an active pharmaceutical ingredient manufacturing technology.
   ii. Is able to develop proposals for modifying a technology when required for technical, safety or economic reasons.
   iii. Is able to identify the risky steps of a technological process based on manufacturing documentation.
   iv. Is able to implement fundamental pharmaceutical industrial reactions safely, in compliance with health and safety at work and economic regulations.
   v. Is able to identify errors occurring in the implementation of the most frequently used pharmaceutical and fine chemical basic reactions and to select appropriate corrective solutions.
   vi. Is able to understand and evaluate technical documentation related to organic chemical syntheses in their field.
   vii. Is able to manage the implementation of the most commonly applied organic synthetic reactions.
   viii. Is able to apply the latest technologies and methods. Strives for environmentally friendly and catalytic solutions.
   ix. Is able to apply the fundamental reactions of the organic chemical industry and to design a technological sequence by appropriately linking them.

c. Attitude
   i. When developing technological processes, takes into account the principles of environmental safety and economic efficiency.
   ii. Strives for the practical application of modern, highly selective and efficient organic synthetic reactions, contributing to the development of sustainable and cost-effective technologies.
   iii. In practical work, applies the acquired knowledge on health and environmental protection related to the use of hydrides, organometallic reagents and strong bases.
   iv. Strives to acquire new knowledge related to fundamental processes.
   v. Strives to apply environmentally friendly and catalytic methods.
   vi. Strives to acquire and apply new knowledge and methods related to fundamental processes in the organic chemical industry.
   vii. In work, keeps in mind the safety, health and environmental aspects related to the chemicals and reactions applied.

viii. Is open to the application of new, innovative technologies and methods.
ix. Introduces new technological solutions with consideration of sustainability aspects.
x. Strives to become familiar with and acquire new knowledge and methods in the field of pharmaceutical formulation technology.

d. Autonomy and responsibility
i. Strives for the continuous development and improvement of the technology under their supervision.
ii. Initiates the application of new, highly selective reactions usable in pharmaceutical and fine chemical syntheses in order to develop efficient procedures and technologies.
iii. During the industrial implementation of the fundamental processes most frequently used in pharmaceutical and fine chemical syntheses, directs the work of assigned staff and the operation of equipment, taking into account the guidance of their superior.
iv. Shares and discusses the results of organic synthetic development work with colleagues, supporting their professional development.
v. During the development of reaction steps, is open to elaborating new professional solutions.
vi. Directs and supervises the work of assigned colleagues in relation to the implementation of reaction steps.
vii. Promotes the development of colleagues by sharing professional experience and through consultations.

5.1.4. Materials Science Module

6. The code of the module in the Study Administration System: 4N-A2-VMT
7. Description, objective and specific features of the module

   In the Materials Science module, the Chemistry of Macromolecules, Materials Science Testing Methods, and subjects presenting plastics, metals, alloys, ceramics and their applications build on physical chemistry and mathematical knowledge. The objective of the module is to provide students interested in modern materials science with a comprehensive overview of the properties and testing methods of the main material types. Graduates are primarily employed in research fields and in technical areas applying complex technologies.
8. Total credit value of the module: 26 credits
9. Subjects comprising the module

Subject code	Subject name	Credits
BMEVEFAA708	Materials Science Testing Methods	4
BMEVEMGA511	Physics of Polymers	3
BMEVEFAA601	Advanced Engineering Ceramics	2

BMEVEMGA603	Materials Science Laboratory	3
BMEVEFKA603	Physical Chemistry of Surfaces	3
BMEVEMGA888	Summer Traineeship	0
BMEGEMTBVFM	Metals and Metal Matrix Composites	2
BMEVEMGA502	Materials Science Testing Methods Laboratory	3
BMEVEFAA707	Non-conventional Materials	3
BMEVEFAA777	Design	3

10. Competencies covered by the module
    a. Knowledge
        i. Has knowledge of the significance of interfaces in natural science processes.
        ii. Has knowledge of methods suitable for monitoring surface processes, as well as their limitations and reliability.
        iii. Has knowledge of the components, production methods and applications of the most commonly used metals and alloys.
        iv. Has knowledge of the basics of the production, structure and properties of advanced ceramics used in the chemical industry.
        v. Has knowledge of the physical background of basic characterisation methods of structural materials.
        vi. Has knowledge of the basic equipment used for the production and processing of structural materials.
        vii. Has knowledge of the safety and environmental protection aspects of basic processing procedures.
        viii. Is expected to recognise the relationships between structure and properties in the case of the non-conventional materials studied and to generalise this knowledge.
    b. Skills
        i. Is able to perform laboratory-level material testing methods.
        ii. Is able to evaluate measurement data related to interfacial phenomena on the basis of different models.
        iii. Is expected to be able to apply previously learned mathematical relationships when interpreting relationships presented in lectures and when preparing laboratory reports.
        iv. Is able to interpret failure processes of metals and to propose the elimination of faults.
        v. Based on knowledge of structure–property relationships of advanced engineering ceramics, is able to identify the causes of ceramic failure and propose solutions to given problems.
        vi. Is able to assess the safety risks of a complex production process and propose measures to avoid them.

vii. Is able to handle the online documentation of equipment used in material production and to take into account the safety data sheets of materials used during production.

c. Attitude
   i. Is aware of the environmental aspects of interfacial phenomena.
   ii. Is open to acquiring metal processing methods that are environmentally friendly.
   iii. In laboratory work, enforces the requirements and considerations of safety, health and environmental protection.
   iv. Strives to individually supplement the knowledge acquired in class in the given topic.
   v. Evaluates the economic efficiency of the plant designed.
   vi. Seeks to solve the design task using the most advanced techniques available in the literature.
d. Autonomy and responsibility
   i. Is able to independently assess the importance and significance of interfacial phenomena.
   ii. Carries out measurements independently based on the guidance of their workplace supervisor.
   iii. Is expected to prepare laboratory reports independently.
   iv. Performs laboratory work independently, following the guidance of their workplace supervisor, and to a high standard.
   v. Is expected to know and comply with occupational safety and fire protection regulations required for laboratory work.
   vi. Is expected to ask the lecturer or laboratory instructor if something is not understood during lectures or laboratory practices.

5.1.5. Plastics module

11. The code of the module in the Study Administration System: 4N-A2-VMT
12. Description, objective and specific features of the module

    The defining subjects of the Plastics sub-specialisation are Plastics Physics, Plastics Processing and Plastics Testing, which build on general knowledge of the chemistry of macromolecules and materials science testing methods. The objective of the module is to provide the theoretical and practical knowledge required for the plastics industry; accordingly, graduates primarily work in the plastics industry.
13. Total credit value of the module: 26 credits
14. Subjects comprising the module

Subject code	Subject name	Credits
BMEVEFAA708	Materials Science Testing Methods	4

BMEVEMGA509	Physics of Plastics lab	3
BMEVEMGA511	Physics of Polymers	3
BMEVEMGA608	Plastics Processing	7
BMEVEMGA610	Polymer Additives	2
BMEVEMGA888	Summer Traineeship	0
BMEVEFAA777	Design	3
BMEVEFAA705	Plastics Processing Machines and Tools	4
BMEVEFAA708	Materials Science Testing Methods	4
BMEVEMGA509	Physics of Plastics lab	

15. Competencies covered by the module

a, Knowledge

i. Has knowledge of the mathematical and scientific background of polymer physical processes.
ii. Has knowledge of the measurement methods, instruments and equipment used to investigate polymer physical processes, as well as their conditions of application.
iii. Has knowledge of the chemical processes occurring during the degradation of polymers.
iv. Has knowledge of the materials used for the stabilisation of polymers and the conditions of their application.
v. Has knowledge of the health and environmental consequences of the use of stabilisers applied in the plastics industry.
vi. Has knowledge of the types, main properties and applicability of plastics used during plastics processing.
vii. Has knowledge of the design and process control procedures of the main plastics processing operations.
viii. Has knowledge of the operation, structure and main setting aspects of the most common plastics processing equipment (extruders, injection moulding machines, equipment suitable for thermoforming and hollow body production, and additive manufacturing machines).
ix. Has knowledge of possible faults in plastics product design and production, as well as the principles of manufacturing high-quality products.

b, Skills

i. Acquires basic control and operational knowledge of the main plastics processing technologies.

ii. Recognises the fundamental faults occurring in extrusion and injection moulding and knows general solutions to them.
iii. Is able to produce and interpret reports in Hungarian and in one additional foreign language.
iv. Acquires basic knowledge of the operation of production systems, which can be adapted and applied in individually installed systems.
v. Has knowledge of the chemical processes occurring during the degradation of polymers.
vi. Has knowledge of the materials used for the stabilisation of polymers and the conditions of their application.
vii. Has knowledge of the health and environmental consequences of the use of stabilisers applied in the plastics industry.
viii. Is able to assess the safety risks of a complex production process and propose measures to avoid them.
ix. Is able to handle the online documentation of equipment used in material production and to take into account the safety data sheets of materials used during production.

c, Attitude

i. Demonstrates a positive attitude towards new and challenging demands that can only be met through lifelong learning.
ii. Active participation in practices is required to complete the subject.
iii. During lectures and practices, becomes familiar with the environmental impact and energy requirements of equipment.
iv. On this basis, is able to take sustainability aspects into account.
v. Carries out design tasks independently and solves them by expanding their knowledge from additional sources.
vi. Seeks to solve the design task using the most advanced techniques available in the literature.

d, Autonomy and responsibility

i. Develops independent and critical thinking.
ii. During practices and plant visits, receives accident and fire protection instruction that provides an approach applicable in later professional practice.
iii. During group tasks in practices, shares results and experience with peers.
iv. Performs work in compliance with the safety instructions of the laboratory practice leader.

5.2. Specific methods of knowledge assessment for the individual modules

(if different from those set out in Section 2.5.1): not different

5.3. Internal quality assurance of the modules

The internal quality assurance of the modules is carried out in consideration of the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015). The objective of quality assurance is to support the achievement of the educational objectives and learning outcomes, to continuously improve the professional standard of teaching, and to increase student satisfaction.

The main elements of quality assurance:

- Verification of learning outcomes and curriculum alignment

The review of the learning outcomes assigned to the modules is carried out regularly, and their alignment with the educational objectives and level descriptors is ensured. Subject coordinators are responsible for keeping the teaching material up to date and for ensuring the modernity of the applied methodologies. The persons responsible for the subjects included in the modules strive for continuous consultation and for aligning the subject syllabi. In many cases, lecturers of other subjects within the module are also involved in the teaching of a given subject, which supports the effective coordination of the module's subjects.

- Evaluation of teaching activity and student performance

The quality of teaching is regularly reviewed on the basis of lecturer self-evaluation, feedback from colleagues, and student opinions. Based on students' academic results, the achievement of learning outcomes is continuously assessed, with particular attention to a transparent and proportionate assessment system.

- Feedback and development measures

Based on feedback from students and lecturers, subject leaders evaluate the operation of the module on an annual basis. The results of the evaluation are incorporated into subject development processes. Changes are implemented in a documented manner following faculty-level consultation.

Quality assurance processes are supported by the faculty and institutional quality management system, ensuring transparency, traceability and the involvement of stakeholders.

6. Recommended curriculum of the educational programme

6.1. Recommended curriculum of the educational programme

The recommended curriculum of the educational programme, or its availability, must be presented here, or the recommended curriculum table must be embedded here.

Recommended curriculum of the educational programme:

VE_BSC_Mintatanterv
i_táblázat_2014_V01.›

6.2. Subject correspondence with the previous recommended curriculum

Not relevant, as there are no students studying under a previous recommended curriculum.

6.2.1. Correspondence of subjects of the previous recommended curriculum

The resolution of the Credit Transfer Committee:

Number: not revelant

Date: not relevant

Subjects of the outgoing recommended curriculum {recommended curriculum identifier or name }		Equivalent subjects in the new recommended curriculum	
Code	Subject name	Code	Subject name