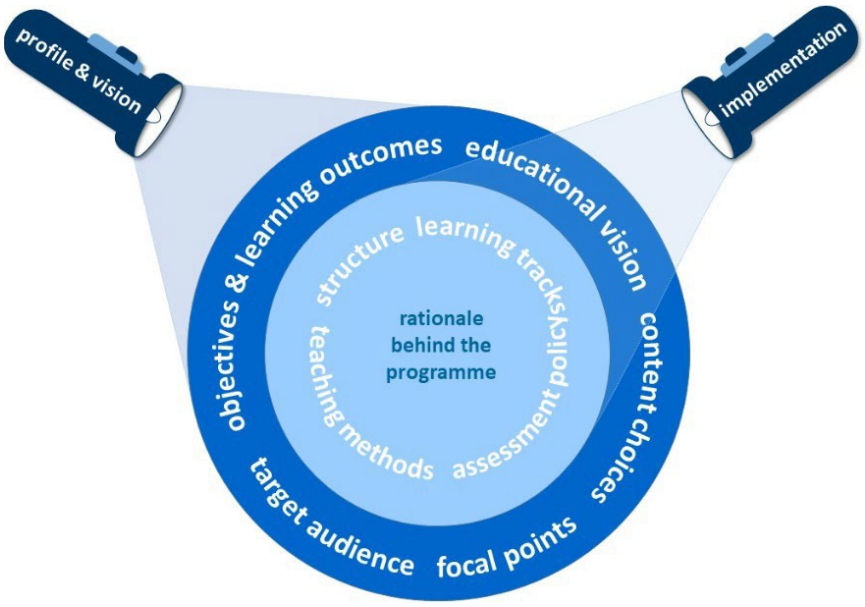
KU LEUVEN

BLUEPRINT

BACHELOR OF ENGINEERING SCIENCE

FACULTY OF ENGINEERING SCIENCE



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Bachelor of Engineering Science

Profile and vision

The Faculty of Engineering Science brings the intellectual and human capital of each individual student to a higher level by offering a research based education in scientific and engineering fundamentals. The Faculty stimulates students to practice in-depth learning by addressing and challenging their 'disciplinary future self', to make them aware of who they wish to become as a professional (*Beruf*) and as members of society in general (*Bildung*). In order to stimulate the development of the students' 'disciplinary future self', the Faculty provides multidisciplinary programmes that acquaint students with the engineering profession and with related disciplines. We value both breadth and depth of knowledge, expanding the reasoning, communication and problem-solving abilities, in order to prepare students for lifelong learning. The research-oriented education is based on research programmes, which are defined and developed in close collaboration with recognised international peers and with industry.

The Bachelor of Engineering programme delivers engineers, who are firmly grounded in the basics of mathematics, sciences and technology, and are trained in a multidisciplinary curriculum. This three-year programme provides the students with the primary knowledge, skills and attitudes of an academic engineer. The programme contains substantial theoretical knowledge. The multidisciplinary character is achieved through a combination of a major and a minor in two different disciplines, after being introduced to all the options during the first three general semesters. During the bachelor's programme, students acquire basic skills that will be further developed in the master's programme, such as analytical, practical and creative skills. They also get an introduction to the principles of business and management, and a selection of topics from humanities.

Goals and learning outcomes

The Faculty educates students in the various roles engineers can take: engineers as experts in their discipline, engineers as researchers, engineers as problem solvers and designers, engineers as professionals and engineers in an international context. Furthermore, the Faculty of Engineering Science applies the ACQA criteria for the elaboration of the learning outcomes. The NVAO recognises these ACQA criteria as an operationalisation of the more global Dublin descriptors for academic engineering education. The ACQA framework distinguishes seven areas of competence with regard to method, domain and context, which will be translated into a list of concrete, operational learning outcomes.

The objective of the bachelor programme is a broad education in the relevant fundamental disciplines in the engineering science with a deepening in one or two specific domains. From the early phases of the programme, students are trained in technological creativity, group work and the development of presentation and reporting skills. A characteristic example is the course 'Problem Solving and Design' (PS&D), which is a common theme running through all three stages of the bachelor's programme. Students solve technical issues and they work and communicate as a team. As such, the students apply scientific knowledge to concrete technological problems with gradually increasing complexity. The specific programme outcomes of the Bachelor of Engineering Science are available on this webpage: https://onderwijsaanbod.kuleuven.be/opleidingen/n/CQ_50362492.htm#activetab=doelstellingen.

Target group

The programme is focused on students with a strong interest in mathematics and science, with a good problem solving capacity and with an interest in the social and psychological relevance of technology and the impact of it on the society. Students preferably had six hours of maths (or more) in secondary education.

Students must deliver a certificate of participation in the positioning test. This attendance certificate is only valid for registration in the following academic year. The positioning test is non-binding. Students can register for the study programme, regardless of the results. The test determines the trajectory. Students who don't pass the test, will follow a remedial trajectory.

Realisation

Structure

The bachelor's programme consists of three stages. The programme is split up into two parts of three semesters each. All students attend the first part, typically referred to as '*B1*'. It includes basic science courses like mathematics, energy and matter; introductory courses for different engineering fields like information theory, material science and thermodynamics; and a selection of general interest topics like economics and philosophy. The programme has a continual focus on (interdisciplinary) problem solving and design. The structure of the programme is illustrated in detail in table 1.

The second part of the bachelor's programme, the '*B2*', starts the fourth semester. The student selects a major and a minor. The main driver for this double selection is the Faculty's policy to leave multiple options open for every student at the start of the master's programme. For the second part in the bachelor's programme, the student chooses among seven majors: 'Civil Engineering', 'Chemical Engineering', 'Computer Science', 'Electrical Engineering', 'Biomedical Technology', 'Materials Engineering' and 'Mechanical Engineering'. There are nine minors. Seven of them are abridged versions of the corresponding

majors, the two others are 'Architecture and Environment' and 'Business Management'. Not all major-minor combinations are offered. Table 2 lists the different combinations.

- Majors contain discipline-specific technology courses and PS&D.
- Minors contain discipline-specific technology courses.
- Both major and minor are supplemented with general interest courses.

The major-minor combination approach does not only prepare the students for the master's programme, corresponding to their major, but also for the Faculty's multidisciplinary master's programmes. For example, the Master of Engineering: Energy draws on knowledge from both Electrical Engineering and Mechanical Engineering. A consequence of our choice for a curriculum where students are trained in two disciplines, is that our students are less specialised than in other curricula, where students start a specific engineering discipline from day one.

The major-minor combination has an influence on the subsequent master's programme. There are three scenarios:

1. The major-minor combination seamlessly relates to the subsequent master's programmes.
2. In case a major-minor combination does not completely prepare the student for a specific master's programme, the master's programme allows some flexibility to enable the student to submit the Individual Study Programme (ISP) with some adjustment.
3. If a large part of the required prior knowledge is missing, the student has to enrol in a preparatory programme. Depending on the additional number of credits, the student can simultaneously attend the first master's year during the bachelor's programme, or he will have to add one or two additional semesters to his study programme.

Semester 1						
H01A8A Technical Chemistry	H01B0A Applied Mechanics 1	H01A4A Applied Algebra	H01A0B Analysis 1	H01B9A PS&D1		
Semester 2						
H01B4A Thermodyn.	H01B2A General Physics	H01D0A Material Science	H01ZS Electri-cal Networks	H01A2A Analysis 2	H01B6B Informatics	H01C2A PS&D2
Semester 3						
H01C6A Organic Chemistry	H01C8A Applied Mechanics 2	H01D8B Numerical Mathematics	H01A6A Probability and Statistics	H08WOA Analysis 3	H01D2A Information Processing & Transmission	H01D7B Economics	H01D4B PS&D3
Matter and Energy	Mathematics	Information	Humanities	PS&D		

Table 1. The composition of the bachelor's programme (semesters 1-3, the so-called 'B1')

Major/Minor	BT	CE	CHE	CS	EE	MAE	ME	AE	BM
Biomedical Technology (BT)			·	·	·	·	·		
Civil Engineering (CE)						·	·	·	·
Chemical Engineering (CHE)	·					·	·		·
Computer Science (CS)	·				·		·		·
Electrical Engineering (EE)	·			·		·	·		·
Materials Engineering (MAE)	·	·	·		·		·		·
Mechanical Engineering (ME)	·	·	·	·	·	·			·

Table 2. Possible major-minor combinations. (AE: Architecture and Environment; BM: Business Management)

The learning environment

The three main delivery modes (lecture, practical and assignment) are characterised by the role of the lecturer and the student, respectively. The programmes combine the most appropriate delivery modes for each course and a proper balance over the entire curriculum is envisaged. The general objective is to activate students, stimulate them to work independently or in a group, and to have a proper balance between the different delivery modes.

The Faculty and its programmes recognise the importance of a high-quality assessment. High-quality evaluation is therefore fully embedded in the learning environment: it is aligned with the objectives, uses the appropriate evaluation formats, and it is adapted to fit the characteristics of the students concerned, who also receive feedback in a timely and appropriate manner. The policy document 'Tests and Assessments' describes the policy of assessment at the Faculty:

- alignment with programme and learning outcomes,
- feedback,
- quality assurance, transparency and the ombuds service,
- evaluation of master's theses and internships (*only relevant for masters*),
- organisation of assessments, including special provisions for students with a disability.

All aspects of quality assurance (including the implementation of the Faculty's examination regulations, the development of the programmes, the choice of assessment modes, the specific learning outcomes) are monitored and governed by the Educational Committee (EC) of each (cluster of) programme(s). All programme directors of the different ECs take part in the Faculty's Educational Committee (FEC).

Learning pathways

The first three semesters of the bachelor's programme are common for all students. The main goal is to acquire a strong and solid basis in mathematics, science and technology, and to get acquainted with the major engineering disciplines. As demonstrated in table 1, '*B1*' is compiled of four major pathways: Matter&Energy, Mathematics, Information and PS&D. The latter is continued in all subsequent programmes and will be discussed below, whereas the other pathways prepare the students for more specialised ones in '*B2*' and following initial masters. Semesters four to six are customised, based on the student's interest by offering 34 combinations between seven majors and nine minors. A short description of major and minor options in the Bachelor of Engineering is given below.

Biomedical Technology: The 'Biomedical Technology' major responds to the increased technological needs in healthcare and strives to integrate technological knowledge with medical knowledge. Therefore, students are expected to be medically oriented, capable of understanding medical needs and translating them into technical requirements. To this end, students must acquire basic medical knowledge in cell biology, anatomy and physiology, as well as basic technical-scientific knowledge in systems theory, electronic basic circuits, transport phenomena, statistics and digital signal processing. Their strong interdisciplinary training in various engineering disciplines combined with basic medical knowledge enables them to apply this to the analysis and mathematical modeling of physiological processes, tissue mechanics, biomedical signals and images.

Civil and Building Engineering: The 'Civil and Building Engineering' major is designed to provide the students with the fundamental knowledge that is needed to understand daily practice, but also to be innovative in the wide range of civil and building engineering activities, embedded in a mobile yet sustainable society. The program strongly focuses on the structural behaviour of simple building components and built constructions, in several different building materials. Complementarily, the programme adds additional pillars by means of courses on hydraulics and building physics. This program offers students a technical and scientific base knowledge, from construction materials to construction components and from building to infrastructure, including societal and environmental aspects.

Chemical Engineering: The 'Chemical Engineering' major focuses on the chemical-technological execution of processes in which the nature, the properties or the composition of raw materials are changed. The programme teaches students to use their knowledge of chemical processes for the development of technical products and the management and improvement of industrial processes, while taking care of the environment and the overall safety. Key courses are organised within the domains of separation processes, reactor design, environmental technology and transport phenomena, with the aim of providing the necessary scientific and technological foundation for further specialisation in chemical engineering, either in process- or product-related fields.

Computer Science: The 'Computer Science' major provides an introduction to the discipline of computer science, in which the emphasis is placed on the design, specification, implementation, maintenance and management of software programs. The students study the underlying systems and technology (operating systems, networks, databases), as well as the algorithms and program designs for different application areas. The programme should enable students to become the architects of complex and evolving systems. Course subjects include software engineering, control systems, databases, discrete and numerical methods, networks and artificial intelligence. Some courses include programming projects that are done individually or in small groups.

Electrical Engineering: The 'Electrical Engineering' major provides a basic insight into the specific domain of electrical engineering and its application, with physics, mathematics and computer science serving as the foundation. The focus of the major lies in understanding the functioning, design and realisation of electronic and electrical systems. Key courses are organised within the domains of systems analysis, signal processing, telecommunications, electronics, electricity and energy. All this is applied in a one-year project in which students go through the design cycle to create a prototype: starting from specifications, to planning the design, modelling it, and finally assembling and testing the hardware and software.

Materials Engineering: In the 'Materials Engineering' major, students acquire the basic knowledge by studying thoroughly the links between structure, properties, production, and applications of both traditional and advanced materials, which is vividly illustrated by the 'Problem Solving and Engineering Design' project *'Reverse Engineering: The car'*. Students can already experience the possibilities of materials research through their own sub-project within the framework of ongoing research projects in the Department of Materials Engineering.

Mechanical Engineering: The 'Mechanical Engineering' major brings together the fundamental principles of mechanics of solids and fluids with a variety of application disciplines, covering the development, production and operation of machines, tools and processes, and the relationship to their economic, social and environmental impact. The prime focus of the programme is on the development, utilisation and interpretation of mathematical models to describe structural mechanics, mechanisms and vibrations, thermodynamics, fluid mechanics and heat transfer, electrical motors and energy, and finally production technology. An analytical, model-based approach in theoretical courses, practice and laboratory sessions is complemented with an extensive design assignment, which is entirely defined by industry with realistic specifications.

Architecture and Environment: Complementary to the 'Civil and Building Engineering' track, this minor aims to enrich the students' knowledge of the fields of architecture and environment. Considering the former, the students are introduced to the history of architecture, structural design methods and building economy management. In relation to the latter, the students get acquainted with geological, environmental and ecological characteristics of the built environment.

Business Management: the 'Business Management' minor gives the students a taste of relevant knowledge and skills in management and leadership. The courses that are taught, are dedicated to designing, developing and improving integrated systems of people, product innovation, operations research and management, management accounting and supply chain engineering. 'Business management' uses the specialised technical background that is needed for an engineer, but also relies on mathematical, physical and economical laws. The goal is to design enterprise systems, and to predict and evaluate their behaviour.

The problem solver and designer

This extensive project-based learning pathway allows students to develop their creative design skills and problem solving abilities, and to address, research and solve real life problems. Through this pathway, students develop problem solving abilities and design qualities in group activities. Also, the design and the practical implementation of a solution play an important role.

This learning pathway trains the students in the successive phases of design procedures: formulation of a problem statement, collection of relevant information, independent analysis, evaluation and selection of information, reduction of the problem into a workable model, solution or solution method, implementation of a solution, evaluation of the result and reporting.

Strong emphasis is placed on transferable and transversal skills such as written and oral communication, group work, leadership, project management, responsibility and norms of engineering practice, taking initiative, and entrepreneurship. Other transferable skills like information literacy, intellectual integrity and plagiarism, and academic writing are included in the programme through other courses, workshops, etc.

This role mainly addresses competence area 3 (skilled in design), as well as competence areas 6 (ability to collaborate and communicate) and 7 (social and temporal context) of the ACQA criteria.

First steps as a researcher

Research and education are closely related in the Faculty, as it is the Faculty's policy to support programmes with strong research activities. The departments of the Faculty have an excellent research record and run many research projects, both with national and international partners.

Lecturers in the bachelor programme have roots in research activities in well-focused topics. In the bachelor's programme, a lot of attention is paid to simple application areas that are closely linked to the scientific research of a research department. The bachelor programme prepares the students for different master programmes, depending on the combination of major and minor.

This role mainly addresses competence areas 2 (research) and 4 (scientific approach) of the ACQA criteria.

Becoming a bachelor in an international context

This bachelor programme is imbedded in the Faculty of Engineering, a faculty with a strong international reputation

that aims at developing an international open policy and atmosphere. The Faculty is not only encouraging its (master) students, researchers and scholars to have an international experience but is also home to a vibrant community of international students, staff and researchers. Hence, the Faculty's and the programme's international activities are extensive and diverse, allowing its bachelor students to profit from the international atmosphere at the Faculty.

Some examples of international activity:

- The Faculty is a member of several distinguished networks of technical universities in Europe such as CLUSTER, CESAER, and ATHENS.
- The Faculty does not only participate in an Erasmus Mundus programme and EIT-KIC programmes, but also provides several English master's programmes for incoming students.
- The Faculty offers students (masters) mobility and staff exchange on a European (Erasmus) and intercontinental level. By having good contacts with a selected number of international universities, the high-level quality of the education, taken abroad, is assured. Furthermore, students and researchers get the opportunity to participate in international research projects, international internships and development cooperation projects.

This role mainly addresses competence area 7 (taking into account temporal and social context) of the ACQA criteria.

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