# Appendices Bachelor's degree programme Chemical Engineering

## Appendix I Learning outcomes of the degree programme (Article 1.3)

**A. Generic learning outcomes – Knowledge**

A1. Bachelor's graduates have general knowledge of the foundations and history of mathematics, natural sciences and technology, in particular those of their own discipline.

A2. Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1 for further specification) to a certain extent and are familiar with the interrelationships of these concepts within their own discipline as well as with other disciplines.

A3. Bachelor's graduates have in-depth knowledge of several current topics within their own discipline.

A4. Bachelor's graduates are familiar with the quantitative character of the fields of mathematics and natural sciences and have an understanding of the methods used in these fields, and particularly within their own discipline, including computer-aided methods.

A5. Bachelor's graduates have sufficient knowledge and understanding of mathematics and natural sciences to successfully complete a follow-up Master's degree programme in their own discipline.

A6. Bachelor's graduates are aware of the societal, ethical and social aspects involved in the fields of mathematics and natural sciences.

**B. Generic learning outcomes – Skills**

B1. (Research) Bachelor's graduates are able to draw up a research question, design, plan and conduct research and report on it independently with a certain degree of supervision. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field.

B2. (Designing) Bachelor's graduates are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account the requirements of the client and/or technical preconditions – find a solution.

B3. (Gathering information) Bachelor's graduates are able to gather relevant information using modern means of communication and to critically interpret this information.

B4. (Collaborating) Bachelor's graduates are able to collaborate in teams (including multidisciplinary teams) on technical-scientific problems.

B5. (Communicating) Bachelor's graduates are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others. They are familiar with the relevant means of communication.

B6. (Reflecting) Bachelor's graduates are able to assess their own actions and those of others in a natural sciences context, bearing in mind the social/societal and ethical aspects.

B7. (Learning skills) Bachelor's graduates are able to apply learning skills that enable them to pursue a follow-up degree and acquire knowledge in new fields with a high level of autonomy.

B8. Additional subject-specific skills are listed in Appendix 2.

## Appendix 1 Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Chemical Engineering has:

1.1. knowledge of the most important fields of i) process technology: physical transport phenomena, chemical reactor engineering, separation methods, and process design, ii) product technology: materials science, design methodology, and processing, and iii) basic aspects of chemistry: inorganic, organic, analytical, physical, and polymer chemistry and biochemistry.
1.2. necessary background knowledge of Mathematics and Physics,
1.3. understanding of the position and role of the discipline within science and society, and also in the international character of the discipline.

The Bachelor's graduate has become familiar with the following key elements of Chemical Engineering:

*a*. Important aspects of chemical terminology, nomenclature and conventions.
*b*. Numerical and computational skills, including error analysis, understanding of the proper order of magnitude and correct use of units.
*c*. The most important types of chemical reactions and their characteristics.
*d*. The principles and procedures that are used in the chemical analysis and in the characterization of chemical compounds.
*e*. The design of industrial processes, taking into account flow and transfer of matter and energy.
*f*. The principles of Thermodynamics and phase diagrams.
*g*. Kinetics of various chemical reactions.
*h*. Dimensional analysis and its application in various (technological) problems.
*i*. Basic knowledge of fluid dynamics and heat and mass transfer and their application in various parts of process technology.
*j*. Knowledge of equipment that is used in many chemical processes.
*k*. The principles of separation methods and their application in industry.
*l*. Basic knowledge of industrial chemistry and reactor engineering.
*m*. Materials Science with emphasis on structure-property relationships and their application in various areas of Product Technology (production, analysis, etc.).
*n*. The principles of production, structure and properties of polymers and the use of these in various types of chemical products.
*o*. Basic knowledge of Product Technology.
*p*. Thinking in systems that are relevant for industrial chemistry and technology.
*q*. The properties of chemicals and the environmental and safety aspects of using them.

## Appendix 2 Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Chemical Engineering has developed the skills and competences mentioned below.

*Chemical Engineering-related cognitive skills and competences*

The Bachelor's graduate is:

2.1 able to demonstrate and use his/her knowledge and understanding of essential facts, concepts, principles and theories related to the topics, as defined in Appendix Ib, for the (re)design new chemical processes/products.
2.2 able to apply knowledge and understanding to solve basic qualitative and quantitative problems,
2.3 skilled in evaluating, interpreting and combining chemical and process/product technological information and data,
2.4 able to recognize and implement 'good laboratory practice',
2.5 familiar with project work,
2.6 able to adopt a professional attitude regarding environmental and safety aspects and possible ethical implications in the context of research, education and industry.
2.7 able to work at different levels of abstraction and detail, including system design level,
2.8 able to see, where necessary, the importance of other disciplines (interdisciplinarity) and their contribution in the design process.

*Chemical Engineering-related practical skills*

The Bachelor's graduate is:

2.9 skilled in the use of standard laboratory procedures and in the use of equipment for synthetic and analytical work,
2.10 able to verify chemical properties, to observe and measure events or changes, and to systematically archive and document data,
2.11 able to interpret data, obtained from observations and measurements, and relate it to the right theories,
2.12 able to assess the risks of laboratory procedures and the use of chemicals,
2.13 skilled in the safe handling of chemicals, taking into account physical and chemical properties, including the various specific risks of use, and is also able to act adequately in emergency situations in the laboratory,
2.14 able to use IT skills appropriate to the chosen specialization.

## Appendix II Follow-on Master's degree programmes (Article 1.5)

The Bachelor's degree programme will grant unconditional admission to the following Master's degree programmes at the University of Groningen:

- Chemical Engineering
- Education and Communication in Mathematics and Natural Sciences
- Energy and Environmental Sciences

And to the following joint degree programme:

- Water Technology

## Appendix III Majors and Minors in the degree programme (Article 2.1.2)

1) The programme consists of the Major Chemical Engineering
2) The programme consists of a deepening Minor Chemical Engineering

## Appendix IV Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Form of examinations; Article 7.4**

| Course unit | ECTS | Assessment method | Practical |
|---|---|---|---|
| Calculus for Chemistry and Chemical Engineering | 5 | Written exam, test | x |
| Molecules: Structure, Reactivity, and Function | 5 | Assignments, Written exam, practical assessment, report, test | x |
| Choice:<br>▪ From Bacteria to Plastic<br>▪ Physics Laboratory 1<br>▪ Introduction to Mathematics | 5 | ▪ Reports, oral exam, lab journal, practical assessment,<br>▪ Written exam, practical assessment<br>▪ Written exam | x<br><br>x |
| Organic Chemistry 1 | 5 | Written exam, test | |
| Practicum Synthesis and Analysis 1 | 5 | Practical assessment, report, discussion of results | x |
| Physical Chemistry 1 | 5 | Written exam, practical assessment, homework assignments | x |
| Biochemistry | 5 | Written exam, practical assignment | x |
| Biochemistry Practicum | 5 | Lab journal, practical assessment, oral exam | x |
| Spectroscopy | 5 | Written exam, computer assignment, test | x |
| Process and Product Technology | 5 | Written exam | |
| Inorganic Chemistry | 5 | Written exam | |
| First Year Symposium | 5 | Presentation, mandatory attendance, report | x |

## Appendix V Course units in the post-propaedeutic phase

- **List of course units; Article 6.1**
- **Course units with one or more practicals; Article 6.2**
- **Compulsory order of examinations; Article 7.2**
- **Form of examinations; Article 7.4**

| Course unit | ECTS | Assessment method | Practical | Prerequisites |
|---|---|---|---|---|
| Technical Thermodynamics | 5 | Written exam | | |
| Organic Chemistry 2 | 5 | Written exam, homework assignments | | |
| Practicum Synthesis 2 | 5 | Assessment of practical, report, | x | |
| Introduction to Programming and Numerical Methods | 5 | Practical Computer assignments, written exam | x | |
| Single-Phase Reactors | 5 | Written exam, computer assignments | x | |
| Linear Algebra for Chemistry and Chemical Engineering | 5 | Written exam, computer assignments | x | |
| Product Technology | 5 | Written exam, assignment, | x | |
| Separation Processes | 5 | Written exam | x | |
| Science, Ethics, Technology, and Society | 5 | Written exam, performance, essay, presentation, | x | |
| Physical Transport Phenomena 1 | 5 | Written exam | | |
| Macromolecular Chemistry | 5 | Written exam, tests, presentation | x | |
| Practicum Macromolecular Chemistry | 5 | Practical assessment, reports, oral exam | X | |
| General Process Equipment | 5 | practical assessment, report, test | x | |
| Multiphase Reactors | 5 | Written exam | | |
| Physical Transport Phenomena 2 | 5 | Written exam | | |
| Process Dynamics | 5 | Assignments, report | x | |
| Special Process Equipment | 5 | Assignments, presentation and report, | x | |
| Electives, courses from Bachelor's programmes in Chemistry, Chemical Engineering, (Applied) Physics, Astronomy, (Applied) Mathematics, Industrial Engineering and Management, which are to be individually approved by the Exam Committee. | 20 | See the programme specific appendices IV and V of the Teaching and Examination Regulation. | See the programme specific appendices IV and V of the Teaching and Examination Regulation. | See the programme specific appendices IV and V of the Teaching and Examination Regulation. |
| Bachelor Project | 15 | Performance, presentation, report | x | Passed 150 ECTS of the Bachelor's degree programme of Chemical Engineering |

**Elective offered by Chemical Engineering**

| | | | | |
|---|---|---|---|---|
| Minor Research Project | 10 or 15 | Performance, presentation, report | x | |

# Appendix VIII Admission to the post-propaedeutic phase

The following candidates will be admitted to the post-propaedeutic phase:

- Holders of a propaedeutic certificate of the degree programmes in Chemistry or Chemical Engineering

# Appendix IX Contact Hours in the propaedeutic phase

| **Bachelor year 1** | |
|---|---|
| **Type of contact** | **Number of contact hours per year** |
| Lectures | 250 |
| Tutorials | 230 |
| Practical | 330 |
| Computer practical | 90 |
| Study support/Mentor groups | 8 |
| Internship support and guidance | - |
| Exams | 52 |
| Misc. contact hours | - |