Scheikunde OW 2012

Department of
Chemical Engineering and Chemistry,
Eindhoven University of Technology

QANU, September 2012

Quality Assurance Netherlands Universities (QANU)
Catharijnesingel 56
PO Box 8035
3503 RA Utrecht
The Netherlands

Phone: +31 (0) 30 230 3100
Telefax: +31 (0) 30 230 3129
E-mail: info@qanu.nl
Internet: www.qanu.nl

Project number: Q339

CONTENTS

This report was finalized on 10 September 2012

Report on the bachelor's programme Chemical Engineering and the master's programme Chemical Engineering of Eindhoven University of Technology

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Chemical Engineering

Name of the programme:	Chemical Engineering
CROHO number:	56960
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	
Location(s):	Eindhoven
Mode(s) of study:	full time, part time
Expiration of accreditation:	31-12-2013

Master's programme Chemical Engineering

Name of the programme:	Chemical Engineering
CROHO number:	60437
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	Process Engineering, Molecular Engineering, Polymers & Composites
Location(s):	Eindhoven
Mode(s) of study:	full time, part time, dual
Expiration of accreditation:	31-12-2013

The visit of the assessment committee Scheikunde OW 2012 to the Department of Chemical Engineering and Chemistry of Eindhoven University of Technology took place on 26 April 2012..

Administrative data regarding the institution

Name of the institution:	Eindhoven University of Technology
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Chemical Engineering and the master's programme Chemical Engineering consisted of:

- prof. dr. E. Schacht, honorary full professor, Department Organic Chemistry, Ghent University, Belgium;
- dr. J. Lerou, consultant and adjunct professor in Chemical Engineering, Pennsylvania State University US;
- prof.dr. B.U.W. Maes, research professor University Antwerpen, Belgium;
- prof.dr. J.W. Verhoeven, professor emeritus Organic Chemistry, University of Amsterdam;
- Maja Medic, master student Life Science and Technology, Leiden University.

The committee was supported by dr. B.M. van Balen, who acted as secretary and cluster coordinator.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation
The assessment of the Chemical Engineering programmes of Eindhoven University is part of a cluster assessment of 33 chemistry degree programmes offered by ten universities. The entire cluster committee consists of twelve members. The kick off meeting for the cluster assessment was scheduled on 22 March 2012. During this meeting the committee members received an introduction into the assessment framework and evaluation procedures and the committee agreed upon it's general working method. For each visit a sub committee is composed that ensures the necessary expertise to evaluate the programme. Furthermore the domain specific requirements and the most recent developments concerning the Chemistry domain were discussed. These domain specific requirements and the actual context form the starting point for the evaluation of the quality of the degree programmes.

The committee chair and the co-ordinator preserved the consistency in evaluation in the cluster project.

In preparation of the assessment of the programme a self-assessment report was prepared by the programme management. This report was sent to QANU and, after a check by the secretary of the Committee to ensure that the information provided was complete, forwarded to the Committee members. The Committee prepared the site visit by studying the self-assessment report and a number of Bachelor's and Master's theses. The secretary of the committee selected fifteen theses randomly and stratified out of a list of all graduates of the last two years per programme. The following stratification is used: five theses for each degree programme with low grades (6-6.5), five theses with middle ranged grades (7-8) and five theses with high grades. QANU asked the programmes to send the theses including the assessment by the supervisor and examinator and divided them among the sub-committee members, each committee member therefore assessed three theses per programme.

When a thesis was assessed as questionable or unsatisfactory by a committee member, a reassessment was done by another committee member. In the case that more than 10% of the theses were assessed as questionable or unsatisfactory by two committee members the selection of theses for the programme was extended to 25.

Site visit
The Committee members formulated questions raised by studying the self-assessment report in advance. These questions were circulated in the commitee.

The Committee visited the programme on 26 April 2012. The programme of the site visit was developed by the Committee's secretary in consultation with the programme management and the chair of the Committee. The Committee interviewed, next to students, teachers and alumni, the programme management and representatives of the Faculty Board, the Examination Board and the student and teacher members of the Programme Committee. An open office hour was scheduled and announced (but not used).

During the site visit the Committee studied additional material made available by the programme management. Appendix 7 gives a complete overview of all documents available during the site visit. The last hours of the site visit were used by the Committee to establish the assessments of the programme and to prepare the presentation of the findings of the Committee to the representatives of the programme.

Report
The secretary wrote a draft report on the basis of the findings of the committee. The draft report has been amended and detailed by the committee members. After approval of the draft report by the committee it was sent to the Department for a check on facts. The comments by the Department were discussed in the committee, this discussion resulted in some changes in the report, subsequently the committee established the final report.

The assessment was performed according to the NVAO (Accreditation Organization of the Netherlands and Flanders) framework for limited programme assessment (as of 20 November 2011). In this framework a four-point scale is prescribed for both the general assessment and assessment of each of the three standards. The committee used the following definitions for the assessment of both the standards and the programme as a whole:

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

General Assessment

- When standard 1 or standard 3 is assessed as 'unsatisfactory' , the general assessment of a programme is 'unsatisfactory' .

- The general assessment of the programme can be good when at least two standards, including standard 3, are assessed as 'good',

- The general assessment of the programme can be excellent when at least two standards, including standard 3, are assessed as 'excellent'.

Summary judgement

Intended learning outcomes
The bachelor's programme *Chemical Engineering* offers a broad curriculum in three areas: Process Engineering, Chemistry and Materials Science. This programme enables students to specialize in a subsequent master's programme in one of the mentioned areas. The intended learning outcomes for the bachelor's programme are derived from the domain specific requirements. According to the committee these are in line with the international standards for a bachelor's programme Chemical Engineering. The master's programme Chemical Engineering aims at training chemical engineers to thoroughly develop knowledge in process engineering, supramolecular chemistry, catalysis, or polymer chemistry and technology. The learning outcomes of the master's programme are described in line with this objective.

The committee was impressed by the strong, clear vision of the programme management for the future of this programme and fully supports the restructuring plans. The management presented a detailed business plan to further improve the programmes. The programmes the Faculty intends to offer are well elaborated and have a clear focus. The bachelor's programme *Chemical Engineering* is quite unique in the Netherlands, given the broad and thorough scope of the education.

Teaching learning environment
In the bachelor's programme, all students take the same Major and select a coherent Minor programme. The students finalise their bachelor's programme with a Major project in research or design of 7 EC. The bachelor's programme is organized in such a way that, during each quarter, three or four theoretical courses are planned in combination with a laboratory course and/or a design-based learning project. The knowledge offered in theoretical courses forms the basis for laboratory courses, which, in turn, prepare students for the experimental work in the design-based learning projects and the Major project. In the interview with the students it was confirmed that the bachelor's programme is structured in a cohesive way. The basic teaching concept, which in short can be described as design based learning, integration of knowledge, insight, application and design as well as research skills, is in the committee's opinion very supportive for the learning process of the students.

The master's programme offers the students track-specific compulsory courses; a compulsory course on academic competences, an internship; a multidisciplinary project; an optional programme and a graduation thesis. The students report that the master's programme prepares them adequately for both the labour market and continuing study in a PhD programme. The programme is a good balance between theory, practice, research and design. The academic staff involved in teaching is very good, has an excellent record in research and good teaching skills. The facilities for teaching and for the students are very good. The Helix building where the Chemistry programmes are housing are very well equipped and supportive for the learning process of the students.

The TU/e MSc programme in Chemical Engineering is highly valued at national and international levels as e.g. indicated by the benchmarking conducted by the German Centre for Higher Education in 2010, which ranks the TU/e programme as one of the top Excellent Chemistry programmes in Europe

Assessment and achieved learning outcomes
The types of examination and feedback methods are determined by the position of curriculum components within the curriculum and by the educational objectives of the

program. The committee has seen that a well-balanced variety of examination forms are used in the bachelor's and master's programme. The assessment of general skills occurs throughout the curriculum in the different design-based learning projects and laboratory courses. The committee assessed a random selection of bachelor's and master's theses and concluded that all theses met the requirements.
It is evident that the graduated bachelor's students are very well prepared for the master's programme Chemical Engineering, both at the TU/e as well as elsewhere. Graduated master's students of the TU/e are sought after at the job market both in the Netherlands as well as abroad.

The committee has established that the programme has an adequate examination and assessment system. Tests, assignments and theses are assessed in an adequate way. The Examination Board performs it tasks in an adequate way. The committee however advises the Board of Examiners to develop a more proactive policy to assure the quality of the examination.

In conclusion, the committee is convinced that the objectives put forward in the intended learning outcomes are fully realised.

Bachelor's programme Chemical Engineering:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	good
Standard 3: Assessment and achieved learning outcomes	good
General conclusion	good

Master's programme Chemical Engineering:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	good
Standard 3: Assessment and achieved learning outcomes	good
General conclusion	good

The chair and the secretary of the committee hereby declare that all members of the committee have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 10 September 2012

Prof. em. Etienne Schacht

dr. Barbara van Balen

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

1.1. Findings

Bachelor's Programme

The department of Chemical Engineering and Chemistry at the Eindhoven University of Technology has chosen to offer a broad and thorough foundation curriculum for the bachelor's degree programme in three areas: Process Engineering, Chemistry and Materials Science. According to the self evaluation report the strength of the degree programme originates in its broad scope, enabling students to specialize in a subsequent master's programme in one of the mentioned areas or domains. Students will be able to communicate with specialists from at least two other disciplines, and can use their knowledge from all three disciplines to tackle problems in their field. The bachelor's programme in Chemical Engineering is geared toward facilitating the transfer of students to a master's degree programme. Students who successfully complete the minor Education and Communication obtain a teaching qualification, enabling them to enter the professional field after obtaining their bachelor's degree.

The learning outcomes of the bachelor's degree programme are presented in Appendix 3. They contain the categories of domain-specific and general learning outcomes. Domain-specific competencies are divided into three main groups:

- Chemistry: this includes the basic principles of analytical chemistry, inorganic chemistry, organic chemistry, polymer chemistry, thermodynamics, chemical bonding, catalysis, biochemistry, spectroscopy, physical chemistry, and reactor kinetics.
- Process engineering: this includes the basic principles of physical transport phenomena, applied thermodynamics, unit operations, chemical reactor engineering, process control and process design.
- Materials science: this includes the basic principles of organic, macromolecular, and inorganic synthesis, polymer technology, phase theory, interface chemistry, and materials science of metals, polymers and ceramics.

In brief, the domain-specific learning outcomes concern the command of the basic principles of mathematics, physics, computer science, process engineering, chemistry and materials science. The committee is convinced that the result is a very good programme that, given its broad and thorough foundation curriculum, is rather unique in The Netherlands and competitive with other European universities.

Master's programme

The master's programme Chemical Engineering of the TU/e offers three tracks: Process Engineering, Molecular Engineering and Polymers & Composites. The TU/e Department of Chemical Engineering and Chemistry describes in the self-evaluation report that it beliefs that the only way for master's students to reach the necessary scientific depth and technological innovation required by the field is for them to conduct research as a significant part of their graduate studies.
The master's programme Chemical Engineering of the TU/e aims at training chemical engineers to thoroughly develop knowledge in process engineering, supramolecular chemistry, catalysis, or polymer chemistry and technology. It provides education that will prepare graduates for leadership positions within the chemical and associated industries, as well as for carrying out academic research. The learning outcomes of the master's programme in Chemical Engineering comprise seven categories:

1. Specialist expertise
2. Knowledge-activation and acquisition skills
3. Academic competences
4. Integrative skills
5. Contextual abilities
6. Interactive skills
7. Basic operational skills

The learning outcomes are included in Appendix 3 to this report.

At the end of the programme the graduate demonstrates:

- the command of specialist expertise in the field of molecular engineering, process engineering, or polymers and composites;
- the ability to reactivate previously acquired knowledge, acquire and expand knowledge in disciplines closely related to one's own discipline, and integrate disciplinary knowledge in a multidisciplinary problem;
- the possession of academic competences by showing the ability to think analytically and logically, to independently generate and apply knowledge, to reflect on one's own action and on the relationship between technology and society;
- the ability to combine elements of specialist expertise and knowledge for the purpose of analyzing complex problems in the field of chemical engineering;
- the ability and will to consider societal, socio-economic, safety and environmental preconditions of one's own conduct;
- demonstrates the command of interactive skills as the ability to work in a multidisciplinary and or multicultural team of experts, to present results both orally and in written form; and show leadership skills;
- the ability to work with the basic operational skills regarding research, development and design.

At the start of the site visit the dean of the Faculty displayed the plans to restructure the bachelor's and the master's curriculum and gave an extended explanation of the vision underlying this restructuring. The redesigned bachelor's programme will start as of September 2012, the redesigned master's programme in 2013.

The purpose of the restructuring is to preserve the strong points in the current programme, to achieve more efficiency, to improve the yields and to address a broader student population.

Next to a university wide common framework for the content of the curriculum, a common teaching concept and student coaching plan are the focus of this restructuring.
The committee appreciates the current quality of the programme that was awarded the Eurobachelor label by the European Chemistry Thematic Network. The well thought plan to further improve the programme aiming to maintain a competitive position in the education of chemical engineers is a proof of a good management vision.

1.2. Considerations

The assessment committee observed that the management of the Faculty has a strong vision on the Chemical Engineering programmes as well as the teaching and student coaching and has set out clear lines for the future to preserve high quality degree programmes in Chemical Engineering in Eindhoven. The committee appreciates this strong involvement of the Faculty's management with the quality of teaching and the future of Chemical Engineering.

The programmes the Faculty intend to offer are according to the committee ambitious, but reachable. They are well defined programmes with a clear unique focus. The committee concludes that the programmes provide an answer to a need in society for trained engineers who are thoroughly trained in research and design and are competitive on an international level.

The intended learning outcomes of the bachelor's as well as the master's programme are, according to the committee, well described in terms of level and orientation and are in line with the domain specific framework and the international requirements for Chemistry and Chemical Engineering.

The committee established that the bachelor's programme intends to offer students a thorough general, broad and up to date education in the field of Chemical Engineering. The master's programme offers the students the possibility to obtain thorough knowledge, insight and skills in one of three well defined specialisation tracks. The three tracks in the master's programme are of good quality. The track on Polymers & Composites is unique in The Netherlands and very competitive on a European level. All three master's tracks are backed up by top-class science in that field, as evidenced by the number of ERC and NWO TOP awards.

Conclusion

Bachelor's programme Chemical Engineering: the committee assesses Standard 1 as **good**.
Master's programme Chemical Engineering: the committee assesses Standard 1 as **good**.

Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

2.1. Findings

Bachelor's Programme

Curriculum

In the bachelor's programme, all students take the same Major of 150 EC. In addition, students select a coherent Minor programme of 30 EC. The students finalise their programme with a Major project in research or design of 7 EC. The Major programme covers the disciplines of Process Engineering, Chemistry and Materials Science and is structured around six thematic lines:

- Sustainable Energy
- Product Design & Process Management
- Sustainable Molecular Engineering
- Health & Life Sciences
- Nanotechnology
- Advanced Materials

In the course of the curriculum, each of the themes returns in the form of a design-based learning project. Students can fully acquaint themselves with each of the themes, for which there are design-based learning projects, laboratory courses, and theoretical courses. The theoretical courses that are offered fall within the context of the themes; they have a disciplinary character and are linked with actual developments in the domain. Appendix 4 gives an overview of the curriculum.

In the first semester of the first year, students are introduced to the field of chemical engineering and chemistry by means of a chemistry laboratory course, a design-based learning project concerning the topic of sustainable energy, three introduction courses to the fields of materials science, chemistry and process engineering. Students also follow supporting courses in the fields of thermodynamics, physics and mathematics. The preliminary project on mathematics and chemical calculations in the first quarter allows students to make a smooth transition to university education, and to alleviate any deficiencies in the field of mathematics and basic chemical concepts.

The bachelor's programme is organized in such a way that, during each quarter, three or four theoretical courses are planned in combination with a laboratory course and/or a design-based learning project. The knowledge offered in theoretical courses forms the basis for laboratory courses, which, in turn, prepare students for the experimental work in the design based learning projects (DBL) and the Major project.

In the interview with the students was confirmed that the bachelor's programme is structured in a cohesive and satisfying way. Learning outcomes and competences to be achieved by the students in the courses are built on what was learned previously. There is, according to the students, no dysfunctional overlapping. The students report about a good balance between theory, practical work and projects. They are enabled by the design based learning (DBL) projects to apply knowledge and skills to a 'real' problem. The students are very satisfied with the programme.

Teaching concept and teaching formats

The bachelor's programme in Chemical Engineering employs the TU/e teaching concept, based on the following core principles:

- The University provides informal contacts between teaching staff and fellow students, and focuses on good study performance.
- Students are offered a combination of academic knowledge and skills that are appropriate for academics and engineers in particular.
- The TU/e strives for quality by focusing on the education of individuals. This is achieved by maintaining a favourable student/teacher ratio and by offering a challenging honours track for excellent students.
- The TU/e opts for active learning: project work and supervised self-study sessions are important components of the study schedule.
- To help students develop their academic skills, the TU/e uses design-based learning. This is a form of technical scientific education in which students actively work together on multidisciplinary assignments.
- The theoretical courses are generally meant to realize a set of domain-specific educational objectives. Most of these courses consist of three elements: lectures, self-study (which includes both supervised and independent learning), and a written exam.

Specific objectives of design-based learning (DBL) projects are:

- to teach students to reactivate knowledge previously acquired during lectures by means of addressing complex chemical / chemical engineering problems, which are as realistic as possible, and in a number of cases are cross-disciplinary. Students must show they are able to integrate knowledge from various disciplines;
- to teach students how to work in teams in a professional manner in order to obtain a joint result in a limited period of time;
- to allow students the opportunity to practice various communicative skills in order to communicate information about their research results to colleagues, both verbally and in writing;
- to motivate students to connect field-specific knowledge gained in a multidisciplinary context with socially relevant and interesting subjects.

The aim of the laboratory courses is to teach practical and theoretical skills needed in a research context. Apart from the well-known practical chemical skills, this also involves data handling and statistics, laboratory safety, reporting, presentation techniques and experimental design.

The Major project serves as a bachelor's thesis and is as such a closure of the undergraduate programme at the end of the third year. The thesis concerns a research or design project that falls within one of the six themes of the bachelor's programme.

.

The students report about a good balance between theory, practicals and projects. They are enabled by the DBL projects to apply knowledge and skills to a 'real' problem. The students are very satisfied with the programme.

The first year of the bachelor's programme has an orientating, selective, and referring function for the programme. The curriculum allows the department to assess, within the timeframe of the first semester, whether a student is suitable for the degree programme and whether the degree programme suits the student. When suitability issues arise within the first semester, students are intensively monitored by their adviser, and when necessary, are actively guided to seek a more appropriate programme of study.

The department currently seeks to retain 70% of their first-year students and to reduce the number of student dropouts in the first year. To achieve this, the so-called 'binding recommendation for continuation of studies' (BSA) was implemented in the 2009-2010 academic year: students who receive a negative study advice are not allowed to re-enroll in the programme, resulting in a lower number of dropouts (see Appendix 5).

TU/e bachelor's students in Chemical Engineering who successfully obtained at least 160 EC are allowed to participate in master's courses and exams, due to the fact that the remaining 20 EC are often distributed over the whole year. The rationale for allowing this stems from the fact that student progress would be negatively affected if they were only allowed to take bachelor's courses and exams. The possible disadvantages of this measure are that the division between the bachelor's and the master's programme is not always clear and that students who follow a few master's courses may postpone the completion of their bachelor's programme for another year.

Starting in the 2012-2013 academic year, all bachelor's students in the Netherlands, including TU/e students, are required to complete their bachelor's programme before entering a master's program: the so-called 'harde knip' will be then introduced. It is expected that this will influence the bachelor's success rate in a positive way.

The students appreciate the accessibility of the teaching staff. They describe that the doors of the staff rooms are always open and students can walk in for consultation. Furthermore, they feel well supervised and coached. Study delay is a well known phenomenon, but the students do not see this as a problem caused by the programme. The programme can be finalised within the scheduled time, but students prefer to broaden their experience during their bachelor's study. Participating in study association boards and organisation of excursions and guest lectures is, according to the students, the main cause for study delay. The students confirm the assets of the BSA to help students to make a deliberate choice for a study that fits their capabilities and interests, but they do not see the advantages of the 'harde knip' between bachelor's and master's programme. The institution undertakes a variety of initiatives to increase the cohort numbers.

Master's programme
The TU/e master's programme in Chemical Engineering is part of the graduate programme Chemical Engineering and Chemistry. The programme offers three tracks from which students can choose: Process Engineering, Molecular Engineering, or Polymers and Composites. The Molecular Engineering track consists of two sub-tracks: Organic Chemistry and Inorganic Chemistry. The master track programmes comply with the following structure:

- a track-specific compulsory module of 21 EC consisting of five to seven courses;
- a compulsory course FACTS3 on academic competences, comprising 6 EC;
- an internship of 20 EC;
- a multidisciplinary project of 8 EC;
- an optional programme of 12 or 27 EC;
- a graduation thesis of 38 or 53 EC.

Appendix 4 provides an overview of the curriculum.

Before students can make the necessary choices from the various curriculum components in order to outline their definite master's degree program, they first have to make two important decisions at the level of the programme as such, namely:

1. The track choice: the domain-specific, technological-scientific discipline the student wishes to specialize in.
2. The Profile choice: the professional perspective and/or the academic accents or extension a student wishes to establish in his or her study. For this choice students can select one of the four 'predefined' profiles: Research and Design, Technical Management, Technology Entrepreneurship, or Technology Development and Globalization, a combination of these profiles, or a free-choice profile, which students can compile themselves. The choice of the profile in particular determines the contents of the Optional Program, but it can also influence the choice of the Multidisciplinary Project and the Graduation Project.

All theoretical courses are programmed in the first master year. In the second year, students undertake their graduation project and the industrial internship. The coherence of the programme is ensured in part through the components of the track-specific obligatory programme and in part by the choices students make in their optional programme. At the start of the master's programme, students are mentored by a faculty member (assistant, associate or full professor) who advises them with the composition of their study programme. The development of academic and research skills is ensured throughout the curriculum by offering disciplinary knowledge and skills in the obligatory programme, offering general academic competences in the course FACTS, enhancing multidisciplinary and communication skills in the multidisciplinary project, gaining more depth with respect to the graduation project in the optional program, and finally conducting independent research during the graduation project. The industrial internship serves as an orientation towards the professional field.

Teaching concept and teaching formats
The primary teaching concepts of the master's programme are individual, research and design-oriented education. As part of their academic education, students can participate in education from other disciplines. The track-specific obligatory programme is taught at an advanced scientific level and includes the latest advances in the field. In nearly every curriculum component of the master's degree programme there is a certain degree of interaction between students themselves, and between students and lecturers. The various types of examination for the courses match the various working methods and objectives.

For the Master's degree programme in Chemical Engineering student recruitment is done from the following categories:

- students with a BSc degree in Chemical Engineering from TU/e;
- students with a BSc degree in Chemistry / Chemical Engineering from another Dutch university;
- students with a professional bachelor's degree from an Institute of Higher Education in Chemical Engineering or related field;
- international students with a BSc in Chemical Engineering or related degree.

Students with a BSc degree in Chemical Engineering from TU/e, University of Twente and Delft University of Technology can transfer smoothly to the master's programme in Chemical Engineering. Some students coming from a related bachelor's degree programme from one of the other Dutch universities may have to follow a custom-designed study programme to bring them up to level. The professional (hbo) bachelor in chemical engineering or chemistry from a university of applied sciences will first transfer to the pre-master programme in Chemical Engineering. This programme consists of a series of bachelor's courses, which will bring the

students to the right academic level; subsequently, they will be able to follow the regular curriculum of the master's programme, where they will be exempted from the industrial internship.

Students experience a lot of freedom in the master's programme to make their own choices. They are satisfied with the supervision they receive in preparing and during the internship and by writing the thesis. The information about the master's programme provided for students from abroad is sufficient and foreign students in general are very satisfied with the programme and the amount of guidance they receive. Students with a bachelor's degree in higher vocational education report that the pre-master programme is a good preparation for their participation in the master's programme. In fact this pre-master programme is also selective. When a student is able to finalise the pre-master he or she will also be able to graduate in the master's programme. The student population in the master's programme is therefore diverse. Not only students who did their bachelor in Eindhoven enroll for the master's programme, but relatively many 'HBO' students and a high number of foreign students also participate. The management is anticipating a reduction in grants provided by the government and is actively searching for alternatives, e.g. scholarships from industry to make grants available for foreign students. The committee noted that the programme is internationally well visible and has a very good reputation.

Teaching staff
The department of Chemical Engineering & Chemistry has three main premises to improve and assure the teaching quality of its scientific staff. Firstly, newly appointed scientific staff at the Department of Chemical Engineering & Chemistry must have an outstanding track-record: they must hold a PhD degree, have several years (at least 2-4) of (preferably international) post-doc experience. Furthermore, they must have teaching experience or at least affinity for providing education if they lack educational experience. The applicant's potential teaching skills are formally assessed by BKO staff. Moreover, they must be willing to follow the didactical training to obtain the University Teaching Qualification. The Departmental Career Development committee (UHD commissie), consisting of four professors and the director of education, advises the board of the department after assessing the portfolios of presented candidate(s). Newly tenured professors, associate- and assistant-professors must have obtained their University Teaching Qualification within three years after appointment. Holding a BKO certificate is a necessary condition for career advancement. Scientific personnel who do not perform well enough are obliged to follow additional teaching courses to obtain the University Teaching Qualification, even if they have reached their final hierarchical position.

Staff members can expect annual appraisal evaluations with regard to their performance in research, education, valorisation and managerial activities. In these performance evaluations educational targets are discussed:

- courses that have been or are going to be designed;
- the nature of courses that are going to be taught: theoretical versus practical;
- level of the courses: BSc versus MSc level.

To measure the results, the scores of the student evaluations are used to objectify possible conclusions.

The entire academic staff (assistant professors, associate professors and full professors) spend about 25% of their time on education (lectures, labs, supervision, design-based learning),

about 50% on all research-related aspects, and about 25% on organizational matters. The student-staff ratio for both bachelor's and master's programme is on average 25 students per 1fte teaching time of the staff.

Students confirm that the quality of the teaching staff is good and, as mentioned before, that the staff is easily accessible. The students report that the staff teaches from the heart, with a thorough and deep understanding of the material resulting from long time experience and research on high level. It is the experience of the students that when there is a problem reported with the teaching quality, measures will be taken for improvement. Teachers use their own research as sources for lectures. The quality of the research programmes in which the staff is participating is recently evaluated and assessed as very good to excellent.

Programme-specific services and facilities
The Department of Chemical Engineering and Chemistry is housed in two buildings: the Helix building, consisting of an east and west wing, and the Matrix building. On the various floors of these buildings, there are rooms used for lessons and colloquia. The laboratories and rooms for the laboratory courses can be found in the laboratory areas of the buildings. On the ground floor of the Helix building there are lecture halls of various seating capacities. All rooms are equipped with necessary audiovisual equipment, presentation equipment and whiteboards. Apart from the department's own buildings, faculty and students also make use of the lecture rooms in the Auditorium. Rooms for project education (MDP and DBL projects) are located in the Matrix building.

The equipment in the classrooms and laboratories meet all current teaching and research requirements. In the setting up of these spaces, much attention was paid to the multipurpose nature of the rooms, enabling students to work individually, in teams or project groups. Certain laboratories have been specially equipped for the teaching of general laboratory skills to first year students. Furthermore, the laboratories are equipped to support the students' activities and they contain all necessary apparatus and equipment for lab and DBL projects.
Both the Matrix and Helix buildings have a wireless network.

All TU/e departments make use of the central OWIS system for registration of students' progress. Students have read-only access to their personal academic results registered on the OWIS system. Students are notified by e-mail when new examination results have been added. Thus, students are kept fully abreast of the progress and state of their studies. Actual information about the curriculum, the digital study guide, the education and (final) examinations regulations (OER), the study schedules and all study-related matters can be found through the e-learning environment OASE (http://education.tue.nl), the electronic study guide Owinfo (http://owinfo.tue.nl) and the electronic communication platform Stipt! (http://Stipt.chem.tue.nl). In addition to these electronic platforms, students can gain information from the student administration office, the TU/e Student and Education Service Centre, the student counselors, and the departmental students association 'Jan Pieter Minckelers'.

The evaluation committee who visited the chemical engineering programmes of the TU/e in 2007 assessed the building, facilities and laboratories as good. While the facilities did not change in the mean time, the evaluation commission 2012 did not have a reason to visit the building and facilities and adopted the 2007 assessment.

Students can gain advice about study-related matters from different study advisers and coaches:

- the student-tutor;
- the teacher-tutor;
- the departmental study adviser;
- the institutional study advisers.

In the first semester, student guidance is the primary responsibility of the student-tutors, senior students who also act as supervisors for new students' first design-based learning project. Under the supervision of the Student and Education Service Center (STU), the student-tutors monitor and supervise how their tutor group makes the transfer from secondary school education to university education.

In the course of the second quarter of the first semester, the departmental study adviser extensively analyzes the study progress and personal development of all first-year students in order to form a good picture of their study prospects. In the beginning of January, the adviser subsequently invites all students whose situation is worrisome for a personal talk, during which together they attempt to find the cause of the disappointing results. The adviser also gives advice with respect to the (near) future.

After the second quarter, the students also receive - from the Board of Examiners - a written preliminary study recommendation. This advice gives an indication of the study progress and serves as a warning for students who are making insufficient study progress.
In the second semester, the responsibility for student guidance is transferred from the student tutors to the lecturer-tutors. The focus of student guidance gradually shifts from helping students to unlearn poor study behavior picked up before entering university to helping them to acquire a positive academic attitude and to develop competencies. The lecturer tutors hold meetings twice a year in which students' development is discussed.

In the course of the second semester, the adviser carefully monitors the progress of the students who were invited to meet in January to discuss concerns about their study progress. Based on the advisers' findings, students will be invited for a second meeting, if necessary. At the end of the first year of enrolment the student will receive a written "binding recommendation for continuation of studies" (BSA), which indicates either positive or negative study advice:

a. A positive recommendation is issued if the student has obtained 30 ECTS or more; the student may continue with the bachelor's program.
b. A negative binding recommendation is issued if the student has obtained 29 ECTS or less; the student may not continue with the bachelor's program. In addition, the student may not be re-admitted to the programmefor a period of three years.

Students who have been issued a positive recommendation but who have not obtained 40 EC will be offered the opportunity, in the form of a study contract, to take a number of second-year courses, in addition to the remaining first-year courses, and to take part in the corresponding examinations. All students must pass their first year examination within two years. If students do not succeed in doing so, they will no longer be allowed to sit post-propaedeutic examinations and they will be placed under the direct supervision of the Board of Examiners.

Study guidance in the first year is rather intensive, but is gradually reduced. In the second and third years, the student and lecturer-tutor will meet at least twice a year. The students' adviser

will only meet students at the students' own initiative, unless it is deemed necessary to meet more frequently. The students interviewed by the committee during the site visit were very positive about the guidance and study – advice offered to them.

2.2. Considerations

Bachelor's programme
The Committee concludes that the content and structure of the curriculum enable the admitted students to achieve the intended learning outcomes. The programme has a good balance between theory, practical work and research and design projects. Research and recent developments in the field have a prominent place in the programme. The teaching-learning concept that structures the programme is in the view of the committee very good and supportive for the learning process of the students. The teaching staff is involved in actual innovative research and internationally well known. The staff is enthusiastic and supportive for the students. The facilities are good and support the teaching-learning concept by enabling the students to work together on projects and assignments and to perform small scale research and design projects. The programme, the teachers and the tutoring are well appreciated by the students. In the opinion of the committee, the bachelor's programme Chemical Engineering is a challenging and interesting programme of high level, providing the students with a broad, but thorough education well preparing for a master study in Chemical Engineering.

The committee observed that the programme management is well aware that intake of students and the students progress should be improved. As described in the section on Standard 1 the Faculty has plans to restructure the programme and one of the objectives of the restructuring is to interest more groups of students for chemical engineering. Measures are also taken to improve the students' progress. The commission is convinced that these issues have the full attention of the Faculty.

Master's programme
The committee has established that the master's programme enables the students to develop their competences in chemical engineering on an advanced level and prepares the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in chemical engineering is required. The master's programme is in the opinion of the committee interesting and challenging. It provides a good balance between research and theory. Students have the possibility to shape the programme according to their own individual wishes and interests. Students participate in research departments and are involved in innovative high level research projects.

The committee is convinced that the students receive sufficient guidance and supervision during their internship and master thesis project. Furthermore the teaching staff involved and the facilities are good.

The committee appreciates the international oriented research climate in the Faculty and has established that the Faculty is also successful in internationalisation of the degree programme by attracting foreign students to the master's programme and by enabling its 'own' students to do part of the master's programme abroad. The committee is convinced that the international orientation of the programme contributes to its quality. The master's programme tracks, in particular Polymers & Composites are very good. The latter is unique in the Netherlands and can compete with polymer science & engineering programmes in Europe.

The TU/e MSc programme in Chemical Engineering is highly valued at national and international levels as e.g. indicated by the benchmarking conducted by the German Centre for Higher Education in 2010, which ranks the TU/e programme as one of the top Excellent Chemistry programmes in Europe

Conclusion
Bachelor's programme Chemical Engineering: the committee assesses Standard 2 as **good**.
Master's programme Chemical Engineering: the committee assesses Standard 2 as **good**.

Standard 3: Assessment and achieved learning outcomes

The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

3.1. Findings

The types of examination and feedback methods are determined by the position of curriculum components within the curriculum and by the educational objectives of the programme. In the selection of the type of examination, the compulsory sequence of the curriculum is explicitly taken into account: in the course of the programme, students learn to integrate knowledge, insight and skills through achieving domain-specific and general competencies. The types of examination and assessment must match the learning process of the students in order to support optimal learning behavior.
The curriculum components are offered in four main types: Lectures, Lab courses, Design-Based Learning projects and Projects (Major/Minor).

In the examination schedule, there is no overlap between 1st and 2nd year exams or 2nd and 3rd year exams. This allows students who missed exams in one year to do the exams the following year. All written exams are offered twice a year. The assessment of general skills occurs throughout the curriculum in the different design-based learning projects and laboratory courses. In most cases, students discuss the progress they make with their lecturer tutor.

The Department Board establishes the Education and (final) Examination Regulations, and the Board of Examiners establishes the Rules and Regulations. In these two documents the guidelines and arrangements with respect to tests, assessments and examinations have been laid down. The examiners who are responsible for the contents of the examination and the assessment are all academic staff members and are experienced in setting and assessing examinations. The examiner is the senior lecturer of the curriculum component concerned.

The curriculum components are evaluated periodically by the quality assurance committee. These evaluations are also aimed to determine whether the examinations are representative of the contents of the curriculum component, whether the students have enough time to sit the examinations, and whether the questions are clearly written.

In a number of cases, exams are graded by 2 or 3 individual examiners. This practice is not structural but is employed at the discretion of the individual lecturer. If an examination shows a success rate of less than 50%, the secretariat of the student administration informs the Director of Education, who subsequently contacts the lecturer to see whether no mistakes were made with respect to the type of examination or the relationship between the examination and the educational objectives.

The Board of Examiners acts according to its legal tasks. For that purpose the board holds monthly meetings. Recurrent tasks are:

- establishing the results of (final) examinations;
- deciding on requests for deviations from the program;
- deciding on requests for exemptions with respect to certain examinations;
- deciding on other requests for deviation from the stipulations in the Education and (final)
- Education Regulations;
- dealing with instances of fraud;
- dealing with requests for a second assessment;
- assuring the quality of exams.

Since academic year 2010-2011, the board of examiners has issued an annual report of its activities.

The committee met the Board of Examiners during the site visit and discussed the activities the Board carries out in regard to the quality assurance of the exams. The Board reported that it monitors the graduation results by comparing the results of each capacity group with the average results. In case of major deviations an investigation will follow, but this does not happen often. The Board of Examiners performs its legal tasks but does not pro-actively controls the quality of the exams, the assessment procedures and graduation theses.

Bachelor's programme
The Major project can be seen as the bachelor's thesis leading to graduation. By executing the Major project, the students show if they have achieved the learning outcomes of the bachelor's programme. The students' field-specific expertise and their research, academic and communicative skills are all assessed in the following areas: independent execution, structural approach and insight, the depth reached in the project, scholarly attitude and originality of the approach.

The research topic for the major project falls within one of the six themes of the bachelor's programme: Sustainable Energy Technologies, Nanotechnology, Health and Life Sciences, Sustainable Molecular Engineering, Advanced Materials en Product Design & Process Management, and is directly linked with actual research conducted at the department.For the assessment of the Major projects, a standard form is used to evaluate the different aspects of the projects.

Without exception, all graduates of the BSc programme enter a master's programme. Only one or two students per year will enter a master's programme other than Chemical Engineering at the TU/e. The committee noticed that all bachelor's students continuing their

study in a master's programme Chemical Engineering are very well prepared. They have all the capacities and knowledge to achieve the final qualifications of the master's programme.

Master's programme
Master students are assessed through written exams, oral exams and assignments. The student finalises his or her studies with a graduation project which consists of three examination components: a final thesis, an oral presentation of the research project and an examination. The thesis will be assessment by a thesis assessment committee, which consists of at least four members:

- the graduation project supervisor who acts as chairperson for the committee;
- the project supervisor;
- at least one other member of the research group in which the student has been conducting
- the graduation project;
- at least one member working in one of the other research groups of the department, or an expert from outside the department.

The thesis assessment committee gives an advice to the graduation project supervisor about the assessment of the graduation project, using the 'Assessment form Graduation project'. In the assessment of the graduation project the following aspects are considered:

- the independency of the student in performing research and writing the thesis;
- did the student show theoretical insight in the thesis;
- creativity by conducting the research design, the method used, the analysis and the report;
- the execution of the graduation assignment(s);
- written report;
- oral presentation;
- the examination.

The selfevaluation report states that according to the WO-monitor graduates are almost unanimously satisfied with the education they received. It says also that the master graduation project permits the graduate to enter the labor market without difficulty at an advanced level which is demonstrated by the fact that 80% of the TU/e ME master graduates find a job almost immediately within their own or in a closely related field.

The committee assessed fifteen recent bachelor's theses (Major projects) and fifteen master's theses and established that all theses met the requirements for graduation. On average the theses are of good quality, some of the theses the committee has assessed were considered as very good. The committee has not seen any thesis that was on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. The information provided on the assessment forms however differs from almost no details to extended argumentation for the final mark. A more uniform reporting is needed.

Graduates from TU/e Chemical Engineering are very well appreciated on the job market, both in the Netherlands as well as abroad. TU/e students easily find a job on an academic level after graduation.

3.2. Considerations

The committee has established that the programme has an adequate assessment system and assessment procedures. The assessment procedures are sufficiently implemented in the programme. The master's theses are adequately assessed by a committee of four. The committee advises to rethink the procedure for the bachelor's thesis and involve a second independent reviewer.

The committee has seen that bachelor's and master's students finish each course with a test. During the programmes students are assessed by a variety and combination of test methods: attendance, participation, written exams and assignments. The committee studied the overview of assessment methods carefully and also looked into several tests. The committee views the mix of assessment methods used throughout the programmes to be balanced and appropriate. The given variety and combination of testing provides for assessing knowledge, understanding, applying knowledge and skills sufficiently.

The committee advises the Board of Examiners to continue their efforts to guarantee the quality assurance of all exams and tests, but in particular the graduation theses. The Board of Examiners should continue their efforts to monitor the quality of the theses as wells as the assessment of the theses. Continued care should be taken to establish an evaluation system, with uniform and transparent evaluation forms that contain brief comments justifying the scores for the subcriteria and the overall grading.

Overall, the committee concludes that the course tests, the bachelor's theses and the performance of graduates in the master's programme demonstrate the achieved level of the bachelor's programme Chemical Engineering, which is in agreement with the intended learning outcomes on a high level.

The committee also concludes that the master's thesis and the performance of graduates in the labour market and in PhD trajectories demonstrate the achieved high level of the master's programme Chemical Engineering.

Conclusion

Bachelor's programme Chemical Engineering: the committee assesses Standard 3 as good.
Master's programme Chemical Engineering: the committee assesses Standard 3 as good

General conclusion

The committee concludes that programme management has a clear and strong vision for the future of the Chemical Engineering in Eindhoven. The programme is of great relevance to society, continuance of the programme is necessary. The plans set out by the management seems viable to the Committee. The ongoing restructuring is made with the objective to place the bachelor's and master's education programmes in line with the revised research focussing within the Faculty where Chemical & Process Technology and Molecular Systems & Materials Chemistry are identified as the strongholds. The committee concludes that the intended learning outcomes of the bachelor's and the master's programme have been concretised well in terms of content, level and orientation. The committee views that the intended learning outcomes meet the international requirements fully without any doubt and is of a good level that is competitive within Europe.

According to the committee the content and structure of the curricula and the available staff, services and facilities clearly constitute a coherent, attractive and challenging teaching-learning environment for the students.

Overall, the committee concludes that the programmes have an adequate assessment system in place and demonstrate sufficiently that the intended learning outcomes are achieved.

Conclusion
The committee assesses the *bachelor's programme Chemical Engineering* as **good**.
The committee assesses the *master's programme Chemical Engineering* as **good**.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Jan J. Lerou is director of Jan Lerou Consulting and associate professor in Chemical Engineering of the Pennsylvania State University and Washington University in St. Louis. He got his master's degree in Chemical Engineering from the Catholic University Leuven, Leuven, Belgium in 1970 and his PhD Chemical Engineering from the Universiteit Gent, Gent, Belgium.
He was, among others, Fulbright-Hays Senior Fellow at the University of Houston, Texas, 1976-77 and received several prices and grants for his research on Process Modeling.
Among his other activities in his long career were: Member of the Advisory/Editorial Board of IE&C Research, CaTTech, Industrial Catalysis News, and Chemical Engineering Research and Design, the Transactions of the Institution of Chemical Engineers (U.K.), member of the Dutch research assessment committee Chemistry in 2001-2002 and chair of the assessment committee for Chemical Engineering, Material Science and Engineering, Textile Engineering and Rheology for the Flemish Universities in 2008-2009.
Dr. Lerou is author and co-author of more than 40 refereed papers and 9 US patents. He gave more than 100 lectures at institutes and conferences in 20 countries.

Bert Maes got his master's degree Chemistry (cum laude) from the University of Antwerp (UA) in 1997 and his PhD in Sciences at the same university in 2001. From 2001 to 2003 he was Postdoctoral fellow at UA with a subsidy from FWO Flanders. During that time he performed a postdoc in the Hungarian Academy of Sciences in Budapest working in the group of Prof. G. Hajós (2002) in the field of heterocyclic chemistry. In 2005 he became lecturer and subsequently senior lecturer at the Department Chemistry of UA. In 2009 he obtained a research professorship at UA. In 2010 he performed a sabbatical at the ENS in Paris (Prof. A. Jutand) working on the use of electrochemistry to investigate reaction mechanisms in homogeneous catalysis. His research focuses on heterocyclic chemistry, homogeneous catalysis and sustainable chemistry. Dr. Maes is author and co-author of around 80 papers and 2 patents. He gave several lectures at international conferences, is a member of several international boards and currently leads a group of 9 postdocs and 5 PhD students.

Maja Medic is masterstudent Life Science and Technology University Leiden, Leiden. She received her bachelor's degree Life Science and Technology (cum laud) from the University Leiden and Technical University Delft in 2011. In 2009 she received the 'Jong Talent' grant from the Royal Dutch Society of Sciences. She is student member of the master's programme committee Life Science and Technology (since 2011), member of the Symposium committee of the Study Association LIFE (since 2010) and was student member of the bachelor's programme committee Life Science and Technology.

Etienne Schacht is honorary full professor in Polymer Science at the Department of Organic Chemistry of the University of Gent, Belgium. He is founder of the Polymer Chemistry & Biomaterials Research Group of the University Gent, co-author of more than 440 peer reviewed international papers, promoter of more than 50 Ph-D works; co-founder and former president of the Belgian Polymer Group (BPG); honorary member of the BPG council and currently coördinator of the BPG ThinkTank group: co-founder and former president of IBITECH, the Institute for Biomedical Technology University Gent; honorary member of the Romanian Society for Biomaterials. He has been involved in a large number of European and national and regional research projects. Prof. Schacht was for 12 years

member of the Council of the European Society for Biomaterials, where he was responsible for the European Doctoral Award programme. He is/was member of the editorial board of several international research journals and served as external expert for several European organizations. He was external coordinator of the 2011 assessment of the research at the Department of Engineering of the Free University Brussel. At present Prof. Schacht is chairman of a committee of the FRS-F.N.R.S of the French community in Belgium.

Jan Verhoeven was between 1980 and 2001 full professor in Organic Chemistry at the University of Amsterdam (UvA). He also studied Chemistry at the University of Amsterdam, where in graduated cum laude in 1965. He received his PhD at the same university in 1969 with a dissertation on Intramolecular Electron Donor-Acceptor Interactions in NAralkyl-pyridinium Ions. After a short post doctoral internship at the ETH Zürich he became a member of the academic staff of the research group Physical Organic Chemistry (UvA).In 1982 he became a member of the Royal Dutch Academy of Sciences. His research interest concerns processes and the role of light, in particular the study of photo-induced electron-transfer and the design and application of luminescent molecules and materials. From 1992 until 1996 he was president of the European Photochemistry Association (EPA) and in 1998 and 2000 respectively vice-president and president of the Gordon Research Conference on Electron-Donor-Acceptor Interactions. From 1987 until 2002 he was guest professor at the Catholic University Leuven in Belgium. In 1997 and in 2000 he was chosen by the UvA chemistry students as the best teacher of the year. In 2006 Verhoeven was member of the assessment committee for the assessment of the Dutch Chemistry degree programmes and in 2009 he participated in the committee that assessed the Biology and Molecular Science and Technology programmes of the University Leiden.

Appendix 2: Domain-specific framework of reference

De regiecommissie van de VSNU Kamer Scheikunde heeft in overleg met het afnemend veld onderstaand referentiekader voor de bachelor- en masteropleidingen Scheikunde, Scheikundige Technologie, Moleculaire Levenswetenschappen, Natuurwetenschappen en (Bio)-Farmaceutische Wetenschappen opgesteld. De opleidingen worden gezamenlijk aangeduid als '*chemie en verwante moleculaire opleidingen*".

Deze bijlage bevat het referentiekader voor de bacheloropleidingen.

Karakterisering van universitaire bacheloropleidingen binnen het domein *chemie en verwante moleculaire opleidingen* in Nederland

In de Nederlandse structuur is een bacheloropleiding in de eerste plaats gericht op doorstroming naar een masteropleiding, waarbij sprake moet zijn van verbreding van de keuzemogelijkheden. Zo hebben studenten de mogelijkheid om na hun bacheloropleiding bij een andere universiteit een (Engelstalige) masteropleiding te volgen. De bacheloropleiding zal dus breed en oriënterend moeten zijn met de mogelijkheid tot differentiatie, zonder dat dit de mogelijkheden van keuze voor een masteropleiding binnen de *chemie en verwante moleculaire opleidingen* te veel beperkt. Daarnaast is uitstroom na de bacheloropleiding mogelijk, zodat de opleiding tevens een afgerond karakter dient te hebben. De bacheloropleiding dient tevens gericht te zijn op de ontwikkeling van algemene academische vaardigheden en een academische attitude, zodat afgestudeerde bachelorstudenten kunnen doorstromen naar functies in de maatschappij waarvoor dit soort vaardigheden worden gevraagd[1].

De aanwezigheid van hooggekwalificeerde docenten met een universitaire achtergrond is van groot belang voor de aard en het niveau van het wetenschappelijk onderwijs in de bacheloropleiding. Docenten zijn gepromoveerd, hebben ervaring met en zijn betrokken bij het wetenschappelijk onderzoek. Daarnaast is een academische ambiance wat betreft infrastructuur en onderzoeksomgeving vereist.

Tegen deze achtergrond zijn onderstaande eindkwalificaties voor een Nederlandse universitaire bacheloropleiding *chemie en verwante moleculaire opleidingen* geformuleerd. Het diploma dat wordt behaald is een Bachelor of Science (BSc) in scheikunde, chemische technologie, moleculaire levenswetenschappen, natuurwetenschappen, of (Bio)-farmaceutische wetenschappen.

Eindkwalificaties van de universitaire bacheloropleiding Scheikunde/Scheikundige Technologie

Vakverbonden kennis en vaardigheden

De Bachelor of Science in Chemistry/Chemical Engineering:

- heeft voldoende inzicht in de diverse specialisaties van de Scheikunde/Scheikundige Technologie die voortbouwen op de bachelorfase om een verantwoorde keuze te maken voor een vervolgopleiding;

[1] Bij het arbeidsmarktperspectief voor de BSc in *chemie en verwante moleculaire opleidingen* dient rekening te worden gehouden met de typisch Nederlandse situatie dat grote werkgevers voor posities, waarvoor bachelors (BSc) in aanmerking zouden kunnen komen, de voorkeur geven aan bachelors of applied science (BASc ('hbo'ers')). Deze laatsten zijn doorgaans meer opgeleid in de praktische vaardigheden, en als beroepsopleiding meer toegespitst op het werken in de chemische industrie. De meeste andere Europese landen (met uitzondering van Duitsland en Engeland) hebben geen opleidingen vergelijkbaar met de Nederlandse bachelor of applied science.

- heeft een gedegen theoretische en praktische basiskennis van de Scheikunde[2] /Scheikundige Technologie[3] en de hulpvakken Natuurkunde, Wiskunde, Informatica, Biologie/ (Bio)technologie die toereikend is om met succes een masteropleiding op het terrein van de Scheikunde/Scheikundige Technologie te volgen;
- heeft kennisgemaakt met wetenschappelijke onderzoeksvaardigheden en ontwerpmethoden op het gebied van de Scheikunde respectievelijk de Scheikundige Technologie en heeft daarvan een proeve van bekwaamheid afgelegd;
- is zich bewust van de mogelijkheden op de arbeidsmarkt na eventuele afsluiting van de studie met een bachelordiploma;
- heeft kennis van de veiligheids- en milieu-aspecten van de scheikunde;
- is zich bewust van de rol van de scheikunde in de maatschappij en van het internationale karakter van de scheikunde.

Algemene vaardigheden

De Bachelor of Science in Chemistry/Chemical Engineering beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in projectgroepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Eindkwalificaties van de universitaire bacheloropleiding Moleculaire Levenswetenschappen Wageningen

Vakverbonden kennis en vaardigheden

De Bachelor of Science in Moleculaire Levenswetenschappen Wageningen:

- heeft voldoende inzicht in de diverse specialisaties van de moleculaire levenswetenschappen die voortbouwen op de bachelorfase om een verantwoorde keuze te maken voor een vervolgopleiding;
- heeft een gedegen theoretische en praktische basiskennis van de moleculaire levenswetenschappen[4] en de hulpvakken Natuurkunde, Wiskunde, Informatica, Biologie/ (Bio)technologie die toereikend is om met succes een masteropleiding op het terrein van de moleculaire levenswetenschappen te volgen;
- heeft kennisgemaakt met wetenschappelijke onderzoeksvaardigheden en ontwerpmethoden op het gebied van de moleculaire levenswetenschappen en heeft daarvan een proeve van bekwaamheid afgelegd;
- is zich bewust van de mogelijkheden op de arbeidsmarkt na eventuele afsluiting van de studie met een bachelordiploma;
- heeft kennis van de veiligheids- en milieu-aspecten van de scheikunde en genetische modificaties;
- is zich bewust van de rol van de scheikunde en (bio)technologie in de maatschappij en van het internationale karakter ervan.

[2] Te weten analytische chemie, anorganische chemie, biochemie, fysische chemie, organische chemie.

[3] Te weten analytische chemie, anorganische chemie, biochemie, fysische chemie, organische chemie, fysische transportverschijnselen, procesontwerp, chemische reactorkunde, scheidingsmethoden, procestechnologie, systeem- en regeltechniek, materiaalkunde.

[4] Te weten analytische chemie, anorganische chemie, biochemie, fysische chemie, organische chemie, microbiologie, biochemie, moleculaire biologie

Algemene vaardigheden

De Bachelor of Science in Moleculaire Levenswetenschappen Wageningen beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in projectgroepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Eindkwalificaties van de universitaire bacheloropleiding Moleculaire Levenswetenschappen Nijmegen

Vakverbonden kennis en vaardigheden

De bachelor of Science in Moleculaire Levenswetenschappen Nijmegen:

- Is in staat, op basis van zijn kennis van de chemie, biologie, medische wetenschappen en bijbehorende hulpwetenschappen, om een onderzoek naar de moleculaire achtergronden van biomedische processen kritisch te analyseren, waarbij hij gebruik weet te maken van de onderlinge verbanden tussen genoemde disciplines.
- Is in staat, gebaseerd op zijn kennis en inzicht in de moleculaire structuur en reactiviteit van zowel de levende als de niet-levende materie, om theoretische en praktische analyses te verrichten aan moleculaire reacties en interacties.
- Is in staat, gebaseerd op zijn kennis en inzicht in de genetische grondslag van levende processen, om de relatie aan te geven tussen genetische informatie en biomedische processen, en daarmee een verklaring te geven voor de rol van individuele moleculen bij ziekteprocessen.
- Is in staat een verscheidenheid aan relevante, basale technieken te hanteren en heeft het vermogen zich nieuwe technische vaardigheden eigen te maken.
- Is in staat, gebaseerd op zijn theoretische en praktische vaardigheden, om een experiment op het gebied van de moleculaire levenswetenschappen probleemgericht op te zetten aan de hand van een door hemzelf gestelde hypothese, daarvan de resultaten systematisch te bewerken en kritisch te interpreteren, en vervolgens conclusies uit dit onderzoek te trekken.
- Is in staat de resultaten van zijn onderzoek op een heldere manier schriftelijk te verwoorden, gebaseerd op de opbouw van een wetenschappelijk artikel.
- Is na een oriëntatie op de mogelijke afstudeervarianten en afweging van maatschappelijke perspectieven in staat om een gefundeerde keuze te maken voor een masteropleiding. Is daarbinnen in staat om zich in een periode van een jaar theoretisch en experimenteel te specialiseren in een vakgebied dat zich bezig houdt met onderzoek aan de moleculaire basis van biologische en biomedische processen.

Algemene vaardigheden

De Bachelor of Science in Moleculaire Levenswetenschappen Nijmegen beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in projectgroepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Eindkwalificaties van de universitaire bacheloropleiding Natuurwetenschappen

Vakverbonden kennis en vaardigheden

De Bachelor of Science in Natuurwetenschappen:

- heeft een algemeen inzicht verworven in de kernbegrippen en kenmerkende werkwijzen van de constituerende disciplines
- heeft zich daartoe de belangrijkste algemene biologisch-chemische, fysisch-chemische en biologisch-fysische denk- en werkwijzen hebben eigen gemaakt, nodig om multidisiplinaire natuurwetenschappelijke problemen te begrijpen in hun maatschappelijke en wetenschappelijke context

- kan concrete wetenschappelijke problemen binnen de natuurwetenschappen analyseren door middel van abstractie en op basis van natuurwetenschappelijke theoriën en modellen
- kan daartoe zelfstandig kennisbronnen in het relevante wetenschapsgebied opsporen, raadplegen en bewerken
- kan bestaand onderzoek naar vraagstukken van natuurwetenschappelijke aard begrijpen vanuit een basiskennis van de betreffende disciplines
- kan natuurwetenschappelijke vraagstellingen omzetten in een toetsbare hypothese volgens de criteria van empirisch onderzoek
- kan onder begeleiding deze hypotheses toetsen in de vorm van experimenten en daaraan gerelateerd theoretisch onderzoek
- is in staat zijn de maatschappelijke discussie over vraagstukken en problemen op multidisciplinair natuurwetenschappelijk gebied kritisch te volgen
- is in staat zijn een gemotiveerde keuze te maken voor ofwel het vervolg van de studie op masterniveau ofwel voor uitstroom naar een andere opleiding dan wel een functie in de samenleving

Algemene vaardigheden

De Bachelor of Science in Natuurwetenschappen beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in projectgroepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Eindkwalificaties van de universitaire bacheloropleiding Farmaceutische Wetenschappen

Vakverbonden kennis en vaardigheden

De Bachelor of Science in Farmaceutische wetenschappen:

- heeft voldoende inzicht in de diverse specialisaties van de farmaceutische wetenschappen die voortbouwen op de bachelorfase om een verantwoorde keuze te maken voor een vervolgopleiding;
- heeft een gedegen theoretische en praktische basiskennis van de scheikunde (te weten analytische chemie, biochemie, organische chemie, theoretische chemie) en de farmaceutische wetenschappen, alsmede de hulpvakken natuurkunde, wiskunde, informatica, biologie en medische fysiologie die toereikend is om met succes een masteropleiding op het terrein van de farmaceutische wetenschappen te volgen;
- heeft kennis gemaakt met wetenschappelijke onderzoeksvaardigheden op het gebied van de farmaceutische wetenschappen en heeft daarvan een proeve van bekwaamheid afgelegd;
- is zich bewust van de mogelijkheden op de arbeidsmarkt na eventuele afsluiting van de studie met een bachelordiploma;
- heeft kennis van de veiligheids- en milieu-aspecten van de farmaceutische wetenschappen;
- is zich bewust van de rol van de farmaceutische wetenschappen in de maatschappij en van het internationale karakter van de farmaceutische wetenschappen.

Algemene vaardigheden

De Bachelor of Science in Farmaceutische wetenschappen beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in groepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Eindkwalificaties van de universitaire bacheloropleiding Bio-Farmaceutische Wetenschappen

Vakverbonden kennis en vaardigheden

De Bachelor of Science in Bio-Farmaceutische Wetenschappen:

- heeft voldoende inzicht in de diverse specialisaties van de (bio-)farmaceutische wetenschappen en aanpalende opleidingen op het gebied van de chemie en de moleculaire levenswetenschappen die voortbouwen op de bachelorfase om een verantwoorde keuze te maken voor een vervolgopleiding;
- heeft een gedegen theoretische en praktische basiskennis van de scheikunde (organische en analytische chemie, biochemie, moleculaire biologie) en de bio-farmaceutische wetenschappen (ontwikkeling en effecten van geneesmiddelen, actuele concepten en werkwijzen van het geneesmiddelenonderzoek), alsmede hulpvakken (wiskunde, informatica, fysiologie, pathologie, anatomie, immunologie), die toereikend is om met succes een masteropleiding op het terrein van de bio-farmaceutische wetenschappen of een verwant vakgebied te volgen;
- heeft overzicht gekregen van het vakgebied van het geneesmiddelenonderzoek en inzicht verkregen in de positie van verschillende deelgebieden binnen dit vakgebied en hun relatie tot aanpalende wetenschapsgebieden
- heeft inzicht verkregen in de wijze waarop bij geneesmiddelenonderzoek gangbare hypothesen via experimenten kunnen worden getoetst en hoe verworven kennis kan leiden tot theorievorming
- heeft kennis gemaakt met wetenschappelijke onderzoeksvaardigheden op het gebied van geneesmiddelenonderzoek en heeft daarvan een proeve van bekwaamheid afgelegd;
- is zich bewust van de mogelijkheden op de arbeidsmarkt na eventuele afsluiting van de studie met een bachelordiploma;
- heeft kennis van de veiligheids- en milieu-aspecten van de bio-farmaceutische wetenschappen;
- is zich bewust van de rol van de geneesmiddelenonderzoek in de maatschappij en van het internationale karakter van de (bio-)farmaceutische wetenschappen.

Algemene vaardigheden

De Bachelor of Science in Bio-Farmaceutische Wetenschappen beheerst de algemene vaardigheden op het gebied van het presenteren en rapporteren, informatie zoeken en verwerken, computergebruik, projectmatig werken en het werken in groepen. Voor een gedetailleerde beschrijving van cognitieve en communicatieve competenties wordt verwezen naar het opleidingsspecifieke deel.

Globale curriculumstructuur van een universitaire bacheloropleiding *chemie en verwante moleculaire opleidingen* in Nederland

De bacheloropleiding bestaat uit een basisprogramma van minimaal twee studiejaren. Het derde studiejaar van de bacheloropleiding omvat een substantieel deel aan chemie of verwante moleculaire vakken binnen het domein. Daarnaast kan maximaal een derde door de studenten worden ingevuld als keuzeruimte. Het is wenselijk om in het derde studiejaar ruimte in het programma te hebben voor oriëntatie op de praktijk. In het derde jaar wordt een individuele proeve van bekwaamheid afgelegd. Dat kan een onderzoeksscriptie zijn, een ontwerp of een stage.

Appendix 3: Intended learning outcomes

Bachelor programme Chemical Engineering

The learning outcomes of the bachelor programme contain the categories of domain-specific and general learning outcomes.

Domain-specific competencies are divided into three main groups:

- Chemistry: this includes the basic principles of analytical chemistry, inorganic chemistry, organic chemistry, polymer chemistry, thermodynamics, chemical bonding, catalysis, biochemistry, spectroscopy, physical chemistry, and reactor kinetics.
- Process engineering: this includes the basic principles of physical transport phenomena, applied thermodynamics, unit operations, chemical reactor engineering, process control and process design.
- Materials science: this includes the basic principles of organic, macromolecular, and inorganic synthesis, polymer technology, phase theory, interface chemistry, and materials science of metals, polymers and ceramics.

In brief, the domain-specific learning outcomes concern the command of the basic principles of mathematics, physics, computer science, process engineering, chemistry and materials science.

The general learning outcomes are divided into six categories:
a. Knowledge activation and knowledge acquisition abilities
b. Academic competencies
c. Contextual skills
d. Interactive skills
e. Design and research skills
f. Learning abilities with respect to the master's degree program

a. Knowledge activation and acquisition abilities
Students demonstrate the ability to:
i. re-activate relevant parts of previously acquired knowledge;
ii. build on and apply knowledge or developments within the professional field;
iii. quickly acquire new knowledge from disciplines closely related to one's own discipline;
iv. combine domain-specific knowledge and skills.

b. Academic competencies
Students demonstrate the ability to:
i. analyze and solve simple problems in the domains of Process Engineering, Chemistry and Materials Science;
ii. apply logical reasoning to subjects both from the own discipline and other disciplines;
iii. independently develop and apply knowledge;
iv. critically reflect upon own thoughts, decisions and actions.

c. Contextual skills
Students demonstrate the ability to:
i. reflect on the relation between technology and society, through knowledge of the history of technology, philosophy of science, design methodology, and technology and ethics;
ii. have insight into socio-economic preconditions of one's own conduct and to analyze and discuss this subject;

iii. have insight into the safety preconditions of one's own conduct and be able to analyze and discuss this subject;
iv. have insight into the preconditions of environmental engineering of one's own conduct and be able to analyze and discuss this subject.

d. Interactive skills
Students demonstrate the ability to:
i. independently operate over a long period of time in a (multidisciplinary) team, by using personal qualities, without predetermined guidelines and deadlines;
ii. to explain one's ideas and opinions univocally by clear usage, appropriate body language and correct stylistic language; both verbal and written language is used correctly, with the appropriate register for the target group (presentations, reports, discussions).

e. Design and research skills.
Students demonstrate the ability to:
i. apply the acquired knowledge and skills in a design task or a research problem;
ii. have insight into the design or research process by being able to take and substantiate decisions;
iii. creatively approach and deal with a research or design problem.

f. Learning abilities with respect to the master's degree program.
Students have:
i. the professional study and work attitude necessary to successfully follow a master's degree programme that is related to the bachelor's degree program;
ii. mastered the relevant study skills to successfully follow a master's degree programme that is related to the bachelor's degree programme (time management, setting goals, studying books, the ability to concentrate and motivate).

Master's programme Chemical Engineering

At the end of the programme the graduate demonstates:

a. the command of specialist expertise in the field of molecular engineering, process engineering, or polymers and composites;
b. the ability to reactivate previously acquired knowledge, acquire and expand knowledge in disciplines closely related to one's own discipline, and integrate disciplinary knowledge in a multidisciplinary problem;
c. the possession of academic competences by showing the ability to think analytically and logically, to independently generate and apply knowledge, to reflect on one's own action and on the relationship between technology and society;
d. the ability to combine elements of specialist expertise and knowledge for the purpose of analyzing complex problems in the field of chemical engineering;
e. the ability and will to consider societal, socio-economic, safety and environmental preconditions of one's own conduct;
f. demonstrates the command of interactive skills as the ability to work in a multidisciplinary and or multicultural team of experts, to present results both orally and in written form; and show leadership skills;
g. the ability to work with the basic operational skills regarding research, development and design.

Appendix 4: Overview of the curricula

Bachelor programma Chemical Engineering

<table>
<tr><td rowspan="4">Year 1</td><td>Q1</td><td>DBL Sustainable Energy</td><td colspan="2">Lab Basic Chemistry</td><td>Start-up project Math. and Chem. calculations</td><td>Overview Process Industry</td><td>Chemical Bond & Spectroscopy A</td></tr>
<tr><td>Q2</td><td></td><td></td><td>Thermodynamics & Phase equilibrium. A</td><td>Materials Science A</td><td>Calculus A</td><td>Physics A</td></tr>
<tr><td>Q3</td><td>Lab Materials Science</td><td>Acad. Comp.</td><td>Thermodynamics & Phase equilibrium. B</td><td>Organic Chemistry A</td><td>Linear Algebra</td><td>Physics B</td></tr>
<tr><td>Q4</td><td></td><td colspan="2">DBL Nanotechnology</td><td>Organic Chemistry B</td><td>Calculus B</td><td>Physical Trans. phenomena A</td></tr>
<tr><td rowspan="4">Year 2</td><td>Q1</td><td colspan="2">Lab Organic Chemistry</td><td rowspan="2">Ethics & Safety + Academic Comp</td><td>Chemical Bond & Spectroscopy B</td><td>Biochemistry</td><td>Reaction Kinetics & Catalysis</td></tr>
<tr><td>Q2</td><td colspan="2">Lab Inorganic Chemistry</td><td>Inorganic Chemistry</td><td>Polymer Chemistry</td><td>Physical Trans. phenomena B</td></tr>
<tr><td>Q3</td><td colspan="2">DBL Sustainable Molecular Eng.</td><td>DBL Health & life Science</td><td>Interface Chemistry</td><td>Materials Science B</td><td>Chemical Reactors A</td></tr>
<tr><td>Q4</td><td colspan="2">Lab Process Technology</td><td>Separation Technology</td><td>Materials Science C</td><td>Chemical Reactors B</td></tr>
<tr><td rowspan="4">Year 3</td><td>Q1</td><td colspan="6">Minor</td></tr>
<tr><td>Q2</td><td colspan="6"></td></tr>
<tr><td>Q3</td><td colspan="2"></td><td colspan="2">DBL Advanced Materials</td><td>Process Design</td><td>Multiphase Systems</td><td>Physical Chemistry</td></tr>
<tr><td>Q4</td><td colspan="3">Major Project</td><td>DBL Product Design & Process Management</td><td>Process Control</td><td>Mol. Sim. in Chem. Eng.</td></tr>
</table>

Courses in the bachelor's programme:

	EC
DBL Nanotechnology	4
DBL Sustainable Molecular Engineering	4
DBL Health & Life Sciences	4
DBL Sustainable Energy	4
DBL Product Design & Process Man.	4
DBL Advanced Materials	4
Lab Basic Chemistry	4
Lab Organic Chemistry	4
Lab Inorganic Chemistry	4
Lab Materials Sciences	4
Lab Process Technology	4
1 Calculus A	3
2 Overview of the Process industry	3
3 Chemical Bonding & Spectroscopy A	3
4 Thermodynamics & Phase equilibria A	3
5 Materials Science and Engineering A (Panoramic)	3
6 Physics A (Mechanics)	3
7 Linear Algebra	3
8 Thermodynamics & Phase equilibria B	3
9 Organic Chemistry A	3
10 Calculus B	3
11 Organic Chemistry B	3
12 Physical Transport Phenomena A	3
13 Biochemistry	3
14 Chemical Bonding & Spectroscopy B	3
15 Inorganic Chemistry	3
16 Reaction kinetics and Catalysis	3
17 Polymer chemistry	3
18 Physical Transport Phenomena B	3
19 Chemical Reactor Engineering A	3
20 Physics B (Optics/Electromagnetism)	3
21 Separation technology	3
22 Materials Science & Engineering B (processing)	3
23 Interface chemistry	3
24 Materials Science & Engineering C (Properties)	3
25 Chemical reactor engineering B	3
26 Reaction and separation in two-phase systems	3
27 Process design	3
28 Process control	3
29 Physical chemistry	3
30 Computational Methods in Chem. Eng.	3

Furthermore, the Major contains the project Technology and Ethics, the pre-master's projects mathematics & chemical calculations, the major project and the academic skills /portfolio.

Master's programme Chemical Engineering

1st year

	Quarter	General obligatory components	Track-specific obligatory program			
			Process Engineering	Polymers & Composites	Molecular Engineering	
					Sub-track Organic Chemistry	Sub-track Inorganic Chemistry
1st year	1st quarter	FACTS	Advanced transport phenomena	Characterization of materials A	Physical organic chemistry	Introduction to catalysis
	2nd quarter	FACTS	Integrated process design	Advanced mechanical properties Advanced functional properties Rheology A	Advanced organic chemistry	Chemistry of catalytic systems A
	3rd quarter	MDP	Multiphase reactors Thermodynamics for chemical engineers	Natural vs. synthetic materials A Thermodynamics of materials	Synthetic organic chemistry	
	4th quarter	MDP	Mass transfer operations	Manufacturing of multi-material devices		Chemistry of catalytic systems B
2nd year	Graduation project					
	Industrial internship					

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Table 1: intake numbers bachelor's programme per student category (VSNU numbers, in *italic*, departmental numbers)

Year	Size of cohort per student category					Total
	VWO	HBO prop	HBO[5]	International	Other[6]	
04/ 05	33	1	33	1	4	72
05/ 06	57	1	17	0	1	76
06/ 07	44	4	16	2	5	71
07/ 08	52	1	15	2	0	70
08/ 09	44	1	20	1	3	69
09/ 10	51	1	11	0	1	64
10/ 11	*44*	*2*	*18*	*1*	*3*	*68*
11/ 12	*42*	*2*	*24*	*7*	*2*	*78*

Table 2: Student dropouts in bachelor's programme (VSNU numbers, in italic departmental numbers)

Cohort	Student dropouts (* departmental numbers as of 1st October 2011)				
	Cohort size	after 1 year	after 2 years	after 3 years	Selectivity of 1st year
	absolute	percentage (cumulative), is not displayed if total smaller than 4			
02/ 03	25	16	16	20	80
03/ 04	50	18	30	32	56
04/ 05	33	12	18	18	67
05/ 06	57	19	25	30	65
06/ 07	44	25	30	32	79
07/ 08	52	23	31	33	71
08/ 09	44	14	27	*29	
09/ 10	51	39	*43		
10/11	*44	*20			

[5] Before gaining admission to the master's program, *HBO* bachelor's graduates must complete a transition programme on bachelor's level.
[6] Students transferring from other university bachelor's programs.

Table 3: Propaedeutic yield of VWO intake on 1st September (departmental numbers as of 1st October 2011)

Cohort	Cohort size	In 1 year		In 2 years		After 2 years	
	absolute	percentage	absolute	percentage	absolute	percentage	absolute
2005	57	18	10	54	31	67	38
2006	44	20	9	61	27	70	31
2007	52	19	10	46	24	59	31
2008	44	20	9	43	19	57	25
2009	51	33	17	47	24	55	28

Table 4: Bachelor's graduates per study duration (VSNU numbers, in *italic* departmental numbers).

Cohort	Size	% of	% students completing their Bachelor (* departmental numbers as of 1st October)				
	Re-enrol.	total cohort	after 3 years	after 4 years	after 5 years	after 6 years	> 6 year
04/ 05	29	88	10	45	76	83	
05/ 06	46	81	17	41	54	*71*	
06/ 07	33	75	6	27	**55*		
07/ 08	40	77	8	**13*			
08/ 09	38	86	**3*				

Table 5: Cohort size and origin of Master's intake (departmental numbers)

Cohort size[7] and origin of Master's intake						
M Chemical engineering (60437)			Full time and part time			
Year	**TU/e**	**Other universities NL**	**HBO**	**Dual[8]**	**International**	**Total**
03/ 04	0	0	0	8	11	19
04/ 05	13	0	0	0	9	22
05/ 06	16	2	19	0	7	44
06/ 07	40	0	7	5	13	65
07/ 08	36	1	20	0	6	63
08/ 09	25	2	10	19	5	61
09/ 10	22	0	13	0	21	56
10/ 11	24	2	13	1	22	62

[7] Cohort size: enrolment during the academic year from 1st September until 31st August

[8] Engineers from industry holding a bachelor's degree who combine their professional career with studying in the Master's Degree Program

Table 5: Length of stay at TU/e for different student's origins in the master's programme (departmental numbers)

M3.3	Length of stay at TU/e corresponding to different students' origins							
M Chemical engineering								
(full time)								
	TU/e		**Other universities NL**		**HBO**		**International**	
	Number of graduates	**Length of stay**	**Number of graduates**	**Length of stay**	**Number of graduates**	**Length of stay**	**Number of graduates**	**Length of stay**
Graduation year	absolute	Average[9]	absolute	average	absolute	average	absolute	average
04/ 05	0		0		0		3	26,3
05/ 06	9	66,8	0		0		10	30,4
06/ 07	5	69,0	1	35,3	17	31,1	8	28,1
07/ 08	10	74,1	0		11	34,4	11	26,6
08/ 09	23	78,5	1	37,8	8	39,7	4	25,1
09/ 10	28	75,9	0		17	41,2	4	26,9

Table 6: Study duration for different student categories in the master's programme (departmental numbers)

M3.1	Study duration							
M Chemical Engineering								
(full time)								
	Own university		**Other universities NL**		**HBO**		**International**	
	Number of graduates	**Study duration**	**Graduates**	**Study duration**	**Graduates**	**Study[10] duration**	**Graduates**	**Study duration**
year	absolute	average[11]	absolute	average	absolute	average	absolute	average
04/ 05	0		0		0		0	
05/ 06	9	16,8	0		0		2	30,0
06/ 07	5	26,4	1	20,2	17	-	4	40,9
07/ 08	10	29,9	0		11	-	1	53,9
08/ 09	23	28,6	1	17,9	8	-	6	27,6
09/ 10	28	33,1	0		17	-	10	25,6

Teacher-student ratio achieved

[9] In months

[10] Due to different administrative regulations throughout the years, it is not possible to have a consistent definition of study duration in the Master's for HBO intake. The length of stay at TU/e gives a better picture instead.

[11] In months

Table 7: Student/staff ratio for both bachelor's and master's programs

	Enrolment graduates			Enrolment undergraduates			Staff	Student/ staff ratio
	Total	men	women	total	Men	women	fte	
04/ 05	40	28	12	176	151	25	16	14
05/ 06	80	64	16	236	204	32	18.4	18
06/ 07	124	97	27	264	231	33	19.1	21
07/ 08	151	123	28	291	250	41	19.5	23
08/ 09	183	146	37	257	226	31	18.4	24
09/ 10	194	157	37	268	237	31	16.9	28
10/ 11	199	163	36	259	222	37	18.5	25

Average amount of face-to-face instruction per stage of the study programme

Table 8: Distribution of study load over the different educational working formats in the bachelor's programme

	Year	Lectures	Instructions & independent Learning under supervision	Assignments and project work	Laboratory courses	Design-based learning projects	Individual study	Exams	Total
Major	1	366	218	20	160	160	693 (200 hrs for preparation for exams)	63	**1680**
	2	364	156	16	240	160	707 (164 hrs for preparation for exams)	37	**1680**
	3	140	60	196	0	160	269 (65 hrs for preparation for exams)	15	**840**
Minor	3	196	72	196	40		315 (125 hrs for preparation for exams)	21	**840**

Table 9: study load distribution (in ECTS) in the first master year

	Process Engineering		Molecular Engineering		Polymers & Composites	
	Compulsory	Elective	Compulsory	(Semi)Elective	Compulsory	Elective
1st quarter	7	8	3	12	6	9
2nd quarter	8	7	3	12	12	3
3rd quarter	12	3	0-3	12-15	10	5
4th quarter	8	7	0-3	12-15	7	8

Appendix 6: Programme of the site visit

bezoekprogramma ba/ma			Panelsamenstelling
08.30	09.30	Management	Jaap Schouten (decaan) , Bert de With (vice decaan) , Peter Janssens (Opl. Dir.) ,Ouafae el Fahmi (beleidsmedewerker)
09.30	10.30	Studenten (Bachelor en Master)	Alexandra Wijpkema (B 1e), Lotte van Beek (B 2e), Eveline Hermans (B 3), Stephanie Bex (M), Martijn van Zanten (M), Wilma Hofman (M HBO), Charley Schaefer (M), Luuk Seelen (M), Evelien Baeten (M int, België), Geert Pirotte (int, belgië),
10.30	11.15	Docenten Bachelor en Master	Hans Kuipers, Maaike Kroon, Han Goossens, Nico Sommerdijk (Excellence coach), Martijn Wienk (OGO), Anja Palmans, Bert Meijer
11.15	11.30	Pause	
11.30	12.00	Opleidingscommissie en Docenten studentengeleding,	Studenten: Nicky Oppers, Olaf Vorselen, Yoran Zonneveld, Roderigh Roling, Patricia Tijssen, Jordi Lugger. Docentengeleding: Martin van Sint Annaland (vz), Albert Schenning, Mart de Croon, Hans Heuts
12.00	12.45	Lunch	
12.45	13.30	Examencommissie en studieadviseurs	Examencommissie: Xander Nijhuis, Tonek Jansen, Jos Laven, Ouafae el Fahmi (vz), Ton Jansen (ambtelijk secretaris), Kim Pauwels (studieadviseur Ma), Hans Deuss (studieadviseur Ba)
13.30	14.00	Alumni	Tim van Acker (Shell), Robin de Bruijn (eigen bedrijf), Anke Hermans (Bodec ingenieursbureau), Kevin van Eeten (promovendus), Frank Halters (Fuji)
14.00	14.30	Voorbereiding eindgesprek	Alleen commissie
14.30	15.30	Eindgesprek met management	Jaap Schouten (decaan) , Bert de With (vice decaan) , Peter Janssens (Opl. Dir.) ,Ouafae el Fahmi (beleidsmedewerker)
15.30	17.30	Opstellen bevindingen	Alleen commissie
17.30	17.45	Mondelinge voorlopige rapportage	Allen

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bachelortheses
0593378
0633099
0616500
0608197
0572955
0631712
0634979
0649194
0655466
0566393
0596090
0649071
0632971
0636358
0635194

Mastertheses
0728268
0588769
0589511
0728488
0501586
0728877
0728976
0589255
0593026
0585935
0729576
0730266
0730307
0730363
0727571

During the site visit, the committee studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment)

- Course manuals bachelor's and master's programme
- Standard / basic books
- Tests , assessment criteria, assessment forms and answers
- Minutes of the Board of Examiners 2009- 2011
- Minutes of het Programme committee 2009 – 2011
- Assessment report on bachelor's and master's programme chemical engineering, QANU, 2007
- Assessment report on chemical engineering research, QANU, 2010

Appendix 8: Declarations of independence

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Etienne SCHACHT

ADRES: Rysseveldstraat, 99
B-8840 STADEN, België

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

ZIE BIJLAGE

AANGEVRAAGD DOOR DE INSTELLING:

ZIE BIJLAGE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands-vlaamse accreditatieorganisatie

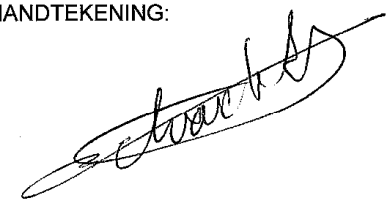
VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam DATUM: 22/03/2012

HANDTEKENING:



nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Maja Medić

PRIVÉ ADRES: Rijnsburgerweg 124 G31
2333 AG Leiden

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam DATUM: 22-03-2012

HANDTEKENING: maja medić

nvao
nederlands-vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: MAES BERT

PRIVÉ ADRES: LAARSTRAAT 51
2610 WILRIJK
BELGIË

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands-vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

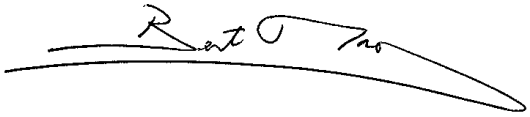
VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam

DATUM: 22/3/12

HANDTEKENING:



nvao
nederlands-vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: J. W. Verhoeven

PRIVÉ ADRES: Westerzoom 34
1541 TW, Koog aan de Zaan (NL)

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Scheikunde

AANGEVRAAGD DOOR DE INSTELLING:

RUL, TUD, TUE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

Q339

nvao
nederlands - vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Jan J Lerou

HOME ADDRESS: 4182 Shire Cove Road

Hilliard, OH 43026, USA

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / ~~SECRETARY:~~

Scheikunde OW 2012
Leiden - Delft - Eindhoven

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

1

nvao
nederlands - vlaamse accreditatieorganisatie

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Hilliard, OH DATE: 22-Mar-12

SIGNATURE: 

Q339

nvao
nederlands-vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Barbara van Balen

PRIVÉ ADRES:

Kleine Houtweg 8 2012 CH Haarlem

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Scheikunde OW 2012
Leiden - Delft - Eindhoven - UvA - Utrecht

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands-vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Rotterdam DATUM: 23-8-2012

HANDTEKENING: