

Assessment report  
Limited Framework Programme Assessment

**Master Chemical Engineering**

Eindhoven University of Technology

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## 1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Master Chemical Engineering programme of Eindhoven University of Technology. The programme was assessed according to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

The panel considers the programme objectives to be sound. The panel welcomes students being educated in-depth in either the chemical and process technology specialisation or the molecular systems and materials chemistry specialisation of the chemical engineering domain. The panel regards the bachelor-master trajectory with the broad and fundamental Bachelor Chemical Engineering and Chemistry programme and these specialisations in the Master programme to be a very valuable concept. The panel appreciates the strongly research-driven profile of the programme.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic chemical sciences programmes. The panel appreciates the efforts by the joint programmes in chemical sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this Eindhoven University of Technology programme may be clearly distinguished within the framework.

The programme meeting international domain-specific standards for chemical engineering and chemistry programmes is appreciated by the panel.

The panel is positive about the intensive relations the programme maintains with the professional field, allowing the programme to keep pace with trends in industry. At the same time, the panel recommends to formulate future trends in more clear terms to allow the programme to adjust to these trends.

The objectives have been translated well into the intended learning outcomes of the programme, meeting the programme objectives and matching the master level criteria.

The panel regards the number of incoming students in the programme to be favourable.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the contents of the curriculum, especially noting the courses to be seriously designed and to be solid in terms of contents. The panel is positive about the industry internship in the curriculum, allowing students to become acquainted with the professional field. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the role of the mentor ensuring the coherence of students' curricula. The panel appreciates the academic and professional skills being addressed and advises the programme to continue along this path.

The lecturers in the programme are experienced and well-reputed researchers and skilled teachers. They are all PhDs and are engaged in current, relevant research, referring to their research in the lectures. Their educational capabilities are up to standard. The capacities of the lecturers are appreciated by the students.

The entry requirements and admission procedures of the programme are appropriate and strict.

The educational concept and the study methods of the programme are adequate and varied, promoting research-based and student-activating learning. The panel is positive about new computer-based study methods being introduced. The students-to-staff ratio and the number of hours of face-to-face education in the programme meet the standards. The study guidance by mentors and the study advisor is up to standard. The panel considers the programme to be feasible. The student success rates are favourable.

The programme examination and assessment policies are appropriate, being in line with the university guidelines. The position and authority of the Examination Committee for the programme are adequate. The examination methods are consistent with the goals and the contents of the courses and the industrial internship. The supervision processes for the Master graduation projects are well-organised. The assessment procedures for these projects are very elaborate and well-structured, involving at least four examiners and being conducted using scoring forms with relevant criteria. The panel advises to add more extensive written comments to the scoring forms to substantiate the grades. The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The fraud and plagiarism formalities are up to standard.

The course examinations are challenging. The panel supports the grades awarded to the Master graduation projects by the programme examiners. The panel regards the projects to be well-elaborated and well-founded, comprising comprehensive literature surveys, including appropriate research questions and showing state-of-the-art approaches. The panel appreciates the sizeable proportion of students having their theses published.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the graduates to be very well prepared for both PhD positions and jobs in industry. In recent surveys, 60 % of the alumni reported to be content or very content with the programme in terms of preparation for their careers. The panel recommends to gather more information on alumni careers.

The panel that conducted the assessment of the Master Chemical Engineering programme of Eindhoven University of Technology assesses this programme to meet the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, judging the programme to be good. Therefore, the panel recommends NVAO to accredit this programme.

Rotterdam, 6 February 2019

Prof. dr. M.A. Cohen Stuart  
(panel chair)

drs. W. Vercouteren  
(panel secretary)

## 2. Assessment process

The evaluation agency Certiked VBI received the request by Eindhoven University of Technology to support the limited framework programme assessment process for the Master Chemical Engineering programme of this University. The objective of the programme assessment process was to assess whether the programme would conform to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

Management of the programmes in the assessment cluster WO Scheikunde convened to discuss the composition of the assessment panel and to draft the list of candidates.

Having conferred with management of the Master Chemical Engineering programme of Eindhoven University of Technology, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so. The panel composition was as follows:

- Prof. dr. M.A. Cohen Stuart, professor emeritus, chair of Physical Chemistry & Colloid Chemistry, Wageningen University, professor emeritus of Physical Surface Chemistry, University of Twente, professor East China University of Science and Technology, Shanghai, China (panel chair);
- Prof. dr. A.H.T. Boyen, associate professor emeritus, Faculty of Sciences and Bio-engineering Sciences, Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (panel member);
- Prof. dr. M.K. Van Bael, professor Inorganic and Physical Chemistry, head of Inorganic and Physical Chemistry Research Group, University of Hasselt (panel member);
- Prof. dr. ir. G.B. Marin, professor Chemical Reaction Engineering, head Laboratory for Chemical Technology, Ghent University (panel member);
- Drs. O. de Vreede, head Innovation and Human Capital, VNCI, Association of the Dutch Chemical Industry (panel member);
- L. Büller BSc, student Master Life Science and Technology, Delft University of Technology (student member).

On behalf of Certiked, drs. W. Vercooteren served as the process coordinator and secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed and observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO have given their approval.

To prepare the assessment process, the process coordinator convened with management of the programme to discuss the outline of the self-assessment report, the subjects to be addressed in this report and the site visit schedule. In addition, the planning of the activities in preparation of the site visit were discussed. In the course of the process preparing for the site visit, programme management and the Certiked process coordinator regularly had contact to fine-tune the process. The activities prior to the site visit have been performed as planned. Programme management approved of the site visit schedule.

Well in advance of the site visit date, programme management sent the list of final projects of graduates of the programme of the most recent years. Acting on behalf of the assessment panel, the process coordinator selected the theses of 15 graduates from the last two years. The grade distribution in the selection was ensured to conform to the grade distribution in the list, sent by programme management.

The panel chair and the panel members were sent the self-assessment report of the programme, including appendices. In the self-assessment report, the student chapter was included. In addition, the expert panel members were forwarded a number of theses of the programme graduates, these theses being part of the selection made by the process coordinator.

Several weeks before the site visit date, the assessment panel chair and the process coordinator met to discuss the self-assessment report provided by programme management, the procedures regarding the assessment process and the site visit schedule. In this meeting, the profile of panel chairs of NVAO was discussed as well. The panel chair was informed about the competencies, listed in the profile. Documents pertaining to a number of these competencies were presented to the panel chair. The meeting between the panel chair and the process coordinator served as the briefing for panel chairs, as meant in the NVAO profile of panel chairs.

Prior to the date of the site visit, all panel members sent in their preliminary findings, based on the self-assessment report and the final projects studied, and a number of questions to be put to the programme representatives on the day of the site visit. The panel secretary summarised this information, compiling a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

The panel found the self-assessment report to be somewhat less explicit in presenting the genuine profile and the essential characteristics of the programme.

Shortly before the site visit date, the complete panel met to go over the preliminary findings concerning the quality of the programme. During this preliminary meeting, the preliminary findings of the panel members, including those about the theses were discussed. The procedures to be adopted during the site visit, including the questions to be put to the programme representatives on the basis of the list compiled, were discussed as well.

On 17 September 2018, the panel conducted the site visit on the Eindhoven University of Technology campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with the Departmental Board, programme management, Examination Committee members, lecturers and final projects examiners, and students and alumni.

In a closed session near the end of the site visit, the panel considered every one of the findings, weighed the considerations and arrived at conclusions with regard to the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the considerations and conclusions to programme representatives.

Clearly separated from the process of the programme assessment, the assessment panel members and programme representatives met to conduct the development dialogue, with the objective to discuss future developments of the programme.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied it and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given two weeks to respond. Having been corrected for these factual inaccuracies, the Certiked bureau sent the report to the University Board to accompany their request for re-accreditation of this programme.

### 3. Programme administrative information

Name programme in CROHO: M Chemical Engineering  
Orientation, level programme: Academic Master  
Grade: MSc in Chemical Engineering  
Number of credits: 120 EC  
Specialisations: Chemical and Process Technology  
Molecular Systems and Materials Chemistry  
Location: Eindhoven  
Mode of study: Full-time (language of instruction English)  
Registration in CROHO: 21PG-60437

Name of institution: Eindhoven University of Technology  
Status of institution: Government-funded University  
Institution's quality assurance: Approved

## 4. Findings, considerations and assessments per standard

### 4.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

#### *Findings*

The Master Chemical Engineering programme is one of the programmes offered by the Department of Chemical Engineering and Chemistry of Eindhoven University of Technology. The Board of the Department has the responsibility for the programme quality. The programme director, assisted by the programme coordinator, takes care of the day-to-day management of the programme. The Programme Committee, consisting of an equal number of lecturers and students, advises programme management on quality issues. The Examination Committee has the authority to ensure the quality of examinations and assessments of the programme. The Programme Committee and the Examination Committee are shared by this Master programme and the Bachelor Chemical Engineering and Chemistry programme.

The programme is a two-year, research-based master programme, offering students the specialisations in either chemical and process technology or molecular systems and materials chemistry. The objectives of the chemical and process technology specialisation are to educate students in understanding, description, design and development of new chemical processes and the adaptation of existing processes. In the molecular systems and materials chemistry specialisation, students are educated in designing and making molecules and materials with specific properties, using catalysis, inorganic chemistry and organic chemistry knowledge, insights and tools.

The objectives of the programme conform to the domain-specific reference framework for the chemical sciences in the Netherlands, which has been drafted by the joint programmes of this assessment cluster in the Netherlands. In this domain-specific framework, reference has been made to international frameworks and benchmark statements. This Eindhoven University of Technology programme may be regarded to be placed in the chemistry and chemical engineering sub-domains of the chemical sciences.

The chemical and process technology specialisation has been accredited by the Institution of Chemical Engineers (IChemE), whereas the molecular systems and materials chemistry specialisation has been granted the Euromaster label by the European Chemistry Thematic Network (ECTN). These awards signify the programme meeting international standards in chemical engineering and chemistry.

The programme keeps abreast of current trends in the professional field, maintaining intensive relations with industry through part-time professors from industry and through numerous PhD-trajectories co-financed by industry. The objectives of the programme are to prepare students for the labour market, either for industry or for PhD trajectories.



The programme objectives have been translated into the intended learning outcomes of the programme. The intended learning outcomes specify, among others, knowledge and understanding of the chemical engineering domain, specifically in one of the specialisations mentioned, design and research skills in this domain, and academic and professional skills, such as critical thinking, communication skills and collaboration skills in multidisciplinary teams.

Programme management drafted a table from which the correspondence of the intended learning outcomes to the Dublin descriptors for master programmes may be inferred.

#### *Considerations*

The panel considers the programme objectives to be sound. The panel welcomes students being educated in-depth in either the chemical and process technology specialisation or the molecular systems and materials chemistry specialisation of the chemical engineering domain. The panel regards the bachelor-master trajectory with the broad and fundamental Bachelor Chemical Engineering and Chemistry programme and these specialisations in the Master programme to be a very valuable concept. The panel appreciates the strongly research-driven profile of the programme.

The objectives of the programme are within the boundaries of the domain-specific reference framework for academic Chemical Sciences programmes. The panel appreciates the efforts by the joint programmes in chemical sciences in the Netherlands to draft this framework and regards this to be a sound and up-to-date description of this domain. The profile of this Eindhoven University of Technology programme may be clearly distinguished within the framework.

The programme meeting international domain-specific standards for chemical engineering and chemistry programmes is appreciated by the panel.

The panel is positive about the intensive relations the programme maintains with the professional field, allowing the programme to keep pace with trends in industry. At the same time, the panel recommends to formulate future trends in more clear terms to allow the programme to adjust to these trends.

The objectives have been well-translated into the intended learning outcomes of the programme. They cover the programme objectives appropriately and are stated in clear terms. The intended learning outcomes conform to the master level.

#### *Assessment of this standard*

These considerations have led the assessment panel to assess standard 1, Intended learning outcomes, to be good.

## 4.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

### *Findings*

The number of incoming students in the programme has fluctuated to some extent, going from 71 students in 2012 to 87 students in 2016. The average influx was 69 students over the last five years, excluding the extraordinary year of 2014. About 70 % of the inflow come from the Bachelor Chemical Engineering and Chemistry programme of Eindhoven University of Technology or from higher vocational education institutes (hbo). About 30 % of the incoming students come from abroad. About 25 % of the students are female.

The curriculum has a study load of 120 EC and takes two years to complete. Programme management presented a table, mapping the intended learning outcomes to the curriculum components. The curriculum has been organised in line with the Graduate School structure, which applies to all master programmes of the university. The curriculum is composed of compulsory core courses (20 EC), specialisation elective courses (20 EC), free elective courses (15 EC), industrial internship (20 EC) and Master graduation project (45 EC). The cursory part of the curriculum is scheduled in the first year, whereas the internship and the graduation project are to be found in the second year. The core courses allow students to gain knowledge and understanding of one of the two specialisations mentioned. The specialisation electives serve to deepen knowledge and understanding of their preferred specialisation. These courses correspond to the research interests of the Department. In the free electives, students may specialise further or may explore other disciplines. In the Master graduation project, students conduct the individual research project in their chosen specialisation. The industrial internship gives students the chance to become acquainted with industry in the domain. Students tend to schedule the internship at the end of curriculum, to try and find employment at the internship company. Academic and professional skills, such as presentation, academic writing and collaborative working skills, are part of the courses, the internship and the graduation project. New trends, such as scientific computing and automation of chemical plants, are researched by the lecturers and are introduced in the curriculum. Students may take courses or do the internships abroad. Some 40 % of the students spend part of the curriculum abroad.

About 39 lecturers are involved in the programme. Lecturers are active researchers, doing research within one of the research groups of the Department of Chemical Engineering and Chemistry. All of the lecturers in the programme are PhDs. The proportion of lecturers being BKO-certified is about 50 %, whereas another 14 % of the lecturers are in the process of obtaining their BKO-certificate. In addition to this permanent staff, about 190 PhD students spend 10 % of their time on teaching in the programme, supervising students in projects and in guided self-study classes. Survey results show students to be very appreciative of the domain-specific and professional field knowledge, and of the teaching qualities of the lecturers. As has been indicated, part-time lecturers from industry are involved in the courses.

Students are admitted to the programme, provided they have bachelor degrees in chemical engineering or in related fields from Dutch universities. Applicants having vocational higher education bachelor degrees in any of these fields, are only admitted after having completed the 30 EC pre-master programme. Students coming from abroad have to be proficient in English and have to report appropriate university training in this field, being in line with Nuffic- and Naric-standards. The prerequisites for foreign students are rather detailed. Information about the programme is provided through a number of channels. In pre-described procedures and on the basis of documented requests, the programme Examination Committee grants exemptions.

The programme educational concept is to offer research-based, activating and small-scale education. The average number of hours of face-to-face education in the curriculum is 18 hours per week in the cursory, first year of the curriculum. In the second year, the number of contact hours is 40 hours in total. The study methods are selected in line with the educational concept and include lectures, tutorials, guided self-study and group work on practical and design-based learning projects. Guided self-study is meant for students to do exercises. In the projects, students do close-ended or open-ended assignments in small groups. The laboratory facilities are kept up-to-date. New, computer-based study methods are being introduced. At least two lecturers are involved in the courses. The panel notes the programme to invest in practical facilities. Every one of the students have access to their mentor. The mentor, being a staff member, guides students in their curriculum choices, promoting curriculum coherence and preparing students for their future careers. The Department academic advisor advises students on study-related issues and monitors study progress. The overall students-to-staff ratio is 16 : 1 (on basis of total fte's). The student success rates after two years are on average about 48 % and after three years they are on average 92 % (figures for last five cohorts). Students regard the programme to be feasible.

#### *Considerations*

The panel regards the number of incoming students in the programme to be favourable.

The curriculum matches the intended learning outcomes of the programme. The panel appreciates the contents of the curriculum, especially noting the courses to be seriously designed and to be solid in terms of contents. The panel is positive about the industry internship in the curriculum, allowing students to become acquainted with the professional field. The panel regards the curriculum to be research-based and to be up-to-date, new trends being incorporated. The curriculum is coherent, the role of the mentor ensuring the coherence of students' curricula. The panel appreciates the academic and professional skills being addressed and advises the programme to continue along this path.

The lecturers in the programme are experienced and well-reputed researchers and skilled teachers. They are all PhDs and are engaged in current, relevant research, referring to their research in the lectures. Their educational capabilities are regarded by the panel to be up to standard. The panel notes the capacities of the lecturers to be appreciated by the students.

The entry requirements and admission procedures of the programme are appropriate and strict.

The educational concept and the study methods of the programme are adequate and varied, promoting research-based and student-activating learning. The panel is positive about new computer-based study

methods being introduced. The students-to-staff ratio and the number of hours of face-to-face education in the programme meet the standards. The study guidance by mentors and the study advisor is up to standard. The panel considers the programme to be feasible. The student success rates are favourable.

*Assessment of this standard*

These considerations have led the assessment panel to assess standard 2, Teaching-learning environment, to be satisfactory.

### 4.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.

#### *Findings*

The examinations and assessments in the programme are governed by the Education and Examination Regulations for the programme, drafted by the Board of the Department of Chemical Engineering and Chemistry and by the Rules and Regulations of the Examination Committee for the programme. Both of these documents comply with Eindhoven University of Technology guidelines. As has been indicated, the Examination Committee has the authority to ensure the quality of examinations and assessments of the programme.

The examination methods selected in the programme are aligned with the course goals and meet the knowledge, understanding and skills to be assessed. The examination methods include written examinations (open-book and closed-book), written assignments and oral presentations. In case of group work, individual performances by students are assessed by means of individual written reports or oral assessments. In the industrial internships, students are assessed on the basis of the presentation, reflection report and internship report. The programme is experimenting with electronic assessments. The experiments are monitored by the Examination Committee.

The Master graduation project is an individual research project. Students conduct this project in one of the research groups of the Department of Chemical Engineering and Chemistry. In some cases, these may be conducted at partner universities abroad. Students are entitled to their individual supervisor. Day-to-day projects supervisors may be PhD students, acting under the responsibility of supervisors. The projects are assessed on the basis of, among others, theoretical insights, self-reliance, project execution and work effectiveness. Both the written report and the oral defence are assessed. The project is assessed by an assessment committee, composed of at least four members, being the graduation supervisor, the project supervisor, a member from the laboratory of the project and at least one member from another research group. For their assessments, they use a scoring form.

In the programme, measures are being taken to ensure the validity, reliability and transparency of examinations and assessments. Examinations drafted by one examiner are peer-reviewed by another examiner. Model answers for the assessments are included. In most instances, a number of examiners are involved in the assessments. The Examination Committee makes analyses of examinations in case of deviant grade distributions. Fraud or plagiarism cases in the programme are handled by the Examination Committee. Only few cases occurred the last few years.

#### *Considerations*

The panel considers the examination and assessment policies for the programme to be appropriate, these being in line with the Eindhoven University of Technology guidelines. The position and authority of the Examination Committee of the programme are up to standard, this committee being in control of the examinations and assessments of the programme.

The panel approves of the examination methods adopted in the programme, noting these are consistent with the goals and the contents of the courses as well as with the industrial internship goals.

The supervision and assessment processes for the Master graduation projects are well-organised. Students are offered appropriate supervision. The assessment procedures are very elaborate and well-structured, involving at least four examiners and being conducted using scoring forms with relevant criteria. The panel advises to add more extensive written comments to the scoring forms to substantiate the grades.

The measures taken to ensure the validity, reliability and transparency of examinations and assessments are adequate. The fraud and plagiarism formalities are up to standard.

*Assessment of this standard*

The considerations have led the assessment panel to assess standard 3, Student assessment, to be satisfactory.

#### 4.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

##### *Findings*

The panel studied the examinations of a number of courses of the programme.

The panel reviewed the Master graduation projects of fifteen graduates of the programme with different grades. In the projects, students have to demonstrate to be able to conduct an individual research project within the domain of the programme. About 20 % of the students manage to have their theses published, mostly as part of the PhD trajectory publications.

As has been indicated, graduates of the programme are prepared for PhD trajectories or for positions in industry. About 39 % of the graduates continue their studies as PhD students. The other students go on to find positions in industry after graduation. About 90 % of the graduates find appropriate positions within two months after graduation. In recent alumni surveys, about 60 % of the alumni expressed being content or very content with the programme as preparation for their careers.

##### *Considerations*

The panel regards the course examinations, which were reviewed by the panel members, to be challenging.

The panel supports the grades awarded to the Master graduation projects by the programme examiners. The panel considers these projects to be well-elaborated and well-founded, comprising comprehensive literature surveys, including appropriate research questions and showing state-of-the-art approaches. The panel appreciates the sizeable proportion of students having their theses published.

The panel is convinced that students having completed the programme reached the intended learning outcomes and regards the graduates of this programme to be very well prepared for both PhD positions and jobs in industry.

In recent surveys, 60 % of the alumni reported to be content or very content with the programme in terms of preparation for their careers. The panel recommends to gather more information on alumni careers.

##### *Assessment of this standard*

The considerations have led the assessment panel to assess standard 4, Achieved learning outcomes, to be good.

## 5. Overview of assessments

Standard	Assessment
Standard 1. Intended learning outcomes	Good
Standard 2: Teaching-learning environment	Satisfactory
Standard 3: Student assessment	Satisfactory
Standard 4: Achieved learning outcomes	Good
Programme	Good



## 6. Recommendations

In this report, a number of recommendations by the panel have been listed. For the sake of clarity, these have been brought together below.

- To formulate future trends, relevant for the programme, in more clear terms to allow the programme to adjust to these trends.
- To continue to promote in the curriculum the students' education in academic and professional skills, such as presentation, academic writing and collaborative working skills.
- To add more extensive written comments to the scoring forms of the Master graduation projects to substantiate the grades.
- To gather more information on alumni careers in order to analyse the programme as preparation for these careers.