Assessment plan bachelor's degree programme Chemistry 2022-2023

Introduction

This assessment plan is a systematic description of the type of assessment used in the various modules of the bachelor's degree programme Chemistry. This assessment plan fits within the assessment policy of the Faculty of Science and Engineering[1], and the protocol used by the Board of Examiners of the degree programme [2].

The assessment plan is based on:

- the learning outcomes of the degree programme (appendix 1);
- the Teaching and Examination regulations of the degree programme;
- the description of the various modules of the degree programme in the digital course catalogue *Ocasys*, including:
  - Objective of the module;
  - Course content;
  - Lecturers and examiners;
  - Assessment method used;
  - Lecture format.

The assessment plan contains two parts:

1. An overview of the examiners and assessment types used for all modules in the bachelor's degree programme Chemistry.

   The following types of assessments are distinguished in this scheme:
   - Written examination (WE)
   - Multiple choice (MC)
   - Interim Test (IT)
   - Oral examination (OE)
   - Assignment (AST)
   - Report (R)
   - Assessment of Practical work, including laboratory and computer work (PR)
   - Presentation (P)
   - Mandatory Attendance (Att)

2. Matrices describing the relation between the various modules of the bachelor's degree programme Chemistry and the learning outcomes of the degree programme.

[1] FSE Quality Assurance Manual 2018-2019

[2] Quality Assurance Guide for the Board of Examiners 2015

Part 1: Examiners and assessment type of course units in the degree programme (examiner in bold is first examiner)

Course unit	Examiners	Assessment type
Core programme		
First Year		
Maths for Chemistry and Engineering (**CH**)	**S.S. Faraji** / T. K. Gebretekle	WE, IT
Molecules: Structure, Reactivity and Function (**CH**)	**E. Otten**/ C. Mayer	WE, IT, PR, AST
Concepts of Chemistry and Engineering (**CE**)	**N.N.H.M. Eisink** /N.H. Katsonis	WE, PR
Organic Chemistry 1 (**CH**)	**M.D. Witte /** T. Kudernac	WE, IT
Transport phenomena (**CE**)	**F.Picchioni /** P.Raffa	WE, IT
Practical Course: Synthesis and Analysis (**CH**)	**A.J. Minnaard** / W.R. Browne	R, PR
Sustainability projects	**P. Karka** / H. Heeres	R, P, AST
Biochemistry and biotechnology (**CH**)	**J. Broos** /C. Mayer	WE
Physical Chemistry 1 (**CH**)	**K.M. Tych /** W.R. Browne	WE, IT, PR
Linear Algebra and multivariable calculus	**P. Lamprou** / P.Tibboel	WE, IT, AST
Inorganic Chemistry (**CH**)	**E. Otten** / J.E.M.N. Klein	WE
Spectroscopy (**CH**)	**W.R. Browne** / M. Tromp	WE, IT
Second Year		
Organic Chemistry 2	**S. Harutyunyan** / W.R. Browne	WE, AST
Physical Properties of Materials 1	**G. R. Blake /** B. Noheda	WE, MC, AST
Synthesis 2 Lab Course	**M.T.C. Walvoort** / W.R. Browne	R, PR
Physical Chemistry 2	**A.H. de Vries /** W.R. Browne	WE, PR
Soft Molecular Materials	**S. Otto /** N.H. Katsonis	WE
Bioenergy, Metabolism and Bioresources	**D.J. Slotboom** / M. Heinemann	WE
Quantum Chemistry	**R.W.H. Havenith** / J.E.M.N. Klein	WE, PR
Macromolecular Chemistry	**K.U. Loos** / D. Maniar	WE, P
Practical Macromolecular Chemistry	**W.R. Browne** / T. R. Canrinus	R, PR
Chemistry & Society: Ethical and Professional Aspects	**M.J. van den Nieuwenhof-Schilstra /** J. Zevenberg	WE, MC, R, P, AST
Third Year		
Bachelor Research Project	See list of examiners	R, P, PR
Specialisation Smart Materials		
Physical Properties of Materials 2	**J. Even** / B. Noheda Pinuaga	WE, P
Molecular Design	**A.H. de Vries** / S.J. Marrink	WE, PR, AST
Materials Design: Theoretical Methods	**A. Borschevsky /** R.W.A. Havenith	WE, R, AST
Trends in Polymer Science	**G. Portale** / K.U. Loos	WE
Specialisation Chemistry of life		
Recombinant DNA and Biotechnology	**M.H.K. Linskens** /D.J. Slotboom	WE, MC, PR, AST
Chemical Biology	**G. Maglia /** M.D.Witte	WE
(Bio-)Catalysis	**J.G. Roelfes** / M.W. Fraaije	WE, AST
Cellular Chemistry	**F. Bianchi** / J.L. Kamenz	WE, P
Specialisation Sustainable Chemistry and Energy		
Electrochemistry and Energy	**W.R. Browne** / M. Tromp	WE, PR
Green chemistry and photochemistry	**S.B. Beil** / R. Hage	WE, P, AST
(Bio-)Catalysis	See above	
Physical Organic and Photo- Chemistry	**J.E.M.N. Klein /** W.R.Browne	WE

Course unit	Examiners	Assessment type
Specialisation Electives		
Research Practical: Chemical Biology	**G. Maglia /** M.W. Fraaije	R, P, PR
Research Practical: Polymer Chemistry	**K.U. Loos** / D. Maniar	OE, R, PR
Research Practical: Organic & Molecular Inorganic Chemistry	**T. Kudernác** / J.G. Roelfes	R, P, PR
Research Practical: Materials Design Experiments *	**B. Noheda Pinuaga** / G.R. Blake	R, PR
Minor Electives		
Soft Molecular Materials	See above	
Bioenergy, Metabolism and Bioresources	See above	
Medicinal Chemistry I	**A.M.W.H. Thunnissen /** A. Guskov	WE, R
Structural Probes and Solid Materials	**G.R. Blake** / B. Noheda Pinuaga	WE, PR
Solar Cells	**L.J.A. Koster** / J.C. Hummelen	WE, R, P
Carbohydrates	**M.T.C. Walvoort** / M.D. Witte	WE
Electrochemical Technology	**W.R. Browne** / M. Tromp	WE, PR
Organic synthesis	**A.J. Minnaard/**M.C.Walvoort	WE, AST
Nuclear and Radiochemistry	**J. Even** / P.H. Elzinga	WE, P
Coordination Chemistry	**L. Protesescu /** E. Otten	WE
Minor Electives from other programmes		
Nuclear Energy (**PH**)	See Assessment plan PH	
Single-Phase Reactors (**CE**)	See Assessment plan CE	
Molecular Biophysics (**PH**)	See Assessment plan PH	
Introduction to Science Communication (**EC**)	See Assessment plan EC	
Oriëntatie op Onderwijs in de Bètawetenschappen (**EC**)	See Assessment plan EC	

Examiners for individual projects:
Beil, S.B.*
Bianchi, F.
Blake, G.R.
Borschevsky, A.*
Bozorg, M.*
Broos, J. (BSc)
Browne, W.R.
Canrinus, T.R.
Chiechi, R.C.
Eisink, N.N.H.M.
Even, J.
Faraji, S.S.
Feringa, B.L. (exempt)
Fraaije, M.W.
Guskov, A. (BSc)
Hage, R.*
Harutyunyan, S.
Havenith, R.W.A.
Heinemann, M.
Hofman, A.H.*
Incarnato, D.*
Kamperman, M.
Katsonis, N.H.
Klei, I. J. van der (BSc)
Klein, J.E.M.N.
Kortholt, A. (BSc)
Kudernac, T
Lerch, M*
Linskens, M.H.K. (BSc)
Loos, K.U.
Maglia, G.
Marrink, S.J.
Mayer, C.
Maniar, D.
Milias Argeitis, A.* (BSc)
Minnaard, A.J.
Noheda Pinuaga, B.
Otten, E.
Otto, S.
Paulino, C. Batista* (BSc)
Poolman, B.
Portale, G.
Protesescu, L.*
Reintjens, N.R.M.*
Rijn, P. van
Roelfes, J.G.
Roos, W.H.
Slotboom, D.J.
Szymanski, W.C.
Thunnissen, A.M.W.H.
Tromp, M.
Tych, K.M.
Vries, A.H. de
Walvoort, M.T.C.
Witte, M.D.

* Examiners without UTQ, should be accompanied by a certified examiner

An examiner from the Chemical Engineering Bachelor can act as a second supervisor for a Chemistry Bachelor Research Project.

Part 2: Relation between the learning outcomes and the curriculum

(for learning outcomes see Appendix 1)

Core Programme																														
Learning outcomes	**A1**	**A 2**	**A 3**	**A 4**	**A5**	**A 6**	**B1**	**B 2**	**B 3**	**B 4**	**B5**	**B 6**	**B7**	**1.1**	**1. 2**	**1. 3**	**1. 4**	**1. 5**	**2. 1**	**2. 2**	**2. 3**	**2. 4**	**2. 5**	**2. 6**	**2. 7**	**2. 8**	**2. 9**	**2. 10**	**2. 11**	**2. 12**
Maths for Chemistry and Engineering	+	+		+	+								+				+			+										
Molecules: Structure, Reactivity and Function	+	+			+								+	+					+	+		+	+	+	+	+	+	+	+	
Concepts of Chemistry and Engineering		+		+	+									+		+	+		+	+	+									
Organic Chemistry 1	+	+			+								+	+					+	+										
Transport phenomena	+	+		+										+			+			+										
Practical Course: Synthesis and Analysis		+			+		+				+			+					+		+	+		+	+	+	+	+	+	+
Sustainable projects		+	+				+		+	+	+		+					+	+				+							+
Biochemistry&Biotehcnology	+	+			+								+	+					+	+	+									+
Physical Chemistry 1	+	+		+	+								+	+			+		+	+	+									+
Linear Algebra and multivariable calculus	+	+		+	+								+				+			+										
Inorganic Chemistry	+	+			+								+	+					+	+				+						
Spectroscopy	+	+		+	+								+	+			+		+	+										+
Organic Chemistry 2	+	+			+			+					+	+					+	+										
Physical Properties of Materials 1	+	+	+		+								+	+	+				+	+										
Synthesis 2 Lab Course					+		+				+								+		+	+		+	+	+	+	+	+	+
Physical Chemistry 2	+	+		+	+								+	+			+		+	+										+
Soft Molecular Materials		+	+										+		+				+	+										
Bioenergy, Metabolism and Bioresources		+	+			+					+	+	+		+			+	+	+				+						
Quantum Chemistry	+	+			+								+	+			+		+	+										+
Macromolecular Chemistry	+	+			+					+	+			+			+		+	+										
Practical Macromolecular Chemistry		+			+				+		+			+					+	+	+	+	+	+	+	+	+	+	+	+
Chemistry & Society: Ethical and Professional Aspects	+	+				+			+	+	+	+						+												
Bachelor Research Project	+	+	+	+	+		+	+	+	+	+	+	+	+			+		+	+	+	+	+	+	+	+	+	+	+	+

Specializations																														
Learning outcomes	**A1**	**A 2**	**A 3**	**A 4**	**A5**	**A 6**	**B1**	**B 2**	**B 3**	**B 4**	**B5**	**B 6**	**B7**	**1.1**	**1. 2**	**1. 3**	**1. 4**	**1. 5**	**2. 1**	**2. 2**	**2. 3**	**2. 4**	**2. 5**	**2. 6**	**2. 7**	**2. 8**	**2. 9**	**2. 10**	**2. 11**	**2. 12**
Smart Materials																														
Physical Properties of Materials 2		+	+										+		+				+	+										
Molecular Design		+	+	+					+		+		+		+				+	+	+									+
Materials Design: Theoretical Methods		+	+	+											+					+						+	+			+
Trends in Polymer Science		+	+										+		+				+	+										
Chemistry of life																														
Recombinant DNA and Biotechnology		+	+										+		+				+	+										
Chemical Biology		+	+										+		+				+	+	+									
(Bio-)Catalysis		+	+						+		+		+		+				+	+										
Cellular Chemistry		+	+						+				+		+				+	+										
Sustainable Chemistry and Energy																														
Electrochemistry and Energy		+	+	+				+		+			+		+		+		+	+	+	+		+	+	+	+	+	+	+
Green chemistry and photochemistry		+	+										+		+			+	+	+										
(Bio-)Catalysis																														
Physical Organic and Photo- Chemistry		+	+	+									+		+		+		+	+	+									

Electives																														
Learning outcomes	**A1**	**A 2**	**A 3**	**A 4**	**A5**	**A 6**	**B1**	**B 2**	**B 3**	**B 4**	**B5**	**B 6**	**B7**	**1.1**	**1. 2**	**1. 3**	**1. 4**	**1. 5**	**2. 1**	**2. 2**	**2. 3**	**2. 4**	**2. 5**	**2. 6**	**2. 7**	**2. 8**	**2. 9**	**2. 10**	**2. 11**	**2. 12**
Research **Electives**																														
Research Practical: Chemical Biology	+	+	+			+	+	+	+	+				+				+	+	+	+	+	+	+	+	+	+	+	+	
Research Practical: Polymer Chemistry		+	+	+				+	+	+	+				+				+	+	+	+	+	+	+	+	+	+	+	+
Research Practical: OMIC		+	+	+			+	+	+		+	+			+				+	+	+	+		+	+	+	+	+	+	+
Research Practical: Materials Design Experiments		+	+	+				+	+	+	+				+				+	+	+	+		+	+	+	+	+	+	+

Appendix 1: Learning outcomes of the degree programme

Learning outcomes of the bachelor's degree programme Chemistry

A. Generic learning outcomes – Knowledge

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

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

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

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

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

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

B. Generic learning outcomes – Skills

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

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

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

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

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

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

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

B8. Additional subject-specific skills are listed in Appendix 1.2.

Appendix 1.1: Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Chemistry has:

1.1. knowledge of the most important fields of Chemistry: Inorganic, Organic, Analytical, Physical, Macromolecular Chemistry and Biochemistry, furthermore general knowledge of more specific fields such as Theoretical Chemistry, Materials Chemistry, etc.,

1.2. knowledge of at least one multidisciplinary field: 'Chemistry of Life', 'Smart Materials' and 'Sustainable Energy and Chemistry',

1.3. a broad general knowledge of subjects within their own discipline or of subjects within a different discipline,

1.4. necessary background knowledge of Mathematics and Physics,

1.5. understanding of the position and role of the discipline within science and society, and also in the international character of the discipline.

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

a. The important aspects of chemical terminology, nomenclature and conventions.

b. Numerical and computational skills, including error analysis, understanding of the proper order of magnitude and correct use of units.

c. The most important types of chemical reactions and their characteristics.

d. The principles and procedures that are used in the analysis and in the characterization of chemical compounds.

e. The fundamental techniques of structural analysis, including spectroscopy.

f. The properties of various states of matter and the common theories to describe them.

g. The principles of Quantum Mechanics and its applications in the description of structure and properties of atoms and molecules.

h. The principles of Thermodynamics and its applications in Chemistry.

i. The kinetics of chemical processes, catalysis and mechanical interpretation of chemical reactions.

j. The typical properties of elements and their compounds, including group relationships and trends in the periodic table.

k. The structural properties of chemical elements and their compounds.

l. The typical properties of aliphatic, aromatic, heterocyclic and organometallic compounds.

m. The nature and behavior of functional groups in molecules.

n. Important synthetic routes of organic/inorganic chemistry.

o. The relationship between bulk properties of matter and properties of individual atoms and molecules, including macromolecules (both natural and synthetic).

p. The structure and reactivity of important types of biomolecules and the chemistry of important biological processes.

q. The design of processes (also on industrial scale), taking into account flow and transfer of matter and energy.

r. Properties of chemicals and the involved environmental and safety aspects.

Appendix 1.2: Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Chemistry has developed the skills and competencies mentioned below.

Chemistry-related cognitive skills and competencies
The Bachelor's graduate is:

2.1. able to demonstrate and use their knowledge and understanding of essential facts, concepts, principles and theories related to the topics, as defined in Appendix I, in various situations,
2.2. able to apply knowledge and understanding to solve basic qualitative and quantitative problems,
2.3. skilled in evaluating, interpreting and combining chemical information and data,
2.4. able to recognize and implement 'good laboratory practice',
2.5. familiar with project work,
2.6. able to adopt a professional attitude regarding environmental and safety aspects and possible ethical implications in the context of research, education and industry.

Chemistry-related practical skills
The Bachelor's graduate is:

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