Programme-Specific Section of the Education and Examination Regulations for the Bachelor's Programme in Applied Mathematics

The rules in this Section are part of the programme portion of the Student Charter, including the Education and Examination Regulations for the Bachelor's programme in Applied Mathematics offered by the Faculty of Electrical Engineering, Mathematics and Computer Science of the University of Twente.

Contents

1 Contents and structure of the programme

1.1 General objectives of the programme

The objective of the bachelor's programme in Applied Mathematics is to train and educate its students to become academics who practice mathematics in the perspective of applications, in a societal and multidisciplinary context.

Most graduates will continue their education in a master's programme.

1.2 Provisions required by the Higher Education and Research Act (WHW)

The letters associated with the various paragraphs below refer to the corresponding letters in Article 7.13, paragraph 2 of the WHW.

a. The content of the programme and the associated examinations
The study units comprising the bachelor's programme in Applied Mathematics is given in Table 1, Table 2 and Table 3 in Appendix A. The rules regarding the Final Examination is given in Article 3.4.

For students who started the programme prior to September 1, 2013, study units comprising the curriculum are given in Table 4, Table 5 and Table 6 in Appendix A. These study units are no longer offered, and so, these students will have to make use of the transitional arrangements in Section 4. The rules regarding the Final Examination is given in Article 4.1.5.

Annex B contains a curriculum that has been adjusted for the combined final degree audit for Applied Mathematics and Applied Physics.

and Annex C contains a curriculum that has been adjusted for the combined final degree audit for Applied Mathematics and Technical Computer Science.

b. The content of the specialisations offered by the programme
The programme offers a single specialisation, with its content as described in provision **a.**

c. The Programme Intended Learning Outcomes
The programme covers four fields of competence:

(a) domain expertise;

(b) research and modelling skills;

(c) professional skills;

(d) academic reflection.

These fields of competence are specified further in eleven PILOs:

1. The graduate has thorough knowledge of mathematical theories in the areas of algebra, analysis, statistics, stochastics, and discrete mathematics, and an understanding of the application of these theories in technology, health care and business administration (associated with domain expertise).
2. The graduate can deal with abstraction, is capable of formal reasoning and can construct mathematical proofs (associated with domain expertise).
3. The graduate can use various research methods to answer research questions (associated with research and modelling skills).
4. The graduate can design and analyse mathematical models for problems of a multidisciplinary nature and assess their usefulness in practical situations (associated with research and modelling skills).
5. The graduate is proficient in using a computer to address the increasing size and complexity

of mathematical problems. Computer algebra, numerical methods and simulations are key applications in this regard (associated with research and modelling skills).

6. The graduate is information literate. The graduate is adept at making the most of the library's resources, including advanced search methods in modern library networks (associated with research and modelling skills and professional skills).
7. The graduate is proficient in oral and written communication, and is able to work effectively in a team. The graduate is capable of continuously developing collaborative skills.
8. The graduate has insight into the position of the field of applied mathematics in society and has acquired a basic understanding of the philosophy of science (associated with academic reflection).
9. The graduate can shape his/her learning process, his/her competencies and develop his/her professional identity, by consciously choosing, motivating and completing study units that match personal capacities, skills, and motivation.
10. The graduate is aware of the opportunities for further specialisation in a Master's programme or for finding gainful employment (associated with academic reflection).
11. The graduate is interculturally competent.

d. Structure of practicals
Practicals are not subject to any specific provisions with regard to their structure.

e. Study load of the programme and of each of the study units in the programme
The study load of the study units is indicated in Table 1, Table 2, and Table 3 in Appendix A.

f. Specific rules regarding Binding Recommendation (BSA)
A student of bachelor's degree programme in Applied Mathematics will receive a positive BSA upon satisfying the following conditions (Article 6.3, Guideline and Model EER):

1. Successful completion of at least 45 credits, including all the study units of at least two modules.
2. Successful completion of at least two of the following study units: Linear Structures I, Linear Structures II, and Analysis I.

Students pursuing a double degree in Applied Mathematics and Applied Physics are subject to different BSA provisions, as given in Article 5 of Annex B.

Students pursuing a double degree in Applied Mathematics and Technical Computer Science are subject to different BSA provisions, as given in Article 8 of Annex C.

g. Study load of the Master's programme
Not applicable.

h. The sequence of examinations
Any restriction on the sequence of examinations with relation to academic prerequisites is indicated in Appendix A.

i. Programme format
The programme is offered on a full-time basis.

j. Sequence and periods for examinations and degree audits
The schedules indicate the tests that make up an examination. Degree audits are not restricted to specific periods.

k. Not applicable

l. Teaching method and assessment and examination formats
The teaching method for the various study units is indicated in Appendix A. The following abbreviations are used:

Lec	Lecture,
Tu	Tutorial,
PR	Practical,
COL	Colstruction,
SS	Self Study.

The examination format for the study units is indicated in Appendix A. The following abbreviations are used:

W	Written examination,
Or	Oral examination,
O	One or more assignments: the student submits work (assignments, reports, essays, other documents) and the examiner assesses it without the student being present,
P	Practical assignment: the student creates and submits a product that can be activated and subsequently, assessed on behaviour and/or function and/or usability (e.g. a working program or a functioning prototype),
Pj	Project: the student participates in a number of group activities. The student will be assessed both on his individual contribution to the activities and the group's products (report, presentation, program),
Ps	Presentation: the student gives a presentation to the examiner and a group of interested people, generally fellow students.

These codes indicate the nature of assessment, without prescribing any rules for assessment.

m. See Guideline and Model EER, Article 7.1.

n. See Guideline and Model EER, Article 4.5.

o. See Guideline and Model EER, Article 4.6.

p. See Guideline and Model EER, Article 4.8.

q. See Guideline and Model EER, Article 4.8.3.

r. See Guideline and Model EER, Article 3.4

s. Admission standards for examinations and practicals
The admission standards are listed in Appendix A.

t. Required participation in a practical exercise as a component of an examination
The 'form of assessment' column in Table 1, Table 2 and Table 3 in Appendix A shows whether participation is required in a practical exercise as a component of an examination.

u. See Guideline and Model EER, Articles 6.1 and 6.2.

v. Not applicable.

2 Description of modules

Table 1, Table 2 and Table 3 in Appendix A provide the study units and their related ECs for each module. The mode of teaching and assessment are also given there.

Brief descriptions and *module intended learning outcomes* for Modules 1-8, 11 and 12 are given below. For more detailed descriptions and intended learning outcomes for the individual study-units within a module, we refer to the Student Information System (Osiris) and the Learning Management System (Canvas).

2.1 Module 1. Structures and Models

This module is the first acquaintance with studying Applied Mathematics. The first taste of abstract and formal reasoning is received through Linear Structures I and Prooflab. Exposure to programming and modelling comes through the project (implemented with MATLAB).

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ is aware of what it means to study applied mathematics at an academic level;
- ☐ knows and can apply the very basics of mathematics and modelling in about every subsequent module.

2.2 Module 2. Mathematical Proof Techniques

This module is primarily about deepening of abstraction and formal reasoning, studied from different perspectives: Linear Structures II, Analysis I, and Linear Optimization. The project: Prooflab II allows the student to experience how a complex proof can be decomposed systematically into different proof techniques.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ is proficient in abstract and formal reasoning in basic mathematics;
- ☐ has an overview of proof techniques;
- ☐ is able to assess and understand complex proofs and is able to derive proofs in a systematic way.

2.3 Module 3. Fields and Electromagnetism

This module is centred around vector calculus and its applications in physics. The module is a joint effort of Applied Mathematics and Applied Physics. In the project, students build electromagnetic devices from a historical perspective using modern materials. In addition, students gain knowledge about programming in a structured way, including the mathematics behind it, and about presenting mathematical topics.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ is able to use vector calculus in basic electromagnetic problems, both on a theoretical and a practical level;
- ☐ is able to write, design and analyze basic data and control structures, like conditional statements and loops, and provide a formal proof for the correctness of such constructs;
- ☐ is able to concisely convey mathematical concepts using presentation skills.

2.4 Module 4. Signals and Uncertainty

In this module, students get introduced to the mathematical foundation of probability theory and to frequency domain based tools to analyse signals as well as differential equations. The project allows the students to apply the gained knowledge in predicting some signals together with an uncertainty analysis. In addition, collaboration in relatively large groups is a focus point of the project.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ has knowledge of and insight into probability models, and is able to analyse them and interpret the outcomes;
- ☐ has knowledge of and insight into frequency domain analysis and ability to understand both signals and differential equations using frequency domain tools;
- ☐ is able to analyse large amounts of data, using, in particular, frequency domain tools and, working together, obtain predictions and understand the accuracy of those predictions.

2.5 Module 5. Statistics and Analysis

Mathematical Statistics and applying different statistical techniques in analysing real life data are what students learn in this module. Furthermore, the module broadens the knowledge of Analysis. Also, as part of the Reflection learning line, the students learn the cultural differences within and outside the field of mathematics.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ is able to derive mathematically the standard techniques for statistical data analysis and apply them properly;
- ☐ is able to work with infinite series of real numbers and functions, with metric spaces and with differentiability of functions in n-dimensional Euclidean spaces.

2.6 Module 6. Dynamical Systems

This module is about dynamic phenomena, their mathematical representations, computational aspects and applications in control problems. The subjects of the module are Ordinary Differential Equations (ODEs), Systems Theory, and Numerical Mathematics. The project focuses on modelling dynamical systems using the knowledge of the aforementioned subjects.

The intended learning outcomes are: After successful completion of the module, the student

- ☐ is able to analyse and control solutions of systems of ODEs;
- ☐ can model a physical system with ODEs;
- ☐ is able to use various numerical and analytical techniques to study the model.

2.7 Module 7. Discrete Structures and Efficient Algorithms

This module deals with discrete problems as encountered in various practical problems and solutions thereof using efficient algorithms. The module is a joint effort of Applied Mathematics and Technical Computer Science. Central in the module is a project about graph isomorphisms. The theoretical parts that are used and needed in this project are Algorithmic Discrete Mathematics, Language & Machines, and Algebra. The module also contains a training in Python.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ has knowledge of and insight into discrete structures as studied in mathematics and computer science;

- ☐ is able to apply the techniques to analyse these structures and to solve relevant problems through appropriate algorithms;
- ☐ is able to deduce the complexity and efficiency of such algorithms.

2.8 Module 8. Modelling and Analysis of Stochastic Processes

This module is about modelling situations with uncertainty using stochastic processes. The module is a joint effort of Applied Mathematics, Industrial Engineering and Management and Civil Engineering. The theoretical parts are closely connected (Stochastic Models being focused on applicability, while Markov Chains is more in depth), and Project Stochastic Models is closely related to Stochastic Models itself. The final multidisciplinary project serves the purpose of integrating all the acquired knowledge, working in a team of students from different disciplines.

The intended learning outcomes are: After successful completion of the module, the student:

- ☐ knows how to recognise when a situation or system should be modelled using stochastic models, and is able to select the most appropriate models;
- ☐ has knowledge of and insight into methods to analyse and/or simulate such models;
- ☐ is able to interpret the outcomes of the analysis or simulation.

2.9 Modules 11 and 12

The last semester of the programme contains the Reflections on Mathematical Research, Bachelor's Assignment, and the Electives. The Electives and Complex Function Theory broaden the students' horizon enabling them in making an informed choice of the subsequent master's programme. The course Reflection on Mathematical Research I forms prior knowledge for the Bachelor's Assignment. Reflection on Mathematical Research II is the preparation of the actual Bachelor's Assignment. The student shows his/her skills of being able to integrate all of the gathered knowledge by executing the Bachelor's Assignment.

3 Specific characteristics of the programme

3.1 Language of tuition

English is the language of tuition - the examinations are administered in English. Exam and test questions have to be answered in English. Answers in any other language will be ignored and therefore not marked.

3.1.1 Transitional arrangement for cohorts 2015 and earlier

Students from cohort 2015 or earlier are entitled to language support.

3.2 Educational prerequisites

The following additional provisions apply with regard to the educational prerequisites in Article 2.1 of the general section of these Education and Examination Regulations.

Students with a first-year certificate from a technology programme at a university of applied sciences may be admitted to the Bachelor's programme in Applied Mathematics if they satisfy the following conditions:

- Colloquium doctum examinations for both Mathematics B and English
- Taking part in an Applied Mathematics matching activity. The programme's recommendation following the matching activity is binding.

3.3 Registration of results

In addition to Article 4.1 of the general section:

- Exemptions for examinations are indicated with the code 'VR', and they are assigned a numerical value of 6.0 for weighting purposes.
- The student thus has the option of requesting an exemption with the consequence that the exemption be assigned a value of 6 for weighting purposes, or the student may decide to take the exam and possibly earn a higher mark.
- The exam results of Sufficient (S) and Insufficient (U) have no numerical values.

3.4 Pass/Fail regulation

Students who meet the following requirements will pass the Final Examination of the Bachelor's programme in Applied Mathematics:

a. The student has received an assessment for all study units of the Bachelor's curriculum;
b. All study units have been completed with a grade of 5.0 or higher;
c. No more than one grade of 5.0 for the study units of the first year of the Bachelor's curriculum and no more than one grade of 5.0 for the study units of the second and third years combined. In case a study-unit has entered the curriculum through a transition rule, as given in Article 4.2, and its grade has been determined using a compensation-scheme, then it counts as a grade of 5.0;
d. The grade for the Bachelor's Assignment is 6.0 or higher;
e. The average of all grades is 6.0 or higher, without taking into account the complete/incomplete grades. This is a weighted average based on the corresponding number of ECs per study unit.

In all other cases, the student will not pass the final examination.

3.5 Cum Laude (with distinction)

A student may pass the Bachelor's final examination with distinction (cum laude). As a guideline for determining whether to award a degree with distinction, all of the following conditions should be met:

a. The student passes the Bachelor's final examination within four years of initial enrolment (performance requirement);

b. The student's average grade is 8.0 or higher, without taking into account the complete/incomplete grades. This is a weighted average based on the corresponding number of ECs per study unit. Results for study units outside the examination programme, are not taken into account.

c. All study units are completed with a passing grade. In case a study-unit has entered the curriculum through a transition rule, as given in Article 4.2, its grade must not have been determined using a compensation-scheme of 2019-20 or earlier;

d. No more than one study unit may have a grade lower than 7.0;

e. The grade of Bachelor's Assignment is an 8.5 or higher.

In exceptional cases and at the student's request, the Examination Board may award the distinction of cum laude if the student has met all requirements with the exception of the performance requirement, due to extenuating circumstances. These circumstances may involve delays recognised and provided for by the institution. It should be noted that the distinction of cum laude is never awarded automatically.

3.6 BSA rules

The programme uses the BSA module in Osiris.

- At the conclusion of Module 1 and Module 2, interim recommendations will be given. It can be positive, neutral or negative;
- The final and binding recommendations (BSA) are issued based on the results of the study units of the first year.
- These official recommendations are issued by the Programme Board.
- The letters containing the binding recommendations are sent and signed digitally.

3.7 Electives and Minor

Students of the bachelor's programme in Applied Mathematics may choose elective courses as given in Module-11 of Table 3.

Minor profiles of Module-9 and Module-10 (Table 3) can be chosen from the approved minors listed on the minors website: www.utwente.nl/minor;

Students may compose their own proposal for the minors and submit it to the Examination Board for approval. The proposal for the minor must meet the following conditions:

- The minor's academic level must be assured (to be assessed by the Examination Board).
- The minor's components are to be cohesive.

3.8 Secondary school teaching certificate

Students who pass the 30-EC minor *Leren Lesgeven*[1] receive, alongside a Bachelor's degree in Applied Mathematics, a mathematics teaching qualification for the initial years of senior general secondary education (HAVO), pre-university education (VWO), and the theoretical learning pathway of pre-vocational secondary education (VMBO) in the Netherlands.

3.9 Bachelor's Assignment confidentiality

Reports of Bachelor's Assignments are public documents except in the cases listed below. The Programme Board may deem a report to be confidential for a specific period based on a detailed request:

a. The first supervisor must submit a request to the Programme Board prior to the start of the final assignment.

b. The confidential report must be accessible/available to the committee responsible for assessing the Bachelor's Assignment, the Programme Board, and representatives of bodies that have a statutory duty of overseeing the quality of the assessment or the programme as a whole.

c. The parties mentioned above are required to respect confidentiality with regard to the report.

3.10 Double Degree programmes

The programme offers two double degrees: Applied Mathematics combined with Applied Physics, and Applied Mathematics combined with Technical Computer Science. A tailored curriculum applies to students pursuing such a double degree.

All additional rules concerning the double degree AM-AP and AM-TCS are stipulated in Annex B and Annex C, respectively.

3.11 Evaluation of education

To monitor and to improve the quality of teaching, the AM BSc programme uses information about the students' learning experiences. This information is obtained from:

a. Internal evaluations
   - SEQ (Student Experience Questionnaire)
   - Panel discussions with students and teachers.

b. External sources
   - National Student Survey (NSE)
   - National Alumni Survey
   - International Student Barometer

[1] The minor *Leren Lesgeven* is only available in Dutch

4 Transitional arrangements

Notwithstanding the current Education and Examination Regulations, the following transitional provisions apply for students who started the programme under a previous set of Education and Examination Regulations.

4.1 Transitional arrangements for students of cohorts 2012 and earlier

Study units corresponding to Table 4, Table 5 and Table 6 in Appendix A are no longer offered. For the students who started the programme on September 1st 2012 or earlier, the following provisions apply.

4.1.1 Elective: Random Signals and Filtering

A student who started the programme on September 1, 2009 or earlier and who passed the course Random Signals and Systems (191571080) may use this course as the elective course Random Signals and Filtering (201200135).

4.1.2 Minor

Deviating from a 20 EC minor (Table 6), students are allowed to take a minor of a study load between 15 and 30 EC.

4.1.3 Bachelor's Assignment

The Bachelor's Assignment is now an individual assignment (of study-load 10 EC) combined with the courses Reflection on Mathematical Research I and II (5 EC + 2 EC). Students may submit a substantiated request to the Examination Board if they wish to deviate from it.

4.1.4 Discontinued courses

Students who still need to complete courses for which exams are no longer offered and for which there is no transitional arrangement provided, must contact the Study Advisor. An attempt will then be made to find study units from the current curriculum that cover the missing learning goals. The replacement has to be approved by the Examination Board.

4.1.5 Bachelor's final examination

Students will pass the Bachelor's final examination once they have satisfied the following conditions:

- All study units from the first year of the Bachelor's curriculum for cohorts 2012 and earlier (Table 4) have been completed with a grade of 5.0 or higher and no more than one 5.0;
- All study units from the second and third years of the Bachelor's curriculum for cohorts 2012 and earlier (Table 5 and Table 6) have been completed with a grade of 5.0 or higher and no more than one 5.0;
- The average of all grades is greater than or equal to 6.0;
- The grade for the Bachelor's Assignment is 6.0 or higher.

4.2 Transitional arrangements for students of cohort 2013 until 2019

Modules as 15 EC study-units are no longer offered. Students from cohort 2013 through 2019 have to follow the current version of the Modules, consisting of several study-units totalling 15 EC. For these Students, however, the following provisions apply.

4.2.1 Already completed modules

M1 Students who passed the study-unit Structures and Models with code 201800135, 201700118 or 201300056 may use this course to replace all the study units of Module-01 of Table 1.

M2 Students who passed the study-unit Mathematical Proof Techniques with code 201800136 or 201700140, or the study-unit Techniques for Mathematical Proofs (201300057) may use this course to replace all the study units of Module-02 of Table 1.

M3 Students who passed the study-unit Fields and Electromagnetism with code 201800137, 201400535 or 201300183 may use this course to replace all the study units of Module-03 of Table 1.

M4 Students who passed the study-unit Signals and Uncertainty with code 201800138 or 201300182 may use this course to replace all the study units of Module-04 of Table 1.

M5 Students who passed the study-unit Statistics and Analysis with code 201800139 or 201400218 may use this course to replace all the study units of Module-05 of Table 2.

M6 Students who passed the study-unit Dynamical Systems with code 201500103 or 201400222 may use this course to replace all the study units of Module-06 of Table 2.

M7 Students who passed the study-unit Discrete Structures and Efficient Algorithms with code 201800141, 201700304, 201600270 or 201400433 may use this course to replace all the study units of Module-07 of Table 2.

M8 Students who passed the study-unit Modelling and Analysis of Stochastic Processes for Math (201400434) may use this course to replace all the study units of Module-08 of Table 2.

M11 Students who passed the study-unit with course-code 201500379 and name either Bachelor's Assignment prep or Bachelor's Assignment & Electives may use this course to replace all the study units of Module-11 of Table 3.

M12 Students who passed the study-unit with course-code 201500380 and name either Bachelor's Assignment or Finalising Thesis - Bachelor's Assignment may use this course to replace all the study units of Module-12 of Table 3.

4.2.2 Component-grade to course-grade for incomplete modules

If a student has not passed a 15-EC Module, but has a valid component-grade of 4.8 or higher on 31-08-2020, and the module-component in consideration has become a stand-alone study-unit in the bachelor curriculum of 2020-21, then the component-grade will be converted into the course-grade for the respective study-unit on 01-09-2020, as per the rounding off scheme of Article 4.1.9 of the Guideline and Model EER.

A Bachelor's programme AM

1 Curriculum AM

Study Units		Study	Teaching	Form of
Code	Name	load (EC)	method	assessment
Module-01: Structures and Models				
202001214	Calculus I & Prooflab I	4 EC	Lec + Tu	W + O
202001325	Linear Structures I	6 EC	Lec + Tu	W
202001326	Project Programming, Modelling and Cultural Differences	5 EC	Lec + P	Pj + P
Module-02: Mathematical Proof Techniques				
202001223	Calculus II	4 EC	Lec + Tu	W
202001329	Analysis I	3 EC	Lec + Tu	W
202001330	Linear Structures II	3 EC	Lec + Tu	W
202001331	Linear Optimization	3 EC	Lec + Tu	W
202001332	Project Prooflab II	2 EC	SS + Tu	O
Module-03: Fields and Electromagnetism				
202001229	Vector Calculus	2 EC	Lec + Tu	W
202001335	Electromagnetics	5 EC	Lec + Tu	W
202001336	Introduction to Programming	1 EC	PR	P
202001337	Analytical Programming	1 EC	PR	P
202001338	Prooflab III	1 EC	Lec + Tu	O
202001339	Presenting a Mathematical Subject	2 EC	PR	Ps
202001340	Project Fields and Electromagnetism	3 EC	Pj	P
Module-04: Signals and Uncertainty				
202001343	Signals & Transforms	5 EC	Lec + Tu	W
202001344	Probability Theory	5 EC	Lec + Tu	W
202001345	Project Signals and Uncertainty	5 EC	Lec + PR	Pj + P
	Entire academic year	**60 EC**		

Table 1: The first academic year

Study Units Code	Name	Study load (EC)	Teaching method	Form of assessment
Module-05: Statistics and Analysis				
202001348	Mathematical Statistics	6 EC	Lec + Tu	W
202001349	Project Statistics	2 EC	Lec + PR	Pr
202001350	Analysis II	5 EC	Lec + Tu	W
202001351	Prooflab Revisited: Diversity in Cultures	2 EC	Lec	Pj + Ps
Module-06: Dynamical Systems				
202001354	Ordinary Differential Equations	4 EC	Lec + Tu	W
202001355	Systems Theory	4 EC	Lec + Tu	W
202001356	Numerical Mathematics	4 EC	Lec + PR	W + P
202001357	Project Dynamical Systems	3 EC	PR	Pj
Module-07: Discrete Structures & Efficient Algorithms				
202001360	Algorithmic Discrete Mathematics	5 EC	Lec + Tu	W
202001361	Languages & Machines	3.5 EC	Lec + Tu	W
202001362	Algebra	3.5 EC	Lec + Tu	W
202001363	Implementation Project on Graph Isomorphism	3 EC	PR	Pj
Module-08: Modelling & Analysis of Stochastic Processes for Math				
202001366	Stochastic Models	5 EC	Lec + Tu	W
202001367	Project Stochastic Models	1.5 EC	PR	Pj
202001368	Markov Chains	2.5 EC	Lec + Tu	W
202001369	Project Stochastic Simulation	4 EC	PR	Pj + P
202001370	Multidisciplinary Project	2 EC	PR	Pj
	Entire academic year	**60 EC**		

Table 2: The second academic year

Study Units Code	Name	Study load (EC)	Teaching method	Form of assessment
Minor profile M9 + M10 [a]		30 EC		
Module-11: Electives & Preparation Bachelor's Thesis				
202001373	Reflection on Mathematical Research I [b]	5 EC	Lec	O
Electives: *Two of the following four courses must be included in the students' exam programme:*				
202001374	Graph Theory	5 EC	Lec + Tu	W
202001375	Mathematical optimization	5 EC	Lec + Tu	W
202001376	Introduction to PDE	5 EC	Lec + Tu	W
202001377	Simultaneous Statistical Inference	5 EC	Lec + Tu	W
Module-12: Finalising Bachelor's Thesis				
202001381	Complex Function Theory	3 EC	Lec + Tu	W
202001380	Reflection on Mathematical Research II [c]	2 EC	Lec	O
202001379	Bachelor's Assignment [c]	10 EC	PR	P + Ps
	Entire academic year	**60 EC**		

Table 3: The third academic year

[a] Sequence requirement 1: students may only participate in these study units once they have gained at least 75 EC.

[b] Sequence requirement 2: students may only participate in these study units once they have passed all the study units of the first eight modules.

[c] Sequence requirement 3: students may only participate in these study units once they have passed the study unit *Reflection on Mathematical Research I (202001373).*

2 Curriculum AM for cohorts 2012 and earlier

Study Units		Study load (EC)	Form of assessment
Code	**Name**		
201100103	Calculus	5 EC	W + P
201100104	Vector Calculus	4 EC	W + P
201100100	Linear Structures I	5 EC	W
201100101	Linear Structures II	5 EC	W
191521611	Discrete Mathematics I	4 EC	W
191521631	Discrete Mathematics II	4 EC	W
191530370	Probability	5 EC	W
201100102	Analysis I	5 EC	W
191560123	Ordinary Differential Equations	4 EC	W
191580751	Deterministic Models in the OR	4 EC	W
191521501	Mathematical Modelling I	2 EC	Pj + O
191540160	Algorithms and Programming I	2 EC	P
194113000	Great minds in the history of science	3 EC	W or O
Elective:		5 EC	
191403021	Dynamics		W
191580612	Introduction to Mathematical Economics		W + P
	Entire academic year	**60 EC**	

Table 4: The first academic year for cohorts starting prior to September 1st 2013

Study Units		Study load (EC)	Teaching method	Form of assessment
Code	**Name**			
201100109	Signals and Tranforms	5 EC	Lec + Tu + PR	W
191515603	Intr. to investment theory	5 EC	Lec + Tu	W
191530382	Mathematical Statistics	5 EC	Lec + Tu	W
191530651	Markov Chains	5 EC	COL	W
191540270	Numerical Math. and Modelling	4 EC	Lec + Tu + PR	W + P
191505001	Presenting a mathematical topic	2 EC	Ps	Pr
191540170	Algorithms and Programming II	3 EC	COL + PR	P
191560561	Intro to mathematical systems theory	5 EC	Lec + Tu + PR	W + P
191505271	Mathematical Modelling II	5 EC	Lec + PR	Pj + O
191521400	Analysis II	5 EC	Lec + Tu	W
191511410	Algebra and security	5 EC	Lec + Tu	W
Elective:		5 EC		
191403033	Dyn. Modelling and Simulation		Lec + PR	W + P
191530881	Stochastic models in OM		Lec + Tu	W
Elective:		5 EC		
191403051	Electricity and Magnetism		Lec + Tu	W
192111801	Basic models in computer science		Lec + Tu + PR	W + P
	Entire academic year	**60 EC**		

Table 5: The second academic year for cohorts starting prior to September 1st 2013

Study Units		Study	Teaching	Form of
Code	**Name**	**load (EC)**	**method**	**assessment**
191530821	Stochastic Simulation Project	5 EC	Lec	P + Or
Elective:		5 EC		
191561620	Optimal control		Lec	W
201200135	Random Signals and Filtering		Lec	W
Elective		5 EC		
191520751	Graph Theory		Lec + Tu	W
191550105	Theory of Partial Differential Equations		Lec + Tu	W
191530440	Regression and ANOVA	5 EC	Lec + PR	W + P
191520252	Complex Function Theory	5 EC	Lec + Tu	W
191580251	Mathematical Programming	5 EC	Lec + Tu + PR	W or Or
191599220	Bachelor's Assignment	10 EC		Pj + O
Minor		20 EC		
	Entire academic year	**60 EC**		

Table 6: The third academic year for cohorts starting prior to September 1st 2013

Requirements for the Bachelor's Assignment:
A student may only participate in this study unit once he has gained his first-year certificate and at least 60 EC from the second and third years of the Bachelor's curriculum, excluding the minor. Furthermore, the student must have completed the subjects listed as prerequisites for the relevant assignments, and he must have passed Mathematical Modelling II.

Requirements for the Minor:
At a specific date, to be announced in advance, the student must have gained at least 80 EC. The credit total includes the results of examinations from the fourth quarter (or directly subsequent to the fourth quarter), whereas results of examinations during the summer break will not be included. The Examination Board may grant dispensation from the 80-credit requirement in individual cases.

B Annex to the education and examination regulations for the double degree programme Applied Mathematics and Applied Physics

This annex describes the rules regarding the double degree programme Bachelor's in Applied Mathematics and Bachelor's in Applied Physics. The studying requirements are based on the Rules of the Examination Board AM and the AP Examination Board[2].

The annex contains the following paragraphs:

1. Study programme AM-AP
2. Transitional arrangements
3. Safety
4. Minor and Bachelor's Assignment
5. Binding Recommendation (BSA)

[2] In the event of a change to the double degree programme as stated in Article 1 of this annex, individual agreements will be made with the students by the examination committees of both programmes

1 Study programme AM-AP

The tailored programme for the double degree Bachelor's in Applied Mathematics and Bachelor's in Applied Physics is summarised in Tables 7, 8 and 9 below:

Quartile	Applied Mathematics components		Applied Physics components	
Q1	Linear Structures I	6 EC	Dynamics & Relativity	5 EC
(21 EC)	Calculus I + Prooflab I	4 EC	Experimentation 1	1.5 EC
	Workshop Intercultural Awareness		Programming & Data processing 1	2 EC
			Project Dynamics & Relativity	2.5 EC
Q2	Calculus II	4 EC	Thermodynamics	4 EC
(20 EC)	Linear Structures II	3 EC	Programming & Data processing 2	1 EC
	Analysis I	3 EC		
	Linear Optimization	3 EC		
	Project Prooflab II	2 EC		
Q3	Prooflab III	1 EC	Electromagnetism	5 EC
(18 EC)	Presenting a Mathematical Subject	2 EC	Vector Calculus	2 EC
			Instrumentation	4 EC
			Project Electromagnetisme en Meten	3 EC
			Analytical programming	1 EC
Q4	Probability Theory	5 EC	Quantum Matter	5 EC
(20 EC)	Signals and Transforms	5 EC		
	Project Signals and Uncertainty	5 EC		
Entire academic year:		**79 EC**		

Table 7: The first academic year for the double degree programme AM-AP

Quartile	Applied Mathematics components		Applied Physics components	
Q5	Mathematical Statistics	6 EC	Models	4.5 EC
(20.5 EC)	Analysis II	5 EC	Project Signalen, Modellen en Systemen	3 EC
	Prooflab Revisited	2 EC		
Q6	Ordinary Differential Equations	4 EC	Quantum Mechanics	6 EC
(21 EC)	Systems Theory	4 EC		
	Numerical Mathematics	4 EC		
	Project Dynamical Systems	3 EC		
Q7	Discrete Mathematics & Algebra	6 EC	Solid State Physics	7 EC
(21 EC)			Statistical Physics	6 EC
			PDE	2 EC
Q8	Markov Chains	4 EC	Physics of Fluids	7 EC
(19 EC)			Electrodynamics	6 EC
			Numerical Methods for PDE	2 EC
Entire academic year:		**81.5 EC**		

Table 8: The second academic year for the double degree programme AM-AP

2 Transitional arrangements

For students who started the programme earlier than September 1st 2020, many study units, or parts thereof, as they existed at the time the student's enrolment, may no longer be offered. The curriculum, as given in Article 1 of this annex, serves as the basis for establishing the results of the bachelor's final examination.

Curricula of previous years and accompanying transitional arrangements are published on the Applied Mathematics website: https://www.utwente.nl/en/bam/bachelors-curriculum/

Quartile	Applied Mathematics components		Applied Physics components	
Q9 *(15 EC)*	**Minor** https://www.utwente.nl/en/education/electives/minor/			
Q10 *(17 EC)*	Electives selection (10 EC)			
			Optics	7 EC
Q11 *(15 EC)*	Reflection on Mathematical Research I (5 EC)			
	10 EC of Electives from:			
	Graph Theory	5 EC	Computational Physics	2.5/5 EC
	Introduction to PDE	5 EC	Physical Materials Science	5 EC
	Simultaneous Statistical Inference	5 EC	Machine Learning	3/5 EC
	Mathematical Optimization	5 EC	Remote Control of Experiments	2.5/5 EC
			Soft Matter Physics	5 EC
			Technical Optics	5 EC
Q12 *(20 EC)*	Complex Function Theory			3 EC
	Reflection on Mathematical Research II			2 EC
	Bachelor's Assignment			15 EC
Entire academic year: 67 EC				

Table 9: The third academic year for the double degree programme AM-AP

3 Safety

Safety requirements are compulsory while working in a laboratory. The student is obliged to follow these rules.

4 Minor and Bachelor's Assignment

a. The minor consists of 15 EC (a quartile); The permitted minor offer is stated on the minor website: https://www.utwente.nl/en/education/electives/minor/

b. Before starting a minor, the student is expected to meet the prior knowledge requirements, as described in the minor's course catalogue.

c. Before starting a minor, the student must have obtained at least 100 EC from the B1 and B2 programs of the Bachelor's programme.

d. The student can only register for the Bachelor's Assignment examination component if he has fully passed the first year programme and if he obtained a minimum of 60 EC from the second and third year programme excluding the minor.

e. After the advice of the Examination Board, at the request of the student, the Programme Board may grant exemption from the condition referred in Paragraph a., Paragraph b., Paragraph c. and Paragraph d. of this article. This may cause a delay in the study progress.

5 Binding Recommendation (BSA)

A student pursuing the double degree programme, as stipulated in Article 1 of this annex, will receive a positive recommendation on continuation of the study programme in Applied Matematics upon satisfying the following conditions (Article 6.3, Guideline and Model EER):

1. Successful completion of at least 45 credits from the first year's study units.
2. Successful completion of at least two of the following study units: Linear Structures I, Linear Structures II, and Analysis I.
3. A maximum of 15 EC incomplete from the total ECs associated with the first year's AM-study units of the double degree programme. See Article 1 for the AM-study units.

C Annex to the education and examination regulations for the double degree programme Applied Mathematics and Technical Computer Science

This annex describes the rules regarding the double degree programme Bachelor's in Applied Mathematics and Bachelor's in Technical Computer Science.

The annex contains the following paragraphs:

1. Study programme AM-TCS
2. Extra requirements for double degree AM-TCS
3. Elective section
4. Sequence requirements
5. Teaching evaluation
6. Pass/Fail Regulations
7. Cum Laude
8. Binding Recommendation (BSA)
9. Transitional arrangements

1 Study programme AM-TCS

The tailored programme for the double degree Bachelor's in Applied Mathematics and Bachelor's in Technical Computer Science is summarised in Tables 10, 11 and 12 below:

Course code	Course name	Q	EC	Division	Prerequisites
202001325	Linear Structures I	1A	6	AM	
202001190	Introduction to Mathematics + Calculus 1A	1A	4	AM/TCS	
202001022	Pearls of Computer Science Core	1A	11	TCS	
201500112	Programming Theory & Project	1B	8	TCS	
202001197	Calculus 1B for CS	1B	3	AM/TCS	
202001329	Analysis I	1B	3	AM	
202001332	Project: Prooflab II	1B	2	AM	
202001330	Linear Structures II	1B	3	AM	202001325
202001026	Network Systems Core	2A	12	TCS	
202001231	Vector Calculus EE	2A	3	AM	
202001339	Presenting a Mathematical Subject	2A	2	AM	
202001343	Signals & Transforms	2B	5	AM	
202001344	Probability Theory AM	2B	5	AM/TCS	
202001028	Data & Information Core	2B	12	TCS	201500112
Entire academic year:			**79 EC**		

Table 10: The first academic year for the double degree programme AM-TCS

Course code	Course name	Q	EC	Division	Prerequisites
202001348	Mathematical Statistics	1A	6	AM/TCS	202001344
202001349	Project Statistics	1A	2	AM	
202001030	Computer Systems Core for CS	1A	12	TCS	
202001355	Systems Theory	1B	4	AM	
202001354	Ordinary Differential Equations	1B	4	AM	202001197
202001032	Intelligent Interaction Design Core for CS/BIT	1B	12	TCS	
201600061	Introduction Mathematical Modelling	2A	1	AM	
202001360	Algorithmic Discrete Mathematics	2A	5	AM/TCS	
202001361	Languages & Machines	2A	3.5	AM/TCS	
202001362	Algebra	2A	3.5	AM/TCS	
202001363	Implementation Project on Graph Isomorphism	2A	3	AM/TCS	202001030
202001366	Stochastic Models	2B	5	AM	
202001367	Project: Stochastic Models	2B	1.5	AM	
202001368	Markov Chains	2B	2.5	AM	
202001369	Project: Stochastic Simulation	2B	4	AM	
202001370	Multidisciplinary Project	2B	2	AM	
202001345	Project Signals & Uncertainty	2B	5	AM	
Entire academic year:			**76 EC**		

Table 11: The second academic year for the double degree programme AM-TCS

2 Extra requirements for double degree AM-TCS

The prospective student enrolled to the double degree programme AM-TCS must attend an extra intake/conversation to determine whether the student is motivated, ambitious and possesses the skills needed to succeed in the double degree programme.

Course code	Course name	Q	EC	Division	Prerequisites
202001350	Analysis II	1A	5	AM	
201400365	Discrete Mathematics (M5)	1A	3	TCS	
202001373	Reflection on Mathematical Research I	1A	5	AM	
	Minor selection	1B	15	AM/TCS	Entire first year
202001049	Design Project Core	2A	15	TCS	All components of 8 quartiles, including all first year components
	Elective AM selection	2A	5	AM	
201700274	Bachelor's Assignment Double Degree	2B	15	AM/TCS	
202001380	Reflection on Mathematical Research II	2B	2	AM	
202001381	Complex Function Theory	2B	3	AM	
Entire academic year:			**68 EC**		

Table 12: The third academic year for the double degree programme AM-TCS

3 Elective section

1. The Elective section consists of one elective course and one minor module;
2. The elective course must be chosen from:
   - ☐ 202001374 Graph Theory
   - ☐ 202001375 Mathematical Optimization
   - ☐ 202001376 Introduction to the Theory of PDE
   - ☐ 202001377 Simultaneous Statistical Inference
3. Available minors are listed on the minors site: www.utwente.nl/en/education/electives/minor/;
4. For an individual minor approval of the AM examination board is needed.

4 Sequence requirements

1. A student may enrol in the minor through the Minor Bureau once he/she has completed all first year study units upon registration in Osiris;
2. A student may only enrol in the Bachelor's Assignment once he/she has passed all first year study units and at least 8 quartiles of the complete programme.

5 Teaching evaluation

1. All study units of the programme are parts of some modules. The online Student Experience Questionnaire (SEQ) is used for evaluation purposes at the conclusion of modules;
2. At least once a year there will be a panel of discussion with students participating in the double degree;
3. Additionally, there will be an extra panel discussion after the first semester of the first year.

6 Pass/fail regulations

1. Students who meet the following requirements will pass the Bachelor's final degree audit for the AM and the TCS programme:
   a. The student has received an assessment for all study units of the double degree programme;
   b. The grades are 6.0 or higher for all study units.

2. In all other cases not specified under paragraph 1, the student will not pass the final degree audit for AM and TCS and will not receive the Bachelor's degrees.

7 Cum Laude

1. A student may pass the Bachelor's final degree audit for TCS and AM with distinction (cum laude) upon meeting the following requirements:
    a. The student passes the Bachelor's final degree audit for TCS and AM within four years of initial enrolment (performance requirement);
    b. The weighted average of the grades is 8.0 or higher (non-numeric assessments and exemptions not included). The average is weighted based upon the amount of credits.
    c. The grade for the Bachelor's Assignment is 8.0 or higher.
2. In exceptional cases and at the student's request, the Examination Board may award the distinction of cum laude if the student has met all requirements with the exception of the performance requirement, due to extenuating circumstances. These circumstances may involve delays recognised and provided for by the institution.

8 Binding Recommendation (BSA)

A student pursuing the double degree programme, as stipulated in Article 1 of this annex, will receive a positive recommendation on continuation of the study programme in Applied Matematics upon satisfying the following conditions (Article 6.3, Guideline and Model EER):

1. Successful completion of at least 45 credits from the first year's study units.
2. Successful completion of at least two of the following study units: Linear Structures I, Linear Structures II, and Analysis I.
3. A maximum of 15 EC incomplete from the total ECs associated with AM or AM/TCS study units of the first year's programme (see Table 10 in Article 1).

9 Transitional arrangements

For students who started the programme earlier than September 1st 2020, many study units, or parts thereof, as they existed at the time the student's enrolment, may no longer be offered. The curriculum, as given in Article 1 of this annex, serves as the basis for establishing the results of the bachelor's final examination.

Curricula of previous years and accompanying transitional arrangements are published on the Applied Mathematics website: https://www.utwente.nl/en/bam/bachelors-curriculum/