1st May 2020

Faculty of Applied Sciences at Delft University of Technology

Programme specific appendix MSc Life Science & Technology

to the Teaching and Examination Regulations for the MSc programmes of the Faculty of Applied Sciences

2020 - 2021

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2019-2020	**2020 – 2021**
LM3572 - Introduction to Algorithmics & Programming Skills 1 EC	Cancelled
LM3433 – Analysis of Metabolic Networks 5 EC	LM3432 – Analysis of Metabolic Networks 6 EC
LM3581 Systems Biology 3 EC	LM3512NB – Systems Biology 6 EC
Art. 5 'Variations' (so-called annotations) - Education - Communication - Study Abroad - Entrepreneurship - Technology in Sustainable Development (TiSD)	Art. 5 'Special programmes' - Education - Communication - Study Abroad - Management of Technology (entrepreneurship) TiSD = cancelled

Administrative data

1. Name of the programme: M Life Science and Technology
2. Croho: 21PF-66286
3. Level: WO- Master
4. Studyload: 120 EC
5. Specialisations: Cell factory; Biocatalysis; Biochemical engineering
6. Delft University of Technology
7. Government-Funded University
8. Result of review on university level: positive

Period of NVAO accreditation: the duration of the accreditation for an existing study programme is indefinite. Date of delivery of the next visitation report is 1 May 2025

ARTICLE 1 - (in line with TER article 5) – The programme's final attainment levels

Master's degree programme objectives
The objectives of the Master's degree programme in Life Science and Technology are:

- To instill scientific knowledge, insight, as well as methodical, technological and communicational skills that correspond to the specialized field of the degree programme
- To gain an academic attitude with a critical, scientific and creative way of thinking and the ability to engage interdisciplinary work, based on awareness of the ethical and social aspects referring to one's own research, and insight into professional situation and into the consequences for others of one's actions;
- To prepare for a scientific career and post-graduate education, especially for PhD education and to prepare for a career in society.

Exit qualifications Master's graduates:

1. **Competence in one or more scientific disciplines.**

Building on expected prior knowledge in the basic disciplines of biology, chemistry, physics, mathematics, and chemical engineering, the student develops, in the general compulsory modules, a thorough knowledge of the field of contemporary biotechnology at large and of the major interconnections between its founding sub-fields (e.g., cellular metabolism and industrial fermentation). Subsequently, the student takes a preferred orientation along one or two specialization(s) to develop mastery in relevant parts of the disciplines of (bio)chemistry (specialization biocatalysis) and/or industrial genomics, metabolic engineering and physiology (specialization cell factory) and/or biochemical engineering (specialization biochemical engineering). In these specialization-specific modules particular emphasis is placed on the latest results and methodologies and in the courses of their choice the student is stimulated to develop critical reading and interpretational skills with respect to the primary scientific literature.

2. Competence in doing research.

The student is expected to bring some prior experience in (supervised) research, e.g. the 3-months LS&T bachelor research project. The master research project (max. 8 months) is scheduled in the second year of the curriculum, in order for the student to be able to maximally capitalize on previously acquired knowledge. The project is typically carried out in a Department of Biotechnology group with a research profile matching the student's profile to assure a head-on start and expert guidance. A project is designed to be 'integral' i.e. it should trigger exploration of a range of scientific aspects and invoke a range of sufficiently different techniques to stimulate the student to develop intellectual flexibility and interdisciplinary orientation. As an example (for a biocatalysis project): an annotated but otherwise uncharacterized gene is cloned and expressed in a model organism; this species is grown in a fermenter for biomass; the expressed protein is purified; its catalytic activity is explored; prosthetic groups are spectroscopically characterized; a fine-chemical application is devised. The student is challenged to repeatedly formulate sub-research goals and to become acquainted with literature, experimental setups, paradigms in – in the example's case – molecular biology, biochemistry, biophysics and white biotechnology.

3. **Competence in designing**

Based on a succinctly formulated industrial assignment a group of 3-5 students runs a two-months conceptual design project for a bioprocess or a bioproduct. Starting from unbalanced information the group reformulates the assignment and chooses for a limited set of options in the form of a Basis of Design which should be defendable before a coach and an industrial representative. The subsequent design development confronts the team with questions of integration of existing knowledge, exploration of new fields, making choices of limitation, and relating the results to a range of constraints (economic, environmental, societal acceptance, safety, validation, quality assurance). The design project is scheduled to run concurrently with the compulsory module 'ethical, legal and social issues in biotechnology', whose final assignment is to reflect upon the design outcome.

4. **Scientific approach**

The curriculum in general is aimed at educating students to become independent, critical scientists and engineers. The student is exposed to, and trained to identify new developments especially in literature assignments in the profile-specific modules. At least during the period of his/her research project the student is strongly encouraged to attend the monthly ' Kluyver colloquia' of the Department of Biotechnology, where renowned national and international specialists from academia and industry elaborate on relevant topics. Doing a research project also implies participation in the regular work discussions of the hosting research group, where the student regularly presents intermediate results and puts interpretations to the test of a critical peer audience. All MSc students are

stimulated to adopt a 'bold and egalitarian' approach in scientific discussions with their peers, supervisors and teachers.

5. Basic intellectual skills
Extending the basic intellectual skills acquired, e.g., in the LS&T bachelor programme, the student is trained towards independence in assessing problems of increased complexity and in point-of-view adjustment. Decision making (reduction, elimination, re-orientation) is a key element in the design project. The concept of falsification (one original experiment calls for many control experiments) pervades the research project on a daily basis. Critical reading of literature is an integral part of the teaching in profile-specific modules. Modelling and numerical-analysis skills are also developed in several modules, and possible basic gap in knowledge are remedied at curriculum entry time.

6. Competence in co-operation and communication
Fruitful cooperation with equals, but also with external parties, is attained as conditio sine qua non for a successful design project. Choosing, assigning and accepting roles and responsibilities is an integral part of managing the project. Similarly, research projects by necessity provide many opportunities to develop professional cooperativity with technical assistants and with junior and senior scientists. In a different vein cooperativity skills are obtained in the course of the 3-months industrial internship intended to be a 'culture shock' for the student to juxtapose 'the outside' versus academic life. Each of these parts of the curriculum call for formal verbal and written reporting usually in the English language.

7. Taking account of the temporal and social context.
With the compulsory general module 'Ethical, legal and societal issues in biotechnology' the student learns to choose his/her place as a professional in society. In the combination of this module with the Design project the student actualizes the integration of societal aspects in scientific work. Elements of contemporary interaction between society and science & technology also appear in several modules, e.g., atom efficient green chemistry (biocatalysis), toxic metals (advanced enzymology), products from waste (environmental biotechnology).

ARTICLE 2 (in line with TER article 3) – Admission to the programme

2.1. Individuals holding one of the following degrees have access to the education of the Master's degree programme in Life Science & Technology on the condition that all of the stated requirements have been met.

a. Specific university Bachelor's degree:
joint bachelor's degree in Life Science & Technology (Leiden/Delft) or equivalent. These equivalencies and a description of the entry levels, are laid down in the webpage 'transfer matrix'.

b. Other university Bachelor's degree (not including those listed in Subsection a):
The following applies to this category:
- University Bachelor's degree [name, to be confirmed by the admission committee]
- In case required, successful completion of the stated (tailor-made) bridging programme for admission to the Master's degree programme. Bridging programme to be followed: S-LST.

c. Higher professional education degree
The following applies to this category:
- A Bachelor of Engineering degree in Life Science & Technology (HBO) or equivalent can be admitted to the programme. These equivalencies and a description of the entry levels, are laid down in the webpage admission HBO.
- Students with a Bachelor of Engineering degree (HBO) can be admitted to the programme provided he/she has a minimum Grade Point Average of 75% and no delay of study (guideline). Before starting the (Bridging) Programme, students should have successfully passed the entrance exams for Mathematics and English. A tailor-made bridging programme may be part of the entrance requirements.
- In case required, successful completion of the stated (tailor-made) bridging programme for admission to the Master's degree programme. Bridging programme to be followed: S-LST.

d. Foreign degree
This category is subject to:the general selection requirements of Delft University of Technology with regard to prior foreign education, based on a Cumulative Grade Point Average of at least 75% of the maximum number of points

that could be earned, included in the table of countries (see website). A GPA of 75% for key subjects is also required. Students must meet the requirements for satisfactory linguistic mastery of English. One of the following certificates are accepted:

- A TOEFL iBT (Test of English as a Foreign Language internet-Based Test) with an overall band score of at least 90 and a minimum score of 21 for each section.
- An IELTS (academic version) with an overall Band score of at least 6.5 and a minimum of 6.0 for each section.
- A Cambridge Assessment English. Only the following are accepted:
    - C1 Advanced (Certificate of Advanced English) with an overall score of 176 and a minimum of 169 for each section.
    - C2 Proficiency (Certificate of Proficiency in English) with an overall score of 180 and a minimum of 169 for each section

Certificates older than two years are not accepted.

2.2. Access to the education of the Master's degree programme in Life Science & Technology is open to individuals who have demonstrated to the admissions committee that they possess knowledge, insight and skills at the level of the Bachelor's degree mentioned Subsections 2a, or of a university Bachelor's degree, in addition to the further requirements mentioned in Subsections 2b and 2c.

2.3. All students are also subject to the following qualitative admission requirements:

Students who do not possess the degree mentioned in paragraph 1.a. are required to obtain proof of admission to the programme from the dean, who will seek the advice of the admissions officer on this matter. The levels and subjects for assessing previous education are a sufficient level in the following knowledge areas:

a) Mathematics (differential equations, linear algebra)
b) Chemistry (organic, inorganic, analytic, physical)
c) 'Bio' (i.e. biochemistry, molecular genetics, microbiology)
d) (Bio) chemical technology (including transport phenomena)
e) Introduction to a program such as matlab or python.

ARTICLE 3 (in line with TER art. 7) - The study load and academic year

1. The study load for the Master's degree programme is 120 credits. None of the components of the programme may have formed part of the Bachelor's degree programme.
2. The Master's degree programme consists of 2 academic years.
3. One academic year is divided into two semesters, each containing 2 teaching periods.

ARTICLE 4 (in line with TER art. 7) - The composition of the Master's programme

4.1 The study programme is completed in the following way:

a. In the first year: general compulsory courses (15 EC), specialisation courses (18 EC), electives (12 EC), the Design Project (12 EC).
b. In the second year: master thesis project (45 EC) & company internship (18 EC).

4.2. General overview of the programme:

Course code			ECTS = European Credit Transfer System	period /contact hours	exams = e resit = r
Year 1					
1. General mandatory modules					
LM3432	Analysis of Metabolic Networks		6	24/20/0/0	n.a.
LM3452	Bioprocess Integration		6	42/0/0/0	e/r/0/0
LM3561	Ethical, Legal and Social Issues in Biotechnology		3	0/0/0/8	n.a.
LM3822	Design project		12	0/0/0/296	n.a.
		General Mandatory part of the exam pro	27		
2. Specialisation courses		**Students must complete at least one full specialization!**			
2.1 Cell Factory					
LM3442	Metabolic Reprogramming		6	20/4x12/0/0	0/e/r/0
LM3601	Molecular Biotechnology & Genomics		6	20/22/0/0	0/e/r/0
LM3611	Microbial Community Engineering		6	0/0/42/0	0/0/e/r
2.2. Biocatalysis					
LM3701	Advanced Enzymology		6	20/22/0/0	0/e/r/0
LM3731	Advanced Biocatalysis		6	20/22/0/0	0/e/r/0
LM3434	Advanced Protein Chemistry and Analysis		6	0/0/42/0	0/0/e/r
2.3. Biochemical Engineering					
LM3741	Fermentation Technology & Environmental Biotechnology		6	20/22/0/0	0/e/r/0
LM3751	Transport & Separation		6	0/0/42/0	0/0/e/r
LM3761	Numerical Methods, Modeling and Simulation Techniques		6	24/16/0/0	0/e/r/0
		Specialization courses	18 EC		
3 - Electives part					
A list of preferred electives for each specialization and the corresponding procedures for choosing electives are published on Brightspace MSc Life Science & Technology, accessible with a TUD NetID, or on demand through m.vandergeur@tudelft.nl. Specific LST-electives are mentioned hereafter:					
LM3771	Protein Engineering		3	0/0/20/0	0/0/e/r
LM3311	Green Chemistry & Sustainable Technology		3	0/0/0/18	0/0/0/e/r
LM3512NB	Systems Biology		6	0/0/16/0	n.a.
LM3691	iGEM		18		
		Elective courses	12 EC		
YEAR 2					
4 - PROJECTS					
A: LM3901	Master Thesis Project (MEP)		45	n.a.	n.a.
B: LM3802	Company Internship		18	n.a.	n.a.
	or equivalent:				
C: AE4040TU	Joint Interdisciplinary Project	15		Period 1	
	+ 3 EC elective, preferably AS3121 = Scientific writing & argumentation 3	3	18		
		Total year 2	63 EC		
		Total number EC MSc-LST	120 EC		

Students are allowed to substitute 30 EC of the above-mentioned MSc programme LS (12 EC electives + 18 EC company internship) by the following Special Programmes:
Science Communication , ***Science Education*** , ***Management of Technology,*** ***Study Abroad*** .

4.3 MSc - thesis project (MEP) – LM3901

a. ***Entry requirement*** for the MEP project: one retake for a single compulsory / elective course is allowed (mark should be at least 4.5 for the failed exam), not taking into account the Design project & the Company Internship.
b. ***Approval*** of both supervisors ***and*** specialization coordinator is needed.
c. ***Students*** need to deliver a transcript along with their MEP application form.
d. ***Projects in the Faculty of Applied Sciences are allowed.*** Each review committee should have a BT-supervisor, *who also surveys the deadlines of the project*.
e. For proper assessment of ***projects in the research section 'Biotechnology & Society',*** a 4th reviewer should be appointed in the review committee, being an expert in the field of environmental, societal or economic analysis should.
f. Projects on 'Waste Water Treatment' and 'Environmental Engineering' (section Sanitary Engineering, Dept. of Water Management, Faculty of Civil Engineering & Geosciences) and in the Bio-Informatics Lab (Faculty of Electrical Engineering, Mathematics & Computer Science) are also permitted. Each review committee should have a BT-supervisor, *who also surveys the deadlines of the project*.
g. Under exceptional circumstances supervisor and specialization coordinator can deviate from these rules, by formally asking the sub-board of examiners (boardofexaminers-lst-as@tudelft.nl.

4.4 Company internship – LM3802

a. Students perform their Company Internship preferably after the thesis project.
b. The duration of an industrial internship is no longer than **3 months (= 18 EC)**.
c. The industrial internship is carried out in a **company,** or in exceptional cases in a **research institution in the private sector.**
d. In case a student has accepted a longer duration of the internship (i.e. a longer duration at 'own risk and no income') a report on the internship should be handed in within the 3 months of the nominal duration of the internship.
e. Before the start of the Internship, students have to deliver an **Internship Application Form** to the internship office. No application form, no mark in the end!

ARTICLE 5 – Scientific & Social Orientation

Students are allowed to substitute 30 EC of the exam programme as described in 4.2 (12 EC electives + 18 EC company internship) by the following variations:

- Science Education Track of MSc-SEC (Suzanne Karssen - Minekus– TNW) (see also article 7)
- Science Communication Track of MSc-SEC (Suzanne Karssen - Minekus – TNW)
- Study abroad (InternationalOffice-TNW@tudelft.nl).
- Choice of courses from the MSc programme Management of Technology (Mirjam van der Geur)

These special programmes must be approved by the coordinator of the specialization and the sub-Board of Examiners MSc LST.

ARTICLE 6 - Honours programme

Regulations on the Honours programme are described in *article 10 of the Teaching & Examination Regulations* of the Master's degree programmes Applied Sciences 2019-2020.
The honours programme is a challenging additional programme for students with higher than average performance (>7.5 weighted average). The honours programme consists of at least 20 EC on top of the regular master programme of 120 EC. The full Master's programme LST, including the additional honours programme should be finished according to nominal duration, with again a weighted average of 7.5.
Each individual honours programme needs to be discussed with and approved by Director of Studies (prof. dr Ulf Hanefeld) before the start of the honours programme!

Schematic overview of the honours programme

Collective Part (5 EC) – choice out of two courses:
- Critical Reflection on Technology (UD2010, 5EC)
- Business Leadership for Engineers (UD2012, 5 EC)

The **Individual Part (15 EC)** can be ***company-, research-*** or ***design***-oriented.

1. ***Company Oriented***
   Honours Programme of Applied Sciences
   - AS1011HPM Applied Sciences Company Project 12 EC
   - AS1021HPM Applied Sciences Honours Classes 3 EC

2. ***Research Oriented***
to compose a challenging, coherent package of MSc courses ***or*** a research projects of at least 15 EC

3. ***Research & Design oriented***
   to participate in the iGEM project (LM3691, 18 EC).
   The iGEM project can be performed as part of an individual honours programme, under the condition that the Design project (12 EC) will be carried out as well

4. ***Design oriented***
   to compose a challenging package of Design courses, offered by the PDEng programmes of Applied Sciences.

The programme should be submitted to the faculty contact person for the honours programme, mrs Helen Emmerink, after approval by the LST Director of Studies Prof.dr Ulf Hanefeld.

ARTICLE 7 - Education track of the MSc-programme Science Education & Communication (only Dutch-speaking students).

Students in the MSc-programme Life Science & Technology can do educational modules.
The coordinator of the specialisation has to approve this.

The educational programme is aimed at Dutch-speaking students with a BSc-background in (applied) physics, chemistry, life science & technology, applied mathematics and computer science only, because they are oriented towards the Dutch school system and because it includes internships (Schoolpracticum) at Dutch secondary schools. Consequently, the educational specialisation modules are taught in Dutch. The programme consists of Basisdeel/Ed1 (30 EC) and Verdiepingsdeel/Ed2 (30 EC).

- The minor Education (Basisdeel/Ed1) can be done during the bachelor programme and leads to qualification as a *tweedegraads* secondary school teacher with limited qualification (*beperkte bevoegdheid*).
- If a student has done the minor Education, only the Verdiepingsdeel/Ed2 of 30 EC remains for the master programme specialisation. The combination of the minor Education and Ed2 specialisation leads to qualification as a fully-qualified *eerstegraads* (grade-one) secondary school teacher. The qualification will be mentioned on the master diploma. These students can do the Verdiepingsdeel/Ed2 also as a second master.
- Students that did not take the minor Education can follow the Basisdeel/Ed1 specialisation as part of their master programme and then do the Verdiepingsdeel/Ed2 as a second master in order to become fully qualified.

The educational programme should be approved by the SEC-coordinator, Suzanne Karssen - Minekus

ARTICLE 8 - Double degree

Students who opt for a **double degree** (second master) and have obtained permission are allowed to spend the Scientific and Social Orientation on modules from the second master programme.
Double degree programmes combining Life Science & Technology with other master programmes, such as Management of Technology, are always subject to the restrictions imposed by the university. The main restrictions are that the double degree programme comprises at least 180 EC and that there are two identifiable final project reports for both degrees. Formal permission from the Boards of Examiners of both faculties is required.

After approval of the two Boards of Examiners, the approved application has to be sent to the Student Programme Administration, SPA-TNW@TUDelft.nl.

ARTICLE 9 - Explanation of programme components.

Every year, the digital study guide includes a description of the various programme components, along with the criteria for assessing these components if assessment is different from that applied for interim examinations (reports, presentations, etcetera).

ARTICLE 10 - Deviations from the programme

Only in exceptional cases a deviation from the programme is possible. Such deviations need prior approval by the sub-Board of Examiners; for this reason a student should send a legitimate request to the sub-Board of Examiners after consultation with the coordinator of the specialisation.

If students participate in iGEM (LM3691 - 18 EC) as part of their regular programme, they can apply for an exemption for the Design project (LM3822 - 12 EC). The remaining 6 EC are extracurricular.