

THE IMPLEMENTATION REGULATIONS

2014-2015

**MASTER OF SCIENCE
APPLIED EARTH SCIENCES**

DELFT UNIVERSITY OF TECHNOLOGY

Section 1 – Compiling the study programme

Article 1 – The study load

The study load for the Master's degree course is 120 credits. None of the components of the course may have formed part of the Bachelor's degree course in Applied Earth Sciences ("Technische Aardwetenschappen").

Article 2 – Tracks, specialisations and profiles

1. The course comprises the following tracks:

- Petroleum Engineering and Geosciences, as laid down in Article 4 specialisations:
 - Petroleum Engineering
 - Reservoir Geology
- Geo-Engineering, as laid down in Article 5A
- Geoscience and Remote Sensing, as laid down in Article 5B
- Applied Geophysics, as laid down in Article 6
- Resource Engineering, as laid down in Article 7 specialisations:
 - European Mining Course (EMC)
 - European Mineral Engineering Course (EMEC)
 - European Geotechnical and Environmental Course (EGEC).

2. Within a track or within a specialisation the student may opt for the annotations, mentioned in Articles 8 and 9:

- Technology in Sustainable Development
- Entrepreneurship.

Article 3 – Registering the tracks and compiling the examination programme

1. When students register for the Master's degree course, they need to indicate their track and specialisation of interest.
2. At the start of the programme the students need to determine their examination programme in cooperation with the relevant graduation coordinator.
3. Prior to the start of the Final Thesis students need to present to the Board of Examiners their examination programme together with the title, a short abstract, a time schedule and the chairman and members of the assessment committee of the Final Thesis for approval.
4. Any amendments made to the approved examination programme or to the approved assessment committee should be presented to the Board of Examiners for approval.
5. Students who opt for the annotations Technology in Sustainable Development or Entrepreneurship need the approval of their examination programme from the referee of the chosen annotation prior to presenting their examination programme to the Board of Examiners.

Article 4 – The Petroleum Engineering and Geosciences track

1. The study programme of the Petroleum and Geosciences track is compiled in the following way:

- track-linked compulsory core programme
44 credits, laid down in subsection 2
- specialisation-linked subjects:
 - 66 credits for the specialisation Petroleum Engineering, laid down in subsection 3
 - 67 credits for the specialisation Reservoir Geology, laid down in subsection 4
- electives:
 - 10 credits for the specialisation Petroleum Engineering, as laid down in subsection 5
 - 9 credits for the specialisation Reservoir Geology.

2. Compulsory core programme Petroleum Engineering and Geosciences track:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES0102	Image Analysis	1

AES1011	Matlab / Programming	2
AES1300	Properties of Hydrocarbons and Oilfield Fluids	3
AES1310-10	Rock Fluid Physics	3
AES1320	Modelling of fluid Flow in porous Media	3
AES1340	Reservoir Engineering	2
AES1510	Geologic Interpretation of Seismic Data (practical included)	3
AES1520	Log Evaluation	2
AES1802	Geological Fieldwork	3
AES1820-09	Reservoir Characterisation and Development	4
AES1890	Sedimentary Systems	3
AES1920	Geostatistics	2
AES1930	Quantification of Rock Reservoir Images	1
AES2009	Field Development Project	9
AES3820 ¹	Petroleum Geology	3

3. Subjects linked to the specialisation Petroleum Engineering:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1304	Introduction to Petroleum Engineering and NAM Visit	3
AES1330	Drilling and Production Engineering (lab. exp. included)	4
AES1350	Reservoir Simulation	2
AES1360	Production Optimization	3
AES1500	Fundamentals of Borehole Logging	4
WI4012TA	Mathematics, Special Subjects	4
AESM2006	Final Thesis Petroleum Engineering	45

4. Subjects linked to the specialisation Reservoir Geology:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1800	Exploration Geology	3
AES1830	Reservoir Sedimentology	3
AES1840	Advanced Structural Geology	3
AES1850	Geological Modelling	4
AES1860-05	Analysis of Sedimentological Data	3
AES1902	Reservoir Geological Fieldwork	6
AESM2006	Final Thesis Reservoir Geology	45

5. The following optional electives are offered within the specialisation Petroleum Engineering:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1370-12	Non-Thermal Enhanced and Improved Oil Recovery	3
3AES1460	Heavy Oil	2
AES1470	Geothermics	2
AES1490	Advanced Reservoir Simulation	2
WM096TA	Special Topics in Geosciences and Sustainable Development	3

Article 5A – The Geo-Engineering track

1. The study programme for the Geo-Engineering track consists of:

- a common compulsory Geo-Engineering block
72 credits, laid down in subsection 2
- Geo-Engineering electives
adding up to a total of 100 track-linked credits, as laid down in subsections 2 and 3
- electives
20 credits, as laid down in subsection 4.

2. Common compulsory block Geo-Engineering

All students opting for the track Geo-Engineering must complete the following subjects adding up to 72 credits:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1630	Engineering Geology	4
CIE4361	Behaviour of Soils and Rocks	6
CIE4365-13	Coupled Processes in Subsurface	6
CIE4366	Numerical Modelling in Geo-Engineering	6
CIE4395	Risk and Variability in Geo-Engineering	4

¹ Not if AES3820 has been completed in the Bachelor's fase

CIE5320	Site Characterisation, Testing and Physical Modelling	6
AESM2606	Final Thesis Geo-Engineering	40

2. Geo-Engineering electives

If the Bachelor's phase did not include WM0325TA, Technics and Responsibility, students shall choose one out of two:

CIE 4510	Climate Change: Science and Ethics	4
WM0312CIE	Philosophy, Technology Assessment and Ethics	4

Students are required to complete a selection of the following subjects adding up to a total of 100 track-linked credits.

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1501	Methods of Exploration Geophysics	3
AES1640-11	Environmental Geotechnics	4
AES1720-11	Rock Mechanics Applications	5
AES1730	Introduction to geotechnical Engineering	3
AESM2901	Geoscience and Engineering Fieldwork	6
CIE4353	Continuum Mechanics	6
CIE4362	Soil-structure Interaction	3
CIE4363	Foundation and Deep Excavations	4
CIE4367	Embankments and Geosynthetics	4
CIE4390	Geo-risk Management	3
CIE4420	Geohydrology	4
CIE4780	Trending Topics in Geo-Engineering	4
CIE5305	Bored and Immersed Tunnels	4
CIE5340	Soil Dynamics	3
CIE5741	Trenchless Technologies	4
OE4624	Offshore Soil Mechanics	4

4. Electives

Choose two out of:

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES0404-10	Traineeship	10
AES4011-10	Additional MSc Thesis	10
CIE4061-09	Multi-disciplinary Project	10
Any Master's degree course subject Applied Earth Sciences or Civil Engineering		10
Free Master of Science electives		10

Article 5B – The Geoscience and Remote Sensing track

1. The study programme for the Geoscience and Remote Sensing track consists of:

- a common compulsory Geoscience and Remote Sensing block
73 credits, as laid down in subsection 2
- Geoscience and Remote Sensing electives
27 track-linked credits, as laid down in subsections 2 and 3
- electives
20 credits, as laid down in subsection 4.

2. Common compulsory block Geoscience and Remote Sensing

All students opting for the track Geoscience and Remote Sensing must complete the following subjects adding up to 73 credits:

<u>code</u>	<u>subject</u>	<u>ECs</u>
CIE4601	Physics of the Earth and Atmosphere	5
CIE4603	Geo-signal Analysis	5
CIE4604	Simulation and Visualization	5
CIE4606	Geodesy and Remote Sensing	5
CIE4611	Geo-measurement Processing	5
CIE4613 ²	Climate Change: Science and Ethics	5
CIE4615	GRS Fieldwork	3
AESM2640	Final Thesis Geoscience and Remote Sensing	40

3. Geoscience and Remote Sensing electives

Students are required to complete a selection of the following subjects adding up to a total of 27 credits.

² Compulsory if the Bachelor's phase did not include WM0325TA, Technics and Responsibility

Choose at least 12 credits out of:

<u>code</u>	<u>subject</u>	<u>ECs</u>
CIE4602	Observation of Land-surface Processes	4
CIE4605	Atmospheric Science	4
CIE4607	Oceans, Sea-level and Bathymetry	4
CIE4608	Atmospheric Observation	4
CIE4609	Geodesy and Natural Hazards	4
CIE4610	Mass Transport in the Earth's System	4
CIE4614	Land Surveying and Civil Infrastructure	4

and choose adding up to a total of 27 credits out of:

<u>code</u>	<u>subject</u>	<u>ECs</u>
CIE4612	Research Seminar Geoscience and Remote Sensing II	1
CIE5601	Advanced Topics in Geoscience and Remote Sensing	3
CIE5602	Research Seminar Geoscience and Remote Sensing I	1
CIE5603	Advanced Project on GRS	3
Any Master's degree course subject Applied Earth Sciences or Civil Engineering		

4. Electives

Choose two out of:

<u>code</u>	<u>subject</u>	<u>ECs</u>
CIE4040-09	Internship	10
AES4011-10	Additional Thesis	10
CIE4061-09	Multi-disciplinary Project	10
Any Master's degree course subject Applied Earth Sciences or Civil Engineering		10
Free Master of Science electives		10

Article 6 – The Applied Geophysics track

The Applied Geophysics programme is taught at three partner universities:

- TU Delft
- ETH Zürich
- RWTH Aachen

The study programme is compiled in the following way:

First year

Delft

A minimum of 25 credits should be passed from TU Delft subjects, whereby two of the following three blocks must be passed:

- Geology and Interpretation: AES1510 and AES1890 and AES3820
- Electromagnetic Methods: AES1540-11
- Seismic Wave Propagation and Imaging: AES1560.

<u>code</u>	<u>subject</u>	<u>ECs</u>
AES1011	Matlab / Programming	2
AES1501	Methods of Exploration Geophysics	3
AES1510	Geologic Interpretation of Seismic Data	3
AES1540-11	Electromagnetic Exploration Methods	6
AES1550-06	Geophysics Special Subjects	6
AES1560	Advanced Reflection Seismology and Seismic Imaging	6
AES1590-12	Seismic Resolution	5
AES1890	Sedimentary Systems	3
AES3520	Introduction to Reflection Seismics	1
AES3820	Petroleum Geology	3
CIE4606	Geodesy and Remote Sensing	5

Zürich

A minimum of 25 credits should be passed from the ETH Zürich subjects, whereby two of the following three blocks must be passed:

- Processing: 651-4079-00L
- Field Course: 651-4089-00L and 651-4104-00L
- Modelling and Inversion: 651-4094-00L and 651-4096-00L.

<u>code</u>	<u>subject</u>	<u>ECs</u>
651-4079-00L	Reflection Seismology Processing	6

651-4081-00L	Groundwater II	6
651-4087-01L	Case Studies in Engineering and Environmental Geophysics	4
651-4089-00L	Geophysical Field Work and Processing	7
651-4094-00L	Modelling for Applied Geophysicists	3
651-4096-00L	Inverse Theory for Applied Geophysicists	4
651-4099-01L	Soil Mechanics for Geophysics	4
651-4104-00L	Field Work Methods	2

Second year

Aachen

A minimum of 25 credits should be passed from the RWTH Aachen subjects, whereby three of the following four blocks must be passed:

- Geophysics special Methods: 13ws-29463 and 13ws-14238
- Geophysical Logging and Log Interpretation: 13ws-14570
- Geothermics: 13ws-13943
- Hydrogeophysics and Data Analysis in Geoscience: 13ws-18482 and 13ws-18162

<u>code</u>	<u>subject</u>	<u>ECs</u>
13ws-29463	Geophysics special Methods: NMR	3
13ws-14238	Geophysics Special Methods: Spectral IP	3
13ws-14570	Geophysical Logging and Log Interpretation	5
13ws-13943	Geothermics	5
13ws-18482	Hydrogeophysics	3
13ws-18162	Data Analysis in Geoscience	3
13ws-18598	Mineral Exploration	3
13ws-23301	Petroleum System Modelling/Sedimentary Basin Dynamics	6
13ws-29469	Engineering Geophysics	3
13ws-34831	Remote Sensing of Sedimentary Basins	3
13ws-24349	Planning-Realization-Optimization in Georesources Management	3
13ws-24537	Prospect Evaluation and Risk Analysis	3
13ws-24536	Portfolio Management	3
13ws-24346	Energy Resource Management (if Mineral Exploration not taken)	3
13ws-14775	Introduction to scientific Computing Languages	6
13ws-24760	Microstructural Analysis	6
13ws-34157	Applied Structural Geology	3
13ws-12379	Einführung in Geographische Informationssysteme (GIS)	3

Delft/Aachen/Zürich

<u>code</u>	<u>subject</u>	<u>ECs</u>
AESM2506	Final Thesis Applied Geophysics	30

Article 7 – The Resource Engineering track

1. The specialisation European Mining Course, as laid down in subsection 2, is taught at three partner universities:

- Helsinki University of Technology
- RWTH Aachen
- TU Delft

The specialisation European Mineral Engineering Course, as laid down in subsection 3, is taught at four partner universities:

- University of Wrocław (Poland)
- Helsinki University of Technology
- TU Delft
- University of Miskolc (Hungary)

The specialisation European Geotechnical and Environmental Course, as laid down in subsection 4, is taught at three partner universities:

- University of Wrocław (Poland)
- TU Delft
- University of Miskolc (Hungary)

2. The study programme of the specialisation European Mining Course (EMC) is compiled in the following way:

First year

1st semester: Helsinki

<u>code</u>	<u>subject</u>	<u>ECs</u>
H-BSREM	Business Strategies and Risk Evaluation in Mining	5
H-MRD	Mineral Resource Definition	10
H-ESD	Environment and Sustainable Development	5
H-AR	Applied Rock and Soil Mechanics	5
H-FEPHRM	Field Experience and Project in hard Rock Mining	5

2nd semester: Aachen

<u>code</u>	<u>subject</u>	<u>ECs</u>
A-FST	Feasibility Studies	3
A-RME	Reserve Modelling and Estimation	4
A-UMD	Underground Mine Design	4
A-SMD	Surface Mine Design	4
A-FM	Financial Modelling	2
A-MV-14	Mine Ventilation	6
A-CS-14	Case Study	7

Second year

3rd semester: Delft

<u>code</u>	<u>subject</u>	<u>ECs</u>
D-SSL	Soft Skills and Leadership	3
D-LHS	Legal, Health and Safety	10
D-IS	Investment Scenarios: Identifying and Mitigating Project Risk	3
D-MOM	Mine Operational Management	2
D-BQM	Business and Quality Management	5
D-PEIP	Project Execution/Implementation Plan	7

4st semester :

<u>code</u>	<u>subject</u>	<u>ECs</u>
	Final Thesis	30

3. The study programme of the specialisation European Mineral Engineering Course (EMEC) is compiled in the following way:

First year

1st semester: Miskolc

<u>code</u>	<u>subject</u>	<u>ECs</u>
M-PP	Particulate Processes	5
M-MP	Mechanical Processes	7
M-EGM	Economic Geology and Mineralogy	3

1st semester: Wroclaw

<u>code</u>	<u>subject</u>	<u>ECs</u>
W-HM	Hydrometallurgy	6
W-PY	Pyrometallurgy	6
W-BIO	Biomining	4
W-FL-14	Flotation	4

2nd semester : Helsinki

<u>code</u>	<u>subject</u>	<u>ECs</u>
H-SSIRW	Sustainable Systems for inorganic raw Materials	10
H-MRPD	Mineral and recycling Plant Design	8
H-MRBPO	Mineral and recycling Beneficiation Process Optimization	7

Second year

3rd semester: Helsinki

<u>code</u>	<u>subject</u>	<u>ECs</u>
H-ID	Industrial Design	10
H-SSM	Sustainable System Modelling	10
H-DP	Design Project	10

4st semester :

<u>code</u>	<u>subject</u>	<u>ECs</u>
	Final Thesis	30

4. The study programme of the specialisation European Geotechnical and Environmental Course (EGEC) is compiled in the following way:

First year

1st semester: Miskolc

<u>code</u>	<u>subject</u>	<u>ECs</u>
M-MRD	Mineral Resource Definition	8
M-EMG	Engineering and Mining Geophysics	3
M-GERA	Geohydrology and Environmental Risk Assessment	5
M-UWMS	Underground Waste Management and Storage	4
M-GE	Geothermal Energy	4
M-MW	Mine Waste and contaminated Soil Characterization and Treatment	6

2nd semester: Wroclaw

<u>code</u>	<u>subject</u>	<u>ECs</u>
W-PMA	Project Management, Appraisal and Risk Evaluation in Mining	5
W-TPG	Theory and Practice in Geomechanics	7
W-CAGM	Computer aided geological Modelling and Land Reclamation	3
W-TUED	Tunnel and Underground Excavation Design	5
W-EDOP M	Excavation Design in open Pit Mining	5
W-IA	Integrated Analysis of Deformations in geomechanical Engineering	5

Second year

3rd semester: Delft

<u>code</u>	<u>subject</u>	<u>ECs</u>
D-EG-14	Environmental Geotechnics	4
D-RMA	Rock Mechanics Applications	5
D-SR-14	Material Models for Soil and Rocks	6
D-IP	Integrated Project (Environmental Management/Mine Closure)	15

4th semester :

<u>code</u>	<u>subject</u>	<u>ECs</u>
	Final Thesis	30

Section 2 – Annotations and Honours Programme

Article 8 – The Technology in Sustainable Development annotation

1. The examination programme for students who have opted for the annotation known as Technology in Sustainable Development must at least include the following:
 - a. A sustainable development colloquium totalling 5 credits: WM0939TU, Engineering for Sustainable Development,
 - b. Subjects within or outside the realm of the programme adding up to a total of at least 10 credits to be selected from the two clusters:
 - Design, Analysis and Tools
 - Organisation and Society.At least 3 credits should derive from each of the clusters.
Further information on the subjects to be selected and on the clusters is available from the programme coordinator, from the study guide and from the website of Delft University of Technology.
 - c. The Final Thesis must partly focus on the topic of sustainable development. The referent will test the hypothesis of the Final Thesis and the way in which it has been tackled against the extent to which sustainable development issues have been integrated into the project.
3. Students who complete the annotation successfully, receive an annotation Technology in Sustainable Development with their degree certificate.

Article 9 – The Entrepreneurship annotation

1. The examination programme for students who have opted for the annotation Entrepreneurship must at least include the following:
 - a. Electives related to entrepreneurship adding up to a total of 15 credits, 10 of which are extracurricular,
 - b. The Final Thesis must partly focusing on the topic of entrepreneurship.
2. The examination programme for the Entrepreneurship annotation needs the prior approval by the Programme director and a coordinator of Delft Centre for Entrepreneurship.

- Students who complete the annotation successfully, receive an annotation Entrepreneurship with their degree certificate.

Article 10 – Honours Programme Master

- Motivated students who have finished their Bachelor's degree course with a weighed averaged mark of 7.5 or higher, and students who have excelled during the first semester (no fails and a weighed average of 7.5 or higher) are eligible for a special individual programme of 20 credits on top of the Master's degree course: the Honours Programme Master.
- The content of the Honours Programme Master should be thematically consistent. The subject WM0355HT, Critical Reflection on Technology, 5 credits, is compulsory to the Honours Programme Master.
- Students who fulfil, or will fulfil, the requirements laid down in subsection 1, and are interested in the Honours Programme Master can send their application to the programme coordinator together with an essay in English, containing their motivation and a proposal for the programme. The programme has to be approved by a scientific staff member and the programme coordinator.
- The Honours Programme Master has to be completed during the course of the student's Master's programme. None of the results may be lower than 6,0.
- The various parts of the programme will be assessed by the respective examiner(s). The fulfilment of all criteria to the Honours Programme Master will be assessed by the board of examiners.
- Students who have successfully completed the Honours Programme Master will receive a special certificate from the university with their degree certificate.

Section 3 – Transitional programme

Article 11 – Transitional programme for students with a Dutch higher vocational institute Bachelor degree

Students who want to be admitted to the Master's degree course on the basis of a relevant Dutch higher vocational institute Bachelor degree have to complete the following transitional programme first.

<u>code</u>	<u>subject</u>	<u>ECs</u>
AESB1130	Geology 1: Basics	5
AESB1230	Geology 2: North West Europe	5
AESB1420	Mechanics 2	5
AESB2320	Physical Transport Phenomina	5
AESB2330	Soil Mechanics <i>(only for Geo-Engineering)</i>	5
AESB2440	Geostatistics and Remote Sensing	5
AESB3340	Mechanics and Transport by flow in porous Media	5
WI1708TH1	Analysis 1	3
WI1708TH2	Analysis 2	3
WI1708TH3	Analysis 3	3
WI1807TH1	Linear Algebra (part 1)	3
WI1909TH	Differential Equations	3
CTB2400	Numerical Methods for Differential Equations	3

Section 4 – Deviate from examination programme

Article 12 – The free study programme

- Students are free to compile examination programmes that are rounded off with a final exam. Such a programme needs prior approval by the Board of Examiners and it must consist entirely or mainly of subjects given in conjunction with the degree course but it can be complemented with subjects provided by or given in other courses.
- The preliminary approval referred to in subsection 1 must be presented to the Board of Examiners by the student in the form of a justified request.

Section 5 – Examinations and practicals

Article 13 – Practical and/or exercises

1. The course teaching takes the form of lectures, practicals and/or exercises.
2. Practical and/or exercises must be completed before students participate in the examination unless otherwise indicated in the study guide.

Article 14 – The types of examinations

1. The examinations linked to the different subjects are to be completed in the way laid down in the study guide pertaining to the subject in question.
2. Examinations pertaining to subjects given by other programmes are to be completed in the way stipulated by or on behalf of the Teaching and Examination Regulations laid down by the relevant programme.

Article 15 – The frequencies, times and sequences of the exams

1. Written or oral examinations are to be completed in principal at the end of the teaching period in which the subject was taught.
2. The resit periods for any of the written exams referred to in subsection 1 are at the end of the next teaching period. For subjects taught in the fourth teaching period the resit period is in August.
3. Practical and/or exercises may be completed in the way laid down in the relevant timetables.

Section 6 – Access to Field Development Project, Geoscience and Engineering Fieldwork and Final Thesis

Article 16 – Access to Field Development Project

Students may not embark on the Field Development Project (AES2009) until they have completed the following subjects:

AES1300, Properties of Hydrocarbons
AES1310 or AES 1310-10, Rock Fluid Interaction 1
AES1320, Rock Fluid Interaction 2
AES1340, Applied Reservoir Engineering and Simulation 1
AES1510, Geologic Interpretation of Seismic Data
AES1520, Log Evaluation
AES1820 or AES1820-09, Reservoir Characterisation and Development
AES1870, Sequence Stratigraphy, or AES1890, Sedimentary Systems
AES1920, Geostatistics.

Additionally, students with the specialisation Petroleum Engineering are advised to have completed the subjects:

AES1330, Drilling and Production
AES1360, Production Optimisation.

Article 17 – Access to Geoscience and Engineering Fieldwork

Students may not embark on the Geoscience and Engineering Fieldwork (AESM2901) until they have completed the subjects Engineering Geology (AES1630) and Site Characterisation and Testing (CIE5320).

Article 18 – Access to Final Thesis

1. Students may embark on the Final Thesis only when they have no more than 15 credits of uncompleted subjects of the Master's degree course from all their other subjects of the course.
2. Students are only allowed to present their Final Thesis if they have successfully completed all other obligations.

Section 7 – Transition Rulings

Article 19 – Transition Ruling

Students who started the Master's degree course before September 1, 2008 and who have a delay in their study progress, have to request the coordinator of the track programme to define a contract in which is stated which new subjects replace former subjects. The contract needs the approval of the Board of Examiners.