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Faculté des géosciences  
et de l'environnement



UNIVERSITÉ  
DE GENÈVE

FACULTÉ DES SCIENCES

# Master of Science (Msc) in Earth Sciences

## Study Plan

Entry into force: 17 September 2018

*This translation is for information purposes only. The language of the original document takes precedence.*

**ELSTE**



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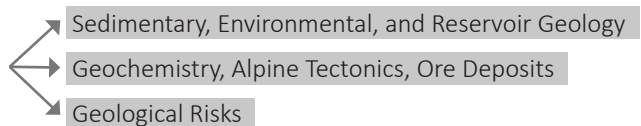
# Master of Science (MSc) in Earth Sciences

In this document, male pronouns are used indiscriminately for females and males

The Master of Science in Earth Sciences is delivered jointly by the University of Geneva and the University of Lausanne, through the «Ecole Lémanique des Sciences de la Terre» (Lemanic School of Earth Sciences- ELSTE).

This second level cycle of 120 ECTS credits program has a proposed period of four semesters. Courses are generally given in French and in English. However, the program can be entirely followed in English.

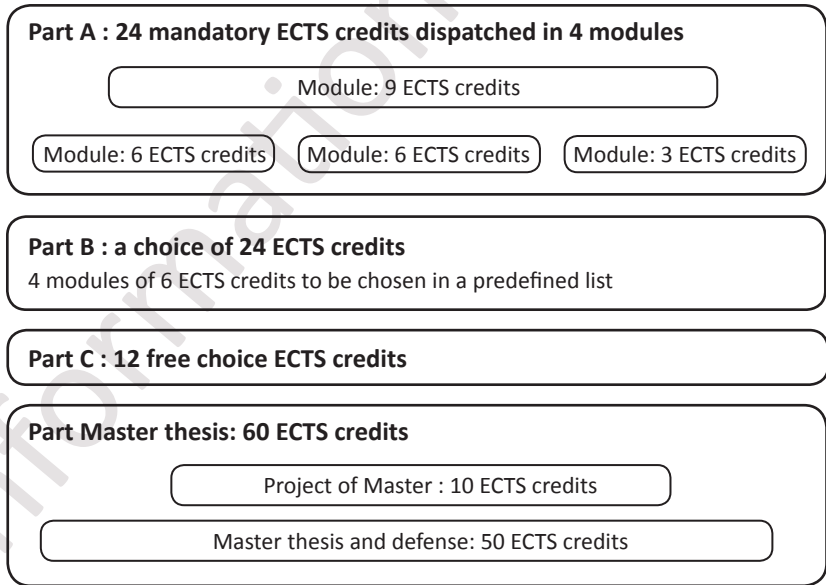
The Master in Earth Sciences has three concentrations :



At the beginning of the Master, each student choses a proposed concentration.

The program of each concentration comprehends:

- A part of 4 mandatory modules (24 ECTS credits)
- A part of 4 modules to be chosen in a predefined list (24 ECTS credits)
- A part of free choice credits (12 ECTS credits)
- A Master thesis of 60 ECTS credits. This thesis is a personal research work under the responsibility of an ELSTE teacher.



Whenever possible, courses must be taken during the first year of the Master.

During the first year of the Master, the student also starts to work on his master thesis in order to present his project of Master before the beginning of the second year of the program. The second year of the Master program is dedicated to the Master thesis.

**It is strongly recommended that students register to a course no later than two weeks before it begins. Otherwise the student could be denied access to the course due to lack of space or material.**

## Sedimentary, Environmental, and Reservoir Geology concentration



### Coordinators: Rossana Martini - Karl Föllmi

The sedimentary cover of the Earth is the result of the interaction between tectonics, weathering and erosion, sediment transport and biological and geochemical processes. Sediments and sedimentary rocks therefore contain fundamental information on the history of the Earth, the environment, climate and life. In addition, sediments and sedimentary rocks are the largest reservoir of the main natural resources such as water, fossil fuels, metals and raw materials. The orientation Sedimentary, Environmental, and Reservoir geology offers a wide and extensive training focusing on sedimentology, stratigraphy, paleontology, basin analysis, reservoir geology, environmental geology and geophysics.

Instruction is provided in the form of ex-cathedra courses, seminars, field trips and independent research. This orientation is unique in Switzerland and Central Europe in general due to its focus on current and fossil surface processes, its interdisciplinary approach, access to a natural laboratory that is the Swiss Jura and the Alps, the number of experts involved, internal to the Universities of Geneva and Lausanne and external guests.

The program proposed in this Master is an ideal preparation to further academic training (PhD) as well as to environmental professions, to engineering geology and to industrial reservoirs and to geo-energy.

### PART A1 mandatory: 24 ECTS credits

The mandatory **part A1** includes four modules:

- Depositional environments and sedimentary processes from source to sink
- Palaeogeography, palaeoclimatology, palaeoecology
- Basin research
- Geophysics across scales for geologists

### Module Depositional environments and sedimentary processes from source to sink

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Depositional environments and sedimentary processes from source to sink</b> <i>Environnements et processus sédimentaires des sources aux bassins</i>	<u>S. Castellort</u> , E. Samankassou, D. Ariztegui, K. Föllmi, A. Moscariello, E. Verrecchia, T. Adatte	Fall 45h C TP S 4d F Spring 8d F	Report, Seminars, Oral or written exam	9
<i>Prerequisite: sedimentology course (BSc)</i>				
<i>One ECTS credits corresponds to 25-30 hours of actual work</i>				
<i>C: course – PW: Practical work – E: Exercices – S: Seminars – F: Field – d: days (block course) – h: hours (weekly course)</i>				

This module must be followed during the two first semesters of the Master and then validated during the following exam session.

### Module Palaeogeography, palaeoclimatology, palaeoecology

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Palaeogeography, palaeoclimatology, palaeoecology</b> <i>Paléogéographie, paléoclimatologie, paléoécologie</i>	<u>R. Martini</u> , E. Samankassou, T. Adatte, D. Ariztegui, K. Föllmi, J. Spangenberg, T. Vennemann, A. Daley, S. Feist-Burkhardt	Fall 70h C PW S	Practical Written exam	6

**Module Basin research**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Basin research</b> <i>Dynamique sédimentaire</i>	<u>S. Castellort</u> , G. Simpson, A. Moscarriello, F. Herman, R. Spikings, M. Lupi, S. Schmidt	Fall 72h C PW S	Written exam	6

**Module Geophysics across scales for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Geophysics across scales for geologists</b> <i>Géophysique à différentes échelles pour géologues</i>	<u>György Hetényi</u> , B. Quintal, M. Lupi, A. Moscarriello	Fall 28h C PW	Written exam	3

The part A1 is validated if each of the four modules is validated.

**PART B1 : a choice of 24 ECTS credits**

The student must select four modules among those proposed in this part:

- Integrated basin analysis
- Fundamentals of numerical modelling and data analysis
- Reservoir geology I
- Reservoir geology II
- Advanced structural geology
- Practical seismic reflection
- Borehole logging and rock physics
- Pratique de la géologie environnementale
- Introduction to fluid flow for geologists
- Spatial analysis applied to geology and risk

**Module Integrated basin analysis**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Integrated basin analysis</b> <i>Analyse de bassin intégrée</i>	<u>A. Moscarriello</u> , E. Samankassou, and colleagues	Spring 10d F S	Exercises Report	6
<i>Prerequisite: modules Reservoir geology I and II, Borehole logging and rock physics, and Practical seismic reflection</i>				

**Module Fundamentals of numerical modelling and data analysis**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Fundamentals of numerical modelling and data analysis</b> <i>Les fondamentaux de la modélisation numérique et l'analyse de données</i>	<u>Y. Podladchikov</u>		)	6
Introduction to data analysis with MATLAB <i>(Introduction à l'analyse de données avec Matlab)</i>	G. Simpson	Fall 3d CE	Practical (Report)	1
MATLAB as a language of scientific computing <i>(Matlab comme langage de calcul scientifique)</i>	Y. Podladchikov	Fall 42h CE	Practical (Report)	3
Physics as a basis for modeling <i>(La physique comme base de modélisation)</i>	Y. Podladchikov	Fall 28h CE	Practical (Report)	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Reservoir geology I**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Reservoir geology I</b> ( <i>Géologie des réservoirs I</i> ) (Courses of this module cannot be taken individually)	<u>A. Moscariello</u>			6
Clastic reservoirs ( <i>Réservoirs clastiques</i> )	A. Moscariello	Spring 5d C PW S	Written or oral exam	3
Carbonate reservoirs ( <i>Réservoirs carbonatés</i> )	A. Moscariello, B. Caline	Spring 5d C PW S	Written or oral exam	3
<i>Prerequisite: modules Basin research, Borehole logging and rock physics, and Practical seismic reflection</i>				

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Reservoir geology II**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Reservoir geology II</b> <i>Géologie des réservoirs II</i> (Les cours de ce module ne peuvent être pris individuellement)	<u>A. Moscariello</u>			6
3D static and geological modelling - Petrel and Eclipse ( <i>Modélisation géologique statique et dynamique en 3D - Petrel et Eclipse</i> )	A. Moscariello and colleagues	Spring 5d C PW S	Written or oral exam	3
From play evaluation to field development ( <i>De l'évaluation du «play» au développement</i> )	A. Moscariello,	Spring 5d C PW S	Written or oral exam	3
<i>Prerequisite: priority will be given to students who have followed the modules Reservoir geology I, Basin research, Borehole logging and rock physics, and Practical seismic reflection</i>				

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Advanced structural geology**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Advanced structural geology</b> <i>Géologie structurale avancée</i>	<u>JL. Epard</u>			6
Alpine Structural Geology ( <i>Géologie structurale alpine</i> )	JL. Epard	Fall 24h C PW	Practical	3
Alpine tectonics, field camp ( <i>Camp de tectonique alpine</i> )	JL. Epard, S. Schmalholz	Spring 6j F	Practical (Report)	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Practical seismic reflection**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Practical seismic reflection</b> <i>Sismique réflexion - pratique</i> (Les cours de ce module ne peuvent être pris individuellement)	<u>A. Moscariello, D. Ariztegui</u>			6
2D and 3D interpretation (Petrel and Kingdom) ( <i>Interprétation 2D et 3D - Petrel et Kingdom</i> )	A. Moscariello	Fall 28h C PW	Practical	3
Marine seismic acquisition, interpretation and data integration ( <i>Acquisition, interprétation et intégration de données sismiques marines</i> )	D. Ariztegui	Spring 8d F	Practical	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Borehole logging and rock physics**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Borehole logging and rock physics</b> <i>Diagraphie de puits et physique des roches</i>	<u>B. Quintal</u> , A. Moscariello	Fall 42h C E + personal work	Practical	6

**Module Pratique de la géologie environnementale**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Pratique de la géologie environnementale (in French)</b>	<u>S. Girardclos</u>			6
Sites contaminés: application géologique et environnementale	S. Girardclos, J. Poté	Spring 5d C PW	Practical	3
Gestion, traitement et entreposage des déchets ( <i>Management, processing and storage of waste</i> )	J. Poté, S. Girardclos, M. Patel, G. Giuliani	Spring 5d C PW	Practical	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Introduction to fluid flow for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Introduction to fluid flow for geologists</b> <i>Introduction pour géologue aux écoulements des fluides</i>	<u>M. Lupi</u> , L. Pioli	Spring 5d C 5d F	Practical	6

**Module Spatial analysis applied to geology and risk**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Spatial analysis applied to geology and risk</b> <i>Analyse spatiale appliquée à la géologie et au risque</i>	<u>M. Sartori</u>			6
Cartographic data management and landslide susceptibility assessment ( <i>Structuration des données géologiques et analyses spatiales appliquées aux instabilités de versant</i> )	M. Sartori, C. Frischknecht	Spring 5d CE	Practical (Report)	3
Spatial risk assessment ( <i>L'évaluation spatiale du risque</i> )	C. Frischknecht, P. Peduzzi, B. Chatenoux	Spring 5d CE	Practical (Report)	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**PART C1 : 12 student's elective ECTS credits**

The student completes his curriculum by selecting courses among those proposed in the Master in Earth Sciences or in other Master's programs (for example: Master in Environmental science, UNIGE; Master in Environmental geosciences, UNIL; Master in biogeosciences, UNIL/UNINE).

The list of courses can contain courses of the Bachelor-level, for a maximum of 5 ECTS credits.

An internship in an enterprise can be validated in this part, as provided by the rules and regulations (art. 15, al. 6).

The student must draw up a list of courses selected in agreement with his Master's thesis supervisor. Here are some suggestions of additional courses that don't appear in the other parts of the study plan:

Course	Teacher	Semester Modality	Evaluation	ECTS Credits
Geology of clays ( <i>Géologie des argiles</i> )	T. Adatte	Spring 3d CE	Practical	1.5
SPACE-GEOENERGY: Geomatics and geo-energy ( <i>Géomatique et géo-énergies</i> )	A. Moscariello, J. Simantov	Spring 5d C	Practical	3
Imperial Barrel Award (AAPG) <i>Réservé en priorité aux étudiants de deuxième année</i>	A. Moscariello (coordinateur)	Spring 6 weeks	Practical	6
Biomineralization ( <i>Biominéralisation</i> )	A. Meibom	Fall 42h C TP	Report Oral presentation	4
Introduction to geothermics ( <i>Introduction à la géothermie</i> )	S. Miller (UNINE)	Fall 4d CE	Practical	2
Introduction to hydrogeology and hydrology ( <i>Introduction à l'hydrogéologie et à l'hydrologie</i> )	Ph. Brunner (UNINE)	Fall 6d CE	Practical	3
Scanning Electron Microscopy ( <i>Microscopie électronique à balayage, MEB</i> )	R. Martini pour l'UNIGE P. Vonlanthen pour l'UNIL	Fall 2d C TP	Validation without grade	1
Optical cathodoluminescence ( <i>Cathodoluminescence optique</i> )	R. Martini	Spring 1d C TP	Validation without grade	0.5
Initiation to the ion probe ( <i>Initiation à la sonde ionique</i> )	A.S. Bouvier, A. Meibom	Spring 1d C TP	Validation without grade	0.5
Electron probe microanalyzer ( <i>Microsonde électronique</i> )	F. Bussy, M. Robyr	Fall 2d C TP	Practical (TP)	1
Stable isotopes analysis ( <i>Analyse des isotopes stables</i> ) <i>Cours sur mesure et sur demande</i>	T. Vennemann	Spring 1d C TP	Practical	0.5
Organic geochemistry ( <i>Géochimie organique</i> )	J. Spangenberg	Spring 6d C TP	Practical	3
PorPerm and QemScan	A. Moscariello	Fall 1d C TP	Validation without grade	0.5
Introduction to inductively-coupled plasma mass-spectrometry ( <i>Introduction à la spectrométrie de masse à source plasma à couplage inductif</i> )	A. Ulianov	Fall 2d C E	Validation without grade	1
Sedimentary laboratory techniques ( <i>Techniques de laboratoires sédimentaires</i> )	M. Weinkauff	Fall 1d C TP	Validation without grade	0.5
Internship in an enterprise (validated by the Master's thesis supervisor)				6
Modules or courses of the curriculum of the Master in Earth Sciences*				
Courses proposed by the MUSE (UNIGE), Environment MSc (UNIL), Biogeosciences MSc (UNIL-UNINE)**				
Courses proposed by another academic institution*				
Courses of the Bachelor-level*				5 crédits ECTS, au maximum
<b>Total of the credits to validate</b>				<b>12 ECTS credits</b>

\*: for these courses, the evaluation and the number of attributed ECTS credits are those contained in the curriculum from which they are taken.

In the part C1, courses are individually validated if their grade is equal of at least 4.0/6 or if the validation is obtained.

**Part Master’s thesis in Earth sciences – 60 ECTS credits**

This Master’s thesis is an individual research work under the responsibility of an ELSTE teacher.

By the end of the first semester of Master’s studies at the latest, the student must have chosen the subject of his Master’s thesis. Before the beginning of the second year of the program, the student must draft and present his Master’s thesis project. The ECTS credits of the Master’s thesis project are obtained when its grade is equal of at least 4.

Theses are evaluated based on the submitted manuscript and the quality of the oral defense. This evaluation, weighted according to stipulations in the internal directive on theses, takes the form of a single grade. ECTS credits for the thesis are earned when that grade is 4 or higher.

Master’s thesis	Semester	Year 1	Year 2	Evaluation	ECTS credits
Master’s thesis project	Spring	•		Report and oral examination	10
Master’s thesis	Spring		•	Manuscript and oral defense	50



## Geochemistry - Alpine Tectonics - Ore Deposits concentration



**Coordinators : Othmar Müntener, Robert Moritz, Stefan Schmalholz**

Terrestrial lithosphere is constantly reshaped by the igneous, metamorphic and tectonic processes strongly generated by heat and mass transfer. The mountain ranges are places of intense volcanic, tectonic and/or seismic activity, sometimes located in densely populated and heavily industrialized areas of the world. The study of the phenomena that shape our planet is also crucial for social and economic issues. It has long been established that the Alps constitute the ideal place to test revolutionary ideas in geodynamics such as the theory of nappes, the geometry of continental passive margins, plate tectonics, regional or contact metamorphism, until the recent debate on the exhumation of rocks formed under ultrahigh pressures. The Alps also allow to study the relationship between climate, erosion and orogenies.

The fieldwork and data analyses are the first step in understanding the formation of mountain chains and the physical and chemical processes that accompany them. It is then necessary to develop models that confront the petrological and thermomechanical processes with the acquired data.

Acquired during the two years of Master study in the orientation Geochemistry, Alpine Tectonics, Ore Deposits, the training provides the tools needed to elucidate the sequence of events recorded in the rocks of our planet, locate areas suitable for the exploitation of raw materials, or examine and explain the dynamic processes affecting the outer parts of our Earth, such as the formation and destruction of mountain ranges, volcanic eruptions or magma genesis. The theoretical and practical courses cover areas such as petrology, isotope geochemistry, tectonics, geodynamics, structural geology, ore deposits, the continuum mechanics, numerical modeling, and analytical methods in laboratory and of course work in the field. Throughout their curriculum in the Master in Earth sciences, students gain theoretical knowledge but also the opportunity to work in a series of state-of-the-art analytical laboratories. Lectures are held in the form of courses, practicals, seminars, field camp. The orientation Geochemistry, Alpine Tectonics, Ore Deposits offers unique courses in Switzerland and Europe through its interdisciplinary approach and the nearby natural laboratory that is the Swiss Jura and the Alps, the number of experts involved, internal to the Universities of Geneva and Lausanne and external guests. The vast and eclectic course offering of this orientation allows students to make a personal university curriculum to meet their needs for guidance, according to their career plan, both to an academic path, as to the professional world, allowing them to focus on jobs in the mining industry, in geological and environmental impact offices or in governmental agencies.

### PART A2 mandatory: 24 ECTS credits

The mandatory **part A2** includes four modules:

- Petrological processes in geodynamic environments
- Quantitative tectonics and rocks deformation
- Geophysics across scales for geologists
- Field trips

### Module Petrological processes in geodynamic environments

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Petrological processes in geodynamic environments</b> <i>Processus pétrologiques dans les environnements géodynamiques</i>	<u>U. Schaltegger, O. Müntener</u> S. Pilet, L. Caricchi L. Baumgartner, S. Schmalholz L. Fontboté	Fall 70h C PW E S	Seminars	9
<i>One ECTS credits corresponds to 25-30 hours of actual work</i>				
<i>C: course – PW: Practical work – E: Exercices – S: Seminars – F: Field – d: days (block course) – h: hours (weekly course)</i>				

This module must be followed during the first semester of the Master and then validated during the following exam session. Il est validé et les 9 crédits ECTS attribués si la note de l'évaluation est de 4 au moins. It is validated and the 9 ECTS credits earned if the grade is at least 4.

**Module Quantitative tectonics and rock deformation**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Quantitative tectonics and rock deformation</b> <i>Tectonique quantitative et déformation des roches</i>	<u>S. Schmalholz</u>			6
Quantitative tectonics ( <i>Tectonique quantitative</i> )	S. Schmalholz	Fall 42h C PW	Practical	4
Microtectonics ( <i>Microtectonique</i> )	M. Robyr, S. Schmalholz	Spring 27h C PW	Practical	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Geophysics across scales for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Geophysics across scales for geologists</b> <i>Géophysique à différentes échelles pour géologues</i>	<u>György Hetényi</u> , B. Quintal, M. Lupi	Fall 28h C PW	Written exam	3

**Module Field trips**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Field trips</b> <i>Camps de terrain</i>	<u>L. Baumgartner</u>	Spring 8d F	Practical	6

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

The part A2 is validated if each of the four modules is validated.

**PART B2 : a choice of 24 ECTS credits**

The student must select four modules among those proposed in this part:

- Stable and radiogenic isotope geochemistry
- Petrology and fluids in the Earth's crust
- Advanced petrology and volcanology
- Advanced structural geology
- Fundamentals of numerical modelling and data analysis
- Ore deposits
- Mineral exploration
- Applied and environmental mineralogy
- Pratique de la géologie environnementale
- Introduction to fluid flow for geologists
- Spatial analysis applied to geology and risk

**Module Stable and radiogenic isotope geochemistry**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Stable and radiogenic isotope geochemistry</b> <i>(Géochimie des isotopes stables et radiogéniques)</i>	<u>M. Chiaradia</u> , E. Samankasou, U. Schaltegger, R. Spikings, T. Vennemann	Every odd semester, Spring 84h C PW S	Written exam	6
<i>Prerequisite: solid background in the basic principles of isotope geology</i>				

**Module Petrology and fluids in the Earth's crust**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Petrology and fluids of the Earth's crust</b> <i>Pétrologie et fluides de la croûte terrestre</i>	<u>R. Moritz</u>			6
Fluids in the Earth crust <i>(Fluides dans la croûte terrestre)</i>	L. Baumgartner	Spring 28h C PW	Validation without grade	2
Low-temperature alteration in the Upper Crust (bisannuel) <i>(Altérations de basse température sur la croûte supérieure)</i>	S. Schmidt	Every even semester Fall 3d C PW	Validation without grade	1.5
Fluid inclusions <i>(Inclusions fluides)</i>	R. Moritz	Fall 3d C PW	Validation without grade	1.5
Reading rocks – Rock textures and fluids <i>(Lecture des roches - textures de roches et fluides)</i>	K. Kouzmanov	Spring 2d C PW	Validation without grade	1

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Advanced petrology and volcanology**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Advanced petrology and volcanology</b> <i>Pétrologie et volcanologie avancée</i> <i>(Courses of this module cannot be taken separately)</i>	<u>L. Caricchi</u> , L. Pioli, C. Bonadonna, S. Pilet			6
Volcanic rocks <i>(Roches volcaniques)</i>	L. Pioli, C. Bonadonna	Fall 28h C	Seminar	2
Volcano petrology <i>(Pétrologie volcanique)</i>	L. Caricchi, S. Pilet	Spring 28h C	Seminar	2
Volcano fieldtrip <i>(Excursion volcanique)</i>	L. Caricchi, C. Bonadonna, S. Pilet, L. Pioli	Spring 5d F	Practical (Report)	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Advanced structural geology**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Advanced structural geology</b> <i>Géologie structurale avancée</i>	<u>JL. Epard</u>			6
Alpine Structural Geology ( <i>Géologie structurale alpine</i> )	JL. Epard	Fall 24h C PW	Practical	3
Alpine tectonics, field camp ( <i>Camp de tectonique alpine</i> )	JL. Epard	Spring 6d F	Practical (Report)	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Fundamentals of numerical modelling and data analysis**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Fundamentals of numerical modelling and data analysis</b> <i>Les fondamentaux de la modélisation numérique et l'analyse de données</i>	<u>Y. Podladchikov</u>			6
Introduction to data analysis with MATLAB ( <i>Introduction à l'analyse de données avec Matlab</i> )	G. Simpson	Fall 3d CE	Practical (Report)	1
MATLAB as a language of scientific computing ( <i>Matlab comme langage de calcul scientifique</i> )	Y. Podladchikov	Fall 42h CE	Practical (Report)	3
Physics as a basis for modeling ( <i>La physique comme base de modélisation</i> )	Y. Podladchikov	Fall 28h CE	Practical (Report)	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Ore deposits**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Ore deposits</b> <i>Gîtes métallifères</i>	<u>L. Fontboté</u>			6
Advanced ore deposits ( <i>Gîtes métallifères - avancé</i> ) <i>Pré-requis: cours «Ore microscopy» ou équivalent</i>	L. Fontboté, K. Kouzmanov, M. Chiaradia, R. Moritz	Fall 10d C PW + personal work	Practical (report, seminar) Written exam	4
Ore microscopy ( <i>Microscopie des minerais</i> )	L. Fontboté, K. Kouzmanov	Fall 6d C PW	Written exam	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Mineral exploration**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Mineral exploration</b> <i>Exploration minière</i>	<u>L. Fontboté</u>			6
Methods of exploration (bisannuel) ( <i>Méthodes d'exploration</i> ) <i>Pré-requis: basic geological and mineral deposit knowledge</i>	G. Beaudoin	Every odd semester Fall 10d CE	Practical (Report)	3
Advanced ore deposits II ( <i>Gîtes métallifères - avancé II</i> ) <i>Pré-requis: Advanced ore deposits et Ore microscopy ou équivalent</i>	L. Fontboté, K. Kouzmanov, M. Chiaradia, R. Moritz	Spring 3d CE	Seminar Oral exam	2
Mining geophysics ( <i>Géophysique minière</i> ) <i>Pré-requis: Introduction à la géophysique</i>	J. Irving	Spring 4d CE	Practical (Exercises, oral presentation)	1

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Applied and environmental mineralogy**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Applied and environmental mineralogy</b> <i>Minéralogie appliquée et environnementale</i>	<u>O. Müntener</u>			6
Gemmology <i>(Gemmologie)</i>	L. Cartier	Spring 6d CE F	Practical (Exercices)	2
Gemmology - field <i>(Gemmologie - terrain)</i> <i>Pré-requis : Gemmology</i>	L. Cartier	Fall 2d F	Validation without grade	1
Applied mineralogy <i>(Minéralogie appliquée)</i>	T. Vennemann, B. Putlitz	Spring 4d C F	Practical (Report)	2
Physics and structure of minerals <i>(Physique et structure des minéraux)</i>	O. Müntener	Spring 14h C	Practical	1

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Pratique de la géologie environnementale**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Pratique de la géologie environnementale (in French)</b>			Practical	6
Sites contaminés: application géologique et environnementale	S. Girardclos, J. Poté	Spring 5d C PW	Practical	3
Gestion, traitement et entreposage des déchets <i>(Management, processing and storage of waste)</i>	J. Poté, S. Girardclos, M. Patel, G. Giuliani	Spring 5d C PW	Practical	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Introduction to fluid flow for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Introduction to fluid flow for geologists</b> <i>Introduction pour géologue aux écoulements des fluides</i>	<u>M. Lupi</u> , L. Pioli and colleagues,	Spring 5d C 5d F	Practical	6

**Module Spatial analysis applied to geology and risk**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Spatial analysis applied to geology and risk</b> <i>Analyse spatiale appliquée à la géologie et au risque</i>			Practical	6
Cartographic data management and landslide susceptibility assessment <i>(Structuration des données géologiques et analyses spatiales appliquées aux instabilités de versant)</i>	M. Sartori, C. Frischknecht	Spring 5d CE	Practical (Report)	3
Spatial risk assessment <i>(L'évaluation spatiale du risque)</i>	C. Frischknecht, P. Peduzzi, B. Chatenoux	Spring 5d CE	Practical (Report)	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**PART C2 : 12 student's elective ECTS credits**

The student completes his curriculum by selecting courses among those proposed in the Master in Earth Sciences or in other Master's programs (for example: Master in Environmental science, UNIGE; Master in Environmental geosciences, UNIL; Master in biogeosciences, UNIL/UNINE).

The list of courses can contain courses of the Bachelor-level, for a maximum of 5 ECTS credits.

An internship in an enterprise can be validated in this part, as provided by the rules and regulations (art. 15, al. 6).

The student must draw up a list of courses selected in agreement with his Master's thesis supervisor. Here are some suggestions of additional courses that don't appear in the other parts of the study plan:

Course	Teacher	Semester Modality	Evaluation	ECTS credits
Syn-tectonic granite emplacement and vein formation – Cévennes, France (bisannuel) ( <i>Mise en place de granites syn-tectoniques et veines hydrothermales - Cévennes, France</i> )	K. Kouzmanov, A. Chauvet	Every odd semester Spring 6d T	Practical	3
Environmental biogeochemistry ( <i>Biogéochimie environnementale</i> ) <i>Pré-requis: general geochemistry, aquatic chemistry, introductory chemistry and physics</i>	J. Peña	Spring 30h C E	Written exam	3
Biom mineralization ( <i>Bio minéralisation</i> )	A. Meibom	Fall 42h C PW	Report Oral presentation	4
Scanning Electron Microscopy ( <i>Microscopie électronique à balayage, MEB</i> )	R. Martini pour l'UNIGE P. Vonlanthen pour l'UNIL	Fall 2d C TP	Validation without grade	1
Optical cathodoluminescence ( <i>Cathodoluminescence optique</i> )	R. Martini	Spring 1d C TP	Validation without grade	0.5
Initiation to the ion probe ( <i>Initiation à la sonde ionique</i> )	A.S. Bouvier, A. Meibom	Spring 1d C TP	Validation without grade	0.5
Electron probe microanalyzer ( <i>Microsonde électronique</i> )	F. Bussy, M. Robyr	Fall 2d C TP	Pratique (TP)	1
Stable isotopes analysis ( <i>Analyse des isotopes stables</i> ) <i>Cours sur mesure et sur demande</i>	T. Vennemann	Spring 1d C TP	Pratique	0.5
PoroPerm and QemScan	A. Moscariello	Fall 1d C TP	Validation without grade	0.5
Introduction to inductively-coupled plasma mass-spectrometry ( <i>Introduction à la spectrométrie de masse à source plasma à couplage inductif</i> )	A. Ulianov	Fall 2d C E	Validation without grade	1
Microtomography ( <i>Microtomographie</i> )	L. Baumgartner	Spring 1d C TP	Validation without grade	0.5
Laboratory techniques in geochemistry ( <i>Techniques de laboratoire en géochimie</i> )	U. Schaltegger	Fall 1d C TP	Validation without grade	0.5
Internship in an enterprise (validated by the Master's thesis supervisor)				6
Modules or courses of the curriculum of the Master in Earth Sciences*				
Courses proposed by the MUSE (UNIGE), Environment MSc (UNIL), Biogeosciences MSc (UNIL-UNINE)*				
Courses proposed by another academic institution*				
Courses of the Bachelor-level**			5 crédits ECTS, au maximum	
<b>Total de crédits à valider</b>				<b>12 crédits ECTS</b>

\*: for these courses, the evaluation and the number of attributed ECTS credits are those contained in the curriculum from which they are taken.

In the part C2, courses are individually validated if their grade is equal of at least 4.0/6 or if the validation is obtained.

**Part Master's thesis in Earth sciences – 60 ECTS credits**

This Master's thesis is an individual research work under the responsibility of an ELSTE teacher.

By the end of the first semester of Master's studies at the latest, the student must have chosen the subject of his Master's thesis. Before the beginning of the second year of the program, the student must draft and present his Master's thesis project. The ECTS credits of the Master's thesis project are obtained when its grade is equal of at least 4.

Theses are evaluated based on the submitted manuscript and the quality of the oral defense. This evaluation, weighted according to stipulations in the internal directive on theses, takes the form of a single grade. ECTS credits for the thesis are earned when that grade is 4 or higher.

Master's thesis	Semester	Year 1	Year 2	Evaluation	ECTS credits
Master's thesis project	Spring	•		Report and oral examination	10
Master's thesis	Spring		•	Manuscript and oral defense	50

## Geological Risks concentration

### Coordinateurs : Costanza Bonadonna

Geological processes such as landslides, earthquakes and volcanic eruptions are fascinating but complex phenomena with potentially significant impacts on society. These impacts may occur at different levels, local, regional and global.

The geological hazards concentration focuses on the dynamic challenges facing societies worldwide when developing risk reduction measures. This concentration forms on the deep and surface processes that generate geological hazards and on assessment methods of exposure and vulnerability of people and the built environment. Hazard and vulnerability assessments are then combined to conduct the analysis of impacts and associated risks. Through this concentration, students have access to teachers at the forefront of research, to acquisition tools of specific data, as well as to different approaches for modeling and risk analysis. Field works enable to integrate various aspects of risk management. This multidisciplinary concentration offers students the opportunity to acquire skills that make them employable in geological and geotechnical consulting firms, international and nongovernmental organizations, and federal offices.

### PART A3 mandatory: 24 ECTS credits

The mandatory **part A4** includes four modules:

- Petrological processes in geodynamic environments
- Fundamentals of numerical modelling and data analysis
- Spatial analysis applied to geology and risk
- Geophysics across scales for geologists

#### Module Petrological processes in geodynamic environments

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Petrological processes in geodynamic environments</b> <i>Processus pétrologiques dans les environnements géodynamiques</i>	<u>U. Schaltegger, O. Müntener</u> S. Pilet, L. Caricchi L. Baumgartner, S. Schmalholz L. Fontboté	Fall 70h C PW E S	Seminars	9
<i>One ECTS credits corresponds to 25-30 hours of actual work</i>				
<i>C: course – PW: Practical work – E: Exercices – S: Seminars – F: Field – d: days (block course) – h: hours (weekly course)</i>				

This module must be followed during the first semester of the Master and then validated during the following exam session. Il est validé et les 9 crédits ECTS attribués si la note de l'évaluation est de 4 au moins. It is validated and the 9 ECTS credits earned if the grade is at least 4.

#### Module Fundamentals of numerical modelling and data analysis

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Fundamentals of numerical modelling and data analysis</b> <i>Les fondamentaux de la modélisation numérique et l'analyse de données</i>	<u>Y. Podladchikov</u>			6
Introduction to data analysis with MATLAB <i>(Introduction à l'analyse de données avec Matlab)</i>	G. Simpson	Fall 3d CE	Practical (Report)	1
MATLAB as a language of scientific computing <i>(Matlab comme langage de calcul scientifique)</i>	Y. Podladchikov	Fall 42h CE	Practical (Report)	3
Physics as a basis for modeling <i>(La physique comme base de modélisation)</i>	Y. Podladchikov	Fall 28h CE	Practical (Report)	2

The courses of this module are validated and the 9 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.



**Module Spatial analysis applied to geology and risk**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Spatial analysis applied to geology and risk</b> <i>Analyse spatiale appliquée à la géologie et au risque</i>	<u>M. Sartori</u>			6
Cartographic data management and landslide susceptibility assessment <i>(Structuration des données géologiques et analyses spatiales appliquées aux instabilités de versant)</i>	M. Sartori, C. Frischknecht	Spring 5d CE	Practical (Report)	3
Spatial risk assessment <i>(L'évaluation spatiale du risque)</i>	C. Frischknecht, P. Peduzzi, B. Chatenoux	Spring 5d CE	Practical (Report)	3

The courses of this module are validated and the 9 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Geophysics across scales for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Geophysics across scales for geologists</b> <i>(Géophysique à différentes échelles pour géologues)</i>	<u>György Hetényi</u> , B. Quintal, M. Lupi, A. Moscariello	Fall 28h C PW	Written exam	3

The part A3 is validated if each of the four modules is validated.

**PART B3 : a choice of 24 ECTS credits**

The student must select four modules among those proposed in this part:

- Advanced petrology and volcanology
- Risk Management
- Volcanic and seismic risk
- Hazards and risks of slope movements
- Advanced risks
- Pratique de la géologie environnementale
- Practical seismic reflection
- Introduction to fluid flow for geologists

**Module Advanced petrology and volcanology**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Advanced petrology and volcanology</b> <i>Pétrologie et volcanologie avancée</i> <i>(Courses of this module cannot be taken separately)</i>	<u>L. Caricchi</u> , L. Pioli, C. Bonadonna, S. Pilet			6
Volcanic rocks ( <i>Roches volcaniques</i> )	L. Pioli, C. Bonadonna	Fall 28h C	Seminar	2
Volcano petrology ( <i>Pétrologie volcanique</i> )	L. Caricchi, S. Pilet	Printemps 28h C	Séminaire	2
Volcano fieldtrip ( <i>Excursion volcanique</i> )	L. Caricchi, C. Bonadonna, S. Pilet, L. Pioli	Printemps 5j T	Pratique (Rapport)	2

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Risk Management**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Risk Management</b> <i>Gestion des risques</i>	<u>S. Menoni</u> , C. Gregg, F. Romerio and teachers of the CERG-C	Fall 84h C	Written exam	6
<i>In this module, courses are in English</i>				

**Module Volcanic and seismic risk**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Volcanic and seismic risk</b> <i>Risques volcaniques et sismiques</i>	<u>C. Bonadonna</u>			6
Volcanic risk ( <i>Risque volcanique</i> ) <i>Pré-requis : Module Risk Management</i>	<u>C. Bonadonna</u> et enseignants du CERG-C	Spring 6d C F	Written exam Practical (Report)	3
Seismic Risk ( <i>Risque sismique</i> )	<u>D. Fäh</u> , B. Duvernay	Spring 6d CE	Written exam	3
<i>In this module, courses are in English</i>				

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Hazards and risks of slope movements**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Hazards and risks of slope movements</b> <i>Dangers et risques de mouvements de versants</i>	<u>M. Jaboyedoff</u>			6
Erosion and slope movements ( <i>Erosion et mouvements de versants</i> )	M. Jaboyedoff	Spring 56h CE	Written exam	4
Hazards and risks of slope mass movements: field camp I ( <i>Risques et dangers liés aux mouvements de versants: terrain I</i> )	MH Derron, M. Jaboyedoff	Spring 5d T	Practical (Report)	2
<i>Prerequisite: Natural risks and hazards (BSc) – Numerical modelling (BSc) or equivalent</i>				

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained. 3 supplementary credits can be obtained in the student's elective part by taking the course «Hazards and risks of slope mass movements: field camp II ».

**Module Advanced risks**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Advanced risks</b> <i>(Risques avancés)</i>	<u>M. Jaboyedoff</u>			6
Advanced quantitative risk and vulnerability <i>(Risques avancés quantitatifs et la vulnérabilité)</i>	M. Jaboyedoff	Fall 28h C 14h E	Written exam Continuous assessment	3
Communication on environmental risks <i>(Communication sur les risques environnementaux)</i>	M. Jaboyedoff, K. Südmeier-Rieux, S. Rondic	Fall 16h C 16h E	Practical (Report)	3
<i>Prerequisite: Environmental hazards (BSc) or equivalent</i>				

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Pratique de la géologie environnementale**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Pratique de la géologie environnementale (in French)</b>	<u>S. Girardclos</u>			6
Sites contaminés: application géologique et environnementale	S. Girardclos, J. Poté	Spring 5d C PW	Practical	3
Gestion, traitement et entreposage des déchets ( <i>Management, processing and storage of waste</i> )	J. Poté, S. Girardclos, M. Patel, G. Giuliani	Spring 5d C PW	Practical	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Practical seismic reflection**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Practical seismic reflection</b> <i>Sismique réflexion - pratique</i> (Courses of this module cannot be taken separately)	<u>A. Moscariello</u> , D. Ariztegui			6
2D and 3D interpretation (Petrel and Kingdom) ( <i>Interprétation 2D et 3D - Petrel et Kingdom</i> )	A. Moscariello	Fall 28h C PW	Practical	3
Marine seismic acquisition, interpretation and data integration ( <i>Acquisition, interprétation et intégration de données sismiques marines</i> )	D. Ariztegui	Spring 8d F	Practical	3

The courses of this module are validated and the 6 ECTS credits earned in a block if the credit-weighted grade average is at least 4 and if the validations are obtained.

**Module Introduction to fluid flow for geologists**

Course	Teacher in charge / Speaker(s)	Semester Modality	Evaluation	ECTS credits
<b>Introduction to fluid flow for geologists</b> <i>Introduction pour géologue aux écoulements des fluides</i>	<u>M. Lupi</u> , L. Pioli	Spring 5d C 5d F	Practical	6

**PART C3 : 12 student's elective ECTS credits**

The student completes his curriculum by selecting courses among those proposed in the Master in Earth Sciences or in other Master's programs (for example: Master in Environmental science, UNIGE; Master in Environmental geosciences, UNIL; Master in biogeosciences, UNIL/UNINE).

The list of courses can contain courses of the Bachelor-level, for a maximum of 5 ECTS credits.

An internship in an enterprise can be validated in this part, as provided by the rules and regulations (art. 15, al. 6).

The student must draw up a list of courses selected in agreement with his Master's thesis supervisor. Here are some suggestions of additional courses that don't appear in the other parts of the study plan:

Course	Teacher	Semester Modality	Evaluation	ECTS credits
Biominalization ( <i>Biominéralisation</i> )	A. Meibom	Fall 42h C TP	Report Oral presentation	4
Hazards and risks of slope mass movements: field camp II ( <i>part I of the field of the module «Hazards and risks of slope movements» mandatory</i> )	M. H. Derron, M. Jaboyedoff	Spring 5d F	Practical (report)	3
Internship in a company (validated by the Master's thesis supervisor)				6
Modules or courses of the curriculum of the Master in Earth Sciences*				
Courses proposed by the MUSE (UNIGE), Environment MSc (UNIL), Biogeosciences MSc (UNIL-UNINE)*				
Courses proposed by another academic institution*				
Courses of the Bachelor-level*				5 ECTS credits, at most
<b>Total of the credits to validate</b>				<b>12 ECTS credits</b>

\*: for these courses, the evaluation and the number of attributed ECTS credits are those contained in the curriculum from which they are taken.

In the part C3, courses are individually validated if their grade is equal of at least 4.0/6 or if the validation is obtained.

**Part Master's thesis in Earth sciences – 60 ECTS credits**

This Master's thesis is an individual research work under the responsibility of an ELSTE teacher.

By the end of the first semester of Master's studies at the latest, the student must have chosen the subject of his Master's thesis. Before the beginning of the second year of the program, the student must draft and present his Master's thesis project. The ECTS credits of the Master's thesis project are obtained when its grade is equal of at least 4.

Theses are evaluated based on the submitted manuscript and the quality of the oral defense. This evaluation, weighted according to stipulations in the internal directive on theses, takes the form of a single grade. ECTS credits for the thesis are earned when that grade is 4 or higher.

Master's thesis	Semester	Year 1	Year 2	Evaluation	ECTS credits
Master's thesis project	Spring	•		Report and oral examination	10
Master's thesis	Spring		•	Manuscript and oral defense	50