Programme syllabus

Master of Science in Engineering and in Education
Civilingenjör och lärare
300.0 credits

Valid for students admitted to the education from autumn 16 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

In times of rapid technological development, there is a strong need for engineers with the competence to act as an intermediary for knowledge and to develop knowledge within the industry, administration, and academia. There is also a pronounced need for teachers who can arouse student interest in mathematics, technology, and natural science subjects.
The combination programme, Master of Science in Engineering and in Education, results in a Master's degree and a teaching degree from The Royal Institute of Technology within one of the subject combinations: mathematics/physics, mathematics/chemistry or mathematics/technology, where the technology subject is profiled towards either information and communication technology or energy and environmental science.The programme gives both the competencies to work as a pedagogical engineer and as a teacher mainly within upper secondary schools and adult education institutions.

In The Higher Education Act (http://www.hsv.se/lagochratt/lagarochregler), the goals for fundamental higher education can be found. In The Higher Education Ordinance, the goals for the Master of Science in Engineering degree and the Master of Science of Education degrees, respectively, can be found.

For KTH's Master of Science in Engineering programmes, the common goals can be found in the local regulations at KTH http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/examina/lokala-foreskrifter-for-examina-pa-grundniva-och-avancerad-niva-lokal-examensordning-1.27227?l=en_UK

In addition to that, KTH in cooperation with Stockholm University have the following goals for the Master of Science in Engineering and in Education programme:

The newly graduated CL-engineer/teacher should, after a short introduction at the work place, be able to independently carry out relatively qualified tasks within his/her profile area. The CL-engineer/teacher should independently and together with others, be able to plan, execute, evaluate, and develop teaching in upper secondary school and other educational environments and participate in the leadership of these. After a few years qualified professional work, the engineer should be able to independently contribute in the utilization and development of new, internationally competitive technology while observing ethical and social factors, and, in addition, be able to make judgments of the long-term consequences for the environment.

In The Higher Education Ordinance, the goals for different degrees are grouped under Knowledge and Understanding, Skills and Abilities, and the Judgment and Approach. KTH in cooperation with Stockholm University have developed the following goals:

Knowledge and understanding

After completing the programme, Master of Science in Engineering and in Education, the student should:

- show a deepened knowledge about central concepts, principles and methods within his/hers subject combination
- show in-debt knowledge of hypothetical-deductive, inductive, deductive, as well as qualitative and quantitative research methodologies.
- show understanding of how technology and natural science as well as pedagogy and subject didactics have a scientific foundation of theory, empiricism and reliable experience
- show knowledge about mathematics' scientific foundation and its logical-deductive structure
- show knowledge about teaching, as well as youth- and adult- learning within mathematics and physics /chemistry/technology
- show knowledge about the organization of the school system, relevant policy documents, curriculum theory and various educational-didactic perspectives, as well as display knowledge about the history of the school system.
- show extensive knowledge in grading.
- show knowledge about groups and organisational processes, relations between leaders and of the importance that such processes and relations are characterised by equality, respect and the principle that all humans are equal in dignity and rights.

Skills and abilities

After completing the programme, Master of Science in Engineering and in Education, the student should:

- show deepened abilities to critically and independently systemise and reflect over one's own and others' experiences and relevant research in order support professional development and knowledge development within mathematics and physics, chemistry or technology
- show the ability to independently search, assimilate, and evaluate new knowledge within mathematical, natural, technical and educational sciences and identify the need to further develop such knowledge.
- show a good ability to independently analyse technical, scientific and mathematical problems and be able to carry out reasoning and calculation central in these areas.
- show the ability to independently, and together with others, lead, plan, carry out, evaluate and develop teaching and education within schools, businesses and organisations.
- show in-debt knowledge how to stimulate each student's learning and development.
- show a good ability to carry out analysis and assessment of the development of knowledge among young people and adults within their combination of subjects.
- show the ability to identify and, in a team, manage special pedagogical needs.
- show the ability to professionally values and communicate human rights and democratical values, to preempt and prevent discrimination and operate from a perspective of social and gender equality.
- show the ability to, within one's own subject area, plan technical and natural-scientific experiments and measurements and evaluate the results
- show the ability to, with mathematical models, describe technical and natural-scientific courses of events and judge these models' potentials and limitations in different situations
- show the ability to, within their combination of subjects, use and reflect upon information and communication technology's potentials in problem solutions within one's own subject area as well as for pedagogical and communicative usage
- show a good ability to, within both of the professional areas, communicate knowledge, experiences, and professional judgments, orally as well as in writing, and to lead and collaborate in professional discussions

Ability to make judgements and adopt a standpoint

After completing the programme, Master of Science in Engineering and in Education, the student should:

- show the ability to evaluate the possibilities and limitations of technology, especially in relation to economically, socially and ecologically sustainable development.
- show both selfknowledge and empathic ability, as well as an ability to act professionally towards students and their caretakers.
- to be able to reflect upon ethnicity, gender, and conditions for sustainable social development
- show the ability to actively participate in democratic consideration and decision processes in a way which exhibits empathy, understanding and respect for individuals and groups with different social, cultural, and religious backgrounds

- show the ability to recognize one's own need for further knowledge and to develop one's professional pedagogical skills.

Extent and content of the programme

The program Master of Science in Engineering and in Education (Civilingenjör och lärare,CL) is established at KTH and is given in cooperation with the Stockholm University (Teacher Training). The programme gives the student two degrees on the second level, a Master of Science in Engineering and a teaching degree with one of the subject-combinations in Mathematics and Physics, Mathematics and Chemistry, Mathematics and Technology: Energy and Environment or Mathematics and Technology: Information and communication. The choice of combination of subjects is made at the end of the first year of study.

The programme consists of 300 higher education credits and is normally divided into 5 years/10 semesters.

The first year of the programme is common to all students. The programme is given mainly in Swedish, but courses in English can occur particulary during the last years. Usage of English course literature may occur during the entire programme.

The programme combines pedagogy, communication and teaching and learning with engineering skills such as ability to assimilate new knowledge and solve problems. This prepares the student for the work market in school as well as in knowledge companies and industry. The programme gives competencies to work as a teacher, especially within upper secondary schools and adult education institutions. Also, the engineering labour market and it´s carrier paths are accesable.

The programme consists of 300 higher education credits and is structually organized according to the following parts:

- Approximately 185 higher education credits in subject studies, including subject didactics in mathematics and physics, chemistry, energy and environmental science, or information and communication technology.
- Approximately 60 higher education credits in educational science subjects.
- 30 higher education credits from an internship, out of which at least 15 higher educational credits from internship as teacher in choosen subjects in upper secondary school.
- An independent 30 higher education credit research project: an in-debt study in mathematics, engineering or natural science, and in educational science.

Eligibility and selection

For acceptance to the programme Master of Science in Engineering and in Education, special eligibility is required.

General eligibility for university studies in Sweden, i.e. completed upper secondary education including documented proficiency in Swedish corresponding to Swedish 3 / Swedish as second language 3 and English corresponding to English 6.

For applicants from the Swedish upper secondary school (gymnasium), before 1 july 2011 this means that a grade of pass or higher must have been achieved in the following courses:

Mathematics course E
Physics course B
Chemistry course A

For applicants from the Swedish upper secondary school (gymnasium), after 1 july 2011 this means that a grade of pass or higher must have been achieved in the following courses:

Mathematics course 4
Physics course 2
Chemistry course 1

See more at http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/examina/lokala-foreskrifter-for-examina-pa-grundniva-och-avancerad-niva-lokal-examensordning-1.27227?l=en_UK

Implementation of the education

Structure of the education

The study year normally consists of 40 weeks. When needed, teaching can continue beyond the study year.
The academic year for KTH's first level programme is divided into four periods, see http://www.kth.se/en/student /schema/lasarsindelning-for-undervisning-och-examination-1.1007?programme=cl.

During the first year, basic subjects such as mathematics, natural sciences and technology are taken,but also courses that provide a glimpse in to the future professional roles.During the fall semester,a course in engineering science at KTH and a course at Stockholm University that provides an introduction to the teaching profession are taken.In a first course in mathematical didactics the student is introduced to the upper secondary school where a large part of the so-called internship(VFU) will take place,and gets the possibility to in practice test the role of a teacher.

From the second year and after, other specialisation subject (Physics, Chemistry, Energy and a second Environment or Information and communication) taken. The studies within these subjects are mainly taken together with other Master of Science in Engineering programmes.

A key idea in the programme is that studies in subject-theory and technology must be weaved in with courses within didactics and educational science and with interdisciplinary courses during the entire programme.

Except for the choice of subject-combination which is done by the end of the first year of study, the choices within the programme are limited.

Courses

The programme is course-based. Lists of courses are included in appendix 1.

In the programme, compulsory and conditionally optional courses are included. The compulsory courses are defined by the teaching and time plans for every study year and specialisation. The courses' goals, prerequisites, contents and examination can be found in the course plans.

In the course list, the number of conditionally optional courses for the respective subject-combination is listed. The conditionally optional courses shall consist of courses in each subject combination and must not duplicate mandatory or conditionally optional courses included in the exam.The choice of conditionally optional courses to be included in the exam must be approved by the program director.

VFU Internship The programme includes 30 higher education credits of internship (VFU). It does not constitute its own course, but is included as portions of certain courses, of these at least 15 higher education credits correspond to internship as a teacher in the choosen subjects in upper secondary school.

During the internship periods of the programme, the student must learn about the complex work in schools and other education environments and tie one's own knowledge development to these. The content in VFU is decided by the courses it is included in and must be specified in the respective course plans.

Internship (VFU) is largerly implemented in upper secondary schools but also within educational activities at museums, science centers and companies.

Grading system

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

Courses at KTH and Stockholm university in the first and the second cycle are graded on a scale from A to F, A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

The grades Pass (p) and Fail (f) are used as final grades for the degree project in accordance with particular circumstances. Courses involving internship (VFU) may have a threr-level grading systems; fail (U), pass (G) and merit (VG).

Conditions for participation in the programme

Description of term enrolment

Before every term, the student must submit an obligatory study enrolment,in the Personal meny. Without the study enrolment, the term and course registration cannot be done for the term. Term and course registration are required in order for the results to be reported and in order to receive aid from CSN.

Observe that one who has not completed term registration risks losing his/her VFU-place and, with that, possibly the chance to complete courses which consist of internship portions.

Course selection

The student is responsible to apply to the optional or conditionally option courses which he/she wishes to take the following term. The application to these courses must be submitted at Antagning.se:

- May 15th, before the Fall term
- November 15th, before the Spring term

For more information, see :http://www.kth.se/student/program/studiedokumentation-1.373670?programme=cl

The student must register him/herself in the course at the first scheduled lecture. Course registration for obligatory courses and optional courses must be done individually in the respective institution or by teh student himself in teh Peronal meny. A student who registers for a course and then decides to discontinue the course must notify the appropriate institution as soon as possible.

Conditions for promotion to the next year

The following point limitations apply for advancement to the next study year:

For studies in study year 2, at least 45 credits from study year 1 must be completed up to the August period.

For studies in study year 3, at least 90 credits from study years 1 and 2 must be completed up to the August period, of which 50 credits has to be from the first year.

For studies in study year 4, at least 150 higher education credits from years 1-3 must be completed of which at least 110 higher education credits from years 1-2.

For studies in study year 5, in addition to what must be completed for advancement to study year 4, at least 45 higher education credits from study year 4 must be completed.

In addition, all courses which are prerequisites to courses in the next study year must be completed by August, at the latest.

An individual study plan must be established for students who do not meet the requirements for advancement to the next study year. The main purpose of the individual study plan in that the student shall complete the remaining stayes during the following academic year. The study plan must include the remaining stayes, that need to be completed, as well as suitable courses included in the following study year. Particular intention shoud be paid to course admission requirements.

Recognition of previous academic studies

The right to receive recognition for previous academic studies is an important incentive for the mobility within the country and between countries, for the higher education institution’s internationalisation work and for the principle of life-long learning.

KTH has a generous method for recognition of previous academic studies which can be given even if the exact programme does not exist at KTH or if the course plans don't completely match those at KTH. The requirements which KTH normally puts on the programme's level and quality must be taken into consideration at the time of recognition.

Recognition of previous academic studies which is done at another higher education institution in Sweden will normally be accepted by KTH.

Students at KTH have the right to request a trial of recognition of previous academic studies.

Students at KTH, who study at another university within the boundaries of the exchange programme, have the right to receive advanced notification about recognition of previous academic studies. Such a decision can be given though a, so called, Learning Agreement established and signed by the coordinator at KTH, contact person at university abroad, and by the student.Decisions about recognition of previous academic studies of courses can be appealed at the Board of Appeals for higher education institutions. The appeal must be submitted to KTH at least three weeks from the day the student was notified of the decision.

In order for the request for recognition of previous academic studies to be tested, the applicant must be able to document that he/she has completed the course with at least a passing grade. When a course, which has been graded by another higher education institution, is recognised for credits, no grade is recorded in the degree certificate.

See more: http://intra.kth.se/en/regelverk/utbildning-forskning/grundutbildning/prestationer/policy-for-tillgodoraknande-av-hogskoleutbildning-inklusive-bedomning-av-reell-kompetens-1.27200

Studies abroad

Studies abroad

Students in the programme Master of Science in Engineering and of Education have the possibility to study at certain foreign higher education institutions during a half study year without the need to pay the course fees which are normally paid by the foreign students. Exchange studies can occur during the third, fourth or fifth study years. It is also possible to do the degree project abroad.

For more information, contact the office's coordinator for studies abroad:http://www.kth.se/student/program/utlandsstudier/utbyte/utbytesuniversitet-cl-1.348439

Degree project

Degree project in technology and learning

Included in the programme is a degree project comprising 30 higher education credits corresponding to about 20 weeks of full-time work. The degree project is normally the concluding course in the programme and must be on the second level. It must show proof of an independent work within technology and learning and include theoretical and/or experimental work, written report and oral presentation, including public discussionof one other student´s project.

Choice of degree project

The subject for the degree project can be suggested by the student, KTH- or Stockholm University institutions, upper secondary schools, Science Centres, or companies. Since the internship is included in the degree project, the work must be proportionally assigned to a secondary schoo, a science centre and/or company.

For more information:https://www.kth.se/student/program/examensarbete/examensarbete-sci?programme=cl

Degree

A Master of Science in Engineering and a Master of Education degree on the second level is received after the completion of the educational programme.

Conditions for the degree:

The student must have fulfilled courses corresponding to 300 higher education credits, whereof:

- 45 higher education credits of Mathematics-natural scientific subjects
- 180 higher education credits of subjects central to the technology area (including 30 higher education credits of degree project work)
- At least 90 higher education credits on the second level, whereof at least 60 higher education credits are in subjects central to the technology area (including 30 higher education credits of degree project work)

The following will be discerned from the above credits:

- A total of 210 higher education credits of subject studies and subject didactic courses within the respective subject combination.
- A total of 60 higher education credits in courses and study units in the educational sciences core of the teacher education.
- 30 higher education credits from internship, of which at least 15 higher education credits derived from subject didactic placement in high school within the respective subject combination.

The name of the degree

Degree of Master of Science in Engineering, Degree Programme in Mathematics and Physics, Mathematics and Chemistry or Mathematics and Technology.

Degree of Master in Education, 300 Credit Points, Degree Programme in Mathematics and Physics, Mathematics and Chemistry or Mathematics and Technology, where the latter is the equivalent of a Master of Science in Engineering in Mathematics and IKT; or Mathematics and Energy and Environment.

The application for the degree is done on a special form. For more information: http://www.kth.se/student/program/examen?programme=cl

Appendix 1 - Course list
Appendix 2 - Programme syllabus descriptions

Appendix 1: Course list

Master of Science in Engineering and in Education (CLGYM), Programme syllabus for studies starting in autumn 2016

General courses

Year 1

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
DD1314	Programming for Interactive Media	8.0	First cycle
DIK200	Learning as Professional Assignments	8.5	First cycle
ED1100	Engineering Science	7.5	First cycle
MJ1530	Physics, Chemistry, Energy and the Environment	15.0	First cycle
SF1661	Perspectives on Mathematics	6.0	First cycle
SF1662	Discrete Mathematics	7.5	First cycle
UMK212	Mathematics Education and Pre-service Placement for Upper Secondary School	7.5	First cycle

Supplementary information

All students follow the same courses during the first year of the programme. At the end of the spring term, the students choose one of the four specialisations:

Mathematics and Physics, Mathematics and Chemistry, Mathematics and Technology, specialising in Energy and environment, Mathematics and Technology specialising in Information and communication technology.

Year 2

Year 3

Year 4

Year 5

Mathematics and Physics (MAFY)

Year 1

Year 2

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
SF1672	Linear Algebra	7.5	First cycle
SF1673	Analysis in one variable	7.5	First cycle
SF1674	Multivariable Calculus	7.5	First cycle
SG1112	Mechanics I	9.0	First cycle
SI1122	Thermodynamics	5.0	First cycle
SI1146	Vector Analysis	4.0	First cycle
SK1104	Classical Physics	7.5	First cycle
UCK300	Educational leadership	6.0	First cycle
UMK310	Development and Learning in Science and Technology	6.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, TO BE CHANGED

The majority of the specialised courses are followed jointly with first-year Engineering Physics. From autumn term 2016, there will be certain changes in the programme syllabus for Engineering Physics. This will also affect the Master of Science in Engineering and Education programme and the Mathematics and Physics specialisation, principally years 2 and 3.

Year 3

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
LT1035	VFU2: Experiments and Informal Learning Environments	11.0	First cycle
ME2084	Organizational Analysis and Professional Roles	4.0	Second cycle
SF1544	Numerical Methods, Basic Course IV	6.0	First cycle

Course code	Course name	Credits	Edu. level
SF1683	Differential Equations and Transforms	9.0	First cycle
SF1917	Probability Theory and Statistics	6.0	First cycle
SG1113	Mechanics, Continuation Course	6.0	First cycle
SH1014	Modern Physics	4.0	First cycle
SI1155	Theoretical Physics	6.0	First cycle
SI1200	Mathematical Methods in Physics	4.0	First cycle
SK1105	Experimental Physics	4.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, TO BE CHANGED

The majority of the specialised courses are followed jointly with second-year Engineering Physics. From autumn term 2016, there will be certain changes in the programme syllabus for Engineering Physics. This will also affect the Master of Science in Engineering and Education programme and the Mathematics and Physics specialisation, principally years 2 and 3.

Year 4

Mandatory courses (53.0 credits)

Course code	Course name	Credits	Edu. level
EH2070	Project Management and Business Development	6.0	Second cycle
EI1228	Electromagnetic Theory, Smaller Course *Continuation from year 3*	6.0	First cycle
MJ2612	Teaching and Sustainable Development	6.0	Second cycle
SF2717	Mathematics, Advanced Course	6.0	Second cycle
SH1015	Applied Modern Physics	5.0	First cycle
UMK702	Teaching and Assessment in Mathematics and Technology or Science	9.0	Second cycle
UMK703	School Placement III with Subject Didactics	15.0	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
DD2401	Neuroscience	7.5	Second cycle
ED2200	Energy and Fusion Research	6.0	Second cycle
EF2200	Plasma Physics	6.0	Second cycle
EF2240	Space Physics	6.0	Second cycle

Course code	Course name	Credits	Edu. level
EG2340	Wind Power Systems	7.5	Second cycle
EI2430	High-voltage Engineering	7.5	Second cycle
EJ1200	Electric Power Systems	6.0	First cycle
EJ2301	Power Electronics	6.0	Second cycle
EL1000	Automatic Control, General Course	6.0	First cycle
HL1007	Medical Engineering, Basic Course	6.0	First cycle
HL2003	Radiation Physics and Biology	6.0	Second cycle
IH1611	Semiconductor Devices	7.5	First cycle
IH2653	Simulation of Semiconductor Devices	7.5	Second cycle
MJ2407	Sustainable Energy Utilisation	9.0	Second cycle
MJ2411	Renewable Energy Technology	6.0	Second cycle
SD2125	Signals and Mechanical Systems	6.0	Second cycle
SE1055	Strength of Materials and Solid Mechanics, Basic Course with Energy Methods	9.0	First cycle
SE2121	Introduction to Biomechanics	9.0	Second cycle
SF1677	Foundations of Analysis	7.5	First cycle
SF1678	Groups and Rings	7.5	First cycle
SF1904	Markov Processes, Basic Course	3.0	First cycle
SF2701	Financial Mathematics, Basic Course	7.5	Second cycle
SF2718	Mathematics for Chemists	6.0	Second cycle
SF2832	Mathematical Systems Theory	7.5	Second cycle
SF2930	Regression Analysis	7.5	Second cycle
SF2940	Probability Theory	7.5	Second cycle
SG1215	Fluid Mechanics	4.0	First cycle
SG2150	Rigid Body Dynamic	7.0	Second cycle
SG2211	Vehicle Aerodynamics	6.0	Second cycle
SG2214	Fluid Mechanics	7.5	Second cycle
SG2215	Compressible Flow	7.5	Second cycle
SG2221	Wave Motions and Hydrodynamic Stability	7.5	Second cycle
SH2103	Subatomic Physics	7.5	Second cycle
SH2203	Experimental Particle Physics	7.5	Second cycle
SH2302	Nuclear Physics	8.0	Second cycle
SH2314	Medical Imaging, Signals and Systems	7.5	Second cycle

Course code	Course name	Credits	Edu. level
SH2402	Astrophysics	6.0	Second cycle
SH2600	Nuclear Reactor Physics, Major Course	9.0	Second cycle
SH2601	Reactor Physics, Minor Course	6.0	Second cycle
SI1162	Statistical Physics	7.5	First cycle
SI1336	Simulation and Modeling	6.0	First cycle
SI2371	Special Relativity	6.0	Second cycle
SI2372	General Relativity	3.0	Second cycle
SI2400	Theoretical Particle Physics	7.5	Second cycle
SI2510	Statistical Mechanics	7.5	Second cycle
SI2520	Nonequilibrium Statistical Mechanics	7.5	Second cycle
SI2530	Computational Physics	7.5	Second cycle
SI2540	Complex Systems	7.5	Second cycle
SI2600	Condensed Matter Theory	7.5	Second cycle
SK2300	Optical Physics	6.0	Second cycle
SK2301	Optical Physics	3.0	Second cycle
SK2320	Problem Solving in Optics	6.0	Second cycle
SK2402	Fundamentals of Photonics	7.5	Second cycle
SK2403	Applied Photonics	6.0	Second cycle
SK2411	Laser Physics	7.5	Second cycle
SK2512	Cellular Biophysics *Only one of the courses SK2512 or SK2513 can be read*	10.0	Second cycle
SK2513	Cell Culture: Theory and Practice *Only one of the courses SK2512 or SK2513 can be read*	4.0	Second cycle
SK2520	Experimental Methods in Molecular Biophysics	8.0	Second cycle
SK2531	Biomedicine for Engineers	12.0	Second cycle
SK2700	Mesoscopic Physics	8.0	Second cycle
SK2710	Spin Electronics	8.0	Second cycle
SK2758	Solid State Physics	7.5	Second cycle
SK2759	Superconductivity and Applications	6.0	Second cycle
SK2760	Chemistry of Nanomaterials	7.5	Second cycle

Supplementary information

The majority of the courses are followed by all students.
Conditionally elective courses in Physics/Mathematics constitute approx. 11 ECTS credits.

Year 5

Mandatory courses (51.0 credits)

Course code	Course name	Credits	Edu. level
AK2055	Theory of Science and Research Methodology for Teachers	4.0	Second cycle
LT200X	Degree Project in Technology and Learning, Second Cycle	30.0	Second cycle
SF2719	The History of Mathematics	6.0	Second cycle
UMK803	Curriculum Theory and Subject Didactics	6.0	Second cycle
UQK701	Special Education- Youth and Adults	5.0	Second cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

The majority of the courses are followed by all students.

Conditionally elective courses in Physics/Mathematics constitute approx. 8 ECTS credits.

Suggestions for conditionally elective courses that are approved for the degree are to be found in the list under CLGYM/MAFY (Master of Science in Engineering and Education programme and the Mathematics and Physics specialisation), year 4, during the academic year 2014/15.

Year 6

Mathematics and Chemistry (MAKE)

Year 1

Year 2

Mandatory courses (67.5 credits)

Course code	Course name	Credits	Edu. level
KA1040	Perspectives on Research and Innovation	8.5	First cycle
KD1230	Organic Chemistry, Basic Concepts and Practice	6.0	First cycle
KD1290	Chemical Analysis	8.5	First cycle
KE1150	Engineering Chemistry	10.0	First cycle
SF1624	Algebra and Geometry	7.5	First cycle
SF1625	Calculus in One Variable	7.5	First cycle
SF1626	Calculus in Several Variable	7.5	First cycle
UCK300	Educational leadership	6.0	First cycle
UMK310	Development and Learning in Science and Technology	6.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED
The majority of the specialised courses are followed jointly with first-year Degree Programme in Engineering Chemistry.

Year 3

Mandatory courses (61.0 credits)

Course code	Course name	Credits	Edu. level
KA1040	Perspectives on Research and Innovation	8.5	First cycle
KD1070	Molecular Structure	6.0	First cycle
KD1080	Chemical Dynamics	6.0	First cycle
KE1160	Thermodynamics	7.5	First cycle
LT1035	VFU2: Experiments and Informal Learning Environments	11.0	First cycle
ME2084	Organizational Analysis and Professional Roles	4.0	Second cycle
SF1514	Numerical Methods, Basic Course	6.0	First cycle
SF1633	Differential Equations I	6.0	First cycle
SF1914	Probability Theory and Statistics	6.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED
The majority of the specialised courses are followed jointly with second-year Degree Programme in Engineering Chemistry.

Year 4

Mandatory courses (48.0 credits)

Course code	Course name	Credits	Edu. level
EH2070	Project Management and Business Development	6.0	Second cycle
MJ2612	Teaching and Sustainable Development	6.0	Second cycle
SF2717	Mathematics, Advanced Course	6.0	Second cycle
SF2718	Mathematics for Chemists	6.0	Second cycle
UMK702	Teaching and Assessment in Mathematics and Technology or Science	9.0	Second cycle
UMK703	School Placement III with Subject Didactics	15.0	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
KD1270	Organic Chemistry, Basic Concepts and Practice 2	7.5	First cycle
KD2155	Solid State Chemistry: Structures and Methods	7.5	Second cycle
KD2170	Nano-structured Materials	7.5	Second cycle
KD2320	Spectroscopic Tools for Chemistry	9.0	Second cycle
KD2330	Analytical Separations	7.5	Second cycle
KD2350	Surfaces, Colloids and Soft Matter	7.5	Second cycle
KD2370	Photo, Radiation and Radical Chemistry	7.5	Second cycle
KE2130	Renewable Fuel Production Processes	7.5	Second cycle
KF2450	Fibre Technology - Natural and Synthetic Fibres	7.5	Second cycle
KF2490	Biocomposite Materials	7.5	Second cycle
MJ2615	Introduction to Industrial Ecology, larger course	7.5	Second cycle
SF1677	Foundations of Analysis	7.5	First cycle
SF1678	Groups and Rings	7.5	First cycle
SF1904	Markov Processes, Basic Course	3.0	First cycle
SF2701	Financial Mathematics, Basic Course	7.5	Second cycle
SF2832	Mathematical Systems Theory	7.5	Second cycle
SF2930	Regression Analysis	7.5	Second cycle
SF2940	Probability Theory	7.5	Second cycle

Supplementary information

The majority of the courses are followed by all students.

Conditionally elective courses in Chemistry/Mathematics constitute approx. 12 ECTS credits.

CK2010 is also conditionally elective

Year 5

Mandatory courses (57.0 credits)

Course code	Course name	Credits	Edu. level
AK2055	Theory of Science and Research Methodology for Teachers	4.0	Second cycle
BB1050	Biotechnology	6.0	First cycle
LT200X	Degree Project in Technology and Learning, Second Cycle	30.0	Second cycle
SF2719	The History of Mathematics	6.0	Second cycle

Course code	Course name	Credits	Edu. level
UMK803	Curriculum Theory and Subject Didactics	6.0	Second cycle
UQK701	Special Education- Youth and Adults	5.0	Second cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

The majority of the courses are followed by all students.

Conditionally elective courses in Chemistry/Mathematics constitute approx. 3 ECTS credits.

Suggestions for conditionally elective courses that are approved for the degree are to be found in the list under CLGYM/MAKE (Master of Science in Engineering and Education programme and the Mathematics and Chemistry specialisation), year 4, during the academic year 2014/15.

Mathematics and Technology: Energy and Environment (TEMI)

Year 1

Year 2

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
AE1503	Environmental Systems Analysis for Teachers	6.0	First cycle
MJ1508	Ecology and Environmental Effects	7.5	First cycle
SF1546	Numerical Methods, Basic Course	6.0	First cycle
SF1624	Algebra and Geometry	7.5	First cycle
SF1625	Calculus in One Variable	7.5	First cycle
SF1626	Calculus in Several Variable	7.5	First cycle
SG1102	Mechanics, Smaller Course	6.0	First cycle
UCK300	Educational leadership	6.0	First cycle
UMK310	Development and Learning in Science and Technology	6.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

The majority of the specialised courses are followed jointly with first-year Degree Programme in Energy and Environment.

Year 3

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
KE1060	Material and Energy Balances	7.5	First cycle
LT1035	VFU2: Experiments and Informal Learning Environments	11.0	First cycle
ME2084	Organizational Analysis and Professional Roles	4.0	Second cycle
MJ1112	Applied Thermodynamics	9.0	First cycle
MJ1145	Energy Systems	7.5	First cycle
MJ2615	Introduction to Industrial Ecology, larger course	7.5	Second cycle
SF1633	Differential Equations I	6.0	First cycle
SF1910	Applied Statistics	7.5	First cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

The majority of the specialised courses are followed jointly with second-year Degree Programme in Energy and Environment

Year 4

Mandatory courses (54.0 credits)

Course code	Course name	Credits	Edu. level
AK2209	Energy Systems in Society	6.0	Second cycle
EH2070	Project Management and Business Development	6.0	Second cycle
MJ2612	Teaching and Sustainable Development	6.0	Second cycle
SF2717	Mathematics, Advanced Course	6.0	Second cycle
SF2718	Mathematics for Chemists	6.0	Second cycle
UMK702	Teaching and Assessment in Mathematics and Technology or Science	9.0	Second cycle
UMK703	School Placement III with Subject Didactics	15.0	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
AE1107	Geoenergy	7.5	First cycle
AG1137	Planning and Governance of Urban and Regional Development	7.5	First cycle

Course code	Course name	Credits	Edu. level
AL2181	Environmental System Analysis and Decision-making	7.5	Second cycle
AL2195	Sustainable Development in Developing Countries	7.5	Second cycle
MG2128	CAD and Other IT Tools in Industrial Processes, Extended Course	7.5	Second cycle
MJ1150	Energy and Systems, Innovation and Entrepreneurship	10.5	First cycle
MJ1501	States and Trends	7.5	First cycle
MJ2627	Environmental Technology, Larger Course	9.0	Second cycle
MJ2629	Environmental Technology, Theory Course	6.0	Second cycle
SE1020	Solid Mechanics, Basic Course	9.0	First cycle
SE1055	Strength of Materials and Solid Mechanics, Basic Course with Energy Methods	9.0	First cycle
SF1678	Groups and Rings	7.5	First cycle
SF1904	Markov Processes, Basic Course	3.0	First cycle
SF2701	Financial Mathematics, Basic Course	7.5	Second cycle
SF2832	Mathematical Systems Theory	7.5	Second cycle
SF2930	Regression Analysis	7.5	Second cycle
SF2940	Probability Theory	7.5	Second cycle

Supplementary information

The majority of the courses are followed by all students.

Conditionally elective courses in Technology/Mathematics constitute approx. 6 ECTS credits.

Year 5

Mandatory courses (51.0 credits)

Course code	Course name	Credits	Edu. level
AK2055	Theory of Science and Research Methodology for Teachers	4.0	Second cycle
LT200X	Degree Project in Technology and Learning, Second Cycle	30.0	Second cycle
SF2719	The History of Mathematics	6.0	Second cycle
UMK803	Curriculum Theory and Subject Didactics	6.0	Second cycle
UQK701	Special Education- Youth and Adults	5.0	Second cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

Conditionally elective courses in Technology/Mathematics constitute approx. 9 ECTS credits.

The majority of the courses are followed by all students.

Suggestions for conditionally elective courses that are approved for the degree are to be found in the list under CLGYM/TEMI (Master of Science in Engineering and Education programme and the Mathematics and Technology specialisation in Energy and Environment), year 4, during the academic year 2014/15.

Mathematics and Technology: Information and communication (TIKT)

Year 1

Year 2

Mandatory courses (60.0 credits)

Course code	Course name	Credits	Edu. level
DD1325	Applied Computer Science with Ethics	7.5	First cycle
DD1380	Java Programming for Python Programmers	1.5	First cycle
DH2624	Human-Computer Interaction - a Didactive Perspective	7.5	Second cycle
IS1500	Computer Organization and Components	9.0	First cycle
SF1624	Algebra and Geometry	7.5	First cycle
SF1625	Calculus in One Variable	7.5	First cycle
SF1626	Calculus in Several Variable	7.5	First cycle
UCK300	Educational leadership	6.0	First cycle
UMK310	Development and Learning in Science and Technology	6.0	First cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED
The majority of the specialised courses are followed jointly with first-year Degree Programme in Computer Science and Engineering or Media Technology.

Year 3

Mandatory courses (58.5 credits)

Course code	Course name	Credits	Edu. level
DD1362	Programming Paradigms	6.0	First cycle
DD1368	Database Technology	6.0	First cycle
DD1393	Software Engineering	10.5	First cycle
DD1395	In-depth Essay in Computer Science	3.0	First cycle
LT1035	VFU2: Experiments and Informal Learning Environments	11.0	First cycle
ME2084	Organizational Analysis and Professional Roles	4.0	Second cycle
SF1514	Numerical Methods, Basic Course	6.0	First cycle

Course code	Course name	Credits	Edu. level
SF1633	Differential Equations I	6.0	First cycle
SF1917	Probability Theory and Statistics	6.0	First cycle

Supplementary information

The majority of the specialised courses are followed jointly with second-year Degree Programme in Computer Science and Engineering or Media Technology.

Year 4

Mandatory courses (42.0 credits)

Course code	Course name	Credits	Edu. level
EH2070	Project Management and Business Development	6.0	Second cycle
MJ2612	Teaching and Sustainable Development	6.0	Second cycle
SF2717	Mathematics, Advanced Course	6.0	Second cycle
UMK702	Teaching and Assessment in Mathematics and Technology or Science	9.0	Second cycle
UMK703	School Placement III with Subject Didactics	15.0	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
DD1362	Programming Paradigms	6.0	First cycle
DD1388	Program System Construction Using C++	7.5	First cycle
DD1396	Parallel and Concurrent Programming in Introduction to Computer Science	3.0	First cycle
DD2350	Algorithms, Data Structures and Complexity	9.5	Second cycle
DD2352	Algorithms and Complexity	7.5	Second cycle
DD2372	Automata and Languages	6.0	Second cycle
DD2395	Computer Security	6.0	Second cycle
DD2418	Language Engineering	6.0	Second cycle
DD2424	Deep Learning in Data Science	7.5	Second cycle
DD2429	Computational Photography	6.0	Second cycle
DD2437	Artificial Neural Networks and Deep Architectures	7.5	Second cycle
DD2440	Advanced Algorithms	6.0	Second cycle
DD2445	Complexity Theory	7.5	Second cycle
DD2447	Statistical Methods in Applied Computer Science	6.0	Second cycle

Course code	Course name	Credits	Edu. level
DD2448	Foundations of Cryptography	7.5	Second cycle
DH2320	Introduction to Visualization and Computer Graphics	6.0	Second cycle
DH2323	Computer Graphics and Interaction	6.0	Second cycle
DH2408	Evaluation Methods in Human-Computer Interaction	6.0	Second cycle
DH2642	Interaction Programming and the Dynamic Web	7.5	Second cycle
DM2518	Mobile Development with Web Technologies	7.5	Second cycle
DT2140	Multimodal Interaction and Interfaces	7.5	Second cycle
IK2218	Protocols and Principles of the Internet	6.0	Second cycle
MG2128	CAD and Other IT Tools in Industrial Processes, Extended Course	7.5	Second cycle
SF1677	Foundations of Analysis	7.5	First cycle
SF1678	Groups and Rings	7.5	First cycle
SF1904	Markov Processes, Basic Course	3.0	First cycle
SF2520	Applied Numerical Methods	7.5	Second cycle
SF2701	Financial Mathematics, Basic Course	7.5	Second cycle
SF2718	Mathematics for Chemists	6.0	Second cycle
SF2832	Mathematical Systems Theory	7.5	Second cycle
SF2930	Regression Analysis	7.5	Second cycle
SF2940	Probability Theory	7.5	Second cycle
SG1510	Introduction to Classical and Solid Mechanics	7.5	First cycle

Supplementary information

The majority of the courses are followed by all students.

Conditionally elective courses in ICT Technology/Mathematics constitute approx. 18 ECTS credits.

Year 5

Mandatory courses (51.0 credits)

Course code	Course name	Credits	Edu. level
AK2055	Theory of Science and Research Methodology for Teachers	4.0	Second cycle
LT200X	Degree Project in Technology and Learning, Second Cycle	30.0	Second cycle
SF2719	The History of Mathematics	6.0	Second cycle
UMK803	Curriculum Theory and Subject Didactics	6.0	Second cycle

Course code	Course name	Credits	Edu. level
UQK701	Special Education- Youth and Adults	5.0	Second cycle

Supplementary information

PRELIMINARY SYLLABUS, MAY BE CHANGED

The majority of the courses are followed by all students.

Conditionally elective courses in ICT Technology/Mathematics constitute approx. 9 ECTS credits.

Suggestions for conditionally elective courses that are approved for the degree are to be found in the list under CLGYM/TIKT (Master of Science in Engineering and Education programme and the Mathematics and Technology with specialisation in Information- and Communication technology), year 4, during the academic year 2014/15.

Appendix 2: Specialisations

Master of Science in Engineering and in Education (CLGYM), Programme syllabus for studies starting in autumn 2016

Mathematics and Physics (MAFY)

Mission statements for the CL program's four branches
The branch specific courses fulfill three purposes. They should
• provide sufficient breadth and depth in the natural sciences and technology for the engineering degree
• factually cover the information contained in the upper secondary and late primary school curriculum
• in keeping with the subject didactic courses, prepare for a deeper understanding of the key issues and learning in the subject area

The goals for the common subject Mathematics
Courses in mathematics provide a sound basis for professional activities as a teacher in upper secondary school and as Master of Science in engineering. The training is comprised of courses developed specifically for the program as well as courses common to most other engineering programmes, the latter are often read together with the co-study programmes.
After completing training in the CL programme, the student will be able to
• describe, use and apply basic concepts, theorems and methods in linear algebra, differential and integral calculus of one and several variables, discrete mathematics as well as probability theory and statistics,
• demonstrate an understanding of the concepts of ordinary and partial differential equation, and how such equations arise in mathematical modeling and how to use and account for common analysis and solution methods,
• implement evidence and mathematical reasoning, and to communicate these both orally and in writing,
• demonstrate knowledge of real analysis and abstract algebra bases,
• use and apply mathematical knowledge in mathematical modeling,
• plan, implement and interpret computer-aided algebraic and numerical calculations central to the engineering profession and for educational math assignments,
• describe some important features of the historical development of the mathematical concept of the world,
• grasp and account for the central parts of school mathematics with confidence and flexibility,
• apply knowledge and skills to teaching and learning within secondary school courses in mathematics

The high mathematics content of the CL program ensures excellent potentialfor the student to succeed inher/hisstudies, andduring the fourth and fifth yearthere is also opportunity to choose advanced courses in mathematics.

Mathematics / Physics
Having completed training in the Mathematics / Physics - branch of the CL program the student should be able to
... explain and use basic principles and relations in the fields of thermodynamics, electrical circuits, electrostatics and magnetism, waves and optics
... carry out physics experiments in both classical and modern physics, both alone and in groups, including readings and error estimation
... master basic engineering methodologies such as estimations, reasonability assessments and dimensional analysis
... formulate relevant mathematical and physical relations and models using vector algebra, vector analysis as well as partial differential equations and solve these
... perform basic calculations in mechanics, especially in the areas of particle dynamics, statics, rigid bodies and shocks
... show an understanding of the foundations of modern physics; relativity, quantum physics, atomic and molecular physics, nuclear physics and solid state physics

... report on sustainable energy options for the future and associated technical and social aspects
... in an educational way communicate information within the technical / physical areas, both orally and in writing
... relate her/his knowledge and skills to teaching and learning in upper secondary school physics courses Fysik 1, 2 and 3
CL students co-study physics courses mainly together with students of the program in Engineering Physics. This applies to basic courses in physics, thermodynamics, mechanics and electricity as well as courses in modern physics and mathematical methods of physics. The elective courses provide opportunities for specialization within the desired area on the second level. The studies during the first year in basic chemistry and energy / environment complement the scientific knowledge breadth. The compulsory courses are thus designed to cover well the subject knowledge for teaching upper secondary school physics courses.

Mathematics and Chemistry (MAKE)

Mathematics/Chemistry
Having completed training in the Mathematics/Chemistry - branch of the CL programme the student should be able to
• demonstrate knowledge of the importance of chemical thermodynamics, chemical equilibrium, molecular structure, kinetics, etc. for chemical reactions and process routes, transportation and balances,
• explain and use basic principles of organic chemistry, analytical chemistry, chemical engineering and biotechnology,
• demonstrate laboratory skills and knowledge of safe handling of chemicals, and the ability to plan, implement and evaluate experiments,
• work efficiently in groups and plan and implement projects within a given framework,
• demonstrate knowledge of the other natural sciences, mathematics and numerical methods in chemistry and the field of chemical engineering,
• identify, formulate and manage problems related to chemistry/chemical engineering in industry, society and research,
• demonstrate the ability to make plausibility assessments of different solutions and to compare and evaluate these,
• consider issues related to security, energy, environment and ethics within the profession,
• present and discuss problems, possible solutions and results both orally and in writing, and communicate information within the field of chemistry/chemical engineering in an educational way to people with or without scientific/technical background,
• have sufficient knowledge in the field to quickly acquire new skills and apply these,
• apply their knowledge and skills to teaching and learning in upper secondary school chemistry courses Kemi 1 and 2.
CL students co-study basic chemistry/chemical engineering courses mainly with students in the in the Chemical Science and Engineering programme. The optional courses provide opportunities for specialization within the desired area on the second level. The studies during the first year in basic physics and energy/environmental science complement the scientific knowledge breadth. The compulsory courses are thus designed to cover well the subject knowledge for teaching upper secondary school chemistry courses.

Mathematics and Technology: Energy and Environment (TEMI)

Mathematics/Energy and Environment
Having completed training in the Mathematics/Energy and Environment branch of the CL program the student should be able to
• demonstrate basic knowledge of all aspects of energy in a broad sense,
• demonstrate knowledge of the validation of energy and environmental systems using modern engineering tools such as environmental systems,
• describe sustainable development and relevant environmental problems at the basic level, encompassing visions, concepts and definitions and be able to describe the state of the world,
• express themselves in a professional way and communicate thoughts, ideas, visions and results to their professional environment and the community,
• reflect on and critically examine the energy and environmental area's historic and future importance to global and local community development and relationship to ecological systems,
• have a holistic approach to sustainable development of system and life cycles for products as well as technical systems based on a multidisciplinary approach and by considering different player perspectives,
• assess ethical issues and conflicting objectives concerning sustainable development and demonstrate deep insight into the engineer's role and responsibility in society, especially in regard to the social, economic and environmental aspects,
• have the skills to challenge, develop and construct problem statements about prevailing habits, thought patterns,

technological and economic systems and cultural and social values,
• communicate information within energy and environmental areas in an educational way, both orally and in writing,
• relate their knowledge and skills to teaching and learning in upper secondary school courses in engineering, energy and environmental science,
CL students mainly co-study the courses in energy and environment with students in the program Energy and Environment. These courses include eg courses in energy systems, environmental systems, ecology and environmental effects, and environmental management. In addition to these they have their own course in learning and sustainable development. The elective courses provide opportunities for specialization within the desired area on the second level. The studies during the first year in basic chemistry and physics complement the scientific knowledge breadth. The compulsory courses are thus designed to cover well the subject knowledge for teaching upper secondary school technology courses and courses in energy and environmental science.

Mathematics and Technology: Information and communication (TIKT)

Mathematics/ICT
Having completed training in the Mathematics/ICT - branch of the CL program the student should be able to
... explain and use basic principles and relationships in programming techniques, object orientation, algorithms, data structures, database technology and computer engineering,
... develop software and software systems in a structured manner, both independently and in groups,
... master basic engineering methodologies such as estimations, plausibility assessments and dimensional analysis,
... model real problems with discrete structures, objects and databases so that they can be solved with computers,
... analyze and evaluate the economic, social, environmental and ethical impact of information technology applications, and to design systems with regard to this,
... communicate information in an educational way within the information technology area, both orally and in writing,
... relate knowledge and skills to teaching and learning in upper secondary school courses in programming and media and communication studies
so that they will be able to ...
... work as teachers in mathematics, programming, media and communication studies,
... work with knowledge management in the public sector and in business,
... work with development of technological learning systems,
... work in the computer industry in their selected specialization.
CL students co-study specialization courses mainlywith students in the programmes Media Technology and Computer Science. The elective courses provide opportunities for specialization within the desired area on the second level. The studies during the first year in basic physics, chemistry, energy/environmental science complement the scientific knowledge breadth.