Linnæus University

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Programme syllabus

Faculty of Technology

Hållbar konstruktionsteknik, masterprogram, 120 högskolepoäng
Sustainable Structural Engineering, Master Programme, 120 credits

Level
Second Level

Date of Ratification
Approved by Faculty of Technology 2017-09-08

Revised 2022-09-09

The programme syllabus is valid from autumn semester 2023

Prerequisites
General entry requirements for second-cycle studies and specific entry requirements:

- Bachelor of Science degree in Civil Engineering, Architectural Engineering or the equivalent. This degree must include a minimum of 7.5 credits in Structural Mechanics or Mechanics of Materials as well as mathematics corresponding to the courses Calculus 1 (7.5 credits) and Vector geometry/Linear algebra (7.5 credits) or the equivalent.
- English 6 or the equivalent.

Description of Programme
The programme provides an extension of in-depth knowledge within structural engineering and prepares the student for work in industry within the field of structural engineering as well as for research studies at doctoral level.

The programme aims to train qualified engineers within structural engineering with focus on computational mechanics, numerical modelling and sustainable structural engineering. The concept of sustainability is reflected in several of the courses within the program, e.i. by discussing such aspects of construction materials, and that the climate and energy use in the building sector is highlighted in particular.

Objectives
Central exam objectives according to the Higher Education Ordinance

Knowledge and understanding
For a Degree of Master (Two Years) students must:

- demonstrate knowledge and understanding in their main field of study, including

both a broad command of the field and deeper knowledge of certain parts of the field, together with a deep insight into current research and development work; and
- demonstrate deeper methodological knowledge in their main field of study.

*Skills and abilities*For a Degree of Master (Two Years) students must:

- demonstrate an ability to integrate knowledge critically and systematically, and to analyse, assess and deal with complex phenomena, issues and situations, even when limited information is available;
- demonstrate an ability to critically, independently and creatively, identify and formulate issues and to plan and, using appropriate methods, carry out advanced tasks within specified time limits and there by contribute to the knowledge development, and evaluate this work;
- demonstrate an ability to clearly present and discuss their conclusions, and the knowledge and arguments behind them, in dialogue with different groups, in national as well as international contexts, orally and in writing; and
- demonstrate the skill required to participate in research and development work or to independently work in other advanced contexts.

Judgement and approach
For a Degree of Master (Two Year) students must:

- demonstrate an ability to make assessments in their main field of study, taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical aspects of research and development work;
- demonstrate insight into the potential and limitations of science, its role in society and people's responsibility for how it is used; and
- demonstrate an ability to identify their need of further knowledge and to take responsibility for developing their knowledge.

Programme-specific objectives

Knowledge and understanding
For the Degree of Master (Two Year) students must:

- demonstrate general knowledge and understanding of the field of civil/structural engineering and
- demonstrate an in-depth extension of knowledge regarding structural mechanics analysis, structural design and structural engineering.

Skills and ability

For a Degree of Master (Two Year) students must:

- demonstrate an ability to analyse and mathematically model engineering problems in a constructive manner, with particular relevance to the structural engineering field,
- demonstrate an ability to analyse and design advanced building constructions,
- demonstrate an ability to utilise modern analysis tools and computer software within calculation mechanics (finite element method),
- demonstrate an ability to specify development projects and assess different

technical solutions early on in a development process,
- demonstrate an ability to plan and conduct independent projects within the fields of civil engineering and architectural engineering,
- demonstrate an ability to communicate technical problems with the help of computer aids and different types of software, and
- demonstrate an ability through written reports and verbal presentations, to professionally present problems, analyses and results.

Judgement and approach
For the Degree of Master (Two Year) students must:

- demonstrate an ability to make engineering assessments, i.e. assess relevance, applicability and thoroughness in analyses and calculations with consideration to relevant assumptions and simplifications, and
- demonstrate an ability to identify needs for additional knowledge in and in connection with the field of civil/structural engineering, and take responsibility for the personal knowledge development.

Content

Programme overview

The first year of the programme consists of courses within mathematics, mechanics, finite element methods and structural dynamics, as well as other methodological and conceptual courses related to structural engineering, energy and environmental implications of building materials, and applied course in concrete structures. The second year encompasses an advanced beam theory course and three applied courses in structural engineering with focus on timber and steel structures. A course in scientific methodology is given before the final degree project.

In agreement with program coordinator, courses can be exchanged for corresponding courses within the program's specialization. This can be applied when the student studied similar courses previously. In exchange for courses, the program coordinator makes sure that the program's objectives are still met. The pre-requisite for courses and the local rules for graduation at Linnaeus University must always be met.

Programme courses
First year:
Analysis of structures (7.5 credits, extension A1N) *
This course primarily deals with element-based, matrix-formulated displacement methods that enable estimations to be made of deformations and section forces in combined structures of beams and bars. This course also includes studies of various structures with mechanical behaviours and modelling aspects of these.

Multivariable calculus and vector calculus (7.5 credits, extension G1F)
This course includes central concepts and theories in multivariable analysis and linear algebra in accordance with the programme courses and the general objective of the programme.

The finite element method (7.5 credits, extension A1N)
This course is based on advanced structural mechanics. The theoretical background of the finite element method and its implementation in various problems is presented. The focus is primarily put on linear elasticity problems.

Structural dynamics (7.5 credits, extension A1F)
Structural dynamics is an area with a wide range of applications spanning from aerospace, vehicle and machine to buildings. Within this area structures' dynamic behaviours are studied; this includes performance, comfort, life and vibrations when time varying loads due to human beings, manoeuvres, wind, earth quakes etc. are applied to the structure. Within Structural Dynamics finite element models are often used to calculate structural responses. In order to minimize material usage, knowledge about dynamic properties is important.

Conceptual structural design (10 credits, extension A1N) *
This course teaches design concepts of structures in relation to standardization and builds upon earlier courses on structural and computational mechanics. It encompasses the design and analysis of structural systems and their realization and idealization in models. Basic design principles, loads on structures and material-specific design rules according to the European structural design standards are introduced and applied in project works. This course forms the basis for material-specific advanced design of structures and their evaluation in relation to sustainability.

The finite element method 2 (5 credits, extension A1F) *
This course deepens the theories on the finite element method. More complicated issues are dealt with, such as modelling of plastic material responses and further non-linear phenomena in structures.

Energy and climate efficient construction (7.5 credits, extension A1N) *
The course provides knowledge on energy and material flow in the built environment. Energy analysis aspects include the energy used during the life cycle of a building, and various fossil fuel and biomass-based energy supply systems. Material flow aspects cover mainly the environmental implications of producing buildings with various framing materials.

Concrete structures 2 (7.5 credits, extension A1F) *
This course deals with advanced analysis of concrete structures and structures where concrete is used in conjunction with other materials. The course also deals with optimisation of concrete structures considering environmental sustainability issues.

Second year:

Steel structures (7.5 credits, extension A1F) *
This course deepens the knowledge regarding how steel can be used in loadbearing structures. In addition, thorough knowledge is provided regarding how steel structures are assembled, how load transmitting components and connections can be analysed and how steel structures can be optimised with respect to material usage. Sustainability issues linked to steel structures are also explored in the course.

Timber structures 2 (7.5 credits, extension A1F) *
The course addresses various structural engineering problems specific to timber structures and how advanced design methods based on the Finite Element Method can be applied. Structures made of glued-laminated timber, solid timber, engineered wood-based products, hybrid structures and composite structures, as well as their detailing, including e.g. connections, holes and notches, are analysed. It offers training in critical analysis of wood-based building systems including stability of timber structures and

their structural detailing. It further gives basic understanding of environmental impacts during the life cycle of timber structures.

Beam theory (5 credits, extension A1F) *
This course includes more complicated phenomena within classical beam theory. Examples of such are Vlaskovs twist and instability phenomena such as tilting.

Building physics with numerical applications (5 credits, extension A1F) *
Within building physics, problems related to dampness and heat in different construction materials and combined materials are treated. The goal of the course is that after the course, students should be able to implement numerical models to solve problems related to moisture and heat. Such issues are important to ensuring a long-term secure and durable building.

Scientific methodology and planning (5 credits, extension A1N)
This course addresses methods and offers practical guidance in defining objectives, limitations and in planning and execution of a project in research and industry. It starts with theory of science with philosophical and theoretical foundations, and it offers training in the ability to present results orally and in written technical reports, including scientific literature search.

Sustainable structural engineering, degree project (30 credits, extensionA2E) *
This course concludes the programme and offers students possibilities to put their experience into practice in the form of an independent project. Students are to demonstrate their ability to implement knowledge acquired throughout the programme, defining a problem, conducting a survey, in addition to analysing and presenting the results.

Courses marked with * are given within the main field of study.

Work experience and community contacts
This programme offers possibilities for students to establish contacts with industry and research groups through the teachers and lecturers who work, or have worked, within the industry or with applied research. Additional contacts are obtained through field trips and the planning of degree dissertation projects, which often have connection to a specific industrial problem. Issues concerning working life are also discussed at the Programme Board.

Internationalization
The programme is given with international students as an important target audience. It is common within similar programmes that students with different nationalities meet and study together. Such studies open up for long-term international relations between students as well as between students and the responsible course lecturers.Any studies abroad must be planned in consultation with the international coordinator at the department and with the lecturer responsible for the programme. The latter approves which courses can be credited to the education.

Sustainable Development
Using wood as a renewable material contributes to sustainable development of the built environment. Another way to contribute to a future sustainable development is to use the right amount of the right material at the right place in a structure so that the total material use is optimised. In addition, a separate course is given in Energy and climate

efficient building techniques, where sustainability issues in the building industry and methods for quantifying sustainability are in focus. Corresponding methods are subsequently applied in engineering design courses.

Quality Development

The programme is evaluated through continuous course evaluations and follow-ups of these, as well as through a yearly programme evaluation where student representatives meet with the programme teachers to discuss the framework, content and relation to the surrounding society. Relevant feedbacks from students are considered, and are discussed with the students at the beginning of courses and at the beginning of the programme.

There is a programme board which meets yearly to discuss issues connected to the development of the programme from academic quality and professional life perspectives. The programme board consists of the programme manager and teachers, students' representatives as well as representatives of building and construction companies.

Degree Certificate

After completing programme studies, corresponding to the requirements expressed in the Higher Education Ordinance degree order as well as Linnaeus University degree order, the student may apply for a degree. Those who have completed the master programme in Sustainable Structural Engineering may obtain the following degree:

Teknologie masterexamen med inriktning mot hållbar konstruktionsteknik
Huvudområde: Byggteknik

Master of Science (120 credits) with specialisation Sustainable Structural Engineering
Main field of study: Civil Engineering.

To obtain the prefix "Teknologie", the student should have a higher education diploma in engineering or a Bachelor degree in technology.

The degree certificate is bilingual (Swedish/English). This certificate is also completed with a Diploma Supplement (in English).

Other Information

The programme contains mandatory elements, which may result in certain expenses to be paid for by the students themselves. Moreover, it is assumed that the student has the digital equipment needed to complete the programme.