Linnæus University

Dnr: 2021/4621-3.1.1.3

Programme syllabus

Faculty of Technology

Simuleringsdriven Produktutveckling, masterprogram, 120 högskolepoäng

Simulation Driven Product Development, master programme, 120 credits

Level
Second Level

Date of Ratification
Approved by Faculty of Technology 2018-06-15

Revised 2021-12-10

The programme syllabus is valid from autumn semester 2022

Prerequisites
General entry requirements for secondcycle studies and specific entry requirements:

- Bachelor of Science in Technology, Engineering or Mathematics
- 7.5 credits Solid Mechanics or Structural Mechanics or equivalent
- 22,5 credits Algebra and Calculus or equivalent
- English 6 or equivalent.

Description of Programme

The program is offered by the Department of Mechanical Engineering at the Faculty of Technology. A program coordinator at the department will have special responsibility for the administration of the program. The program aims to educate qualified engineers in Mechanical Engineering with a focus on product development, computational mechanics and structural dynamics. These skills are demanded by industry as well as Universities and Colleges for development and research. Through active participation in courses and a degree dissertation project within the subject area, students will be offered prerequisites for meeting the expected learning outcomes presented in the previous section. The knowledge and skills acquired by the students will also form the basis for both qualified tasks within the industry and research studies within academy.

Objectives

Central degree objectives in accordance with the Higher Education Ordinance

Knowledge and understanding

For a Degree of Master (120 credits) the student shall

- demonstrate knowledge and understanding in the main field of study, including both broad knowledge of the field and a considerable degree of specialised knowledge in certain areas of the field as well as insight into current research and development work, and
- demonstrate specialised methodological knowledge in the main field of study.

Competence and skills

For a Degree of Master (120 credits) the student shall

- demonstrate the ability to critically and systematically integrate knowledge and analyse, assess and deal with complex phenomena, issues and situations even with limited information,
- demonstrate the ability to identify and formulate issues critically, autonomously and creatively as well as to plan and, using appropriate methods, undertake advanced tasks within predetermined time frames and so contribute to the formation of knowledge as well as the ability to evaluate this work,
- demonstrate the ability in speech and writing both nationally and internationally to clearly report and discuss his or her conclusions and the knowledge and arguments on which they are based in dialogue with different audiences, and
- demonstrate the skills required for participation in research and development work or autonomous employment in some other qualified capacity.

Judgement and approach

For a Degree of Master (120 credits) the student shall

- demonstrate the ability to make assessments in the main field of study informed by relevant disciplinary, social and ethical issues and also to demonstrate awareness of ethical aspects of research and development work,
- demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used, and
- demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

Program Specific Objectives

Knowledge and understanding

For a Degree of Master (120 credits) the student shall

- demonstrate general knowledge and understanding in the field of Mechanical Engineering and
- demonstrate an extension of in-depth knowledge in computing, simulation and product development,

Competence and skills

For a Degree of Master (120 credits) the student shall

- demonstrate the ability to constructively analyze and mathematically model engineer problems in a constructive manner, with particular relevance to the Mechanical Engineering field,

- demonstrate the ability to utilise modern analysis tools in computational mechanics (finite element method) and understand the basic context which the analysis is based on,
- 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 fields that require the above-mentioned skills,
- 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 a Degree of Master (120 credits) the student shall

- 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 Mechanical engineering and take responsibility for the personal knowledge development.

Content

Programme overview

During the first semester, a foundation is given in the field of computational mechanics and structural dynamics as well as to academic studies at advanced level. The second semester provides a basis for experimental methods and development of measurement data. Students gain a deeper understanding of physical systems, its characteristics and the uncertainty in experimental results. In addition, the second semester is devoted to the product lifecycle with a clear sustainability focus. During the third semester, students gain understanding of material mechanics, modeling and methodology to solve industrial problems. The knowledge is applied in a larger independent work that runs during the fourth semester.

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

Year 1, semester 1:

Multivariable Calculus and Vector Calculus (7.5 credits, G1F)
The course includes mathematical concepts and methods for analyzing problems in several variables. Furthermore, students are introduced to Matlab.

Continuum Mechanics (4,5 credits, A1N)*
The course teaches basic concepts in continuum mechanics, where materials are described as a cohesive mass, rather than particles. This includes description of motion

and kinematics, Lagrange and Euler descriptions, as well as basic physical governance equations and balance principles.

Scientific Methodology and Planning (3,0 credits, A1N)*
The course provides an introduction to academic work methods at advanced level. The course covers the areas of project planning and research ethics, academic writing with emphasis on technical scientific writing as well as structured information management, including reference management and copyright. The course also trains the ability to present results both verbally and in writing.

Structural dynamics (7.5 credits, 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.

Finite Element Method (7,5 credit, A1N)*
The course gives an introduction to the finite element method. This includes strong and weak formulations in one and more dimensions for heat conduction and elasticity problems, discretization and form functions, constitutive relationships, isoparametric element formulation, numerical integration of the weak form, and convergence criteria.

Year 1, semester 2:

Finite element method II (5 credits, A1F)*
The course teaches advanced parts of the finite element methodology. This includes the use of nonlinear and time-dependent material models in mechanical analyzes, transient thermomechanical analyzes, coupled thermomechanical problems, and FSI problems (fluid-solid analyzes).

CAE driven Product Development (10.0 credits, A1N)*
All product development is complex. Therefore, one needs a method that systematically breaks down the complexity of smaller and manageable parts. The development phase consists in defining and determing the problems and how these should be resolved before the design work begins. The work method also builds on a certain measure of robustness, both against changes in target image and against other disturbances that usually arise during project implementation.

Material mechanics (7,5 credits, A1N)*
The course teaches basic concepts in material mechanics. This includes a review of the most common deformation mechanisms in engineering materials (metals, ceramics, polymers, composites), elastic and non-elastic material behavior, effective properties of heterogeneous materials and composites, fracture mechanics, and fatigue.

Sustainable Production (7,5 credits, A1N)*
The course teaches sustainability aspects in the product life cycle with emphasis on the production and use phase. Sustainable production aims at economically viable manufacturing, as well as reduced environmental impact and resource utilization. The course illustrates the mutual dependence between product and production development, which underlies the quality of the final product. An introduction to risk assessment and

system security analysis is also given.

Year 2, semester 3:

Experimental Mechanics (7,5 credits, A1F)*
The course focuses on the basic components of experimental vibration analysis, which are required to acquire detailed information about vibration properties, as well as to develop and model real physical systems, but are also useful for design of regulators as well as for condition monitoring. Sensors, measurement techniques, data collection and applied signal processing for measurement and analysis of mechanical fluctuations as well as experimental modal analysis of structures and machines, etc. are discussed in detail. Also robust signal processing methods for monitoring the state of health of rotary machines, such as bearings and gears are illuminated.

Rigid body dynamics and simulation (5,0 credits, A1F)*
The course focuse on large movements of rigid or flexible bodies as well as complex systems of such. The aim is to be able to simulate such movements for complex systems. In addition to giving the theoretical foundation of the subject, the course includes work with commercial software to solve industrial problems.

Advanced Structural Dynamics (5,0 credits, A1F)*
The course teaches validation of structural-dynamic calculation models by correlation with measurement data from vibration tests. Methods for mapping causes of deviations between results from model and test and calibration of calculation models are also discussed in the course.The course deals with validation of structural-dynamic calculation models by correlation with measurement data from vibration tests. Methods for mapping causes of deviations between results from model and test and calibration of calculation models are also discussed in the course.

Scientific Methodology II (5,0 credits, A1N)*
The course focus on science theory, research methodology, research ethics, structured literature search and evaluation of information and sources of information. It also provides practical guidance for defining objectives, delimitations and implementation of research and development projects. The course trains the ability to present results both verbally and in writing in scientific technical reports.

Signal Processing (7,5 credits, A1N)
The course addresses signal theory and stochastic processes with applications in adaptive and statistical signal processing.

Year 2, semester 4:

Degree Project (30 credits, A2E)*
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.

The courses placement can be changed.

Societal relevance
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.

Internationalization
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.

Scope of Programme
The following perspectives were integrated in the programme:

Equality and diversity perspectives within the program and for the vocational role the program prepares is discussed in the program council. Furthermore, all students are treated equally in the program regarding teaching, supervision, etc. in accordance with current regulations and guidelines at LNU.

Sustainable development permeates the program. Economic, environmental and social sustainability is highlighted specifically in the courses Product Development and Sustainable Production. In other courses, the scope is a reflective and evaluating part, especially in the Degree Project.

Ethics will, if possible, permeate all courses within the program but are highlighted in the courses Scientific Methodology I and Scientific Methodology II.

The program includes reflecting on the role of technology in society and how it can contribute to a more sustainable way of life. Furthermore, an entrepreneurial approach is highlighted by the program setting product development in a context of global opportunities and local conditions. It makes it easier for students to see different opportunities, such as local entrepreneurship, but also links to global opportunities. Finally, economic sustainability is an integral part of several courses within the program. These aspects contribute to an entrepreneurial approach.

One step in internationalization has been to change the language of instruction from Swedish to English and in the program students meets people from many different countries and cultures. Creating cooperation agreements with foreign Universities is a future objective of the program.

Quality Development

A program council has been established for the program. The program council consists of teachers, students and representatives from the profession. The program council meets regularly to discuss the education structure, content and professional ties. Course evaluations are conducted by the students after each course through questionnaires and questionnaire summaries. Course coordinator is responsible for conducting course evaluations. At the end of each semester, program evaluations are also conducted by student representatives and program managers. Course and program evaluations are followed up in order to strengthen the quality of education. Compilations of course and program evaluations are filed by the department. The program is reviewed and compared with corresponding courses at other Universities and Higher Education Institutions. Certain audits and quality assurance also take place through contacts with industry, mainly because many students carry out their degree projects in collaboration

with different 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 programme may obtain the following degree:

Students who hold a Technology bachelor's degree may receive:

Teknologie masterexamen med inriktning mot Simuleringsdriven produktutveckling
Huvudområde: Maskinteknik
Master of Science (120 credits) with specilization in Simulation Driven Product Development Systems
Main field of Study: Mechanical Engineering

A student who holds another higher education diploma may receive:

Filosofie masterexamen med inriktning Simuleringsdriven produktutveckling
Huvudområde: Maskinteknik
Master of Science (120 credits) with specilization in Simulation Driven Product Development Systems
Main field of Study: Mechanical Engineering

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

Other Information

Within the program, there are study visits, excursions, study trips and similar compulsory elements that may involve a cost for the student, furthermore it is assumed that students, digital equipment is required to be able to complete the education.