



UiT The Arctic University of Norway

PhD program in engineering science

180 credits

The program description has been approved by the board of Faculty of Engineering Science and Technology on 31.10.2019



Study programme name	Norwegian: Ingeniørvitenskap New Norwegian: Ingeniørvitskap English: Engineering Science
Degree obtained	Philosophiae doctor in engineering science
Target group	The target group for the study program is candidates with master's degree in technical, engineering, or natural science who seek training in the scientific method and research experience in engineering science in an international environment.
Admission requirements, required prerequisite, recommended prerequisite knowledge	In order to be admitted to a doctoral degree program, the applicant must have completed a master's degree with good grades (average grade B; the requirement is specified in the faculty grade form), either an integrated master's degree of 300 credits or a master's degree of 120 credits building upon a bachelor's degree of 180 credits. The faculty may at their discretion approve other qualifications for admission where these are equivalent. Applicants must document proficiency in English that satisfies the Norwegian Higher Education Entrance Qualification.
Certificate of good conduct	Certificate of good conduct is not required.
Suitability assessment	Suitability assessment is not required.
The study programme's Learning Outcome	The study program in engineering science is developed in accordance with the Norwegian national qualification framework, which describes the total learning outcome in terms of knowledge, skills and habits of mind (also called general competence in English in Norway). After completion of the program, the candidate shall have research competence within the candidate's branch of engineering science, with the following total learning outcome: Knowledge: K1. The candidate is in the forefront of knowledge within the candidate's branch of engineering science, and master the field's scientific theory and related problems. K2. The candidate understands the methods and principles of the field, ensuring that research and results within the field are in accordance with ethical principles and scientific methods. K3. The candidate knows and can evaluate the expediency and application of advanced methods and processes within the candidate's core topic in research and development, specifically within the candidate's branch of engineering science. K4. The candidate can contribute to the development of new knowledge, new theories, methods, interpretations and forms of documentation within the candidate's branch of engineering science. Skills:

	F1. The candidate can formulate problems, plan, and carry out research and scholarly development work. F2. The candidate can carry out research and scholarly research work of a high international standard, through understanding, interpreting and analyzing concrete problems, and describe and analyze these problems using advanced mathematical or computational methods related to engineering science. F3. The candidate can handle complex academic issues and challenge established knowledge and practice in the candidate's field. F4. The candidate can disseminate research through oral presentations at scientific conferences, seminars and workshops. Habits of mind (general competence): G1. The candidate can identify new problems arising based on new knowledge within engineering science, and can evaluate the problem's impact on society. G2. The candidate can perform research in a scientifically and ethically sound way, and with professional integrity. G3. The candidate can manage complex interdisciplinary assignments and projects. G4. The candidate can communicate research and development work through recognized Norwegian and international channels. G5. The candidate can participate in debates in the candidate's branch of engineering science in international forums. G6. The candidate can assess the need for, initiate and practice innovation related to his/her branch of engineering science.
Academic content and discription of the study programme	The study program consists of two parts: instruction component and doctoral thesis component. The instruction component is an individual plan consisting of 30 ECTS of courses in the philosophy of science and science methodology and ethics (5 ECTS), transferrable skills such as project management and methodology (up to 5 ECTS), and project disciplinary courses (20—25 ECTS). An individual instruction component is developed for each candidate before admission to the study program. Philosophy of science and science methodology and ethics lay a historical and current theoretical foundation for the scientific method with special focus on engineering science. The training in the subject is planned for the first year of the study. Transferrable skills such as project management and methodology give a basis for planning, carrying through, and report work in the form of research projects. The training in the subject is planned for the first or second year of the study.

Project disciplinary courses give a scientific basis for the project specific methods and necessary knowledge. Project disciplinary courses are planned for all three years of the study.

Courses that are included in the instruction component must be on doctoral level. Each course in the plan may be organized by the faculty, the university, or an external institution such as a university in Norway or abroad. European standard is a requirement for external courses in regard to the descriptions of the learning outcome, number of hours of work, and examination. The PhD student is responsible for meeting the requirements set by external institution.

The faculty has a course catalogue and organizes irregularly and on demand the following courses, where current course descriptions, with learning outcome and number of hours of work, are available on the faculty's webpage:

TEK-8001 Philosophy of science and ethics
TEK-8002 Principles of mathematical analysis
TEK-8003 A basic course in applied mathematics
TEK-8004 Fundamentals of scientific computing
TEK-8015 Multiphysics simulation
TEK-8101 An introduction to homogenization
TEK-8102 Nonlinear control theory
TEK-8103 Algorithms in geometric modeling
TEK-8104 System engineering
TEK-8105 Power electronic converters
TEK-8106 Flows in porous media
TEK-8501 6DOF modelling of physical systems
TEK-8502 Applied spline theory
TEK-8503 Advanced geometric modeling
TEK-8504 Stochastic homogenization
TEK-8505 Functional analysis
TEK-8506 Topics in computational fluid dynamics
TEK-8831 Special curriculum in engineering science (1 ECTS)
TEK-8835 Special curriculum in engineering science (5 ECTS)
TEK-8840 Special curriculum in engineering science (10 ECTS)
TEK-8890 Trial lecture in engineering science
TEK-8900 Doctoral thesis in engineering science

The course TEK-8001 Philosophy of science and ethics is a course that provides training in the philosophy of science and science methodology and ethics.

Courses organized by the High North Academy at the university provide training in transferrable skills such as project management and methodology.

A special curriculum, as listed above, is an individual reading course that may be organized at the faculty in the lack of available and suitable ordinary courses.

Trial lecture. One of four requirements for the PhD degree is the trial lecture according to the university regulations. The candidate shall deliver a trial lecture. The trial lecture is an independent part of the dissertation and shall be on a topic selected by the thesis committee. The purpose is to test the candidate's capability to acquire knowledge outside the discipline of the thesis and the capability to disseminate.

The doctoral thesis. One of four requirements for the PhD degree is the doctoral thesis according to the university regulations. The thesis shall be an independent scientific work that fulfills international standards for ethics, scientific level, and methods within engineering science. The student shall through the thesis contribute to the development of

new scientific knowledge, and the thesis shall be on a level that could be published as a part of the scientific literature in the field.

The contribution to the learning outcome for courses in the study program and the relation between the learning outcome for the study program and the included courses are described in Table 1. LUB-K/F/G in the table refers to the points in the learning outcome description that is given in the section below.

Learning outcome	Philosophy of science and science methodology and ethics	Transferrable skills	Project disciplinary courses	Doctoral thesis	Trial lecture
LUB-K1	X		X	X	
LUB-K2	X	X	X	X	
LUB-K3	X		X	X	
LUB-K4		X	X	X	
LUB-F1		X	X	X	
LUB-F2			X	X	
LUB-F3	X		X	X	X
LUB-F4				X	X
LUB-G1	X	X	X	X	
LUB-G2	X	X		X	
LUB-G3	X	X		X	
LUB-G4	X	X		X	
LUB-G5	X	X		X	
LUB-G6	X	X	X	X	

Table 1. The contribution to the learning outcome in the PhD program in engineering science.

Mandatory elements in the PhD study. The following elements are mandatory in the PhD study in engineering science: admission to the study program, admission agreement, progress reporting, midway evaluation, doctoral thesis, instruction component, trial lecture, dissertation.

Courses abroad. Courses from outside of Norway may be included in the instruction component. The PhD student is responsible for meeting the requirements set by external institution.

Programme structure

The study program is structured to consist of two parts: instruction component and doctoral thesis work.

Instruction component. The instruction component consists of courses on doctorate level with the purpose of complementing the master's degree for the PhD student with the necessary knowledge, skills, and habits of mind that are required for the training in the scientific method, and for the work on the doctoral thesis to achieve its goals. The instruction component consists of 30 ECTS. Courses that are included in the instruction component should be taken in a composition and in a time that is suitable for the doctoral thesis work

	and that gives an opportunity for mobility within the project. An individual plan for the instruction component is adopted on the admission to the study program. Doctoral thesis component. The work on the doctoral thesis consists of research work in engineering science with the purpose of leading to a doctoral thesis in which the results of the research work are documented in agreement with international standards. The doctoral thesis component consists of 150 ECTS. The work on the doctoral thesis should be planned with mobility. An individual plan for the work on the doctoral thesis is adopted on the admission to the study program. A component that helps the PhD student and the faculty to follow up the progress in the project is the midway evaluation. The midway evaluation should be carried out before two years of the study has passed, and should be carried out by the end of the second year. The midway evaluation is followed by annual progress reporting.
Learning activities, examination and assesement	Examination types. For courses in the instruction component, three type of examination are used: oral exam, written exam, and report. For each type of examination, a practice with external professionals used to ensure quality in both examination and grading. The type of examination for each course included in the study program is described in the course descriptions. Types of assessment. For courses in the instruction component mainly three types of assessment are used: summative, norm-referenced, and criterion-referenced. Language. Written works are presented in English.
Exams, assessment, and mandatory tasks	Mandatory task and examination. Mandatory tasks and examination types are described in the formal course descriptions for the respective courses. Grades passed/not passed are used for doctoral level courses at the Faculty of Engineering Science and Technology. Examination semester is contained in the students's individual study plans.
The doctoral thesis	On works that are to be included in the doctoral thesis that are produced during the study period, the name of the university "University of Tromsø – The Arctic University of Norway", and the name of the faculty "Faculty of Engineering Science and Technology" should be mentioned as an affiliation for the PhD student. Name of supervisors should be provided in the doctoral thesis. Examination type. Dissertation. Form of assessment. Normative. Individual work. The work on the doctoral thesis should be carried out as individual work as a main rule. The possibility of several PhD students to write a thesis together is to be decided by the research committee in each such case separately. Language. The doctoral thesis is written in English.
Internationalisation	International mobility. Continuous stays longer than two weeks at a university, a research institute, or a company, in a country other than Norway, where parts of the instruction component or research work is carried out, are counted as international mobility in the PhD study. By internationalization in the PhD study, international collaboration in courses and research are intended. Mobility within the PhD study should be planned for a period such that it does not interfere with either of the instruction component or the doctoral thesis work such that the project

	run the risk of being delayed, and not to interfere with institutional responsibilities of the PhD student such as teaching. Structure for internationalization. The faculty provides financing for mobility within the PhD study for students financed by sources that do not provide financing for mobility in the form of an annual call for international mobility scholarship. The faculty provides annual budget for the PhD students employed with PhD scholarship at the faculty, that permits visits to one to two international conferences per year through the study. The faculty's project support and the director of study assist the PhD students with application for mobility to other funding schemes than those available at the university. The faculty's research groups assist the research environment with financing and regular invitation of guest researchers. The research groups assist the members, among them the PhD students, in career development and to finance participation in international conferences with relevance for the doctoral theses work and the research group activities. The university board decides on the university's participation in international study and network centers. The current participation in international networks, and international study and network centers are described below. Networks for internationalization. The university participates in international study and network centers and international networks. One of the tasks for the centers and the networks is to bridge Norwegian and international research and education. The international network centers and networks have a potential to work as effective learning arenas for habits of mind and transferable skills within internationalization. One of the target groups for the center and the networks is the PhD students. UiT participates in the following centers and networks: • <i>NORDTEK</i> • <i>OFNEC</i> • <i>DNSZ</i> • <i>The Norwegian university center in St. Petersburg.</i> • <i>Center for French-Norwegian research collaboration in human sciences.</i> • <i>NSC – Norwegian study center in York.</i> • <i>NorthNorway European Office (NNEO), Brussels.</i> • <i>Peder Sather Center for Advanced Study – Berkeley.</i> • <i>DNIR – The Norwegian institute in Roma.</i> • <i>The Norwegian institute in Athens.</i> • <i>UArctic - The University of the Arctic.</i>
Scheme for students with external workplace and study location	For the students who do not have workplace at the faculty, the faculty provides the following: • The faculty has infrastructure for sound and video communication for lectures, seminars, and meetings. This is used when appropriate. • When students who do not have workplace at the faculty is visiting the faculty to work, the faculty provides office space. An annual workshop is organized for all PhD students at the faculty. This gives the students who do not have workplace at the faculty an opportunity to be a part of the research environment.

The relevance of the study	The following learning outcome from the study has been evaluated to be relevant for future careers within and outside of academia. Engineering science. Engineering science plays an essential role in today's society, in Norway, in Europe, and globally. This is evident in the current agendas for RCN, ERC, and in the OECD reports with suggested focus areas for the development of Europe. The research training in engineering science is therefore relevant to meet the need for a workforce with knowledge, skills, and habits of mind within engineering science. The scientific method. A successful PhD student in engineering science has gone through 3 years of training in the scientific method. The scientific method is relevant for careers within and outside of academia, within and outside of Norway, in today's society. Academic experience within engineering science. A successful PhD student has at least two and a half years of experience of research work in a discipline within engineering science. The experience is of relevance for the candidate's future career within engineering, both in academia and in the rest of society. The doctoral degree serves as a qualification to academic positions such as lecturer and professor in Norway, and is frequently asked for in research positions outside of academia. The qualification requirement is also practiced internationally. The successful PhD student understands the organization of academic research projects in today's society, and this could be considered important knowledge in the bridging between academia and other parts of society. Project management. A successful PhD student has been project manager (under supervision) for a research project under a period of three years and has by this been trained and gained experience in project methodology, implementation of projects, and reporting respecting international standards. International experience. A successful PhD student has gained experience and obtained competence in both oral and written communication of research results and problems in an international environment. A successful PhD student could be expected to have worked in periods outside of Norway at a university, a research institute, or a company. International network. A successful PhD student has through three years built an international network within academia within the student's branch of engineering science. This network provides access to the forefront of knowledge within a broad area within engineering science.
Requirements on the study program and number of hours of work	The research training is intended to qualify for research activity of international standard and for work in society where high scientific insight and analytical capabilities are required, in accordance with good scientific practice and research ethical standards. Number of hours of work. The study period is three years where the number of hours of work per study year is 1500—1800, in accordance with ECTS (25—30 work hours per credit).
Language	English and Norwegian if required. Students in Norwegian higher education should know and be able to use English. Cf. Språkpolitiske retningslinjer ved UiT.

Administrative responsibility and academic responsibility	The Faculty of Engineering Science and Technology is administratively responsible for the study program in engineering science. The research committee at the faculty serves as program board for the PhD program, and carries the scientific responsibility.
Quality assurance	Study plan. The faculty's research committee decides on changes in the program plan and is responsible for the scientific part of the program. The program plan is annually evaluated in the program report by the director of study. Based on changes in organization of the research training at the university, and changes in the university's PhD regulations, and the outcome of the evaluation in the program report, the program plan is revised annually. The director of study sees to that the program plan is a current description of the study program, and that it meets the universities regulations and local, national and international requirements on the education. Study program. The dean at the faculty adopts function description for the director of study. The director of study is operationally responsible for the study program, the implementation of the program plan. The study program is evaluated annually in the program report by the director of study. Actual costs for the organization of the research training at the faculty are documented in accordance the faculty's budget model for the study program. The study programs coordination with the research training at the university and agreement with the university regulations. In conjunction with the faculty's quality assurance, the faculty participates in the Research administrative forum organized by the Department of research and development at the university. Once a month the members meet for discussions about quality assurance and development of various elements of the research training at the university with special focus on development of the university's PhD regulations and that it is followed. Other focus areas are national requirements from NOKUT, ethical guidelines and coordination of the research training programs at the university. Supplementary provisions. The research committee at the university adopts changes among eventual faculty specific supplementary regulations to the university PhD regulations. The supplementary regulations are evaluated annually in the program report by the director of study. Based on changes in the organization of the research training at the university, changes in the university's PhD regulations, and the program report, the faculty's supplementary regulations are revised annually. The director of study sees to that the supplementary regulations are current and agree with the program plan, and meet the university's PhD regulations, and local, national, and international requirements on the education. Courses on doctorate level at the faculty.

The research committee at the faculty decides on changes in the course catalogue. The director of study evaluates the quality of the course descriptions and sees to that the course catalogue is relevant and broad enough for the faculty's needs and activity. The director of study assists course responsible teachers with quality assurance and development of specific course in the course catalogue. The course responsible teachers evaluate all courses and reports following the adopted templates to the director of study and their department leaders after each implementation of a course, based on written and oral feedback from the students among other things.

Structures for internationalization.

The dean at the faculty sees to that the budget allocations for international mobility scholarships and transition grants are adjusted to the research environment's size in the study programs budget model.

Supervision.

On appointment of supervisors in the PhD study, the faculty requires supervision qualifications corresponding to international standard from 2020. During 2018—2020 a program for quality assurance of supervision and supervision qualification is carried through at the faculty.

Routines, forms, and guidelines.

A part of the faculty's quality assurance of the doctoral education is to have adopted routines and forms for each part of the administration of the study, and if necessary guidelines for students, supervisors, and instructors. The adopted routines, forms, and guidelines are available for the following elements of the study and its administration:

- Template for project description
- Form, routines, and guidelines for program admission
- Form and routines for midway evaluation
- Form and routines for course evaluation reports
- Form, routines, and guidelines for special curriculum in engineering science
- Form for application for approval of instruction component
- Form and routines for appointment of dissertation committee
- Routines for changes in instruction component
- Routines for appointment and withdrawal of supervisors
- Guidelines for evaluation of doctoral thesis
- Form and routines for progress report
- Form and routines for international mobility scholarship
- Form and routines for reporting of mobility
- Form for computation of average grade in master's education
- Routines for organization of dissertation
- Routines and guidelines for scientific qualifications for candidates for PhD scholarships
- Form for admission agreement between student, faculty, and supervisors
- Routines for ending of study
- Routines for printing of doctoral thesis

	Guidelines for financing of PhD study
Other regulations	The PhD study in engineering science follows the Regulations concerning the degree of Philosophiae Doctor (PhD) at the University of Tromsø – The Arctic University of Norway (UiT). The faculty has adopted supplementary provisions.