FACULTY OF NATURAL SCIENCES AND TECHNOLOGY

The PhD programmes are standardized to 180 credits (3 years) including academic and methodological schooling, amounting to 30 credits. The residual 150 credits, which constitute by far the largest and most important part of the research education, are devoted to the research project carried out under academic supervision.

The Faculty of Natural Sciences and Technology offers the following PhD programmes:

• PhD in Biology

• PhD in Biophysics

• PhD in Biotechnology

• PhD in Chemistry

• PhD in Chemical Engineering

• PhD in Physics

• PhD in Materials Science and Engineering

• PhD in Medical Technology - Hosted by the Faculty of Medicine, for more information about the programme: http://www.ntnu.edu/studies/phmedt

Application for admission

All PhD candidates need to apply to be enrolled in a PhD programme by filling out an application form. The main supervisor and the Department give their recommendation before the application is approved by the PhD Programme Council. Admission to all the programmes is decided by the Faculty of Natural Sciences and Technology. It is required that you apply for admission no later than 3 months after you are employed. Applications to the PhD programmes can be submitted at any time.

Admission requirements

Applicants for the PhD programmes at the Faculty of Natural Sciences must have a relevant master's degree or equivalent education, with a strong academic record.
Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS credits). The weighted average grade of the applicant's bachelor degree or equivalent education must be C or higher. Before you can apply for admission to one of the PhD programmes, the funding of the study period, including running costs, must be confirmed.

Organised training plan

The PhD education programme has a prescribed duration of three years of full time study (180 ECTS). A minimum of 30 ECTS credits (equivalent to six months of fulltime study) have to be covered by an organised academic training plan. The training plan has to consist of courses within natural sciences or technology.

A minimum of 20 ECTS credits have to be PhD courses listed in the PhD Study Handbook, or from equivalent programmes at other academic institutions in Norway or abroad.

The course MN8000 "Doing Science: Methods, Ethics & Dissemination" is mandatory for all PhD candidates admitted after 1 July 2015.

The remaining 10 credits can consist of an Individual Study Syllabus or advanced-level Master's courses. An Individual Study Syllabus should have a minimum of 3 credits, and should not overlap with existing courses. The Syllabus must be on a PhD-level and should be within the Professor`s subject area. The Syllabus is to be approved by the PhD Programme Council well before the planned examination.

The Faculty has approved a small selection of courses from the master's course catalogue which can be approved as PhD courses. Information about PhD courses at NTNU: PhD Courses

Advanced courses with varying content (for example "Advanced Biology" and "Advanced physics / theoretical Physics / Biophysics "), must in general be followed by minimum three candidates. Course description and examination will be the same in each realization. Several realizations with the same course code can be arranged simultaneously.

Courses must be weighted with a minimum of 3 credits to be approved as a part of the organized training plan for PhD.

Candidates must apply to the Faculty to make changes in the approved training plan. The application must be prepared together with the main supervisor and be recommended by the PhD Programme Council.

Assessment

All the courses or academic training approved for the PhD programmes require a final assessment in form of an exam, report or other assessments.
Examination of PhD courses at the Faculty is assessed by a mark passed/not passed, where passed correspond to a score of 70 points on a scale from 0 to 100. Approved courses from other faculties will follow the grading scale at those faculties.

Master courses must be passed with the grade A or B. The candidate can retake the exam only once.

Supervision

The main supervisor of the PhD candidates is normally employed at the Faculty of Natural Sciences and Technology, either as full or adjunct professor or as assistant professor. Any deviation from this regulation has to be recommended by the Research Committee at the Faculty for Natural Sciences and Technology and be approved by the Dean.
As a general rule, the PhD candidates must have one or several co-supervisors. Mentors could in addition be assigned. Co-supervisors must have a PhD degree. Post docs, researchers and professor emeritus may act as co-supervisors based on a recommendation from the Head of the Department where the PhD programme is based.

Other requirements

A project description, submitted no later than 6 month after enrolment in the PhD programme is mandatory for all PhD candidates.
As a part of the quality assurance of the PhD programmes, the PhD candidates are also required to respond to a annual progress report to address possible deviation in the progress.

Other information

Admission is to be formalised by a written agreement: “Agreement concerning admission to the organised PhD programme”. The agreement should be signed by the candidate, supervisors, the Department, the Faculty and by any external institutions involved.
Compulsory for all the PhD candidates is a PhD information day arranged in the beginning of each semester. Relevant topics for this seminar are: Ethics, Human-Resources, PhD-studies – the administrative process and Popular disseminations.

The Research Committee at the Faculty of Natural Sciences and Technology

The Research Committee serves as an advisory body for the Dean and the Faculty Board. The primarily task of the Committee is the following-up of the Faculty’s research strategy, serving as an advisory body for grants of research sabbaticals and prioritizing applications for research equipment.
The Research Committee has an overall responsibility for the PhD education, including quality control of admission and implementation of candidates in the PhD programmes.

PhD Programme Council

The PhD Programme Councils are primarily an advisory commission for the Dean, the Head of Department and The Research Committee. The PhD Programme Council is responsible for

suggesting the academic content, structure and implementation of relevant study programmes within the adopted guidelines and directions, delegated from the Dean.

The PhD Programme Councils are chaired by:

- PhD Programme in Biology: Professor Augustine Arukwe
- PhD Programme in Biotechnology: Professor Kjell Morten Vårum
- PhD Programme in Biophysics: Professor Catharina de Lange Davies
- PhD Programme in Chemistry: Professor Signe Kjelstrup
- PhD Programme in Chemical Engineering: Professor Sigurd Skogestad
- PhD Programme in Materials Science and Engineering: Professor Knut Marthinsen
- PhD Programme in Medical Technology: Professor Hans Torp
- PhD Programme in Physics: Professor Catharina de Lange Davies

Information, forms, rules and regulations concerning the PhD education at the Faculty of Natural Sciences and Technology: http://www.ntnu.edu/nt/phd

Contact information:

Higher Executive Officer Anne Sæther, 73 59 38 27, anne.sether@ntnu.no
Advisor Johanne Arff, 982 22 477, johanne.arff@ntnu.no

The Faculty of Natural Sciences and Technology offers the following PhD courses:

Code	Course name	Semester	Credits
MN8000	Doing Science: Methods, Ethics & Dissemination	S17	7,5
AK8002	Early Life History of Fish	S17	7,5
BI8002	Advanced Biosystematics	S17	7,5
BI8010	Systems Biology: Examples from Current Literature	17-18	7,5
BI8011	Seminars in Cell, Molecular Biology and Genomics	S17	7,5
BI8021	Neurobiology	S18	7,5
BI8030	Advanced fishbiology	S18	7,5
BI8060	Bio Optical Properties and Pigmentation in Plants, Algeas and Marine Invertebrates	A17	7,5
BI8071	Biomarkers	A16	7,5
BI8081	Advanced Conservation Biology	A16	7,5
BI8082	Evolutionary and ecological genetics	A17	7,5
BI8091	Advanced Biology	A/S	7,5
BO8031	Plant Ecology III	A17	7,5
ZO8026	Temperature Physiology	A17	7,5
ZO8027	Respiration Physiology	A17	7,5
BT8101	Microbial Ecology	A16	9,0
BT8105	Molecular and Synthetic Biology	S17	7,5
BT8113	Biomaterials	A16	7,5
BT8114	Marine Biochemistry	S17	7,5
BT8115	Protein Structures	S17	7,5
BT8116	Experimental Methods in Biopolymer Chemistry and Glycobiology	S17	7,5
BT8117	Marine Lipids	S17	7,5

BT8118	Systems biology modelling of cellular metabolism	A17	7,5
FY8102	Electron Microscopy and Diffraction	A16	7,5
FY8104	Application of Symmetry Groups in Physics	A17	7,5
FY8201	Polymer Physics	A16	7,5
FY8203	Soft Condensed Matter	S18	7,5
FY8302	Quantum Theory of Solids	A16	7,5
FY8303	Phase Transitions and Critical Phenomena	S17	7,5
FY8304	Mathematical Approximation Methods in Physics	A16	7,5
FY8305	Functional Integral Methods in Condensed Matter Physics	A16	7,5
FY8308	Advanced Quantum Field Theory	A17	7,5
FY8403	Biopolymer Gels and Networks	S17	7,5
FY8408	Introduction to MR imaging	A16	4,0
FY8409	Radiation Therapy Physics	A	4,0
FY8502	Advanced Biophysics	A/S	7,5
FY8503	Advanced Theoretical Physics	A/S	7,5
FY8504	Advanced Experimental Physics	A/S	7,5
KJ8105	Organometallic Compounds in Organic Synthesis	S17	7,5
KJ8107	New Concepts in Organic Synthesis	A16	7,5
KJ8108	Heterocyclic chemistry	A17	7,5
KJ8205	Advanced Molecular Modelling	A16	7,5
KJ8206	Advanced Quantum Chemical Methods	S18	7,5
KP8091	Advanced Chemical Engineering	A/S	7,5
KP8102	Lignocellulosis Chemistry	A17	9,0
KP8105	Mathematical Modelling and Model Fitting	A17	7,5
KP8106	Gas Cleaning with Chemical Solvents	A16	9,0

KP8107	Advanced Course in Membrane Separation Processes/Liquid Processes	S18	9,0
KP8110	Membrane Gas Purification, advanced course	S17	9,0
KP8115	Advanced Process Control	A	7,5
KP8128	Advanced Reactor Modelling	S	12,5
KP8129	Colloid Chemistry for Process Industry	A17	7,5
KP8130	Systembiology, Modelling and Analysis	A17	7,5
KP8131	Crystallization and Particle Design	A16	7,5
KP8132	Applied Heterogeneous Catalysis	A17	7,5
KP8133	Characterization of Heterogeneous Catalysts	A16	7,5
KP8136	Modelling of Catalytic Reactions	S18	7,5
MT8110	Electrochemical Kinetics	A16	7,5
MT8102	Corrosion and Surface Technology	A16	7,5
MT8104	Electrolysis of Light Metals	A16	7,5
MT8108	Mass Transfer	A17	7,5
MT8200	Advanced Chemical Metallurgy	S17	7,5
MT8201	Advanced metalproduction	A	7,5
MT8205	Metallurgical Modelling of Welding	A16	7,5
MT8208	Fatique of Metals	A17	7,5
MT8210	Advanced Solidification Metallurgy	A17	7,5
MT8219	Applied Electron Microscopy	A16	7,5
MT8214	Advanced Silicon - Solar Cells	S17	7,5
MT8215	Dislocation Theory Applied to Thermo-Mechanical Treatments of Metals	A16	7,5
MT8216	Microstructure and Texture Evolution during Thermomechanical Treatment - Phenomena, Theory and Modelling	A17	7,5

MT8218	Advanced Materials Science	A/S	7,5
MT8305	Cement Chemistry	S17	7,5
MT8306	Advanced Ceramics Processing	S18	7,5
MT8307	Thermodynamics of Materials	A16	7,5
MT8308	Advanced Solid State Chemistry	A17	7,5
MT8400	NoRen Interdiciplinary Summer School	A16	3
MT8110	Electrochemical Kinetics	A16	7,5

A: Autumn
S: Spring
(The year is stated for courses not given every year. Lessons are not given in the academic year 2016/2017 for the courses marked with grey.)

The Faculty of Natural Sciences and Technology may approve the following master courses as PhD courses:

Code	Course name	Semester	Credits
BI8061	Biological Oceanography	A16	7,5
BT8119	Food Science, Advanced	A16	7,5
BT8135	Biopolymers Advanced Course	A16	7,5
FY8902	Atmospheric Physics and Climate Change	S17	7,5
FY8903	Gravitation and Cosmology	A16	7,5
FY8904	Computational Physics	S17	7,5
FY8905	Materials Physics	A16	7,5
FY8906	Biophysical Micromethods	A16	7,5
FY8907	Classical Transport Theory	A16	7,5
FY8908	Quantum Optics	A16	7,5
FY8909	Nano Physics	S17	7.5
FY8910	Non-linear dynamics	A16	7.5

KJ8059	Chromatography, advanced course	A	7,5
KJ8072	Advanced Aquatic Chemistry	A	10
KJ8175	Chemometrics	S	7,5
KJ8902	Molecular Modelling	A	7,5
KP8902	Reactor Technology	S	7,5
KP8903	Reaction Kinetics and Catalysis	A	7,5
KP8904	Transport Phenomena	A	7,5
KP8905	Surface- and Colloid Chemistry	S	7,5

A: Autumn
S: Spring
(The year is stated for courses not given every year. Lessons are not given in the academic year 2016/2017 for the courses marked with grey.)

Courses
Information about PhD courses at NTNU: PhD Courses

Description of the PhD programme in Biology

Programme description

The main purpose of the PhD program in Biology is to educate independent researchers at an international level in collaboration with national and international research groups. The department has a broad academic profile in biology, with interactions between organisms and their natural environment as an overriding focus. We have a special responsibility for basic biological research and the broad application of knowledge in social and economic development. The department has extensive research activities, within many biological disciplines, including some international cutting-edge research programs.

The PhD program aims to meet current and future needs for expertise in research, development and dissemination in the university sector and in other public and private institutions, businesses and organizations. The PhD program in Biology will produce qualified candidates for research activities and other work that requires a high level of scientific understanding. The candidate completes an independent research project leading to a thesis at a high professional level. The candidate will learn critical thinking, communication of knowledge and collaboration.

Areas of research

Doctoral work in biology provides expertise in the following research areas: Molecular biology, cell biology, biotechnology, systems biology, plant physiology, animal physiology, environmental toxicology, ecotoxicology, ethology, evolutionary biology, aquatic and terrestrial ecology, biodiversity, natural resources, population genetics, aquaculture, marine biology and systematics.
See the department's website for more information about research and expertise in the department:

http://www.ntnu.edu/biology/research

General learning outcome of the programme

The PhD program will provide training in how to generate and publish new knowledge and strengthen candidates' professional expertise in their fields.

Learning outcome

A candidate who has completed a PhD degree in Biology should have the following learning outcomes defined through knowledge, skills and general abilities:

Knowledge
Upon completion of the PhD program in biology, it is expected that the candidate

- is in the forefront of knowledge in their biological field of specialisation, and can assess the limitations of current knowledge in the field of research
- master the theory, issues and methods
- assess the appropriateness and application of various methods and processes in research and professional development
- contribute to the development of new knowledge, new theories, methods, interpretations and documentation in biology.

Knowledge is achieved by:

- course component of 30 credits
- reading and keeping abreast of the literature in the field
- the PhD dissertation, where the candidate has independently written an introduction that
- provides background for the research, discusses and justifies the choice and use of methods, and
- puts the results as a whole in an international perspective

Skills

Upon completion of the PhD program in biology, it is expected that the candidate can

- formulate research questions and plan and implement research
- conduct research at a high international level
- handle complex technical issues and challenge established knowledge and practice in the field
- combine insights from several disciplines

Skills are achieved through:

- supervision and independent research
- work with publications, submission to international journals and experience with the review process
- the dissertation
- presentation of results at national and international meetings and conferences

General competence

Upon completion of the PhD program in biology, it is expected that the candidate can

- identify new relevant ethical issues and pursue research with professional integrity
- risk assess their operations and maintain health, safety and environment
- manage complex multidisciplinary assignments and projects
- disseminate research and development by recognized national and international channels
- participate in debates in international fora
- assess the need for, initiate, and drive innovation
- conduct original research at a high international level
- transfer and apply their knowledge to meet the needs of the community
- establish professional networks

Admission requirements

Admission to the PhD program requires a broad academic background in biology and other relevant subjects. In line with the requirement for a "strong academic background" it is required that both the bachelor's program (similar to the first three years of technology studies) and the master's program (similar to the last two years of technology studies) are conducted with satisfactory results. The applicant must have average grades of C or better in the bachelor degree (or equivalent qualification) and B or better in the master's degree (or equivalent qualification).

Funding

Financing of the PhD study must be established prior to admission to the PhD program in biology.

Required coursework or other academic training
The course component corresponds to at least one semester of full-time study (30 credits). The main purpose is to give the student general, theoretical knowledge in biology, as well as to provide the theoretical scientific basis needed for the dissertation. The PhD courses in the Department of Biology are given in the list below. The course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component. The faculty provides basic training in ethics, safety and innovation through a mandatory introduction program for PhD candidates.

PhD courses at the Department of Biology:

Code	Course name	Semester	Credits
BI8002	Advanced Biosystematics	S17	7,5
BI8010	Systems Biology: Examples from Current Literature	17-18	7,5
BI8011	Seminars in Cell, Molecular Biology and Genomics	S17	7,5
BI8021	Neurobiology	S18	7,5
BI8030	Advanced fishbiology	S18	7,5
BI8060	Bio Optical Properties and Pigmentation in Plants, Algeas and Marine Invertebrates	A17	7,5
BI8071	Biomarkers	A16	7,5
BI8081	Advanced Conservation Biology	A16	7,5
BI8082	Evolutionary and ecological genetics	A17	7,5
BI8091	Advanced Biology	A/S	7,5
BO8031	Plant Ecology III	A17	7,5
ZO8026	Temperature Physiology	A17	7,5
ZO8027	Respiration Physiology	A17	7,5

PhD /Master courses at the Department of Biology:

Code	Course name	Semester	Credits
AK8002	Early Life History of Fish	S17	7,5
BI8061	Biological Oceanography	A16	7,5

Description of the PhD programme in Biotechnology

Description

The PhD program in Biotechnology is organized research training (doctoral programme), educating independent researchers at an international level in cooperation with national and international research groups and institutions.

The faculty has a broad academic profile in biotechnology. Research is conducted in collaboration within and between research groups at the faculty, in both basic and applied research. The academic community has an extensive and broad research activity, where several disciplines within biotechnology are represented, including some international cutting-edge areas.

The PhD program aims to meet current and future needs for competence in research, development and dissemination at the university, public and private institutions, businesses and organizations.

The PhD program in Biotechnology qualifies for research activities and related work that requires a high level of scientific understanding. The candidate performs an independent research project leading to a thesis at a high professional level. The candidate will learn critical thinking, dissemination of knowledge and collaboration.

Research areas

Doctoral work provides core expertise in one of the following research areas:

- Biopolymers and Biomaterials
- Microbial Biotechnology
- Food Chemistry
- Analysis and Control of Microbial Systems

See the department's website for further information about the subject areas: http://www.ntnu.no/bioteknologi/forskning

Overall learning objectives for the PhD program

The PhD program will provide training in how to generate and publish new knowledge, and strengthen the candidates' professional expertise within their academic field.

The organized research training (doctoral programme) will be at a recognized and international level. It will provide direct personal experience in relevant experimental research, and specialization within key areas of biotechnology.

Learning outcomes

A candidate with a completed PhD degree should have the following learning outcomes defined by knowledge, skills and general competence:

Knowledge

Upon completion of the PhD program in Biotechnology, it is expected that the candidate;

- is in the forefront of knowledge in their field of specialization in biotechnology, and can assess the limitations of current knowledge within this academic field
- can master scientific theory, problems and methods within the academic field of biotechnology
- can assess the appropriateness and application of relevant methods and processes in research and development projects
- can contribute to the development of new knowledge, new theories, methods, interpretations and methods of documentation within this academic field

Knowledge obtained through:

- *the program's mandatory course component of 30 credits (ECTS)*
- *read and keep themselves updated on the literature in the academic field*
- *thesis summary; the candidate has independently written an introduction that provides the background of the research, discusses and justifies the choices and use of methods, and puts the completed results into an international perspective*

Skills

Upon completion of the PhD program in biotechnology, it is expected that the candidate;

- can formulate problems, plan and conduct research and development within biotechnological issues
- can perform relevant experimental research and development in biotechnology at a high, international level
- can deal with complex scientific issues and challenge established knowledge and practices within the academic field

Skills obtained through:

- *supervision and own research*
- *work on publications, submission to international journals and experience with referee statements*
- *dissertation*
- *presentation of results at national and international meetings / conferences*

General knowledge

Upon completion of the PhD program in biotechnology, it is expected that the candidate;

- can identify new relevant ethical issues, and perform their research with professional integrity
- can risk assess their operations and maintain health, safety and environment
- can handle scientific issues where the candidate works in scientific team
- is able to establish professional networks with both Norwegian and international researchers
- can convey research and development by publishing in recognized international journals within the academic field and at national and international conferences
- can participate in debates within the academic field in international fora
- can assess the need for, initiate and drive innovation
- is able to establish professional networks

General competence achieved through:

- *supervision and own research*
- *work with publications and thesis*
- *trial lecture; acquire knowledge about a given topic within a short time, scheduling, search / select / evaluate / process information, oral presentation*

Admission requirements

Admission to the PhD program requires a broad professional background in biotechnology and other relevant subjects. In line with regulation requirements for a "strong academic background", both the Bachelor's program (or the first three years of an integrated, five-year master) and the Master's degree (or the last two years of an integrated, five-year master) must be completed with satisfactory results; the applicant must have average grades of C or better in the bachelor degree (or equivalent qualification) and B or better in the master's degree (or equivalent qualification).

Funding requirements

The financing of the PhD study must be established prior to admission to the PhD program in Biotechnology

Mandatory course component

The course component corresponds to at least one semester full-time study (30 credits). The main purpose is to give the student general, scientific theoretical knowledge in biotechnology, as well as to provide the theoretical scientific basis needed for the dissertation.

At least one of the courses offered by the Department of Biotechnology (see table below) must be chosen as part of the program's course component. The course MN8000 Doing Science: Methods, Ethics and Dissemination constitute a compulsory part of the training component.

The faculty provides an introduction to ethics, HSE and innovation through a mandatory introduction one-day program for PhD candidates.

PhD courses at the Department of Biotechnology:

Emnekode	Emnetittel	Semester	SP
BT8101	Microbial Ecology	A16	9,0
BT8105	Molecular and Synthetic Biology	S17	7,5
BT8113	Biomaterials	A16	7,5
BT8114	Marine Biochemistry	S17	7,5

BT8115	Protein Structures	S17	7,5
BT8116	Experimental Methods in Biopolymer Chemistry and Glycobiology	S17	7,5
BT8117	Marine Lipids	S17	7,5
BT8118	Systems biology modelling of cellular metabolism	A17	7,5

PhD /Master courses at the Department of Biotechnology:

Emnekode	Emnetittel	Semester	SP
BT8119	Food Science, Advanced	A16	7,5
BT8135	Biopolymers Advanced Course	A16	7,5

Recommended courses from other departments:

Emnekode	Emnetittel
AK8002	Early Life History of Fish
FY8403	Biopolymer Gels and Networks
BioStruct	NMR courses

Description of the Ph.D. programme in Biophysics

Description of the academic programme

The Ph.D. programme in biophysics aims to educate independent researchers at a high international level in cooperation with national and international research communities.

The programme aims to fulfil both current and future requirements for competence in research, development, and dissemination at the university, other public and private institutions, companies, and organizations.

The Ph.D. programme in biophysics and medical technology will give the candidates competence within experimental and theoretical biophysics, and medical physics and technology, in addition to strengthening the breadth of the candidate's background within biophysics and medical technology.

The study programme yields generic and analytical competence that can be utilized in industry, research, or education. A person holding a Ph.D. in biophysics has a thorough and broad physics background, with special competence at a high international level within his or her field. The candidate is equipped with the skills and knowledge required to meet continual and demanding changes in today's research.

Candidates will also have the general competence common to all Ph.D. programmes at NTNU.

Subject areas

The programme provides opportunities for various specializations within the fields of biophysics and medical technology, including biopolymers, bionanotechnology, radiation biophysics and photobiophysics, regulation of biological systems, and imaging techniques for tissues, cells and molecules.

For a more detailed description of research areas, see the department website:

http://www.ntnu.no/fysikk

Overall learning goals

The Ph.D. programme aims to train the candidates in producing and publishing new knowledge, strengthen the professional expertise in the specific and general fields, and enable the candidates to contribute to the advancement of the field.

Learning outcome

A candidate who has completed the Ph.D. programme in biophysics should have the following learning outcomes defined in terms of knowledge, skills, and general competence:

Knowledge
The candidate:

- is at the forefront of knowledge within his or her field of biophysics
- has a broad physics background as well as basic knowledge in biology, to allow for future flexibility in the field
- can evaluate the expediency and application of different methods and processes in research and scholarly development projects
- can contribute to the development of new knowledge, new theories, methods, interpretations, and forms of documentation in the field

The knowledge is gained through:

- *formal training of 30 credits*
- *reading and keeping up to date on the literature within the field*
- *writing the summary of the thesis, where the candidate independently writes an introduction giving the background for the work, discusses and justifies the choice of methods, and sets the results in an international context*

Skills
The candidate:

- can formulate problems for, plan and carry out research and scholarly development work
- can use the research methods of the field to create new knowledge, new theories and methods
- can carry out research and scholarly research work of a high international standard
- can handle complex academic issues and challenge established knowledge and practice in the field

The skills are achieved through:

- *guidance and own research*
- *publications, submissions to international journals, and experience with referee statements*
- *the thesis*
- *presentation of results at national and international meetings and conferences*

General competence

The candidate:

- can identify new relevant ethical issues and carry out his or her research with scholarly integrity
- can assess the risks involved in the work, and safeguard HSE
- can manage complex interdisciplinary assignments and projects
- can communicate research and development work through recognized international channels
- can participate in debates in the field in international forums
- can quickly acquire new knowledge
- can establish academic networks

General competence is acquired through:

- *guidance and own research*
- *work with publications and the thesis*
- *a trial lecture on an assigned topic, prepared in a short time*

Requirements for admission, from § 5 and 7.3 in the regulations

To be admitted to the Ph.D. programme a broad background in biophysics and other relevant fields is required. A Master of Physics or equivalent is required. At least 135 credits within physics or physics related subjects at the university level are required. An additional 15 credits are required within biology related subjects.

In accordance with the regulations' requirement of a "strong academic background" it is required that both the previous bachelor studies (equivalent to the first three years of the technology programme) and the master studies (equivalent to the final two years of the technology programme) are completed with satisfactory results. Normally an average grade of C or better is required for the bachelor degree (or equivalent) and B or better for the master degree (or equivalent).

Finances

Funding for the studies must be available before admission to the Ph.D. programme in biophysics.

Required courses

The course part of the programme is equivalent to one full semester of courses (30 credits). The main goals of this part are to give the candidate a general, scientific background in biophysics, and to give the theoretical background required to perform the work.

Normally, a minimum of 15 credits should be within biophysics courses.

PhD candidates within biophysics perform their research within very varied fields. It is therefore important that all the candidates have a background that is relevant and sufficient for their research. It is recommended that the courses are selected so that the candidates get both a breadth within biophysics and medical technology, as well as course work relevant for their particular research.

The Faculty provides training in ethics, HSE and innovation, through a mandatory introduction program for PhD candidates. In addition, the course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component.

Thesis requirements

Topics for the thesis might be:

- Biophysics and biopolymers
- Bionanotechnology
- Microfluidics
- Monte Carlo simulation of biophysical systems
- Nanoparticles and cancer therapy
- Clinical use of multiphoton microscopy
- Magnetic resonance imaging

Other thesis topics could also be possible after special evaluation.

There are no other formal requirements for the thesis in addition to § 10.1 of the regulations.

Description of the PhD programme in physics

Description of the academic programme

The Ph.D. programme in physics aims to educate independent researchers at a high international level in cooperation with national and international research communities.

The programme aims to fulfil both current and future requirements for competence in research, development, and dissemination at the university, other public and private institutions, companies, and organizations.

The physics department covers a broad range of research subjects. We have a particular responsibility for fundamental research, as well as applications of knowledge within the development of industry and society.

The study programme yields generic and analytical competence that can be utilized in industry, research, or education. A person holding a Ph.D. in physics has a thorough and broad physics background, with special competence at a high international level within his or her field. The candidate is equipped with the skills and knowledge required to meet continual and demanding changes in today's research.

Candidates will also have the general competence common to all Ph.D. programmes at NTNU.

Subject areas

The programme provides opportunities for various specializations within the field of physics, including condensed matter physics, astro- and particle physics, quantum field theory, numerical physics, statistical physics, biological physics, optics, energy and environmental physics, and physics of complex systems.

For a more detailed description of research areas, see the department website:

http://www.ntnu.no/fysikk

Overall learning goals

The Ph.D. programme aims to train the candidates in producing and publishing new knowledge, strengthen the professional expertise in the specific and general fields, and enable the candidates to contribute to the advancement of the field.

Learning outcome

A candidate who has completed the Ph.D. programme in physics should have the following learning outcomes defined in terms of knowledge, skills, and general competence:

Knowledge
The candidate:

- is at the forefront of knowledge within his or her field of physics
- has a broad physics background, to allow for future flexibility in the field
- can evaluate the expediency and application of different methods and processes in research and scholarly development projects
- can contribute to the development of new knowledge, new theories, methods, interpretations, and forms of documentation in the field

The knowledge is gained through:

- *formal training of 30 credits*
- *reading and keeping up to date on the literature within the field*
- *writing the summary of the thesis, where the candidate independently writes an introduction giving the background for the work, discusses and justifies the choice of methods, and sets the results in an international context*

Skills
The candidate:

- can formulate problems for, plan and carry out research and scholarly development work
- can use the research methods of the field to create new knowledge, new theories and methods
- can carry out research and scholarly research work of a high international standard
- can handle complex academic issues and challenge established knowledge and practice in the field

The skills are achieved through:

- *guidance and own research*
- *publications, submissions to international journals, and experience with referee statements*
- *the thesis*
- *presentation of results at national and international meetings and conferences*

General competence
The candidate:

- can identify new relevant ethical issues and carry out his or her research with scholarly integrity
- can assess the risks involved in the work, and safeguard HSE
- can manage complex interdisciplinary assignments and projects
- can communicate research and development work through recognized international channels
- can participate in debates in the field in international forums
- can quickly acquire new knowledge
- can establish academic networks

General competence is acquired through:

- *guidance and own research*
- *work with publications and the thesis*
- *a trial lecture on an assigned topic, prepared in a short time*

Requirements for admission, from § 5 and 7.3 in the regulations

To be admitted to the Ph.D. programme a broad background in biophysics and other relevant fields is required. A Master of Physics or equivalent is required. At least 150 credits in physics and physics related topics at university or college level are required.

In accordance with the regulations' requirement of a "strong academic background" it is required that both the previous bachelor studies (equivalent to the first three years of the technology programme) and the master studies (equivalent to the final two years of the technology programme) are completed with satisfactory results. Normally an average grade of C or better is required for the bachelor degree (or equivalent) and B or better for the master degree (or equivalent).

The aim of the programme is to enable Ph.D. candidates in physics from NTNU to have a broad background in physics which enables subsequent flexibility in the field. For this to be possible within a short time-frame, it is assumed that candidates who are admitted have, in addition to training in basic topics in classical and modern physics, an education that has given experience with both theoretical and experimental physics, and which mainly covers key areas such as quantum

mechanics, statistical mechanics, and electromagnetic theory. If the previous education has not covered these central subjects, the candidate may be required to take additional examinations in certain subjects prior to being admitted, or during the doctoral programme, preferably during the first three semesters of study. This coursework cannot be included in the formal course requirements of the Ph.D. programme, and examination in such courses must be passed with a grade of C or better for each of the mandatory courses.

Finances

Funding for the studies must be available before admission to the Ph.D. programme in physics.

Required courses

The course part of the programme is equivalent to one full semester of courses (30 credits). The main goals of this part are to give the candidate a general, scientific background in physics, and to give the theoretical background required to perform the work.

Normally, a minimum of 22.5 credits should be within physics courses.

In his or her future career the Ph.D. candidate will come in contact with broader scientific issues. It is important that the candidate acquires a broad background in physics which enables subsequent flexibility in the field. It is therefore recommended that the courses in the training component of the Ph.D. programme are chosen to provide the candidate with a good overview of diverse topics in physics.

The Faculty provides training in ethics, HSE and innovation, through a mandatory introduction program for PhD candidates. In addition, the course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component.

Ph.D. courses at the Department of physics:

Code	Title	Semester	Credits
FY8102	Elektronmikroskopi og diffraksjon *Electron Microscopy and Diffraction*	A16	7,5
FY8104	Anvendelse av symmetrigrupper i fysikken *Application of Symmetry Groups in Physics*	A17	7,5
FY8201	Polymerfysikk *Polymer Physics*	A16	7,5
FY8203	Myke materialers fysikk *Soft Condensed Matter*	S18	7,5
FY8302	Kvanteteorien for faste stoffer *Quantum Theory of Solids*	A16	7,5
FY8303	Faseoverganger og kritiske fenomener *Phase Transitions and Critical Phenomena*	S17	7,5
FY8304	Matematiske approksimasjonsmetoder i fysikken *Mathematical Approximation Methods in Physics*	A16	7,5
FY8305	Funksjonalintegralmetoder i kondenserte fasers fysikk *Functional Integral Methods in Condensed Matter Physics*	A16	7,5
FY8308	Videregående kvantefeltteori *Advanced quantum field theory*	A17	7,5
FY8403	Biopolymergeler og nettverk *Biopolymer Gels and Networks*	S17	7,5
FY8408	Innføring i MR-avbildning *Introduction to MR imaging*	A16	4,0
FY8409	Klinisk fysikk for stråleterapi *Radiation Therapy Physics*	A16	4,0
FY8502	Avansert biofysikk *Advanced Biophysics*	A/S	7,5
FY8503	Avansert teoretisk fysikk *Advanced Theoretical Physics*	A/S	7,5
FY8504	Avansert eksperimentell fysikk *Advanced Experimental Physics*	A/S	7,5
FY8902	Atmosfærefysikk og klimaendringer *Atmospheric Physics and Climate Change*	S17	7,5
FY8903	Gravitasjon og kosmologi *Gravitation and Cosmology*	A16	7,5
FY8904	Numerisk fysikk *Computational Physics*	S17	7,5
FY8905	Materialfysikk *Materials Physics*	A16	7,5
FY8906	Biofysiske mikroteknikker *Biophysical Micromethods*	A16	7,5
FY8907	Klassisk transportteori *Classical Transport Theory*	A16	7,5
FY8908	Kvanteoptikk *Quantum Optics*	A16	7,5
FY8909	Nanofysikk	S17	7,5

	Nano Physics		
FY8910	Ikkelineær dynamikk *Non-linear dynamics*	A16	7,5
MN8000	Naturvitenskap i praksis: Metode, etikk og formidling *Doing Science: Methods, Ethics and Dissemination*	S17	7,5

Description of PhD programme in chemistry:

Description of academic content

The PhD programme in chemistry has as aim to educate independent researchers on an international level, in collaboration with national and international research institutions.

The programme has a broad profile, including several disciplines in chemistry. The activity is organised in three research groups. They include organic chemistry (synthesis and studies of organic molecules and materials), applied theoretical chemistry (calculations and studies of complex chemical molecules at equilibrium and non-equilibrium conditions) as well as studies in environmental and analytical chemistry.

This basic research may be applied to problems in medical technology, energy conversion, nano-technology and marine chemistry, and such applications are also part of the activity. The methods and techniques used in the program are relevant for applications in the industry and the society at large. The research groups, which include world renowned investigators, have extended international collaborations.

The purpose of the PhD programme is to contribute to national needs for competence in research, this being in the industrial sector, in public and private research institutions as well as in the public sector, as teacher in the higher education system, musea or governmental research institutions.

Candidates that join the PhD programme in Chemistry will qualify for positions in research and in work which demand insight in scientific methods and results. The candidate shall complete, in an independent manner, a research project leading to a PhD thesis at a high scientific level, as judged by a jury with international members. This work will give the candidate competence in the research front. Critical scientific thinking, collaboration ethics, presentation technique, as well as public dissemination will be trained.

Research fields

The work on the PhD thesis will lead to competence in the research front in one of the following fields

- Organic chemistry
- Applied theoretical chemistry
- Environmental and analytical chemistry

The Department homepage gives further information on the research fields, see http://www.ntnu.edu/chemistry

Overall learning aim of the PhD programme

The PhD programme has as aim to train the candidate in the generation and publication of new knowledge, and to strengthen the candidate's general competence in the chosen research field.

Outcome of the learning program

By completing the requirements of the PhD degree in chemistry the candidate shall have the following knowledge, skills and general competence:

Knowledge

Upon the completing of the PhD degree in chemistry, it is expected that the candidate

- Is in the research front of the specialty field, and is able to evaluate limitations of current knowledge in the field.
- Masters the relevant theory, problem formulations and methodologies.
- Is able to evaluate suitability and application of various methods for research and development purposes.
- Can contribute to development of new knowledge, new theories or methods, and interpretations or methods of documentation in chemistry

Knowledge will be achieved through:

- The passing of courses amounting to 30 credit points
- Continuous reading of the field's scientific literature
- The thesis work, where the candidate independently has written an introduction to the work, that gives the background for the research, sets it in an international perspective and gives the rational for the methods used

Skills

At the time of the thesis defence, it is expected that the candidate:

- can formulate problems necessary to plan and carry out research
- can perform research on a high international level
- can handle complex scientific questions and challenge established knowledge within the field
- can combine insights from different fields

Skills will be achieved through:

- *supervison and own research*
- *work with the pulication(s) of the thesis and the international publication process, handling of reviews etc.*
- *presentation of results in national and international meetings/conferences*

Generel competence

At the time of the thesis defence, it is expected that the candidate can:

- perform original research at a high international level
- do this with scientific integrity
- assess risks of own activity for health, environment and safety of self and others.
- direct complex multidisciplinary project work.
- disseminate research and development-results through well reputed national and international channels, in oral and written ways.

- participate in discussions within the field in international fora.
- evaluate and initiate actions of innovative character.
- transfer and use knowledge in a way that meets the need of the society.
- establish and work with peers in networks.

General competence is achieved through:

- *supervision and own research*
- *work on publications and thesis*
- *the trial lecture; documenting the ability to learn a new topic in an allotted, short time and present the results.*

Admission requirements

In order to be admitted to the PhD programme the candidate must document a strong background in the chemistry and in other relevant disciplines. A strong background should, according to the PhD regulations, be understood as a Bachelor degree (or an equivalent thereof) with average grade C or better, plus a Master degree (or an equivalent thereof) with grade B or better.

Financial requirements

Financing of the PhD study must be available before the student is accepted to the PhD programme.

The course part

A set of courses is included in the programme corresponding to one semester full time studies (30 credit hours). The main purpose of the course programme is to give the candidate a broader basis for the work on the thesis (in terms of scientific methods and ethics) plus the necessary theoretical fundament for the thesis work. The course **MN-8000** "Doing Science: Methods, Ethics and Dissemination" (7,5 credits) is a mandatory part of the PhD programme.

PhD courses offered at Department of chemistry are listed below. Candidates from department of chemistry are required to study at least one of these topics.

PhD courses offered at Department of Chemistry:

5 courses are taught every second year. The rest are taught every year.

Code	Course name	Semester	Credits
KJ8105	Organometallic Compounds in Organic Synthesis	S 17	7,5
KJ8107	New Concepts in Organic Synthesis	A 16	7,5
KJ8108	Heterocyclic Chemistry	A 17	7,5

KJ8206	Advanced Quantum Chemical Methods	S 18	7,5
KJ8902	Molecular Modelling Coordinated with lectures in **TKJ4205**	A	7,5
KJ8205	Advanced Molecular Modelling	A 16	7.5
KJ8175	Chemometrics Coordinated with lectures in **TKJ4175**	S	7,5
KJ8072	Advanced Aquatic Chemistry Coordinated with lectures in **KJ3072**	A	10
KJ8059	Chromatography, Advanced Course Coordinated with lectures in **KJ3059**	A	7.5

A: Autumn
S: Spring
(The year is stated for courses not given every year. Lessons are not given in the academic year 2016-2017 for the courses marked in grey.)

Description of the PhD program in Chemical Engineering

Programme description

The PhD programme in Chemical Engineering provides organized research training in the various research areas covered by the Department of Chemical Engineering. The objective to train independent researchers at an international level in close collaboration with national and international research partners. 15 PhD candidates graduate on average from the Department annually.
The programme includes a wide range of research fields within important national and international subject areas. The focus could be on design of new chemical processes, scale up of processes from lab scale to industrial scale, or on further development and optimization of existing processes. In other cases, it could be more relevant to develop methods, be it experimental, mathematical or numerical, to be used as tools for characterizing, studying and understanding the underlying physical and chemical phenomena which control the various process units.
The research activities are carried out in close collaboration with national and international industry and academic partners. This gives PhD projects on topics of high scientific interest and often with a high degree of relevancy for real challenges in industry. The PhD programme is intended to comply with current and future needs for competence and skills in chemical engineering in research, development and dissemination at the university, and at other public and private institutions, enterprises and organizations.
The programme qualifies for research and development and other activities which require a high degree of scientific insight. The candidate performs an independent research project which leads to a scientific thesis at a high professional level. The candidate should learn critical thinking, dissemination of scientific knowledge and findings and team work.
The department has excellent laboratory facilities and an extensive international network. Most of the PhD projects are carried out in close collaboration with the Departments national and international partners. This often includes one extended or several shorter stays outside NTNU or abroad, in particular, this applies to all candidates with a background from NTNU. The possibilities for funding via national and international funding schemes and industry are good.

Areas of research

The PhD programme in Chemical Engineering covers a wide specter of subject areas and candidate is normally expected to specialize within one of these.

The five main areas of research are:

- Catalysis
- Colloid- and Polymer Chemistry
- Process Systems Engineering
- Environmental Engineering and Reactor Technology
- Biorafinery and Fibre Technology, including pulp and paper technology

A more detailed description of ongoing research activities can be found at the department home page:
http://www.ntnu.edu/chemeng/research

General learning outcome for the programme

The PhD programme should give training in the generation and publishing of new knowledge and understanding, and increase the candidates' general competence within their field of speciality. The PhD study should in close collaboration with national and international research partners and relevant industry, educate PhD candidates at a high international level within the research areas covered by the department, and moreover contribute to strengthen the candidates' general competence and skills within state-of-the-art chemical engineering.

Learning outcome

A candidate with a PhD in Chemical Engineering should have the following total learning outcome in terms of knowledge, skills and general competence.

Knowledge

After completed a PhD in chemical engineering the candidate is expected to:
- Be in the forefront of his/her area of specialities and be able to evaluate the limitations in existing knowledge and methods within the relevant research area
- Master the theoretical basis, problems and methods within his/her research area
- Be able to contribute to new knowledge, methods, interpretations and procedures for documentation and dissemination within the research area
- Be familiar with the risks and legal aspects related to experimental activity

Knowledge is achieved through:
- The compulsory course work
- Reading and keeping updated on relevant literature within the field
- Laboratory courses and practical training
- The introductory part and summing up of the research work of the thesis, where the candidate independently describes the background, and discusses and argue for the choice of approach and research methods, relating the actual work to state-of-the-art in the field and places the work into an international perspective

Skills

After completed a PhD in Chemical Engineering the candidate is expected to:
- Being able to formulate problems and make adequate plans for research and development
- Can perform and critically evaluate own and others experimental and/or theoretical research work with respect to methods, accuracy, sources of error, good conduct of HSE etc.

- Can carry out research at a high international level
- Can handle complex scientific problems and challenge established knowledge and common practice within the area of research

Skills are achieved through:

- Supervision and own research activities
- Preparation and submission of peer-review journal papers, and experience related to the revision and re-submission of reviewed papers
- The thesis
- Presentation of own research and results at national and international conferences

General competence

After completing a PhD in Chemical Engineering the candidate is expected to:

- Be able to identify ethical problems and execute own research with professional integrity and independence
- Be able to risk assess own research activities and adequately take care of health, security environmental issues
- Be able to organise and lead complex interdisciplinary projects
- Be able to be an active partner and handle relevant scientific problems where the candidate works as a part of a research team
- Be able to present own research and results through relevant national and international fora
- Be able to participate in debates within the field of speciality in national and international fora
- Be able to assess the needs for and to initiate innovation
- Be able to establish a professional network

General competence is achieved through:

- Supervision and own research
- The process of preparing publications and preparing the thesis
- The trial lecture, by acquiring knowledge about a new topic in a short time, time planning, seek/select/evaluate/process and prepare an oral presentation
- Gradually become part of a professional network during the PhD period

Admission requirements

Applicants for the PhD programme in Chemical Engineering must have a relevant master's degree or equivalent education, with a strong academic record.
Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS). The weighted average grade of the applicant's bachelor degree or equivalent education must be higher than C.

Funding

Before you can apply for admission to the PhD programme, the funding of the study period, including running costs, must be confirmed.

Required coursework or other academic training

An important part of the PhD education is the required course work, or academic training. It corresponds to at least one semester of full time study (30 credits). The main objective is to provide the candidate with a general and broad theoretical background in chemical engineering as well as giving the candidate the necessary competence and skills required for their actual PhD project.
For applicants with another background than Master in Chemical Engineering it is recommended to include in the course plan some of the following courses, with the aim of filling in holes in the background knowledge:

TKP4110 Chemical reaction engineering (Autumn)
TKP4105 Separation technology (Autumn)
TKP4165 Process design (Spring)

The faculty offers compulsory training in ethics, HSE and innovation.
MN8000 “Doing Science: Methods, Ethics and Dissemination” constitutes a compulsory part of the training component.

Requirements for the thesis

The thesis is to be an independent scientific work at an international level.
The thesis may be in the form of a monograph or consist of a collection of scientific papers (see § 10.1.)

PhD courses at Department of Chemical Engineering:

Course	Course name	Semester	Credits
KP8091	Advanced Chemical Engineering	A/S	7,5
KP8102	Lignocellulosic Chemistry	A17	9,0
KP8105	Mathematical Modelling and Model Fitting	A17	7,5
KP8106	Gas Cleaning with Chemical Solvents	A16	9,0
KP8107	Advanced Course in Membrane Separation Processes/Liquid Processes	S18	9,0
KP8110	Membrane Gas Purification, advanced course	S17	9,0
KP8115	Advanced Process Control	A	7,5
KP8128	Advanced Reactor Modelling	S	12,5
KP8129	Colloid Chemistry for Process Industry	A17	7,5
KP8130	Systembiology, Modelling and Analysis	A17	7,5

KP8131	Crystallization and Particle Design	A16	7,5
KP8132	Applied Heterogeneous Catalysis	A17	7,5
KP8133	Characterization of Heterogeneous Catalysts	A16	7,5
KP8136	Modelling of Catalytic Reactions	S18	7,5

Ph.d.-courses/mastercourses at Department of Chemical Engineering:

Course	Course name	Semester	Credits
KP8902	Reactor Technology	S	7,5
KP8903	Reaction Kinetics and Catalysis	A	7,5
KP8904	Transport Phenomena	A	7,5
KP8905	Surface- and Colloid Chemistry	A	7,5

A: Autumn
S: Spring
(The year is stated for courses not given every year. Lessons are not given in the academic year 2016/2017 for the courses marked in grey.)

PhD programme in material science and engineering

General programme description

The PhD programme in materials science and engineering provides organized research training in the various research areas covered by the Department of Materials Science and Engineering (DMSE), with the objective to train independent researchers at an international level in close collaboration with national and international research partners.

The programme includes a wide range of research fields within physical and process metallurgy with focus on light metals and silicon including solar grade silicon, corrosion, electrochemical energy technology, inorganic materials, ceramics and nano-structured materials. 15 PhD candidates graduate on average from DMSE annually.

The Department of Materials Science and Engineering covers a broad spectrum of fields within materials science and engineering. The research activities are carried out in close collaboration with national and international industry and academic partners. This gives PhD projects on topics of high scientific interest and often with a high degree of relevancy for real challenges in industry.

The PhD programme is intended to comply with current and future needs for competence and skills in material science and engineering in research, development and dissemination at the university, and at other public and private institutions, enterprises and organizations.

The PhD programme in materials science and engineering qualifies for research and development and other activities which require a high degree of scientific insight. The candidate performs an independent research project which leads to a scientific thesis at a high professional level. The candidate should learn critical thinking, dissemination of scientific knowledge and findings and team work.

The department has excellent laboratory facilities and an extensive international network. Most of the PhD projects are carried out in close collaboration with DMSE's national and international partners and often with one extended or several shorter stays outside NTNU or abroad. The possibilities for funding via national and international funding schemes and industry are good.

Areas of Research

The PhD work gives high level of competence within one of the following research areas:

- Metal production and recycling
- Materials development and use
- Materials for energy technology

A more detailed description of ongoing research activities at the department can be found at the Department of Materials Science and Engineering
http://www.ntnu.edu/mse/research

General learning outcome for the programme

The PhD programme should give training in the generation and publishing of new knowledge and understanding, and increase the candidates' general competence within their field of speciality.

The PhD study in materials science and engineering should in close collaboration with national and international research partners and relevant industry, educate PhD candidates at a high international level within the research areas covered by the department, and moreover contribute to strengthen the candidates' general competence and skills within state-of-the-art materials science and engineering.

Learning outcome

A candidate with a PhD in materials science and engineering should have the following total learning outcome in terms of knowledge, skills and general competence

Knowledge
After completed a PhD in materials science and engineering the candidate is expected to:

- Be in the forefront of his/her area of specialities and be able to evaluate the limitations in existing knowledge and methods within the relevant research area
- Mastering the theoretical basis, problems and methods within his/her research area
- Be able to contribute to new knowledge, methods, interpretations and procedures for documentation and dissemination within the research area
- Be familiar with the risks and legal aspects related to experimental activity

Knowledge is achieved through:

- *The compulsory course work (30 credits)*
- *Reading and keeping updated on relevant literature within the field*
- *Laboratory courses and practical training*
- *The introductory part and summing up of the research work of the thesis, where the candidate independently describes the background, and discusses and argue for the choice of approach and research methods, relating the actual work to state-of-the-art in the field and place the work into an international perspective*

Skills
After completed a PhD in material science and engineering the candidate is expected to:

- Being able to formulate problems and make adequate plans for research and development
- Can perform and critically evaluate own and others experimental and/or theoretical research work with respect to methods, accuracy, sources of error, good conduct of HSE etc.
- Can carry out research at a high international level
- Can handle complex scientific problems and challenge established knowledge and common practice within the area of research

Skills are achieved through:

- *Supervision and own research activities*
- *Preparation and submission of peer-review journal papers, and experience related to the revision and re-submission of reviewed papers*
- *The thesis*

- *Presentation of own research and results at national and international conferences*

General competence
After completed a PhD in materials science and engineering the candidate is expected to:

- Be able to identify ethical problems and execute own research with professional integrity and independence
- Be able to risk assess own research activities and adequately take care of health, security environmental issues
- Be able to organise and lead complex interdisciplinary projects
- Be able to be an active partner and handle relevant scientific problems where the candidate works as a part of a research team
- Be able to present own research and results through relevant national and international fora
- Be able to participate in debates within the field of speciality in national and international fora
- Be able to assess the needs for and to initiate innovation
- Be able to establish a professional network

General competence is achieved through:

- *Supervision and own research*
- *The process of preparing publications and preparing the thesis*
- *The trial lecture, by acquiring knowledge about a new topic in a short time, time planning, seek/select/evaluate/process and prepare an oral presentation*
- *Gradually become part of a professional network during the PhD period*

Requirements for admission to the programme, cf. § 5

Applicants for the PhD programme in materials science and engineering must have a relevant master's degree or equivalent education, with a strong academic record.

Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS). The weighted average grade of the applicant's bachelor degree or equivalent education must be higher than C.

Funding

Before you can apply for admission to the PhD programme, the funding of the study period, including running costs, must be confirmed.

Course work, jfr. § 7.3

An important part of the PhD education is the required course work, or academic training. It corresponds to at least one semester of full time study (30 credits). The main objective is to provide the candidate with a general and broad theoretical background in materials science and engineering as well as giving the candidate the necessary competence and skills required for their actual PhD project.

The plan for academic training should be adapted to the research area of the candidates' PhD project and worked out together with the main supervisor. The course work should consist of a minimum of 30 credits, of which at least 20 credits are to be taken as established PhD level courses.

Normally a minimum of two PhD/MSc courses (15 credits) should be chosen from the courses offered by DMSE.

MN8000 “Doing Science: Methods, Ethics and Dissemination” constitutes a compulsory part of the training component.

The NT- faculty offers introductory training in ethics, HSE and innovation through a compulsory one day introduction seminar.

PhD courses at Department of Materials Science and Engineering:

Course	Course name	Semester	Credits
MT8110	Electrochemical Kinetics	A16	7,5
MT8102	Corrosion and Surface Technology	A16	7,5
MT8104	Electrolysis of Light Metals	A16	7,5
MT8108	Mass Transfer	A17	7,5
MT8200	Advanced Chemical Metallurgy	S17	7,5
MT8201	Advanced metalproduction	A	7,5
MT8205	Metallurgical Modelling of Welding	A16	7,5
MT8208	Fatique of Metals	A17	7,5
MT8210	Advanced Solidification Metallurgy	A17	7,5
MT8219	Applied Electron Microscopy	A16	7,5
MT8214	Advanced Silicon - Solar Cells	S17	7,5
MT8215	Dislocation Theory Applied to Thermo-Mechanical Treatments of Metals	A16	7,5
MT8216	Microstructure and Texture Evolution during Thermomechanical Treatment - Phenomena, Theory and Modelling	A17	7,5
MT8218	Advanced Materials Science	A/S	7,5
MT8305	Cement Chemistry	S17	7,5

MT8306	Advanced Ceramics Processing	S18	7,5
MT8307	Thermodynamics of Materials	A16	7,5
MT8308	Advanced Solid State Chemistry	A17	7,5
MT8400	NoRen Interdiciplinary Summer School	A16	3

A: Autumn
S: Spring
(The year is stated for courses not given every year. Lessons are not given in the academic year 2016/2017 for the courses marked in grey.)