Doctoral programme — Chemical Science and Engineering

The programme description was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

Programme description (KTHKEV)

Programme name
Chemical Science and Engineering (Kemivetenskap)

Subject area
When KTH's predecessor, Teknologiska Institutet in Stockholm, was founded in 1827, there were only two professorships, one in chemistry and one in physics. Chemistry's great significance has from the beginning been a red ribbon running throughout KTH's history. To begin with, the subject was centred in solid application, to respond to the strong advance of industrialization in the 1800s. When Teknologiska Institutet became the Royal Institute of Technology in 1877, there were five subject areas, one of them Chemical Technology. Eventually, the need to find scientific explanations for key industrial issues grew. Chemical Technology ended up in the force field between more fundamental and more applied activity. Even today force fields between fundamental and applied aspects remain, even if they take other forms and constantly evolve with new challenges.

The School of Chemical Science and Engineering today comprises the areas of Chemistry, Chemical Engineering and Technology, and Fibre and Polymer Technology, with both fundamental and applied chemical science research for sustainable development through scientific excellence. Examples of research areas are alternative energy sources, sustainable exploitation of our natural resources, new functional materials and alternative synthesis paths for new medicines. The contact network between different industries and research institutes is extremely well spread-out and many research projects take place in close cooperation with the industry. The School is responsible for Civil Engineer and Bachelor of Science in Engineering degrees in chemistry and chemical engineering and Technology at KTH, as well as a number of international Master's programmes.

The doctoral programme is intended to lead to a licentiate degree and/or doctoral degree in chemical science and engineering, with specialization in chemistry, chemical engineering and technology or fibre and polymer Science. Appendix 1 subject area syllabuses.

Chemistry

Research and postgraduate studies at the Department of Chemistry are conducted within: Analytical, Physical, Organic, Inorganic and Nuclear Chemistry, as well as Surface and Corrosion science. The basic chemistry subjects at KTH form the basis of the broad system-oriented chemical engineering and technology education in both graduate education and research/postgraduate studies. Collaboration/integration between fundamental and technology-oriented subjects is the technical faculties' unique strength over other faculties. They also form the basis for the training of researchers with sound knowledge in one of the fundamental chemistry subjects with expansion and grounding of these skills in other subjects and in chemical engineering and technology.

Chemical engineering and technology
Research and postgraduate studies at the Department of Chemical Engineering and Technology are conducted in several areas. A common aspect is the use of a set of tools which are deemed to define the subject chemical engineering as it is portrayed in the Department of Chemical Engineering and Technology. This general set of tools, also known as “the chemical engineering and technology toolbox” is based on scientific evidence and consists of the following:
Material and energy balances applied to all types of chemical and biochemical systems, Transport Phenomena (momentum, heat and mass transfer), Chemical Engineering Thermodynamics and Kinetics, Separation Processes and Phase Equilibria, Chemical and Electrochemical Reaction Engineering and Process Chemistry.

**Fibre and polymer science**

Research and postgraduate studies at the Department of Fibre and polymer technology are conducted within: Biocomposites, Fibre Technology, Polymer Technology, Polymeric Materials, Wood Chemistry and Pulp Technology and Coating Technology.

The subject area comprises Polymer Synthesis, Polymers' Physical Chemistry, Polymer Physics, Polymer Mechanics and Rheology. There will also be an emphasis on the relationship between macromolecular structure, physical properties and the product’s final properties. Special consideration is given to the polymers’ production, synthesis, modification and use, both as material in the form of plastic, rubber, fibre, adhesive and binding agents in paints and varnishes and as auxiliary chemicals. This includes e.g., molecular structure (synthesis and characterization), degradation, long-term properties and polymeric materials’ interaction with the environment.

The subject area also comprises biofibres' chemical composition, fibres' physical chemistry, fibre physics, fibre mechanics, biofibre composites and fibre properties in three-dimensional fibre networks. Emphasis is placed on demonstrating how fibres' composition and physical properties affect the fibres' interaction with each other and with other materials. The impact of the fibre liberation process and the paper manufacturing process on pulp and paper properties is also emphasized.

**The doctoral programme’s overall purpose and learning outcomes**

The purpose of KTH's doctoral programmes is to provide society with qualified researchers who can contribute to sustainable societal development. The goal of the education is that the postgraduates will become independent, excellent researchers. Overall aim of the doctoral programme Chemical science and engineering involves creating a doctoral programme of the highest international standard, which is characterized by frontier research, strong links with industry, and international cooperation. The doctoral programme Chemical Science and Engineering combines the School of Chemical Science and Engineering's expertise in chemistry, chemical engineering and technology, and fibre and polymer science in one doctoral programme under the current organization.

The goal of the education in the doctoral programme Chemical Science and Engineering, according to KTH’s overall objectives, is to give the student sound knowledge in the subject area Chemical Science and Engineering, and the ability to conduct independent research, development, teaching and preparation work in different areas of society. The objective of the doctoral degree is also to provide the student with the ability to critically and independently initiate, plan and manage such work. The doctoral programme is run by the Programme Director/FA. A reference group, consisting of one representative from each subject specialization, will be made available to the Programme Director. These members are nominated by the heads of department for each field of activity and elected by the Dean/FA. The reference group also includes one postgraduate representative, nominated by the Postgraduate Students’ Council and decided by the Dean/FA.

**The doctoral programme’s size and recruitment**

The target group for the programme is students with a Master’s from one of the School of Chemical Science and Engineering’s Master’s programmes Chemical Engineering for Energy and Environment, Macromolecular Materials and Molecular Science and Engineering, or equivalent education from another university with a Civil Engineering, Master's or equivalent degree, in e.g., Chemistry, Chemical Engineering and Technology or Materials Science and Engineering or another subject relevant to the project.

In the existing environment, approx. 200 postgraduates are enrolled. In the new doctoral programme, an estimated 30 new postgraduate students are admitted/take examinations every year.
Those eligible to apply to the doctoral programme are students who meet the Basic eligibility in accordance with Chapter 7, Section 39 of the Higher Education Ordinance:

1. has taken a second level qualification,
2. has completed course requirements of at least 240 higher education credits, including at least 60 higher education credits at second level, or
3. has acquired essentially corresponding knowledge in some other way in Sweden or abroad.

The faculty board may permit an exemption from the requirement of basic eligibility in the case of an individual applicant, if there are special grounds.

Recruitment and admissions are carried out in accordance with KTH's regulations. Postgraduate positions are advertised in accordance with KTH's guidelines. Admission and selection is carried out in accordance with the syllabus in each postgraduate subject. In the doctoral programme there are around 60-70 main supervisors with qualifications required for appointment to a readership (Appendix 2).

**Funding**

The majority of postgraduate positions are financed through external research projects. The main research financiers, apart from the industry, include various research foundations such as KAW, EU Framework programmes, government funding agencies such as VINNOVA, VR, Formas and MISTRA, as well as international funding agencies such as CSC. Potential excellence positions will be taken into account in the School's budget negotiations in the President's contracts.

**Courses**

The courses within the doctoral programme are all offered within a third-cycle subject and are therefore presented in the study plan for the subject.

**Quality enhancement activities**

**Supervision**

Supervision takes place in accordance with KTH's guidelines with main supervisors who, as a minimum, possess qualifications required for appointment to a readership and a minimum of one deputy supervisor. In accordance with CHE's development plan, supervisor training is mandatory for new supervisors and is offered to other supervisors. At least 5 supervisors each year are to undergo supervisor training, and in 2012, all researchers will have completed teacher training.

**Thesis/essay work**

The postgraduate's development is followed through the individual syllabus, which is drawn up within 6 months following admission, and is subsequently revised at least once per year. The thesis is a compulsory part of postgraduate education. The aim of this part of the education is that the student develops the ability to make independent contributions to the research and also the capacity for scientific cooperation, within and outside their own field. The thesis shall contain new research results that the student has developed, independently or in cooperation with others. The main scientific results should fulfil the quality requirements for publication in internationally recognized journals with referee system. It should be possible to distinguish one postgraduate's contribution to the texts comprised by the thesis from the other authors involved.

The thesis should normally be written in English. It should be in the form of a compilation of scientific articles, but may in special cases be presented as a monograph thesis. In the former case there should be a specific written summary. Irrespective of whether the thesis is intended to be a monograph thesis or a compilation thesis the aim during the postgraduate studies should be international publication of the achieved results. Licentiate essay work should contain scientific material corresponding to at least two regular articles eligible for publication in internationally recognized journals with peer review. A doctoral thesis should contain scientific
material corresponding to at least four such articles. To ensure that KTH's quality standards are met, the doctoral thesis and licentiate essay work are reviewed continuously during their preparation. Responsibility for this falls primarily on the designated supervisors. In addition, the internal pre-assessment of the manuscript will take place in the School before the thesis is printed. The thesis is presented and defended at a public defence.

Courses

The doctoral programme's specialization and its courses are covered by the School's strong and research-intensive activities. The courses are described in the database KOPPS. Course evaluations are made for courses with more than 10 participants.

Educational environment

The overall objective is to provide a safe and sound working environment which has no adverse effect on our surroundings, and a pleasant work climate for all. Postgraduates have access to welfare and occupational health.

The School provides information mainly through "Kemibladet" an established information and communication forum within the School. A common school education office provides administrative support for admissions, follow-ups and defences. All newly admitted postgraduates are offered an introductory seminar, 1-2 times per year. The postgraduates have representatives in all governing groups, such as boards, management groups at both school and department levels. In addition, the Director of Graduate Studies and the School's Postgraduate Students' Council meet approximately 2 times per semester.

A common school schedule of seminars offers a number of seminars per year. The intention of this is primarily to increase the general awareness of the activities at the School. Workshops are organized by individual researchers, or alternatively, the School organizes other means of making cross communication.

Experimental resources

All postgraduates have access to fully equipped laboratories and thereby a large number of instruments, encompassing ~150 different analytical instruments. In the near future, access to incubation laboratories will be possible, where opportunities are given for the development of ideas for new businesses. In addition to KTH's main library, subject-specific libraries are also available in the various departments.

National and international network

International activity in the doctoral programme takes place when, for example, all postgraduates participate in presentations at international conferences. The School awards scholarships for these purposes annually. The postgraduates are encouraged to spend part of postgraduate studies at an international higher education institute, such as under the EU's Framework Programmes. At a national level there is, for example, the Forest Products Industry Research College FPIRC, which organizes doctoral courses/summer university open to both Swedish and international postgraduates. Within the School of Chemical Science and Engineering, joint seminars are conducted, as well as approximately 10 seminars per year and an annual joint school day. Collaboration with industry takes place with, for example, guest speakers, within advanced subjects, but also within complementary skills, for example, entrepreneurship. Examples of other activities include mentor programmes, Alumni activities, and KAKA job fairs which take place on a regular basis. The programme's national and international contact networks are described in appendix 4.

The above is enumerated and defined in appendix 3.

Further instructions for registration

Research at the School of Chemical Science and Engineering is characterized by strong cooperation, both nationally and internationally with other partners. There are often several other national institutions/universities/institutes and companies actively involved in postgraduate projects, which means that the majority of the postgraduates carry out parts of their projects at other universities, thereby gaining experience of working in large projects. Researchers at the School are linked to several national research centres and large research
projects. Examples include Wallenberg Wood Science Center (WWSC) at KTH and Chalmers, EcoBuild (SP Trätek), WURC (SLU), BioMime (KTH), CoDirect (SP YKI/KTH/SU) and Kombatt (SSF/Sicomp). There are also strong links to independent research institutes, for example, the Institute for Surface Chemistry, Innventia and Sverea SP where postgraduates are given the opportunity for extended exposure to industrial projects and research.

The international cooperation takes place both through the work presented by postgraduates at international scientific conferences and through participation in international research exchange. Researchers at the School regularly organize international conferences both at KTH and in collaboration with foreign universities. The regions where most cooperation takes place are currently Europe, North America, Asia, Australia and South Africa, where an established contact network exists. The cooperation also means that a large number of postgraduates conduct a part of their work at a foreign university in both the long and short term. The cooperation projects often take place in the framework of major international exchanges and cooperation projects, for example, EU projects and bilateral exchange programmes. Examples of current projects of this nature are the Wood Wisdom project (Sweden, – Finland-Germany), several EU projects can be mentioned here, examples include Marie Curie Research Training Networks SOCON (surfactants and polymers under confinement) and BIOCONTROL. Researchers at the School also have a wide informal international network through which postgraduates are offered the opportunity to study at a foreign university during their postgraduate study and post-doctoral studies after the postgraduate work.

An updated list of current research is available on each department's website: http://www.kth.se/che/departments

**Appendixes**

Appendix 1.1: Study plan for third-cycle subject Fibre and Polymer Science (FPVET).

Appendix 1.2: Study plan for third-cycle subject Chemistry (KEMI).

Appendix 1.3: Study plan for third-cycle subject Chemical Engineering (KEMTEK).

Appendix 2: List containing names and subject areas of supervisors within the programme

Appendix 3: Presentation of the programme’s national and international network
Doctoral programme — Chemical Science and Engineering

Appendix 1.1: Study plan for third-cycle subject Fibre and Polymer Science (FPVET).

The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

Subject title
Fibre and Polymer Science (Fiber- och polymervetenskap)

Subject description and programme outcomes

Scientific field
There are joint provisions and regulations for postgraduate studies at KTH in the regulatory framework for KTH's postgraduate courses (http://www.kth.se/info/kth-handboken/II/index.html). This syllabus for postgraduate studies in the subject Fibre and Polymer Science supplements the joint provisions and guidelines with the following subject-specific instructions.

Description of possible specialisation
The subject has no specialisations.

Specification of how the programme outcomes are to be achieved
Postgraduate courses in Fibre and Polymer Science combine basic knowledge of chemistry, physics and mathematics with applied engineering subjects in order to give the students comprehensive technical/scientific expertise in areas which are of industrial relevance. The objective of the postgraduate studies in fibre and polymer science is to provide the students with sound knowledge in the subject area and the ability to conduct independent research, development, teaching and research work in different areas of society.

The objective of the doctoral degree is also to provide the student with the ability to critically and independently initiate, plan and manage such work.

This means that upon completion of the education postgraduates should be able to:

1. describe and explain the theories and empirical results within their area of specialization
2. formulate concrete research issues in the field of fibre and polymer science
3. use scientific methods and develop new knowledge through their own scientific studies
4. critically analyze and evaluate the applied methods and results from both their own scientific studies and those of others
5. present and discuss research results in the scientific community
6. present research in a pedagogical manner outside the scientific community and in educational contexts
7. assess the ethical aspects of research in the field of fibre and polymer science and act based on these
8. identify needs for new knowledge and have knowledge of initiating and managing research

All of the skills listed above should be developed in a natural manner during the supervision process. The courses should help develop the skills described in 1, 3, 6 and 7. Participation in seminars and teaching and attending conferences will help to develop the skills described in 1, 4 and 5.
Current research

Research and postgraduate studies at the Department of Fibre and polymer technology are conducted at six departments: Biocomposites, Fibre Technology, Polymer Technology, Polymeric Materials, Wood Chemistry and Pulp Technology and Coating Technology.

The subject area comprises Polymer Synthesis, Polymers' Physical Chemistry, Polymer Physics, Polymer Mechanics and Rheology. There will also be an emphasis on the relationship between macromolecular structure, physical properties and the product's final properties. Special consideration is given to the polymers' production, synthesis, modification and use, both as material in the form of plastic, rubber, fibre, adhesive and binding agents in paints and varnishes and as auxiliary chemicals. This includes e.g., molecular structure (synthesis and characterization), degradation, long-term properties and polymeric materials’ interaction with the environment.

The subject area also comprises biofibres' chemical composition, fibres' physical chemistry, fibre physics, fibre mechanics, biofibre composites and fibre properties in three-dimensional fibre networks. Emphasis is placed on demonstrating how fibres' composition and physical properties affect the fibres’ interaction with each other and with other material. The impact of the fibre liberation process and the paper manufacturing process on pulp and paper properties is also emphasized.

Programme structure

Postgraduate studies consist of coursework and a thesis. The course stages may comprise lectures, literature studies and problem-solving as well as active participation in seminars, provided that a clear examination stage is included. Courses can be studied within the department or in collaboration with other Swedish or foreign research institutions.

Postgraduate studies are conducted under the management of a main supervisor, together with one or more deputy supervisors, in accordance with an individual syllabus approved by the Director of Graduate Studies. The individual syllabus of the student should be adjusted to the prior knowledge and the focus of the thesis. The postgraduate's progress should be assessed at least once a year in connection with the review of the individual syllabus which should be done by the student and main supervisor and it should be adopted by the Director of Graduate Studies.

As a part of the education active participation in research seminars at the department is required. Postgraduates should present his/her results at research seminars, preferably on occasions during the study period. Postgraduates should also participate in national and international conferences within the discipline.

Compulsory and recommended courses

The licentiate degree consists of coursework consisting of a minimum of 30 credits and a thesis of 90 credits to give a total of 120 credits. Of the total course work at least half should be conducted at postgraduate level. The doctoral degree consists of coursework consisting of a minimum of 60 credits and a thesis of 180 credits which gives a total of 240 credits. Of the total course work at least 60 per cent should be conducted at postgraduate level. The coursework for both the licentiate and doctoral degree consists of a compulsory course in Research Ethics, recommended courses and optional courses.

The courses should be studied in accordance with the agreement between the student and the main supervisor which is reached as a part of the individual syllabus.

Compulsory courses

Research ethics equivalent to a minimum of 1.5 credits

Recommended courses

It is recommended that postgraduates take a general course in philosophy of science and research methodology and second level courses as well as doctoral courses with specializations which correspond to the specialization of the research project.
Courses appropriate for postgraduate studies can be selected from, inter alia, the list on the website of the School of Chemical Science and Engineering at the following address: "http://www.kth.se/che/intern/doktorandsida/doktorandkurser". If preferable, courses can also be selected from the range at other institutes of higher education, for example, Stockholm University and Karolinska Institutet.

Optional courses

Courses appropriate for postgraduate studies can be selected from, inter alia, the list on the website of the School of Chemical Science and Engineering at the following address: "http://www.kth.se/che/intern/doktorandsida/doktorandkurser". If preferable, courses can also be selected from the range at other institutes of higher education, for example, Stockholm University and Karolinska Institutet.

Courses from other disciplines may be included depending on the specialization of the thesis. See KTH's regulatory framework for credit transfer. Courses from the first and second cycles may only be included if they cover relevant disciplines for postgraduate studies and they should not constitute prior knowledge or provide specific entry requirements for admission in the postgraduate subject fibre and polymer technology.

Additional course stages which both the main supervisor and the student consider to be important for the thesis work may also be included in the coursework of the licentiate and doctoral degrees. Such accredited activities may take the form of individual literature courses with clear degree stages. Credit transfer for such activities requires a prior agreement between the subject representative and student with credits established in the individual syllabus. Other activities which provide credits may include a maximum of 7.5 credits for the licentiate degree and 15 credits for the doctoral degree. Requirements for courses in teaching and learning in higher education may be included if teaching within basic and second level courses can take place.

Thesis

The thesis is a compulsory part of the postgraduate studies. This part of the education aims to develop the students' ability to make independent contributions to research, scientific cooperation, within and outside their own field. The thesis shall contain new research findings which the student has developed independently or in cooperation with others. The main scientific results should fulfil the quality requirements for publication in internationally recognized journals with referee systems. It should be possible to distinguish the postgraduate's contribution to the texts included in the thesis from that of the other authors involved.

The thesis should normally be written in English. It should be designed as a compilation of scientific articles but in special cases it can be presented as a monograph thesis. In the former case there should be a specific written summary. Irrespective of whether the thesis is intended to be a monograph thesis or a compilation thesis the aim during the postgraduate studies should be international publication of the achieved results. A licentiate essay should contain scientific material corresponding to at least two normal articles which can be published in internationally recognized journals with peer review. A doctoral thesis should contain scientific material corresponding to at least four such articles.

The doctoral thesis is normally based on the licentiate thesis.

Entry requirements and selection

General and special admission requirements and prior knowledge

In accordance with Chapter 7, Section 39 of the Higher Education Ordinance a person has basic eligibility for third level education if he or she

1. has taken a second level qualification,
2. has completed course requirements of at least 240 higher education credits, including at least 60 higher education credits at second level, or
3. has acquired essentially corresponding knowledge in some other way in Sweden or abroad.
The faculty board may permit an exemption from the requirement of basic eligibility in the case of an individual applicant, if there are special grounds.

Special eligibility

The education is based on the premise that the student has acquired knowledge equivalent to courses at second level in the subject area fibre and polymer science but he/she may have another background which is relevant for the individual syllabus.

Postgraduates are expected to be able to read and write scientific English and speak English fluently.

Selection rules and procedures

Admission to postgraduate studies is determined by the Dean at the School of Chemical Science and Engineering following preparation by the main supervisor and, where appropriate, the Director of Graduate Studies (during assessment of eligibility to study). In addition to the assessment of eligibility, the applicant's level of knowledge, maturity and ability to independently review and critically analyze form the basis of selection. Past academic performance for courses of an in-depth nature in academic education at basic and second level and the independent scientific work are central in this assessment. The applicants are interviewed by the main supervisor in order to obtain a comprehensive basis for the decision. Contact is usually made with former lecturers of the applicant. Selection among applicants for postgraduate studies is done by the main supervisor in connection with admission.

The programme’s degrees and examinations

Degree of Licentiate and Degree of Doctor (PhD)

The licentiate degree consists of coursework consisting of 30 credits and an essay of 90 credits.

The essay should be presented and defended in accordance with KTH’s general regulations. The doctoral degree consists of coursework consisting of 60 credits and a thesis of 180 credits. The thesis should be presented and defended in accordance with KTH’s general regulations. Courses and thesis work included in the licentiate degree may also be credited in a doctoral degree.

The programme’s examinations

The courses at postgraduate level should include a written or verbal knowledge test. The structure of the examination should, in each case, be such that the examiner can ascertain that the student has assimilated all the course content.
Doctoral programme — Chemical Science and Engineering

Appendix 1.2: Study plan for third-cycle subject Chemistry (KEMI).

The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

Subject title
Chemistry (Kemi)

Subject description and programme outcomes

Scientific field
There are joint provisions and guidelines for postgraduate studies at KTH in the regulatory framework for KTH's postgraduate education. This syllabus for postgraduate studies in the subject chemistry supplements the common provisions and guidelines with the following subject-specific instructions.

Description of possible specialisation
The subject has no specialisations.

Specification of how the programme outcomes are to be achieved
Research and postgraduate studies in the subject of chemistry at KTH are purely scientific in their basis, however, through their environment there is a clear link to engineering science. This means that activity is formally divided into the traditional educational subjects, but special attention is paid to interdisciplinary cooperation between these subjects and with other disciplines represented at KTH.

The goal of the postgraduate studies in chemistry is to provide the student with sound knowledge in the subject area chemistry and the ability to conduct independent research, development and investigative work within different areas of society.

The goal of the doctoral degree is furthermore to give the student the ability to critically and independently initiate, plan and manage such work.

This means that upon completion of the education postgraduates should be able to:

1. Describe and explain the theories and empirical results within their area of specialization
2. Formulate concrete research issues in the field of chemistry.
3. Use scientific methods and develop new knowledge through their own scientific studies.
4. Critically analyze and evaluate the applied methods and results from both their own scientific studies and those of others.
5. Present and discuss research results in the scientific community.
6. Present research in a pedagogical manner outside the scientific community and in educational contexts.
7. Assess the ethical aspects of research in the field of chemistry and act based on these
8. Describe the conditions and mechanisms for financing research.

Current research
Research and education at postgraduate level at the Department of Chemistry is conducted within six departments:
Analytical, Physical, Organic, Inorganic and Nuclear Chemistry, as well as Surface and Corrosion science. The basic chemistry subjects at KTH form the basis of the broad system-oriented chemical engineering and technology education in both graduate education and research/postgraduate studies. Collaboration/integration between fundamental and technology-oriented subjects is the technical faculties' unique strength over other faculties. They also form the basis for the training of researchers with sound knowledge in one of the fundamental chemistry subjects with expansion and grounding of these skills in other subjects and in chemical engineering and technology.

Programme structure

Postgraduate studies consist of coursework and a thesis. The course stages may comprise lectures, literature studies and problem-solving as well as active participation in seminars, provided that a clear examination stage is included. Courses can be studied within the department or in collaboration with other Swedish or foreign research institutions.

Postgraduate studies are conducted under the management of a main supervisor, together with one or more deputy supervisors, in accordance with an individual syllabus approved by the Director of Postgraduate Studies. The individual syllabus of the student should be adjusted to the prior knowledge and the focus of the thesis. The postgraduate's progress is to be assessed at least once a year in connection with revision of the individual syllabus which is drawn up by the student and main supervisor.

As a part of the education active participation in research seminars at the department is required.

Postgraduates are to present their results at research seminars, preferably on a number of occasions during the study period. Postgraduates are also to participate in national and international conferences within the discipline.

Compulsory and recommended courses

The licentiate degree consists of coursework consisting of 30 credits and a thesis of 90 credits which gives a total of 120 credits. The doctoral degree consists of coursework consisting of 60 credits and a thesis of 180 credits which gives a total of 240 credits.

The coursework for both the licentiate and doctoral degree consists of a compulsory course in Research Ethics, as well as optional courses. Due to the broad nature of the subject Chemistry, no courses other than the Research Ethics course are compulsory.

For postgraduates who attend classes, the course Basic Communication and Teaching (LH200V, 3 credits) or equivalent is compulsory. The courses should be studied in accordance with the agreement between the student and the main supervisor, which is made in the individual syllabus.

Compulsory courses

Research Ethics (F3B5219), 1.5 credits

Recommended courses

It is recommended that postgraduates study a general course in Philosophy of Science and Research Methodology, as well as advanced and doctoral courses with a specialization which corresponds to the specialization of the research project.

Courses suitable for postgraduate studies can be selected from a list on the School of Chemical Science and Engineering's website, "http://www.kth.se/che/internt/doktorandsida/doktorandkurser". If preferable, courses can also be selected from the range at other institutes of higher education, for example, Stockholm University and Karolinska Institutet.

Optional courses
Optional courses suitable for postgraduate studies may, for example, be selected from the list at the School of Chemical Science and Engineering's website, "http://www.kth.se/che/intern/doktorandsida/doktorandkurser". If preferable, courses can also be selected from the range at other institutes of higher education, for example, Stockholm University and Karolinska Institutet.

Courses from other disciplines may be included depending on the specialization of the thesis.

Following agreement with the main supervisor, credits can be awarded in the individual syllabus for courses completed at graduate level. For credit transfer, the provisions of KTH's Degree Ordinance for postgraduate degrees are to be observed. For doctoral degrees, at least 60% of the total coursework is to be at postgraduate level; for licentiate degrees, at least 50%. Furthermore, in accordance with the Degree Ordinance, courses at graduate level in the scientific area of technology are not considered part of doctoral and licentiate degrees. For education at graduate and advanced levels up to 240 credits, credit transfer is not permitted. Credit transfer cannot be made for courses which are required for special eligibility for postgraduate education.

Additional course stages which the main supervisor and student jointly consider important for the thesis work may also be included in the coursework of the licentiate and doctoral degrees. Such accredited activities can take the form of individual literature courses with clear degree stages. Credit transfer for such activities requires a prior agreement between the subject representative and student with credits established in the individual syllabus. Other activities which provide credits may include a maximum of 7.5 credits for the licentiate degree and 15 credits for the doctoral degree.

**Thesis**

The thesis is a compulsory part of postgraduate education. The aim of this part of the education is that the student develops the ability to make independent contributions to the research. Development of the capacity for scientific cooperation, within and outside of their own field, is normally also part of the thesis.

The thesis shall contain new research findings which the student has developed independently or in cooperation with others. The main scientific results should meet the quality requirements for publication in internationally recognized journals with referee systems. It should be possible to distinguish one postgraduate's contribution to the texts comprised by the thesis from the other authors involved.

The thesis should normally be written in English. It should be designed as a compilation of scientific articles but in special cases it can be presented as a monograph thesis. In the former case there should be a specific written summary. Irrespective of whether the thesis is intended to be a monograph thesis or a compilation thesis the aim during the postgraduate studies should be international publication of the achieved results. Licentiate essay work should contain scientific material corresponding to at least two articles eligible for publication in internationally recognized journals with peer review. Ordinarily, a doctoral thesis contains scientific material corresponding to at least four such articles for guidance. The pre-assessment and the grading board are responsible, however, for ensuring that the thesis meets the quality standards.

The doctoral thesis is normally based on the licentiate thesis.

**Entry requirements and selection**

**General and special admission requirements and prior knowledge**

In accordance with Chapter 7, Section 39 of the Higher Education Ordinance a person has basic eligibility for third level education if he or she

1. has taken a second level qualification,
2. has completed course requirements of at least 240 higher education credits, including at least 60 higher education credits at second level, or
3. has acquired essentially corresponding knowledge in some other way in Sweden or abroad.

The faculty board may permit an exemption from the requirement of basic eligibility in the case of an individual applicant, if there are special grounds.
Selection rules and procedures

Admission to postgraduate studies is decided by the Dean at the School of Chemical Science and Engineering, following preparation by the main supervisor and, where appropriate, by the Director of Postgraduate Studies (during assessment of eligibility to study).

In addition to the assessment of eligibility, the applicant's level of knowledge, maturity and ability to independently review and critically analyze form the basis of selection. Past academic performance for courses of an in-depth nature in academic education at basic and second level and the independent scientific work are central in this assessment. The applicants are interviewed by the main supervisor in order to obtain a comprehensive basis for the decision. Contact is usually made with former lecturers of the applicant. Selection among applicants for postgraduate studies is done by the main supervisor in connection with admission.

The programme’s degrees and examinations

Degree of Licentiate and Degree of Doctor (PhD)

The licentiate degree consists of coursework consisting of 30 credits and a thesis of 90 credits. The thesis should be presented and defended in accordance with KTH's general regulations.

The doctoral degree consists of coursework consisting of 60 credits and a thesis of 180 credits. The thesis should be presented and defended in accordance with KTH's general regulations. Courses and thesis work included in the licentiate degree may also be credited in a doctoral degree.

The programme’s examinations

The courses at postgraduate level should include a written or verbal knowledge test. The structure of the examination should, in each case, be such that the examiner can ascertain that the student has assimilated all the course content.
Doctoral programme — Chemical Science and Engineering

Appendix 1.3: Study plan for third-cycle subject Chemical Engineering (KEMTEK).

The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

Subject title
Chemical Engineering (Kemiteknik)

Subject description and programme outcomes

Scientific field
There are joint provisions and regulations for postgraduate studies at KTH in the regulatory framework for KTH’s postgraduate courses (intra.kth.se/regelverk/utbildning-forskning/forskarutbildning). This syllabus for postgraduate studies in the subject chemical engineering supplements the joint provisions and guidelines with the following subject-specific instructions.

Description of possible specialisation
The subject has no specialisations.

Specification of how the programme outcomes are to be achieved
Postgraduate studies in Chemical Engineering combine basic knowledge of chemistry, physics and mathematics with basic and applied engineering subjects in order to give the student a comprehensive technical and scientific expertise in areas which are of industrial and social relevance.

The objective of the postgraduate studies in chemical engineering is to provide the students with sound knowledge in the subject area and the ability to conduct independent research, development, teaching and research work in different areas of society.

The objective of the doctoral degree is also to provide the student with the ability to critically and independently initiate, plan and manage such work.

This means that upon completion of the education postgraduates should be able to:

1. describe and explain the theories and empirical results within their area of specialization
2. formulate concrete research issues in the field of chemical engineering
3. use scientific methods and develop new knowledge through their own scientific studies
4. critically analyze and evaluate the applied methods and results from both their own scientific studies and those of others
5. present and discuss research results in the scientific community
6. present research in a pedagogical manner outside the scientific community and in educational contexts
7. assess the ethical aspects of research in the field of chemical engineering and act based on these
8. identify needs for new knowledge and have knowledge of initiating and managing research and be aware of the mechanisms for obtaining funds to conduct research.
Current research

Research and postgraduate studies at the Department of Chemical Engineering and Technology are conducted in several areas. A common aspect is the use of a set of tools which are deemed to define the subject chemical engineering as it is portrayed in the Department of Chemical Engineering and Technology. This general set of tools, also known as "the chemical engineering tool box" is based on scientific evidence and consists of the following:

- Material and energy balances applied to all types of chemical and biochemical systems
- Transport phenomena (momentum, heat and mass transfer)
- Chemical engineering thermodynamics and kinetics
- Separation processes and phase equilibrium
- Chemical and electrochemical reaction engineering
- Process chemistry

Programme structure

Postgraduate studies consist of coursework and a thesis. The course stages may comprise lectures, literature studies and problem-solving as well as active participation in seminars, provided that a clear examination stage is included. Courses can be studied within the department or in collaboration with other Swedish or foreign research institutions.

Postgraduate studies are conducted under the management of a main supervisor, together with one or more deputy supervisors, in accordance with an individual syllabus approved by the Director of Graduate Studies. The individual syllabus of the student should be adjusted to the prior knowledge and the focus of the thesis. The postgraduate's progress should be assessed at least once a year in connection with the review of the individual syllabus which should be done by the student and main supervisor and it should be adopted by the Director of Graduate Studies.

As a part of the education active participation in research seminars at the department is required. Postgraduates should present his/her results at research seminars, preferably on occasions during the study period. Postgraduates should also participate in national and international conferences within the discipline.

Compulsory and recommended courses

The licentiate degree consists of coursework consisting of 30 credits and a thesis of 90 credits to give a total of 120 credits. The doctoral degree consists of coursework consisting of 60 credits and a thesis of 180 credits which gives a total of 240 credits.

The coursework for both the licentiate and doctoral degree consists of a compulsory course in Research Ethics, recommended courses and optional courses. The courses should be studied in accordance with the agreement between the student and the main supervisor which is reached as a part of the individual syllabus.

Recommended courses

It is recommended that students study a general course in philosophy of science and research methodology and second level courses as well as doctoral courses with specializations which correspond to the specialization of the research project.

Courses appropriate for postgraduate studies can be selected from, inter alia, the list on the website of the School of Chemical Science and Engineering at the following address: www.kth.se/che/internt/doktorandsida/doktorandkurser. If preferable, courses can also be selected from the range at other institutes of higher education.

Optional courses

Optional courses suitable for postgraduate studies may, for example, be selected from the list on the website of the School of Chemical Science and Engineering at the following address: www.kth.se/che/internt/doktorandsida /doktorandkurser. If preferable, courses can also here be selected from the range at other institutes of higher education.
Courses from other disciplines may be included depending on the specialization of the thesis. See KTH's regulatory framework for credit transfer. Courses from the first and second cycles may only be included if they cover relevant disciplines for postgraduate studies and they should not constitute prior knowledge or provide specific eligibility for admission to the postgraduate subject Chemical Engineering and Technology.

Additional course stages which the main supervisor and student jointly consider important for the thesis work may also be included in the coursework of the licentiate and doctoral degrees. Such accredited activities can take the form of individual literature courses with clear degree stages. Credit transfer for such activities requires a prior agreement between the main supervisor and student with credits established in the individual syllabus. Other activities which provide credits may include a maximum of 7.5 credits for the licentiate degree and 15 credits for the doctoral degree. Requirements for courses in teaching and learning in higher education may be included if teaching within first and second cycle courses can take place.

**Thesis**

The thesis is a compulsory part of the postgraduate studies. This part of the education aims to develop the students' ability to make independent contributions to research, scientific cooperation, within and outside their own field. The thesis shall contain new research findings which the student has developed independently or in cooperation with others. The main scientific results should fulfil the quality requirements for publication in internationally recognized journals with reference systems. It should be possible to distinguish one postgraduate student's contribution to the texts comprised by the thesis from that of the other authors involved.

The thesis should normally be written in English. It should be designed as a compilation of scientific articles but in special cases it can be presented as a monograph thesis. In the former case there should be a specific written summary. Irrespective of whether the thesis is intended to be a monograph thesis or a compilation thesis the aim during the postgraduate studies should be international publication of the achieved results. Licentiate essay work should contain scientific material corresponding to at least two regular articles eligible for publication in internationally recognized journals with peer review. A doctoral thesis should contain scientific material corresponding to at least four such articles. The doctoral thesis is normally based on the licentiate thesis.

**Entry requirements and selection**

**General and special admission requirements and prior knowledge**

In accordance with Chapter 7, Section 39 of the Higher Education Ordinance a person has basic eligibility for third level education if he or she

1. has taken a second level qualification,
2. has completed course requirements of at least 240 higher education credits, including at least 60 higher education credits at second level, or
3. has acquired essentially corresponding knowledge in some other way in Sweden or abroad. The faculty board may permit an exemption from the requirement of basic eligibility in the case of an individual applicant, if there are special grounds.

**Special eligibility**

The education is based on the premise that the student has acquired knowledge equivalent to courses at second level in the subject area Chemical Engineering but he/she may have another background which is relevant for the individual syllabus If during the admission the student lacks the prior knowledge necessary for taking the education at second level, the main supervisor should ensure that the student assimilates this prior knowledge during the first year. Assimilation of this prior knowledge cannot be awarded credits in the education's coursework, but should be stated as an objective in the individual syllabus and should be evaluated after the first year. Postgraduates are expected to be able to read and write scientific English and speak English fluently.
Selection rules and procedures

Admission to postgraduate studies is determined by the Dean at the School of Chemical Science and Engineering following preparation by the main supervisor and, where appropriate, the Director of Graduate Studies (during assessment of eligibility to study). In addition to the assessment of eligibility, the applicant's level of knowledge, maturity and ability to independently review and critically analyze form the basis of selection. Past academic performance for courses of an in-depth nature in academic education at first and second cycle and the independent scientific work are central in this assessment. The applicants are interviewed by the main supervisor in order to obtain a comprehensive basis for the decision. Contact is usually made with former lecturers of the applicant. Selection among applicants for postgraduate studies is done by the main supervisor in connection with admission.

The programme’s degrees and examinations

Degree of Licentiate and Degree of Doctor (PhD)

The licentiate degree consists of coursework consisting of 30 credits and an essay of 90 credits.

The essay should be presented and defended in accordance with KTH’s general regulations. The doctoral degree consists of coursework consisting of 60 credits and a thesis of 180 credits. The thesis should be presented and defended in accordance with KTH’s general regulations. Courses and thesis work included in the licentiate degree may also be credited in a doctoral degree.

The programme’s examinations

The courses at postgraduate level should include a written or verbal knowledge test. The structure of the examination should, in each case, be such that the examiner can ascertain that the student has assimilated all the course content.
Doctoral programme — Chemical Science and Engineering

Appendix 2: List containing names and subject areas of supervisors within the programme

The programme description was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.

<table>
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<th>DEPARTMENT</th>
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<td>Anna Finne Wistrand</td>
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<td>Anders Hagfeldt</td>
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<tr>
<td>Åsa Emmer</td>
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<td>Klas Engvall</td>
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<td>Åke Rasmuson</td>
<td>Professor</td>
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Doctoral programme — Chemical Science and Engineering

Appendix 3: Presentation of the programme’s national and international network

The programme description was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring II.

Research at the School of Chemical Science and Engineering is characterized by strong cooperation, both nationally and internationally with other partners. There are often several other national institutions/universities/institutes and companies actively involved in postgraduate projects, which means that the majority of the postgraduates carry out parts of their projects at other universities, thereby gaining experience of working in large projects. Researchers at the School are linked to several national research centres and large research projects. Examples include Wallenberg Wood Science Center (WWSC) at KTH and Chalmers, EcoBuild (SP Trätek), WURC (SLU), BioMime (KTH), CoDirect (SP YKI/KTH/SU) and Kombatt (SSF/Sicomp). There are also strong links to independent research institutes, for example, the Institute for Surface Chemistry, Invenntia and Sverea SP where postgraduates are given the opportunity for extended exposure to industrial projects and research.

The international cooperation takes place both through the work presented by postgraduates at international scientific conferences and through participation in international research exchange. Researchers at the School regularly organize international conferences both at KTH and in collaboration with foreign universities. The regions where most cooperation takes place are currently Europe, North America, Asia, Australia and South Africa, where an established contact network exists. The cooperation also means that a large number of postgraduates conduct a part of their work at a foreign university in both the long and short term. The cooperation projects often take place in the framework of major international exchanges and cooperation projects, for example, EU projects and bilateral exchange programmes. Examples of current projects of this nature are the Wood Wisdom project (Sweden, – Finland-Germany), several EU projects can be mentioned here, examples include Marie Curie Research Training Networks SOCON (surfactants and polymers under confinement) and BIOCONTROL. Researchers at the School also have a wide informal international network through which postgraduates are offered the opportunity to study at a foreign university during their postgraduate study and post-doctoral studies after the postgraduate work.

An updated list of current research is available on each department's website: http://www.kth.se/che/departments