

Graduate studies at Linnaeus University is governed in the Swedish Higher Education Act and the Higher Education Ordinance plus the local rules for graduate education that the University has established. In which bodies decisions are made is apparent from the University's decision-making and delegation of authority regulations.

## **Curriculum for third-cycle studies in the field of Terotechnology at the graduate level**

Curriculum and research programme for studies in the field of Terotechnology at the graduate level, adopted by the Board of the Faculty of Technology on 05/02/2016, taking effect as of 05/02/2016.

### **1. Educational Programme**

At Linnaeus University, the field and course of study referred to as Terotechnology covers a wide spectrum of activities and contains both theory and application. The system is a combination of management, finance, and engineering sciences and other experiences that will be applied to the processes, equipment, organisations, skills and the environment in order to continuously reduce production costs as well as to increase quality, profitability and competitiveness. The main area covers the sub-areas such as maintenance technology, production methods, quality, production logistics, lifecycle cost, qualitative and quantitative methods of analysis, information systems, organisation and management, ICT, decision support systems and modelling. All research in the Terotechnology contains development, usage and analysis of models, systems and methods. Within the Terotechnology, the abstraction level is so high that problems can be analysed and be dealt with outside of their original context. Crucial causal relationships between the various different areas of work in a manufacturing/production process (or a service-generating process) can be isolated and studied separately. Conceptualisation and the usage of appropriate terminology become central. Terotechnology includes tools and methods necessary for scientific analysis, to diagnose, evaluate, question and develop methods related/connected to cost-effective development and improvement of manufacturing/production.

Within the applied Terotechnology, the link to the practical problems and issues is clear and requires a deep understanding of the different areas within Terotechnology as well as their application. Innovation occurs in different ways: New models and methods are applied to classic production and maintenance problems, or known methods are analysed, developed and transferred to the new areas of application wherein the set of problems which arise are analysed.

The applications are found primarily in areas where high precision or a high degree of automation is sought, for example those linked to productivity, precision in maintenance planning, the accuracy of diagnosis, cost effectiveness in investment and development. Terotechnology also seeks to establish itself in many activities where the possibilities for predictions and precision remain more limited. Such activities may include property

maintenance, supply of skills or expertise, the work environment, the environment in general, energy and finance. The purpose is to identify the connection and the modelling, quantification, optimisation and establishment of comprehensive images of various different operations/activities involving equipment, humans, energy, the environment, skills and finance.

Doctoral students normally choose a specialisation for their studies in conjunction with the commencement of their graduate programme. Terotechnology is established through a wide network of contacts and partners from several universities and enterprises, nationally and internationally.

## **2. The objectives of the educational programme**

### **2a. PhD**

#### **Goals according to the Higher Education Ordinance**

##### **Knowledge and understanding**

*For the doctoral degree, the doctoral student must*

- show broad knowledge in and a systematic understanding of the particular field of research and subject in general, as well as an in-depth and genuine specialist knowledge within a defined part of the field of research, and*
- show familiarity with scientific methodology in general and with the specific research area methods in particular.*

For a doctorate in Terotechnology, that can mean (but is not limited to)

- insight into the main areas of the field,
- scientific methods from all areas, and
- more in-depth specialisation in at least one of the currently active research projects at the University.

##### **Skills and abilities**

*For the doctoral degree the student is required to*

- display the ability to engage in scientific analysis and synthesis, as well as to independently make a critical review and assessment of new and complex phenomena, issues/problems and situations,*
- display the ability to critically, independently, creatively and with scientific accuracy, identify and formulate issues, as well as the ability to plan and carry out a research and other advanced tasks with appropriate methods within given time frames and review and to evaluate such work,*
- show, with a doctoral dissertation, his/her ability to contribute substantially to the development of knowledge with their own research,*
- display the ability in both national and international contexts, orally and in writing, to be able to present and discuss research and research results with authority in dialogue with the scholarly community and society in general,*
- display the ability to be able to identify their needs for further knowledge, and*
- display the ability to contribute within research and training as well as in the other advanced professional contexts to the development of society, and to support the learning of others.*

For a doctorate in Terotechnology, this can mean (but is not limited to)

- the capability to achieve innovation within a limited part of terotechnology (conceptualisation, contributions, models, applications),
- the ability to communicate his/her results in such a way as to arouse interest and offer wide feedback among researchers within terotechnology and related fields,
- the ability to review the scientific reasoning and detect shortcomings or errors in these,
- the ability to ensure that new results are correct, with a rich selection of methods,
- the ability to independently immerse oneself in the literature at all levels within the specific area of research, in a secure manner, and
- the ability to deal with the real issues with regard to the overall concept.

### **Capacity to make evaluations and communication skills**

*For the doctoral degree, the doctoral student must*

- *display intellectual independence and scientific probity, plus the ability to make ethical assessments related to research, and*
- *display an in-depth insight into the possibilities of science and its limitations, its role in society, and the individual's personal responsibility for how it is used.*

For a doctorate in Terotechnology, this can mean (but is not limited to)

- the ability to see one's own results in a scientific and social context,
- the ability to identify new areas that require ethical consideration and assessments,
- the ability to make ethical considerations within all areas where these issues are already recognised, and
- knowledge of the applicable copyright and ethical guidelines for the publication of scientific results at all levels (author, reviewer and editor).

### **Specific goals for the educational programme**

*For a PhD in Terotechnology, the doctoral student must*

- *be prepared for a hypothetical future labour market.*

For a doctorate in Terotechnology, this can mean (but is not limited to)

- the knowledge and skills required to work within a university or within any industry outside of a university,
- higher education teaching skills for future work in the education sector, or
- knowledge of technology, management and financial topics for future work in the business world, and
- experiences outside of their own research environment.

### **Contents and achievement of goals**

A doctoral degree in Terotechnology ordinarily requires four years of study full-time and is attained after completing an educational programme of at least 240 higher education credits consisting of coursework totalling 60-80 credits and an approved scientific dissertation of 160-180 credits. The graduate educational programme in Terotechnology at Linnaeus University is designed so that the planned objectives are fulfilled.

Graduate student education takes place within the department's research environment. This graduate student training environment based on modelling and simulation in production and structural dynamics, metallurgy, wood technology/woodworking. The environment consists of researchers with interests such as analysis, organisation and management, information systems, decision support systems, in addition to the above mentioned areas. This graduate

student educational environment facilitates cooperation with other fields or academic disciplines, particularly with Computer Science, construction technology, wood technology/woodworking within its own faculty, and with macroeconomics in other faculties.

The department actively ensures that as a large part of the staff as possible are actively engaged researchers, so that they can contribute to the research dissertation work. The individual who is selected to be the primary academic supervisor is chosen from among the accomplished researchers who have the relevant educational background and experience, and who have a proven track record in publishing. The selection of candidates is made among those applicants who meet the admission requirements, see below.

The educational programme consists of research and dissertation work, courses, participation in seminars, and participation in national and international academic conferences. A portion of the studies will be accomplished outside of one's own research environment.

### **Course component**

The course component of the programme consists of required courses and elective courses.

#### Required courses

- Theory of Science and Ethics, 4 credits
- Research Methodology, 5 credits
- Seminar course, 4 credits
- Career Planning course, 2 credits

#### Elective courses

At least 45 credits of the selectable rates should represent the areas

- Maintenance Technology
- Production and Production Logistics
- Quantitative Analysis Methods
- Financial Considerations and Life Cycle Cost
- Analytical Tools For Technical Problems
- Information Systems and Decision Support Systems
- Continuous and Cost Effective Improvement.

The number of credits per course is determined individually for each doctoral student depending upon the doctoral student's educational background and experience. Which elective courses the graduate student should take is determined by the student in consultation with the examiner and academic supervisor. The actual courses is established in the individual study plan, see below.

### **The dissertation work and its quality assurance**

For the PhD, the doctoral student must write a scientific dissertation and the subject of the dissertation is chosen so that it is supported by the research groups that are currently active. Tentatively, the topic is chosen in consultation with the academic supervisor prior to the acceptance to the programme, and the topic subsequently defined and demarcated more precisely as early as possible during the doctoral studies. The dissertation can be designed as a coherent piece of work (monograph) or as a summary of published articles or papers (compilation dissertation).

A monograph dissertation is typically a single cohesive text which concerns a single theme, into chapters, authored by one individual alone, and which is based on previously unpublished results from independently conducted research. The doctoral student is the sole author of a monograph dissertation. A monograph dissertation must meet the same criteria of scientific validity as a compilation dissertation.

Compilation dissertations normally contain a number of articles or subprojects and a compilation part (kappa). The articles must have a quality which is deemed sufficient for them to be able to be published in a journal, after any required editing. Some of them should be published or at least accepted for publication. The doctoral student must have contributed to the research findings included in the dissertation in an extensive manner. At least one article in a compilation dissertation must have the student as the first author. The compilation component must contain a discussion of the work's theoretical basis, and relationship to previous research and related subjects. The relationship between the articles is discussed in this part. If any of the articles included are co-authored with other individuals, then the doctoral student must declare their efforts and contributions in the preface.

In order that the progression in the dissertation work will be able to be followed step by step (with the writing of monographs), a follow up review of the work occurs once halfway through, and once after the dissertation work is assessed to be virtually finished. Both occasions may be accomplished in the form of an "internal defence." The latter occasion is done with a discussant from another university. When writing a compilation dissertation, a seminar is held annually where the doctoral student describes the results and findings in their research. A discussion of the article manuscript is a part of the seminar course above. The purpose of this is to obtain the level of preparation and production that allows the works to be published in a journal with a readership as broad as possible. The follow-up of the dissertation work should be documented in the individual study plan.

The dissertation should preferably be written in English, in order to facilitate international assessment. Dissertations written in English are to have a summary in Swedish. If the dissertation is written in Swedish, it must have a summary in English.

### **Achievement of goals**

Doctoral students acquire broad knowledge and understanding within their field of research primarily via the basic course requirements and by becoming an integral part of the department's research group. Course coordinators with very good qualifications are selected for the course part and contribute to give a broad view of the subject.

The PhD student will acquire a deep knowledge and understanding in their field by actively participating in relevant academic conferences and via their own personal research work. Doctoral students actively choose, in consultation with the examiner and their academic supervisors, the specialisation courses that support their research work. The specialisation courses are often arranged so that they can attract eminent specialists and contributors from various different parts of the world. One part of the specialisation courses are reading courses, where the doctoral student will show that he/she safely can immerse themselves in advanced research literature independently.

Doctoral students develop skills and abilities, especially in scientific methodology, via their own research, in cooperation with their academic supervisor and other experienced researchers. With the field of terotechnology, discussions concerning the choice of

methodology in our primary areas are central. All courses and all of the dissertation work is permeated with discussions concerning the “pros and cons” of the various different methods.

The doctoral student must exhibit, via their dissertation work, a significant part of the skills and abilities that are described in the objectives. The principal academic supervisor leads and plans the dissertation work so that it is broken down into supervision sessions, essays/chapters, seminars and conferences. Thus in this way, the skills and abilities that are to be shown via the dissertation work can be achieved step by step.

Valuation capabilities and communication skills are developed via, among other means, that the doctoral student participates in the course in *Scientific Theory and Ethics* (4 credits). Participation in the department’s seminar series, *Seminar Course* (4 credits), is mandatory for all doctoral students. Communication between and terminology within terotechnology is practised here.

The department actively works with preparing their doctoral students for a future labour market. The courses that will be relevant largely depend upon the particular student’s interests and needs for the deepening of it. As one of several career paths is employment in academic positions such as a teacher within the academic world, courses in higher education pedagogy may be included among the elective courses.

## **2 b. Licentiate degree**

### **Goals according to the Higher Education Ordinance**

#### **Knowledge and understanding**

*For the Licentiate degree, the licentiate student must*

*- display knowledge and understanding in the particular field of research, including relevant specialist knowledge in a defined part of this, as well as specialised knowledge of research methodology in general and the specific research area’s methods in particular.*

For a Licentiate degree in Terotechnology, what is specified for a PhD corresponds, with a few exceptions due to that a licentiate student cannot be expected to have the same depth and systematic understanding of the subject area that can be expected of those soon to obtain a PhD.

#### **Skills and abilities**

*For the Licentiate degree, the licentiate student must*

*- show the ability to critically, independently, creatively and with scientific accuracy, identify and formulate issues, to plan and carry out a limited research project and other advanced tasks with adequate and methods within given time frames and thereby contribute to the development of knowledge, and to evaluate this work,*

*- show the ability in both national and international contexts, orally and in writing, to be able to clearly present and discuss research and research results in dialogue with the scholarly community and society in general, and*

*- show the skills required to independently participate in research and development work and to work independently in other advanced contexts.*

For a Licentiate degree in Terotechnology, what is specified for a PhD corresponds, with a few exceptions due to that a licentiate student cannot be expected to have the same capability

to engage in scientific analysis, synthesis, and critical review and understanding that can be expected of those soon to obtain a PhD.

### **Capacity to make evaluations and communication skills**

*For the Licentiate degree, the licentiate student must*

- *the ability to make assessments concerning responsible conduct of research relating to their own research,*
- *insight into the possibilities of science and limitations of science, its role in society and the individual's personal responsibility for how it is used, and*
- *the ability to identify their need of further knowledge and to take responsibility for developing their knowledge.*

For a Licentiate degree in Terotechnology, what is specified for a PhD corresponds, with a few exceptions due to that the licentiate student's more limited educational experience has not been the possibility to develop the intellectual independence and the more in-depth insights that can be expected of those soon to obtain a PhD.

### **Specific goals for the educational programme**

*For the Licentiate degree, the licentiate student must*

- *be prepared for a hypothetical future labour market.*

For a doctorate in Terotechnology, this can mean (but is not limited to)

- the knowledge and skills required to work within a university or within any industry outside of a university,
- the higher education teaching skills for future work in the education sector, or
- knowledge of technology, management and financial topics for future work in the business world, and
- experiences outside of their own research environment.

### **Contents and achievement of goals**

The Licentiate degree in Terotechnology ordinarily requires two years of study full-time and is attained after completing the educational programme of at least 120 higher education credits consisting of coursework of 30-40 credits and an approved scientific thesis of 80-90 credits.

### **Course component**

The course component of the programme consists of required courses and elective courses.

Required courses

- Theory of Science and Ethics, 4 credits
- Research Methodology, 5 credits
- Seminar course, 2 credits
- Career Planning course, 1 credit

Elective courses

At least 18 credits of the elective courses must represent one or more of the following subjects

- Maintenance Technology
- Production and Production Logistics
- Quantitative Analysis Methods
- Finance and Life Cycle Cost

- Analysis Tools For Technical Problems
- Information Systems and Decision Support Systems
- Continuous and Cost Effective Improvement.

The number of credits per course is determined individually for each doctoral student depending upon the doctoral student's educational background and experience. Which elective courses graduate student should take is determined by the examiner, in consultation with the graduate student and their academic supervisor. The actual courses is established in the individual study plan, see below.

### **The thesis work and its quality assurance**

The thesis work and its quality assurance occur in accord with the same principles as discussed above for the doctoral degree. This should however occur taking into account the differences in level which are expressed in the Higher Education Ordinance and which have been identified above.

Prior to receiving the Licentiate degree, the graduate student authors a thesis that can be either a monograph or a compilation thesis. With a compilation thesis, the same principles as described above for the doctoral thesis apply, and it must contain at least two articles/papers of high scientific quality.

The thesis should preferably be written in English, in order to facilitate international assessment. A thesis written in English is to have a summary in Swedish. If the thesis is written in Swedish, it must have a summary in English.

### **Achievement of goals**

The achievement of goals for the Licentiate degree occurs on the same principles as set out for the doctoral degree, and with regard to the wording of the Higher Education Ordinance, for the same as reasons described above.

## **3. Other information**

In the ordinary case, departmental duties in the amount of 20% is included, or alternatively an internship or employment in the business world. The duration of the graduate programme is extended to the same extent, in this case 5 years. Within departmental duties, the organisation of conferences, working with classes at the undergraduate level, and work with the content of courses and educational plans may occur.

## **4. Individual study plan and division of responsibilities**

The individual study plan describes the division of responsibilities, individual programme and course of studies, specific courses, dissertation/thesis work, attainment of goals, and academic guidance leading to a degree. The plan is established by the principal academic supervisor and the graduate student in consultation with the examiner and Head of Department, and a follow-up review will be made at least once annually. It should clearly indicate from the follow-up review how the research and writing is progressing towards the degree.

For general guidelines, see *HF Chapter 6, § 29*.

The principal academic supervisor is responsible for the overall planning of the doctoral programme and for that the stated issues and hypotheses are sufficiently relevant and

interesting, and can be put together in a context. The purpose of this that the dissertation/thesis work will proceed independent of any temporary absence of the principal academic supervisor. The principal academic supervisor also has the responsibility for ensuring that the doctoral student's dissertation output forms a whole in the final stages of their graduate studies.

The examiner has the responsibility for ensuring that the individual study plan sets out, at every instance a review is conducted, how the various degree objectives in this general study plan, Linnaeus University's internal rules and regulations, and the Higher Education Ordinance, will be complied with for the graduate student. The examiner is responsible for ensuring that the graduate student, after completing the graduate education, fulfils all of the goals.

The head of department to which the doctoral candidate is attached, typically via an academic employment position, has the responsibility for ensuring that the requirements that exist in the research environment and the graduate student's working relationship are satisfied. The head of department should take the initiative for the updating of the study plan in the event significant changes in the research environment so requires.

Which decision making body has authority over the graduate students' individual study plans is apparent by the University's decision and delegation of authority rules. The decision making body must take action in the event any of the parties who signed on to the individual study plan do not fulfil their obligations.

A current individual study plan must be available throughout the duration while the graduate studies progresses.

## **5. Assessment**

### **Licentiate Seminar**

The opponent and the chairman of the licentiate seminar are designated. The licentiate thesis is graded by doctoral examiner with the exception of cases where the examiner is the doctoral student's assistant academic supervisor. In such case, another assessor to determine the grade of the licentiate thesis must be appointed. The licentiate thesis must be defended orally at a public seminar led by a chairman.

### **The public defence of the doctoral dissertation**

An examination board shall consist of three members. At least one member of the examination board must be someone who is not employed at Linnaeus University. The examination board may not consist of more than one member who is actively engaged in the same field/environment as the doctoral student. All of the members of the examination board should at a minimum be associate professors or have equivalent expertise. An individual who has been the academic supervisor for the graduate student may not be a member of the examination board. Both genders should be represented in the examination board. The above provisions on participation in the grading of the doctoral dissertation also apply when an alternative member assumes the place of an ordinary member upon their withdrawal from the board.

The courses from the educational programme will be graded Pass or Fail by one of the specifically appointed university teachers (examiner). With the examination and grading of the doctoral dissertation, LnU's Local Rules for Graduate Studies are applied.

Prior to the issuance of the diplomas, the examiner must certify in writing that all the goals of the graduate programme are fulfilled.

## **6. Prerequisites**

### **6a. Basic prerequisites**

The prerequisite policy is stated in *HF Chap. 7, §35* and *HF Chap. 7, §39*.

### **6b. Specific prerequisites**

The prerequisites policy is stated in *HF Chap. 7, §40*.

Specific prerequisites for admission to graduate studies in Terotechnology are required.

- a minimum of 90 higher education credits in the subject Terotechnology or in subjects related to the doctoral level studies, or equivalent knowledge acquired in some other manner either in Sweden or abroad, and
- a good command of Swedish and/or English.

## **7. Evaluation and selection criteria**

Applications to graduate studies are governed by rules in the admission regulations.

The selection of candidates is made with regard to the applicant's ability to successfully complete and benefit from their studies at the graduate level. The assessment takes into account academic skills documented in scientific works, especially focused on the quality of the essays at the undergraduate level, any advanced work and other scientific or scholarly works. The assessment also takes into account the breadth and composition of the undergraduate degree as well as the picture which the intended principal academic supervisor, examiner, and other colleagues in the research group and the subject obtained of the applicant's potential.

The applicants are ranked by the entity concerned for the graduate education after a statement of opinion is received from the prospective principal academic supervisor with proposals on order of precedence.

*Selection among applicants who meet the requirements of §35 and §36 will be made with regard to their potential ability to benefit from the educational programme.*

*The University determines which assessment criteria are to be applied in determining the potential ability to benefit from the educational programme. See also (HF Chapter 7, §41).*

## **8. Admission**

Admission is governed in the admission regulations and Chapter 7, § 36 of the Higher Education Ordinance. The relevant decision-making and preparatory bodies are apparent from the University's decision-making and delegation of authority regulations.

## **9. Transition rules**

Eventual transitional rules in relation to the earlier general curriculum. A graduate student who was accepted for admission to an earlier general curriculum can complete the degree

accordance with this under the precondition that the current Higher Education Regulation is complied with.

Graduate students admitted to the older curriculum in the graduate studies subject Terotechnology, Doc no.: 2011/573 can switch to the current general curriculum.

### **10. The abbreviation of the academic degree**

For graduate degrees within the subject Terotechnology, the title “*Technology*” is used as the first element, unless the undergraduate degree in the subject specifies a different designation.

### **11. The possibility to obtain a 2-year degree**

Within the subject Terotechnology, there is the possibility for graduate students who have the earning of a PhD as their ultimate objective to receive a Licentiate degree.