

## GENERAL SYLLABUS FOR DOCTORAL STUDIES IN PHYSICAL CHEMISTRY

incl. general syllabus for programmes leading to a licentiate degree

Most admissions to doctoral studies at Stockholm University should be to programmes leading to a doctoral degree.

National regulations concerning doctoral studies can be found in the *Higher Education Ordinance*, Chapters 5-7, 10, 12 and Appendix 2. In addition, the following rules and regulations are in effect at Stockholm University: *Admission Regulations for Doctoral Studies at Stockholm University*, *Regulations for Third-Cycle Education and Examinations at Stockholm University*, and *Local System of Qualifications for Stockholm University*.

This general syllabus was adopted by the Board of Science on 2007-07-01 and revised on 2017-06-12, 2020-09-24.

### 1 Subject description

In Physical Chemistry the fundamental laws of Physics are employed to explain chemical and biochemical processes. The subject consists of three topics: 1) Chemical Spectroscopy, studies of the interactions between electromagnetic radiation and matter, 2) Chemical Thermodynamics, studies of the matter at equilibrium, 3) Chemical Dynamics, which describes the matter in change, and 4) Methods for Structure analysis using Electron, X-ray, and Neutron Diffraction. Modern Physical Chemistry is characterized by a molecular approach, with a strong coupling to Quantum Mechanics, and Computational Chemistry. A broad range of topics are included in the PhD programme in Physical Chemistry, which can be characterized as basic or applied research, and range over areas from Biophysical Chemistry to Physical Materials Chemistry.

### 2 Programme objectives

In addition to the provisions for first- and second-cycle studies, third-cycle (doctoral) studies should provide the knowledge and skills required to be able to conduct independent research.

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#### Områdesnämnden för naturvetenskap



The education should also ensure that the student is well prepared for other tasks in the society with high demands on deep knowledge in Physical Chemistry, and Physical-Chemical research methods.

The programme leads to a licentiate or doctoral degree. The objectives defined for these degrees in the *Higher Education Ordinance* are presented in sections 5 and 6 below.

### 3 Prerequisites and entry requirements

Admission to doctoral studies requires that the applicant meets the general and specific entry requirements, in addition to being otherwise capable of completing the training.

#### 3.1 General entry requirements

In order to meet the general entry requirements for doctoral studies, the applicant must have completed a second-cycle degree, completed courses equivalent to at least 240 higher education credits (of which 60 credits must be in the second cycle), or have otherwise acquired equivalent knowledge in Sweden or elsewhere.

The academic area board may permit an exemption from the general entry requirements for an individual applicant under special circumstances.

#### 3.2 Specific entry requirements

Specific eligibility requirement is an education corresponding to a Bachelor exam in Chemistry, Chemical Engineering, or Physics, and an approved independent work (e.g. diploma work) of at least 30 ETC at advanced (M.Sc.) level.

### 4 Selection and admission

The selection between candidates who meet the entry requirements will be made with reference to their ability to benefit from the training. However, the fact that an applicant is deemed able to transfer credits from previous training or professional experience may not alone give the applicant priority over other applicants in the selection process. Admission decisions are made in accordance with current delegation policies.

Important assessment criteria are the following: solid background in theory and experimental skills in the subject, fluent level in Swedish and/or English, analytical ability, creativity, initiative, independence, and ability to collaborate. The assessment is based on the applicant's transcript of record of grads, recommendation letters from supervisors and teachers, as well as on interviews with the applicant.

### 5 Programmes leading to a doctoral degree

#### 5.1 General provisions

Programmes leading to a doctoral degree require four years of full-time study (240 higher education credits), divided into two parts: 60 ECTS courses, and 180 ECTS thesis. A mandatory Midterm Evaluation with the associated Midterm Seminar should be carried out according to specific rules collected in *Guidelines for Midterm Evaluation*. The Midterm Seminar may be replaced by the Licentiate exam (section 6).



Although the course component precedes the thesis component, the student is encouraged to discuss the topic of the thesis at an early stage.

## **Objectives for doctoral degrees according to the Higher Education Ordinance**

### **Knowledge and understanding**

For a Degree of Doctor, the doctoral student must:

- demonstrate broad knowledge in, and a systematic understanding of, the field of research, together with deep and current specialist knowledge in a defined part of this field;
- demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.

### **Skills and abilities**

For a Degree of Doctor, the doctoral student must:

- demonstrate an ability to engage in scholarly analysis and synthesis, as well as in independent, critical review and assessment of new and complex phenomena, issues, and situations;
- demonstrate an ability to identify and formulate issues critically, independently, creatively, and with scholarly precision; to plan and conduct research and other advanced tasks using appropriate methods within specified time limits; and to review and evaluate such work;
- demonstrate an ability to make a substantial contribution to the development of knowledge through their own research in a thesis;
- demonstrate an ability, in both national and international contexts, orally and in writing, to present and discuss research and research findings authoritatively in dialogue with the scholarly community and society in general;
- demonstrate an ability to identify areas where further knowledge is required;
- demonstrate the potential to contribute to social development and support the learning of others, both in the fields of research and education and in other qualified professional contexts.

### **Judgement and approach**

For a Degree of Doctor, the doctoral student must:

- demonstrate intellectual independence and scholarly integrity, as well as an ability to make ethical assessments relating to research;
- demonstrate specialised insight into the potential and limitations of research, its role in society, and the responsibility of the individual for how it is used.

## **5.2 Individual study plan**

An individual study plan must be drawn up for each doctoral student. The individual study plan should include:

- a research plan, including a timetable;
- information relating to how the supervision is organised;
- a plan of which courses/what type of courses the doctoral student is going to take;
- a description of other academic activities, such as participation in seminars and reading courses;
- a description of other obligations the student and the department may have during the training period;
- a financial plan covering the entire period of study;
- if the training is not funded by means of employment, the financial plan should specify what



social benefits apply to the type of funding in question, for example in the event of illness or parental leave.

The individual study plan should be drawn up in consultation with the doctoral student and his or her supervisor, and be reviewed at least once a year. The individual study plan should be adopted and reviewed in accordance with current delegation policies. When the individual study plan is reviewed, it should be specified how the doctoral studies relate to the qualitative targets outlined in the *Higher Education Ordinance*.

### 5.3 Courses and instruction

The course part of the graduate programme in Physical Chemistry contains both mandatory and elective courses. For the PhD exam the mandatory courses consist of three parts:

- i) *Advanced Physical Chemistry* (15 ECTS), which ensures broad knowledge within the research subject,
- ii) A course package arranged by the Chemistry Section of the Academic Area of Science with following courses (9 ECTS):
  - a) *Teaching Chemistry* (2 ECTS)
  - b) *Philosophy of Science and Ethics* (3 ECTS)
  - c) *Writing Science* (3 ECTS)
  - d) *Communicating Science/Arrhenius Seminars* (1 ECTS)
- iii) *PhD seminars at the Department of Materials and Environmental Chemistry* (5 ECTS)

The remaining courses will be selected in consultation with the supervisor.

Doctoral students are expected to participate actively in seminars (that are not included in iii) above) discussing current research findings. Courses or instruction may be provided in collaboration with other departments. Doctoral students are expected to make use of the provided opportunities to attend guest lectures, both in their own and adjacent subject areas.

### 5.4 Thesis

As part of the training, the student will write an academic thesis. The thesis should reflect the doctoral student's ability to complete the selected research task in a scholarly and independent manner, with or without collaboration. The thesis should be of such quality that it could be considered to meet reasonable requirements for publication in an academic journal of good quality. The doctoral thesis should be written either as a unified, coherent academic work (monograph) or as a compilation of academic papers with a summary. The papers may be co-authored with other people, but the doctoral student's contributions must be clearly distinguishable.

The thesis should be written in English. The department is responsible for the English summary of the thesis being translated into Swedish.

### 5.5 Supervision

Each doctoral student should be assigned a principal supervisor and at least one assistant supervisor. At least one of the supervisors should have received training in supervision or be considered to have corresponding qualifications. Decisions regarding supervisors are made in accordance with current delegation policies.

A doctoral student is entitled to change supervisors upon request to the departmental board, in which case the individual study plan should be revised.



## 5.6 Examination and public defence

In order to receive a degree, the student must have received a passing grade on the thesis and the examinations included in the programme. Each course is usually concluded with a written or oral examination. In some cases, continuous examination may take place during teaching sessions or laboratory work. Examinations are assessed using the grades Pass or Fail.

The thesis should be defended orally at a public defence seminar. The defence seminar should follow the regulations of the Academic Area of Science at Stockholm University.

## 5.7 Credit transfer

Provisions concerning credit transfer can be found in the *Higher Education Ordinance*, Chapter 6, sections 6-8.

Courses that were part of the specific entry requirements cannot be given credit for as part of the doctoral degree.

Decisions regarding credit transfer are made in accordance with current delegation policies.

# 6 Programmes leading to a licentiate degree

Under special circumstances, the academic area board may decide to allow admissions to programmes that lead to a licentiate degree worth at least 120 higher education credits. An assessment that funding can be secured for the time required to complete a licentiate degree, but not a doctoral degree, does not alone constitute such a special circumstance.

Decisions to admit students to programmes that lead to a licentiate degree are made in accordance with current delegation policies.

In cases where a student who has been admitted to a programme leading to a licentiate degree student wishes to pursue a doctoral degree, a new academic review and an analysis of the financial plan will be carried out before a decision to admit the student to a programme leading to a doctoral degree can be made in accordance with current delegation policies.

## 6.1 General provisions

A third-cycle programme comprising at least 120 credits, or a part comprising at least 120 credits of a third-cycle programme leading to a doctoral degree, may be completed with a licentiate degree.

For the licentiate degree in Physical Chemistry: the thesis part should comprise 90 ECTS, while the course part is 30 ECTS.

Although the course component precedes the thesis component, the student is encouraged to discuss the topic of the thesis at an early stage.

## Objectives for licentiate degrees according to the Higher Education Ordinance

### Knowledge and understanding

For a Degree of Licentiate, doctoral students must:

- demonstrate knowledge and understanding in the field of research, including current specialist knowledge in a limited area of this field, as well as specialised knowledge of research



methodology in general and the methods of the specific field of research in particular.

### Skills and abilities

For a Degree of Licentiate, doctoral students must:

- demonstrate an ability to critically, independently, creatively, and with scholarly precision identify and formulate issues, and to plan and, using appropriate methods, complete a limited research project and other qualified tasks within specified time limits, so as to contribute to the development of knowledge and to evaluate this work;
- demonstrate an ability to present and discuss research and research findings clearly, in dialogue with the scholarly community and society in general, orally and in writing, in both national and international contexts;
- demonstrate the skills required to participate independently in research and development and to work independently in other advanced contexts.

### Judgement and approach

For a Degree of Licentiate, doctoral students must:

- demonstrate an ability to make assessments of ethical aspects of their own research;
- demonstrate insight into the possibilities and limitations of research, its role in society, and our responsibility for how it is used;
- demonstrate an ability to identify their need of further knowledge and to take responsibility for developing their knowledge.

## 6.2 Individual study plan

The individual study plan should be written the same way as for a doctoral degree, see 5.2.

## 6.3 Courses and instruction

The course part of the graduate programme in Physical Chemistry contains both mandatory and elective courses. For the licentiate exam the mandatory courses consist of two parts:

- i) A course package arranged by the Chemistry Section of the Academic Area of Science with following courses (9 ECTS):
  - e) *Teaching Chemistry* (2 ECTS)
  - f) *Philosophy of Science and Ethics* (3 ECTS)
  - g) *Writing Science* (3 ECTS)
  - h) *Communicating Science/Arrhenius Seminars* (1 ECTS)
- ii) *PhD seminars at the Department of Materials and Environmental Chemistry* (2.5 ECTS)  
The departmental board decides about mandatory courses for the licentiate in Physical Chemistry.

The remaining courses will be selected in consultation with the supervisor.

Doctoral students are expected to participate actively in seminars (that are not included in ii) above) discussing current research findings. Courses or instruction may be provided in collaboration with other departments. Doctoral students are expected to make use of the provided opportunities to attend guest lectures, both in their own and adjacent subject areas.



#### **6.4 Thesis**

As part of the training, the student will write a licentiate thesis. The thesis should be of such quality that it could be considered to meet reasonable requirements for publication in an academic journal of good quality.

#### **6.5 Supervision**

See 5.5.

#### **6.6 Examination**

The first paragraph of 5.6 also applies to licentiate degrees. The examination of a licentiate thesis takes place in connection with a publicly advertised licentiate seminar and should follow the regulations of the Academic Area of Science at Stockholm University.

#### **6.7 Credit transfer**

Provisions concerning credit transfer can be found in the *Higher Education Ordinance*, Chapter 6, sections 6-8.

Courses that were part of the specific entry requirements cannot be given credit for as part of the licentiate degree.

Decisions regarding credit transfer are made in accordance with current delegation policies.