

Subject module in physics

(English version of the legal Danish subject module curriculum)

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The regulations of these subject module specifications are issued pursuant to the Curricula for the Bachelor Study Programme in Natural Sciences, Hum-Tek, Humanities, and Social Science. The regulations of the Curriculum for the Bachelor Study Programme to which the student has been admitted are applicable unless otherwise clearly stated in the regulations of the subject module specifications.

Purpose

§ 1. The purpose of the subject module in physics is for students to acquire a broad and basic knowledge of the theories and methods of the subject.

A further objective of the subject module in physics is to qualify students to enter a Master Programme in Physics or other related subjects.

(2) The subject module in physics is one of two subject modules that form part of the bachelor studies at Roskilde University. The subject module corresponds to 35 ECTS points.

Description of competency

§ 2. The purpose of the subject module in physics is to give students the following knowledge, skills, and qualifications.

Knowledge:

- Knowledge of basic theories in classical mechanics, hydrodynamics, electrodynamics, relativity theory, thermodynamics, and statistical mechanics.

Skills:

- Skills to deal with mathematical methods for the solution of physical models.
- Skills to assess the results of such methods by means of knowledge of physics.
- Skills to deal with and process data and skills to present these graphically or in similar ways.
- Skill to apply numerical methods and computer programmes.
- Skills to read and understand physics literature at textbook level (English and Danish).
- Skills to disseminate results to various target groups.

Qualifications:

- Qualifications to analyse and describe problems in physics in physical terms.
- Qualifications to formalize simple physical problems by including mathematics.
- Qualifications to design and conduct simple experimental investigations.
- Qualifications to apply basic theories of mechanics, thermodynamics, statistical mechanics, and electrodynamics in relation to new (to the students) theoretical and experimental problems.
- Qualifications to acquire knowledge of new (to the students) areas of physics, including familiarizing oneself with scientific papers.

Content and structure

§ 3. The subject module corresponds to 35 ECTS points and consists of the following elements:

- Subject module project in physics, either experimental or theoretical (15 ECTS points).
- Subject module course 1: Thermodynamics and Statistical Mechanics I (5 ECTS points).
- Subject module course 2: Modelling of Physical Systems (5 ECTS points).

- Subject module course 3: Problem Solving in Physics Ia (5 ECTS points).
- Subject module course 4: Problem Solving in Physics Ib (5 ECTS points).

(2) Only when having made at least one project with an experimental content of adequate level and scale, can students choose the theoretical subject module project. Permission to start a theoretical project, therefore, has to be approved by the Board of Studies for Physics. In these cases former experimental projects made during the bachelor study will be considered by the Board.

Recommended academic requirements

§ 4. The academic requirements for admission to the subject module are for students to possess knowledge, skills and qualifications corresponding “BK1: Empirical data”, “BK2: Experimental methods”, “Classical Mechanics” and “Calculus”, all pertaining to the basic part of the Bachelor Programme in Natural Sciences.

Description of the elements of the subject module

§ 5.

Title	Subject module project in physics, experimental.
Type	Project.
Status	Compulsory, cf. § 3. Students must choose either an experimental or a theoretical project.
ECTS	15 ECTS points.
Purpose (assessment criteria)	<p>The purpose of the project is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Insight into the interrelations between model, theory, and experiment in physics. • Understanding of relevant experimental methods and their status in physics. • Overview of theory and models relevant for the chosen problem area. <p>Skills:</p>

	<ul style="list-style-type: none"> • Skills to plan and conduct experimental work. • Skills to critically analyse strengths and weaknesses of applied methods • Skills to analyse and present the obtained experimental data. • Skills to apply relevant physical and mathematical models and theory in the discussion and analysis of the results obtained. <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to identify a non-trivial representative set of problems that can be analysed with available means. • Qualifications to understand a subject area by reading text books and scientific literature. • Qualifications to critically discuss the meaning of the obtained results and to relate such results to selected scientific literature of the subject area, including analysing in specific the interrelations between the experiments conducted and the relevant models and theories. • Qualifications to present the obtained results to a specific target group.
Overall content	<p>Dealing with a relevant set of physical problems primarily by means of (an) experimental method(s).</p> <p>Working with a representative example in the experimental project, students acquire insights into the interrelations between model, theory, and experiment in physics. This is obtained by means of the independent experimental work the results of which is analysed theoretically and/or in relation to a relevant model.</p> <p>The project work is concluded with the writing of a project report.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read scientific literature in English.
Academic requirements	It is recommended that students have passed at least one of the subject module courses.
Examination	The project is made by a group of 2 to 6 students cf. the Curriculum for the relevant Bachelor Study Programme. The project work is assessed at an oral examination. The examination takes 30 minutes

	<p>per student including the assessment discussion.</p> <p>The examination is a group examination. The examination is based on the project report. The examination is a conversation between the students, the supervisor (the internal examiner) and the external examiner.</p> <p>The examination of the students is based on the entire project report and performed in a way which allows individual assessment.</p> <p>The project report as the basis of the examination means that questions from the examiners can be asked not only to the entire project report but also to the subject area of the entire project module.</p> <p>Each student is assessed individually and the assessment is a joint assessment of the project report and the oral presentation.</p>
Marking	7 point scale.
Assessment	External.

Title	Subject module project in physics, theoretical.
Type	Project.
Status	Compulsory, cf. § 3. Students must choose either a theoretical or an experimental project, cf. § 3, (2).
ECTS	15 ECTS points.
Purpose (assessment criteria)	<p>The purpose of the project is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Insight into the interrelations between model, theory, and experiment in physics. • Understanding of relevant theoretical methods and models and their status in physics. • Overview of experimental techniques relevant for the chosen

	<p>set of problems.</p> <p>Skills:</p> <ul style="list-style-type: none"> • Skills to plan and perform theoretical work, including for instance computer simulations. • Skills to critically analyse strengths and weaknesses of applied methods. • Skills to analyse and present the results obtained. • Skills to apply relevant physical and mathematical models. • Skills to present the obtained results for a specific target group. <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to identify a non-trivial representative problem/set of problems which can be analysed with available means. • Qualifications to understand a subject area by reading text books and scientific literature. • Qualifications to critically discuss the meaning of the obtained results and to relate such results to selected scientific literature of the subject area, including comparing, in specific, the results with experimental results found in the literature.
Overall content	<p>Dealing with a relevant set of problems in physics by means of primarily theoretical method(s), including computer simulations.</p> <p>Working with a representative example in the theoretical project, students acquire insights into the interrelations between model, theory and experiment in physics. This is obtained by means of a theoretical work combining theory and/or model with experiments conducted by others.</p> <p>The project work is concluded with the writing of a project report.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read scientific literature in English.

Academic requirements	It is recommended that students have passed at least one of the subject module courses.
Examination	<p>The project is made by a group of 2 to 6 students. The project work is assessed at an oral examination. The examination takes 30 minutes per student including the assessment discussion.</p> <p>The examination is a group examination. The examination is based on the project report. The examination is a conversation between the students, the supervisor (the internal examiner) and the external examiner.</p> <p>The examination of the students is based on the entire project report and performed in a way which allows individual assessment.</p> <p>The project report as the basis of the examination means that questions from the examiners can be asked not only to the entire project report but also to the subject area of the entire project module.</p> <p>Each student is assessed individually and the assessment is a joint assessment of the project report and the oral presentation.</p>
Marking	7 point scale.
Assessment	External.

Subject module course 1	
Title	Thermodynamics and Statistical Mechanics I.
Type	Course.
Status	Compulsory.
ECTS	5 ECTS points.
Purpose (assessment criteria)	<p>The purpose of the course is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Knowledge of statistical mechanics for isolated systems.

	<ul style="list-style-type: none"> • Knowledge of the concepts of temperature and entropy. • Knowledge of the third law of thermodynamics. • Knowledge of equations of state. • Knowledge of free energies and their derivations. • Knowledge of thermo-dynamical response functions. • Knowledge of Boltzmann's statistics. <p>Skills:</p> <ul style="list-style-type: none"> • Skills to solve relevant problems in thermodynamics. • Skills to solve basic exercises in statistical mechanics. • Skills to apply the following mathematical methods in problem solving: Taylor expansion, differentials of functions with several variables, change of variable, integrals. <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to interpret obtained results in physical terms and to communicate such interpretations in writing.
Overall content	<p>Thermodynamics and statistical mechanics.</p> <p>Students are to acquire a basic understanding of the theory of thermodynamics and an introduction to statistical mechanics.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read scientific literature in English.
Academic requirements	None.
Examination	<p>The examination is a 4 hour individual, written examination held at the university.</p> <p>Aid: One or more pages with key equations of the curriculum will be enclosed to the examination paper.</p>
Marking	7 point scale.
Assessment	External.

Subject module course 2	
Title	Modelling of Physical Systems
Type	Course.
Status	Compulsory.
ECTS	5 ECTS points.
Purpose (assessment criteria)	<p>The purpose of the course is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Knowledge of the interrelations between theory, model, and experiment in various experimental contexts. • Insight in selected elements of electrodynamics, classical mechanics, and thermodynamics in experimental contexts. • Overview of the applied experimental methods and their status in physics. • Insight into the meaning of exact analogies in physics. <p>Skills:</p> <ul style="list-style-type: none"> • Skills to make physical models in a continuous interplay between theory and experiment. • Skill to apply a modeling tool language at an elementary level. • Skills to apply various technicalities of instruments in physics, for instance electronic measuring devices and data collection for computer. • Skills to apply complex functions and linear differential equations in the modeling of experimental results. • Skills to handle numerical calculation of data. • Skills to present obtained experimental results in reports. <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to discuss and analyse the meaning of the obtained experimental results and to relate these to the relevant theories and models.
Overall content	Experimental work with different dynamic systems of

	<p>electrodynamics, classical mechanics, and thermodynamics.</p> <p>The object of the course Modelling of Physical Systems is to develop students' ability to make models of physical systems based on an interaction between theory, model, and experiment.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read academic literature in English.
Academic requirements	None.
Examination	<p>The examination is an individual oral examination based on a central theme which has been dealt with in one or more of the reports made by the groups of students during the course. The theme on which the examination is based is drawn by lot and the examination takes place without any further preparation.</p> <p>The examination lasts 30 minutes including the assessment discussion.</p>
Marking	7 point scale.
Assessment	External.

Subject module course 3	
Title	Problem Solving in Physics Ia.
Type	Course.
Status	Compulsory.
ECTS	5 ECTS points.

Purpose (assessment criteria)	<p>The purpose of the course is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Knowledge of classical mechanics. • Knowledge of the relativity theory. <p>Skills:</p> <ul style="list-style-type: none"> • Skills to argue for and decide which physics is involved in an open ended problem. • Skills to define an open ended simple problem in physical and mathematical terms, solve the problem, and analyse the solution. <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to comprehend the difference between closed and open ended problems in physics • Qualification to recognize one's own strengths and weaknesses in terms of "thinking as a physicist" within the areas mentioned in the above paragraph about "Knowledge" .
Overall content	<p>The course Problem Solving in Physics Ia introduces to the students the difference between closed and open ended problems, methods and ways of reasoning related to formalizing physical problems, the solving of these and the analysis of the solutions.</p> <p>The course concentrates on the solution of problems/tasks, and the open ended problems are taken from the curriculum in physics at upper secondary level with an addition of classical mechanics and theory of relativity.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read scientific literature in English.
Academic requirements	It is recommended that students have passed subject module courses 1 and 2.

Examination	<p>The examination is a 4 hour written examination followed by an oral evaluation with the participation of the student and examiner(s). The examination takes place at the university.</p> <p>Aid: Formulary of 2 A4 sized pages as a maximum, made by the student her/himself.</p> <p>The written test is assessed not only on the basis of correct results but also on the capability on part of the student to analyse problems and to suggest solutions even though these have not been carried through completely. To pass the examination students must have insight into the distinction between problems with closed and open ended formulations in physics and they must be aware of their own strengths and weaknesses in relation to the solution of open ended problems.</p>
Marking	Passed/Failed.
Assessment	Internal.
Fagmodulkursus 4	
Title	Problem Solving in Physics Ib.
Type	Course.
Fagtype	Compulsory.
ECTS	5 ECTS points.
Purpose (assessment criteria)	<p>The purpose of the course is for students to acquire:</p> <p>Knowledge:</p> <ul style="list-style-type: none"> • Knowledge of classical mechanics. • Knowledge of hydrodynamics. • Knowledge of thermodynamics. • Knowledge of statistical mechanics. • Knowledge of the relativity theory. <p>Skills:</p> <ul style="list-style-type: none"> • Skills to define and discuss which physics is involved in a specific problem with an open ended formulation. • Skills to “translate” an open ended problem to physical and mathematical terms, to solve the problem, and to validate the

	<p>solution.</p> <p>Qualifications:</p> <ul style="list-style-type: none"> • Qualifications to “think as a physicist” within the areas mentioned in the above paragraph about “Knowledge”.
Overall content	<p>The purpose of the course Problem solving in Physics Ib is to develop students’ skills and qualifications to formalize physical problems, solve these and discuss their solutions. This is done by exemplary work within the framework of a series of theory constructions in physics.</p> <p>The course concentrates on the solution of tasks/problems, and the open ended problems are taken from the curriculum in physics at upper secondary level with an addition of classical mechanics, hydrodynamics, thermodynamics, statistical mechanics, and theory of relativity.</p>
Language	Danish or English.
Reading skills	Students are expected to be able to read scientific literature in English.
Academic requirements	Students must have acquired knowledge, skills and qualifications equivalent to subject module course 3.
Examination	<p>The examination is a 4 hour individual written examination held at the university.</p> <p>Aid: Formulary of 2 A4 sized pages as a maximum, made by the student her/himself.</p> <p>The assessment of the tasks of the written test is not only based on a correct result but also on the analysis of the problems and the solutions suggested by the student also in the cases where the student has not been able to finalize the analysis.</p>
Marking	7 point scale.
Assessment	External.

Coming into force and transitional rules

§ 6. The description of the subject modules will come into force on 1st September, 2013.

(2) The description of the subject modules apply to all students admitted to a Bachelor Programme as per 1st September 2012 or later.

Adopted by the Board of Studies for *Physics* at a meeting on the 17th November, 2012.

Approved by the Board of Studies for the Bachelor Study Programme in Natural Sciences on the 21st November, 2012.

Approved by the Vice-rector Hanne Leth Andersen on the 5th December, 2012.