Faculty of Science

# FYTB14, Theoretical Physics: Classical Mechanics and Special Relativity, 7.5 credits

*Teoretisk fysik: Klassisk mekanik och speciell relativitetsteori, 7,5 högskolepoäng*

**First Cycle / Grundnivå**

## Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2016-05-15 and was last revised on 2022-12-08. The revised syllabus applies from 2022-12-08, autumn semester 2023.

## General Information

The course is an elective course for first-cycle studies for a degree of Bachelor of Science in Physics.

*Language of instruction:* English

| *Main field of studies* | *Depth of study relative to the degree requirements* |
|---|---|
| Physics | G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements |

## Learning outcomes

The overall goal of the course is that the students should learn the foundations of classical mechanics based on the principle of least action with emphasis on symmetries and conservation laws as well as special relativity with emphasis on relativistic kinematics.

### Knowledge and understanding

On completion of the course, the students shall be able to:

1. describe the use of generalised coordinates for a given mechanical system and how Lagrange's equations follow from the principle of the least action,
2. at a general level be able to explain the Hamilton formalism for mechanics,
3. explain how conservation laws arises from different symmetries,
4. use space-time diagrams and describe causal relationships.

### Competence and skills

On completion of the course, the students shall be able to:

5. choose appropriate generalised coordinates for a given mechanical system and use these to describe the time evolution of the system as well as to find stationary solutions and analyse the stability of these,
6. use symmetries to simplify the solution of the equations of motion,
7. make calculations and manipulations with four-vectors and other tensors as well as Lorentz transforming these between different coordinate systems in Minkowski space,
8. analyse simple particle reactions using relativistic kinematics,
9. orally describe a modern application of classical mechanics or special relativity.

### Judgement and approach

On completion of the course, the students shall be able to:

10. in oral form review and assess an oral presentation.

## Course content

The course contains classical mechanics and special relativity. In particular the following is included:

- the Lagrange formalism: the principle of least action, Euler Lagrange's equations, conservation laws and generalised coordinates,
- introduction to the Hamilton formalism,
- constraints and Lagrange multipliers,
- general treatment of the two-body problem and Kepler's laws,
- Lorentz transformations,
- four-vectors and relativistic kinematics.

## Course design

The teaching consists of lectures and problem solving sessions as well as compulsory written hand-in assignments. Furthermore, a compulsory project is included.

## Assessment

The examination consists of:

- compulsory written hand-in assignments during the course - examines a selection of the intended learning outcomes,
- oral presentation of a project with oral feedback on another student's presentation - examines in particular the intended learning outcomes 9 and 10,
- a written examination at the end of the course - examines all the intended learning outcomes. Under special circumstances the written exam can be replaced by an oral one.

Students who do not pass the regular exam are offered a new possibility shortly after the regular exam.

The examiner, in consultation with Disability Support Services, may deviate from the

regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

*Subcourses that are part of this course can be found in an appendix at the end of this document.*

## Grades

Marking scale: Fail, Pass, Pass with distinction.
For a Pass grade on the whole course, the student must have Pass grades on the written examination, oral presentation of a project, oral feedback on another student's presentation, and written hand-in assignments.

The grading scale for hand-in assignments and project is Fail, Pass, whereas the written examination is graded according to the scale Fail, Pass, Pass with Distinction.

The final grade is determined by grade on the written examination.

## Entry requirements

The prerequisites required for admission to the course are, general entry requirements as well as 30 credits in physics and 45 credits in mathematics, including knowledge corresponding to:

- FYSA12 Introduction to University Physics, with Mechanics and Electricity, 15 credits,
- NUMA01 Computational Programming with Python, 7.5 credits,
- MATB21 Analysis in Several Variables 1, 7.5 credits
- MATB22 Linear algebra 2, 7.5 credits,

*alternatively* 75 credits in mathematics, including knowledge corresponding to:

- NUMA01 Computational Programming with Python, 7.5 credits,
- MATB21 Analysis in Several Variables 1, 7.5 credits,
- MATB22 Linear algebra 2, 7.5 credits,
- MATB23 Analysis in Several Variables 2, 7.5 credits
- MATB24 Linear Analysis, 7.5 credits.

English 6/English B.

## Further information

The course may not be included towards a degree together with FYTB03 Classical Mechanics and Special Relativity 7.5 credits and FYTA12 Fundamental Theoretical Physics, 30 credits.

## Subcourses in FYTB14, Theoretical Physics: Classical Mechanics and Special Relativity

Applies from H23

2301 Hand-in Assignments and Project, 1,5 hp
Grading scale: Fail, Pass
2302 Written Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction

Applies from V17

1601 Hand-in Assignments and Project, 1,5 hp
Grading scale: Fail, Pass
1602 Written Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction