Reg No: FYAD16/20242

Faculty of Health, Science and Technology
Physics

Syllabus

Analytical Mechanics

Course Code:	FYAD16
Course Title:	Analytical Mechanics *Analytisk mekanik*
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	Second cycle, has only first-cycle course/s as entry requirements (A1N)

Major Field of Study:
FYA (Physics)
TKA (Engineering Physics)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2024-02-05, and is valid from the Autumn semester 2024 at Karlstad University.

Prerequisites
45 ECTS credits in Physics, including Mechanics with Applications 1, 7.5 ECTS credits, Mechanics with Applications 2, 7.5 ECTS credits, and Introductory Modern Physics, 7.5 ECTS credits, plus 30 ECTS credits in Mathematics, including Complex Analysis and Transforms, 7.5 ECTS credits, plus upper secondary level English 6, or equivalent

Learning Outcomes
The aim of the course is for students to acquire in-depth conceptual and applied knowledge in classical mechanics and the ability to analyse mechanical systems using the Lagrange and Hamilton formalisms.

Upon completion of the course, students should be able to:
- apply the Lagrange and Hamilton formalisms, including variational calculus and the method

of Lagrange multipliers, to mechanical systems with a small number of degrees of freedom and with holonomic constraints,
- give an account of the connection between symmetries and conservation laws,
- derive the equations of motion for the Kepler problem, for the rigid body and for oscillation phenomena with the help of the Lagrange or Hamilton formalism, as well as describe the solution of these equations of motion,
-find normal coordinates for solving the equations of motion for small oscillations, and
-demonstrate an improved ability to interpret scientific texts.

Content
The mathematical structure of mechanics:
- review of Newton's description of mechanics
- generalised coordinates, Lagrange and Hamilton equations, variational calculus, Hamilton's principle
- symmetries and conservation laws
- canonical transformations, Poisson brackets
- inertial systems, Galilei transformations
- mathematical tools: calculus of variations, Legendre transformation, tensor calculus, separation of variables

Applications:
- holonomic and nonholonomic constraints
- two-body problem, Kepler problem
- kinematics of rigid bodies, dynamics of rigid bodies
- small oscillations
- the body in magnetic fields, vortices in fluids
- electrical circuits

Reading List
See separate document.

Examination
Assessment is based on individual hand-in assignments and individual written and oral presentations of an advanced study project.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades Fail (U), Pass (G), or Distinction (VG) is awarded in the examination of the course.For students in Engineering, one of the grades 5 (Pass with Distinction), 4 (Pass with Some Distinction), 3 (Pass), or U (Fail) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information
The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.