SYLLABUS

Mechanics II 7.5 credits F0008T

Mekanik II

Course syllabus admitted: Autumn 2023 Sp 1 - Present

DECISION DATE
2022-02-14

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LULEÅ TEKNISKA UNIVERSITET

Mechanics II 7.5 credits F0008T

Mekanik II

First cycle, F0008T

Education level	Grade scale	Subject	Subject group (SCB)
First cycle	G U 3 4 5	Fysik	Physics

Main field of study

Engineering Physics and Electrical Engineering

Entry requirements

In order to meet the general entry requirements for first cycle studies you must have successfully completed upper secondary education and documented skills in English language and and basic mechanics corresponding to the courses Physics 1 and 3 (F0004T and F0006T). Basic courses in calculus, algebra, analysis and ordinary differential equations corresponding to the courses M0047T, M0048M, M0049T, M0055M. Alternatively for the master programme in secondary education, teaching in the upper-secondary school.

Selection

The selection is based on 1-165 credits.

Course Aim

The content of the course is a continuation of the basic courses in mechanics and aims for students to further broaden and deepen their knowledge of classical mechanics, which also becomes a base for further studies in physics. It also includes alternative methods within classical mechanics.

After passing this course the student can:

1. Knowledge and understanding

- describe and express the conditions for body equilibrium in three dimensions.
- account for concepts and explain basic concepts and laws within three-dimensional classical particle and rigid dynamics.
- explain inertial forces and describe when they occur.
- account for systems undergoing damped and forced vibrations, explain resonance and exemplify its consequences.
- describe analytical mechanics as an alternative method to Newton's laws, can elucidate basic concepts and account for Lagrange's and Hamilton's equations.

2. Competence and skills

- determine the conditions for force equilibrium of bodies in three dimensions.
- solve problems with movement of bodies in three dimensions i.e. make calculations based on translating, accelerating and rotating coordinate systems, use Newton's laws, central-force motion, energy methods, momentum, inertial matrix, Euler's equations for gyroscopic motion and analyze damped, forced and coupled oscillations.
- calculate dynamic forces in rotating mechanical systems due to dynamic imbalance and determine how these can be reduced by balancing.
- solve dynamic problems for particles and rigid bodies using analytical mechanics:

a) formulate Lagrange and Hamilton's functions for different physical situations;

a) formulate Lagrange and Hamilton's functions for different physical situations;

b) formulate theoretical models with the Lagrange function and the Hamilton function;

c) derive the equations of motion and solve Euler-Lagrange's equations for mechanical systems with one or more generalized coordinates.

- solve somewhat more complicated technical dynamics problems, analytically and numerically.
- summarize, present and communicate calculations and conclusions in writing so that it is easy to follow.

3. Judgement and approach

- clarify restraints in analytical models of real mechanical systems and decide when numerical methods need to be used.
- critically review calculations and simulations of dynamics problems, interpret results, draw conclusions on plausibility and compare methods.
- use a scientific approach to argue on calculations and results, relate to engineering applications as well.

Contents

Equilibrium in three dimensions.

Oblique central impact.
Kinematics and kinetics in three dimensions: relative motion; motion relative accelerating, translating and rotating coordinates; central-force motion; Newton's laws; equations of motion; momentum; angular momentum; kinetic energy; angular-momentum equations; the inertia tensor; rotation about a fixed point; parallel-plane motion; dynamic imbalance and balancing of rotating masses; Euler angles; Euler's equations for rigid body and gyroscopic motion; precession with zero moment.

Vibrations: free, damped and forced (Newton, analytical mechanics, energy methods).

Analytical mechanics:
principle of least action; the Lagrange function and Euler-Lagranges equations; invariances and conservation laws; constraint; degrees of freedom; phase space; generalized coordinates; generalized momentum; Hamilton's principle; the Hamilton function; Hamiltonial mechanics; canonical equations and Hamilton-Jacobi theory (overview).

Realization

Each course occasion´s language and form is stated and appear on the course page on Luleå University of Technology's website.

The teaching consists of lectures and lessons. In order for the student to achieve the course objectives, the student is encouraged to participate in these learning activities, read the corresponding sections in the course literature and solve the proposed exercises. It is mandatory laboratory work on, for example, rotor balancing and bearing forces as well as at least one major assignment/presentation. The assignment is to solve a more advanced dynamic problem: based on analytical mechanics, a mathematical model is formulated that is solved both analytically, based on appropriate boundaries and approximations, and by using computer-based methods (normally Matlab, or Python) for numerical solution.

Alternatively, if agreed between student and examiner, the laboratory exercise for students at the master programme in secondary education - upper-secondary school, can be to develop a student laboration in agreement with the learning outcomes that can be used in physics teaching.

Examination

If there is a decision on special educational support, in accordance with the Guideline Student's rights and obligations at Luleå University of Technology, an adapted or alternative form of examination can be provided.
It is normally a written examination with differentiated numerical grades at the end of the course. In addition, approved report of hand-in assignments and presentation of laboratory results, are required. Some sub-parts of the assignments may need to be presented orally.

Unauthorized aids during exams and assessments

If a student, by using unauthorized aids, tries to mislead during an exam or when a study performance is to be assessed, disciplinary measures may be taken. The term “unauthorized aids” refers to aids that the teacher has not previously specified as permissible aids and that may assist in solving the examination task. This means that all aids not specified as permissible are prohibited. The Swedish version has interpretative precedence in the event of a conflict.

Overlap

The course F0008T is equal to F0055T, MTF112

Course offered by

Department of Engineering Sciences and Mathematics

Modules

Code	Description	Grade scale	Cr	Status	From period	Title
0002	Laboratory work and Assignment report	U G#	1.5	Mandatory	A07	
0004	Written exam	G U 3 4 5	6	Mandatory	A21	

Study guidance

Study guidance for the course is to be found in our learning platform Canvas before the course starts. Students applying for single subject courses get more information in the Welcome letter. You will find the learning platform via My LTU.

Last revised

by Niklas Lehto, Programme Director 2022-02-14

Syllabus established

The syllabus was established by the Department of Applied Physics and Mechanical Engineering 2007-02-28, and remains valid from autumn 2007.