02MECH/02MECHZ
Mechanics
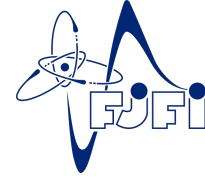
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Course Description

02MECH is a winter semester course for first-year bachelor students covering the basics of mechanics and some advanced methods, such as solving equations of motion for mechanical systems like a particle under constant force, a harmonic oscillator, the central force problem, and rigid bodies.

Each week, there will be two 50-minute lectures and a 50-minute exercise session. Lectures will cover theoretical concepts following the weekly schedule, while exercise sessions will focus on solving problems related to the lecture material. The instruction language is English.

02MECHZ refers to the final exam for 02MECH. The students who pass 02MECH will be eligible to take 02MECHZ. Please see the exam section for more details.

Prerequisite(s)

Knowledge of basic differentiation, integration, and trigonometry would be useful but are not necessary.

Credits: 4 (02MECH) + 2 (02MECHZ)

Reference Textbooks

1. Morin, D. J., *Introduction to Classical Mechanics: With Problems and Solutions*, Cambridge University Press, 2008.
2. Taylor, J. R., *Classical Mechanics*, University Science Books, 2013.
3. Thornton, S. T., Marion, J. B., - *Classical Dynamics of Particles and Systems*, 3$^{\text{rd}}$ Edition, Brooks/Cole, 2003.
4. Halliday, D., Resnick, R., Walker, J., *Fundamentals of Physics*, 10$^{\text{th}}$ Edition (Extended), Wiley, 2013.

Course Objectives

1. To learn the basics of mechanics, and solve simple equations of motion.
2. To understand the general framework for constructing and operating physical models.

Homeworks

Each week, students will be given homework on the topics covered in class. The purpose of homework is that students can work on their own and familiarize themselves with the subject. Homework will not be returned and will not be graded. Solutions to the homework assignments will be provided one week before the upcoming exam date.

Exams

There will be **two midterm exams** and **one final exam** (02MECHZ). Each exam will contain **four questions**, with each question worth **one point**. Students who score at least **50% of the total points** from the midterms will be awarded the **Z (Zápočet) grade**, meaning they will pass 02MECH and receive 4 credits. To qualify for the final exam, students must obtain this Z grade from the midterms. The final exam consists of a **written and an oral component**:

- Only students who score at least **50% on the written part** will proceed to the oral exam.

- The **final letter grade** is primarily determined by the written exam score. However:

  - If the oral exam score is **above 75%**, the final grade is increased by one level.
  - If the oral exam score is **below 25%**, the final grade is decreased by one level.
  - If the oral exam score is **between 25% and 75%**, the final grade remains the same.

- Attendance at the oral exam is **mandatory** for students who pass the written part.

The dates of the exams will be announced in the second week of the semester in KOS. The students are supposed to register for the exams in KOS. The students are required to bring their student ID cards to the exams.

Letter Grade Distribution

$$[3.6 - 4.0] : A = \text{Excellent} \qquad [2.4 - 2.8) : D = \text{Average}$$
$$[3.2 - 3.6) : B = \text{Very Good} \qquad [2.0 - 2.4) : E = \text{Sufficient}$$
$$[2.8 - 3.2) : C = \text{Good} \qquad [0.0 - 2.0) : F = \text{Insufficient}$$

Makeup Exams

If a student fails to obtain at least 50% of the total points from the midterm exams required to qualify for the final exam, they are eligible to take a makeup exam. The makeup exam will be scheduled before the official examination period. The structure and grading of the makeup exam will be identical to the midterms and will cover all the topics from the first two midterms. After taking the makeup exam, the student must achieve at least 50% of the total points from the combined score of the midterms and the makeup exam in order to be eligible to attend the final exam.

Retaking the Course

If a student fails the course for the first time, they may retake it in the following academic year. The student is required to attend all classes and take the exams again. If the student fails the retake, they must obtain special permission from the study department to retake the course one final time.

Attendance and Absences

- Attendance is expected and will be taken each class. You are allowed to miss **1** class during the semester without penalty. Any further absences will result in point and/or grade deductions.

- Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Tentative Course Outline

The weekly coverage might change as it depends on the progress of the class.

Chapter	Week
Mathematical preliminaries	1
Kinematics	2
Dynamics	3
Rotation	4
Conservation theorems	5,6
Small oscillations	7,8
Central-force motion	9,10
Dynamics of system of particles	11
Motion in a non-inertial reference frame	12
Dynamics of rigid bodies	13

Week	Content
Week 1	Scalars, scalar functions, cartesian and polar coordinates, derivatives, integrals, introduction to first- and second-order homogenous differential equations, vectors, vector operations.
Week 2	Reference frames, position, displacement, velocity, acceleration, speed, average speed, momentum, basic types of motion and their superposition.
Week 3	Inertial and non-inertial reference frames, Newton's laws of motion, equation of motion for a particle under a constant force, inclined plane, tension, drag force, friction, freefall and terminal speed, projectile motion.
Week 4	Angular velocity, torque, angular momentum, rotational inertia of a system of particles, Newton's 2nd law in rotational form, uniform circular motion.
Week 5	Conservation of linear and angular momentum, work and kinetic energy, conservative forces and potential energy.
Week 6	Conservation of total energy, total energy as an equation of motion, equilibrium, impulse, power.
Week 7	Simple harmonic oscillator, simple pendulum, phase diagrams for the oscillative behavior.
Week 8	Damped oscillations, driven oscillations, resonance.
Week 9	Definition of central force and its properties, equations of motion for central force problem, orbits, centrifugal energy, effective potential.
Week 10	Two-body problem, planetary motion (cyclic, elliptic, parabolic, and hyperbolic orbits, eccentricity, and total energy), Kepler's laws of planetary motion.
Week 11	Center of mass, reconsideration of basic mechanical quantities, dynamics and conservation laws for system of particles, elastic and inelastic collisions.
Week 12	Centrifugal and coriolis forces, motion relative to the Earth, oblateness of Earth, cyclonic motion in atmosphere.
Week 13	Yo-yo problem, physical pendulum, inertia tensor, Euler's equations, force-free motion of a symmetric top.