Study programme(s): Mathematics (M), Applied Mathematics (MAP)

Course title: THEORETICAL MECHANICS (M148)

Lecturer(s): Srboljub S. Simić

Course status: elective (M), compulsory on module: Techno-mathematics (MAP)

ECTS points: 5

Requirements: Analysis 1 (on M), Differential and Integral Calculus (on MAP)

Learning Objectives

Introducing students to the theoretical aspects of classical mechanics and mathematical methods used in problem formulation, qualitative analysis and problem solving in mechanics.

Learning Outcomes

Minimum: Ability to understand the mathematical formulation of concepts and laws of classical mechanics and mastering the application of a mathematical apparatus in analyzing mechanical systems.

Desirable: Ability to develop a sense of mathematical interpretation of physical terms and gain experience in the application of mathematical apparatus in qualitative and quantitative analysis of mechanical problems.

Syllabus

Theoretical instructions

The world of events, Galileo's transformation, coordinate systems. Tangent and cotangent space. Velocity and acceleration of a particle – path and physical coordinates. Moving frames of reference, rotation matrices, translator, rotational and arbitrary motion. Angular velocity, Euler's theorem, angular acceleration, local coordinates on rotation sets. Complex motion of a particle, velocity and acceleration. Rigid body kinematics. Velocity field of a rigid body's particles, Euler's angular velocity coordinates, acceleration field of a rigid body's particles.
Particle dynamics. Basic notions and axioms. Basic differential equations of motion. Particle motion on the real line, first integral, motion near equilibria, qualitative analysis. General theorems of particle dynamics. Particle motion in a central field – differential equations, conservation laws, Binet's equation.
Non-free particles, equations of the motion of a connected particle, first integrals. Relativistic particle motion.
Particle system dynamics. Two-body problems. General theorems of system dynamics. Unfree systems, general equation of dynamics, generalized coordinates, Lagrange equations of the second kind. Small oscillations. Rigid body dynamic. Inertia tensor, general theorems. Differential equations of a rigid body motion. Integrable cases of rigid body motion: Lagrange's case of gyroscope motion, regular precession, qualitative analysis of rotational motion.

Practical teaching: The exercises follow the expositions from the theoretical instructions.

Literature

1. A. Bakša, S. Simić: **Racionalna mehanika**, udžbenik u pripremi
2. T. Anđelić, R. Stojanović: **Racionalna mehanika**, Zavod za izdavanje udžbenika, Beograd, 1965.
3. M. Lunn: **A First Course in Mechanics**, Oxford University Press, Oxford, 1999.
4. N.M.J. Woodhouse: **Introduction to Analytical Dynamics**, Springer-Verlag, London, 2009.

Number of active classes	**Lectures: 2**	**Exercises: 2**

Teaching methods			
Classic plenary lectures accompanied by presentations and numerical simulations on a computer. Exercises constitute of typical problem-solving sessions.			
Grading (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
colloquia	**60**	oral exam	**40**