Study programmes: BACHELOR STUDIES – Astronomy and Astrophysics

Course name: Fundamentals of Theoretical Mechanics

Lecturers: Voja Radovanović, Duško Latas and other lecturers

Status: Optional

ECTS: 5

Attendance prerequisites: General physics 1

Course aims: This course was dedicated to the principles and applications of classical mechanics. The main aim was to make students familiar with the methodology of analytical mechanics through Hamilton's Principle, Lagrangian and Hamiltonian formalism, and their application to the motion of the system near stable equilibrium, particle in central field and rigid body. In addition, students are introduced to the basic physical ideas and mathematical formalism of the special theory of relativity. The last part of the course is a brief introduction to the mechanics of the continuous deformable media.

Course outcome: Students should: have a understanding of Hamilton's principle, be able to solve mechanical problems using Lagrangian and Hamiltonian formalism, understand the role of symmetry in classical mechanics, have a working knowledge of special relativity.

Course content:

1. The Kinematics of a particle. Velocity and acceleration. Absolute space and time in Newtonian Mechanics. Newton's laws of motion. Galilean transformations. 2. Mechanics of a system of particles. Types of forces. General theorems of Newtonian mechanics. Conservation laws. 3. Constraints. Generalized coordinates. Elements of calculus of variations. Hamilton's principle. Lagrange's equations for a system with potential forces. 4. Lagrange's equations with Lagrange multipliers. Nonpotential forces. 5. Symmetry properties and conservation theorems. The homogeneity of space and conservation of the momentum. The homogeneity of time and conservation of the energy. Isotropy of space and conservation of the angular momentum. 6. Small oscillations about a position of stable equilibrium. 7. Motion in central field. First integrals. Qualitative analysis of motion. Binet's equation. Kepler's problem. 8. Motion of a rigid body. Rotations. Angular velocity. Distribution of velocities in a rigid body. Coriolis theorem. Momentum and angular momentum of a rigid body. Inertia tensor. Kinetic energy of a rigid body. 9. Euler's equations of motion. Lagrange's method for a rigid body. Symmetrical top. 10. Inertial Forces. Hamilton's equations. Poisson bracket. 11. Einstein's postulates. Michelson–Morley experiment. Lorentz transformation. 12. Time dilation. Length contraction. Velocity addition. Minkowski space. Four-velocity. 13. Four-momentum, four-force and energy of a relativistic particle. Scattering. Compton scattering. 14. Mechanics of continuous deformable media. Equation of continuity. Stress tensor. Equations of motion of an elastic medium. Perfect fluid. Euler's and Bernoulli's equation 15. Viscous fluid. Navier-Stokes equation.

Literature:

1. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, Addison Wesley (2002)
2. L. D. Landau and E.M. Lifshitz, Mechanics, Butterworth-Heinemann (1976)
3. Đ.Mušicki, Teorijska mehanika, PMF Beograd, (1987)
4. V. Radovanović, Beleške za predavanja iz teorijske mehanike
5. Павленко Ю.Г., Задачи по теоретической механике, Физматлит (2003)

Number of hours: 5	**Lectures**: 3	**Tutorials**: 2	**Laboratory**: -	**Research**: -

Teaching and learning methods: Lecturing, problem solving, homework assignments.

Assessment (maximal 100 points)			
Course assignments	**points**	**Final exam**	**points**
Lectures	10	Written exam	35
Exercises / Tutorials	-	Oral exam	35
Colloquia	-	Written-oral exam	-
Essay / Project	20		