Taras Shevchenko National University of Kyiv

Physics Department

Course description

Classical Mechanics – 1

Level:	**Language:**	**Duration:**	**Occurrence:**
Bachelor	Ukrainian	1 semester	3rd semester
Credits:	**Total Hours:**	**Contact Hours:**	**Self-study Hours:**
4	120	60	60

Description of Course Work and Examinations

Module-rating system, results are evaluated on a 100-point scale. The course contains 2 midterms 20 pts/90 min each, an oral colloquium 15 pts/90 min and a final problem set for 45 pts that should be completed in 3 days.

Prerequisites

Mathematical Analysis (1st – 2nd semesters), Mechanics (1st semester)

Corequisites

Differential Equations (3rd semester)

Syllabus

General Concepts: subject and problems of classical mechanics, point mass, operational and formal logical quantities, definitions of SI mechanical units (kg, m, s).

Mechanics of Systems of Point Masses: trajectory of a particle, force, superposition principle, Newton's laws and corollaries, mechanical state of a point mass, Galilean invariance principle, laws of conservation and integrals of motion (energy, momentum, angular momentum, Laplace-Runge-Lenz vector), potential, classification of forces (constant, potential, dissipative, gyroscopic), virial theorem.

One-Dimensional Motion: $x(t)$ solution, finite and infinite motion, periodic motion (period, turning points, probability density), small oscillations.

Motion in a Central Field: center-of-mass frame, conservation laws (energy and angular momentum), reduced mass, effective potential, solutions for $r(t)$, $\varphi(t)$ and $r(\varphi)$, finite and infinite motion, periodic motion (radial and angular periods, turning points, closed and unclosed path), falling to the center, capturing cross-section, scattering (angle of deflection, differential and integral scattering cross-section), Coulomb field, Kepler's laws, eccentricity, types of orbits (circle, ellipse, parabola, hyperbola).

Lagrangian Mechanics: motion with constraints, real and virtual displacements, reaction forces, generalized coordinates, Lagrange equations of the 1st and 2nd kind, generalized forces, gauge invariance, coordinate substitution, kinetic energy in curvilinear coordinates, particle in electromagnetic field, Lagrangian of interaction, cyclic coordinates, Routh's method.

Mechanics of Rigid Bodies: degrees of freedom, Euler angles, tensor of inertia, angular momentum, instantaneous axis of rotation, kinetic and potential energy of a rigid body, principal axes and principal moments of inertia, equations of motion, dynamics of a whirligig.

Literature

1. S.Ezhov, M.Makarets, O.Romanenko. *Classical Mechanics*. Kyiv 2007, 399 p, ISBN 978-966-439-029-0.

Instructors

Professor Mykola V. Makarets/Associate Professor Oleksandr V. Romanenko.