Taras Shevchenko National University of Kyiv

Physics Department

Course description

Mechanics

Level:	**Language:**	**Duration:**	**Occurrence:**
Bachelor	Ukrainian	1 semester	1st semester
Credits:	**Total Hours:**	**Contact Hours:**	**Self-study Hours:**
6	180	90	90

Description of Course Work and Examinations

Module-rating system, results are evaluated on a 100-point scale. The course contains 2 midterms 15 pts/90 min each, a final problem set 30 pts/120 min, an exam on higher complexity problems 10 pts/180 min, and a final exam 30 pts/120 min.

Prerequisites

None

Syllabus

Basics: Concept of the reference frame, distance, displacement, velocity, acceleration, components of the acceleration, rotation and its characteristics, vector of an infinitesimal turn, angular velocity and angular acceleration vector, relations between linear and angular quantities for rotational motion, solid body motion as a superposition of translational and rotational motion, degrees of freedom and constraints, inertial frames of reference and Newton's First Law, Newton's Second Law in vector and cordinate representations, inertial mass concept, fundamental interactions and forces that are important for studying mechanics, Newton's Third Law, Galilei's relativity principle and the limitations of the Newton's mechanics, noninertial frames of reference, equation of motion of a particle in a noninertial frame of reference, inertial forces, zero-order approximation of the Earth gravity field, contribution of Earth shape and particle latitude to its motion, weight, weightlessness and overload, microgravity on a space station, tidal forces.

Constants of Motion: momentum of an object (group of objects), conditions for change/conservation of momentum, Coriolis force, geophysics effects, center of mass and its frame of reference, motion of an object with variable mass (Meshchersky equation, Tsiolkovsky formula), rocket and airplane motion, angular momentum of an object (group of objects), conditions of change/conservation of angular momentum, angular momentum in the center-of-mass frame of reference, kinetic energy, work, power, potential forces, external forces, potential energy, conditions of energy conservation of the system.

Introduction to Classical Mechanics: one-dimensional motion in a potential field, scattering, elastic and inelastic collisions, momentum diagram, Kepler's Laws, analysis of satellite motion, escape velocities, two-body problem, motion of rigid bodies, tensor of inertia, parallel axis theorem, gyroscopic motion, gyroscopic forces.

Oscillations: harmonic oscillations (amplitude, phase, frequency), physical and mathematical pendulum, relaxation time, driven, damped and driven damped oscillations, resonance, superposition of perpendicular oscillations, superposition of collinear oscillations, wave distribution, wave equation, phase speed and group speed, longitudinal and transverse waves, standing waves, boundary conditions, dispersion relation, sound waves, Doppler effect.

Special Relativity: Einstein's postulates, Lorentz transformation and its consequences, relativity of simultaneity, invariant interval, velocity addition formula, high-atmosphere muon detection, mass, energy and momentum, massless particles, relativistic dynamics equation.

Literature

1. I.E.Irodov. *Collection of tasks on general physics.* 2001 Saint-Petersburg, ISBN 5-8114-0319-4.
2. D.V. Sivuhin. *General Course of Physics.* Volume 1, *Mechanics* 2005, Moscow, ISBN 9785922102254.

Instructors

Professor Oleg A. Yeshchenko/Professor Serhiy Kondratenko.