PHYS 2P20

Homework
Lectures
Lab Manual
Sakai

2022-23 class
Marks
Integrity
Help
Calendar entry

Introductory Mechanics

Instructor: E. Sternin

News

Course outline

What Brock calendar entry says:

» Mechanics of particles and systems of particles by the Newtonian method; conservation of linear momentum, angular momentum and energy; elementary dynamics of rigid bodies; oscillators; motion under central forces; selected applications.

What do I need to bring into the course?

» This course is a core course of the Physics program, and requires Y1 Physics and Math courses as prerequisites.

Course Goals

» to develop a more comprehensive understanding of Newton's laws of motion and their origin in and application to real physical systems;

» to discover the underlying conservation laws and the manner in which physical systems evolve with time;

» to gain experience in the use of advanced mathematical tools (e.g. advanced algebra and trigonometry, analytic geometry, differential and integral calculus, differential equations);

» to develop experimental data analysis, error estimation, and numerical modelling skills;

» to enhance scientific writing skills.

Textbook

» *An Introduction to Mechanics*, second edition, by Daniel Kleppner and Robert Kolenkow. Cambridge University Press, 2013.

Grade composition

Component	% of the final mark	Notes
Homework	20%	Problem sets, every week. Late submissions have a sinking cap of 15%/day.
Midterm test	10%	An in-class test, date TBA. Only a calculator and one letter-size (one-sided) self-prepared formula sheet allowed; no complete solutions.
Final exam	35%	Minimum passing grade 50%, marks given for correct answers. Only a calculator and one letter-size (one-sided) self-prepared formula sheet allowed; no complete solutions.
Labs	35%	Completion of all labs and submission of all lab reports is required to obtain a grade in the course. Late submissions will not be accepted.

Topics to be covered

This is an approximate list, based on previous experience. As the course progresses, some of topics may be removed and some others may get added.

» **Vectors, a review of concepts**

- » **Ex:** temperature *vs.* velocity
- » algebra of vectors
- » multiplication by a scalar
- » **Ex:** unit vector
- » addition of two vectors
- » **Ex:** subtraction
- » multiplication of two vectors: dot-product
- » multiplication of two vectors: cross-product
- » components of a vector
- » base vectors
- » multiplication table of base vectors
- » derivatives of vectors

» **Kinematics in 2D and 3D**

- » elementary kinematics
- » **Ex:** uniform circular motion
- » solving kinematic equations
- » 2D motion in polar coordinates
- » approximation methods: Taylor series and related expansions

» **Newton's Laws**

- » Newton's Laws
- » inertial and non-inertial frames
- » procedure for applying Newton's Laws to complex systems
- » examples; constraints; non-physical solutions
- » linear restoring force
- » momentum, impulse
- » work and kinetic energy

» **Harmonic oscillator**

- » potential energy, damping, formal solutions to the DE
- » classification of solutions, under- over- and critically-damped cases
- » quality factor Q
- » forced (driven) HO, resonance
- » **Ex:** analogy with LCR circuits

» **Kinematics in 3D**

- » work and energy in 3D, potentials, conservative forces
- » momentum of a system of particles
- » center-of-mass, extended bodies, c.o.m. coordinates
- » rocket motion
- » momentum transport
- » collisions between masses
- » collisions and the c.o.m. coordinates

» **Rotational motion and angular momentum**

- » angular momentum of a particle
- » importance of the 3rd dimension: a conical pendulum

» conservation of angular momentum
» **Ex:** Kepler's 2nd law
» **Ex:** Bohr's atom, quantization of angular momentum
» **Ex:** torque on a conical pendulum
» angular momentum associated with a fixed axis' rotation
» moment of inertia
» parallel axis theorem
» solving problems involving torques
» the physical pendulum, center of gyration
» motions with both translation and rotation
» modified work-energy theorem
» generalization of rotational motion; infinitesimal rotations
» stability of rotating objects; a gyroscope
» generalization of angular momentum; tensor of inertia

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