Introductory Mechanics

Instructor - D. Crandles

What is this course all about?

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 pre-requisites.

Textbook

Classical Mechanics, by John R. Taylor, University Science Books, 2005.

Course Goals

- to develop an understanding of Newton's laws of motion and their application to physical systems
- to discover the underlying conservation laws governing the evolution of physical systems
- 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 understand more comprehensively physical phenomena and the manner in which physical systems evolve with time.

Lectures, assignments, labs

Component	% of the final mark	Notes
Daily Problems	25%	Each class will have one (or two small) problem(s) assigned. Solutions are due during the next lecture period. Late problems will not be accepted.
Test 1	10%	TBA
Test 2	10%	TBA
Final exam	30%	minimum passing grade 50%, marks given for correct answers
Labs*	25%	Begin week TBA

*Frank Benko (B210A, fabenko@brocku.ca) is the senior lab demonstrator, and should be contacted for all details.

Computer-based data acquisition

... is an integral part of the labs. For some experiments, the web-based interface familiar to you from Y1 labs will be used. You may want to consult https://www.physics.brocku.ca/physica/ in advance: under the "Get data" menu selection, select "demo" and click "go"; the demo mode allows you to try the tools without being in the lab.

Other experiments will require more involved and creative data analysis, using the same software. You will be given an opportunity to work through an on-line physica tutorial during one of your labs; you may want to try it out on your own using the "expert mode" of the above web-based version.

Office hours

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Frank Benko (B210A, ext.3417, fabenko@brocku.ca): TBA

Topics to be covered

0. A review of elementary concepts
    - algebra of vectors, components, base vectors
    - motion in several dimensions
    - derivative of a vector
    - integration of kinematic equations
    - polar coordinates, rotational motion
    - Newton's laws
    - examples of application of NLs
    - momentum, impulse
    - work, kinetic energy, reading energy diagrams
1. A simple harmonic oscillator (SHO)
    - SHO as a general physical problem
    - formal solution to the DE
    - damped SHO, driven SHO, resonance, *Q*-factor
    - resonance in LCR circuits
2. Work, energy, momentum
    - work and energy in 3D
    - work-energy theorem
    - conservative forces
    - momentum of a system of particles
    - center of mass, c.o.m. coordinates
    - momentum transport
    - collisions between masses
3. Angular momentum
    - angular momentum of a particle
    - the importance of the 3rd dimension: a conical pendulum
    - conservation of angular momentum, Kepler's laws
    - fixed axis' rotations, moment of inertia
    - parallel axis theorem
4. Rigid body motion: a general treatment
    - solving problems involving torques
    - motions with both translation and rotation
    - modified work-energy theorem
    - examples: a rolling drum, a falling stick
    - angular velocity as a vector, a gyroscope
5. Advanced topics
    - angular momentum in mechanics
    - tensor of inertia
    - principal axes
    - non-inertial reference frames
