

Physics 2820

Computational Mechanics

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PHYS 2820 Computational Mechanics: Newtonian and gravitational dynamics, data analysis, statistics, numerical differentiation and integration, numerical solutions to mechanics problems and vibrations, linear and non-linear oscillators.

The goal of this course is to integrate computational techniques with some fundamental classical mechanics. The course will therefore interweave computational techniques with mechanics by having students work with computers during the laboratories and in assignments. We will work with the programming language *Mathematica* to solve the mechanics problems that we explore. We will use Macs during class but the numerical analysis can be performed on any platform. The software can be purchased at the Computer Purchasing Centre.

Announcements about the course, class notes, assignments and various other goodies will be available from the course web page.

Activity:

Assignments (6)	15 %
Laboratories	15%
Test – mid-term	20 %
Final examination	50 %

Course outline

- 1) Approaches to computational physics, introduction to *Mathematica* and computers
- 2) Reexamining some first year physics problems, pendulums, projectile motion, central forces
- 3) Numerical integration and differentiation, plotting and defining functions
- 4) Forces, inertia, Newton's Law – motion in two dimensions, curvilinear motion, charged particles in a magnetic field, viscosity and drag resistance, simple harmonic motion, simple pendulum.
- 5) Integrating dynamical equations and gravitational theory. Solving projectile motion problems, Eulers method, accuracy, numerical stability, leap-frog method, predictor corrector method, Runge-Kutta techniques, orbits planets and comets:
- 6) Free and forced vibrations - pendulums, decay of free vibrations, complex exponentials, forced oscillations with damping, electrical resonance (Chapters 4 and 5 in French *Vibrations and Waves*).
- 7) Working with numbers on computers, linear least squares, root finding, curve fitting

Texts :

A useful reference text is the book by Boccara, Nino – *Essentials of Mathematica* (2007) which is available as an e-book through the library. We will use your first year physics text as the reference for the mechanics that we discuss.

The software required for the course, Mathematic, is required and can be purchased through the Computer Purchasing Centre (CPC – next to the Science building), for about \$50.

Classes: Tues and Thursday in C-2045 from 2:00 to 3:20. The labs are in C-2039 on Tuesday and Thursday from 3:30 to 5:00.

Schedule – note that we can adjust this schedule if we all agree to do so but this will give you an idea of how things should go.

Assignments will be set out roughly every two weeks and due ten to twelve days later:

Assignment 1 – Out 13 September
Due 20 September

Assignment 2– Out 20 September
Due 2 October

Assignment 3 – Out 4 October
Due 16 October

MidTerm Test – 18 October

Assignment 4 – Out 30 October
Due 8 November

Assignment 5 – Out 8 November
Due 20 November

Assignment 6 - Out 22 November
Due 29 November