Hamiltonian Mechanics – MAT461HS

Spring 2023

Time/location: TU 10-12/OI8180, TH 11-12/BA1240

Instructor: Boris Khesin

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Course description:

The course focuses on the key notions of classical mechanics: Newton equations, variational principles, Lagrangian formulation and Euler-Lagrange equations, the motion in a central force, the motion of a rigid body, small oscillations, Hamiltonian formulation, canonical transformations, Hamilton-Jacobi theory, action-angle variables, and integrable systems.

Textbooks:

1. Goldstein, Poole, and Safko: "Classical Mechanics"
(can be downloaded from
`https://3lib.net/book/3355492/bc94a3`)
2. Arnold: "Mathematical Methods of Classical Mechanics"
(can be downloaded from
`https://3lib.net/book/2297866/63d501`)

Course Website:

The website for the course is `http://www.math.toronto.edu/khesin/teaching/mechanics/mechanics23.html`

Homework Assignments:

There will be 3 assignments approximately weighting 20% each and a final individual project weighting 40% (which includes 2% of in-class participation), which together constitute the full course mark. No late assignments will be accepted.

Note: You must write your solutions yourself, in your own words. If your solution is aided by information from textbooks or online sources, you must properly quote these references.

Code of Behaviour / Plagiarism:

Students should become familiar with and are expected to adhere to the Code of Behaviour on Academic Matters which can be found at:
`http://www.governingcouncil.utoronto.ca/policies/behaveac.htm`

Course Syllabus:

1. Newton equations. Lagrangian Mechanics. Energy and Momentum.
2. The two-body problem. Motion in a central field. The Kepler problem.
3. The Calculus of Variations. Euler-Lagrange equations. Lagrange multipliers.
4. Symmetries and Conservation laws. Noether's theorem.
5. Rigid Bodies. Euler's equations.
6. Hamiltonian Mechanics. Phase space. Symplectic manifolds.
7. Poisson Brackets. Canonical Transformations. Symmetries.
8. Liouville's theorem, Poincaré recurrence.
9. Hamilton-Jacobi theory. Action-angle variables. Integrable systems.
10. Introduction to the Lagrangian and Hamiltonian settings of continuous systems. The hydrodynamical Euler equation.

Prerequisites:

MAT235Y1/MAT237Y1/MAT257Y1 (multivariable calculus),
MAT244H1/MAT267H1 (differential equations),
MAT223 (linear algebra)

Program Area Section: Mathematics