Department of Physics and Astronomy | Stony Brook University

PHY 501

Classical Mechanics

Fall 2026 | 3 credits | Letter graded

Instructor	Professor Alexandre Abanov	**Meetings**	Monday and Wednesday, 9:30–10:50 a.m.
Email	alexandre.abanov@stonybrook.edu	**Classroom**	E&S 069
Office	Physics Building B-102	**Office hours**	TBD
Course site	Brightspace: https://mycourses.stonybrook.edu/d2l/home		

Course description

Analytical classical mechanics, including Lagrangian and Hamiltonian formulations and the Hamilton–Jacobi theory. The course develops variational principles, symmetries and conservation laws, and selected advanced applications including nonlinear and parametric oscillations, planetary motion, continuous media, and nonlinear dynamics.

The course assumes prior undergraduate exposure to mechanics, multivariable calculus, and ordinary differential equations. In particular, students are expected to be comfortable with classical mechanics at least through the material covered in the first six chapters of David Tong's recent book, *Classical Mechanics*. Students who are concerned about their preparation are encouraged to speak with the instructor early in the semester.

Learning goals

By the end of the course, students should be able to

- formulate mechanical systems using Newtonian, Lagrangian, and Hamiltonian methods;
- use symmetries to derive and apply conservation laws;
- analyze central-force motion, small oscillations, and rigid-body dynamics;
- use canonical transformations, Poisson brackets, and Hamilton–Jacobi methods; and
- connect classical mechanics to waves, fields, nonlinear dynamics, and chaos.

Course outline

The sequence below is intentionally broad; emphasis and ordering may be adjusted as the course develops.

1. **Variational principles and equations of motion:** generalized coordinates and constraints; action principles; Lagrange equations; Legendre transforms; Hamiltonian mechanics.
2. **Symmetry and conservation laws:** energy, momentum, angular momentum, and Noether's theorem.
3. **Fundamental mechanical problems:** one-dimensional motion; central forces and Kepler motion; collisions and scattering; charged particles in external fields.
4. **Oscillations and rigid bodies:** normal modes, driven and damped motion, nonlinear and parametric oscillations; inertia tensors, Euler equations, tops, and non-inertial frames.

5. **Canonical methods:** Poisson brackets, canonical transformations, Hamilton–Jacobi theory, action–angle variables, and adiabatic invariants.
6. **Selected advanced topics:** strings, membranes, elastic and fluid media; field-theoretic conservation laws; Poincaré maps and the KAM theorem.

Coursework and assessment

Homework assignments are expected to be submitted through Brightspace on time. They will not be graded in detail, but completing them carefully is essential preparation for quizzes and examinations. Discussion of approaches with classmates is encouraged, but each submitted solution must represent the student's own understanding and work.

Short quizzes will be conducted in class every two weeks, during the first ten minutes of the lecture. The course will also include a midterm examination and a cumulative final examination. All examinations are closed book. Exact dates and submission procedures will be posted in Brightspace.

Component	Weight
Homework	10%
Quizzes	20%
Midterm examination	30%
Final examination	40%

Any adjustment to these weights will be announced in advance.

AI policy. The use of AI tools to support learning and deepen understanding of the material is encouraged. In particular, AI can be valuable for creating visualizations and graphs that illuminate mechanical systems and their dynamics. Students should nevertheless develop and maintain the ability to solve problems independently, without AI assistance. This independent problem-solving ability is essential to learning and is what quizzes and examinations will assess.

University statements

Student Accessibility Support Center. If you have a physical, psychological, medical, or learning disability that may affect your course work, please contact the Student Accessibility Support Center (SASC), Stony Brook Union Suite 107, (631) 632-6748, or sasc@stonybrook.edu. SASC will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during an emergency evacuation are encouraged to discuss their needs with the instructor and SASC. See https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-disabilities/.

Academic integrity. Each student must pursue their academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Suspected instances of academic dishonesty will be reported through the University's applicable academic-integrity procedures. Further information is available at https://www.stonybrook.edu/commcms/studentaffairs/sja/academic-integrity/.

Critical incident management. Stony Brook University expects students to respect the rights, privileges, and property of others. Disruptive behavior that interrupts instruction, compromises the safety of the learning environment, or inhibits students' ability to learn may be reported to the Office of Student Conduct and Community Standards.

Texts and course communication

No single text is required. Lecture notes, assignments, announcements, and any supplementary readings will be distributed through Brightspace. The following books are useful references:

- L. D. Landau and E. M. Lifshitz, *Mechanics*, 3rd ed.
- A. L. Fetter and J. D. Walecka, *Theoretical Mechanics of Particles and Continua*.
- H. Goldstein, C. Poole, and J. Safko, *Classical Mechanics*, 3rd ed.
- V. I. Arnold, *Mathematical Methods of Classical Mechanics*, 2nd ed.
- J. V. José and E. J. Saletan, *Classical Dynamics: A Contemporary Approach*.
- D. Tong, *Classical Mechanics*.