

Advanced Mechanics I. Fall 2025

Classical mechanics of particles and rigid bodies; review of Newtonian mechanics and foundations of Lagrangian and Hamiltonian formalism.

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Office Hours: Mondays 10:30am – 11:30am

Web page: <http://people.physics.tamu.edu/abanov/courses/P302/index302.php>

Texts: Recommended book: John R. Taylor, Classical Mechanics, University Science Books, Any edition.

Recommended book: L.D. Landau and E.M. Lifshitz, Mechanics, Any edition

Free book: Douglas Cline, [Variational Principles in Classical Mechanics](#)

Class lecture notes: http://people.tamu.edu/~abanov/courses/P302/2025_Fall/LectureNotes.pdf

Grading:		Exams:
Midterm Exam	30%	Midterm Exam: October 15-October 17; Take home. Final exam: December 12, Friday, 8-10:00 am. <i>An exam missed without a University excused absence will count as a zero in your final grade. Late homework will not be accepted unless there is instructor's approval prior to the due date. Missed homework will count as a zero in your final grade.</i>
Final (comprehensive)	30%	
Homework (weekly)	40%	

Grading scheme: 90-100 A; 75-89.99 B; 60-74.99 C; 50-59.99 D; 0-49.99 F. Grades may be curved upward. Each homework and exam is graded out of 100 points.

Pre- and Co-requisites: PHYS 309 and 331; PHYS 332 or concurrent enrollment, or instructor's approval.

Honors section only: In order to receive honors credit for a course, the course is “expected to provide increased intellectual challenge through more sophisticated material, a higher level of intellectual engagement, and more responsibility for the learning process than would typically be expected in an undergraduate course.” As such, in addition to more in-depth understanding of the material in lectures will be expected, additional Honors assignments will be required for Honors sections. These assignments will be discussed on the first day of class and details can be found on Canvas. **Exams between honors and non-honors sections will be identical.**

Course Learning Outcomes:

Conceptual knowledge to gain:

- Deeper understanding of classical mechanics and analytic tools. Understanding Newtonian, Lagrangian, and Hamiltonian formulations of classical mechanics and the relations between the three.
- Understand the deep structure of the laws of mechanics.

Upon successful completion of this course, students will be able to:

- Apply the three formulations for the problems in mechanics and understand which of the formulations works best for the problem at hand.

Course timeline:

A rough lecture timeline for the course is given below. The detailed description of the lectures and the full lectures' content can be found in the [lecture notes](#).

Week 1	Lecture 1. Introduction. Lecture 2. Coordinates. Scalars. Vectors. Einstein notations. Lecture 3. Newton's laws.
Week 2	Lecture 4. Air resistance. Lecture 5. Air resistance. Lecture 6. Harmonic oscillations.

Week 3	Lecture 7. Oscillations with dissipation. Lecture 8. External force. Resonance. Response. Lecture 9. Momentum Conservation. Rocket motion. Charged particle in magnetic field.
Week 4	Lecture 10. Kinematics in cylindrical/polar coordinates. Lecture 11. Angular momentum. Angular velocity. Lecture 12. Moment Tensor of inertia. Kinetic energy.
Week 5	Lecture 13. Work. Potential energy. Lecture 14. Energy Conservation. One-dimensional motion. Lecture 15. Spherical coordinates. Central forces.
Week 6	Lecture 16. Effective potential. Kepler orbits. Lecture 17. Kepler orbits continued. Lecture 18. Another derivation. A hidden symmetry.
Week 7	Lecture 19. Conserved Laplace-Runge-Lenz vector. Lecture 20. Kepler orbits continued. Lecture 21. Functions and Functionals.
Week 8	Lecture 22. More on functionals. Lecture 23. Euler-Lagrange equation Lecture 24. Euler-Lagrange equation continued.
Week 9	Lecture 25. Lagrangian mechanics. Lecture 26. Lagrangian mechanics. Lecture 27. Lagrangian mechanics.
Week 10	Lecture 28. Lagrangian mechanics. Lecture 29. Lagrangian mechanics. Lecture 30. Lagrangian's equations for magnetic forces.
Week 11	Lecture 31. Energy conservation. Lecture 32. Hamiltonian. Lecture 33. Hamiltonian equations.
Week 12	Lecture 34. Hamiltonian equations. Examples Lecture 35. Hamiltonian equations. Examples. Phase space. Lecture 36. Liouville's theorem. Poincaré recurrence theorem. Area law.
Week 13	Lecture 37. Adiabatic invariants. Lecture 38. Poisson brackets. Change of Variables. Canonical variables. Lecture 39. Poisson brackets structure. How to compute Poisson brackets for arbitrary
Week 14	Lecture 40. The Jacobi's identity. Lecture 41. Integrals of motion. Angular momentum. Lecture 42. Hamilton-Jacobi equation.

University Policies

This section outlines the university level policies that must be included in each course syllabus. The TAMU Faculty Senate established the wording of these policies.

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” ([Student Rule 7, Section 7.4.1](#)).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” ([Student Rule 7, Section 7.4.2](#)).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#).)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” ([Section 20.1.2.3, Student Rule 20](#)).

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You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to

attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

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Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see [University Rule 08.01.01.M1](#)):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

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Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with [Counseling and Psychological Services \(CAPS\)](#).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's [Title IX webpage](#).

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus

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Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items may do so by going to howdy.tamu.edu and clicking on the "Directory Hold Information" link in the Student Records channel on the MyRecord tab. The complete [FERPA Notice to Students](#) and the student records policy is available on the Office of the Registrar webpage.

Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees honors and awards received, participation in officially recognized activities and sports, medical residence location and medical residence specialization.