

# PHY420 Mechanics

Fall 2024

Aurelia Honerkamp-Smith  
Department of Physics  
404 Lewis Lab  
auh216@lehigh.edu

Time: MWF 16:25-17:15 Eastern US time  
Lecture Format: In person, room 514.

## Course Contents

- 1. Fundamentals of Mechanics.** Newton's laws. Momentum, Energy and Work. One and Many-Particle Systems. Velocity Phase Space.
- 2. Lagrangian Mechanics.** Lagrange's equations. Central Force Motion. The Variational Principle. Symmetry and Conservation. Dissipative Forces in the Lagrangian Formalism.
- 3. Scattering and Linear Oscillations.** Scattering by Central Forces. Chaotic scattering, Cantor Sets and Fractal Dimension. Linearized Linear Oscillations. Chain of Coupled Oscillators. Forced and Damped Oscillators.
- 4. Hamiltonian Formulation of Mechanics.** Hamilton's Canonical Equations. Legendre Transforms. Poisson Brackets. Canonical Transformations. Generating Functions.
- 5. Topics in Hamiltonian Dynamics.** The Hamilton-Jacobi Method. Separation of Variables. Action-angle Variables. Liouville's Integrability Theorem. Elements of Perturbation Theory.
- 6. Nonlinear Dynamics.** Nonlinear Oscillators. Driven Quartic Oscillator. Chaotic Dynamics. The Circle Map. The Kicked Rotator.

## Initial Competences

- Undergraduate course on classical mechanics, good knowledge of multivariable calculus.

## Final Competences

- Ability to apply the methods of Lagrange, Hamilton, and Hamilton-Jacobi (including action-angle variables) to solve problems in mechanical systems consisting of particles.
- Ability to apply canonical transformations and Poisson bracket formulation.
- Understand of the origin of conservation laws in mechanics and the relationship between symmetry and conservation.
- Ability to perform a linear expansion of mechanical systems into normal modes.

- Qualitative understanding of requirements for integrability and onset/characteristics of chaotic behavior.

## Textbooks

Required: J. V. José and E. J. Saletan, “Classical Dynamics. A Contemporary Approach,” Cambridge University Press, 1998. **This textbook is available as an ebook through Lehigh University libraries!**

Recommended: H. Goldstein, C. Poole and J. Safko, “Classical Mechanics,” third edition, Addison-Wesley, 2002

Recommended: S. T. Thornton, J. B. Marion, “Classical Dynamics of Particles and Systems,” fifth edition, Brooks-Cole, 2004. An earlier edition of the textbook (by J. B. Marion, 1970) is available as an ebook through Lehigh University libraries

## Grading

The course grade will be based on:

**1. Weekly homework problems (25%).** Assignments are due Fridays at 5:30. Assignments can be submitted via course site (to be submitted as single pdf file in standard paper size dimensions) or on paper. Solutions to homework problems will be posted on Friday. You may submit one homework assignment the following Monday with no penalty, if you notify me by the due date. Otherwise, assignments submitted late will receive 50% of the available points.

The homework problems are intended for practice and vary in difficulty. It is ok if you are not be able to provide a complete answer to every homework question. I will be be mainly looking for effort, for which you will receive at least 50% for each problem. Please compare the posted solutions with your answers when they are posted.

**2. Two one-hour exams (30%).**

**3. Final exam (45%).**

Accommodations for Students with Disabilities:

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the Universitys educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online

at <https://studentaffairs.lehigh.edu/disabilities>.

The Principles of Our Equitable Community:

Lehigh University endorses The Principles of Our Equitable Community

([http://www.lehigh.edu/inprv/initiatives/PrinciplesEquity\\_Sheet\\_v2\\_032212.pdf](http://www.lehigh.edu/inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf)). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.