

# PHY420 Mechanics

Fall 2020

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Time: MWF 16:25-17:15 Eastern US time

Lecture Format: Online synchronous, recorded lectures available through course site.

## 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.

## Discussion and Individual meetings

Every member of the class will be added to a slack website, to facilitate discussion in groups and individually through messaging. Please use slack for comments or questions (instead of email please), preferably through a channel accessible to the whole class. I will try to answer any questions, within a reasonable time frame, but anyone is welcomed to chime in.

I will be available for individual meetings (through zoom or in person), which can be arranged by sending me a direct message in slack. For in person meetings, we are all expected to strictly follow Lehigh University's safety guidelines.

To get to know everyone, we will arrange short individual zoom meetings at the beginning of the semester.

## Textbooks

Required: J. V. José and E. J. Saletan, "Classical Dynamics. A Contemporary Approach," Cambridge University Press, 1998. The 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 before Friday's class and will be submitted and graded through course site (to be submitted as single pdf file in standard paper size dimensions). Solutions to homework problems will be discussed on Friday.

The homework problems are intended for practice and vary in difficulty. It is ok if you are not be able to provide answer to every homework question. I will be mainly looking for effort, for which you will receive at least 50% for each problem.

**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 University's 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](mailto: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.