# Classical Mechanics
# Physics 215

## Department of Physics at Lehigh University

## Spring 2017

*Instructor:* Gary G. DeLeo

*Office:* 412 Lewis Lab, 83413 (direct), 83931 (Physics office), lgd0 (e-mail)

*Text:* Classical Mechanics, John R. Taylor, University Science Books (2005)

*General Course Requirements:*

Requirements include: (i) reading assigned materials prior to class, (ii) attending all lectures, (iii) completing all homework problems on time, (iv) seeing the instructor if you are having trouble. Students are permitted to work together on homework assignments.

*Grading:*

Your numerical grade will be determined as follows:

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|---|---|
| Hour Exam 1 | 20% |
| Hour Exam 2 | 20% |
| Final Examination | 30% |
| Homework | 20% |
| Attendance | 10% |
| **TOTAL** | **100%** |

*Primary Topics:*

Newton's Laws of Motion (Chap. 1)
Projectiles and Charged Particles (Chap. 2)
Momentum and Angular Momentum (Chap. 3)
Energy (Chap. 4)
Oscillations (Chap. 5)
Calculus of Variations (Chap. 6)
Lagrange's Equations (Chap. 7)
Two-Body Central-Force Problems (Chaps. 8)
Mechanics in Noninertial Frames (Chap. 9)
Rotational Motion of Rigid Bodies (Chap. 10)
Coupled Oscillators and Normal Modes (Chap. 11)

*As Time Permits:*

Nonlinear Mechanics and Chaos (Chap. 12)
Hamiltonian Mechanics (Chap. 13)
Collision Theory (Chap. 14)
Special Relativity (Chap. 15)

***Accommodations for Students with Disabilities:*** *If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, Williams Hall, Suite 301 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.*

***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]. 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.*

**Final Competencies:**

Students will learn to construct differential equations of motion using Newton's second law for systems more complex than those encountered in "freshman physics." These include forces with various combinations of explicit dependencies on position, velocity, and time. Students will be able construct these equations in multiple coordinate systems, and use extensions to the complex plane to facilitate their solutions. They also will be able determine and examine the behaviors of systems under certain limiting by the use of expansions.

Basic principles relating to conservation laws will be reviewed, including energy, linear momentum, and angular momentum. Students will be able to extend their basic understanding using more advanced tools, especially those involving vectors operations.

Students will be able to set up and solve equations for oscillating systems, including those that are damped and/or driven. They will be able to apply methods such as Fourier series and Green's functions to solve problems with driving forces that are not sinusoidal. The principle of superposition will be understood as the bases for these problem solutions.

Students will understand the relationships between Newton's second law, Hamilton's principal, Lagrange's equations, and Hamilton's equations, including the derivations of one from another. In the process, students will learn about functional derivatives, the calculus of variations, virtual displacements, and the nature of constraints. They will be able develop equations of motion using generalized coordinates.

Students will learn to develop the equations of motion for a wide variety of systems using both Lagrangian and Hamiltonian dynamics. They will also understand the relationships between symmetries and conservation laws, and where they appear in these formalisms.

Students will know how these formalisms can be applied to systems with central potentials, and to compute orbital properties in planetary systems.

Lagrangian dynamics will be applied to coupled oscillatory systems. Students will learn how to set up these linear systems and to solve for the vibrational eigenmodes, including normal-mode frequencies, amplitudes and phases, and normal coordinates.

Students will be able to compute the trajectories of particles in accelerated frames of reference, especially rotating frames.

Students will be able to determine the motion of a rigid body under the influence of torque, with a fixed axis or as a free rotator.

Students will learn to predict the outcomes of basics scattering systems, and to convert between frames of reference, especially center of mass and lab frames.

Topics such as scaling theories and special relativity will be covered as time permits.

This list is relatively general and may in places suggest to the reader expectations greater than those I had in mind, and in some cases the opposite. And I may have omitted something important. However, prior to each exam, I will provide more specific lists of expectations appropriate to that exam.