# Physics 301: Classical Mechanics
# Fall 2010

**Susan Lehman** **slehman@wooster.edu**

Taylor 105 330-263-2214 (or x2214)

In Physics 301, we will develop the ideas and mathematics of classical mechanics beyond the introductory material you studied in Foundations of Physics. We will develop new mathematical tools and more abstract ways of analyzing the dynamics of moving, rotating, and oscillating objects. We will go beyond simple motion in inertial reference frames and learn to analyze motion in accelerating and rotating frames.

The major goals for the course are for students to:

- Learn new formulations of mechanics, including the Lagrangian and Hamiltonian.
- Become familiar with the most common problems in classical mechanics and develop an array of mathematical techniques to solve those problems
- Continue developing the capacity to break a complex problem into solvable pieces, and
- Continue developing the ability to explain complicated concepts as clearly as possibly both orally and in written work.

We will use a combination of lectures, group work, demonstrations, simulations, & homework to achieve these goals.

**Lecture**: Mondays, Wednesdays, Fridays 11 – 11:50 am Taylor 109c

**Text**: *Classical Mechanics* by John R. Taylor

**Class Website**: www3.wooster.edu/physics/lehman/p301_2010.html

**Office Hours**: By appointment or when my door is wide open.

**Exams**: There will be three midterm exams, scheduled for Friday September 24, Friday October 29, and Friday December 3. The cumulative final exam is on Monday, December 13 at 9:00 a.m.

**Grading:** Your grade is determined from the exams, lab reports, and homework by the following proportions:

| | |
|---|---|
| Homework | 30 % |
| Midterm exams | 15 % each |
| Final exam | 25 % |

The following scale will be used to determine your final letter grade:

| | |
|---|---|
| Outstanding (A, A-): | > 88 % |
| Good (B+, B, B-): | > 77 % |
| Adequate (C+, C, C-): | > 66 % |
| Minimally passing (D): | > 60% |

All exams must be taken when scheduled. Only truly unavoidable conflicts will be considered for rescheduling the exams. The College sets the final exam date, and only the Dean can grant exceptions. Unannounced quizzes may be given and may not be made up in any case.

## Guiding Principles of the Course

1. People understand concepts better by seeing them in action and thinking about them than by hearing them explained.
2. Physics is learned by working problems, not by reading about working problems. Understanding physics is a learned skill, like cooking or playing basketball. It takes time, effort, and practice.
3. People learn best by thinking about topics and discussing them with others.
4. Students learn most when they take the responsibility for what is learned.

Although this course covers the motion of everyday objects like projectiles and spinning tops, the mathematical tools we use to describe the everyday world are abstract and sometimes difficult to understand. We also may still have non-Newtonian misconceptions about mechanics floating around in our brains. To overcome these notions, it is important to confront them, both mathematically in problems (with lots of practice) and verbally in discussion. B**eing able to explain what you have learned is an essential step in the learning process**.

Thus, for all homework and exams, your work and thought process must be clear. **Neatness counts.** Steps should be explained using short phrases or sentences. Any sketches or graphs should be clearly labeled. Use of *Mathematica* is acceptable and may be required at times, but the solution still needs to be easily understandable. Homework assignments will be long and challenging, so start early.

## Academic Integrity

I encourage you to collaborate on homework, but you **must** first attempt the problem on your own. **The solutions you hand in must be entirely your own work. You may not directly copy words or equations.** A good practice is to re-write your solution without looking at your previous notes to be sure that you understand each step yourself. When you obtain outside help, you must acknowledge it ("After integrating (as suggested by Hermione), I find…"). When you work on a homework assignment with others, please note that on your paper ("I worked with Lise and Hans on these problems").

**Cheating on a test, quiz, or homework is a serious breach of academic integrity and is grounds for an F for the entire course.**

**Direct copying of homework from another student or an online resource is a violation of the Wooster Ethic.**

Other violations of the Wooster Ethic include copying from any source without proper citation, going beyond what is allowed in a group project, fabricating excuses and lying in connection with your academic work. You will be held responsible for your actions. If you are unsure as to what is permissible, always ask!

## Curricular and Extra-curricular Conflicts

The College of Wooster is an academic institution and its fundamental purpose is to stimulate its students to reach the highest standard of intellectual achievement. As an academic institution with this purpose, the College expects students to give the highest priority to their academic responsibilities. When conflicts arise between academic commitments and complementary programs (including athletic, cultural, educational, and volunteer activities), students, faculty, staff, and administrators all share the responsibility of minimizing and resolving them.

As a student you have the responsibility to inform me of potential conflicts as soon as you are aware of them, and to discuss and work with me to identify alternative ways to fulfill your academic commitments.

**If you know of any conflicts that will require you to miss class or lab, notify me immediately.**

## Academic Support from the Learning Center

The Learning Center (ext. 2595) offers services designed to help students improve their overall academic performance. Sessions are structured to promote principles of effective learning and academic management. Any student on campus may schedule sessions at the Learning Center.

The Learning Center also offers a variety of services and accommodations to students with disabilities based on appropriate documentation, nature of disability, and academic need. Any student with a documented learning disability needing academic accommodations is requested to speak with me and with Pam Rose, Director of the Learning Center (ext. 2595), as early in the semester as possible. All discussions will remain confidential.

| Week | | Date | Topic | Sections |
|---|---|---|---|---|
| 1 | M | 30-Aug | Newton's 1st and 2nd Laws | 1.1 - 1.4 |
| | W | 1-Sep | Newton's 3 Law, Momentum Conservation | 1.5 - 1.7 |
| | F | 3-Sep | Projectile Motion and Air Resistance | 2.1 - 2.4 |
| 2 | M | 6-Sep | Motion of a Charge in a Uniform B Field | 2.5 - 2.7 |
| | W | 8-Sep | Rockets and the Center of Mass | 3.1 - 3.3 |
| | F | 10-Sep | Angular Momentum | 3.4 - 3.5 |
| 3 | M | 13-Sep | Work, Energy and Conservative Forces | 4.1 - 4.4 |
| | W | 15-Sep | 1 D Linear and Curvilinear Systems | 4.5 - 4.7 |
| | F | 17-Sep | Central Forces | 4.8 - 4.10 |
| 4 | M | 20-Sep | Simple Harmonic Oscillator 1D | 5.1 - 5.2 |
| | W | 22-Sep | 2D SHM | 5.3 |
| | F | 24-Sep | **EXAM 1 - Chap. 1 to 4** | |
| 5 | M | 27-Sep | Damped Oscillations | 5.4 |
| | W | 29-Sep | Damped, Driven Oscillators and Resonance | 5.5 - 5.6 |
| | F | 1-Oct | Fourier Series and the Driven Oscillator | 5.7 - 5.8 |
| 6 | M | 4-Oct | Calculus of Variations | 6.1 - 6.2 |
| | W | 6-Oct | More Euler - Lagrange | 6.3 - 6.4 |
| | F | 8-Oct | Lagrange's Eqns - Unconstrained | 7.1 |
| 7 | M | 11-Oct | Lagrange's Eqns - Constrained Systems | 7.2 - 7.4 |
| | W | 13-Oct | Lagrange - Examples, Generalized Momenta | 7.5 - 7.7 |
| | F | 15-Oct | Lagrange Multipliers | 7.8, 7.10 |
| 8 | M | 18-Oct | **Fall Break** | |
| | W | 20-Oct | Hamilton's Eqns 1D | 13.1 - 13.2 |
| | F | 22-Oct | Hamilton's Eqns multiD | 13.3 - 13.5 |
| 9 | M | 25-Oct | Phase Space | 13.6 |
| | W | 27-Oct | 2body central force - CM and EOM | 8.1 - 8.3 |
| | F | 29-Oct | **EXAM 2 - Chap. 5 to 7 plus 13** | |
| 10 | M | 1-Nov | 2body - equivalent 1 D, orbit equation | 8.4 - 8.5 |
| | W | 3-Nov | Kepler Orbits, bound and unbound | 8.6 - 8.8 |
| | F | 5-Nov | Acceleration w/o Rotation, Tides | 9.1 - 9.2 |
| 11 | M | 8-Nov | Rotating Frames and N2 | 9.3 - 9.5 |
| | W | 10-Nov | Centifugal and Coriolis Forces | 9.6 - 9.10 |
| | F | 12-Nov | More on non-inertial frames | |
| 12 | M | 15-Nov | Rotation about a fixed axis | 10.1 - 10.2 |
| | W | 17-Nov | The inertia tensor and principal axes | 10.3 - 10.5 |
| | F | 19-Nov | Precession of a Top, Euler's Eqns | 10.6 - 10.8 |
| 13 | M | 22-Nov | Euler Angles and a Spinning Top | 10.9 - 10.10 |
| | W | 24-Nov | **Thanksgiving** | |
| | F | 26-Nov | **Thanksgiving** | |
| 14 | M | 29-Nov | Two Masses, Three Springs - Identical | 11.1 - 11.2 |
| | W | 1-Dec | Two Weakly Coupled Oscillators | 11.3 |
| | F | 3-Dec | **EXAM 3 - Chap. 8 - 10** | |
| 15 | M | 6-Dec | Double Pendulum | 11.4 |
| | W | 8-Dec | General Case and Three coupled Pendulums | 11.5 - 11.6 |
| | F | 10-Dec | Normal Coordinates | 11.7 |