Welcome to Physics 440!

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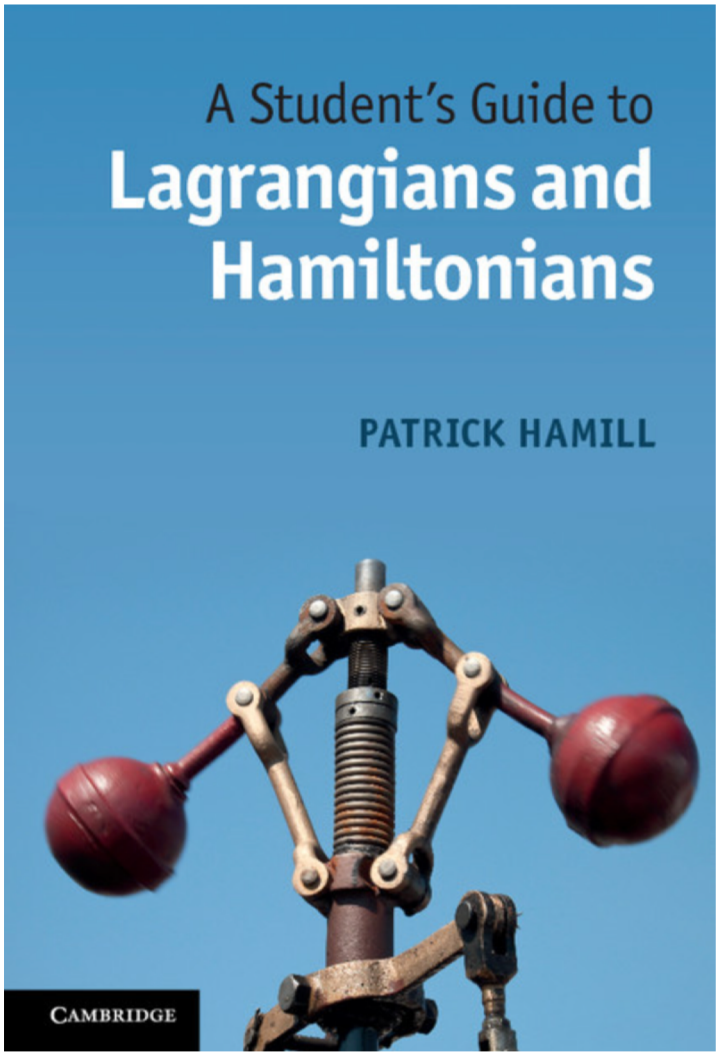
Agenda for today

- Introductions
- Syllabus
- Get started with classical mechanics!

Textbook



A scanned copy of chapter 1 is on D2L, but starting in week 2 you will need your own copy of the book.

We will read chapters 1-6 of the textbook

Content

- Lagrangian and Hamiltonian formulation of classical mechanics.
- Calculus of variations
- Lagrange’s and Hamilton’s equations
- Canonical transformations
- Poisson brackets
- Hamilton-Jacoby theory

Course structure

- Active learning principles
- Very little lecturing
- New material first introduced through the reading assignments and online warm-up quizzes (posted on D2L), which are due on Tuesdays at noon.
- Articulate questions you have about the reading.
- Explain things you find interesting.
- Help me prepare for class!

Assignments and grading

- **In-class activities.** Completed in groups of 3 or 4. Use whiteboards on walls. Not graded. Are designed to help you become familiar with new concepts before you go on to solve homework problems on your own.
- **Warm-up reading quizzes**. One or two free-response questions graded based on effort, not correctness. Due on Tuesdays at noon. 10% of final grade.
- **Homework assignments.** Graded based on completeness, factual correctness, proper use of logical reasoning, and clarity of presentation. You must show the work. Generally due on Thursdays before class. 40% of final grade.
- **In-class exams.** There will be two in-class exams on October 8 and November 5. Questions will be similar to those in the homework assignments and in-class activities. 30% of the final grade.
- **Final exam.** Will be given on November 21, 2:30-4:45pm. Questions will be similar to in-class exams. 20% of the final grade.
- **Final grade**. A– to A: 85% and higher, B– to B+: 70%-85%, C– to C+: 55%-70%, D to D+: 40%-55%, F: less than 40%

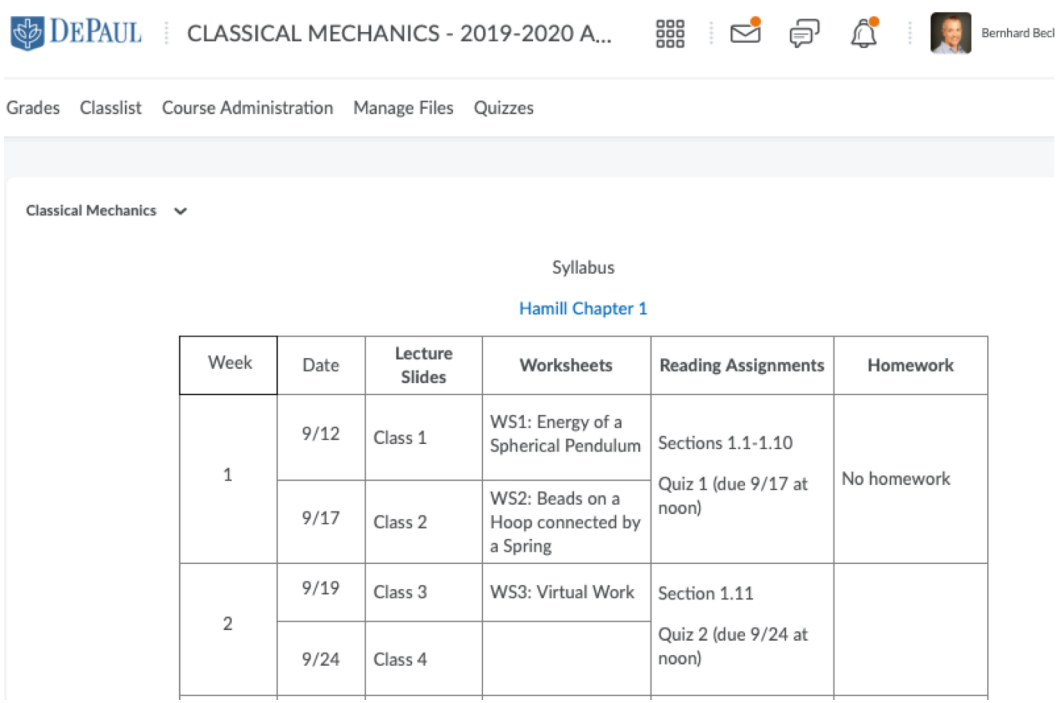
Homework Grading

- Each problem graded on a scale from 0-10.
- 10=perfect, 8-9=acceptable, 6-7=minor revisions necessary, 4-5=major revisions necessary, 0-3=unacceptable
- You may turn in a report discussing what you did wrong on the problem. Depending on the quality of this report, students can back get 50% of the points they lost.

Late assignments

- Warm-up quizzes: Not accepted.
- Homework assignments: The first submission of late homework will be accepted until noon the day after the deadline for 50% credit. After that late homework will not be accepted.
- Make-up exams only in cases of emergencies.

D2L (https://d2l.depaul.edu/)



Week	Date	Lecture Slides	Worksheets	Reading Assignments	Homework
1	9/12	Class 1	WS1: Energy of a Spherical Pendulum	Sections 1.1-1.10 Quiz 1 (due 9/17 at noon)	No homework
	9/17	Class 2	WS2: Beads on a Hoop connected by a Spring		
2	9/19	Class 3	WS3: Virtual Work	Section 1.11 Quiz 2 (due 9/24 at noon)	
	9/24	Class 4			

Posted on our D2L site:

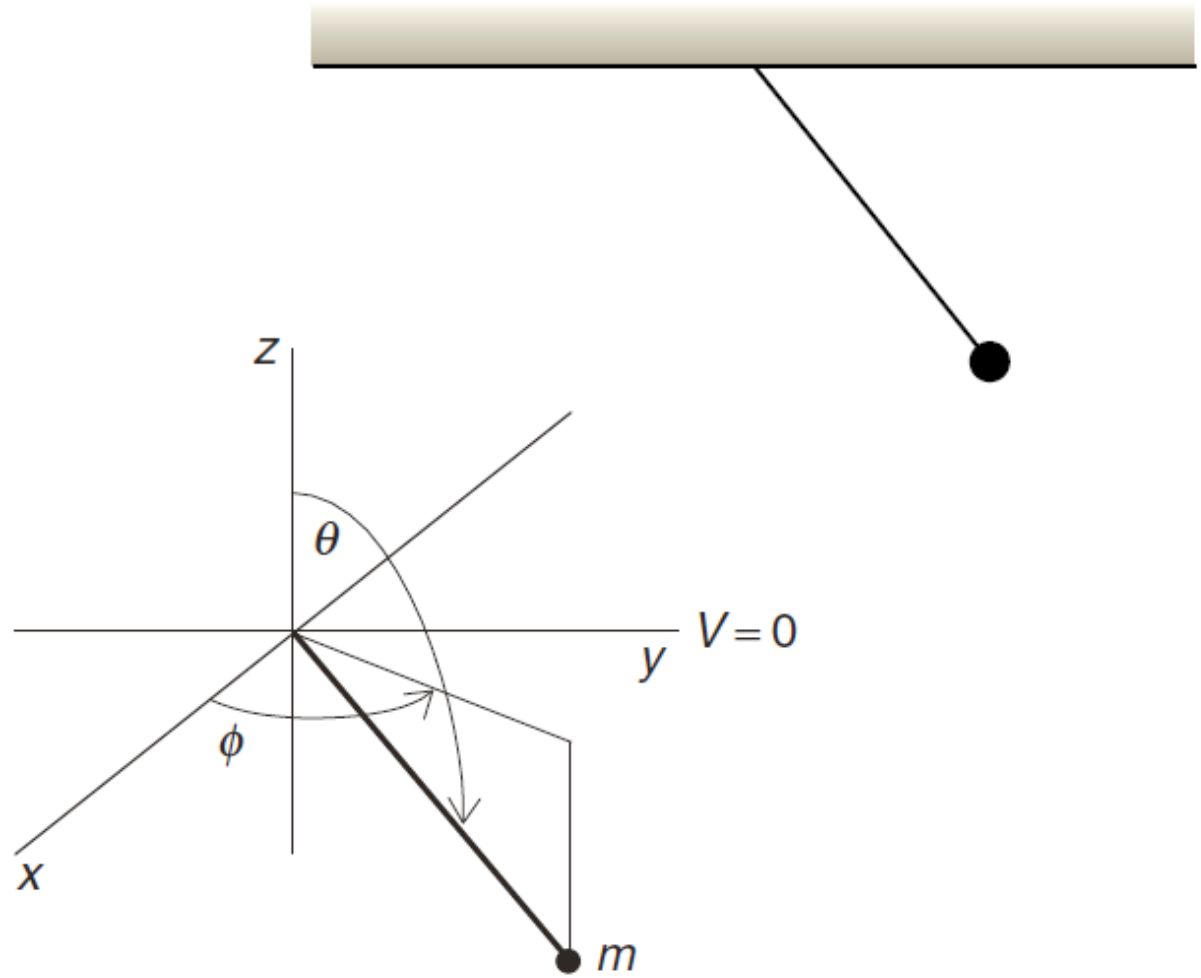
- Due dates
- Lecture slides
- In-class worksheets
- Reading quizzes
- Homework assignments
- Grades
- Exams and solutions to assigned problems will not be posted on D2L.

Upcoming deadlines

- Reading assignment (sections 1.1 to 1.10) and first warm-up quiz due next Tuesday, September 17.
- First homework assignment due next Thursday, September 19.

Worksheet 1: Energy of a Spherical Pendulum

Find the kinetic and potential energy in Cartesian and spherical coordinates



What do we want to learn from this?

- We frequently want to find a coordinate system that provide the minimum number of coordinates to define the system because it simplifies the equations of motion. We'll often start with Cartesian coordinates and then compute the transformation to spherical, cylindrical, etc. coordinates.
- In Lagrangian mechanics we derive the equation of motion using Lagrange's equation : $\frac{d}{dt}\frac{\partial L}{\partial \dot{q}} - \frac{\partial L}{\partial q} = 0$ where $L = T - V$ is the "Lagrangian." Determining T and V is often the first step toward determining the motion of a system.

Trigonometric identities:

You'll need $\sin^2\alpha + \cos^2\alpha = 1$ or worksheet 1, and others for upcoming worksheets. For example, for worksheet 2 you'll need $\sin^2\alpha = \frac{1}{2}(1 - \cos 2\alpha)$

Trigonometric Identities

$$\sin(\theta \pm \phi) = \sin\theta\cos\phi \pm \cos\theta\sin\phi \qquad \cos(\theta \pm \phi) = \cos\theta\cos\phi \mp \sin\theta\sin\phi$$

$$\cos\theta\cos\phi = \tfrac{1}{2}[\cos(\theta+\phi) + \cos(\theta-\phi)] \qquad \sin\theta\sin\phi = \tfrac{1}{2}[\cos(\theta-\phi) - \cos(\theta+\phi)]$$

$$\sin\theta\cos\phi = \tfrac{1}{2}[\sin(\theta+\phi) + \sin(\theta-\phi)]$$

$$\cos^2\theta = \tfrac{1}{2}[1 + \cos 2\theta] \qquad \sin^2\theta = \tfrac{1}{2}[1 - \cos 2\theta]$$

$$\cos\theta + \cos\phi = 2\cos\frac{\theta+\phi}{2}\cos\frac{\theta-\phi}{2} \qquad \cos\theta - \cos\phi = 2\sin\frac{\theta+\phi}{2}\sin\frac{\phi-\theta}{2}$$

$$\sin\theta \pm \sin\phi = 2\sin\frac{\theta \pm \phi}{2}\cos\frac{\theta \mp \phi}{2}$$

$$\cos^2\theta + \sin^2\theta = 1 \qquad \sec^2\theta - \tan^2\theta = 1$$

$$e^{i\theta} = \cos\theta + i\sin\theta \qquad \text{[Euler's relation]}$$

$$\cos\theta = \tfrac{1}{2}(e^{i\theta} + e^{-i\theta}) \qquad \sin\theta = \tfrac{1}{2i}(e^{i\theta} - e^{-i\theta})$$

From Taylor Classical Mechanics

Let’s get started

- Work in two groups of 2 or 3. Make sure that everybody in your group is able to participate in the group work.
- Use the white boards on the walls.
- We will stop about 10 minutes before the end of class and take turns discussing solutions that your group came up with.
- Here is a suggestion for groups, but feel free to change these.

Group 1	Group 2	Group 3	Group 4
Noah Baskes	Samaneh Ahmadinejad	Sanskar Basnet	Daniel Kabat
Shams Eladawy	William Asztalos	James Grammich	Kyle Napoleon
Jason Pero	Nycole Wenner	Timothy Holmes	Noelanni Alvarez