Course Syllabus

PHYS 331 – Advanced Classical Mechanics
Fall 2010

Instructor: Ben Vollmayr-Lee, Olin 168, `ben.vollmayr-lee@bucknell.edu`, x73106

Textbook: John Taylor, Classical Mechanics

Office Hours: Whenever I'm around. My schedule is given below.

Course Web Page: `http://www.eg.bucknell.edu/~bvollmay/phys331`

Course Description

Classical mechanics is where it all started. When Newton was able to demonstrate that the same forces and laws of mechanics that apply to apples and everyday objects (the terrestial) also governed the behavior of the moon and the planets (the celestial), the world took notice and physics was born. Newton's laws of motion, or mechanics, were not only *universal*, they proved to be *useful*. In a wide array of physical situations, classical mechanics all you need to be able to predict the motion of apples, baseballs, bones, bridges, cars, cats, and so on. For these two reasons alone: the universality of the laws, and their wide range of applicability, classical mechanics is an essential topic for students of physics.

But there's more: recent developments in classical mechanics have led to the theory of chaos. This has made classical mechanics a hot area of active research once more. Chaos has lead to significant advances in mathematics and physics (for example, it offers some explanation for the phenomenon of *ergodicity* in statistical mechanics) and fundamentally changes the way we look a predictability and solvability of dynamical systems.

And there's even more: while classical mechanics, by definition, does not include the 20th century advances of quantum mechanics and relativity, it is nevertheless an essential prerequisite for study of these topics. For example, the hamiltonian in quantum mechanics originates from the classical mechanics hamiltonian that we will encounter. We use concepts of forces and energy throughout physics, so a strong grounding in classical mechanics is essential.

While you have studied classical mechanics already in PHYS 211 and 221, in this course we will encounter more advanced techniques and solve a wider variety of problems. For example, we will encounter a reformulation of classical mechanics by Lagrange (and Hamilton) which makes it easier to deal with complicated situations such as more general coordinates or constraints on the motion. We will study the phenomenon of chaos, fully solve two-body orbit problems and derive Kepler's Laws, and develop the theory of effective forces that arise in noninertial frames. And we will complete the progression from point particle dynamics to rigid extended body motion to the full-fledged continuum mechanics of real, non-rigid solids and fluids.

Course Structure

The course material is drawn from the texts and the lectures. Assigned reading will be given on the board for the coming lecture, and should be done before the next lecture. Class time will be used to expand on the reading and to work through examples. This will be done via a combination of lectures and in-class exercises.

- **Homework** — A homework set will be assigned each class period and will be due at the beginning of the following class. While this leads to a lot of homework sets, it offers the advantage of keeping your homework more synchronized with the readings and lectures. Also, you and I both get immediate feedback on your progress through the material.

  You are encouraged to work together on the homework sets, though you must write up the problems yourself.

  No late homework will be accepted! This is because the solution sets will already have been distributed, and because the goal is for you to be working on the problems while we are discussing the material. You will get to drop your lowest four homework grades.

- **Journals** — You are required to submit a journal entry for each reading assignment. These serve the purpose of encouraging you to do the reading and, more importantly, giving me a useful guide as to what we should spend lecture time on, i.e., letting me know what's already clear and what's confusing from the reading. Because I will need to read these before class, they are due before 8:00 am on the day of class.

  To submit your journal entry, log in to your PHYS 331 account, which is accessible via the course web page. Your journal entry should demonstrate that you've done the reading and can contain any or all of the following: a summary, parts you found confusing, parts you found clear, parts you particularly liked or disliked, or general comments about the course. These will be scored on a 2 point scale: 0 if there is no evidence that you've done the reading, 1 if there is some evidence you did the reading, but not a lot of thought put into it, and 2 if your entry reflects you've done the reading and put a reasonable effort into it.

- **Exams** — There will be three in-class midterm exams. The dates for these is given in the Course Schedule below.

Grading

- Problem sets: 20%
- Journals: 10%
- 3 Midterm exams: 45% combined
- Final exam: 25%

Course Schedule

Dates	Topics	Reading
Aug 25–30	Newton's Laws	Ch 1–4
Sep 1–3	Oscillations	Ch 5
Sep 6–15	Nonlinear Mechanics and Chaos	Ch 12
Fri, Sep 17	**Exam 1**	
Sep 22–24	Variational Calculus	Ch 6
Sep 27–Oct 6	Lagrangian Mechanics	Ch 7
Oct 8–Oct 13	Central Force Problems	Ch 8
Fri, Oct 15	**Exam 2**	
Oct 20–27	Noninertial Frames	Ch 9
Oct 29–Nov 5	Rigid Body Motion	Ch 10
Nov 8–15	Coupled Oscillations	Ch 11
Wed, Nov 17	**Exam 3**	
Nov 19–Dec 6	Continuum Mechanics	Ch 16
TBA	**Final Exam**	

My Schedule (8:30–5:00)

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00				**PHYS 211 Lab**	
9:00	**PHYS 331**		**PHYS 331**		**PHYS 331**
10:00	**Exercise**				
11:00					
12:00	**Colloquium**	**Faculty Meeting**	**Exercise and Lunch**	**Department Mtg.**	**Exercise and Lunch**
1:00		**PHYS 211 Lab**		**CSP Meeting**	
2:00					
3:00	**Home with kids**				
4:00					**PHYS 211 Lab Prep**
7–10	**PHYS 211 Lab**				