Course Information

Physics 327/01 (Advanced Classical Mechanics)

Spring 2018

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Course Website: We will use Moodle – http://moodle.lafayette.edu. "PHYS 327.01- Spring 2018 Advanced Mechanics" - should be in your list of current courses. Handouts, homework assignments/solutions, exam solutions, supplemental articles, etc., can be downloaded from this site. Taking a few moments to explore the site at the beginning of the semester is highly recommended.

Prerequisites: The prerequisites for this course are Physics 218 and Math. 264. Of course this implies that the following courses have already been taken as well: Physics 131-132/133 or 151/152, Math 162 and Math 263.

Primary Text: *Classical Mechanics*, John R. Taylor, 2005

Useful supplementary physics texts (get from library, ILL, eCampus.com, etc.):

1. *Newtonian Dynamics*, Ralph Baierlein, 1983.
2. *Classical Dynamics of Particles and Systems 5th ed.*, Stephen T. Thornton and Jerry B. Marion, 2004.
3. *Analytical Mechanics 7th ed.*, G. R. Fowles and G. L. Cassiday, 2005.

4. *Classical Mechanics 5th ed.*, Tom W. B. Tribble and Frank H. Berkshire, 2004.
5. *Newtonian Mechanics*, A. P. French, 1971.
6. *Mechanics 3rd ed.*, Keith R. Symon, 1971.
7. *Introduction to Classical Mechanics, 2nd ed.*, Atam P. Arya, 1998.
8. *Classical Mechanics 3rd ed.*, Herbert Goldstein, Charles Poole and John Safko, 2002.
9. *A First Course in Analytical Mechanics*, Klaus Rossberg, 1983.
10. *Classical Mechanics: A Modern Perspective*, Vernon D. Barger and Martin G. Olsson, 1995.
11. *Classical Mechanics*, Tai L. Chow, 1995 (Beware, first printing full of errors!).
12. *Classical Mechanics*, Richard A. Matzner and Lawrence C. Shepley, 1991.
13. *An Introduction to Mechanics*, Daniel Kleppner and Robert J.Kolenkow
14. *Mechanics: From Newton's Laws to Deterministic Chaos*, F. Scheck, 1996.
15. *Introduction to the Principles of Mechanics*, W. Hauser, 1965.

Suggested supplementary mathematical physics texts (get from library, ILL, eCampus.com, etc.):

1. *Mathematical Methods for Scientists and Engineers*, Donald A. McQuarrie, 2005.
2. *Mathematical Methods in the Physical Sciences 3rd ed.*, Mary J. Boas, 2005.
3. *Mathematical Methods for Physicists 5th ed.*, George B. Arfken and Hans J. Weber, 2001.

Class Overview:

In this course you will learn advanced methods for solving a wide, and I hope, interesting variety of mechanics problems. We shall begin with a brief review of Newtonian mechanics and then move on to two more recent but venerable formulations of mechanics, namely, those due to Lagrange and Hamilton. The last two form particularly effective bridges to Einsteinian relativity and quantum mechanics. Along the way we shall focus on a number of timely, fascinating and important applications, including central force problems, nonlinear mechanics and chaos, and non-inertial reference frames, the latter especially important in analyzing magnetic resonance phenomena, molecular spectroscopy and general rigid body motion. The last few decades have witnessed a renaissance in classical mechanics, primarily as a result of the development of and progress in non-linear dynamics and chaos theory. Further, the recent rapid development of computers has enabled researchers in the field to tackle problems in soft and condensed matter physics, biophysics and cosmology. So, classical mechanics remains a viable and surprisingly relevant field of study even today.

One should note, also, that classical mechanics provides a vast and fertile playground for the development and application of advanced mathematical techniques, many of which can be transferred directly or with suitable modification to other branches of physics and even to other fields of study.

Student Learning Outcomes:

After completing this course, you will be able to...

- Analyze physical situations using non-Cartesian coordinate systems.
- Understand and apply the principles of the calculus of variations.
- Understand the derivation of Lagrange's equations.
- Use Lagrange's equations to solve mechanics problems.
- Evaluate two-body problems using the one dimensional central force formalism.
- Analyze phenomena in rotating reference frames.
- Calculate the rotational motion of three-dimensional bodies.
- Understand phenomena which arise in nonlinear mechanics.
- Understand and use generalized coordinates and the Hamiltonian formulation of mechanics.
- Use numerical tools to solve mechanics problems

Class Structure:

Delivering a lecture in front of class may be the least effective way of teaching physics. To create a more effective learning environment I intend having you do most of the work while I serve primarily as a guide. With that in mind, I envision two or three typical classroom activities: (1) short lectures by me to clarify or amplify key points in the book; (2) individual students presenting problem solutions at the board and (3) breaking up the class into small problem-solving groups which will present results on the blackboard or lead in-class discussions.

Homework and Other Assignments:

Preparing for class and doing the homework are critical to your success. Homework assignments will be given weekly and are to be handed in at the start of class on the due date. Late homework will not be accepted. Solutions to homework will be posted on Moodle the day the assignment is due. Some assignments will be computer-based. It will behoove you to become familiar with, if you haven't already done so, with one or more powerful software programs, such as Mathematica, MATLAB or Maple. Even spreadsheets like Excel may be profitably used for some assignments.

Collaboration and Intellectual Honesty:

Collaboration among students is strongly encouraged. You may work together studying the material and in solving homework problems. However, under no circumstances should you copy each other's solutions. Thus, while close collaboration is encouraged, the final product must represent your own work. Further, you may not collaborate on any exam questions. Directly copying homework solutions or exam answers will result in stiff penalties ranging from a zero for the assignment or exam to failure for the course. If you desire clarification of any of these points, please read the statement on "Academic Honesty" posted under the documents section of Moodle or consult with me.

I encourage all of you to seek help when needed. Generally, the earlier you come the better the results. My office hours are listed on my schedule (included with the first day's handout) and also are posted on the bulletin board next to my office. Interacting with students has been and remains a source of peerless joy to me.

Exams:

There will be two midterm exams given at times shown in the syllabus. There will also be a comprehensive final exam at a time scheduled by the Registrar. Details of the exams (e.g., whether they are open or closed book) have not been determined yet, but they will be provided well in advance of the exam. Exam questions will resemble homework problems. Each midterm exam will be on the material covered in the preceding weeks of the class (i.e., since the previous midterm). The final exam will cover all course material with a slight bias toward material covered after the second midterm.

Grading:

40% Homework and Class Participation
15% Midterm Exam #1
15% Midterm Exam #2
30% Final Exam (Cumulative)

Course Syllabus

Topics	Approximate Number of Classes	Text Chapter
Newtonian Mechanics Review – Projectiles and Drag	3	Ch. 2
Calculus of Variations	3	Ch. 6
Lagrangian Mechanics	6	Ch. 7
Midterm Exam #1	1	Ch. 2,6,7
Central Force Problems	7	Ch. 8

Spring Break		
Non-inertial Reference Frames	4	Ch. 9
Rigid Body Rotation	7	Ch. 10
Midterm Exam #2	1	Ch. 8,9,10
Nonlinear Mechanics	5	Ch. 12
Hamiltonian Mechanics	4	Ch. 13
Review	1	
Final Exam		Inclusive

Accommodation:
My policy – I am here because you are here. It is important to me that you do well in this class. If you have any disabilities which you feel may interfere with your ability to perform well in this class, please contact me to discuss ways of accommodating them.

Moodle & Privacy: Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Meeting Federal Credit Hour Standards: The student work in this course is in full compliance with the federal definition of a four credit hour course. **The federal course credit rule requires a total of 180 hours (12 hours/week) of student work over an approximately 15- week semester for a full (four credit hour) course.** Refer to the Registrar's Office website for the full policy and practice statement (http://registrar.lafayette.edu/additional-resources/cep-course-proposal/).