PHY 440 – Classical Mechanics

Schedule (*Autumn 2019*)**: 4:20 PM–5:50 PM, T-Th, in Byrne 204**

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Office Hours: 12:00 – 1:00 PM on Mondays & Wednesdays, or by appointment
Textbook: *A Student's Guide to Lagrangians and Hamiltonians*, by Patrick Hamill

Purpose and Expectations
This course is about the structure and techniques of classical mechanics. We will move beyond Newton's laws and investigate the Lagrangian and Hamiltonian formulations of classical mechanics. This will lead to greater insight into the mathematical structure of classical mechanics. The topics for this course include generalized coordinates, the calculus of variations, Lagrange's and Hamilton's equations, canonical transformations, Poisson brackets, and Hamilton-Jacoby theory.

Course Structure and Format
The design of this course is based on the best practices developed by the physics education research community. Their work has shown that students learn physics best when courses are structured using *active learning* principles, so this course will be taught in a seminar format. What this means is that I will not be lecturing very much. Instead, once a week you will complete a reading assignment that will introduce you to the course material. Along with each reading assignment comes an online warm-up exercise; these are due at noon on Tuesdays, no exceptions. In the first part of this assignment I want you to articulate any questions you have about the reading assignment. If you feel that you don't have any questions, then you should write about what you found most interesting about the reading, and why. This part is very useful to me when I prepare for class, so I encourage you to ask thoughtful questions.

In addition to providing you an opportunity to ask questions about the week's reading, each warm-up assignment will include one or two free-response questions related to the material in the reading. I will use your responses to the warm-up exercises to prepare the in-class activities and mini-lectures for the week. The on-line warm-up exercises are evaluated based on your effort, not correctness (I don't expect you to master the material before class!), so please feel free to make your best effort in answering all the warm-up questions. While I don't expect you to master the material just by reading the text, I *do* expect you to put time and effort into reading the text and thinking about the material. Because I won't do much lecturing, this is extremely important: reading the textbook is the primary means by which you will be introduced to all the physics and mathematics content in this course. We will use the class time to make sense of what you have already read. While the text for this course is quite readable, it is also an advanced text, particularly in terms of the mathematics it contains. To be successful in this class, you must not only read the text, you must read it closely and carefully. I strongly suggest that you take notes as you read. Pay particular attention to the definitions and examples. Work out most of the examples yourself before reading the solution. I would expect you to spend at least two hours on each class' reading and warm-up assignments.

Assignments and Grading

The in-class exercises are meant to allow you to grasp the concepts before you go on to solve homework problems on your own. Therefore, you should participate with energy and enthusiasm in these exercises.

Homework will be assigned and collected weekly. All the homework assignments are due at the beginning of class on the date indicated on the assignment (usually on Thursdays). The first submission of late homework will be accepted until noon the day after the deadline for 50% credit. Bring late homework to my office, or leave it with the departmental assistant and ask her to time-stamp it.

Homework problems will be judged on completeness and factual correctness, proper use of logical reasoning, and clarity of presentation. You must explicitly *show the work* that was done by you in getting from the statement of the problem to its solution via application of the appropriate physical principle(s), a logically complete sequence of mathematical manipulations, together with phrases that illustrate why you chose each step the way you did, wherever such phrases may be necessary. The problems are meant to test whether *you* understand the material, *not* whether instructor is able fill in holes you left in your solution.

Each problem will be graded on a scale from 0–10 on the following basis: perfect = 10, acceptable = 8-9, minor revisions necessary = 6-7, major revisions necessary = 4-5, unacceptable = 0-3. Students will have a chance to turn in a report discussing what you did wrong on the problem. Depending on the quality of this report, students will be able to earn back 50% of the credit lost in the original submission. These reports must be turned in by the deadline indicated (usually two days after a homework has been returned) in order for students to be eligible to receive the higher scores. Unlike the initial submission, there are no late deadlines for these reports; they must be turned in by the stipulated deadline.

Two in–class exams will be given in the quarter. The exams will be closed book and closed notes with only a calculator allowed. Each exam will have an attached information sheet that may contain useful formulae, constants, etc.

A cumulative final exam will be held on Thursday, November 21, 2019 from 2:30 to 4:45 p.m. The exam will only be given on this day, so plan accordingly. The basic format of the exam will be like the in–class exams.

Grading Policy: The course grade will be determined on the following basis:
Warm-up exercises 10%; Homework 40%; Two in-class exams 30%; Final exam 20%

The final grading scale will be the following (changes may be made if necessary, but only to the student's advantage):

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%	

A grade of incomplete is only given under extreme circumstances (such as an extended stay in the hospital); an incomplete is not a mechanism to improve an unsatisfactory grade.

Students with disabilities: If you are registered with the Office of Students with Disabilities, please make an appointment with the course instructor to discuss any academic accommodations you may need. If you need academic accommodations and are not registered with the Office of Students with Disabilities, please contact the office at 2250 N. Sheffield, Room 370, or by telephone at (773) 325-

1677 (TTY 773-325-7296). Upon individual request, this syllabus can be made available in alternative forms.

Academic integrity: Plagiarism is the act of presenting the work of another and claiming it as one's own; this applies whether the other person is a student or author, whether the material is obtained from handwritten or computer generated notes, published work, or online. As such, plagiarism is unacceptable, and it will be dealt with according to university procedures as outlined in the Student Handbook. Please refer to the Student Handbook for a detailed description of what constitutes the above behavior. Penalties will include a failing grade in the course and may include suspension or expulsion from the university. Note that if two or more solutions are found to be similar, all concerned parties will be penalized, that is, the instructor will hold all parties equally responsible, without determining who copied from whom.

Class Schedule

Warm-up reading quizzes are due at noon. Homework assignments are due at the beginning of class.

Week	**Material Covered**	**Reading**	**Homework**	**Exams**
9/11 – 9/17	Generalized coordinates, constraints	Sections 1.1 – 1.10 Quiz 1 due 9/12	No homework	
9/18 – 9/24	Generalized momentum, conservation laws	Section 1.11 Quiz 2 due 9/19	Homework 1 due 9/14	
9/25 – 10/1	Calculus of variations	Sections 2.1 – 2.4 Quiz 3 due 9/26	Homework 2 due 9/21	
10/2 – 10/8	Lagrangian mechanics, Hamilton's principle	Sections 3.1 – 3.4 Quiz 4 due 10/3	Homework 3 due 9/28	10/3 (in-class)
10/9 – 10/15	Lagrange multipliers	Sections 3.5 – 3.8 Quiz 5 due 10/10	Homework 4 due 10/5	
10/16 – 10/22	Hamilton's canonical equations	Sections 4.1 – 4.7 Quiz 6 due 10/17	Homework 5 due 10/12	
10/23 – 10/29	Canonical transformations	Sections 5.1, 5.2 Quiz 7 due 10/24	Homework 6 due 10/19	
10/30 – 11/5	Poisson brackets, Liouville's theorem	Sections 5.3 – 5.5 Quiz 8 due 10/31	Homework 7 due 10/26	10/31 (in-class)
11/6 – 11/12	Hamilton-Jacobi equation	Sections 6.1 – 6.4 Quiz 9 due 11/7	Homework 8 due 11/2	
11/13 – 11/19		No reading	No homework	
11/21	Final Exam			2:30 to 4:45pm