PHY 313: Mechanics

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Office Hours: TBA --- Zoom Link

Modality

This course is primarily taught ***face-to-face*** unless otherwise indicated.

Description

In this course, we explore classical mechanics from a modern perspective. We will introduce methods allowing us to analyze physical situations in general reference frames, bringing us close to aspects of special and general relativity. By developing the Hamiltonian and Lagrangian descriptions of mechanics, we will glimpse the seeds of quantum theory. We will also explore the concept of symmetry and how it can be precisely encoded in our mathematical descriptions of physics.

Course objectives

- You will develop an understanding of advanced concepts and mathematical descriptions of classical mechanics. These concepts and mathematical ideas include
    - Analysis of more complex mechanical systems
    - Deriving equations of motion from optimization principles
    - Lagrangian and Hamiltonian formulation of mechanics
    - Index notation
    - Advanced vector analysis and basic linear algebra

Prerequisites and Helpful Background Knowledge

Course prerequisites

- PHY 115, PHY 234, MTH 211/213
- Familiarity with calculus through vector calculus (Calculus III)

Helpful background

- Introductory Newtonian mechanics
- Basic linear algebra (comfort with matrix multiplication and addition)

All necessary physics and math will be covered in a self-contained manner in this course, but having some of the above background will be helpful.

Recommended Texts

All course material will be made available through my notes and lecture videos (if applicable). However, the following texts may be useful for following along:

- *Classical Mechanics, 1st Ed.,* by John Taylor **(Main text recommendation)**
- *Lectures on Classical Dynamics* by David Tong (Free supplementary recommendation)

Helpful Resources

- The Cornell note-taking system:
  - http://lsc.cornell.edu/notes.html
  - https://youtu.be/w3pM5hEgBk4
- Classical mechanics course website: http://phy111113.blogs.umassd.edu
- Kagan Physics III site: https://phy115.sites.umassd.edu
- Vector help: Name That Vector; Vector Guessing Game
- Calculus help: Better Explained
- Professor Leonard (math courses via YouTube): https://www.youtube.com/user/professorleonard57
- NancyPi: https://www.youtube.com/channel/UCRGXV1QlxZ8aucmE45tRx8w
- Basics of Linear Algebra (3Blue1Brown): https://www.3blue1brown.com/topics/linear-algebra
- Open Educational Resources: https://www.umassd.edu/faculty/heoa-textbook/oer-resources/

Health, Safety, and Our Responsibilities

Vaccination Requirement

- UMass Dartmouth requires all undergraduate and graduate students to be vaccinated against COVID-19 if they intend to live, learn, or physically come to campus. For more details, pllease see https://www.umassd.edu/covid/planning/
- Students are required to upload their proof of vaccination to the Health Services Portal
- Students claiming an exemption to the requirement must also submit either a written request for exemption upon religious grounds or medical exemption documentation from a healthcare provider.
- Follow these links on how to upload your COVID vaccine documentation guide to add your information to the Health Services portal

Personal Responsibility

- Every member of the UMassD community must do their part to protect one another, including:
    - Using face coverings in all public places on campus unless a medical exemption is obtained
    - Complying with the MA face covering requirement: students and faculty must wear a face covering at all times in classrooms and labs.
    - Practice good personal hygiene including handwashing per CDC guidelines
    - Avoiding eating and drinking in classrooms and labs
    - *Staying home or isolated if they feel sick or exhibit known COVID-19 symptoms*

Course topics

I believe that to encourage actual learning, you should be allowed to demonstrate improved understanding without penalties for making mistakes earlier in the course. I've divided the main material in this course into *topic areas* to help you keep closer track of your strengths and weaknesses. The division also helps me to keep track of your progress, and ultimately forms the basis for your final grade in the course.

Below is a list of the topic areas:

Topic Areas:

T1: Newtonian mechanics
T2: Oscillatory systems
T3: Frames and symmetry
T4: General coordinates
T5: Hamiltonian mechanics
T6: Lagrangian mechanics

NOTE: adjustments may be made to the precise topics and their content as we go.

Course components

Lectures:

Lectures will involve development of the core concepts and mathematical description of general relativity and related topics. We will sometimes do in-class activities involving problems and discussion. You should feel free to ask questions about material and homework. If we spend a substantial amount of time on questions, I will assign readings or videos so that we can make sure to cover all the key course topics.

Reading / Videos:

Reading from my prepared notes or videos I post (time permitting) will be assigned depending on how much the lectures need to be supplemented. I will also post notes and videos after our lectures to aid with reviewing the material we cover.

Homework:

Solving problems is an essential way to develop your skills and understanding of the material. The homework sets for the course are an opportunity to hone your understanding and identify areas that need more work. You will have two tries for each assignment. The first try will usually be due the week after the assignment is posted. I will review the work you hand in and possibly include some minimal comments. Solutions will be posted and you will then use them to correct your original assignment. The corrections should be made alongside the original work with extra pages added as necessary.

Half of the homework credit will be given for handing in the completed homework on the first due date. The other half will be given for submitting your corrections. Credit will be withheld for late or incomplete assignments.

Assessment

Quizzes will have "conceptual" and "quantitative" questions. The conceptual questions assess your grasp of the principles of physics and their implications. The quantitative questions assess your application of mathematical techniques along with your conceptual understanding of the various topic areas to solve problems having to do with a physical scenario. These questions are organized and graded by topic area.

If you do better in a topic area on a later quiz (for example, if you improve your topic 1 score on the final) then I will use the better of the two scores to help determine your final grade.

If you do *worse* in a topic area on a later test I will deduct 20% of the difference between your original score and your most recent performance from your score in that topic area.

Grading

Your grade will be determined on the following basis:

- 70% Average of concept and quantitative quiz scores
- 20% Homework
- 10% Class participation (including attendance)

A+	100		C	70 to 73
A	93 to 100		C-	67 to 70
A-	87 to 93		D+	63 to 67
B+	83 to 87		D	60 to 63
B	80 to 83		D-	57 to 60
B-	77 to 80		F	0 to 57
C+	73 to 77			

NOTE: I reserve the right to adjust this grading scale should the need arise.

Communication with Me

I am very happy to communicate with you in person or by email. In order to help facilitate the best e-mail communication please take note of the following:

- Treat your communications in a professional manner: I am easygoing, but it's important to make a good impression.
- Make sure your full name displays properly in the "From" line of your email.
- Use a concise, descriptive subject line for your email.
- When initiating a conversation, unless your professor explicitly says otherwise, address them as "Dear Professor [their last name],"
- Use good grammar, spelling, and punctuation
    - This is important for both clarity and the impression you give

You may find this document on email etiquette informative (note that I do not agree with all the points made in the article: in particular, I *prefer* to be e-mailed if you have an excused absence from class or lab. I am also happy to take questions about your academic standing in the course once or twice a semester).

Here is another good article on the subject of student/professor interaction. You might find it illuminating.

Classroom Policy

- Our time is valuable: I aim to start each class promptly at the scheduled time and to make sure we end on time.
- I will ask students who are disruptive to leave the classroom.
- I reserve the right to bar students who are late from entering that particular lecture session.
- Laptops, phones, and other such devices should be switched off and stored in your bag or pocket once class has begun. All note-taking should be done in a notebook with pen or pencil.
- Please take a look at this article as an explanation for the previous policy.

Academic Integrity

All UMass Dartmouth students are expected to maintain high standards of academic integrity and scholarly practice. The University does not tolerate academic dishonesty of any variety, whether as a result of a failure to understand required academic and scholarly procedure or as an act of intentional dishonesty.

A student found responsible of academic dishonesty is subject to severe disciplinary action which may include dismissal from the University. The procedure for responding to incidents of academic dishonesty may be found in Section III of this document. You may also refer to the Student Handbook for information about the judicial process.

A high standard of academic integrity promotes the pursuit of truth and learning and respect for the intellectual accomplishments of others. These are values that are fundamental to the mission of this University. Such values are undermined by academic dishonesty.

Academic freedom is a fundamental right in any institution of higher learning. Honesty and integrity are necessary preconditions of this freedom. Academic integrity requires that all academic work be wholly the product of an identified individual or individuals. Joint efforts are legitimate only when the assistance of others is explicitly acknowledged and deemed appropriate by the instructor of the course. Ethical conduct is the obligation of every member of the University community, and breaches of academic integrity constitute serious offenses.

Maintenance of the standards of academic integrity and the successful administration of this policy depend on the mutual cooperation of faculty and students.

Faculty cooperation is essential for successful application of the procedures defined by this Academic Integrity Policy. Faculty members promote academic integrity by making clear on their syllabi their expectations concerning homework assignments, collaborative student efforts, research papers, examinations, computer-based infractions, and the like. Efforts should be made to detect and to prevent cheating and plagiarism in all academic assignments. If faculty members have evidence of academic dishonesty, they are expected to report such evidence promptly.

Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Students are also expected to report incidents of academic dishonesty to the instructor or dean of the instructional unit.

The intent of this policy is to make clear the standards of academic integrity at UMass Dartmouth.

**For additional information on violations, infractions, and consequences visit the UMass Dartmouth Student Academic Integrity Policy at the link below.*

http://www.umassd.edu/studentaffairs/studenthandbookintroduction/studentconductpolicies/academicintegritypolicy/