Physics 624: Classical Mechanics

Fall 2022 (624 section 1, 3 credits)

- Instructor: Jay Nadeau, 370 Science Research and Teaching Center, nadeau@pdx.edu, 503-725-8929
- Office Hours: by appointment. You may email me at any time with questions and I will respond promptly.
- Course Website: https://canvas.pdx.edu/

Course Description

Advanced treatment of analytical mechanics of particles, systems of particles, and rigid bodies. Specifically: 1) Fundamentals of the Lagrangian and Hamiltonian variational approaches to mechanics; 2) mathematical techniques that underlie many other branches of physics; 3) bridges between classical and quantum mechanics.

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Prerequisites: Ph 424 (Classical Mechanics) (highly recommended); vector calculus and linear algebra.

Lectures: MW 10:00-11:50, Parkmill (PKM) 259
Dates: Sept 26, 2022-December 5, 2022

The required textbook for this course is *Variational Principles in Classical Mechanics* by Douglas Cline. This book is free and Creative Commons licensed.

Here is a pdf version
https://phys.libretexts.org/Bookshelves/Classical_Mechanics/Variational_Principles_in_Classical_Mechanics_(Cline)

Print copies are $16 on Amazon.

We will formally cover the Appendices and Chapters 4-9 and 14-18.
Although we will not formally cover Chapters 1-3 (Newtonian mechanics), these chapters are assumed to be review and you are expected to read them and to know the material as the basis for the other work.

Homework: There is biweekly assigned homework. Homework will be due before Thursday's class starting Week 2. All of the problem sets will be available from the start of class. WARNING: these problems are hard. Don't get behind. I will accept late work but you'll regret it if you fall behind. Better to get ahead if you can.

Exams: There will be 1 midterm exam and a final. The midterms will cover the material from preceding chapters, and the final is comprehensive. In class exams are closed everything--you will also be provided with useful constants, integrals, and certain formulas. Standard calculators are permitted but probably not useful. Phones, laptops,

tablets, or other communication devices are not allowed. To each test bring a bluebook (or loose paper) and a pencil. If you are very sick the day of the exam, please notify me as soon as you can by phone or email. The in-class exam problems will be much easier than the homework problems. The take-home exams are open textbook and notes.

Exam dates and material covered
Monday 10/24/22: Chapters 4,6, Appendices. In class.
Final Exam: Take home. Comprehensive.

Grading
The grade of each exam and the course will follow this scale by default, but will be curved as needed.
A: 89-110%
A-: 85-88%
B+: 82-84%
B: 75-81%
B-: 70-74%
C+: 67-69%
C: 60-66%
C-: 55-59%;
D: 40-54%
F <40%

Calculating grades
Grade is calculated as Homework (50%)+ midterm (20%) + final (30%).

POLICY STATEMENTS
Academic Honesty: "Academic honesty is a cornerstone of any meaningful education and a reflection of each student's maturity and integrity. The Code of Student Conduct and Responsibility, which applies to all students, prohibits all forms of academic cheating, fraud, and dishonesty. These acts include, but are not limited to: plagiarism, buying and selling of course assignments and research papers, performing academic assignments (including tests and examinations) for other persons, unauthorized disclosure and receipt of academic information, and other practices commonly understood to be academically dishonest" – Portland State University Bulletin, General Catalog Issue, Vol. 50, 2016-2017.

Title IX – Portland State is committed to providing an environment free of all forms of prohibited discrimination and sexual harassment (sexual assault, domestic and dating violence, and gender or sex-based harassment and stalking). If you have experienced any form of gender or sex-based discrimination or harassment, know that help and support are available. PSU has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and on-housing accommodations, helping with legal protective orders, and more. Information about PSU's support services on campus, including confidential services and reporting options, can be found on PSU's Sexual Misconduct Prevention and Response website at:

http://www.pdx.edu/sexual-assault/get-help or you may call a confidential IPV Advocate at 503-725-5672. Please be aware that all PSU faculty members and instructors are required to report information of an incident that may constitute prohibited discrimination, including sexual harassment and sexual violence. This means that if you tell me about a situation of sexual harassment or sexual violence that may have violated university policy or student code of conduct, I have to share the information with my supervisor or the University's Title IX Coordinator or the Office of Affirmative Action. For more information about Title IX please complete the required student module Creating a Safe Campus in your D2L.

Disability Accommodations at PSU – PSU values diversity and inclusion; we are committed to fostering mutual respect and full participation for all students. My goal is to create a learning environment that is equitable, useable, inclusive, and welcoming. If any aspects of instruction or course design result in barriers to your inclusion or learning, please notify me. The Disability Resource Center (DRC) provides reasonable accommodations for students who encounter barriers in the learning environment. If you have, or think you may have, a disability that may affect your work in this class and feel you need accommodations, contact the Disability Resource Center to schedule an appointment and initiate a conversation about reasonable accommodations. The DRC is located in 116 Smith Memorial Student Union, 503-725-4150, drc@pdx.edu, https://www.pdx.edu/drc.

COVID STATEMENT

Classroom Requirements for All Students and Faculty Due to Covid-19

The University has established rules and policies to make the return to the classroom as safe as possible. It is required for everyone to follow all the Return to Campus rules and policies. To participate in this class, PSU requires all students to comply with the following.

Vaccination

- Be vaccinated against COVID-19 and complete the COVID-19 vaccination attestation form. Those students with medical or nonmedical exemptions or who will not be on campus at all must complete the process described on the "COVID-19 Vaccine Exemption Request Form" to establish those exemptions.

Health Check, Illness, Exposure, or Positive Test for COVID-19

- If you are feeling sick or have been exposed to COVID-19, do not come to campus. Call The Center for Student Health and Counseling (SHAC) to discuss your symptoms and situation at 503-725-2800. They will advise you on testing, quarantine, and when you can return to campus.

- If you test positive for COVID, report your result to SHAC and do not come to campus. SHAC will advise you on quarantine, notification of close contacts, and when you can return to campus.
- Please notify me (i.e. your instructor), should you need to miss a class period for any of these reasons so that we can discuss strategies to support your learning during this time.
- If I become ill or need to quarantine during the term, either I or the department chair will notify you via PSU email about my absence and how course instruction will continue.

Failure to Comply with Any of these Rules

As the instructor of this course, the University has given me the authority to require your compliance with these policies. If you do not comply with these requirements, I may ask you to leave the classroom, or I may need to cancel the class session entirely.

In addition, failure to comply with these requirements may result in a referral to the Office of the Dean of Student Life to consider charges under PSU's Code of Conduct. A student found to have violated a university rule (or rules) through the due process of student conduct might face disciplinary and educational sanctions (or consequences). For a complete list of sanctions, see Section 14 of the Student Code of Conduct & Responsibility.

Guidance May Change

Please note that the University rules, policies, and guidance may change at any time at the direction of the CDC, State, or County requirements. Please review the University's main COVID-19 Response webpage and look for emails from the University on these topics.

Schedule:

Week	Dates	Topics, Readings, Assignments, Deadlines
1	**09/26/22** **09/28/22**	Lecture 1: Mathematical topics (tensors, multivariable calculus) (Appendices) Lecture 2: Bifurcations and chaos (Chapter 4)
2	**10/03/22** **10/05/22**	Lecture 3: Calculus of variations (Chapter 5) Lecture 4: Calculus of variations continued (Chapter 5) **Homework 1 due: Appendices, Chapter 4**
3	**10/10/22** **010/12/22**	Lecture 5: Lagrangian dynamics (Chapter 6) Lecture 6: Holonomic systems (Chapter 6)
4	**10/17/22** **10/19/22**	Lecture 7: More Lagrangians (Chapter 6, supplement) Lecture 8: Non-holonomic systems (Chapter 6) **Homework 2 due: Chapter 6**
5	**10/24/22** **10/26/22**	**Midterm 1: Appendices, Chapters 4,6** Lecture 9: Hamiltonian introduction, symmetry (Chapter 7)
6	**10/31/22** **11/02/22**	Lecture 10: Hamiltonian mechanics (Chapter 8) Lecture 11: Central force (Chapter 9) **Homework 3 due: Chapters 7,8**
7	**11/07/22** **11/09/22**	Lecture 12: Scattering (Chapter 9) Lecture 13: Coupled linear oscillators (Chapter 14)
8	**11/14/22** **11/16/22**	Lecture 14: Normal modes for coupled oscillators (Chapter 14) Lecture 15: Interacting systems (Chapter 5): Real gases **Homework 4 due: Chapters 9, 14**
9	**11/21/22** **11/23/22**	Lecture 15: Advanced Hamiltonian mechanics (Chapter 15) Lecture 16: Advanced Hamiltonian mechanics 2 (Chapter 15)
10	**11/28/22** **11/30/22**	Lecture 17: Special relativity (Chapter 17) Lecture 18: Transition to quantum mechanics (Chapter 18) **Homework 5 due: Chapter 15**
Final Exam		Take home, problems from Chapters 17-18