PHYS 355 # Classical Mechanics **Fall 2024**

Course #28176 (3 credits)

Instructor: Dr. Alan R. Denton `alan.denton@ndsu.edu`
Professor, Dept. of Physics office: SE 214B, NDSU

Classes: TTh, 2:00-3:15 pm, SE 221 **Office Hours:** MW, 2-3 pm (or drop in)

Bulletin Description:

Basic concepts, single and coupled oscillators, variational calculus, Lagrangian dynamics, Hamiltonian dynamics, central force motion, and accelerated coordinate systems.

Prerequisites: PHYS 252, MATH 265 (basic knowledge of mechanics and calculus)

Objectives: Students will master the foundations of classical mechanics and learn to apply theoretical and computational methods to model a variety of physical systems, including projectiles, charged particles, oscillators, planetary systems, and rigid bodies.

Format: Students are expected to review assigned resources in advance and attend class prepared to discuss and work through guided exercises. You are not expected to fully understand the material before class, but be familiar with terminology and definitions. In this way, class time can be used more effectively to deepen conceptual understanding, strengthen problem-solving skills, and discuss practical relevance and applications.

Textbook: J. R. Taylor, *Classical Mechanics* (University Science Books, 2005)

Evaluation:

Problem Sets	50 pts	(group work and in-class presentations)
Quizzes	25 pts	
Exams	150 pts	(best 2/3 midterms and a final exam)
Project	25 pts	
Total	250 pts	

Attendance is expected (NDSU Policy 333, `www.ndsu.edu/fileadmin/policy/333.pdf`). Class attendance and engagement are strongly correlated with success in this course!

Problem Sets: Assignments will be posted on Blackboard (`https://bb.ndsu.nodak.edu`). Class time will be allotted for group work on assigned problems. A representative from each group will present solutions at the board and guide discussions in class (see Rubric).

Quizzes: Short quizzes to guide reading assignments will be posted on Blackboard.

Project: Group work on a research proposal and oral presentation (see Guidelines).

Grading: A: $\geq 85\%$, B: 70 to $< 85\%$, C: 55 to $< 70\%$, D: 40 to $< 55\%$, F: $< 40\%$
Grades will not be curved and any shift in grade boundaries will be only in your favor.

Health and Safety Expectations

Requests for remote participation due to health concerns will be accommodated. Do not come to class if you are sick or, if infected by COVID-19, during your five-day isolation period. Do not come to class if you have been exposed to individuals who tested positive for COVID-19 and/or you have been notified to self-quarantine due to exposure.

Preliminary Schedule

Week	Topic
1-2	Newton's Laws of Motion
2-3	Projectiles and Charged Particles
4	Momentum and Angular Momentum
5-6	Energy
September 26	**Midterm Exam 1**
6-7	Oscillations
8	Calculus of Variations
9-10	Lagrange's Equations
October 31	**Midterm Exam 2**
11	Hamiltonian Mechanics
12	Two-Body Central-Force Problems
13-14	Mechanics in Noninertial Frames
December 3	**Midterm Exam 3**
14-15	Rotational Motion of Rigid Bodies
16	Coupled Oscillators and Normal Modes
December 16, 1:00 PM	**Final Exam**

Computational Examples and Exercises

To deepen conceptual understanding and build computational skills, we will make use of Mathematica, Python, and *Simulations in Physics* in the Open Source Physics Library, free Java software that can be downloaded, compiled, and run on any computer.

The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at `www.ndsu.edu/academichonesty`.

All access to NDSU computers must respect NDSU Senate Policy, section 158: Acceptable use of Electronic Communication Devices
`https://www.ndsu.edu/fileadmin/policy/158.pdf`

Any students with disabilities or other special needs, who need special accommodations in this course are invited to share concerns or requests with the instructor and to contact the Disability Services Office (`www.ndsu.edu/disabilityservices`*) as soon as possible.*

Problem Set Guidelines and Expectations

Together with your group, in and out of class, discuss and solve all assigned problems.

Each group member contributes to discussions and writes solutions in their own words.

A complete written solution includes (1) statements of physical concepts and principles, (2) definitions of all symbols, (3) explanations in words of all steps, and (4) conclusion (interpreting significance). A series of equations lacking context is not acceptable.

Each group collaborates and submits one set of handwritten solutions on Blackboard.

Each group member prepares to present solutions in class (all are accountable).

Rubric for Evaluating Presentations of Solutions

Element	**Expectations**	**Score**
clarity	identify concepts, define symbols, write legibly	3
completeness	show all steps and explain reasoning	3
accuracy	reason logically to obtain correct results	3
interpretation	explain meaning and significance of results	3
accountability	answer questions and defend solution	3
Total		15

Group Project Guidelines and Expectations

With instructor guidance, choose a relevant topic, do some background reading, and prepare a 10-page (double-spaced, 12-pt font) research proposal and 15-min oral presentation. The written proposal and presentation slides must each include the following components:

Introduction: Provide relevant background information and a broad overview of the field. Identify unresolved questions of interest and importance on the frontier of knowledge.

Objectives: State the objectives of the proposed research, motivated by open questions.

Methods: Describe theoretical, computational or experimental methods that would be appropriate to address the objectives, produce results, and resolve the open questions.

Significance: Discuss broader significance of the proposed research for science and society.

References: Provide a complete list of references, which should be cited in the proposal.

Roles: State how each group member contributed to preparing proposal and presentation.

Supplemental References

H. Goldstein, *Classical Mechanics*, 3rd ed. (Pearson, 2001).

S. T. Thornton and J. B. Marion *Classical Dynamics of Particles and Systems*, 5th ed. (Cengage Learning, 2003).

P. Hamill, *Intermediate Dynamics*, 2nd ed. (Cambridge, 2022).

T. M. Helliwell and V. V. Sahakian, *Modern Classical Mechanics* (Cambridge, 2021).

V. I. Arnold, *Mathematical Methods of Classical Mechanics* (Springer, 1989).

H. Gould, J. Tobochnik, and W. Christian, *An Introduction to Computer Simulation Methods*, 3rd ed. (Pearson, 2007).

N. J. Giordano and H. Nakanishi, *Computational Physics*, 2nd ed. (Benjamin Cummings, 2005).

Taylor and Goldstein are available for one-day loan from the NDSU Main Library.