University of Mississippi

Department of Physics and Astronomy

Physics 709: Advanced Mechanics I

Syllabus

Instructor: James Bonifacio
Email: jjbonifa@go.olemiss.edu

Fall 2025

Accessing homeworks and lecture notes will be through Blackboard.

Location and time

Classes: Monday, Wednesday, and Friday from 8:00 to 8:50 in Lewis 104.
Office hours: By appointment.

Text

We will mainly follow the book *Classical Mechanics* (3rd Edition) by Goldstein, Poole, and Safko. Other useful texts include: *Theoretical Mechanics of Particles and Continua* by Fetter and Walecka, *Mechanics* by Landau and Lifshitz, and *Mathematical Methods of Classical Mechanics* by Arnold. Useful lecture notes include: *Lectures on Classical Dynamics* by David Tong, *Classical Mechanics III* by Iain Stewart, and *Classical Mechanics for Mathematicians* by Tim Adamo.

Course goals and learning outcomes

This is a standard core course in the graduate curriculum for physics. In this course, we will learn advanced methods for analyzing the mechanical properties and dynamics of particles, systems of particles, and extended bodies in translational, bound, and rotational motion. We will also learn Hamilton's methods in classical mechanics which provide a fluid transition to concepts in quantum mechanics.

The significant goals of this course are for students to advance and expand their mathematical toolkit and improve their analytical reasoning.

Evaluation

Grades:

Letter grade	Percentage range
A	[88, 100]
B	[75, 88)
C	[65, 75)
D	[55, 65)
F	[0, 55)

Grade breakdown: 40% homework, 20% midterm, and 40% final.

Homework, tests, and final exam

Homework assignments will be announced via Blackboard and must be submitted by 9:00 am on the due date (usually a Thursday). The grading for these assignments is divided as follows: 20% of your grade will be attributed to attempting all problems and submitting the homework on time, while the remaining 80% will be based on the accuracy of your solutions.[1] As a result, late homework submissions can score a maximum of 80%. Exceptions and extensions can be granted for good cause, but requests for these must be made at least 24 hours before the deadline. Any homework handed in after the solutions have been posted will receive a score of zero. Answers copied from external sources will also be given a score of zero. Homework should be submitted in person to my office or slid under the door to Room 211. Please ensure that your submissions are legible.

The midterm and final examinations will be conducted in-person. As practice for the comprehensive exam, no outside resources or materials will be allowed during the examinations.

Attendance

Students are expected to attend each lecture unless they have a valid reason for being absent. If you need to miss a lecture, make contact with me as early as possible. It is recommended that you read the book or lecture note sections in advance and come ready to participate. If you miss an exam or cannot turn in homework, please inform the instructor beforehand and get a doctor's note if applicable. Absences from tests count as zeros, unless they are justified. If you must be absent during a test for a University sponsored event, you must discuss this with the instructor before the test date.

[1] More precisely, the formula for the number of points n is

$$n = 0.8n_{\text{correct}} + 0.1n_{\text{attempted on time}} + 0.1(n_{\text{attempted on time}} - n_{\text{correct late points that replace incorrect on time points}}).$$

Academic Integrity

Violations of the University's policy of academic integrity will result in a failing grade and other disciplinary actions. A student with a documented case of plagiarism or cheating in this course will receive a failing grade for the course and may face disciplinary action by the University, including expulsion. In particular, do not turn in problem set solutions copied from online sources, past solutions, a solutions manual, or produced by an AI system. Copying solutions does nothing to enhance your learning. If this occurs then you will get an automatic zero for the problem set. It if happens more than once, it will be reported to the chair of the department.

Disability Access and Inclusion

The University of Mississippi is committed to the creation of inclusive learning environments for all students. If there are aspects of the instruction or design of this course that result in barriers to your full inclusion and participation, or to accurate assessment of your achievement, please contact the course instructor as soon as possible. Barriers may include but are not necessarily limited to, timed exams and in-class assignments, difficulty with the acquisition of lecture content, inaccessible web content, and the use of non-captioned or non-transcribed video and audio files. If you are registered with SDS, you must log in to your Rebel Access portal at https://sds.olemiss.edu/rebel-access-portal to request approved accommodations. If you are NOT registered with SDS, you must complete the process to become registered. To begin that process, please visit our website at https://sds.olemiss.edu/apply-for-services. SDS will: 1. Complete a comprehensive review to determine your eligibility for accommodations, 2. If approved, disseminate to your instructors a Faculty Notification Letter, 3. Facilitate the removal of barriers, and, 4. Ensure you have equal access to the same opportunities for success that are available to all students. If you have questions, contact SDS at 662-915-7128 or sds@olemiss.edu.

Audio and video recording

Audio and/or video recording of class lectures is not allowed unless explicit permission is given by the instructor. Permission will only be given if the student has a Student Disability Services request. In such cases, recordings may only be used by the student to whom permission is given and all recordings must be deleted at the end of the semester. Recordings may not be distributed online or elsewhere.

Other

If a change in the syllabus becomes necessary during the semester, it will be discussed in class and then posted on Blackboard. This website will also contain up-to-date information on the class schedule, homework assignments and complementary material.

Schedule (subject to change)

Week	Date	Lecture #	Topic	Homework
1	August 25 (M)	1	syllabus and Newton's laws §1.1	
	August 27 (W)	2	Newton's laws §1.1	
	August 29 (F)	3	§1.1, Systems of particles §1.2	
2	September 1 (M)	—	no class – Labour day holiday	
	September 3 (W)	4	Systems of particles §1.2	PS1 due (Th)
	September 5 (F)	5	Constraints §1.3	
3	September 8 (M)	6	D'Alembert's principle §1.4	
	September 10 (W)	7	Simple examples §1.6	
	September 12 (F)	8	Hamilton's principle §2.1	
4	September 15 (M)	9	Calculus of variations §2.2	
	September 17 (W)	10	Calculus of variations §2.2	PS2 due (Th)
	September 19 (F)	11	Euler–Lagrange equations §2.3	
5	September 22 (M)	12	Lagrange multipliers §2.4	
	September 24 (W)	13	Noether's theorem §2.6	
	September 26 (F)	14	Central force EOM §3.1 & §3.2	
6	September 29 (M)	15	Classifying orbits §3.3	
	October 1 (W)	16	Orbit equation §3.5	PS3 due (W)
	October 3 (F)	17	midterm 8am–10am (TBC)	midterm
7	October 6 (M)	18	Kepler problem: orbits §3.7	
	October 8 (W)	19	Kepler problem: motion in time §3.8	
	October 10 (F)	20	Laplace–Runge–Lenz vector §3.9	
8	October 13 (M)	21	Scattering §3.10	
	October 15 (W)	22	Oscillations about equilibrium §6.1	PS4 due (Th)
	October 17 (F)	23	Eigenvalue equation §6.2	
9	October 20 (M)	24	Normal modes §6.3	
	October 22 (W)	25	Example §6.4	
	October 24 (F)	26	Rigid body kinematics §4.1 – §4.3	
10	October 27 (M)	27	Euler angles §4.4 – §4.6	
	October 29 (W)	28	Rotations §4.7 & §4.8	PS5 due (Th)
	October 31 (F)	29	Coriolis effect §4.9 & §4.10	
11	November 3 (M)	30	Rigid body EOM §5.1 – §5.3	
	November 5 (W)	31	Inertia tensor §5.3 & §5.4	
	November 7 (F)	32	Torque–free motion §5.5 & §5.6	
12	November 10 (M)	33	Torque–free motion §5.6	
	November 12 (W)	34	Heavy symmetrical top §5.7	PS6 due (Th)
	November 14 (F)	35	Hamilton's equations of motion §8.1	
13	November 17 (M)	36	Conservation theorems §8.2	
	November 19 (W)	37	Canonical transformations §9.1 & §9.2	
	November 21 (F)	38	Poisson brackets §9.5 – §9.7	
14	November 24 (M)	—	no class – Thanksgiving holidays	
	November 26 (W)	—	no class – Thanksgiving holidays	
	November 28 (F)	—	no class – Thanksgiving holidays	
15	December 1 (M)	39	Poisson brackets §9.5 – §9.7	
	December 3 (W)	40	Hamilton–Jacobi equation §10.1	PS7 due (Th)
	December 5 (F)	41	Kepler revisited §10.5	
	December 8 (M)	—	final exam 8:00–11:00 am	