

Course Syllabus

Course Information

PHYS 5311.001 – Classical Mechanics
Fall 2024
Tuesday and Thursday 11:30 am – 12:45 pm
SCI 2.203

Professor Contact Information

Professor Michael Kesden	TA Adam Aker
Office Location: SCI 3.120	SCI 3.129
Office Phone: 972-883-3598	
E-mail: kesden@utdallas.edu	adam.r.a1@utdallas.edu
Office Hours: Th 5:30 – 7:30 pm, SCI 3.265	Tu 1:00 – 2:00 pm, SCI 3.253

Course Pre-requisites, Co-requisites, and/or Other Restrictions

This is a core course for both the MS and PhD programs in physics. Students are expected to have completed PHYS 3312 – Classical Mechanics and its pre-requisite PHYS 3411 – Theoretical Physics or their equivalents at their undergraduate institutions. If you have already completed a graduate course in classical mechanics, please consult the instructor to determine whether you need to take this course.

Course Description

A course that aims to provide intensive training in problem solving. Rigorous survey of the ellipsoid of inertia and its eigenstructure; Euler's equations, spinning tops; Lagrangian and Hamiltonian formalism with applications; small oscillations; Lagrange multipliers and corresponding constraint forces, canonical transformations, Lagrange and Poisson brackets, Hamilton-Jacobi theory; action-angle variables (3-0) Y

Student Learning Objectives/Outcomes

At the end of this course, students should be able to:

- Use Lagrange's equations to solve problems with and without constraints.
- Identify conserved quantities from symmetries of the Lagrangian.
- Specify the orientation of a rigid body using Euler angles.

- Calculate the inertia tensor of rigid bodies in a well-chosen coordinate basis.
- Use the Euler equations to determine the orientation of a rigid body as a function of time.
- Identify the normal modes of oscillation of a system and their frequencies.
- Express the Hamiltonian of a system in terms of canonical variables and obtain differential equations for these variables from Hamilton's equations.
- Perform canonical transformations between variables.
- Solve the Hamilton-Jacobi equation for Hamilton's principal or characteristic functions that describe the motion of a mechanical system.
- Use action-angle variables to describe a physical system.

Required Textbooks and Materials

We will be covering a subset of the chapters in "Classical Mechanics" (3rd Edition) by Herbert Goldstein, Charles Poole, and John Safko, Addison Wesley (2002), but earlier editions of this book should also be satisfactory.

Suggested Course Materials

Those looking to review undergraduate material can consult Classical Dynamics of Particles and Systems (5th Edition) by Stephen T. Thornton and Jerry B. Marion, Thompson Learning Inc. (2004). Earlier editions of this book are probably equally useful.

The new textbook "Modern Classical Mechanics" by T. M. Helliwell and V. V. Sahakian, Cambridge University Press (2021) is a potentially useful reference that illustrates the connection between classical mechanics and other subfields.

The textbook "Modern Classical Physics: *Optics, Fluids, Plasmas, Elasticity, Relativity, and Statistical Physics*" by Kip S. Thorne and Roger D. Blandford, Princeton University Press (2017) provides a comprehensive introduction to modern applications of classical physics.

Assignments & Academic Calendar

WEEK/ DATES	TOPIC/LECTURE	READING	ASSESSMENT / ACTIVITY	DUE DATE
1 8/20 - 8/22	Introduction Elementary Principles	Chp. 1		

WEEK/ DATES	TOPIC/LECTURE	READING	ASSESSMENT / ACTIVITY	DUE DATE
2 8/27 - 8/29	Elementary Principles (cont.) Variational Principles	Chp. 2		
3 9/3 - 9/5	Variational Principles (cont.)		HW #1	9/6
4 9/10 - 9/12	Rigid Body Kinematics	Chp. 4	HW #2	9/13
5 9/17 - 9/19	Rigid Body Kinematics (cont.) Rigid Body Equations of Motion	Chp. 5		
6 9/24 - 9/26	Rigid Body Equations of Motion (cont.)		HW #3	9/27
7 10/1 - 10/3	Oscillations	Chp. 6	Exam #1	10/4
8 10/8 - 10/10	Oscillations (cont.) Hamilton Equations of Motion	Chp. 8		
9 10/15 - 10/17	Hamilton Equations of Motion (cont.)		HW #4	10/18
10 10/22 - 10/24	Canonical Transformations	Chp. 9		
11 10/29 - 10/31	Canonical Transformations (cont.)			
12 11/5 - 11/7	Hamilton-Jacobi Theory	Chp. 10	HW #5	11/8

WEEK/ DATES	TOPIC/LECTURE	READING	ASSESSMENT / ACTIVITY	DUE DATE
13 11/12 - 11/14	Hamilton-Jacobi Theory (cont.)		Exam #2	11/15
14 11/19 – 11/21	Action-Angle Variables	Chp. 10		
15 12/3 - 12/5	Action-Angle Variables (cont.)		HW #6	12/6
16 12/7- 12/13	Final Exam Period		Exam #3	12/12

Grading Policy

The six homework assignments combined are worth 25% of the total grade. Students may discuss the homework problems with each other, but each student is responsible for preparing their own solutions.

Each of the three exams are worth 25% of the total grade. Students may not discuss the exams with each other or external sources.

PHYS 5311 is a core graduate course, so all graduate students must receive a grade of B or better to satisfy degree requirements.

Course & Instructor Policies

Questions in class and attendance at office hours are strongly encouraged!!!

Make-up exams will only be given under extraordinary circumstances at the discretion of the instructor and must be requested **before** the scheduled exam.

There are **no** extra-credit assignments.

Homework assignments will be posted and submitted on eLearning. Students turning homework in late will lose 15% of the credit each day and receive no credit after 7 days.

Exams #1 and #2 will be conducted at the UTD Testing Center. Students are allowed to bring in a calculator and one two-sided sheet of notes for each exam. Exam #3 will be in class on the date and time assigned by the Registrar.

Class Materials

Lecture notes will be posted on eLearning after they are covered in class.

The instructor may provide class materials that will be made available to all students registered for this class as they are intended to supplement the classroom experience. These materials may be downloaded during the course, however, these materials are for registered students' use only. Classroom materials may not be reproduced or shared with those not in class, or uploaded to other online environments except to implement an approved AccessAbility Resource Center accommodation. Failure to comply with these University requirements is a violation of the [Student Code of Conduct](#).

Class Attendance

The University's attendance policy requirement is that individual faculty set their course attendance requirements. Regular and punctual class attendance is expected. Students who fail to attend class regularly are inviting scholastic difficulty. In some courses, instructors may have special attendance requirements; these should be made known to students during the first week of classes.

Class Participation

Regular class participation is expected. Students who fail to participate in class regularly are inviting scholastic difficulty. A portion of the grade for this course is directly tied to your participation in this class. It also includes engaging in group or other activities during class that solicit your feedback on homework assignments, readings, or materials covered in the lectures (and/or labs). Class participation is documented by faculty. Successful participation is defined as consistently adhering to University requirements, as presented in this syllabus. Failure to comply with these University requirements is a violation of the [Student Code of Conduct](#).

Class Recordings

Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the [Student Code of Conduct](#).

The instructor may record meetings of this course. These recordings will be made available to all students registered for this class if the intent is to supplement the classroom experience. If the instructor or a UTD school/department/office plans any other uses for the recordings, consent of the students identifiable in the recordings is required prior to such use unless an exception is allowed by law.

Comet Creed

This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

“As a Comet, I pledge honesty, integrity, and service in all that I do.”

Academic Support Resources

The information contained in the following link lists the University’s academic support resources for all students.

Please see <http://go.utdallas.edu/academic-support-resources>.

UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University’s policies and procedures segment of the course syllabus. Please review the catalog sections regarding the [credit/no credit](#) or [pass/fail](#) grading option and withdrawal from class.

Please go to <http://go.utdallas.edu/syllabus-policies> for these policies.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.