

PHY6246: Graduate Classical Mechanics

Fall 2021 Syllabus

Instructor

Prof. Laura Blecha

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Office location & phone: NPB 2075, (352) 392-4948

(Note: email and Canvas are the best ways to contact me.)

Class meeting times & location

MWF, Period 3: 9:35 am - 10:25 am

(All times listed in this syllabus are in the Eastern time zone.)

Classroom: NPB 1101

Remote attendance: An option for remote class attendance via Zoom will be provided to students for *at least* the first two weeks of class; this option may continue for the entire semester if the instructor determines that it best meets the needs of the class. The Zoom link will be available in Canvas. You do not need to sign up for a separate section of the course to choose the remote option over in-person attendance.

If any adjustments to these plans become necessary due to public health or other considerations, these changes will be announced on Canvas. Please check Canvas and your UF e-mail regularly to stay up to date on all course announcements.

Health & safety

In response to COVID-19, the following practices are in place to maintain your learning environment, to enhance the safety of our in-classroom interactions, and to further the health and safety of ourselves, our neighbors, and our loved ones.

- **If you are not vaccinated, get vaccinated.** Vaccines are readily available at no cost and have been demonstrated to be safe and effective against the COVID-19 virus. Visit this link for details on where to get your shot, including options that do not require an appointment:
<https://coronavirus.uflhealth.org/vaccinations/vaccine-availability/>.
Students who receive the first dose of the vaccine somewhere off-campus and/or outside of Gainesville can still receive their second dose on campus.
- **You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.** Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Hand sanitizing stations will be located in every classroom.
- **If you are sick, stay home and self-quarantine.** Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
 - Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work.
 - **If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on-campus facilities.** Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- **Continue to regularly visit coronavirus.UFHealth.org and coronavirus.ufl.edu for up-to-date information about COVID-19 and vaccination.**

Office hours

- 8:30 – 9:30 am on Mondays before class (**in my office***, NPB 2075)
***Note: you must wear a mask** while attending office hours in my office, regardless of vaccination status. If you choose not to wear a mask, you should instead plan to attend Zoom office hours or schedule another time to meet with me via Zoom (see below for details). Note also that Monday office hours will *not* be held if there is no Monday class session.
- 1:30 – 2:30* pm on Tuesdays (**via Zoom**; link available in Canvas)
***Note:** In weeks with no Monday class session and no Monday in-person office hours, Tuesday Zoom office hours will be extended to 3:30pm.
- **You are always welcome to contact me via email or Canvas to set up a meeting outside of office hours.**

Course objectives and goals

A primary goal of the course is to develop and apply the formulation of classical mechanics by using the canonical variational methods due to Lagrange, Hamilton, and Jacobi. The emphasis will be on the canonical structure of classical mechanics, in which

the parallels to quantum mechanics are most transparent. More broadly, this course aims to enable you to make the passage from undergraduate- to graduate-level analysis and problem-solving skills, and to establish connections with other areas of physics.

We start with Hamilton's principle of least action to derive Lagrange's equations, and we apply the formalism to dynamical systems with constraints. Conservation of energy, momentum, and angular momentum are linked to symmetry principles. Canonical transformation theory will be developed leading to action-angle variables and the Hamilton-Jacobi equation. We will discuss applications to perturbations about the Kepler solution, small oscillations, rigid body motion, and other topics.

Textbook

The required textbook for this course is:

Classical Mechanics

H. Goldstein, C. Poole and J. Safko

3rd Edition, 2002

ISBN 978-0-201-65702-9

Please be aware that a list of errata for the textbook is available here:

<http://astro.physics.sc.edu/goldstein/1-2-3To6.html>.

Depending on which printing of the 3rd edition you have, some of these errors may already be corrected in your version. I will make every effort to note if there are any instances when errata are present in homework problems assigned from the textbook.

Prerequisites

If you are not a Physics graduate student, these are pre-requisites for this course:

- PHY3221 and PHY4222 - Undergraduate Classical Mechanics
- PHY3323 and PHY4324 - Undergraduate Electromagnetism

Grading

Grading will be based on a scale from 0 to 100 percentage points. The final grade is calculated as follows: 60% exam grades (where Exam 1 and Exam 2 are each worth 30% of your total grade) and 40% homework. The conversion to letter grades will be done using the following conversion table after rounding the total percentage points to zero decimal places. Grade cutoffs may be lowered, but they will not be raised. Your scores will be entered into Canvas in a timely manner. Below we discuss each component of your grade in more detail.

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
≥ 85	≥ 79	≥ 73	≥ 67	≥ 62	≥ 56	≥ 50	≥ 44	≥ 38	≥ 35	≥ 30	< 30

Exams

There will be two take-home exams during the semester. Exam #1 will be made available at 8:00 am on Thursday, Oct. 14 and will be due at 11:59 pm on Friday, Oct. 15. Exam #2 will be made available at 8:00 am on Monday, Dec. 6 and will be due at 11:59 pm on Tuesday, Dec. 7. Please note that although you are allotted 40 hours for each exam, you expected to need only a small fraction of this time to complete them. The exams are each assigned over two days to allow you to fit them into your schedule.

Homework

Homework will be assigned weekly and will be posted in the “Assignments” module on Canvas. Homework will be due on Wednesdays before the start of class (9:35am). Cooperation on homework is permitted and discussion of problems among students is encouraged. The final homework score is calculated as an average of all homework scores after dropping the two lowest homework scores. Therefore, there will be no extensions or makeup homework assignments. Exceptions for extenuating circumstances such as illness or hardship will be reviewed on a case-by-case basis.

Course schedule (tentative – subject to change)

The schedule below lists the topics planned for each lecture, as well as the corresponding chapters and sections in the textbook. This schedule is likely to evolve. Changes will be announced on Canvas as well as during class time. Please check Canvas and your UF e-mail regularly for changes and class announcements. It is your responsibility to be aware of changes posted on Canvas or sent by e-mail.

Week #	Lecture #	Date	Topics
1	1	8/23	Introduction; Advantages of Alternative Formulations to Newtonian Dynamics (Ch. 1)
	2	8/25	Lagrange's Equations (Ch. 1)
	N/A	8/27	No Class – Instructor Travel* Watch pre-recorded content
2	N/A	8/30	No Class – Instructor Travel* Watch pre-recorded content
	3	9/1	Variational Principles; Hamilton's Principle (Ch. 2)
	4	9/3	Variational Principles; Hamilton's Principle (Ch. 2)
3	N/A	9/6	No Class – Labor Day
	5	9/8	Conservation Laws and Symmetries (Ch. 2)
	6	9/10	Conservation Laws and Symmetries (Ch. 2)
4	7	9/13	The Central Force Problem (Ch. 3)
	8	9/15	The Central Force Problem (Ch. 3)

	9	9/17	The Central Force Problem (Ch. 3)
5	10	9/20	The Central Force Problem (Ch. 3)
	11	9/22	Kinematics of Rigid Body Motion (Ch. 4)
	12	9/24	Kinematics of Rigid Body Motion (Ch. 4)
6	13	9/27	Kinematics of Rigid Body Motion (Ch. 4)
	14	9/29	Kinematics of Rigid Body Motion (Ch. 4)
	15	10/1	Rigid Body Equations of Motion (Ch. 5)
7	16	10/4	Rigid Body Equations of Motion (Ch. 5)
	17	10/6	Rigid Body Equations of Motion (Ch. 5)
	N/A	10/8	No Class -- Homecoming
8	18	10/11	Rigid Body Equations of Motion (Ch. 5)
	19	10/13	Oscillations (Ch. 6)
	N/A	10/14 – 10/15	No Class – Take Home Exam #1
9	20	10/18	Oscillations (Ch. 6)
	21	10/20	Oscillations (Ch. 6)
	22	10/22	Oscillations (Ch. 6)
10	23	10/25	Hamilton's Equations (Ch. 8)
	24	10/27	Hamilton's Equations (Ch. 8)
	25	10/29	Hamilton's Equations (Ch. 8)
11	26	11/1	Hamilton's Equations (Ch. 8)
	27	11/3	Canonical Transformations (Ch. 9)
	28	11/5	Canonical Transformations (Ch. 9)
12	29	11/8	Canonical Transformations (Ch. 9)
	30	11/10	Canonical Transformations (Ch. 9)
	31	11/12	Hamilton-Jacobi Theory (Ch. 10)
13	32	11/15	Hamilton-Jacobi Theory (Ch. 10)
	33	11/17	Hamilton-Jacobi Theory (Ch. 10)
	34	11/19	Hamilton-Jacobi Theory (Ch. 10)
14	35	11/22	Perturbation Theory (Ch. 12)
	N/A	11/24	No Class – Thanksgiving Break
	N/A	11/26	No Class – Thanksgiving Break
15	36	11/29	Perturbation Theory (Ch. 12)
	37	12/1	Perturbation Theory (Ch. 12)
	38	12/3	Perturbation Theory (Ch. 12)
16	N/A	12/6 – 12/7	No Class – Take Home Exam #2
	39	12/8	Optional Class Session – Topic TBD

*Because class sessions will not be held on 8/27 and 8/30, students are encouraged to use the time to view the pre-recorded content that the instructor will make available in Canvas. All material from canceled classes will be made up by the end of the semester.

Inclusive learning environment

Physics is practiced and advanced by a scientific community of individuals with diverse backgrounds and identities and is open and welcoming to everyone. I recognize the value of diversity, equity, and inclusion in all aspects of this course. This includes but is not limited to a diversity of age, background, ethnicity, gender identity and expression, national origin, religious affiliation, sexual orientation, and other visible and non-visible categories that you bring with you to our shared study of physics. In this small class, we will be working closely together throughout the semester. I expect that all students will contribute to a respectful, welcoming, and inclusive environment. This includes attentive listening, showing patience with each other, and respect for all questions asked by members of the class.

Physics, like all human endeavors, is something that is learned. My aim is to foster an atmosphere of learning that is based on inclusion, transparency, and respect for all participants. I acknowledge the different needs and perspectives we each bring to our common learning space and strive to provide everyone with equal access. **All students meeting the course prerequisites belong here and are well positioned for success.**

Accessibility

I am committed to supporting the learning process for all students. You are encouraged to contact me as soon as possible if you are having difficulties in the course. Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center. (352- 392-8565, <https://disability.ufl.edu>). It is important for students to share their accommodation letter with their instructor and discuss their access needs as early as possible in the semester.

Class attendance

Requirements for class attendance, assignments, and other work in this course are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

UF grading policies

Information on current UF grading policies for assigning grade points can be found here:

<https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/>

Online course evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summary results of these assessments are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

The Honor Pledge

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: ‘On my honor, I have neither given nor received unauthorized aid in doing this assignment.’ The Honor Code (<http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.”

In-class recording policy

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A class lecture is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To publish means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student

within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third-party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Campus resources

Health, wellness, & basic needs

- U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.edu or (352) 392-1575 so that a team member can reach out to the student.
- Counseling and Wellness Center: <https://counseling.ufl.edu/>, 392-1575 (or 9-1-1 for emergencies).
- Title IX Office: 427 Yon Hall, <https://titleix.ufl.edu/get-help/> (Includes a list of on- & off-campus resources)
- Student Health Care Center, 392-1161, <https://shcc.ufl.edu>
- UF Aid-a-Gator Program. Provide grants to students experiencing unanticipated expenses due to an emergency situation. <https://www.sfa.ufl.edu/aidagator/>

Academic resources

- E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learningsupport@ufl.edu. <https://lss.at.ufl.edu/help.shtml> .
- Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling. <https://career.ufl.edu/>
- Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.
- Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <http://teachingcenter.ufl.edu/>
- Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <http://writing.ufl.edu/writing-studio/>
- Student Complaints: <https://registrar.ufl.edu/writtencomplaints>; <http://distance.ufl.edu/student-complaint-process/>