Physics 330 Theoretical Mechanics Fall 2022

Class Mtgs: MWF 2:20 PM - 3:20 PM
Office: Trexler 266D
Email: fatima@roanoke.edu
Office Hours & Location: T/Th 9:50AM – 11:50 AM
(Trexler 266D/via zoom by appointment)

Instructor: Dr. Fatima
Phone: 375-2057
Classroom: Trexler 272

Course Description:

Developed examination of central force motion, coupled systems, rigid body motion, and the Lagrangian and Hamiltonian formulations.

Textbook:

• *Classical Mechanics* by John R. Taylor, University Science Books, 2005.
(Note: The ISBN-13 number for this textbook is 978-1891389221.)

Purpose of the Course:

Theoretical (classical) mechanics enables us to understand and predict the behavior of objects as varied as baseballs, rocket ships and red giant stars. Built on the foundation of Newton's Laws, theoretical mechanics incorporates a set of powerful physical concepts and mathematical techniques. These provide valuable physical insight and form the basis for much of the work done in applied physics and engineering.

This course will expand your insight into the physical world, increase your mathematical maturity, and further develop your problem-solving capabilities. You will also gain experience in working with short computer simulations and in using Mathematica (or Maxima, an open-source alternative). I hope that, as you work through the challenging problems this semester, you will also come to appreciate the beauty and elegance of theoretical mechanics.

Intended Learning Outcomes:

1. learn and articulate the fundamental concepts of theoretical mechanics
2. solve challenging problems using advanced mathematical techniques
3. gain facility with computer simulation and using symbolic math packages
4. improve skill in presenting challenging material to a group of peers

Feedback and Evaluation:

I will assign numerical grades to all your work. I *may* curve your final grades (upward), but otherwise you can expect to receive an "A" for 90-100, a "B" for 80-89, etc. I will assign +/- to your final grades by examining the distribution of grades. These are the categories and percentages that will be used:

Problem sets:	40% (6 @ 6.6 % each)
Participation:	10 %
Teaching presentation:	10 %
Tests:	25 % (2 @ 12.5 % each)
Final exam:	15 %

Problem sets are due **at the start of class** on the due date. You will learn the material best by working and persevering with challenging problems. Each problem set will also include a computing exercise of some kind. I encourage you to discuss problem sets with other students, but you must not just borrow a problem solution from another student; you should write up the solution independently.

Participation will include a variety of in-class activities, including problem-solving at the board, computer simulation exercises, and guided worksheets. The grade in this category will be based on completion of these in-class activities, as well as attendance and summaries of two MCSP Colloquium Talks.

Teaching presentation: During the last two weeks of class, you will teach a class on a further topic in theoretical mechanics as part of a team of three students. I will provide a list of suggested topics.

Tests 1 and 2 will cover unit 1 and unit 2, respectively, and will involve problems similar to those in the problem sets. The tests be given in a take-home format over a period of 5 days and will include a time limit of 8 hours for the total work allowed.

The final exam will be comprehensive (i.e., cover the entire semester) and will also include conceptual questions, including a couple questions on the material in the teaching presentations given by your fellow students.

MCSP Colloquium Series:

The MCSP department offers a series of discussions that appeal to a broad range of interests related to these math, computer science and physics. Members of this class are invited to be involved with all of these meetings; however, participation in **at least two** of these sessions is mandatory. Within **one week** of attending a colloquium you must submit (via Inquire) a one-page single-spaced paper reflecting on the discussion. This should not simply be a regurgitation of the content, but rather a personal contemplation of the experience.

General Attendance Policy:

You are expected to attend every meeting. If you are going to be absent, I must be notified in advance. You are accountable for all work missed because of an absence. Your fourth and each additional absence will result in a 2-point reduction in your final course grade. You get three freebies so that I don't have to distinguish between excused and unexcused absences. College athletes will be afforded wiggle room; please come see me immediately if you are an athlete. If you should have an emergency that requires you to miss a large chunk of the course, please notify me ASAP.

Covid-19 Illness Attendance Policy:

If you have a temperature of 100.4 or higher or other COVID symptoms, don't come to class. Call Health Services IMMEDIATELY. Do not come to class or go to any public area on campus. For your absence to be excused, you must give Health Services permission to notify me that you have consulted them about COVID symptoms. If Health Services informs you that you should isolate and not attend class for multiple days, inform me so that we can plan to keep you current in the course. All absences caused by consultation with Health Services about coronavirus symptoms or isolation ordered by Health Services

will be excused but you will need to do the work and graded assignments even if we extend a deadline for you.

Masks:
The college is starting the term without a specific mask mandate. You are encouraged to wear mask. If the policy changes, I will update the syllabus.

Policy on Late Work:
I will grade an assignment with a 10% lateness deduction if turned in by 5:00PM on the due date. Following that, assignments will receive a further 10% lateness deduction for each successive day late (with days considered to end at 5:00 PM).

Make-up Tests:
Make-up tests will not be given. If you miss a test, and have an official college excuse for that absence, then your final exam grade will count for the missed test.

Academic Integrity:
The College academic integrity policies are vigorously enforced. Although you are encouraged to work in groups on your homework assignments, all work turned in for a grade must be your own. Please familiarize yourself with the College's academic integrity policies.

Disability Support Services:

Accessible Education Services (AES) is in the Goode-Pasfield Center for Learning and Teaching in **Fintel Library**. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-3752247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

Note: You should expect to spend a combined total of 12 hours per week (on average) on lecture, homework, and reading for PHYS 330.

Tentative Schedule:

Class #	Date	Class Topic	Reading	Due
		UNIT 1: Mechanics, Friction, & Oscillations		
1	Aug. 31	Intro, Newton's laws of motion	--	
2	Sept. 02	Newton's laws in polar coordinates	1.6, 1.7	
3	Sept. 05	Linear and angular momentum	3.1-3.5	
4	Sept. 07	Kinetic and potential energy	4.1-4.5	

5	Sept. 09	Central forces	4.6-4.8	
6	Sept. 12	Linear air resistance	2.1-2.3	PS 1
7	Sept. 14	Quadratic air resistance	2.4	
8	Sept. 16	Oscillators with damping	5.1-5.4	
9	Sept. 19	Driven damped oscillator & resonance	5.5, 5.6	
10	Sept. 21	Fourier series solution I	5.7	
11	Sept. 26	Fourier series solution II	5.8	PS 2
12	Sept. 28	Fourier series solution III	--	
13	Sept. 30	Coupled oscillators	11.1	
14	Oct. 03	Normal modes I	11.2	
15	Oct. 05	Normal modes II	11.3	
		UNIT 2: Lagrangian & Hamiltonian Mechanics		
16	Oct. 07	Normal modes III	6.1, 6.2	
17	Oct. 10	Calculus of variations	6.3	PS 3
18	Oct. 12	Euler-Lagrange equation I	6.4	
	Oct. 15-23	**FALL BREAK**		
19	Oct. 24	Euler-Lagrange equation II **(Take-home I given out)**	7.1	
20	Oct. 26	Lagrange's equations of motion	7.2-7.4	
21	Oct. 28	Lagrange's equations of motion **(Take-home I due)**	7.5	**Takehome I**
22	Oct. 31	Using Lagrange's equations I		
23	Nov. 02	Using Lagrange's equations II	7.6,7.7,11.	
24	Nov. 04	The two-body problem	8.1-8.3	
25	Nov. 07	Equivalent one-dimensional problem	8.4, 8.5	PS 4
26	Nov. 09	The Kepler orbits	8.6-8.8	
27	Nov. 11	The Kepler orbits II		
28	Nov. 14	Hamilton's equations I	13.1,13.2	
29	Nov. 16	Hamilton's equations II	13.3	
		UNIT 3: Rigid Body Rotation; Group Presentations		
30	Nov. 18	Moment of inertia tensor	10.1 -10.3	PS 5
31	Nov. 21	Principal axes of inertia	10.4-10.6	
	Nov. 23-25	**THANKSGIVING BREAK**		
32	Nov. 28	Work on presentations in class **(Take-home II given**		
33	Nov. 30	Group presentation 01	as assigned	
34	Dec. 02	Group presentation 02 **(Take-home II due)**		**Takehome II**
35	Dec. 05	Group presentation 03	as assigned	
37	Dec. 07	Group presentation 04	as assigned	

38	Dec. 09	Group presentation 05	as assigned	PS 6
	Dec. 13	**FINAL EXAM (Tuesday, 02:00-5:00 PM)**		

Disclaimer: Everything above is subject to change with notice and, where appropriate, your approval.