Physics 330 Theoretical Mechanics Fall 2024

Class Mtgs: MWF 9:40 AM - 10:40 AM Instructor: Dr. Fatima
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Email: fatima@roanoke.edu Classroom: Trexler 273
Office Hours & Location: M 12:00 PM -1:00 PM & T 8:50AM – 11:50 AM
(Life Science 401B /via zoom by appointment)
Additional Hours: By Appointment

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:	35% (6 @ 5.8 % each)
Participation:	15 %
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, and 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 final exam will be comprehensive (i.e., cover the entire semester) and will also include conceptual questions, including questions on the material in the teaching presentations given by your fellow students. Test make-up for excused reasons (family or medical emergencies, and university-recognized commitments) must be discussed and arranged with me at least one week in advance, unless it is an emergency.

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 third and each additional absence will result in a 2-point reduction in your final course grade. You get two 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.

Policy on Late Work:
I will grade an assignment with a 2% lateness deduction if turned in by 12:00AM on the due date. Following that, assignments will receive a further 5% lateness deduction for each successive day late (with days considered to end at 12:00 AM).

Use of Electronic Devices: Electronic devices are valuable tools; therefore, my general policy is to allow the use of electronic devices in the classroom. Laptops or tablets may be used for note-taking during regular class sessions if this seems useful to you. Scientific calculators may be used during class when needed and during exams.

However, I expect your phones to be on silent mode and out of reach at all times, and I expect that any electronic devices will not be used to browse the internet or communicate with anyone inside or outside of class. A violation of this policy during an exam will be considered violation of Roanoke College's Academic Integrity policy, and I reserve the right to limit the use of electronic devices in the classroom if I feel this policy is being abused.

Subject Tutoring: located on the lower level of Fintel Library (Room 5), is open 4-9 PM, Sunday-

Thursday. Subject Tutors are highly trained, current students who offer free, one-on-one (and small group) tutorials in over 80 courses taught at Roanoke College, including: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, and Social Sciences. Check out all available subjects and schedule 30- or 60-minute appointments at www.roanoke.edu/tutoring. If you have a question, feel free to stop by, or contact us at subject_tutoring@roanoke.edu or 540-375-2590. See you soon!

Academic Integrity:

Your learning and integrity are at the core of your RC education. For this reason, you must follow the rules outline in the College's AI policies. See https://www.roanoke.edu/inside/a-z_index/academic_affairs/academic_integrity. Collaboration is an important skill that you will be asked to develop in class and in lab, and I would encourage you to extend this practice beyond the classroom as you work on problem sets. However, for the homework in particular, the final write-up should reflect your own understanding of the problem and I ask that you include the names of anyone you collaborated with when you turn in your problem set.

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 540-375-2247 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. 28	Intro, Newton's laws of motion	--	
2	Aug. 30	Newton's laws in polar coordinates	1.6, 1.7	
3	Sept. 02			
4	Sept. 04	Linear and angular momentum	3.1-3.5	
5	Sept. 06	Kinetic and potential energy	4.1-4.5	
6	Sept. 09	Central forces	4.6-4.8	PS 1
7	Sept. 11			
8	Sept. 13	Oscillators with damping	5.1-5.4	
9	Sept. 16	Driven damped oscillator & resonance	5.5, 5.6	
10	Sept. 18			
11	Sept. 20			PS 2
12	Sept. 23	Coupled oscillators	11.1	
13	Sept. 25			
14	Sept. 27	Normal modes I	11.2	
15	Sept. 30	Normal modes II	11.3	

		UNIT 2: Lagrangian & Hamiltonian Mechanics		
16	Oct. 02	Normal modes III	6.1, 6.2	
17	**Oct. 04**	**Exam 1**		
18	Oct. 07			
19	Oct. 09	Calculus of variations	6.3	
20	Oct. 11			PS 3
	Oct. 14-18	**FALL BREAK**		
21	Oct. 21	Euler-Lagrange equation I	6.4	
22	Oct. 23	Euler-Lagrange equation II	7.1	
23	Oct. 25			
24	Oct. 28	Using Lagrange's equations	7.6,7.7,11.4	PS 4
25	Oct. 30			
26	Nov. 01	The two-body problem	8.1-8.3	
27	**Nov. 04**	**Exam 2**		
28	Nov. 06	The Kepler orbits	8.6-8.8	
29	Nov. 08			
30	Nov. 11	Hamilton's equations I	13.1,13.2	PS 5
31	Nov. 13			
32	Nov. 15	Lagrange's equations of motion	7.2-7.5	
33	Nov. 18			
34	Nov. 20	Hamilton's equations II	13.3	PS 6
35	Nov. 22	Work on presentations in class		
36	Nov. 25	Group presentation 01	as assigned	
	Nov. 27-29	**THANKSGIVING BREAK**		
37	Dec. 02	Group presentation 02	as assigned	
38	Dec. 04	Group presentation 03	as assigned	
39	Dec. 06	Review Class		
	Dec. 11	**FINAL EXAM (8:30 AM- 11:30 AM)**		

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