Welcome to Theoretical Mechanics II (PHYS 612, CRN 24238)! The class meets Tuesdays and Thursdays, 10:00 – 11:50 in 318 Willamette. The class will run for five weeks (last lecture Feb 9, 2023), and will be followed by PHYS 613 in the same time slot.

**Course website (Canvas):** [https://canvas.uoregon.edu/courses/214768](https://canvas.uoregon.edu/courses/214768). Lecture notes and problem sets will be posted on the Canvas site.

**Instructors**

**Jayson Paulose**  
Office: 375 Willamette  
Email: jpmelkani@uoregon.edu  
Office hours: see Canvas page for up-to-date information

**Abhijeet Melkani (Graduate TA)**  
Office: 361 Willamette  
Email: amelkani@uoregon.edu  
Office hours: see Canvas page for up-to-date information

**Description**

This is the second course in the graduate sequence on classical mechanics. We will build upon the framework developed in PHYS 611, with a mix of theoretical understanding of the fundamentals of mechanics and practical applications that you might encounter in your research or in a colloquium. We will further probe the structure of solutions to mechanics problems, focusing on aspects of geometry and topology of solutions in phase space. We will ask what it means for a system to be completely solvable, or **integrable**, at least in principle; we will then explore the behavior of **chaotic** systems that depart from this behavior.

**Course objectives**

The goals of this course are to impart a working knowledge of the following topics in classical mechanics:

- Normal modes of mechanical systems with many degrees of freedom
- Hamiltonian formalism, phase space dynamics, generators of motion
- Hamilton-Jacobi theory
- Dynamical stability and deterministic chaos
By “working knowledge”, I mean that you will be familiar with concepts and techniques at a level that will let you understand their use in the scientific literature, seminars, and colloquia; and (perhaps with additional resources) use them in your research area. We will also place the developments in their historical context, to illuminate how developments in classical mechanics underpin much of modern physics.

Course materials

I will post lecture notes that, for the most part, are self-contained presentations of the course material. However, many students find it useful to have a structured textbook (or several) as an additional reference. Material for lectures will primarily be drawn from the following textbooks, copies of which are available at the UO libraries if you would like to refer to them.

Primary textbook: Modern Classical Mechanics, Helliwell and Sahakian
This is a modern treatment of the topic with plenty of worked examples. The textbook is not required, but strongly recommended as a learning aid especially if a structured text and practice problems suit your learning style. Readings will be posted from the textbook each week, and problem sets may include exercises from it. Available at the Duck Store or online. A copy has been placed on reserve at the Science Library. I have also left a copy for shared use in the Binney lounge.

Additional references:
These are additional resources which I draw on when preparing the lectures. They are of vastly different styles and different students might find different resources appealing.

- Theoretical mechanics of particles and continua, A. Fetter and J. Walecka
- Mechanics, L. Landau and E. Lifshitz (Course of Theoretical Physics vol. 1)
- Analytical Mechanics, L. Hand & J. Finch
- Mechanics, F. Scheck (available electronically via UO Libraries on SpringerLink)
- Mathematical Methods of Classical Mechanics, V. Arnold (available electronically via UO Libraries on SpringerLink)

You might also have an advanced mechanics textbook that you are already familiar with; it is likely that it will include most of the topics in the class.

Communication

How I communicate with you:

- Class-wide announcements will be posted as Canvas Announcements which are accessible at the Canvas site, as email, or as texts. Please set your preferred notification method under Account -> Notifications.
- The course materials will be organized as weekly Modules on the Canvas site. I will post readings in advance of each week on Friday of the previous week, as well as lecture materials and problem sets within the module for each week.
I will get in touch with individual students over email.

**How (and why) to communicate with me:**
I enjoy talking to students and am happy to discuss any aspect of the course, or talk about science/graduate school/life. I strongly believe that every student can succeed in this course – please get in touch with me if you are having trouble with any aspect of it so we can work together to facilitate your success. Ways to get in touch are:

- Attend office hours! I aim to host one in-person session and one Zoom session each week. Up-to-date information on times and location will be on the 'Office hours information' Canvas page.
- Email me (jpaulose@uoregon.edu). I will try my best to respond within one business day.
- I am happy to make additional time to meet outside office hours if you cannot make them or would like to meet one-on-one. Please send me an email to make an appointment.

**Grading policy, classroom expectations, and attendance**

Grades will be assigned according to the following rubric:

- Classroom participation: 10%
- Problem sets: 55%
- Final: 35%

In-class worksheets and participation in discussion around them are integral to learning in this course. The participation component is intended to reflect that I value this form of learning and to incentivize active engagement in the class. You will receive full credit if you attend most lectures and engage in small-group discussions respectfully and thoughtfully. If you miss lectures for any reason (including illness or quarantine), you can make up the participation component by working through the activities (which will be posted on Canvas) and sending me an email with your answers and any questions/comments you might have.

Problem sets will be assigned weekly, typically on Thursdays, and will be usually due at the start of class on the following Thursday. Each student gets one "late homework pass" for the course: you will be allowed to hand in one problem set up to one week late (with the understanding that you will not refer to the solutions, or discuss them with your classmates, after the solutions have been posted). To use the pass, simply email the instructors. All future late submissions will receive no credit, unless you have discussed any extenuating circumstances with me before the original due date.

The final will be a take-home exam similar in format to a problem set, except that you are not allowed to discuss the answers with anyone. It will be posted in Week 5 and be due in Week 6.

**Additional course policies**

- Cell phone use is prohibited during class. Cell phones should be silenced and put away.
• Laptops and tablets are not to be used, except as a note-taking device.
• Collaborating on the homework is allowed and encouraged. However, you have to turn in your own work. It is up to you to make sure that you understand the material independently. You will not be able to collaborate on the exams.
• Much of the points on homework and exams will be assigned for the arguments leading up to the final answer. You will be expected to show your work and demonstrate that you understand the steps involved.
• The teaching assistant will be involved in grading your coursework. If you have any concerns about this, please discuss the matter with me.
• Please do not hesitate to email me to discuss any aspect of the course, including this syllabus!

Accessibility

I take my responsibility to create inclusive learning environments seriously. Please notify me if there are aspects of this course that result in barriers to your participation. For more information or assistance, you are also encouraged to contact the Accessible Education Center, 164 Oregon Hall, 346-1155; website: http://aec.uoregon.edu/. The AEC offers a wide range of support services including note-taking, testing services, sign language interpretation and adaptive technology.

Academic integrity

It has become quite easy to find solutions to homework problems online. Use of these solutions or similar materials is not allowed: it goes against the pedagogical purpose of graduate school, is unfair to your classmates, and violates the University Student Conduct Code (available at http://conduct.uoregon.edu).