Math 428/609E: Mathematical Classical Mechanics
Spring Term, 2025

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Course Website	`http://www.math.ubc.ca/~lior/teaching/2425/428_W25/`
Contact me at	`lior@math.ubc.ca` or at MATX 1112
My Website	`http://www.math.ubc.ca/~lior/`
Class	TTh 10:00-11:30 at ESB 4127 and on Zoom (link on course website)
Office Hours	TTh 11:30-12:00 at ESB 4127 and on Zoom; further office hours TBA
Textbook	None required; see below for recommendations
(Informal) Prerequisites	Basic mechanics; elementary differential equations; real analysis

About the course

This is a course in formal mechanics from a mathematical point of view, developing in parallel the mathematical machinery and physical ideas. Some of the material will be developed in the problem sets. The graduate side of the course will make a higher emphasis on manifolds and may involve more advanced mathematics.

	Physics	Mathematics
1	Kinematics	Coordinates
2	Newtonian mechanics	ODE, tangent and cotangent vectors
3	Lagrangian mechanics	Calculus of variations, convexity, symmetry and conservation laws
4	Angular momentum	The rotation group
5	Hamiltonian mechanics	Manifolds, measures

The main pre-requisites are basic mechanics (e.g. UBC PHYS 216), elementary ODE (e.g. UBC MATH 215), and real analysis (e.g. UBC MATH 320). Linear algebra (MATH 223) will be an advantage.

Textbook

There are many books covering this material; the main mathematical references are [1, 5]. Our main physical references will be [3, 4]. Additional books include [2].

Evaluation and grading; levels of participation

On the use of external resources

By necessity many homework problems in this course are *standard*, or involve proofs of standard results which may be found in many websites and textbooks. Please refrain from submitting solutions you found online, in textbooks, or obtained from experts. It is normal to talk to each other and to experts as you learn the material, but you may not

submit answers substantially created by others. Please cite specifically any external resource or person you have used. In particular, the use of generative AI tools (including ChatGPT and similar) to complete or support the completion of any assignment in this course is not allowed and would be considered academic misconduct.

Undergraduates (MATH 428)

The grade will be based on weekly problem sets (50%) and one final exam (50%).

- Extra credit may be given the parts of the problem sets designated for graduate students.

Graduate students (MATH 609E & PIMS Network-wide Course)

The grade will be based on the weekly problem sets only. Graduate students may take the course for different reasons (ranging from planning to conduct research in mathematical physics to pure personal interest) and should calibrate their efforts depending on their personal learning goals.

- Students should communicate to the instructor early in the term their goals of the course. Students should do as much work on each problem set as they deem appropriate.
- Graduate students will be judged appropriate to their goals.

Remote participation

The course will be simultaneously broadcast on Zoom and open for remote participation, including as a PIMS network-wide course. The Zoom link is posted to the course website.

Registration

I would appreciate remote students interested in the course to send me an email describing their physics and mathematics experience and their intended level of participation (see above).

1. Students at Canadian PIMS member universities may apply for graduate credit via the Western Deans' Agreement. Please be advised, in some cases students must enroll 6 weeks in advance of the term start date and will typically be required to pay ancillary fees to the host institution (as much as $270) or explicitly request exemptions. Please follow the link above for details of fees at specific sites.
2. Students at universities not covered by the WDA but which are part of the Canadian Association for Graduate Studies may still be eligible to register for this course under the Canadian University Graduate Transfer Agreement. Details of this program vary by university and are also typically subject to ancillary fees. Please contact your local Graduate Student Advisor for more information.
3. As an alternative to formal registeration remote students may enrol in a local "reading course" at their home university. In that case please have the faculty member responsible for the reading course (usually your advisor) write to me to request that I grade your homework and send a grade back.
4. Anyone (anywhere in the world) who is interested in mathematics and would like to learn some Number Theory is welcome to attend the lectures as well as the online office hours. To be clear I will only mark the homework of registered participants.

Online classes

1. All remote and in-person participants are strongly encourage to **interrupt the lectures** repeatedly with their questions (even "can you explain that again?" or "what do you mean by 'continuous'?"). Such questions are welcome, encouraged, and are **absolutely essential** for learning to take place in a course of this type.
2. All classes will be recorded, with the recordings placed on a public website (likely YouTube). Participants who do not wish to be recorded may join the Zoom session under pseudonyms, and only ask questions via chat.
3. There will be online office hours to support the remote participants.
4. All course information will be posted on the course website and will remain accessible in perpetuity to anyone anywhere.

Boilerplate

1. The mathematics department's General Syllabus Information applies to this course.
2. In case of inclement weather the course may revert to Zoom-only.

References

[1] V. I. Arnol d. *Mathematical methods of classical mechanics*, volume 60 of *Graduate Texts in Mathematics*. Springer-Verlag, New York, [1989?]. Translated from the 1974 Russian original by K. Vogtmann and A. Weinstein, Corrected reprint of the second (1989) edition.

[2] Richard H. Cushman and Larry M. Bates. *Global aspects of classical integrable systems*. Birkhäuser/Springer, Basel, second edition, 2015.

[3] Herbert Goldstein. *Classical mechanics*. Addison-Wesley Series in Physics. Addison-Wesley Publishing Co., Reading, MA, second edition, 1980.

[4] L. D. Landau and E. M. Lifshitz. *Mechanics*, volume Vol. 1 of *Course of Theoretical Physics*. Pergamon Press, Oxford; Addison-Wesley Publishing Co., Inc., Reading, MA, 1960. Translated from the Russian by J. B. Bell.

[5] Michael Spivak. *Physics for mathematicians—mechanics I*. Publish or Perish, Inc., Houston, TX, 2010.