Fluid mechanics and soft matter

1 Class time

- Lecture
  Mon: 8:00-10:00

- Exercises
  Thu: 14:00-15:00

2 Course content:

This course introduces the fundamental principles of fluid mechanics and elasticity as a foundation for the study of soft matter physics. Building on these core concepts, we will explore a range of soft matter systems, including colloids, polymers, liquid crystals, emulsions, foams, and biological materials. Emphasis will be placed on understanding how microscopic interactions and structures give rise to macroscopic mechanical and dynamical properties, highlighting the relationship between molecular-scale phenomena and continuum-level descriptions.

3 Instructor information

- Instructor: Prof. Guillermina Ramirez-San Juan.
- Teaching assistants:
  Aikaterini Kourkolou
  Alara Kiris

4 Course exercise sheets

There will be an exercise sheet for every week of the course. The exercise sheets will be posted on Moodle one week before the session in which they are discussed, except for Week 1, whose sheet will be provided on the first day of class.

5 Course Materials

Course materials such as lecture notes, and additional readings are provided on moodle as a courtesy and at the discretion of the instructor.

6 Grading

- 100% of your grade will be the written final exam, which will be held in January 2026.

7 Course content

These are the topics that will be covered during the course.

Week 1. Lecture 1. Introduction to Soft Matter

Week 2. Lecture 2. Fluid dynamics: Classical results in fluid statics

Week 3. No class

Week 4. Lecture 3: Fluid dynamics: Navier stokes equations

Week 5. Lecture 4: Fluid dynamics: Dimensionless numbers, viscous flows

Week 6. Lecture 5: Elasticity I

Week 7. Break

Week 8. Lecture 6: Elasticity II

Week 9. Lecture 7: Brownian motion and thermal fluctuations

Week 10. Lecture 8. Polymer Solutions

Week 11. Lecture 9. Polymer Gels

Week 12. Lecture 10. Colloidal suspensions: Emulsions

Week 13. Lecture 11: Liquid crystals

Week 14. Lecture 12: Interfaces, surfaces and membranes

Week 15. Lecture 13: Active matter

8 Bibliography

The course follows closely the following textbook:

- van Saarloos, Wim; Vitelli, Vincenzo; Zeravcic, Zorana (2024). Soft Matter. Princeton University Press.

Supplemental reading to solidify your understanding or learn more about specific topics:

- Doi, Masao (2013). *Soft Matter Physics*. Oxford University Press.
- Boal, David (2012). *Mechanics of the Cell*. 2nd edition. Cambridge University Press.