ME-466

Instability

Gallaire François

Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Energy Management and Sustainability	MA1, MA3	Opt.
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.
Mechanics		Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course focuses on the physical mechanisms at the origin of the transition of a flow from laminar to turbulent using the hydrodynamic instability theory.

Content

Learn to understand the complex phenomena originating in the destabilization of laminar flows, and their transition to turbulence. Know how to linearize the fluid equations and to formulate the question of stability of a flow in terms of an eigenvalue problem and a dispersion relation. Identify the physical mechanisms resulting in classical instabilities as Kelvin-Helmholtz instability. Spatial instability in open flows. Understanding the different types of bifurcations. Reading scientific literature.

Keywords

Instability, linearization, bifurcation

Learning Prerequisites

Required courses

Incompressible fluid mechanics

Recommended courses

hydrodynamics

Important concepts to start the course

- concept of linear operator and eigenvalues
- be able to solve a linear differential system at constant coefficients
- Fourier analysis
- Taylor expansions
- Navier-Stokes equations

- Use a work methodology appropriate to the task.
- Use both general and domain specific IT resources and tools
- Make an oral presentation.

- Write a literature review which assesses the state of the art.
- Summarize an article or a technical report.

Learning Outcomes

By the end of the course, the student must be able to:

- Describe the physical differences between laminar and turbulent flows, AH4
- Implement the basics of computer programming; develop a (simple) structures software using a programming language / environment such as C, Fortran or Matlab, AH40
- Describe the physical differences between laminar and turbulent flows, AH4
- Integrate the basics of computer programming; develop a (simple) structures software using a programming language / environment such as C, Fortran or Matlab, AH25

Transversal skills

- Use both general and domain specific IT resources and tools
- Write a literature review which assesses the state of the art.
- Use a work methodology appropriate to the task.
- Summarize an article or a technical report.

Teaching methods

Lectures, exercice and homework

Expected student activities

The students should follow the lectures and practise at home both the resolution of application exercises and the reading of scientific articles.

Assessment methods

Written exam.

Supervision

Office hours	Yes
Assistants	No
Forum	No

Resources

Bibliography

Instabilités hyrodynamiques, F. Charru, CNRS Editions, 2007
Introduction to Hydrodynamic Stability, P.G. Drazin, Cambridge Univ. Press, 2002.

Ressources en bibliothèque

- Introduction to hydrodynamic stability
- Instabilités hydrodynamiques - papier
- Instabilités hydrodynamiques - ebook

Moodle Link

- http://moodle.epfl.ch/course/view.php?id=4471