Dynamic instabilities and chaotic transport

ECTS credits
3 credits

In brief

Course langage: French

Presentation

Prerequisites

Mechanics
Mathematical modeling of complex systems

Learning objectives

- To know how to apply the notions discussed in the course "Mathematical modeling of complex systems" to complex systems" to examples of dynamic systems from fluid and solid mechanics.
fluid and solid mechanics.
- Know the concept of instability, identify its occurrence through several applications.
- Know the properties of a Hamiltonian system, identify the critical points in the phase space, understand deterministic chaos in a Hamiltonian system, understand transport in a chaotic system.

Description of the programme

Starting from the general equations of the mechanics of continuous media (MMC, 1A), we establish the equations of motion of the considered system, and we discretize in space to return to a dynamic system, generally of small dimension. Instabilities and their consequences are described using the basic notions seen in the course "Mathematical modeling of complex systems".

Some examples from solid mechanics (16 h)

- Collapse of a structure by buckling.
- Fracture of a brake or clutch disc.

- Self-oscillations in musical instruments (strings, winds, brass instruments).
- Aeroelastic instability of a wing, a bridge; ground instability of a helicopter.

Some examples from fluid mechanics (22 h)

The behavior of a chaotic Hamiltonian system and transport phenomena are studied. The notion of transport is illustrated by numerical applications using the analogy between Hamiltonian systems and incompressible fluids.
- Fusion plasmas (dynamics and chaos of magnetic lines, particle diffusion by
ExB drift).
- Neutral fluids: dynamics and mixing in fluids

Generic central skills and knowledge targeted in the discipline

Mastering complexity and systems.
This course develops the theoretical tools necessary to understand the instabilities of chaotic systems. It contributes to allow students to apprehend the richness of behaviors of a dynamic system, to bring them the tools to describe them through applications from mechanics.

How knowledge is tested

- CC1 : Dynamic instabilities in continuous media (TP), 40
- CC2 : Chaotic transport and control strategies : applications to fluids (TP), 30
- DS1 : Chaotic transport, 30

Bibliography

Course handout.

Teaching team

* Guido Ciraolo (CEA)
* Bruno Cochelin
* Emmanuelle Sarrouy
* Frédéric Schwander

Total des heures		**38h**
CM	Master class	10h
TD	Directed work	6h
TP	Practical work	22h

Useful info

Name responsible for EU

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