INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

FUNDAMENTALS OF CIVIL ENGINEERING FIELD_13 ECTS

Introducing

Description

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

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Partial Differential Equations and Numerical Analysis

Introducing

Description

Chapter 1 - Introduction to PDEs and classification -
Prerequisites in linear algebra, integration, resolution of ordinary differential equations, functions of several variables; Terminology and Examples of PDEs; Classification of linear PDEs of order 2.

Chapter 2 - Fourier Series -
Physical motivation; Space of periodic functions of square integrable; Trigonometric series; Fourier coefficient; Fourier series in L^1 (Dirichlet Thm) then in L^2 (Parseval Identity).

Chapter 3 - Fourier Transform -
Analysis and Synthesis of the Fourier transform on L^1, algebraic and derivation properties, inverse Tf and Plancherel Formula, Convolution; TF on L^2 and illustrative examples.

Chapter 4 - Sturm Liouville Problem -
Definition, examples and properties of the solutions.

Chapter 5 - Solving PDEs by Separation of Variables
Well-posed problem and Boundary conditions; Homogeneous 1D heat equation; Homogeneous 1D wave equation; Generalities on the method of separation of variables (homogeneous Eq, then with source term, then with non-homogeneous boundary conditions, and interest in knowing the associated Sturm Liouville problem)

Students will be provided with a course handout, TD statements (then their corrections) and TP. The TP will be carried out under Python

Objectives

This UE aims to master some basic mathematical concepts for the study of partial differential equations (PDE) by the future engineer in Civil Engineering or Mechanical Engineering. This UE is naturally composed of academic knowledge presented in lectures, and computational know-how (studied in tutorials) and numerical know-how (implemented in practical work). Students will learn to identify and classify PDEs according to their nature (elliptic, parabolic, hyperbolic). They will approach the basic concepts, properties and theorems concerning Fourier series and Fourier transforms, which are powerful tools for solving PDEs, particularly in areas related to periodic phenomena and vibrations. Finally, the separation of variables, a classic and effective technique for solving certain classes of PDEs, will be formalized and studied. This method will be illustrated through several concrete examples linked to wave-type equations (vibration phenomenon) or heat (diffusion phenomenon).

Necessary prerequisites

Mathematics UE for years 1 and 2.
More specifically:
- linear algebra (Diagonalization of matrices)
- integration (change of variable, Integrations by parts)
- resolution of ordinary differential equations (characteristic polynomial, solution of the homogeneous equation and particular solution...)
- functions with several variables (derivation)

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Practical info

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Solid mechanics

Introducing

Description

Theory of stresses, theory of strains, displacement-strain relationship, linear elasticity constitutive law, formulation of the elasticity problem, analytical methods for solving the general problem of linear elasticity. Applications in practical exercises using Python programming language.

Objectives

At the end of this module, the student should have a comprehensive understanding of solid deformation mechanics, stresses, linearized strains, displacement fields and the constitutive relationship in elasticity.
The student should be able to:
- Analyze the state of stress and strain of a solid under loading.
- Calculate the stress state based on the strain state and vice versa.
- Calculate the strain state based on the displacement field.
- Establish equations for the local equilibrium of the solid at every point.
- Propose a relevant modeling of a real problem, particularly in terms of boundary conditions.
- Calculate the stresses from the diagrams of internal solicitations obtained from beam theory.

Necessary prerequisites

Mathematics (analysis, linear algebra, numerical analysis), general mechanics (statics and kinematics), beam theory (internal solicitations, stresses in beams...), basics in Python programming.

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Practical info

Location(s)

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Fluid mechanics

Introducing

Description

Fluid Mechanics: Introductory definitions and general properties of a fluid, forces acting on a fluid particle. Fluid statics for incompressible and compressible fluids, manometry, buoyant force, forces and moments exerted by a fluid on flat and curved surfaces, and pressure distribution in rigid body motion. Fluid dynamics and kinematics, Euler's equation, Bernoulli's equation, mass conservation, control volume and Reynolds transport theorem, linear momentum equation.

Objectives

Fluid Mechanics:

At the end of this module, the student should have understood and be able to explain (main concepts):
- The concept of a fluid and the forces acting on a fluid particle.
- The distribution of static pressure within a fluid and the forces exerted by the fluid on a solid surface.
- The ideal fluid in motion: kinematics and dynamics.

The student should be able to:
- Calculate the forces exerted by a fluid on flat and curved solid surfaces.
- Use Bernoulli's equation (energy conservation) and Euler's theorem (momentum conservation) in a wide range of practical applications.

Necessary prerequisites

Basic thermodynamics concepts facilitate a better understanding of the fundamental principles.

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Practical info

Location(s)

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Ecological Transition, GHG Reduction, Responsibility and Environment (EARTH)

Introducing

Description

The teaching includes a "2 tonnes" workshop, which provides a fun way of understanding the orders of magnitude linked to the objectives of carbon neutrality in 2050. It also includes assignments on the following topics: housing; electricity production; inequalities and responsibilities; mobility; the climate inaction debate; agriculture and food; and aeronautics. Students also work on a complex problem linked to ecological issues, starting their reflections from an everyday object or service.

Objectives

At the end of this module, the student will be able to:

- Be comfortable with the fundamental concepts related to greenhouse gas emissions, and be able to make simple calculations on this subject.
- Know the order of magnitude of important quantities.
- Be able to fetch emission values from the ADEME database and use them appropriately.
- Think about ecological issues in all their complexity and study a specific problem
- Have an understanding of life cycle analysis and how to apply it
- Be able to research scientific literature
- Be able to understand and analyse figures/data
- Draw political conclusions from scientific facts and one's own values
- Debate, discuss and confront points of view.

Necessary prerequisites

Basic knowledge on energy.

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