

MATHEMATICS AND MECHANICS 1 FIELD_12 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

Mathematical tools 1

Introducing

Description

Part: Mathematical Concepts

- Generalized integrals and series
- Continuity and differentiability of multivariable functions
- Hessian matrix and optimization

Part: Numerical Analysis

- Introduction to Python and numerical analysis (1 Lab Session)
- Direct resolution of linear systems (Gaussian elimination and LU decomposition)
- Solving nonlinear equations (Bisection, Newton's method, and fixed-point iteration)

Part: Probability and Statistics

- Events, probabilities, conditioning, independence
- Random variables, probability distributions, discrete variables
- Continuous random variables, random vectors
- Statistical inference: point estimation, confidence intervals, and hypothesis testing

Objectives

This Teaching Unit (UE) aims to master the essential concepts and foundational knowledge in mathematics for engineers in Civil Engineering or Mechanical Engineering. The UE is divided into three components with complementary objectives:

1. Mathematical Concepts: Master essential mathematical tools for Civil or Mechanical Engineering.

2. Numerical Analysis: Implement efficient algorithms using Python and analyze their convergence.

3. Probability and Statistics: Understand and apply probabilistic and statistical modeling.

Necessary prerequisites

1st year linear algebra and analysis, programming in Python language

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Mechanics

Introducing

Description

Analyze structure equilibrium and apply Newton's second law to a system of rigid bodies:

- Model usual mechanical actions as wrenches using screw theory (kinematic joints and external forces)
- Model friction using Coulomb's Law of Friction
- Model the tilting of a plane joint using a mobile point of application for the normal force
- Identify a statically determinate/indeterminate system (number of static unknowns)
- Determine a solving strategy for the second law (systems of interest, external forces, free body diagram, equations to use, solid bodies subjected to only two external forces)
- Calculate the mechanical actions that need to be determined (joints or actuators)
- Validate the stability of a structure (sliding, tilting on a plane, loss of contact)

Determine the absolute or relative velocity and acceleration of a point on a rigid body:

- Interpret the kinematic parameterization of a mechanism
- Describe the velocity vector field that characterizes a body's motion as a twist using screw theory
- Apply velocity addition, velocity field analysis and time derivatives of vectors in rotating frames
- Determine the condition for rolling without slipping at the contact between two bodies
- Solve a 2D kinematics problem graphically (instantaneous axis of rotation, velocity field)

Objectives

Solid mechanics

At the end of this course, you will be able to:

- determine the mechanical loads exerted on rigid bodies (preliminary step to sizing),
- verify the stability conditions of a mechanism (friction, tilting, loss of contact),
- analyze velocities and accelerations in a mechanism (particularly in power transmissions).

Necessary prerequisites

- Reading a kinematic diagram
- Solving systems of algebraic equations
- Trigonometry and projections
- Vectors, scalar and vector products
- Derivatives of composite functions

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