

MATHEMATICS AND MECHANICS II FIELD_9 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

Ordinary Differential Equations and Series

Introducing

Description

1. Review and Additions on First- and Second-Order Scalar ODEs: Linear cases, Equations of Mechanics, Riccati Equations.
2. Qualitative Aspects of ODEs: Maximal and global solutions, Existence and Uniqueness Theorems, Equations with separable variables, Phase portraits.
3. Numerical Aspects of ODEs: Euler schemes, Trapezoidal method, Runge-Kutta schemes, Error estimation.
4. Function Series: Review of function sequences and numerical series, Modes of convergence and summation properties, Power series applications to ODEs.
5. Linear Differential Systems: First-order systems with constant coefficients, Matrix exponential, Practical resolution, Phase portraits in the plane, Stability of equilibria.
6. Laplace Transform: Integral definition, Computational properties, Applications to ODEs.

Objectives

This module introduces the mathematical framework of Ordinary Differential Equations (ODEs) and provides methods for qualitative and quantitative analysis. Students are expected to identify the type of an ODE and apply appropriate techniques to solve or characterize its solutions.

Necessary prerequisites

Mathematics courses from the first year and UE I2ICMT31.

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Energy Mix and Transition

Introducing

Description

The main concepts covered during the course are: conversion, transport, storage and usage efficiencies / power flux density / material resource intensity / load factor / stock and flow concepts / production and demand profiles / networking / energy mix / energy transition scenarios for 2050.

The course covers the following technologies: wind generation, electrolytic storage (H₂), photovoltaics, electrochemical batteries, hydroelectricity / WWTP, fossil-nuclear-biomass power stations, biogas production.

Objectives

To understand the stakes involved in supplying energy to our production system.

To be able to answer the following questions:

- How do we obtain our energy today (knowing the different means of conversion and storage, and the different mixes) ?
- What are the orders of magnitude for our individual and national energy consumption on a day-to-day basis ?
- Where are the dependencies, weaknesses and limits of our energy supply ?
- How can we build an energy mix that meets our demand profile up to 2050 and the challenge of

decarbonization ?

Necessary prerequisites

Be familiar with the concepts of electrical power and energy, as well as the general concepts of efficiency and density.

Have acquired the knowledge and skills of the first year at INSA, especially in electrokinetics, mechanics and thermodynamics.

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Practical info

Location(s)

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Digital culture and skills 1

Introducing

Description

Introductory course to AI: history, algorithms, issues.
"No code" discovery of neural networks on Vittascience;
notebook for building a small character recognition
network.

Presentation of PIX and study of a certain number of
themes independently with the objective of passing the
PIX certification at the end of the 3rd year.

Objectives

At the end of this module, the student will have
discovered the first dimensions of the field of AI:
history, examples of what AI allows, distinction between
supervised and unsupervised learning, rapid scope of
techniques and algorithms, ethical aspects, risks and
controversies. In a second part, the student will have
advanced his PIX course according to the defined
program.

Necessary prerequisites

Basics of Python Programming

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Practical info

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Dynamics

Introducing

Description

- Analyze the spatial mass distribution of a rigid body (inertia matrix, center of mass).

Newton's first law of motion for a system of rigid bodies:

- Determine the linear and angular momentum and their time derivatives using screw theory
- Determine a solving strategy to apply the first law (systems of interest, equations to be used)
- Determine mechanical actions or differential equations of motion by applying the first law

Work-energy theorem for a system of rigid bodies:

- Calculate the kinetic energy of a body in motion (rotation, translation, helical motion)
- Determine the power of external forces and contact forces
- Derive an equation of motion or determine a force using the work-energy theorem (WET)

Objectives

Rigid body dynamics

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

- Determine the motion of a mechanism over time given the forces acting on it,
- Determine the mechanical actions in the joints or actuators required to produce the desired motion.

Newton's first law of motion and the work-energy theorem (WET) will be used

Necessary prerequisites

Solid mechanics I course:

- Force and moment calculation
- Common forces modeling
- Calculation of velocity and acceleration
- Screw theory: modeling forces as wrenches and velocity fields as twists
- Solving a statics problem

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Practical info

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