MATHEMATICS AND MECHANICS 2 FIELD_11 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

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Mathematical tools 2

Introducing

Description

Linear Algebra

Eigen-elements: eigenvalues, eigenvectors, characteristic polynomial

Diagonalization

Applications

Euclidean Spaces

Scalar product: examples, properties

Orthogonality: Pythagoras theorem, orthogonal bases, orthogonal projection

Bilinear Algebra

Bilinearity

Symmetric positive definite matrices: definition, properties, characterization

Ordinary Differential Equations (ODEs) – Linear

Examples, general framework of affine ODEs

Special case of linear ODEs with constant coefficients

Multivariable Functions

Notion of differential for multivariable functions

First- and second-order optimality conditions

Multiple integrals

Numerical Analysis

Numerical resolution of ODEs

Interpolation

Numerical integration

Least squares method

Objectives

At the end of this module, the student should have understood and be able to explain the following key concepts:

Knowledge of the main results in matrix reduction

Understanding the concept of scalar product and orthogonality

Basic notions of bilinear algebra

The concept of the differential of a multivariable function and partial derivatives

Solving linear differential equations with or without a forcing term

Calculations of integrals of functions of several variables

Finding extrema of a function

The least squares method

Numerical interpolation

Numerical integration

Numerical resolution of differential equations

List of competencies:
Code Competency
1_1 Master mathematical concepts and computational tools relevant to engineering
1_2 Develop rigorous scientific reasoning and the capacity for abstraction
2_1 Master the fundamental tools of the mathematical engineer
(Competency matrix of CTI, 2019)

Necessary prerequisites

Linear algebra and first-year analysis, programming in Python.

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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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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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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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