

PHYSICS, MATHEMATICS AND SCIENTIFIC CULTURE 2 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

Nanophysics

Introducing

Description

Wave phenomena, interferences and diffraction. Particle phenomena. The dual nature of waves and particles, application to electron microscopy. Quantum physics

laws. Quantum effects and applications. Scanning tunnelling microscope, quantum wells and quantum dots, application to radioactivity, harmonic oscillator, vibrations of molecules and Infrared spectroscopy, kinetic momentum and its application to molecular rotation spectroscopy, spin and its applications in NMR and MRI. Atomic and molecular orbitals. X-rays . Lasers. Crystalline solids, concept of energy bands, application in semiconductor electronic devices.

Objectives

At the end of this module, the student will have understood and be able to explain :

The fundamentals of wave propagation and quantum physics that are necessary for the understanding of modern electronic devices and analytical techniques

The principle of analytical techniques commonly used in laboratories and the underlying molecular mechanisms of quantum physics

The student will be able to:

Formulate in his own words some nano-scale mechanisms and give concrete examples of micro and nano-devices together with well-known analytical methods using these mechanisms

Master elementary phenomena of nano-scale physics

Select the best method for a specific characterisation on the basis of the acquired concepts.

Carry out some nano-scale characterisation methods

Link mathematical formalism of quantum physics to real applications

Grasp the necessary approximations that are required in quantum physics

Bring together these different concepts to assimilate them, extract them from their context in order to apply them to real situations.

Necessary prerequisites

L1 level in Mechanics, Electrostatics, Optics and Mathematics.

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Practical info

Location(s)

 Toulouse

Analysis 2

Introducing

Location(s)

 Toulouse

Description

Numerical series, power series.

Objectives

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

- determine the different kinds of convergence of numerical series.
- study the convergence of power series.

Necessary prerequisites

Analysis lectures of first year

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Practical info

Probabilities and statistics

Introducing

Description

- Random variables (discrete or continuous) and their characteristics
- Multidimensional random variables, conditional distributions and independence
- Limit theorems (LLN and CLT) and approximation of laws
- Statistical estimation, both punctual and using confidence intervals
- Statistical test for mean.

Objectives

At the end of this module, the student should have understood and be able to explain (main concepts):

- what a random variable (discrete or continuous) and its characteristics are
- how to apply limit theorems such as the Law of Large Numbers (LLN) or the Central Limit Theorem (CLT)
- the notion of statistical estimation
- the notion of statistical test.

The student will be able to:

- to determine the law of a random variable, to compute its expectation, variance, cumulative distributive, etc
- to study the independence of random variables
- to approximate distributions by using underlying limit theorems
- to estimate using confidence intervals some unknown

parameters (expectation, variance, proportion) associated to a large population
- perform a statistical test for a mean.

Necessary prerequisites

Analysis I and Analysis II

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Practical info

Location(s)

 Toulouse

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)

 Toulouse

Elective scientific course

Introducing

Description

Students take one of the following courses, of their choice:

- spatial data acquisition,
- mechanics for health,
- Python for engineers,
- networks and electrical machines.

Objectives

Elective courses are scientific courses related to the content of the pre-orientation, i.e. courses that can be used by future engineers in the Civil Engineering and Mechanical Engineering sectors. These courses are not prerequisites for the rest of the curriculum.

Necessary prerequisites

See detailed descriptions of each course.

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Practical info

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 Toulouse