INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

PHYSICAL, CHEMICAL AND INDUSTRIAL SCIENCES FIELD_26 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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Chemistry

Introducing

Description

Electronic structure of atoms - atomic Orbitals - periodic table of the elements - Periodicity of the properties - Covalent bonds - Molecular orbitals - pH of aqueous solutions - Solubility, precipitation - Oxidation, reduction.
Laboratory work: Set of six experiments, introducing the implementation of basic laboratory equipment - Titration by acid-basic and oxidation-reduction reactions - Titration by precipitation reactions - Spectrophometric and potentiometric titrations (pH-metric, silver electrode) - Equilibrium of affinity per exchange of ions.

Objectives

1. Memorize the definitions and the chemistry-related vocabulary.
2. Determine the atom structure
3. Describe the structure of the periodic table of the elements.
4. Propose a structure for a molecule (Lewis and spatial) from its raw formula.
5. Describe the link within molecules.
6. Describe the structure of metallic and ionic solids.
7. Describe interactions between molecules.
8. Describe the liquid water structure and explain the main reactivities in solution (equation balance sheet reflecting a reaction of dissolution, precipitation, acid-basic or oxidation- reduction).
9. Analyse a problem to identify the ingredients likely to be present in solution. Deduce one or several equations showing the conservation of elements, the electro neutrality and the constant of balance.
10. Solve a problem about chemistry solutions coming up with as equation as there is unknowns in this problem in order to calculate the unknowns¿ concentration.
11. Describe the principle and be able to implement the basic experimental technics for the analysis
12. Carry out a lab experiment and analyse the result.

Necessary prerequisites

Basic knowledge in physical science (atoms structure, radiation) and in chemistry as describe in the program of the final year high school science.

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Electrical phenomena

Introducing

Description

Electrokintecis 1
*Fundamentals of electrokinetics (current, voltage, resistors)
*Study of electrical circuits
*Current/voltage calculations using various theorems

Electrokinetics 2
*Linear components in transient state (resistors, capacitors, coils)
*Transient state and mathematical tools, first and second-order circuits
*Sinusoidal state and complex notation

Electrostatics
*Scalar fields, vector fields
*Differential operators of field theory
* Invariances and Symmetries
*Electric charges and their interactions
*The electric field
*The electrostatic potential
*The local equations of the electric field and the electrostatic potential
* Calculation methods and application examples
*Conductors
* Capacitors and electrical energy

Objectives

This course is divided into three modules (Electrokinetics 1, Electrokinetics 2, Electrostatics). It begins with an introduction to the basic concepts of electrokinetics (current, electric potential, voltage, etc.), the study of voltage/current generators and resistors, and their characteristics in a steady-state regime. This is followed by the study of electrical circuits using various general laws and theorems. Topics covered include Kirchhoff's laws, superposition theorems, Norton's theorem, Thévenin's theorem, Millman's theorem, and simplification through equivalent circuits. The course then delves into the operation of two other elements, namely capacitors and coils, in circuits, both in transient and sinusoidal states. Mathematical formalism using complex notation to describe the latter will also be employed. Students will grasp these concepts through interactive lectures, and they will see practical applications and engage in exercises during tutorials. The setting up of electrical circuits and the visualization and measurement of signals/parametersand other phenomena will be put into practice during labs. An introduction to instrumentation using LabVIEW will also be offered during these sessions.

Finally, the electrostatics part aims to discover how the natural sciences formalize electrical effects related to electric charges present in matter. This formalism also allows for the study of spatial representation (coordinate systems) and field theory (differential operators). Phenomena depending on time (moving charges) are not covered. The various chapters of the course and associated tutorial sessions enable students to progress towards calculating the electric field and electrostatic potential generated by any charge system and describe the electrification of conductive materials. This introduction leads to capacitors and methods for storing electrical energy associated with them. A practical session illustrates the main effects of electrostatics (electric forces, point effects, electrostatic influence).

The aim of the course is to discover the way natural sciences formalize the electrical effects, linked to the electrical charges present in matter.

This formalism also makes it possible to work on the representation of space (coordinate systems) and field theory (differential operators). Time-dependent phenomena (moving charges are not covered). The different chapters of the course and the associated tutorial sessions allow students to progress towards the methods of calculating the electric field and the electrostatic potential generated by any system of charges, then towards the description of the electrification of conductive materials and thus to introduce capacitors and the associated methods of storage of electrical energy. A practical session illustrates the main effects of electrostatics (electrical forces, tip effects, electrostatic influence, etc.).

Necessary prerequisites

Mathematical tools of 1A : Vectors, derivatives and integrals

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Classical mechanics

Introducing

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Thermodynamics

Introducing

Description

Fundamental concepts (concept of systems, evolution of a system, mathematical tools in thermodynamics, ideal gas model). Work and heat. The first law of thermodynamics and the internal energy function. The enthalpy function and the steady-state systems. Thermodynamic functions changes during reactions. Physical equilibria for a pure substance (phases diagram, real fluids). Thermodynamic machines (enthalpy and entropy diagram, power plants, refrigeration units and heat pumps).

Objectives

At the end of this module, the student should have understood and be able to explain:
- the inductive approach specific to thermodynamics which consists in generalizing, by defining them as laws, the conditions for conservation of energy and evolution of systems;
- the meaning, relevance and fields of application of the main thermodynamic functions (internal energy, enthalpy, entropy and free enthalpy).

The student should be able to:
- identify the studied system and to carry out on this system, in a current and systematic way, the mass balance, the energy balance and the entropy balance;
- use and interpret the enthalpy diagram and the entropic diagram of real fluids;
- apply thermodynamics to the understanding and description of equilibria between phases for a pure substance;
- explain the operation of thermodynamic machines (power plant, refrigeration unit, heat pump), based on the two laws of thermodynamics and on the equilibria between phases.

Necessary prerequisites

Function of several variables and partial derivatives concepts. Integrals of usual functions. Mastery of units. General knowledge of physics and mechanics from high school.

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Industrial sciences

Introducing

Description

- Industrial product lifecycle
- 3D computer modeling
- 2D and 3D drawing
- introduction to mechanical design

--> Time : 27,5 h.

Objectives

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

Basic knowledge of mechanical design and manufacturing.

The student will be able to:

1) Module CSM (Mechanical Design):

_ Identify parts of a mechanical system using a mechanical drawing
_ Model simple parts and simple assemblies using CAD software
_ Design a simple mechanical product, describe it using appropriate mechanical engineering wording

Necessary prerequisites

This is an introductory class to industrial design and manufacturing. Students are supposed to have a good knowledge of High School Maths and Physics.

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Geometrical optics

Introducing

Description

- Generalities on the properties and the propagation of light. Reflection and refraction of light. Basic laws of geometrical optics. Fermat's principle.

- Image formation by optical systems. Stigmatism and paraxial approximation.

- Study of the basic components of optical systems (thin lenses and spherical mirrors).

- Application: study of some optical instruments (microscopes, telescopes, camera lenses, ...). Construction, working principle, and some figures of merit (linear and angular magnification, optical power).

The geometrical optics course is based on a triple approach: calculations, geometrical constructions and experiments (through simple observation experiments realized during the tutorial sessions and more complex experiments during the lab sessions.)

Objectives

The goal of this optics course is the study of optical phenomena and optical instruments through a geometric description of light propagation.

The course also aims at developing the students scientific reasoning skills.

Necessary prerequisites

Elementary notions of geometry and trigonometry.

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INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Acquire new theoretical concepts

Introducing

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Solve a problem

Introducing

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Conduct analyze and report experiments

Introducing

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Thinking Together the New Socio-Ecological Challenges and our Responsibility

Introducing

Description

The student understands the orders of magnitude of the impacts of human activities in the 20th and 21st centuries: carbon impact, atmospheric CO2 concentration, species extinction, biodiversity, environment, etc.

The student is able to identify the contribution of engineering to these impacts

The student is able to consider solutions, not just technical ones (avoiding techno-solutionism)

The student is able to develop a systemic vision of human impacts on the planet (climate fresco, systemic and complexity analysis)
The student is able to analyze and critically examine the use of numbers and figures relating to socio-ecological issues, and their various interpretations.

The student is made aware of the concept of environmental justice (climate fresco, ethics).

The student is able to question certain engineering activities and their uses.

Objectives

Thinking Together New Socio-Ecological Challenges and Our Responsibility:
Understanding the limits of the Anthropocene and its consequences for our present: socio-ecological issues

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...

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