2nd YEAR CHEMICAL, BIOCHEMICAL AND ENVIRONMENTAL ENGENEERING

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

Mathematics

Introducing

Description

In the Analysis-Algebra course:
- Laplace transform and application to the resolution of first and second order linear ODEs.
- bilinear algebra: bilinear forms, symmetric bilinear forms, associated quadratic form, scalar product, orthogonality, Gram-Schmidt orthogonalization procedure, orthogonal of a vector subspace, orthogonal projection, norm associated with a scalar product, convergence, continuity, Weierstrass theorem.
- functions of several variables: continuity, partial derivatives, differentiability, local extremum points, multiple integrals.

In the Probabilities section:
- probability space and conditional probabilities, independence of events
- discrete and continuous random variables (law of probability, expectation, variance, etc.)
- couples of random variables
- limit theorems (law of large numbers, central limit theorem)

Objectives

Introduce the Laplace transform and its use to solve certain ordinary differential equations.
Introduce some notions of bilinear algebra, in particular the scalar product and orthogonality.
Introduce concepts of analysis in several variables.
Introduce the basic concepts of probability.

Necessary prerequisites

1st year linear algebra.
1st year analysis: functions of a single variable (continuity, derivative, integrals, local extremum points).
Newton binomial, geometric series, exponential series.

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Practical info

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Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Transfer bases

Introducing

Description

Transport phenomena: Continuum media, concept of shear stress. Statics of fluids. Kinematics of fluids.
Principles of conservation of mass, momentum and energy. Writing local equations and the global balances of mass, momentum and energy. Rheological laws (examples of Newtonian fluid and some non-Newtonian fluids).
Boundary conditions.
Exact solutions of some model problems. Analogies of transfers (Newton, Fourier, Fick).

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
- The basics of continuum mechanics
- The concept of balance and the different scales of application
The student will be able to:
- Define a system and its contours, and calculate inlet, outlet and transformation fluxes
- Write local and macroscopic balances of mass, energy and momentum
- Solve analytically simple problems of Newtonian fluid mechanics

Necessary prerequisites

UF "Thermodynamics - Basics and Applications" from the first year of INSA or equivalent.
First-year mathematics (differential and integral calculus, notions of geometry, trigonometry and algebra).

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Practical info

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Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Organic chemistry

Introducing

Description

Part I: Spatial and electronic structures.
- Hybridization of atomic orbitals and geometry of organic molecules.
- Nomenclature.
- Constitutional and conformational isomerism.
- Stereochemistry (enantiomerism, diastereosisomerism).
- Electronic effects: polarity, polarizability, inductive and mesomeric effects.
- Structure-reactivity relationship: the main classes of reagents: acids, bases, nucleophiles, electrophiles, reaction intermediates: carbocations, carbanions, free radicals.

Part Two: Reactivity of compounds. The main reaction mechanisms.

- Radical substitutions on alkanes (SR).
- Electrophilic additions to alkenes (AE).
- Electrophilic substitutions on arenes (SE).
- Nucleophilic substitutions in aliphatic series (SN1 and SN2).
- Elimination reactions (E1 and E2).

Basic practical work:
- Doubling of a racemic mixture.
- Chemical synthesis.
Acquire and implement the main experimental techniques (distillation, extraction, reflux set-up, recrystallisation, TLC and silica gel column chromatography).
- Raise students' awareness of safety during chemical manipulations.

UV visible spectrophotometry: principles, theory, Beer Lambert's Law.
IR and NMR spectroscopy: principles, equipment, interpretation of spectra.

Objectives

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

- the spatial and electronic structures of molecules in order to understand the main reaction mechanisms and their stereochemical consequences.

- the basic reaction mechanisms of chemical reactions in the living world and industrial organic chemistry.

The student should be able to:

- Identify the main chemical functions and name chemical compounds.
- Represent chemical compounds (Newman, Fischer, Cram).
- Distinguish between the different types of isomerism: conformational and configurational isomerism (enantiomerism, diastereoisomerism).
- Analyse electronic effects (inductive effects and mesomeric effects) in a molecule.
- Describe the different classes of reagents and reaction intermediates.
- Describe the main reaction mechanisms encountered in chemistry: Radical substitutions on alkanes (SR), Electrophilic additions on alkenes (AE), Electrophilic substitutions on arenes (SE), Nucleophilic substitutions in aliphatic series (SN1 and SN2), Elimination reactions (E1 and E2).
- Carry out organic syntheses using the basic experimental techniques of organic chemistry.
- Use the various techniques for characterising organic compounds (UV, IR, NMR)

- Interpret UV, IR and NMR spectra

Necessary prerequisites

I1ANETCH Atomistic
I1ANETCH Solution chemistry

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Practical info

Location(s)

Toulouse

Thermodynamics of physical-chemical systems

Introducing

Description

Systems, quantities and properties of states
Energy description of systems
Macroscopic properties of pure components
Description of physicochemical systems
Reaction quantities
Chemical potential and fugacity
Real solutions
Characterization of phase equilibria
Chemical equilibrium

Objectives

At the end of this module, the student will have acquired systematic practice in the implementation of material and energy balances with chemical reactions, and analyzes in closed and open energy systems. He will understand the behavior of real fluids, the generalized formulation of these behaviors using equations of state, their behavior in saturation zones, the main associated thermodynamic diagrams and their application to various systems.

He will have acquired the basics of thermochemistry including reaction quantities as well as the influence of temperature on these quantities (Kirschhoff), the heat of reaction, and will apply this knowledge to reactive systems under various conditions both theoretically through supervised work and practically in TP.

He will also have acquired the bases for the description of physicochemical systems and solutions (ideal/non-ideal) allowing the characterization and calculations of equilibrium between phases in the solutions. These bases are necessary for understanding and sizing unit operations in chemical and biochemical systems.

He will understand and apply the concepts associated with chemical equilibria: limitation of reaction progress, stability, instability and spontaneity of chemical reactions, chemical equilibrium constant, displacement of the equilibrium (Lechatelier's law).

He will apply this knowledge to homogeneous equilibria in the gas phase and in the condensed phase as well as to heterogeneous chemical equilibria.

Necessary prerequisites

UF « Thermodynamique Bases et applications » (code I1ANTH11) de la première année de l'INSA ou équivalent.

Évaluation

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Practical info

Location(s)

Toulouse

Structural Biochemistry

Introducing

Description

Detailed description of the structure of the molecules listed below and their major role in the cellular functioning of living beings:
- Monosaccharides, oligosaccharides, and polysaccharides
- Fatty acids and lipids
- Nucleotides and nucleic acids (DNA and RNA)
- Amino acids and proteins

Description and implementation of several analytical methods to elucidate the structure of certain compounds.
Introduction to the study and use of these biomolecules for biotechnologies in the context of ecological transition, sustainable development, and the bioeconomy.

Objectives

By the end of this module, students should have understood and been able to describe the overall structure of the four major classes of biomolecules that make up living systems (carbohydrates, lipids, nucleic acids, and proteins), as well as their function in cells. Students will also be aware of the great diversity that exists in the living world and its importance. They will also be able to cite certain techniques for analyzing these molecules and should be familiar with some simple examples of their relevance to biotechnology.

Necessary prerequisites

I1ANBC11 Chemistry
I2BECH11 Organic chemistry

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Practical info

Location(s)

Toulouse

Expression

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

Contemporary economy and ecological transition

Introducing

Description

The main areas studied are as follows:

- The market
- Economic actors
- Income and distribution
- Economic growth
- Unemployment
- Financing the economy
- Currency and inflation
- Economic policies
- New economic models

Objectives

The objective of this course is to provide basic concepts allowing students to better understand their current and future environment and to identify the main issues.

Students will be able to carry on a conversation and debate using arguments based on knowledge of fundamental economic mechanisms and some theories of economic thought.

Necessary prerequisites

None

Évaluation

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Practical info

Location(s)

Toulouse

Foreign Language 1

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Internship defense

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Professional path initiative

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

Physical Activities and Sports

Introducing

Description

The APS (Physical and Sports Activities) offering is structured around several categories:

Team sports: football, basketball, volleyball

Individual sports: tennis, badminton, climbing, judo, strength training, gymnastics

Artistic and expressive activities: circuit training, dance

Outdoor activities: outdoor physical and nature-based activities (OPNA), golf

Adapted sports: adapted strength training, learn-to-swim, learn-to-ride, Pilates, sophrology

At the beginning of the academic year, students use a dedicated platform ("choix APS") to rank the available APS options in order of preference. Each student is then assigned an activity based on their choices and availability.

All APS sessions are supervised by certified PE teachers, either permanent staff (CAPEPS, AGREGATION holders) or external instructors.

Objectives

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

Deepened self-awareness.

Ability to interact effectively with others.

The student should be able to:

Analyze a problem collaboratively (identify the issue, define possible approaches through interactive discussion).

Facilitate group expression and decision-making, allowing everyone to share their opinion.

Adjust and regulate their behavior in response to others.

Identify their own strengths and weaknesses, as well as those of others.

Apply these insights in the context of physical and sports practice.

Évaluation

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Practical info

Location(s)

Toulouse

Analytical Methods 1

Introducing

Description

This module is divided into three parts in order to understand and manage theoretical and experimental concepts relating to analytical methods.

Electrochemistry (Conductimetry, probes, ion-selective electrodes).

Liquid and gas Chromatographies: theory, instrumentation and quantification methods.

Sensors (biomass, microscopy, temperature, flow, pressure, viscosity, etc.).

Objectives

At the end of this module, the student will have understood and be able to explain the principles of analytical techniques implemented currently in laboratories and the associated mechanisms using his/her knowledge in quantum physics and chemistry (chemical reactions, physical and chemical properties ¿)

The student will be able to:

AA1 Choose the most relevant technique regarding the problem by explaining the relating theoretical concepts.

AA2 Carry out these analytical techniques.

AA3 Define and interface sensors with their electronic signal processing unit and identify needs for filtering, amplification and other signal processing requirements

AA4 Analyse and discuss the results in a critical way.

Necessary prerequisites

Thermodynamic 1Y (I1ANETTH) and 2Y (I2BETH11) / Chemistry of solutions 1Y (I1ANETCH) / Organic Chemistry 2Y (I2BECH11) / biostructural chemistry 2Y / Electrokinetics 1Y

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Practical info

Location(s)

Toulouse

Chemical reaction engineering

Introducing

Description

Mass balance in reactional homogeneous systems. Continuous and batch systems. Transient and steady states. Progress reaction parameters and global balances. Reaction rate, law for reaction rates and temperature influence. Identification of reaction rate laws. Pseudo-first order approximation. Ideal reactors (batch, continuous stirred and plug flow). Mass balances application in ideal reactors. Isothermal reactors design.

Objectives

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

- kinetics of a chemical, or biochemical reaction
- Rate-limiting step, catalysis, inhibition
- Reaction rates, kinetic order and constant, activation energy
- Reaction progress parameters
- Mass balances applied to reactors
- Continuous and batch stirred reactors
- Plug flow reactors

The student will be able to:

- define a system, its boundaries, for a defined purpose; calculate all the molar fluxes (inlet, outlet, transformation, variation);
- choose the best ideal reactor for a homogeneous isothermal chemical reaction in liquid phase and calculate it (reactor design)
- write mass balances by using reaction progress parameters
- establish a kinetic law from reaction mechanisms in the case of simple chemical and enzymatic reactions. Understand how physiological aspects can impact the kinetics of microbiological reactions.
- propose experimental and numerical methods for determining the kinetic law for a homogeneous reaction from experimental data.
- determine a kinetic constant for a given temperature (Arrhenius law)
- treat a general homogeneous isothermal problem of chemical reaction engineering

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Practical info

Location(s)

Toulouse

Process control

Introducing

Description

- Overall total or partial mass balance, enthalpy balance in transient and steady state
- Concept of system, input and output variables, disturbance
- Some mathematical aspects: linearization of a function with several variables, Laplace Transformation
- Transfer function
- Block diagram
¿ 1st order, 2nd order and pure delay linear systems
- Open loop and closed loop
- Derivative Proportional Integral Regulation
- Concept of stability of a system
- Setting the parameters of a regulator
- Applications: chemical and biological reactors

Objectives

Acquire the main concepts of process control and apply them to simple cases of process engineering and biochemical engineering.

Necessary prerequisites

I2BEBT10 Global mass and energy balances on geometric domains
I2BEMT11 Laplace transform, Taylor expansion, Decomposition into simple elements

Évaluation

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Industrial facilities

Introducing

Description

-Introduction of general concepts associated with a process, including classification and schematization and the notion of unit operation.
- Presentation of the methodology for carrying out (macroscopic) mass balances on a process in stationary mode including the notion of variance
- Application of these concepts on case studies of increasing complexity
- Mass balances on different unit operations (separator, mixer, divider, etc.) and on processes combining these unit operations, reactors, etc. –
-Mass balances on installations with or without recycling

Objectives

The mass balance is an essential tool for quantifying the performance of industrial installations and optimizing them according to criteria of yield, production, productivity, etc. It is also an essential tool for the environmental assessment of processes and bioprocesses. This course therefore aims to train students in the functional analysis approach of processes by introducing the basic concepts associated with the study of processes, including their schematization and the writing of the corresponding macroscopic mass balances. It presents a methodology for solving these balances through the concept of the degree of freedom of a system (variance). These approaches are illustrated through case studies ranging from a unit operation to a complex process operating in steady state.
At the end of the course, the student will be able to:
- Understand the basic concepts associated with processes (continuous process, discontinuous process, reactions, separations, recycling) –
-Understand and analyze a process from the diagram and literal descriptive elements in order to identify the mass flows (flow rates and compositions)
- Calculate the variance of a system and a process
- Write and solve the mass balances associated with an industrial installation operating in steady state
- Present these results by checking their consistency (physical meaning, units..)

Necessary prerequisites

none

Évaluation

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Practical info

Location(s)

Toulouse

Careers

Introducing

Description

The number of hours devoted to “discovering careers” is approximately 50 hours. It encompasses all the activities listed below and scheduled in the timetable.

Project to discover engineering professions and functions
This project is carried out in groups of 5 or 6, and aims to expose students to the realities of the industrial world as early as possible. To this end, they are asked to carry out a study designed to identify the jobs available to them - R&D engineer, quality engineer, production engineer, technical sales engineer, etc. - and the sectors in which they will be able to work - environment, pharmaceuticals, chemicals, agri-food, etc. Ideally, all these projects should cover the full range of opportunities offered by the 2 Biochemical Engineering and Process Engineering specializations.

Please note that these projects are not bibliographic projects designed to explain how a particular product is made! The aim is to place each industrial branch - which can, if necessary, be described in scientific and technological terms - in its organizational, economic, environmental and/or societal context, and above all to identify the specific features, in terms of the job, of the engineers working in it. Students are guided in their work by a teacher, but it is essential that during these projects students get out of INSA, meet professionals, visit factories, firms, design offices…

Objectives

The “discovering careers” section complements the “PPI” scheme, which helps students to reflect on and discuss their educational and career plans, and to take a more coherent career path. The objectives of “discovering careers” are listed below (in no particular order):
1°) to help students project themselves into what will be their daily professional life when they leave INSA, and to enable them to make their choice of specialization in year 3 in a well-thought-out manner. The aim is to give them as complete a picture as possible of the career opportunities available at the end of the 2 specializations to which the pre-orientation leads;
2°) to encourage students to open up to the world outside INSA, with particular emphasis on contacts with industry;
3°) to enable students to understand the usefulness of the courses they are taking by placing them in a professional context;
4°) to give students who have a particular project the opportunity to implement it (civic or community project, etc.)

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Practical info

Location(s)

Toulouse

Numerical calculation and statistics

Introducing

Description

Numerical calculation:
- concept of loop, tracing of functions
- calculation of an integral by a numerical method (trapezoid, midpoint) writing of a generic solver.
- resolution of nonlinear equation systems: Newton's method.
- resolution of differential equations: explicit and implicit Euler method
- resolution of a system of differential equations: use of an EDO solver

Statistics
- one- and two-dimensional descriptive statistics
- principal component analysis
- the point estimate and by confidence intervals of the mean and variance in the Gaussian and non-Gaussian case
- tests on the mean, homogeneity and normality
- the principles of linear models and generalized linear models.

Objectives

Give students basic programming training
Learn numerical methods to solve the different classes of equations typical of their future field of specialty (Chemical and Biological Engineering)

Necessary prerequisites

Elementary notion of mathematical analysis: Matrix, vectors, scalar product
Basic notions of programming: loop, test, assignment, writing functions

Évaluation

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Practical info

Location(s)

Toulouse

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

Évaluation

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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

Microbiology

Introducing

Description

Microbiology :
- Cell biology of microorganisms: General aspects of the microbial world, Prokaryotes: structure and function, Eukaryotes: structure and function, Nutrition and growth, Viruses.
- Classification: Principles of classification, Identification methods, Overview of the microbial world.
- Industrial applications: Industrial microbiology, Water treatment and microorganisms, Negative implications of microorganisms.

Objectives

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

Structure of prokaryotes and eukaryotes. Reproduction. Nutrition. Notion of metabolism. Growth and counting. Classification, identification and industrial applications of microorganisms.

The student should be able to:
Describe microbial diversity and its role in natural cycles. Present the structures and functions of cellular components. Grow and count microorganisms. Master the investigative methods used to classify and characterise organisms. Describe the products of industrial microbiology and water treatment techniques.

Necessary prerequisites

I2BEBS10 Structural biochemistry of carbohydrates, lipids and proteins.

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Elective scientific course

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

Foreign language 2

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Professional Path Initiative 2nd Year

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Physical Activities and Sports

Introducing

Description

Évaluation

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Practical info

Location(s)

Toulouse