FOURTH YEAR INSA TOULOUSE

Autumn semester

Unit operations 1	5 credits	59h
Unit operations 2	5 credits	81h
Processes simulation and analysis	5 credits	69h
Heterogeneous reaction engineering	6 credits	67h
Chemical and environmental engineer, define and build a project	5 credits	61h
Improve your management abilities	4 credits	45h

Spring semester

Heat exchangers with or without phase transition and simultaneous heat and mass transfer	5 credits	68h
Processes & energy	5 credits	42h
Project for research introduction	5 credits	12h
Metrology Environnement and Risks	6 credits	67h
Improving autonomy and building a professional project	4 credits	39h
Communicating within organizations	6 credits	75h

Unit operations 1

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
59h

Presentation

Description

Programme (detailed contents):

* Intermolecular and interfacial interactions occurring in physical and chemical processes (interfaces and colloïds - molecular interactions - surface tensions - capillarity - wettability - adhesion - Surfactants - Interfacial forces : application to colloids), coalescence...

* Membrane, filtration media and fouling (types of processes, media, membrane- operating parameters and fouling phenomena for pressure-driven membrane processes, retention phenomena),effect of operating conditions on the process selectivity and productivity, mass balances and design of deep-bed filters, of membrane processes.Energy consumption.

* Mixing

Macroscopic characterization of the mixing

Technology of mixers : stirred tanks and static mixers

Mixers design

Objectives

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

- the basic concepts of interface and colloidal systems

- phase equilibrium diagrams

- general concept for mass transfer unit operations (ideal stages, operating line...).

Kinetic limitations and theirs effects on separation and mixing

- different ways to perform separation processes

- basic concepts of deep-bed filtration and membrane separation (UF/MF/NF)

The student will be able to:

- identify interactions between compounds or interface/ compounds involved in separation and mixing operations

- identify main membrane fouling phenomena for a given application

- use the equilibrium diagrams

Pre-requisites

Thermodynamics.

Fluid properties and mass transfer.

Hydraulics and dispersed systems.

Basic concepts of Chemistry and Physics .

Useful info

Contacts

Education manager
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Place

Toulouse

Unit operations 2

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
81h

Presentation

Description

Programme (detailed contents):

* General concepts for mass transfer unit operations (presentation, ideal stages, operating lines, equilibrium stage, kinetic concepts)

* Unit operations of mass transfer

Technology of different separators

Design tools of separators. Application to extraction, distillation (continuous and batch), absorption, adsorption..

Organisation:

Lectures, tutorials and lab work.

Objectives

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

- Phase equilibrium diagrams

- General concept for mass transfer unit operations (Ideal stages, operating lines...). Kinetic limitations and theirs effects on separation

- Different ways to perform separation processes (single contact, cross-current and counter-current contactors)

- design tools for separators.

The student will be able to:

- use the equilibrium diagrams

- choose the required technology for a separation

- choose the contact mode

- write the mass balance

- design a multistage separation device (extraction, distillation, adsorption, absorption...)

- then propose a contactor technology.

Pre-requisites

Transport and reaction in fluid medium.

Thermodynamics.

Fluid properties and mass transfer.

Basic concepts for unit operations.

Useful info

Place

Toulouse

Processes simulation and analysis

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
69h

Presentation

Description

Programme (detailed contents):

- local scale: Computational fluid dynamics, principles, applications, solving the equations, turbulence modelling. Software FLUENT

- unit operation or process scale: simulation (material and energy balances, elements of design of apparatus) on different processes operating in continuous operation and simulation of batch chemical reactors or distillation columns. Software PROSIM

- process scale: methodology for environmental impacts assessment. Life cycle analysis. Carbon footprint. Data utilization. Software Umberto

Organisation:

Introduction lectures, tutorials on computer, individually or in pairs. Project: performing a Life cycle analysis on a process.

Objectives

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

- the basics of chemical engineering process simulation tools at various scales

- the life cycle and carbon balance principles

- the basics of multidimensional analysis

- the elementary notions about process optimisation

The student will be able to:

- select the appropriate simulation tool with respect to the scale of investigation

- synthesize their knowledge to analyze the results of a commercial simulation tool

- simulate industrial processes in steady state

- perform the Life Cycle Analysis of an existing process

- use the FLUENT software to simulate single phase flows

- use the PROSIM Plus software to simulate general steady state processes

- use the UMBERTO software to perform a global analysis of a process within its environment.

- gather knowledge from various fields to choose the modelling approach, perform the set-up of the simulation and analyse the results

- perform an optimisation study with PROSIM

- set up simulations of unsteady state processes with PROSIM Batch and FLUENT

Pre-requisites

Modelling and numerical solution for fluid mechanics

Thermodynamics

Basic concepts for OPU

Technology and design of OPU

Hydraulic and dispersed systems

Transport and reaction in fluid medium

Useful info

Place

Toulouse

Heterogeneous reaction engineering

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
67h

Presentation

Description

Program (detailed contents):

- Interest and technologies for heterogeneous reactors.

- Catalytic reactors: Notions of catalyst and heterogeneous kinetics; Limitations by external or internal mass transfer, Calculation of effectiveness factors, Thiele Modulus, Modelling and design of fixed bed reactors (mass balances).

- Gas/liquid reactors: Gas/liquid mass transfer with chemical reactions; Hatta Number; Enhancement factor, Working regimes; Modelling and design of gas/liquid reactors; Choice of the reactor type.

- Biological reactions and reactors: analysis of stoechiometry and kinetics of biological reactions; Bioreactor analysis: design and operation of batch, fed-batch and continuous bioreactors, with or without recycling based on simple reaction kinetics with the goal of cell or metabolite production and pollution treatment

Organisation:

Lectures, tutorials, labwork.

Cases study project in small groups: definition of the physical problem and writing of the equations for a complex system including the transport and heterogeneous reaction steps and its resolution using a numeric tool.

Objectives

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

- the different types of chemical and biological catalysts and their working modes

- the stoichiometry, kinetic laws and their combination for the description of microbial cell behaviour for growth and production,

- the notion of limiting step(s) in heterogeneous reactions

- the notion of apparent reaction rate

- the expression and meaning of dimensionless numbers (Hatta, Thiele, Weiss, Biot...)

- the notions of effectiveness factor and enhancement factor

- the description and modelling of batch, fed-batch and continuous, single or multi stage biological reactors with or without recycling.

The student will be able to:

- determine the limiting process(es) in a chemical heterogeneous reaction

- express the apparent global rate of a chemical reaction depending on the working conditions

- identify the general metabolic scheme of microbial growth

- establish the stoichiometric equations and kinetic laws for biological reactions with respect to the environment conditions

establish an intrinsic kinetic law

- select and design the most suitable reactor to perform a given reaction

- integrate and prioritize the mechanisms in order to model homogenous and heterogeneous biological and chemical reactors

Pre-requisites

Transport and reaction in fluid media

Fluid properties and mass transfer

Thermodynamics

Thermal transfers and reactors

Microbiology and statistics

Useful info

Place

Toulouse

Chemical and environmental engineer, define and build a project

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
61h

Presentation

Description

Programme (detailed contents):

Part Standardization / Management System

- Understand the tasks of a manager (QS) E

- Know the principles of ISO standards including product quality, safety, environment

- Know how to apply / implement an ISO-type approach

- Understand the implementation of environmental management system by offering / using tools

prioritization of environmental issues within a company

Program :

management system related to ISO 9000 - 14000-18000: installation, diagnostic, monitoring

Knowledge of engineering professions: presentation of different trades and activity area that can be offered to young engineers in process and environment engineering: engineering, production, R & D, teacher and researcher, consultant and environmental management, territorial engineer, project engineer. Tools specific to these businesses (which are part of their knowledge and skills), how to access and career development are discussed.

Theoretical principles will be illustrated in a project. The practice of an individual or collective sport will allow the students to develop skills like teamwork, be involved but also observe, himself question

Organization (course):

Lectures from external actors engaged in the trades concerned are organized (around 20 speakers, with time activity ranging from 1 to 25 years). Students begin to weave their network and can better identify the jobs they want to exercise, when they leave the university

Objectives

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

AA1: Identify business sectors :engineering, territorial engineering, environmental management, research, development, production, consulting, sales engineer ...), their specificities, their tools and conditions for access.

AA2: Identify major constraints in industrial production,

know the key steps of responses to supply and achievement of business calls, the principles of public and private markets, the basics of environmental management and sustainable development.

AA3: applying the acquired scientific and technical training in process engineering in the context of industries and trades

AA4: namely build a professional network of contacts from meetings and information presented by the speakers

AA5: get involved in a group and a project to adapt, dare drive the action, ie abandon, propose ...

Pre-requisites

All the Chemical Engineering training

Useful info

Place

Toulouse

Improve your management abilities

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
45h

Presentation

Objectives

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

* The basic rules of business law

* The objectives, principles and means of marketing

* The principles and procedures of financial diagnosis and / or investment

The student will be able to :

Apply principles and rules of management and law in simple situations. Take into account the parameters of the management (customer needs, cost effectiveness and legal compliance).

Useful info

Contacts

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Place

Toulouse

Heat exchangers with or without phase transition and simultaneous heat and mass transfer

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
68h

Presentation

Description

Programme (detailed contents):

*TEMA standards, multi-tubular, plate exchangers, stirred vessels, condensers, boilers, evaporators (software Aspen HTFS), and their utilisation. Parallel, counter current, cross-flow, multi-pass heat exchanger

* Design procedure

Local and overall heat transfer coefficients, exchange area, logarithmic mean temperature difference LMTD. Pressure drop.

Efficiency. Different exchanger geometries will be considered.

*Condensation, application to the design of industrial condensers of different types of vapour mixtures.

*Boiling, evaporation, multiple effects evaporators

*Unit operations involving simultaneous mass and heat transfer: design of a cooling tower, dehumidification tower, air conditioner, extension to systems using other vapour than steam. Drying, design of dryers.

Organisation:

Lectures, tutorials and lab-work.

Objectives

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

- the different types of heat exchangers, condenser, evaporators and other contactors carrying out both heat and mass transfer (cooling tower, humidification-dehumidification process, air conditioning systems, drying equipments,..)

- the mass and heat transfer mechanisms in these equipments

- the notion of efficiency

- film-wise and drop-wise condensation, the characteristics of the condensation of single or mixed vapours with or without incondensable compounds

- the different mechanisms of boiling

- the concept of local coefficient and overall heat transfer coefficient

- the concept of simultaneous mass/heat transfer and their application to engineering especially for handling the system Air/Water/Steam

The student will be able to:

- select the adequate technology of the heat exchanger depending on the process requirement

- establish mass and energy balances on heat exchanger (continuous or batch, with or without phase change)

- establish simultaneous mass and energy balances

- design exchangers of all type: determine the local and overall transfer coefficient, evaluate its performance and its variation with a change of operating conditions

- use software such as ASPEN HTFS to design the heat exchanger

- design unit operations involving simultaneous transfers, such as cooling tower, dehumidification tower, air conditioners, dryers.

- provide basic elements useful for the design of furnaces

Pre-requisites

Thermal transfers and reactors

Fluid properties and mass transfer

Thermodynamics

Useful info

Place

Toulouse

Processes & energy

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
42h

Presentation

Description

Programme (detailed contents):

- the global context of production and processing energy

- processes for power generation,

- renewable energies : wind, solar and biogas,

- steam power cycles: Carnot cycle with superheat, reheat and withdrawals (cycle with maximum theoretical efficiency). Application to nuclear plants. Cogeneration systems. Size and optimization of the plant (energy and exergy efficiency)

- refrigeration cycles from reverse Carnot cycle without change of state to the real cycle of refrigerating machines with change of state.

- the absorption chillers. Size and optimization of the plant (energy and exergy efficiency)

- the gas liquefaction. Cycle at maximum theoretical efficiency, Linde and Claude cycles. Presentation facilities for liquefying air and separating components. Special facilities for hydrogen and helium.

Organisation:

Lectures, tutorials and lab work. This modules includes visiting of: a wind farm, a nuclear power plant (Golfech) and a landfill site (Montech)

Objectives

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

- the world context of power-generating systems, which produces a net power output from a fossil, nuclear or renewable energy source.

- the legal and technical context of the various forms of renewable energy (wind, solar photovoltaic, biomass ...),

- the different thermodynamic cycles associated to the power generation systems, the refrigeration and heat pump systems and the gas liquefaction.

- the use of energy and exergy balances for these thermodynamic systems in order to optimize their operation

The student will be able to:

- design a given steam power plant, including the choice of working fluid temperatures, pressures and the determination of fluid working flows plus the pre-sizing of compressors and turbines

- design a refrigeration system, including the choice of working fluid temperatures, pressures and the determination of fluid working flows plus the preliminary design of compressors and expansion devices,

- design a gas liquefaction plant

- participate in the implementation of a wind energy area development and a site photovoltaic,

- participate in the implementation of a biogas network.

Pre-requisites

Thermodynamics.

Useful info

Place

Toulouse

Project for research introduction

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
12h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Program:

- the national research structures

- the principles of patent right

- how to perform a relevant literature review on a subject

- identification of a problem and scientific approach to solve it

- participation to a current research project in a laboratory

- health and safety rules in a research laboratory

Project management: definition and organization

- content (clearly define the limits and tasks)

- deadlines (with prioritization of tasks, Gantt chart)

- HR (assign tasks to people with skills, communication, team management)

- risk analysis, cost estimation.

Organization:

Conferences. Lectures and tutorials on literature survey.

Supervised research project performed in group of 3 students on current projects of the laboratory, by using the project management approach. Presentation of the project results in a poster session.

Objectives

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

- the approach and tools for a good literature and patent survey

- how to develop a scientific work

- the health and safety rules in a research laboratory

- the basic methods for project management

- the organisation of the public research in France

- principles of patent right

The student will be able to:

- to delimit and deepen a scientific research project

- to draw an up-to-date inventory of knowledge on this topic and to identify the international leading research teams

- to propose and to experimentally perform a scientific approach to address a problem based upon the previous literature survey with respect to health and safety rules

- to share and communicate the results with a common scientific formalism (paper, poster)

- to perform a project management approach

Pre-requisites

Literature survey basic knowledge.

Project management.

Scientific knowledge in relation to the research project.

Useful info

Place

Toulouse

Metrology Environnement and Risks

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
67h

Presentation

Description

Law and Regulations in Environment

Environment Process Safety

- Dispersion of pollutants - modeling, risk assessment methods on the environment,

- Characterization and classification of wastes, waste management (treatment and storage sectors), common and radioactive wastes, environmental impact of wastes .

- Notions about the main categories of risk in Chemical Engineering: calculating probabilities of effects induced on human, toxicity, different types of explosions, thermal-runaway. Methods and devices for protection .

Metrology for Environment

- quality of measurements (accuracy, detection and quantification thresholds, robustness, repeatability, reproducibility)

- Metrology for measuring environmental impacts and / or processes design

Organisation:

Law in Environment (lectures 10h tutorials 5h)

Environment Process Safety (30h)

Environment (15h lectures / TD)

Process savety 15h including 10h lectures and 5h tutorials

Research project combining law and environmental risks (80h Estimated personal work)

Metrology for Environment (during lectures 3.75h tutorials 5h Labworks 24h)

measurement tools applied to the characterization of complex matrices or media (NTK analyzers, COD, gas, on-line UV, ionic chromatography ...). Meaning of quantities in the fields of environment and processing methods.

Quality of measurements: accuracy, reproducibility, detection and quantification thresholds. Statistical analysis of the measurements and for data calculations.

Application to the analyses of compounds in complex solutions, offline and online measurements for compounds in both liquid and gas phases, characterizations of aerobic and anaerobic biological degradation (determination of kinetic and stoichiometric parameters).

Objectives

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

-the principles of environmental laws in France , and what tools to access legal informations

- the choice of suitable and argued measurements either for the analysis of environmental impacts or to process design

- what are the main environmental issues and principles of waste management

- the main risks in the process industry and mechanisms linked to accidents

The student will be able to:

AA1 : find and use legal informations (from legacy context) related to environmental law (ICPE , TGAP , environmental impacts, ...)

AA2 : choose and apply relevant method (s) in order to characterize the compounds and / or pollutants in complex environments or matrix doing a critical analysis of the methodology and the experimental results

AA3 : analyze a case of risk for Environment , to identify the categories of impacts, to describe pollution from the origin (=source) to the environmental targets

AA4 : analyze a situation of industrial risk, to identify and to calculate physico-chemical parameters of the involved phenomena and to propose technical solutions

Pre-requisites

The whole Chemical Engineering course.

Useful info

Place

Toulouse

Improving autonomy and building a professional project

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
39h

Presentation

Objectives

Construire une équipe projet, Approfondir ses connaissances,

Investir le métier, les domaines d'activité, les fonctions.

L'étudiant devra être capable de :

- d'analyser avec les autres un problème posé (Identifier le problème, définir les axes d'approche dans un bilan interactif : organisation, physique, technique, stratégique, motivation, confiance...

- de décider ensemble (permettre à tout le monde d'exprimer son avis, ajuster et réguler sa conduite en fonction de l'analyse collective),

- d'identifier les ressources du groupe (sens critique, repérage des points forts et faibles de chacun).

Place

Toulouse

Useful info

Communicating within organizations

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Objectives

The classes given in French will focus on :

- How to react to society's demand for technical and scientific information

- How to foster critical thinking in order to give appropriate answers when questioned about such issues

- How to communicate effectively in the workplace

The classes given in English will focus on the specific linguistic characteristics of English used in such contexts in order for the students to understand and master them.

The students will also be made aware of the specificity of professional communication within the English-speaking world

Module L2

The objectives, defined in reference to the CEFRL for the 5 language activities, depend on the language studied - Chinese, German, Spanish - and the level of the student.

They can be consulted on :

https://moodle.insa-toulouse.fr/course/view.php?id=44

In certain cases, students may be authorised to follow an English module instead of another language.

Pre-requisites

For classes in English : mastery of general English.

Useful info

Place

Toulouse