FIFTH YEAR INSA TOULOUSE

Autumn semester

Design and environmental assessment of processes	9 credits	47h
Human Resources Management and Group Work	6 credits	75h

OPTION 1

Engineering of drinking water production and water treatment		86h
Rational use of energy		75h

OPTION 2

Waste treatment and valorization	5 credits	76h
Separation processes for specific quality water production and new resource exploitation	5 credits	51h

OPTION 3

Process control & optimization	5 credits	75h
Reactor Design & Flow Assurance	5 credits	52h

Spring semester

Training period (4th year)	9 credits	1h
Training period (5th year)	21 credits	2h

Design and environmental assessment of processes

ECTS
9 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
47h

Presentation

Description

Programme (detailed contents):

Safe, clean and sober processes. Green chemistry and processes. Technologies associated with green processes. Scientific English. Project design: design and assessment of a plant.

Organisation:

The training will begin with lectures on green chemistry and green processes that students will have to take into account in the design project proposed afterwards. By groups of 3-4, they will develop a project from a general proposition of the teacher. They will have to: Establish a precise specification and design a full installation ; Assess the process in terms of its environmental impact, and estimate its cost.

For this, they will use their scientific knowledge but also the scientific and technical documentation in English and French. Periodical meetings with English teachers concerning their project will enable them to learn the specificities of scientific English.

Objectives

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

- the concepts of clean, sober, safe processes, the principles of green chemistry and green processes and the associated technology choices

- particularities of scientific English

The student will be able to:

- establish a specification for a given process from a general request

- design the process, taking into account its environmental and economic aspects

- conduct an environmental assessment of the studied process

- write a scientifically supported report to explain the choices and calculations in the process design

- present the process from different points of view: scientific, environmental and economic aspects

- use the chemical engineering scientific literature in English

- make a scientific oral presentation in English about the process

Pre-requisites

All the Chemical Engineering training

Useful info

Place

Toulouse

Human Resources Management and Group Work

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Objectives

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

Human Resource Management

Aims and organisation of a Human Resources position, job analysis and forecasting, recruiting, work motivation, skills, salary, training, career management, conflict mitigation, work contract

Social Psychology

Groups, what they are, their influences and dynamics

The student will be able to analyse a group situation

Pre-requisites

None

Place

Toulouse

Useful info

Engineering of drinking water production and water treatment

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
86h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Programme (detailed contents):

- fresh water resources, availability, quality and uses

- pollutions due to the conventional waste water treatment line

- regulations on potable water (national and international level) and on waste waters

- the drinking water production lines, role of unit operations and history of these lines – design of coagulation, settling, ultrafiltration, removal of iron and manganese, ozonation and chlorination steps

- the waste water treatment lines – design of an activated sludge system – sludge methanisation (digestion, treatment and valorisation of biogas) – sludge treatment : wetting and wet air oxidation)

Organisation:

Lecture-conferences, a project, tutored problems based on complex and real examples and lab-work (on a biological system for waste water treatment and on a membrane process). The project focuses on the design of a WW treatment plant in the framework of a real situation renewed each year.

Objectives

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

- the notions of resources and uses of water, of pollutions of receiving waters

- the european and french regulations on potable water and on waster water treatment

- the main treatment lines for drinking water production and for waste water treatment and the function of unit operations in these lines

- the more recent technologies that are mainly used in these lines and the principle of their operation

The student will be able to:

- elaborate a document concerning the treatment plant definition and construction

- propose a drinking water production line (from fresh waters) and designing the main operations in this line as well as the energetic consumption

- compare different processes for waste water and sludge treatment

- design a wastewater treatment plant for the removal of major pollutants and choosing a technology for sludge treatment

- design a sludge digestion system

Pre-requisites

Hydraulics and dispersed systems

Heat transfers and real reactors

Thermodynamic properties of real fluids and mass transfer

Basic concepts for unit operations

Unit operations : technology and design

Basis on chemistry and biochemistry

Useful info

Place

Toulouse

Rational use of energy

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Description

Program (detailed contents):

This training will introduce the general concept of « rational use of energy ». Scientific approaches (LCA, energetic balance, exergetic balance) able to answer the requirements for an efficient use of energy will be revised and applied to energy production/consumption systems and to industrial plants. New concepts such as Pinch analysis and numerical optimization, will be developed for completing the global approach for energy-use assessment and optimization.

Organisation:

Lectures, tutorials, projects. During projects, the students will apply the different methods for energy-use assessment to energy-production and consumption systems. Dysfunctions must be identified and optimal solutions will be proposed. Students will so understand the advantages and the drawbacks of these different assessment methods.

Objectives

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

*How to establish a life cycle analysis on energy production processes and different energy use scenarios; to use a software (Umberto) and the appropriate databases. Use of results for process eco-design.

* Pinch analysis for improving energy use in a process.

*Other optimization methods (numerical methods) depending on the case study for process ecodesign.

*Establish energy and exergy balances on energy production or energy consumption scenarios. Critical analysis of the obtained results.

*Identify dysfunctions in a system and to propose optimal solutions. To propose new scenarios considering energy aspects.

The student will be able to:

*Mobilise knowledges in chemical engineering in order to solve complex problems in the field of matter and energy processing.

*Conception, design, modelling, conducting and optimizing (for technical and economical criteria) installations in the field of chemical engineering

* Considering safety, energy efficiency and management of environmental impacts in the early step of process design and in functioning of unit processes and processes.

*Conception of new unit processes and processes in different industrial fields like Ecoindustry, Energy, Environment, in order to reduce the climate change threat and contribute to energy transition.

Pre-requisites

Energetic thermodynamics

Process simulation and assessment

Processes and energy

Heat transfer : unit operations and simultaneous heat and mass transfer

Useful info

Place

> Toulouse

Waste treatment and valorization

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
76h

Presentation

Description

Programme (detailed contents):

French and European legal definition of waste. Strategies for wastes elimination (source reduction, valorisation and treatment). Legal policies.

Air pollution control.

Treatment and valorisation of industrial and urban solids wastes. Energy valorization and material recovery.

Introduction to soil pollution and soil risk assessment. Soil treatment processes.

Organisation:

This training is organised as an active learning. Different activities with a common interest (a specific industrial activity) will allow students to approach various aspects of the waste treatment problem. Specific lectures will be proposed, including conferences of industrial partners.

Objectives

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

- the legal and usual definitions of wastes in France. Waste characterisation

- the strategies for waste control

- the principles of unit operations and processes commonly used in waste (gas effluent, wastewater and solids waste) reduction, treatment or valorisation (chemical, biochemical and thermal processes).

- the principles of the French methodology for polluted soils risk assessment, the basis of soil treatment processes.

The student will be able to:

- identify basic rules and policies for an environmental problem, and use it to define a technical problem or to propose an adapted solution

- quantify the dispersion of air pollutants from industrial sources

- determine the valorisation potential for an industrial waste (or gas effluent or wastewater)

- select and design processes for air pollution control and for the treatment or valorisation of industrial water and solid wastes

- understand the risk assessment report of a site

Pre-requisites

All the basic Chemical Engineering courses

Physical, chemical, biological and mathematical fundamentals

Metrology, environment and risks

Useful info

Place

Toulouse

Separation processes for specific quality water production and new resource exploitation

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
51h

Presentation

Description

Programme (detailed contents):

1 New resources for human, agricultural or industrial use

Sea water /brine Waters

Secondary effluents

Nitrogen, Phosphorus

(bio) products from wastewaters

2 Processes for specific quality water production

Reuse

Desalination

Water for process (conditioning)

1. Recycling (water in the process)

1. Design of unit operations

- ion exchange, chromatography, adsorption/ desorption

- Reverse osmosis, electrodialysis

- decarbonation,precipitation, crystallization

Organisation:

L/T/Lab work/project

Objectives

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

- to know the context of the new resources for water and compounds of interest (sea/brine waters, secondary effluent, food bio products)

- To know specific processes for water production (desalination, reuse, ultrapure water, water for industrial use ..)

- principle and design of sorption unit operations (ion exchange, preparative chromatography, adsorption)

- principle and design of advanced membrane separation operations (reverse osmosis, electromembrane processes)

- principle and design of unit operations based on a phase transition (precipitation, crystallization,...)

The student will be able to:

- to design processes for domestic wastewaters tertiary reuse

- to design desalination processes

- to design design processes for ultrapure water production or specific water for utilities

- identify new resources

- conceive and design systems for these new resource use

- apply the knowledge to other case studies

Pre-requisites

Basic concepts for unit operations

Technology and design of unit operations

Heat transfer and reactors

Basis of chemistry

Useful info

Place

Toulouse

Process control & optimization

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Description

Programme (detailed contents):

* Process control and regulation (classical control, advanced control)
* Modelling and simulation of dynamic systems
* Single-objective optimization
* Applied optimization (multi-objective, evolutionary algorithms, advanced optimization)

Organisation:

* Big pictures + Jigsaw
* Lectures
* Tutorials
* Project

During the project, the following tasks will be pursued:

* WWTP Modelling via Matlab
* WWTP single-objective optimization via Golden number method
* Regulation of WWTP in the dynamic regime via Simulink
* A serious game on process control
* Optimization of coupled WWTP-cogeneration (renewable energy production)

All above-mentioned items are provided in English. I5PECS11 is an English training unit (EMINSA project 2016).

Objectives

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

1. how to proceed for the simulation and regulation of dynamic systems via:

a) An open programming platform (Matlab)

b) A multi-domain dynamic system analyzer (Simulink)

2. how to formulate and solve an optimization problem (single-objective or multi-objective) through suited methods (derivative-based or evolutionary)

The student will be able to:

3. compare different methods for the regulation and optimization of a dynamic industrial case study (Waste Water Treatment Plant – WWTP)

Pre-requisites

Analysis and computing

Modelling and numerical solution for fluid mechanics

Heterogeneous reactor engineering

The whole chemical engineering course

Useful info

Place

Toulouse

Reactor Design & Flow Assurance

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
52h

Presentation

Description

Program (detailed contents):

Development of conservation equations for mass, momentum, species transport and energy by phase-averaging to describe locally multiphase systems.

Establishment and modelling of 3D, 2D, 1D and 0D multiphase systems.

Flow regimes in multiphase system (bubble column, airlift, gas-liquid transport, liquid-liquid flows...)

Closure relations (isolated, diluted, dense swarm), coupling and interactions between entities (population balance and exchange term).

Deep use of existing simulation tool in function of the physical scales, limited phenomena and coupling effects (Excel, Matlab, Ansys, Comsol). Tools benchmarking.

Organisation:

* Face to face lectures
* Academic and tutorials exercises of engineering (agitated and aerated tank, ozonation tower, airlift bioreactor, crystallisation column, multiphase transport in pipe and micro-reactor, liquid-liquid settler...). Cookbooks with recipes and tutorials.
* Industrial and numerical work project with partnership and evolving in an engineer training period. Serious games on a virtual industrial reactor.
* Practical works on instrumented pilot scale (multiphase process with coupling: oxidation in an airlift, agitated tank...)
* Invited conferences of industrial partners

Objectives

Programme (detailed contents):

* Process control and regulation (classical control, advanced control)
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Organisation:

* Big pictures + Jigsaw
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Pre-requisites

Modelling and numerical solution for fluid mechanics

Thermal transfer and reactors

Basic concepts for OPU

Technology and design of OPU

Processes simulation and analysis

Useful info

Place

› Toulouse

Training period (4th year)

ECTS
9 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
1h

In brief

Teaching language(s): Français, Anglais

Useful info

Place

Toulouse

Training period (5th year)

ECTS
21 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
2h

In brief

Teaching language(s): Français, Anglais

Useful info

Place

Toulouse