



Ecole Nationale Supérieure en Génie  
des Technologies Industrielles

# COURSE CATALOGUE

Third Year (M2, Sem. 9 and 10)

**2023 - 2024**

## GENERAL CHRONOLOGY

### Speciality Energetics and Process Engineering

3rd Year (Master II)	S10	Sept. Aug. Jul. Jun. May Apr.	Industrial Training 30 ECTS		MAE Training	Professional Contracts
	S9	Mar. Feb. Jan. Dec. Nov. Oct.	Common Courses EN : SB or TEDDI ; Proc : PE or CPAO 30 ECTS	Mobilité académique		
2nd Year (Master I)		Sept. Aug. Jul. Jun.	Industrial or Research Training		Master in Management (MAE)	
	S8	May Apr. Mar. Feb. Jan.	Common and Specialized Courses Energetics or Process Engineering 30 ECTS	Mobilité académique		
	S7	Dec. Nov. Oct. Sept.	Common and Specialized Courses Energetics or Process Engineering 30 ECTS			
1st Year (Bachelor)		Aug. Jul. Jun.	Short Training			
	S6	May Apr. Mar. Feb. Jan.	Common and Specialized Courses Energetics or Process Engineering 30 ECTS			
	S5	Dec. Nov. Oct. Sept.	Common Courses 30 ECTS			



CPGE BUT L3

Course Catalogue

## GENERAL CHRONOLOGY

### Speciality Electrical Engineering and Computer Science

3rd Year (Master II)	S10	Aug. Jul. Jun. May Apr. Mar.	25 weeks in the company 1 week in the academic center  30 ECTS	International mobility
	S9	Feb. Jan. Dec. Nov. Oct. Sept.	15 weeks in the academic center 11 weeks in the company  30 ECTS	252 h of face-to-face 46 h AP 100 h Design project
2nd Year (Master I)	S8	Aug. Jul. Jun. May Apr. Mar. Feb. Jan.	12 weeks in the company 1 week in the academic center  14 weeks in the academic center 9 weeks in the company  30 ECTS	International mobility  318 h of face-to-face 70 h AP
	S7	Dec. Nov. Oct. Sept.	11 weeks in the academic center 6 weeks in  30 ECTS	350 h of face-to-face 20 h AP
1st Year (Bachelor)	S6	Aug. Jul. Jun. May Apr. Mar. Feb. Jan.	12 weeks in the company 1 week in the academic center  14 weeks in the academic center 9 weeks in the company  30 ECTS	316 h of face-to-face 20 h AP
	S5	Dec. Nov. Oct. Sept.	11 weeks in the academic center 6 weeks in  30 ECTS	340 h of face-to-face 30 h AP



BUT L3 BTS

## NOMENCLATURE

**UE** : Teaching unit

**EC** : Constituent Element

**CM** : Lectures

**TD** : Tutorials

**TP** : Practical work

**Proj.** : Project

**TA** : Autonomous work

**TC** : Common Course

**EN** : Speciality « Energy »

**GP** : Speciality « Process Engineering »

**GEII** : Speciality « Electrical Engineering and Computer Science»

**EN SB** : Speciality « Energy » - Pathways (3A) « Smart Building »

**EN TEDDI** : Speciality « Energy » - Pathways (3A) « Transition Énergétique et Développement Durable dans l'Industrie »

**GP PE** : Speciality « Process Engineering » – Pathways (3A) « Procédés pour l'Environnement »

**GP CPAO** : Speciality « Process Engineering » – Pathways (3A) « Conception des Procédés assistée par Ordinateur »

**GEII HT** : Speciality « Electrical Engineering and Computer Science» – Pathways (3A) « Haute Tension »

## NOMENCLATURE FOR ASSESSMENT PROCEDURES

**Nature\_1** (**Modality\_1**) x Weighting\_factor\_1 + **Nature\_2** (**Modality\_2**) x Weighting\_factor\_2 + ...

### Assessment nature

CC: Continuous Assessment

Proj: Project

Sta: Work placement

TP: Practical Examination

CoE: Reading Comprehension (languages)

CoO: Listening Comprehension (languages)

ExE: Writing (languages)

ExO: Speaking (languages)

IntO: Oral Interaction (languages)

Cert: Certificate of competency in languages

EvaC: Skills assessment

### Assessment modalities

EE: Written examination (by default, if no information provided)

EO: Oral examination

EM: Engine examination

ES: Surprise written examination

PA: Active participation

Sout: Oral defense

Rap: Written report

Prog: Computer program

Tr: Work (within the framework of a work placement, a project or practical work)

D: File

CR: Report (within the framework of practical work)

LA: Reading articles

sd: no document is allowed (by default, if no information provided)

da: documents are allowed (da: further details on the authorized documents)

st: no smart object is allowed (mobile phones, smartwatches...) (by default, if no information provided)

ta: smart objects are allowed

sc: no calculator is allowed (by default, if no information provided) ca: calculators are allowed

### Operators

x/y: x or y

max(x, y): Maximum in several assessments

moyenne(x): Average of several assessments of the same kind and coefficient

## Examples

### CC (EE, 2h)

A 2-hour written examination, no document allowed, no calculator allowed.

### CC (EM, 2h, da:tutoriels) x 1/2 + CC (EE, 2h) x 1/2

A 2-hour engine examination, tutorials are allowed, coefficient 1/2 and a 2-hour written examination, no document allowed, no calculator allowed, coefficient 1/2

### CC (ES, 15mn) x 1/10 + CC (EE, 2h, da:tous, ca) x 9/10

A 15-minute surprise examination, no document allowed, no calculator allowed, coefficient 1/10 and a 2-hour written examination, all documents allowed, calculator allowed, coefficient 9/10.

### TP(EO, 10mn) x 1/4 + TP(EO, 10mn) x 1/4 + TP(CR) x 1/2

Practical work assessed by two oral examinations, each with a coefficient 1/4, and a practical work report, coefficient 1/2.

### Proj (PA, Rap, Sout)

Project assessed by the active participation, a written report and an oral defense.

### Sta (Tr, Rap, Sout)

Work placement assessed by work, a written report and an oral defense.

### CoE(PA) x 1/4 + CoO(PA) x 1/4 + ExE(EE, 1h) x 1/4 + Cert(TOEIC) x 1/4

Example for a foreign language: Reading comprehension assessed by the active participation, Listening comprehension assessed by the active participation, Writing assessed by a 1-hour written examination, no document allowed, Test of English (TOEIC). Same weighted grades for each assessment.

## Semestre 9

### LIST OF TEACHING UNITS (UE) OF THE SEMESTER

TC, Spe ou Path- ways	Code UE	Entitled UE	ECTS
GP-EN	EC9CI	Engineering Culture S9	4
GP-EN	EC9PR	Design Project S9	4
GP-EN	EC9SI	Industrial Internship S9	4
EN- TEDDI	EE9IP	Generation, conversion and distribution of energy S9	8
EN- TEDDI	EE9IT	Rational use of energy S9	6
EN- TEDDI	EE9IG	Global approach to the world of energy S9	4
EN-SB	EE9BC	Building S9	7
EN-SB	EE9BS	Energetic systems	7
EN-SB	EE9BI	IoT	4
GP-PE	PT9ET	Treatment Processes S9	7
GP-PE	PT9EB	Biology and Pollution control S9	7
GP-PE	PT9EN	Industrial implementation S9	4
GP- CPAO	EP9OO	Conception S9	7
GP- CPAO	EP9MS	Modelling and Simulation S9	7
GP- CPAO	EP9OI	Industry 4.0 S9	4
GEII	EG9AP	Apprenticeship S9	6
GEII	EG9CI	Culture of the Engineer S9	6
GEII	EG9HT	High tension	8
GEII	EG9PP	Pulsed Power	6
GEII	EG9SP	Safety, protection and industrial processes	4

## Tronc Commun GP et EN

3rd Year - Semester 9 - Commun Course EN+GP														
UE Name	Code		EC Name	Teachers	Hours (h)								ECTS / Coef.	
	UE	EC			Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef.
Engineering Culture S9	EC9CI	EC9CI1	Quality and Security Management	Ricarde M.	107	28	20	10	10	0	8	0	4	0.25
		EC9CI2	Communication	Naudy F.		22	14	8	6	0	8	4		0.20
		EC9CI3	Professional Insertion and occupational health	Thibaud J-C., Picard G.		19	13	6	7	0	6	0		0.15
		EC9CI4	Human Ressource Management	Fall A.		24	18	14	4	0	6	0		0.25
		EC9CI5	Costs evaluation in industrial processes	Rouch F.		14	8	4	4	0	6	6		0.15
Design Project S9	EC9PR	EC9PR1	Design Project	Kousksou T.	100	100	0	0	0	0	100	100	4	1.00
Industrial Internship S9	EC9SI	EC9SI1	Industrial Internship / Supported Personal Project	Kousksou T., Vaxelaire J.	0	0	0	0	0	0	0	0	4	1.00
Total TC					207		73	42	31	0	134	110	12	



## TEACHING UNIT (UE) :

Engineering Culture S9

ECTS : 4

Code UE : EC9CI

## SKILLS COVERED BY THE UE :

- Demonstrate the knowledge of fundamental principles of quality management: standards, audit, certification...
- Demonstrate the knowledge of the issues and methods of business safety management
- Demonstrate the ability to fit into an organization, to animate it and to develop it: project management, human resource management, financial management, business management and/or legal management
- Understand the basic methods concerning process economic assessment

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EC9CI1	Quality and Security Management	0.25	CC(EF, 2h, ca)
EC9CI2	Communication	0.2	CC(participation)x0.4 + EO(10 min)x0.6
EC9CI3	Professional Insertion and occupational health	0.15	Insertion professionnelle : CC(PA) Santé au travail : Proj (Sout)
EC9CI4	Human Ressource Management	0.25	CC(EF, 2h)
EC9CI5	Costs evaluation in industrial processes	0.15	CC(EF, 1h, da : cours, ca)x1/2 + Proj(Rap)x1/2

EC : Quality and Security Management

EC9CI1

coeff : 0.25

Teacher In Charge : Ricarde M.

CM : 10 h

TD : 10 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

Quality occupies a central importance in companies. This training aims at preparing the engineers for this dimension, whether it is for the managerial aspects or for the more technical aspects bound to the industrial world. This education leans on concrete examples of production units or industrial projects. This course also approaches the management system HSE. Educational platform <https://elearn.univ-pau.fr>

## LEARNING OUTCOMES

The skills developed by this course allow engineers to become integrated into a service quality or to decline the quality approach in other services.

## DESCRIPTION

- The quality management system.
- Continuous improvement
- Plan Do Check Act
- Bases of auditing and the auditing techniques of examining, questioning, evaluating and reporting.
- Quality Standards and certification. ISO 9000 et ISO9001
- Quality tools :
  - Methodology : Pareto chart
  - Cause-and-Effect Diagram The "Five Ws" (and one H) Traceability
  - Effective brainstorming and meetings Technical and Statistical Process Control (SPC)
  - Random inspection (MIL STD 105.D/NFX 06-022) Process capability & control chart
  - Design of experiments (initiation)
- Management system HSE:
  - Accident (rate of gravity and rate of frequency)
  - The prevention and risk assessment
  - The actors of safety

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- Regulations
  - Responsibility
  - Dangerous substances and chemicals
  - The HSE organization in a company

### **RECOMMENDED READING**

Normes ISO9000 et ISO9001.

Formulaires et outils qualité AFNOR.

Appliquer la maîtrise statistique des procédés MSP-SPC, Maurice PILLET, Editions d'organisation.

Méthodes et outils pour résoudre un problème, Alain-Michel CHAUVEL, L'USINE NOUVELLE.

Qualité en production, Daniel DURET & Maurice PILLET, Editions d'organisation.

### **PREREQUISITE**

None

### **ASSESSMENT**

CC(EF, 2h, ca)

EC : Communication

EC9CI2

coeff : 0.2

Teacher In Charge : Naudy F.

CM : 8 h

TD : 6 h

TP : 0 h

Proj : 4 h

Language Français

## OVERVIEW

This course aims to provide tools and methods to improve written and oral communication, to understand communication situations and to adapt to be more efficient in the professional context.

## LEARNING OUTCOMES

- Have a good understanding and command of the basics in oral and written communication
- Effectively use the methods for preparing an oral presentation
- Be familiar with the tools used in debating with and convincing an audience
- Be familiar with the various ways of facilitating a group of persons
- Be able to manage difficult discussions
- Design a personal development plan so as to reinforce one's ability to communicate and co-operate.

## DESCRIPTION

### 1- The fundamentals of communication

- Theoretical models and references
- Verbal and non-verbal communication
- The stakes of interpersonal oral communication

### 2- Self-knowledge and building a professional image

- Behavioural competencies (soft skills)
- Cv
- Covering letter

### 3- Communication and personality type

- Needs and motivation

- Process Communication
- Facilitating elements of the relationship

#### 4- Professional Writing and Oral Presentations

- Writing emails, giving presentations
- Presentations in limited time (introducing yourself, pitching)
- Professional presentation

#### 5- Communication and Collective Moments

- Group facilitation and active listening
- Negotiation
- Conflict Management

### **RECOMMENDED READING**

Watzlawick Paul Une logique de communication

Damasio Antonio Looking for Spinoza: Joy, Sorrow and The Feeling Brain Kourilsky Françoise  
Du désir au plaisir de changer

Rosenberg M. T. Non-violent Communication: A Language of Life Audebert Patrick Bien négocier

Morel Christian Les décisions absurdes, tomes 1 et 2

### **PREREQUISITE**

Personal reflection upon one's own communication practices

### **ASSESSMENT**

CC(participation)x0.4 + EO(10 min)x0.6

EC : Professional Insertion and occupational health

EC9CI3

coeff : 0.15

Teacher In Charge : Thibaud J-C., Picard G.

CM : 6 h

TD : 7 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

### LEARNING OUTCOMES

#### PROFESSIONAL INSERTION:

Be able to understand and use all the tools used for recruitment and be prepared for the interview.

#### OCCUPATIONAL HEALTH:

To know the different aspects of occupational health

Know how to identify and understand the role of the different players in occupational health in the company.

To integrate benchmarks on the analysis of work situations.

Learn to integrate real working conditions into the conduct of projects.

## CONTENT

#### PROFESSIONAL INSERTION:

- the 2.0 resume, the tools (Job Board, CV Video, social media)
- the recruitment interview : success or disaster

#### OCCUPATIONAL HEALTH:

Develop skills in the analysis of work situations

Develop knowledge on the physical and cognitive dimensions of work Develop knowledge on the "ills" of work (MSD, RPS.)

Develop knowledge on the actors of health at work (internal and external) Study of a concrete case of project management integrating working conditions

## RECOMMENDED READING

## PREREQUISITE

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## ASSESSMENT

Insertion professionnelle : CC(PA) Santé au travail : Proj (Sout)

EC : Human Ressource Management		EC9CI4	coeff : 0.25
Teacher In Charge : Fall A.			
CM : 14 h	TD : 4 h	TP : 0 h	Proj : 0 h
Language Français			

## OVERVIEW

This course is an introduction to Human Resource Management (HRM). The aim of this lecture is to teach students the key concepts and techniques required for decision making in this area.

## LEARNING OUTCOMES

- Master the tools for the development of management for jobs and skills
- Know the steps of recruitment and optimization tools
- Know the different devices for professional training.
- Being able to have critical look at the remuneration system of a company
- Master the tools of individual evaluation
- Know the characteristics of teams and Management
- Being able to analyze an HR policy and taking measures of adjustment required

## DESCRIPTION

General Introduction to HRM

Chapter 1 : Personnel Administration

Chapter 2 : Recruitment - process optimization

Chapter 3: Profesional training

Chapter 4: Pay systems

Chapter 5: Individual evaluating

Chapter 6: GPEC

Chapter 7: Team management

## RECOMMENDED READING

- Encyclopédie des Ressources Humaines, sous la direction de José Allouche, Vuibert, 2006
- Fonction RH, Thévenet et ali., Pearson, 3ieme édition, 2012



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- Gestion des ressources humaines, de Jean-Marie Peretti, Vuibert, 2007
  - Organisation et gestion de l'entreprise, de Richard Soparnot, Dunod, 2006

### **PREREQUISITE**

### **ASSESSMENT**

CC(EF, 2h)

EC : Costs evaluation in industrial processes

EC9CI5

coeff : 0.15

Teacher In Charge : Rouch F.

CM : 4 h

TD : 4 h

TP : 0 h

Proj : 6 h

Language Français

## OVERVIEW

The goal of this course is to present evaluation of methods of investments and process operating costs. This theoretical education is completed by feedback from industrial partners.

## LEARNING OUTCOMES

- To know the basic methods of economic evaluation of processes.
- To be able to carry out the economic evaluation of a process.

## DESCRIPTION

Chapter 1: Elements of economic calculation

- Study of the profitability of projects: Taxes and duties; Profitability criteria
- Operating cost and cost price: Definition and breakdown of the operating cost / cost price
- Investments: The various investment charges
- Labour costs

Chapter 2: Investments at the limits of the manufacturing units (ILUF)

- UBLI: average structure, evaluation and estimation
- Accuracy of investment calculation methods
- Adaptation of investment data

Chapter 3: Investment calculation methods

- Exponential (global) methods
- Factorial methods
- Pre-estimated IFP method: examples

## RECOMMENDED READING

Manuel d'évaluation économique des procédés, A. Chauvel et al - Technip Cost Engineering Analysis, W.R. Park, D.E. Jackson - John Wiley & Sons

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Plant Design and Economics for Chemical Engineers, Peters, Timmerhaus - Mc Graw Hill

**PREREQUISITE**

**ASSESSMENT**

CC(Ee, 1h, da : cours, ca)x1/2 + Proj(Rap)x1/2

## TEACHING UNIT (UE) :

### Design Project S9

ECTS : 4

Code UE : EC9PR

## SKILLS COVERED BY THE UE :

Demonstrate the ability to master at the same time all the previously acquired skills:

- scientific skills,
- work in teams,
- project management,
- English, technique and communication

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EC9PR1	Design Project	1	Proj(rap, sout)x1/4 + Proj(rap, sout)x3/4

EC : Design Project

EC9PR1

coeff : 1

Teacher In Charge : Kousksou T.

CM : 0 h

TD : 0 h

TP : 0 h

Proj : 100 h

Language Français

## OVERVIEW

This project, completed in a team from 3 to 5 students, consists in designing and in sizing an industrial installation.

## LEARNING OUTCOMES

Demonstrate his(her) capacity to master simultaneously all the previously acquired skills in ENSGTI : scientific skills, teamwork, project management, technical English and communication.

## DESCRIPTION

- Mass balance
- Energy balance
- Sizing of 3 or 4 unit operations or systems
- Safety research
- Process control research
- Economic research
- Environmental research
- Energy optimisation

## RECOMMENDED READING

## PREREQUISITE

First and second year at the ENSGTI

## ASSESSMENT

Proj(rap, sout)x1/4 + Proj(rap, sout)x3/4

TEACHING UNIT (UE) :

Industrial Internship S9

ECTS : 4

Code UE : EC9SI

SKILLS COVERED BY THE UE :

**COMPETENCIES COMMON TO ALL COURSES:**

1. Integrate into the organisation in order to ensure the interface with the "sponsor" (R&D department, customer or other...) by managing the commercial, technical and financial aspects throughout a project, up to, eventually, the implementation and start-up of the industrial unit.
2. Communicate in a way that is adapted to the situation and the people involved, in order to support the development of a project.
3. Apply the principles of Occupational Health and Safety in the context of your activities in order to prevent risks.
4. Apply the principles of company ethics by taking into account the organisation and management of governance.

**SPECIFIC SKILLS DEPENDING ON THE TYPE OF INTERNSHIP:**

Energetic:

- Apply the basic principles of energy (material, energy and momentum balances; mass or momentum transfer; coupled heat transfer) to determine the topology, sizing and operation of systems and different technologies.
- Use computerised CAD/CAM, simulation (possibly dynamic), optimisation and control tools for energy systems to ensure that technical.
- Get involved with the relevant departments (technical and commercial departments) in the management of a portfolio of clients and prospects with the aim of promoting the service and product offer.
- Understand the needs of clients in order to provide appropriate technical and financial solutions by ensuring compliance with regulatory, legal, administrative and financial procedures.

- Participate in the design and response to consultations or calls for tender in collaboration with the company's areas of expertise in order to carry out energy and/or sustainable development studies.
- Carry out an economic and commercial watch on the market (follow the news of clients and prospects) in order to detect threats and commercial opportunities.

#### Processes:

- Use the basic principles of process engineering (material, energy and momentum balances; concept of equilibrium; notion of chemical kinetics; mass, heat or momentum transfer) to :
  - item determine the topology, the dimensioning and the functioning of the processes and the various unit operations,
  - propose improvements in the performance of industrial production installations
- Implement computerised flowsheeting, optimisation, simulation (possibly dynamic) and control tools for industrial processes to ensure that technical, economic, environmental and safety issues are taken into account.
- Implement experiments (physical or virtual) to validate proposals while respecting the environment.
- Design and implement metrology and control systems to ensure proper operation of production facilities.

#### LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EC9SI1	Industrial Internship / Supported Personal Project	1	Sta(Tr, Rap, Sout)

EC : Industrial Internship / Supported Personal Project

EC9SI1

coeff : 1

Teacher In Charge : Kousksou T., Vaxelaire J.

CM : 0 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

Internship in a company of 2 to 4 months, with engineering missions or Supervised Individual Project.

## LEARNING OUTCOMES

Defined on the UE

## DESCRIPTION

**Preliminary work to identify the specific skills to be developed during the internship must be carried out during the first month of the internship and will be passed on to the academic and industrial tutors in order to demonstrate a good understanding of the expectations of the internship.**

Different skills are identified according to the speciality and type of placement in the EU syllabus. 4 competences are common to all placements and, depending on the type of placement, the student will have to choose one or several other specific competences, possibly in a partial way.

**Among the 4 competences common to all courses, two items will be developed:**

### 1. Occupational Health and Safety (OHS)

- Understand the issues (human, social, economic and legal) of occupational health and safety.
- Specify the classification of the industrial site in the regulatory sense (site subject to declaration, registration, authorisation, SEVESO site). Why this classification by the State services?
- To observe safety in the company
- Define the indicators (frequency rate, severity rate, work accident contribution rate, etc.). Do specific indicators exist for subcontracting?
- Identify the sources of available information (single document, occupational medicine, etc.).
- Define the organisation of feedback.
- The accident declaration (first aid, accident without/with work stoppage). Who does what?
- Accident analysis (collection of facts, accident analysis, accident analysis method - e.g. construction of a Cause Tree). Describe the organisation of these accident analysis procedures.



- Communication actions on safety ? Existence of a bulletin for general distribution, such as "safety flash", "accident flash".
  - Know the organisation set up to manage a crisis situation: I.O.P. (Internal Operation Plan), I.P.P. (Particular Intervention Plan), etc.; identify the players.
  - Indicate some preventive actions planned in the company
  - Indicate the safety training of personnel and subcontractors planned.
- Personal analysis: the student must indicate the repercussions of the safety constraints on his work station in the broad sense.

## 2. Governance and Management of the company's ethics.

Governance of the company: Organisation of governance

- What is the status of the company (SA, SARL, subsidiary...)?
- Present the company's organisation chart.
- Explain the roles and responsibilities of the main departments in this governance.
- What are the company's strategic axes?
- What are the values promoted by the company (ethics, integrity, innovation, customer satisfaction, etc.)?
- What are the links between the governance of the company and the team (department) in which the internship takes place?

Ethics in business

The student engineer will observe the company's behaviour in relation to its economic partners, study the company's values, the fight against fraud and corruption, compliance with rules and regulations, the fight against harassment and discrimination...

Personal analysis: for example, how governance has impacted the internship and/or give his/her opinion on governance.

### **The student must:**

- **After one month's work placement, have identified the specific skills to be developed during the internship and have communicated this to the academic and industrial tutors**
- **in their report and during the internship defence, demonstrate the acquisition of specific skills by relying on their achievements**
- **develop the two compulsory items in their placement report (approximately 2 pages per item), firstly in a general manner, then they will develop their own analysis of these subjects by making the link (as far as possible) between these two aspects and their own activities.**

### **RECOMMENDED READING**

<https://travail-emploi.gouv.fr/emploi/emploi-et-handicap/>

<https://www.agefiph.fr/>

<http://www.fiphfp.fr/>

### **PREREQUISITE**

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## ASSESSMENT

Sta(Tr, Rap, Sout)

## SPECIALITY Energy - Pathways TEDDI

3rd Year - Semester 9 - EN														
Energy Transition and Sustainable Development in Industry (TEDDI)														
UE Name	Code		EC Name	Hours (h)								ECTS / Coef.		
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef. EC	
Generation, conversion and distribution of energy S9	EE9IP	EE9IP1	Nuclear energy	221	54	36	32	4	0	18	0	8	0.24	
		EE9IP2	Carbon Energy		24	16	8	8	0	8	0		0.10	
		EE9IP3	Renewable Energy I: Solar		52	26	12	14	0	26	18		0.23	
		EE9IP4	Renewable energy II: Marine and wind		18	12	8	4	0	6	0		0.08	
		EE9IP5	Renewable energy III: Developing technologies		33	22	14	8	0	11	0		0.14	
		EE9IP6	Energetic networks		40	16	12	4	0	24	12		0.21	
Rational use of energy S9	EE9IT	EE9IT1	Energy audits	177	60	30	30	0	0	30	10	6	0.34	
		EE9IT2	Energy efficiency		48	28	14	14	0	20	20		0.27	
		EE9IT3	Energy storage		16	8	8	0	0	8	0		0.09	
		EE9IT4	Advanced physics modeling		53	28	22	6	0	25	25		0.30	
Global approach to the world of energy S9	EE9IG	EE9IG1	Geopolitical situation and world panorama	114	30	20	20	0	0	10	0	4	0.25	
		EE9IG2	Business model and project financing		20	10	2	8	0	10	14		0.17	
		EE9IG3	Energy legislation		30	12	12	0	0	18	0		0.25	
		EE9IG4	Energy economics		34	10	10	0	0	24	0		0.33	
Total Parcours				398	222	160	62	0	176	85	14			
Total TC + Parcours				605	295							26		

## TEACHING UNIT (UE) :

Generation, conversion and distribution of energy S9

ECTS : 8

Code UE : EE9IP

## SKILLS COVERED BY THE UE :

- Mastery of all energy production channels
- Mastery of energy vectors and energy operators and delivery methods
- Know-how in terms of dimensioning and operating modes

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9IP1	Nuclear energy	0.24	CC (EE, 2h, sd) *0.5 + CC (EE, 2h, sd) *0.5
EE9IP2	Carbon Energy	0.1	CC (EE, 1h, sd) x 0.5 + CC (EE, 1h, sd) x 0.5
EE9IP3	Renewable Energy I: Solar	0.23	CC (EE, 1h, sd) x 0.8 + CC (EE, 1h, sd, ca) x 0.2
EE9IP4	Renewable energy II: Marine and wind	0.08	CC (EE, 1h, sd) x 0.5 + CC (EE, 1h, sd) x 0.5
EE9IP5	Renewable energy III: Developing technologies	0.14	CC (EE, 1h, sd) x 0.4 + CC (EE, 1h, sd) x 0.3 + CC (EE, 1h, sd) x 0.3
EE9IP6	Energetic networks	0.21	CC (EE, 1h, sd) x 0.5 + Proj (rap) x 0.5

EC : Nuclear energy

EE9IP1

coeff : 0.24

Teacher In Charge : DOUCET S., POIXBLANC N.

CM : 32 h

TD : 4 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The aim of this lecture is to present the basic principles of pressurized water reactor (PWR) and their intrinsic parameters. Fundamentals of nuclear security are also given.

## LEARNING OUTCOMES

- Be able to describe how works a PWR.
- Be able to identify and describe the influence of each parameter.
- Be aware of nuclear security.
- Be able to analyze a nuclear accident

## DESCRIPTION

Hazards and safety

1. Forewords
2. Radioprotection
3. Nuclear safety
4. Reporting a safety analysis
5. Impact during normal and incidental behavior
6. Case study

Reactors

7. Introduction : nuclear electricity.
8. Principles of a PWR
9. Nuclear physics
10. Interactions between primary and secondary coolants
11. Safety
12. Radiological protection
13. Nuclear accidents
14. Three Mile Island

15. Tchernobyl

16. Fukushima

### **RECOMMENDED READING**

### **PREREQUISITE**

Thermodynamique des cycles combinés, Transferts thermiques

### **ASSESSMENT**

CC (EE, 2h, sd) \*0.5 + CC (EE, 2h, sd) \*0.5

EC : Carbon Energy

EE9IP2

coeff : 0.1

Teacher In Charge : DUCOUSSO M.

CM : 8 h

TD : 8 h

TP : 0 h

Proj : 0 h

Language Anglais

## OVERVIEW

The aim of this lecture is to present the basic principles of main power plants based on fossil energy, be it oil & gas or coal.

## LEARNING OUTCOMES

- Be able to describe how works and to operate a themal power plant.
- Be able to identify and describe the influence of each parameter.

## DESCRIPTION

- Context and challenges to produce electricity from thermal power plants
- Boiler cycle
- Gas turbine
- Combined cycles power station

## RECOMMENDED READING

R. Gicquel, Systèmes énergétiques, Tomes 1 et 2, Paris : Presse de l'Ecole des Mines, 2009, 372 p et 378 p

J. H. Horlock, Advance gas turbine cycles, Elsevier Sciences, 2003, 230 p

## PREREQUISITE

Cours de : Combustion industrielle (2A), Thermodynamique des cycles (2A)

## ASSESSMENT

CC (EE, 1h, sd) x 0.5 + CC (EE, 1h, sd) x 0.5

EC : Renewable Energy I: Solar

EE9IP3

coeff : 0.23

Teacher In Charge : GIBOUT S., MASSIP G., SERRA S.

CM : 12 h

TD : 14 h

TP : 0 h

Proj : 18 h

Language Français

## OVERVIEW

The aim of this lecture is to present the basic principles of solar renewable energy.

## LEARNING OUTCOMES

- Be able to describe and distinguish the various solar energies.
- To be able to estimate the solar resource.
- Be able to develop and operate solar power plants.

## DESCRIPTION

Solar potential

1. Forewords
2. Solar irradiation on the earth
3. Solar irradiation on the ground and interactions with atmosphere

Thermal solar

1. Introduction
2. Various captors
3. Heat and/or electricity production

PV

1. Electricity recalls
2. Photo-electrical conversion
3. Power plant (receptors, inverters. . . )

## RECOMMENDED READING

## PREREQUISITE

Thermodynamique, Transferts thermiques, Électricité



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## ASSESSMENT

$CC (EE, 1h, sd) \times 0.8 + CC (EE, 1h, sd, ca) \times 0.2$

EC : Renewable energy II: Marine and wind

EE9IP4

coeff : 0.08

Teacher In Charge : CHABANAS. C, LARA CRUZ J.

CM : 8 h

TD : 4 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The purpose of this course is to introduce students to the specifics of renewable energy based on marine, hydro and wind resources.

## LEARNING OUTCOMES

- Be able to describe and distinguish the various marine and wind energies.
- Know how to convert kinetic energy into electricity.
- Be able to develop and operate marine and wind power plants

## DESCRIPTION

Marine & Hydro power

1. Force-vitesse trade-off
2. Hydro-electricity
3. Hydropower
4. Wave energy
5. Marine thermal energy
6. Tidal power

Wind power

1. Measurement and statistical representation of the wind resource
2. Principle of production estimation
3. Wind energy and recoverable part (Betz theory)
4. Wind turbine technology

## RECOMMENDED READING

## PREREQUISITE

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## ASSESSMENT

$CC (EE, 1h, sd) \times 0.5 + CC (EE, 1h, sd) \times 0.5$

EC : Renewable energy III: Developing technologies

EE9IP5

coeff : 0.14

Teacher In Charge : Porfirio J., MARIAS F., CHABAB S., Rahain W., Lalanne L.

CM : 14 h

TD : 8 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The aim of this lecture is to present the basic principles of developing and under-development renewable technologies.

## LEARNING OUTCOMES

- Be able to describe and distinguish the future renewable technologies and the technological and/or economic leaps necessary for their development
- To know the various technological aspects of the development of these sectors.
- To master the physical bases of each sector

## DESCRIPTION

### Hydrogen

1. How to better know hydrogen
2. Energy storage
3. Fuel-cells
4. Fields of application

### Geothermal energy 1. Context

2. Introduction
3. Applications
4. Case studies

### Bio-energy

1. Introduction
2. Bio-combustibles
3. Bio-gases
4. Bio-fuels

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## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

$CC (EE, 1h, sd) \times 0.4 + CC (EE, 1h, sd) \times 0.3 + CC (EE, 1h, sd) \times 0.3$

EC : Energetic networks

EE9IP6

coeff : 0.21

Teacher In Charge : TILLOUS F., FOURNIER JB., FONT-SALLES O., CONQUES F., PERRIN G.

CM : 12 h

TD : 4 h

TP : 0 h

Proj : 12 h

Language Français

## OVERVIEW

The objective of this course is to introduce students to the various types of energy transmission networks, and the associated techniques and management methods in production.

## LEARNING OUTCOMES

- Be able to describe the various energy networks.
- Master the concepts associated with their daily use.

## DESCRIPTION

1. The electricity networks
  - 1.1 Electricity production
  - 1.2 Transport of electricity
  - 1.3 Distribution
  - 1.4 Concession regimes
  - 1.5 Smart-grids
2. Gas networks
  - 2.1 Generalities
  - 2.2 The gas chain
  - 2.3 The natural gas market
3. Heating and cooling networks
  - 3.1 Introduction
  - 3.2 Components of a DHC network

## RECOMMENDED READING

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### **PREREQUISITE**

Thermodynamique des cycles combinés, Transferts thermiques

### **ASSESSMENT**

CC (EE, 1h, sd) x 0.5 + Proj (rap) x 0.5

## TEACHING UNIT (UE) :

Rational use of energy S9

ECTS : 6

Code UE : EE9IT

## SKILLS COVERED BY THE UE :

- Mastering the global energy situation and the associated stakeholders
- Mastering the various socio-economical and political features of energy market
- Mastering energy consumption
- Mastering the overall impact of new projects

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9IT1	Energy audits	0.34	CC (EE, 1h, sd) x 0.5 + CC (EE, 1h, sd) x 0.5
EE9IT2	Energy efficiency	0.27	Proj (PA) x 0.5 + Proj (Rap) x 0.5
EE9IT3	Energy storage	0.09	CC (EE, 2h, da: cours et TD, ca)
EE9IT4	Advanced physics modeling	0.3	CC (EE, 1h30min, da: tous, ca) x 0.25 + Proj (Rap) x 0.75



EC : Energy audits		EE9IT1	coeff : 0.34
Teacher In Charge : BARBE L.			
CM : 30 h	TD : 0 h	TP : 0 h	Proj : 10 h
Language Français			

## OVERVIEW

L'objectif de ce cours est d'aborder les différentes méthodes de réalisation d'un audit énergétique, puis de proposer des sources d'économie en analysant le fonctionnement de certains appareils.

## LEARNING OUTCOMES

- Be able to realize an electrical energy balance
- Be able to realize an thermal energy balance
- Master the different ways to save energy.

## DESCRIPTION

1. Introduction
2. Basic notions
  - a. Ratios
  - b. Pricings
  - c. Methodology
3. Measurements tools
4. Potential energy savings
  - a. Heating and hot water production (DHW)
  - b. Lighting, air treatment
  - c. Cold production and air conditioning
5. Use of renewable energy

## RECOMMENDED READING

Mémotech Génie Energétique

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Guides techniques ADEME

**PREREQUISITE**

**ASSESSMENT**

CC (EE, 1h, sd) x 0.5 + CC (EE, 1h, sd) x 0.5

EC : Energy efficiency		EE9IT2	coeff : 0.27
Teacher In Charge : GUELLIL M., SOCHARD S.			
CM : 14 h	TD : 14 h	TP : 0 h	Proj : 20 h
Language Fr/En			

## OVERVIEW

The objective of this course is to approach energy efficiency, whose goal is to produce as much or more while consuming less. This makes it possible to combine the imperatives of industrial and economic development with criteria of respect for the environment and reduction of consumption.

## LEARNING OUTCOMES

- To know and control energy flows.
- Know how to conduct studies integrating the notions of efficiency.

## DESCRIPTION

1. The challenges of energy efficiency
2. Energy efficiency in energy production
  - a. Fuels
  - b. Electricity production
  - c. Heat production
3. Management and management of industrial projects
4. Pinch analysis

## RECOMMENDED READING

Mémotech Génie Energétique  
Guides techniques ADEME

## PREREQUISITE

## ASSESSMENT

Proj (PA) x 0.5 + Proj (Rap) x 0.5

EC : Energy storage

EE9IT3

coeff : 0.09

Teacher In Charge : BEDCARRATS J.-P.

CM : 8 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Anglais

## OVERVIEW

Energy Storage (ES) systems can play an important role, as they provide great potential for facilitating energy savings and reducing environmental impact. ES appears to provide one of the most advantageous solutions for correcting the mismatch that often occurs between the supply and demand of energy. The objective of this course is to summarize and explain the most important basics and applications of energy storage.

## LEARNING OUTCOMES

- Know how to store energy.
- Know how to design and manage electricity storage.
- Know how to design and manage heat and cold storage.
- Know how to design and manage carbon capture and storage.

## DESCRIPTION

1. Introduction

2. Energy demand

3. Energy storage methods

- a. Mechanical storage
- b. Chemical storage
- c. Magnetic storage
- d. Thermal energy storage (TES)

4. Hydrogen for energy storage

- a. Characteristics of hydrogen
- b. Hydrogen storage technologies

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c. Hydrogen production

5. Comparison of storage technologies

6. Carbon capture and storage (CCS)

**RECOMMENDED READING**

Thermal Energy Storage : Systems and Applications. Ibrahim Dincer, Marc Rosen. Wiley, 2002.  
Stockage par chaleur latente. Jean-Pierre Dumas. Techniques de l'Ingénieur BE9-7751-22, 2002.  
Heat and cold storage with PCM. An up to date introduction into basics and applications.  
Harald Mehling. Luisa F. Cabeza. Series: Heat and Mass Transfer. Springer, 2008.

**PREREQUISITE**

**ASSESSMENT**

CC (EE,2h, da:cours et TD, ca)

EC : Advanced physics modeling		EE9IT4	coeff : 0.3
Teacher In Charge : CHABAB S., MANCEAU R.			
CM : 22 h	TD : 6 h	TP : 0 h	Proj : 25 h
Language Anglais			

## OVERVIEW

This lecture gives additional theoretical backgrounds to deal with complex systems.

## LEARNING OUTCOMES

- Be able to design every kind of system.
- Be able to optimize a given system.

## DESCRIPTION

1. Gas turbines
  - a. Types of gas turbines
  - b. Principles
  - c. Design
  - d. Trials and certification
2. Turbulence modeling
  - a. CFD recalls
  - b. RANS
  - c. LES, URANS and hybrid RANS/LES

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC (EE, 1h30min, da:tous, ca) x 0.25 + Proj (Rap) x 0.75

TEACHING UNIT (UE) :

Global approach to the world of energy S9

ECTS : 4

Code UE : EE9IG

SKILLS COVERED BY THE UE :

- Develop a multifactorial and broad vision of the energy world
- Know how to apprehend energy problems with a cross-disciplinary approach
- Learn to communicate and work on cross-cutting themes

**Accessible to students of the EN speciality: TEDDI**

LIST OF COMPONENT ELEMENTS (EC)

CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9IG1	Geopolitical situation and world panorama	0.25	CC (EE, 1h30, da, ca)
EE9IG2	Business model and project financing	0.17	Proj (Rap)
EE9IG3	Energy legislation	0.25	CC (EE, 1h)
EE9IG4	Energy economics	0.33	CC(EE, 30 min, da)x0.5 + CC (EE, 30 min, sd)x0.5

EC : Geopolitical situation and world panorama

EE9IG1

coeff : 0.25

Teacher In Charge : GUERITTE C.

CM : 20 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The aim of this course is to provide a global inventory of the state of forces and presences at play in the current energy world. A particular focus is put on the origin and the methods of exploitation of the main resources.

## LEARNING OUTCOMES

- Be able to locate and quote the major centres and the main routes.
- Master the triptych of economic/societal/social notions.
- Know and anticipate the future evolution of energy needs and their impact on the economy, lifestyles and the planet
- Know how to articulate sustainable development approaches with economic and political constraints, both at local and national level.
- Know how to research, investigate, respect and anticipate standards and regulations.

## DESCRIPTION

### 1. Energy and climate

Elements of context

Financing and regulation

### 2. The agenda

### 3. Fossil fuels

Definition

Origin and world distribution

Uses in the industrial chain

Issues



#### 4. Renewable energies

Definition

Types and technologies

Development potential

Issues

#### 5. Energy economics

Energy from an economic perspective

The current situation and future prospects

Financing sustainable development

### **RECOMMENDED READING**

### **PREREQUISITE**

### **ASSESSMENT**

CC (EE, 1h30, da, ca)

EC : Business model and project financing

EE9IG2

coeff : 0.17

Teacher In Charge : Latour S.

CM : 2 h

TD : 8 h

TP : 0 h

Proj : 14 h

Language Français

## OVERVIEW

The purpose of this course is to learn how to put together presentation and business plan in order to demonstrate the economic and financial feasibility of a project.

## LEARNING OUTCOMES

- Be able to design a business model.
- Be able to estimate and improve the profitability of a project.

## DESCRIPTION

1. Construction of the business plan
  - a. Productible
  - b. Fixed and variable costs
  - c. Taxes and duties
  - d. Income
2. Micro-economic indicator
  - a. NPV, IRR, discount rate
  - b. The raising of debt financing
  - c. Vitality and sustainability of a project

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

Proj (Rap)

EC : Energy legislation

EE9IG3

coeff : 0.25

Teacher In Charge : De Fontenelle L., Drouiller C.

CM : 12 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The purpose of this course is to learn the legal basis and competent authorities in the field of energy law.

## LEARNING OUTCOMES

- Know the general organisation of the judicial authority.
- Be able to find a legislative text.
- Be able to understand judicial decisions.

## DESCRIPTION

1. Introduction
2. The organisation of law and justice
3. Energy code
4. Origins of the law and sources
5. Judicial decisions

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC (EE, 1h)

EC : Energy economics

EE9IG4

coeff : 0.33

Teacher In Charge : LE CACHEUX J., Guellil M.

CM : 10 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The purpose of this course is to learn about the functioning and context of the energy market.

## LEARNING OUTCOMES

- Know the basics of energy economics.
- Be able to understand the economic context (type of competition, organisational role of the public authorities, etc.).
- Be able to understand the business models.
- Be able to understand the evolution of the energy market.

## DESCRIPTION

1. Introduction
2. Basic economics and econometrics
3. Actors
4. The issues

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC(EE, 30 min, da)x0.5 + CC (EE, 30 min, sd)x0.5

## SPECIALITY Energy - Pathways SB

3rd Year - Semester 9 - EN															
Smart Building (SB)															
UE Name	Code		EC Name	Hours (h)										ECTS / Coef.	
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef. EC		
Building S9	EE9BC	EE9BC1	Building technology	206	52	30	22	8	0	22	0	7	0.25		
		EE9BC2	Comfort		62	38	22	16	0	24	0		0.31		
		EE9BC3	Energetic		92	32	24	8	0	60	56		0.44		
Energetic systems	EE9BS	EE9BS1	Fluidics	210	100	40	20	20	0	60	60	7	0.48		
		EE9BS2	renewable and recovery energies 1 : solar energy		68	32	16	16	0	36	48		0.32		
		EE9BS3	renewable and recovery energies 2 : Biomass and		42	18	12	6	0	24	0		0.20		
IoT	EE9BI	EE9BI1	Machine learning for energy	120	40	28	12	16	0	12	24	4	0.38		
		EE9BI2	Material design		46	26	18	8	0	20	20		0.34		
		EE9BI3	Software design		34	16	8	8	0	18	28		0.28		
Total Parcours				536	536	260	154	106	0	276	236	18			
Total TC + Parcours				743		333						30			

## TEACHING UNIT (UE) :

Building S9

ECTS : 7

Code UE : EE9BC

## SKILLS COVERED BY THE UE :

- know the specific technical vocabulary in building field ;
- predict and understand the thermal behaviour of buildings ;
- Evaluate the performances of building and propose relevant remediation action

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9BC1	Building technology	0.25	CC (EE, 2h, sd, ca)
EE9BC2	Comfort	0.31	CC(2h,EE)*3/4 + CC(1h,EE)*1/8 + CC(1h,EE)*1/8
EE9BC3	Energetic	0.44	CC (EE, 1h, sd) x 1/2 + Proj(Rap,) x 1/2

EC : Building technology

EE9BC1

coeff : 0.25

Teacher In Charge : Garnesson T. ; S. Gibout, PEREVOZCHIKOV I.

CM : 22 h

TD : 8 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The objective of this module is to provide students with the knowledge and basic vocabulary in the field of construction. Digital mock-ups (BIM) will be discussed.

It also includes an introduction to Building Management Systems.

## LEARNING OUTCOMES

At the end of this module, students must be able to :

- Identify the different professions involved in the construction
- Know the different materials and their application areas
- Read and understand a plan
- Identify - from drawings or on site - the different singular points which can have an impact on thermal performance.
- To know the functionalities and uses of BMS/BMS systems.

## DESCRIPTION

- Construction materials and use
- Construction Technology
- Reading of Plan
- Singular points: infiltration and thermal bridging
- Digital mock-ups and BIM
- On site visits (if possible,)
- BMS / BMS systems

## RECOMMENDED READING

Building thermics course

## PREREQUISITE

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## ASSESSMENT

CC (EE, 2h, sd, ca)



EC : Comfort

EE9BC2

coeff : 0.31

Teacher In Charge : C. HORT, LARRIEU B., L. ZALEWSKI

CM : 22 h

TD : 16 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The primary role of a building is to create an "inner space" in order to ensure a level of comfort for users. In the building sector, we first think of hydrothermal comfort, but one must also take into account the indoor air quality and lighting.

## LEARNING OUTCOMES

At the end of this module, students should be able to:

- identify constraints comforts specific use
- evaluate the performance of a local with respect to these constraints
- identify ways to implement to achieve this goal

## DESCRIPTION

- Air quality
- Thermal confort
- Ligthing

## RECOMMENDED READING

## PREREQUISITE

Building Heating, Air Treatment

## ASSESSMENT

$CC(2h,EE)*3/4 + CC(1h,EE)*1/8 + CC(1h,EE)*1/8$

EC : Energetic

EE9BC3

coeff : 0.44

Teacher In Charge : P. VAN HOEVELAKEN

CM : 24 h

TD : 8 h

TP : 0 h

Proj : 56 h

Language Français

## OVERVIEW

This module brings together in a coherent approach the tools for predicting and analysing the thermal behaviour of a building and the tools.

## LEARNING OUTCOMES

- Understand the physical laws specific to the building industry
- Know how to use a STD software
- To analyse the results of STD and to identify the tracks of improvement
- Know how to carry out a regulatory study
- Master the Pleiades tool

## DESCRIPTION

- Thermal regulations (RT)
- Dynamic Thermal Simulation
- Energy audit in the building

## RECOMMENDED READING

## PREREQUISITE

Building heating, Air treatment, Heat transfer

## ASSESSMENT

CC (EE, 1h, sd) x 1/2 + Proj(Rap,) x 1/2

## TEACHING UNIT (UE) :

Energetic systems

ECTS : 7

Code UE : EE9BS

## SKILLS COVERED BY THE UE :

- To know the thermal equipment allowing to maintain the chosen level of comfort
- Know how to size the fluid networks
- Know how to size renewable production systems

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9BS1	Fluidics	0.48	Proj(Rap)
EE9BS2	renewable and recovery energies 1 : solar energy	0.32	CC (EE, 2h, sd) * 1/3 + Proj (Rap) x 2/3
EE9BS3	renewable and recovery energies 2 : Biomass and storage	0.2	CC (EE, 2h, da:cours et TD, ca)x2/3+CC (EE, 1h, sd)x1/3

EC : Fluidics		EE9BS1	coeff : 0.48
Teacher In Charge : N. CHARTRAIN			
CM : 20 h	TD : 20 h	TP : 0 h	Proj : 60 h
Language Français			

## OVERVIEW

Conception et dimensionnement des installations de ventilation, chauffage, climatisation et plomberie

## LEARNING OUTCOMES

- Know how to dimension a complete installation
- Evaluate and select the different technological options
- Write calculation notes

## DESCRIPTION

- Introduction : Ventilation

- Single/double flow ventilation

- o Air handling unit
- o Extraction and diffusion
- o Fire protection Heating and air conditioning

- Reminders RT2012

- o Heat and climate balances
- o Types of emitters
- o Distribution Network (Pressure Losses, Insulation, etc.)
- o Heat and cooling production
- o Typical installation diagrams

- Plumbing - Hot water

- o Definition of requirements
- o Types of production
- o Typical installation diagrams

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### **RECOMMENDED READING**

Mémotech Génie Énergétique

### **PREREQUISITE**

Thermique du bâtiment, traitement de l'air, Thermodynamique appliquée, réseaux fluides

### **ASSESSMENT**

Proj(Rap)

EC : renewable and recovery energies 1 : solar energy

EE9BS2

coeff : 0.32

Teacher In Charge : S. GIBOUT, R. SUBILEAU

CM : 16 h

TD : 16 h

TP : 0 h

Proj : 48 h

Language Fr/En

## OVERVIEW

This course deals with the different facets of solar energy, starting from the resource and focusing on the two conversion processes adapted to buildings: Solar thermal and photovoltaic.

## LEARNING OUTCOMES

- Estimate the solar resource in a given location
- Know how to size thermal production equipment (individual / collective)
- Understand the principles of photovoltaic conversion
- Know how to size a photovoltaic production system and know the associated regulatory framework.

## DESCRIPTION

1. Estimation of the solar resource
2. Thermal conversion
3. Photovoltaic conversion

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC (EE, 2h, sd) \* 1/3 + Proj (Rap) x 2/3

EC : renewable and recovery energies 2 : Biomass and storage EE9BS3 coeff : 0.2

Teacher In Charge : J.-P. BEDECARRATS, Marias F.

CM : 12 h

TD : 6 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

This course is divided into two distinct parts concerning respectively the energy use of biomass (mainly combustion) and the problem of energy storage.

## LEARNING OUTCOMES

- To be familiar with electricity storage facilities.
- Know the cold and heat storage facilities.
- Know the main energy uses of biomass.

## DESCRIPTION

1. Thermal energy storage technologies (sensible, latent, chemical)
2. Electrical energy storage technologies
3. Biomass and energy recovery

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC (EE, 2h, da: cours et TD, ca) x 2/3 + CC (EE, 1h, sd) x 1/3

## TEACHING UNIT (UE) :

IoT

ECTS : 4

Code UE : EE9BI

## SKILLS COVERED BY THE UE :

- To know the new approaches in the analysis and intelligent control of buildings
- Know how to design and implement connected sensors

**Accessible to students of the EN speciality: SB**

LIST OF COMPONENT ELEMENTS (EC)

CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EE9BI1	Machine learning for energy	0.38	CC (EE, 1h, sd) * 1/3 + Proj(Rap) * 2/3
EE9BI2	Material design	0.34	CC (EE, 1h, sd) * 1/3 + Proj (Rap) x 2/3
EE9BI3	Software design	0.28	CC (EE, 1h, sd) * 1/3 + Proj (Rap) x 2/3



EC : Machine learning for energy		EE9BI1	coeff : 0.38
Teacher In Charge : W. Maréchal, Philippe Cotte, Matteo Rizzato			
CM : 12 h	TD : 16 h	TP : 0 h	Proj : 24 h
Language Français			

## OVERVIEW

Machine learning techniques have revolutionised all strata of our societies and activities. The building industry is no exception to this trend. This introductory course will allow you, from concrete applications, to know and use the principal algorithms of machine learning (ML).

## LEARNING OUTCOMES

- Know the use cases of the different ML methods
- Understand the use of the main algorithms in the context of Smart Building

## DESCRIPTION

- Introduction : What is Machine Learning?
- The main types of learning: supervised, unsupervised, reinforcement
- Regression algorithms
- Classification algorithms
- Neural networks and Deep Learning

## RECOMMENDED READING

## PREREQUISITE

Calcul scientifique 1, Optimisation, Programmation

## ASSESSMENT

CC (EE, 1h, sd) \* 1/3 + Proj(Rap) \* 2/3

EC : Material design		EE9BI2	coeff : 0.34
Teacher In Charge : C. PHAM, C. ARRABIE, S. GIBOUT			
CM : 18 h	TD : 8 h	TP : 0 h	Proj : 20 h
Language Français			

## OVERVIEW

This course deals with the "hardware" part of the data acquisition chain. It includes a reminder of the main sensors relevant to the building industry, as well as their implementation on the Arduino and Raspberry Pi platforms. Long distance / low speed wireless communication (LoRa / Sigfox) will also be presented.

## LEARNING OUTCOMES

- Know how to specify and design an autonomous connected sensor
- Understand the issues related to autonomy
- Know how to transmit data to a "cloud" service

## DESCRIPTION

- Introduction to IoT
- Wireless communication
- Sensors and interfacing

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

CC (EE, 1h, sd) \* 1/3 + Proj (Rap) x 2/3

EC : Software design		EE9BI3	coeff : 0.28
Teacher In Charge : C. ARRABIE, S. GIBOUT			
CM : 8 h	TD : 8 h	TP : 0 h	Proj : 28 h
Language Français			

## OVERVIEW

The data produced by the sensors is intended to be exploited in order to deduce relevant information (see Audit and Data Mining). To do this, it is necessary that these data are stored, classified and accessible. This course approaches, always in practical form, the software technologies which allow it.

## LEARNING OUTCOMES

- Know how to query an SQL database
- Know how to define a database structure
- Know the http protocol and WEB technologies
- Know how to interface with a third party data source (REST API)

## DESCRIPTION

- Introduction to databases and the SQL language
- WEB technology
- Api Rest

## RECOMMENDED READING

## PREREQUISITE

Programmation

## ASSESSMENT

CC (EE, 1h, sd) \* 1/3 + Proj (Rap) x 2/3

## SPECIALITY Process Engineering - Pathways PE

3rd Year - Semester 9 - GP														
Processes for the Environment (PE)														
UE Name	Code		EC Name	Hours (h)								ECTS / Coef.		
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef. EC	
Treatment Processes S9	PT9ET	PT9ET1	Wastewater Treatment	193	55	25	18	7	0	30	20	7	0.29	
		PT9ET2	Waste Treatment		52	27	27	0	0	25	8		0.29	
		PT9ET3	Air Treatment		56	26	13	13	0	30	20		0.29	
		PT9ET4	Drinking Water and Water Distribution		30	20	20	0	0	10	0		0.13	
Biology and Pollution control S9	PT9EB	PT9EB1	Biology and Microbiology	190	55	30	20	10	0	25	20	7	0.29	
		PT9EB2	Biological Reactors Engineering		27	15	8	7	0	12	0		0.14	
		PT9EB3	Water Pollution Control		31	16	8	8	0	15	0		0.21	
		PT9EB4	Air Pollution Control		45	25	13	13	0	20	0		0.21	
		PT9EB5	Practical Works		32	32	0	0	32	0	0		0.15	
Industrial implementation S9	PT9EN	EP9OO2	Process Synthesis	110	40	18	4	14	0	22	30	4	0.36	
		PT9EN1	Industrial Risk Management		34	24	24	0	0	10	0		0.31	
		PT9EN3	Introduction to construction contracts		16	8	8	0	0	8	0		0.15	
		PT9EN4	Environmental Management		20	10	5	5	0	10	8		0.18	
Total Parcours				493	493	276	168	77	32	217	106	18		
Total TC + Parcours				700		349						30		

## TEACHING UNIT (UE) :

Treatment Processes S9

ECTS : 7

Code UE : PT9ET

## SKILLS COVERED BY THE UE :

- Identify and be able to select wastewater and waste gas (liquid or solid) treatment processes
- Demonstrate the ability to dimension main unit operations specific to the different possible effluent treatments

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
PT9ET1	Wastewater Treatment	0.29	Proj(Rap, Sout)*1/2+CC(Ee, 2h, sd, ca)*1/2
PT9ET2	Waste Treatment	0.29	CC (Ee, 2h, sd, ca)x4/5 + Projx1/5
PT9ET3	Air Treatment	0.29	CC(Ee, 2h, ca) x0.67+ Proj(Sout)x0.33
PT9ET4	Drinking Water and Water Distribution	0.13	CC (Ee, 1,5h, da, ca)

EC : Wastewater Treatment

PT9ET1

coeff : 0.29

Teacher In Charge : Vaxelaire J., Salin D.

CM : 18 h

TD : 7 h

TP : 0 h

Proj : 20 h

Language Français

## OVERVIEW

Due to environmental regulations many processes have been developed for wastewater treatment. The lecture presents a review of the main processes implicated in industrial and domestic water treatment. Some design elements are also proposed.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge in the wastewater treatment field
- have a basic knowledge on physics, chemistry and biology involved in the classical treatment processes
- be able to design and control wastewater treatment processes

## DESCRIPTION

Part I: Physico-chemical treatments

Pretreatments (Screening, Sand removal, Grease removal)

Decantation

Flotation

Deep bed filtration

Part II: Biological treatment

Principles of biological treatment (Mechanisms involved; Carbon, nitrogen and phosphorus removal)

Free bacterial culture processes (activated sludge, lagoon, membrane bioreactor)

Fixed bacterial culture processes (biofilm, biofilters, trickling filters, biodiscs,)

Processes adapted to small communities

Part III: Experience feedback

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### **RECOMMENDED READING**

- DEGREMONT "Memento technique de l'eau", Ed. Degrémont Suez, 10th édition, 2005.
- HENDRICKS D., "Water treatment unit processes, physical and chemical", Ed. Taylor and Francis, 2006.
- HENZE M., HARREMOES P., LA COUR JANSEN J., ARVIN E. "Wastewater treatment", Ed. Springer, 1996.

### **PREREQUISITE**

Introduction au génie chimique

### **ASSESSMENT**

Proj(Rap, Sout)\*1/2+CC(Ee, 2h, sd, ca)\*1/2

EC : Waste Treatment

PT9ET2

coeff : 0.29

Teacher In Charge : Baron T., Le Boulicaut C. , Mercadier J., Vaxelaire J.

CM : 27 h

TD : 0 h

TP : 0 h

Proj : 8 h

Language Français

## OVERVIEW

Due to environmental regulations many processes have been developed for waste treatment and disposal. The lecture proposes a review of the main processes implicated in industrial and domestic waste treatment, and some design elements.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge in the waste treatment field
- have a basic knowledge on physics, chemistry and biology involved in the classical treatment processes
- be able to design and control waste treatment processes

## DESCRIPTION

### Part I: Incineration

Introduction to waste management.

Incineration process: storage, furnace, boiler, cogeneration, flue gas treatment

### Part II: Hydrothermal oxidation

Subcritical oxidation of organic wastes: presentation of different processes

Oxidation with supercritical water: interest and pilot plant

### Part III: Sludge treatment

Production and regulations

Characterisation (physical, chemical and biological features)

Options for biosolids use and sludge disposal

Treatment options,

- Stabilisation (anaerobic and aerobic digestion, chemical stabilisation, composting)



- Dehydration (conditioning, thickening, mechanical dewatering, thermal drying)

Part IV: Case study.

Plastic waste treatment

Plastic waste production and evolution.

Advantages and difficulties of plastic waste recycling: environmental, economical and social aspects.

Some treatment processes: mechanical, incineration with energy recycling. Life cycle assessment

### **RECOMMENDED READING**

Sludge into biosolids. Processing, disposal and utilization, Ed L. Spinoso and P.A. Vesilind, IWA Publishing, 2001.

Sludge engineering, Ed. F.D. Sanin, W.W. Clarkson, P.A. Vesilind, DEStech Publications, Inc., 2011.

Traiter et valoriser les boues, OTV, 1997.

L'incinération des déchets ménagers, J.Y Legoux et C. Le Douce. Economica, 1995

### **PREREQUISITE**

Notions de base de génie des procédés

### **ASSESSMENT**

CC (EE, 2h, sd, ca)x4/5 + Projx1/5

EC : Air Treatment		PT9ET3	coeff : 0.29
Teacher In Charge : Hort C., Sochard S.			
CM : 13 h	TD : 13 h	TP : 0 h	Proj : 20 h
Language Français			

## OVERVIEW

Due to environmental regulations many processes have been developed for air treatment. The lecture presents a review of the main processes implicated in industrial gas and domestic air treatment. Some design elements are also proposed.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge in the air treatment field
- have a basic knowledge on physics, chemistry and biology involved in the classical treatment processes
- be able to design and control air treatment processes

## DESCRIPTION

### Part I: Gas waste treatment

- Introduction to air and gas waste treatment
  - Air pollutants
  - A global approach for air treatment
- Dust removal
- Acid gas treatment
- Flue gas denitrification
- Thermal and catalytic oxidation
- Adsorption
- Absorption
- Ground storage of CO<sub>2</sub>

### Part II: Biological treatments

- Biofilters
- Bioscrubbers

- Biotrickling filters
- Other processes (membrane systems. . . )
- Modelling aspects
- Industrial biofilters and bioscrubbers
- Domestic air treatment

### RECOMMENDED READING

Popescou M., Blanchard J.M., Carré J. – Analyse et traitement physicochimique des rejets atmosphériques industriels, Tec & Doc Lavoisier Paris, 1998, ISBN 2-7430-0247-6

Le Cloirec P. – Les composés organiques volatils (COV) dans l'environnement, Tec & Doc Lavoisier Paris, 1998, ISBN 2-7430-0232-8

Kennes C. and Veiga M.C. – Bioreactors for waste Gas Treatment, Kluwer Academic Publishers 2001

Shareefdeen Z. and Singh A. – Biotechnology for odor and air pollution control , Springer, 2005

S. Biccchi - Les polluants et les techniques d'épuration des fumées, Lavoisier Tec & Doc, Paris 1998

### PREREQUISITE

Introduction to chemical engineering, thermodynamic of the solutions, modeling, bioreactors

### ASSESSMENT

CC(EF, 2h, ca) x0.67+ Proj(Sout)x0.33

EC : Drinking Water and Water Distribution

PT9ET4

coeff : 0.13

Teacher In Charge : Salin D.

CM : 20 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

To improve sanitary conditions, numerous processes have developed to insure drinking water production. The lecture presents a review of the main processes used, and some basic aspects for the design of drinking water distribution networks. Some design elements of the different systems are also proposed.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge in drinking water and water distribution fields.
- have a basic knowledge on physics, chemistry and biology involved in the classical treatment processes
- be able to design and control usual processes

## DESCRIPTION

Part I: Drinking water production

Introduction: basic needs, resources, regulations

Underground water treatment:

- iron removal, manganese removal
- ammonia treatment
- other treatments: arsenic, fluorine...
- disinfection by chlorination
- complementary treatments: neutralisation, calcium carbonate stability

Surface water treatment

- usual processes: pre-treatment, flocculation, decantation, filtration
- sterilisation: ozonization, UV, chlorination
- complementary treatments: membrane systems, activated carbon

## Part II: Hydraulic and networks

### Background relative to hydraulic

- Energy notion : Bernoulli's theorem
- Head loss notion
- Simplified computation aspects

### Design of drinking water distribution networks

- the different types of pipes and network modules
- design

### Pumping stations

- constitutive elements
- design
- main problems: water hammer

### RECOMMENDED READING

- DEGREMONT "Memento technique de l'eau", Ed. Degremont Suez, 10th édition, 2005.
- Techniques appliquées au traitement de l'eau, Ed ellipses, 2001
- Guide de conception (Canada) – [www.mddep.gouv.qc.ca/eau/guide](http://www.mddep.gouv.qc.ca/eau/guide)

### PREREQUISITE

Introduction au génie chimique et à la mécanique des fluides

### ASSESSMENT

CC (EE, 1,5h, da, ca)

## TEACHING UNIT (UE) :

Biology and Pollution control S9

ECTS : 7

Code UE : PT9EB

## SKILLS COVERED BY THE UE :

- Understand biological mechanisms and their utility in pollution treatment
- Identify and measure various pollutants

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
PT9EB1	Biology and Microbiology	0.29	Proj (Sout, Rap)
PT9EB2	Biological Reactors Engineering	0.14	CC (EE, sd, 2h, ca)
PT9EB3	Water Pollution Control	0.21	CC (EE, 2h)
PT9EB4	Air Pollution Control	0.21	CC (EE, 1,5 h, da : cours uniquement, ca)x1/2+ CC (EE, 1,5 h, da : cours uniquement, ca) x1/2
PT9EB5	Practical Works	0.15	TP(CR)

EC : Biology and Microbiology		PT9EB1	coeff : 0.29
Teacher In Charge : Aliaga C., Olivier J.			
CM : 20 h	TD : 10 h	TP : 0 h	Proj : 20 h
Language Français			

## OVERVIEW

The aim of this subject is to give the basis of biochemistry (macromolecules) and cellular biology (procaryotics and eucaryotics organisms) to understand biotechnological applications in pollution control.

## LEARNING OUTCOMES

After this course, students should be able to:

- know the structure and the properties of the main biological molecules
- know and recognise the major characteristics of micro-organisms used in industrial productions (bacterial , fungi)
- understand the major ways of metabolism used in industry (fermentation, production of enzymes ...)
- understand the major ways of hygienization used in pollution control (drinking water, disinfection ...)
- understand biological mechanisms involved in the process of waste water treatments
- have notions of genetics to understand the utilisation of GMO (genetics modified organisms)

## DESCRIPTION

### Part I : Biochemistry

Lipids, carbohydrates, proteins, nucleic acids, redox reactions

### Part II : Cellular and molecular biology

Eucaryotic and procaryotic cell constituents

Part III : Genetics and biotechnology  
DNA, RNA, protein synthesis and biotechnologies (GMO)

Part IV : Cellular metabolism and industrial applications  
Respiration, fermentation, wastewater treatments, hygienization of drinking water...

### **RECOMMENDED READING**

- G. KARP, "Biologie cellulaire et moléculaire", Ed. De Boeck Université, 1998
- D. VOET, J.G. VOET, "Biochimie", Ed. De Boeck Université, 1998
- K. ARMS, P.S. CAMP "Biologie", Ed. De Boeck Université, 1989
- P. ATKINS, L. JONES, "Chimie", Ed. De Boeck Université, 1998

### **PREREQUISITE**

Notions of biology

### **ASSESSMENT**

Proj (Sout, Rap)



EC : Biological Reactors Engineering

PT9EB2

coeff : 0.14

Teacher In Charge : Vaxelaire J.,

CM : 8 h

TD : 7 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

Biological reactors are the centre of many biological processes involved in chemical, pharmaceutical, food, waste treatment industry. Analysis and design of such reactors are presented in the lecture.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge on enzymatic and microbial kinetics
- be able to write balances on enzymatic and microbial reactors
- have a basic knowledge to design and control biological reactors

## DESCRIPTION

### Part I: Kinetics

The kinetics of enzyme-catalysed reactions (simple enzyme kinetics with one or two substrates, activation and inhibition, immobilised-enzyme technology).

The kinetics of substrate use, product formation and biomass production in cell cultures.

### Part II: Reactors design

Ideal enzyme reactors (Batch and plug-flow reactors, CSTR)

The different technologies of enzyme reactors

Ideal cell reactors (Batch, fed-batch and plug-flow reactors, CSTR)

Oxygen transfer

Analysis of multiple interacting microbial populations

Criteria for the selection of a cell reactor technology

## RECOMMENDED READING

BAILEY J.E., OLLIS D.F. "Biochemical engineering fundamentals", Ed. Mac GRAW HILL, 1986

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SCRIBAN R. " Biotechnologie", Technique et Documentation, Ed. LAVOISIER, 1993, Paris

**PREREQUISITE**

Génie de la réaction

**ASSESSMENT**

CC (EE, sd, 2h, ca)

EC : Water Pollution Control

PT9EB3

coeff : 0.21

Teacher In Charge : Vaxelaire J.

CM : 8 h

TD : 8 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The importance of water in our society requires some frequent controls of the quality. The lecture presents the main methods to analyse and control the quality of fresh water, wastewater and drinking water.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge to implement sampling (and know how to store the samples)
- be able to understand and use water analysis data

## DESCRIPTION

Part I: Sampling and storage of the samples

Part II: Usual parameters of water analysis

The results (units, ways to present the data, accuracy...)

The main analysis to carry out in situ: temperature, pH, conductivity, dissolved oxygen, turbidity)

Alkalinity: m-alk, p-alk, hardness,...

Pollution factors: organic pollution, nitrogen pollution, phosphorus pollution...

Part III: Critical analysis of an analysis report

## RECOMMENDED READING

Rodier J., Legube B., Merlet N. et coll. "L'analyse de l'eau", 9ème édition, Dunod, 2009

## PREREQUISITE

Chimie des solutions

## ASSESSMENT

CC (EE, 2h)

EC : Air Pollution Control

PT9EB4

coeff : 0.21

Teacher In Charge : Jambert C., Serça D.

CM : 12.5 h

TD : 12.5 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The change of reactive and radiation properties of the atmosphere (“global change”) are, currently, of main interest for the environmental sciences. The lecture presents this problematic and the ways to study it, using atmospheric chemistry and meteorological methods.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge in atmosphere chemistry allowing to understand the outcomes different phenomena relative to the air composition changes: climate warming, the ozone hole, photochemical pollution
- know the impacts (health, ecosystems, ...) and the trends of air pollution
- know the regulations and the management of the “atmospheric system”
- know the different techniques and approaches to measure the trace components in the atmosphere
- have a basic knowledge of the methods used to measure the atmospheric flux

## DESCRIPTION

### Part I: Introduction

The atmospheric system, physic and chemistry (dynamic, main trace components)/ biogeochemical cycles/ the main source of trace components/ notions of photochemistry, kinetic and catalysis, life time, concentration variability

### Part II: Atmospheric chemistry

Gaseous phase chemistry of the stratosphere and the troposphere/ catalytic cycles of destruction/ free radical reactions/ troposphere photochemical production/ chemistry of the atmosphere in aqueous phase

### Part III: Pollution

The pollution at different spatial scales/ impacts of the atmosphere pollution on the health, the ecosystems and the infrastructures/ history of the emission and the concentrations of pollutants/ regulation management (LAURE, international agreements, emission standards), control networks.

### Part IV: Control of atmosphere concentrations

Introduction (notion of atmospheric concentrations, P and T corrections)/ passive/active measurement/ local measurement/ method to measure gaseous pollutants/ calibration methods/ standard laboratories.

### Part V: Control of the flux at the interface ground/atmosphere

Introduction / box model/ flux measurement at different scales- micrometeorological approaches/ atmospheric deposit

### RECOMMENDED READING

- Physique et Chimie de l'Atmosphère : R. Delmas, G. Mégie, V.-H. Peuch, Ed. Belin, Collection Echelles, octobre 2005, ISBN10 : 2-7011-3700-4.
- OMER7-A: Outil nuMERique pédagogique pour l'étude des Sciences de l'Environnement Terrestre-Atmosphère), site Internet (<http://omer7a.obs-mip.fr/>)

### PREREQUISITE

Notions de base en chimie

### ASSESSMENT

CC (EE, 1,5 h, da : cours uniquement, ca)x1/2+ CC (EE, 1,5 h, da : cours uniquement, ca) x1/2

EC : Practical Works

PT9EB5

coeff : 0.15

Teacher In Charge : Casas L., Vaxelaire J.

CM : 0 h

TD : 0 h

TP : 32 h

Proj : 0 h

Language Français

## OVERVIEW

Laboratory pilot plants allow the students to have practical investigations on some common processes used to treat wastewater and carried out common pollution measurements.

## LEARNING OUTCOMES

After this course, students should:

- have a basic knowledge to manage the main processes used to treat wastewater

## DESCRIPTION

Wastewater treatment by activated sludge

Biofilter

Methanisation

Coagulation-flocculation and settling

## RECOMMENDED READING

- G. KARP, "Biologie cellulaire et moléculaire", Ed. De Boeck Université, 1998
- D. VOET, J.G. VOET, "Biochimie", Ed. De Boeck Université, 1998
- K. ARMS, P.S. CAMP "Biologie", Ed. De Boeck Université, 1989
- P. ATKINS, L. JONES, "Chimie", Ed. De Boeck Université, 1998

## PREREQUISITE

Basic background in chemical engineering and water pollution measurement

## ASSESSMENT

TP(CR)

TEACHING UNIT (UE) :

Industrial implementation S9

ECTS : 4

Code UE : PT9EN

SKILLS COVERED BY THE UE :

- Have a basic understanding of the design and management of the implementation of an industrial process

**Accessible to students of the GP speciality: PE**

LIST OF COMPONENT ELEMENTS (EC)

CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EP9OO2	Process Synthesis	0.36	Proj (Rap)
PT9EN1	Industrial Risk Management	0.31	Proj (Soutx1/3 + Rapx2/3)
PT9EN3	Introduction to construction contracts	0.15	CC (EE, 30min, da, ca)
PT9EN4	Environmental Management	0.18	CC (EE, 2h)

EC : Process Synthesis		EP9OO2	coeff : 0.36
Teacher In Charge : Sochard S.			
CM : 4 h	TD : 14 h	TP : 0 h	Proj : 30 h
Language Français			

## OVERVIEW

Process synthesis is a methodology based on the experience and know-how of engineers. These qualitative procedure leads to an acceptable (from a technical and economical point of view) process pre design using heuristic rules.

## LEARNING OUTCOMES

After this course, students must:

- know the main steps of the hierarchical procedure proposed by Douglas
- know at each steps the main heuristics
- be able to image the pre design of a process based on these rules

## DESCRIPTION

Based on the HDA process, the main steps of the method are illustrated:

1. definition of the inputs and outputs of the process
2. choice of reactors and definition of the recycle structure
3. definition of the vapour and liquid separation systems
4. definition of the heat exchanger network.

## RECOMMENDED READING

Conceptual Design of Chemical Processes ; J.M. Douglas; McGraw-Hill, Inc.; New York, 1988

## PREREQUISITE

Unit Operation, mass and heat balances

## ASSESSMENT

Proj (Rap)



EC : Industrial Risk Management		PT9EN1	coeff : 0.31
Teacher In Charge : Baron T.			
CM : 24 h	TD : 0 h	TP : 0 h	Proj : 0 h
Language Français			

## OVERVIEW

Process synthesis is a methodology based on the experience and know-how of engineers. This qualitative procedure leads to an acceptable (from a technical and economical point of view) process pre design using heuristic rules.

## LEARNING OUTCOMES

After this course, students must:

- know the main steps of the hierarchical procedure proposed by Douglas
- know at each step the main heuristics
- be able to image the pre design of a process based on these rules

## DESCRIPTION

1. Definition of process inputs (raw materials) and outputs,
2. General process structure
3. Reactive zone : heat effect, reactor type
4. Design of gas and liquid separation, 5. Heat exchanger network design.

## RECOMMENDED READING

Conceptual Design of Chemical Processes ; J.M. Douglas; McGraw-Hill, Inc.; New York, 1988  
 Process Design Principles; W.D. Seider, J.D. Seader, D.R. Lewin. J Wiley&Sons 1999  
 Analysis, Synthesis and Design of chemical Processes; R. Turton, RC Bailie, W.B. Whiting, J.A. Shaeiwitz. Prentice Hall 1998

## PREREQUISITE

Opérations unitaires, bilans de matière et de chaleur

## ASSESSMENT

Proj (Soutx1/3 + Rapx2/3)

EC : Introduction to construction contracts

PT9EN3

coeff : 0.15

Teacher In Charge : Salin D.

CM : 8 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## OVERVIEW

The main goal of the lecture is to provide vocabulary and the basic background to understand how construction contracts work.

## LEARNING OUTCOMES

After this course, students should:

- Know partners acting in a construction contract
- Have the basic knowledge about the role of everybody and about the running of the different stages from the design to the construction
- Be able to understand the different types of contracts and the documents relative to the contracts
- Have the basic knowledge about work site progress, about the documents to prepare and about the financial and the administrative aspects

## CODESCRIPTIONTENU

Part I: Generalities and vocabulary

The notion of construction contracts

The people acting in construction :

-Leader

-Design and management

-Security

-Companies, groups and subcontracting

Part II: The design stage

Operations Schedule

-Preliminary studies

-Choice of the type of contract

#### Role of the prime contractor

- Definition of the goal and of the type of contract
- Content of the studies and of the documents to established

#### Other partners

- SPS manager
- Technical manager
- OPC

#### Part III: Contract signing

##### Usual rules

- Contract price
  - Call for tenders (procedure)
- ##### Rules about private or public construction contract signing

##### Consultation files and companies answers

##### Companies choice and contract establishment

#### Part IV: Construction stage

##### Preparation stage

- Documents to prepare
- Meeting
- Planning

##### Construction stage

- Service order
- Meeting and report
- Administrative and financial management

##### End of construction

- Tests stage
- Acceptance procedure
- Final report
- Litigation

#### **RECOMMENDED READING**

- CODE DES MARCHES PUBLICS – [www.legifrance.fr](http://www.legifrance.fr) - Guide de bonnes pratiques en matière de marchés publics -2012 -Circulaire du 14 février 2012 - Guide pratique des conducteurs de chantiers – 2006 – [www.fntp.fr](http://www.fntp.fr) - 170 séquences pour mener une opération de construction – H. Debaveye et P. Haxaire – 7ème Ed 2010 Edition Le Moniteur

#### **PREREQUISITE**

#### **ASSESSMENT**

CC (EE, 30min, da, ca)

EC : Environmental Management		PT9EN4	coeff : 0.18
Teacher In Charge : Tetgein T.			
CM : 5 h	TD : 5 h	TP : 0 h	Proj : 8 h
Language Français			

## OVERVIEW

This lecture is complementary to lectures dealing with water, air and waste treatment. It presents industrial field in terms of organisation and environmental regulation.

## LEARNING OUTCOMES

After this course, students should:

- know how the ISO 14001 standard (environmental management) is applied in manufactures to be in coherence with a society already under ISO 14001 standard or to develop an environmental management system.
- be able to carry out a analysis of environmental risks due to manufacture activity
- know the main environmental regulations and their impact on the design and the management of industrial processes

## DESCRIPTION

Part I: Environmental management system: ISO 14001 standard

Continuous improving cycle presenting the main stages to establish an environmental management system :

- impact analysis
- planning
- construction
- control
- improvement

Part II: Analysis of Hygiene, Security and Environmental (HSE) risks

- Hygiene:  
chemicals management
- Environment:  
- Laws relative to the Installations Classified for the Protection of the Environment

- 
- Prevention and control of atmospheric pollution
  - Protection of water resource and aquatic environments
  - The waste
  - Prevention and control of noise and vibrations
  - Security: prevention of technological risk and security at workplace

### **RECOMMENDED READING**

Techniques de l'ingénieur : Environnement (vol G1 à G5)

Réglementation sur les déchets, eaux, ICPE, air (Collection Recueils de textes réglementaires ACFCI, AFNOR)

### **PREREQUISITE**

Notions de base en génie chimique

### **ASSESSMENT**

CC (EE, 2h)

## SPECIALITY Process Engineering - Pathways CPAO

3rd Year - Semester 9 - GP														
Computer Aided Process Design (CPAO)														
UE Name	Code		EC Name	Hours (h)								ECTS / Coef.		
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef. EC	
Conception S9	EP90O	EP90O01	Advanced Process Control	210	48	30	10	20	0	18	0	7	0.28	
		EP90O02	Process Synthesis		40	18	4	14	0	22	36		0.14	
		EP90O03	Utilities Optimization		47	20	0	20	0	27	47		0.14	
		EP90O04	Supply Chain Management - Scheduling		54	30	30	0	0	24	54		0.29	
		EP90O05	Data Reconciliation		21	10	4	6	0	11	17		0.15	
Modelling and Simulation S9	EP9MS	EP9MS1	Modeling Process Operation II	209	44	24	2	22	0	20	42	7	0.21	
		EP9MS2	Computation Fluid Mechanics		48	20	4	16	0	28	44		0.21	
		EP9MS3	Industrial Process Simulation		32	20	20	0	0	12	32		0.21	
		EP9MS4	Batch Processes		44	24	8	0	16	20	0		0.16	
		EP9MS5	MODELLING, SIMULATION AND OPTIMISATION		41	30	10	20	0	11	0		0.21	
Industry 4.0 S9	EP9OI	EP9OI1	Machine Learning and Data Science	116	28	14	10	4	0	14	5	4	0.25	
		EP9OI2	Artificial Intelligence and Industrial Systems		28	14	10	4	0	14	5		0.25	
		EP9OI3	Industry 4.0 cyber-physical Systems Engineering		60	40	40	0	0	20	5		0.50	
Total Parcours				419	226		92	118	16	193	272	14		
Total TC + Parcours				626	299								26	

## TEACHING UNIT (UE) :

### Conception S9

ECTS : 7

Code UE : EP9OO

## SKILLS COVERED BY THE UE :

- Have notions of economic evaluation of processes and industrial risk management
- Master the tools (computer, heuristic, thermodynamic...) of process design and optimisation

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EP9OO1	Advanced Process Control	0.28	CC(Ee, 2h, ca)
EP9OO2	Process Synthesis	0.14	Proj(Rap)
EP9OO3	Utilities Optimization	0.14	Proj (Rap, Prog)
EP9OO4	Supply Chain Management - Scheduling	0.29	CC(Ee)x0.2 + CC(PA)x0.4 + Proj(Rap)x0.4
EP9OO5	Data Reconciliation	0.15	Proj(Rap)

EC : Advanced Process Control		EP9001	coeff : 0.28
Teacher In Charge : Ricarde M. Marias F.			
CM : 10 h	TD : 20 h	TP : 0 h	Proj : 0 h
Language Fr/En			

## OVERVIEW

Process automation and control methods: theory and use for petrol, chemical and pharmaceuticals industries. Educational platform : <https://elearn.univ-pau.fr/>

## LEARNING OUTCOMES

This education allows students to plan and to specify process control systems:

- safety loops,
- starting sequences,
- control loops.

## DESCRIPTION

Digital control system

- PLC architecture / Supervision
- Alarm management
- Sequence and grafcet
- Introduction to BATCH control.

Safety loops

- Matrix or flowchart representation
- Safety instrumented system SIS
- Safety integrity level SIL.

Advanced regulation

- PID recall
- split-range
- Ratio regulation
- Cascade regulation
- Predictive control



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Examples and applications: boiler, exchanger, distillation column. Computer simulator for the implementation of advanced regulations and for the parameterization of the gain and the integral.

### **RECOMMENDED READING**

Régulation industrielle, Emmanuel Godoy, Collectif Dunod, L'Usine Nouvelle. Régulation P.I.D, Daniel Lequesne, Lavoisier.

Régulation de chaudières (Conférence Framatome).

Système et instrumentation de sécurité (Yokogawa, Triconex, ICS...). RsBatch (Rockwell). SIMATIC Safety Matrix (Siemens)

### **PREREQUISITE**

Connaissances en régulation PID

### **ASSESSMENT**

CC(EF, 2h, ca)

EC : Process Synthesis

EP9OO2

coeff : 0.14

Teacher In Charge : Sochard S.

CM : 4 h

TD : 14 h

TP : 0 h

Proj : 36 h

Language Fr/En

## OVERVIEW

Process synthesis is a methodology based on the experience and know-how of engineers. These qualitative procedure leads to an acceptable (from a technical and economical point of view) process pre design using heuristic rules.

## LEARNING OUTCOMES

After this course, students must:

- know the main steps of the hierarchical procedure proposed by Douglas
- know at each steps the main heuristics
- be able to image the pre design of a process based on these rules

## DESCRIPTION

Based on the HDA process, the main steps of the method are illustrated:

1. definition of the inputs and outputs of the process
2. choice of reactors and definition of the recycle structure
3. definition of the vapour and liquid separation systems
4. definition of the heat exchanger network.

## RECOMMENDED READING

Conceptual Design of Chemical Processes ; J.M. Douglas; McGraw-Hill, Inc.; New York, 1988

## PREREQUISITE

Unit Operation, mass and heat balances

## ASSESSMENT

Proj(Rap)

EC : Utilities Optimization		EP9OO3	coeff : 0.14
Teacher In Charge : Baudet P. (Proesis)			
CM : 0 h	TD : 20 h	TP : 0 h	Proj : 47 h
Language Fr/En			

## OVERVIEW

Optimisation is one of the major quantitative tools for decision-making in Chemical Engineering. Students are familiarized with Process Optimization (operating and design parameter optimization) using flowsheeting environments (ProSim Plus and/or Pro II).

The production of utilities has become very common practice in the context of energy transition. In this course, the students are brought, working on a project, to optimize the operating parameters of a utility production plant, in a Flowsheeting environment (Ariane)

## LEARNING OUTCOMES

At the end of this course, students should :

- Have advanced knowledge of the main optimization algorithms in continuous and mixed variables
- Be able to formulate and solve a complex problem, using commercial tools: Ariane

## DESCRIPTION

During this project, the students will become familiar with the very fashionable world of utility production, initially through the Ariane software. In a second time, the piloting of the Ariane software in various configurations will be the occasion to work on :

- VBA in Excel
- The vbs for the piloting of executables, whatever they are
- Numerical methods (implementation of a Newton method in Ariane piloting)

## RECOMMENDED READING

Optimization of Chemical Processes T.F. Edgar, D.M. Himmelblau – McGraw Hill International Edition

## PREREQUISITE

Utilities, optimization methods and common sense

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## ASSESSMENT

Proj (Rap, Prog)

EC : Supply Chain Management - Scheduling		EP9OO4	coeff : 0.29
Teacher In Charge : Lelkes Z.			
CM : 30 h	TD : 0 h	TP : 0 h	Proj : 54 h
Language Fr/En			

## OVERVIEW

The aim of the course is the familiarization the students with the AIMMS optimization platform. Understanding the SCM and scheduling problems (capacity optimization, short term planning, flow-shop, job-shop).

## LEARNING OUTCOMES

After the course the students will be able to do:

- Use AIMMS platform for optimization
- Formalization of Supply Chain optimization problem
- Know different heuristics and meta-heuristics methods for scheduling optimization
- Understand the parts of a complete scheduling planning system (capacity planning, operation scheduling optimization, reactive scheduling)

## DESCRIPTION

During the course we will present the followings:

- AIMMS optimization platform
- AIMMS project, model tree, algorithmic features, GUI, integration
- Case study: SCM optimization problem in SAB Miller company
- Programming a simple SCM optimization problem in AIMMS
- Programming rolling horizon optimization in AIMMS
- Flow-shop, job-shop scheduling, heuristics and meta-heuristics methods
- Case study: a simple job-shop scheduling problem in AIMMS
- Case study: Scheduling in Graboplast company

## RECOMMENDED READING

Johannes Bisschop: AIMMS Optimization Modeling

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Marcel Roelofs, Johannes Bisschop: AIMMS User's Guide

**PREREQUISITE**

Méthodes d'optimisation (GC2MI2)

**ASSESSMENT**

$CC(EE) \times 0.2 + CC(PA) \times 0.4 + Proj(Rap) \times 0.4$

EC : Data Reconciliation

EP9OO5

coeff : 0.15

Teacher In Charge : Sochard S.

CM : 4 h

TD : 6 h

TP : 0 h

Proj : 17 h

Language Fr/En

## OVERVIEW

In a wide range of situations, chemical engineers point out differences between experiments and theories. So the main question is : “are my experiments bad or have I used a wrong theory?”. This course gives some answers based on a systematic approach to this central question.

## LEARNING OUTCOMES

After this course, students must:

- The problem
- Calculation of a coherent set of measurements
- Diagnosis of the operation of the sensors
- Validation on incompletely observed systems
- Discovering the VALI software

## CONTENU

The course is structured as follows

-THE PROBLEMATIC

-CALCULATION OF A COHERENT SET OF MEASUREMENTS

-DIAGNOSIS ON THE FUNCTIONING OF SENSORS

-VALIDATION ON INCOMPLETELY OBSERVED SYSTEMS

## RECOMMENDED READING

Validation de données et diagnostic ; J. Ragot, D. Maquin, G. Bloch, M. Darouach ; HERMES, Paris 1990.

Ensembles et statistique ; C. Tricot, J.M. Picard ; Mac Graw Hill, Montréal, 1969.

Modélisation et estimation des erreurs de mesure ; M. Neuilly ; Tech. et Doc., Lavoisier, 1993.

Méthodes numériques appliquées ; A. Gourdin, M. Bouhmeurat ; Tech. et Doc., 1983.

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## PREREQUISITE

## ASSESSMENT

Proj(Rap)



## TEACHING UNIT (UE) :

### Modelling and Simulation S9

ECTS : 7

Code UE : EP9MS

## SKILLS COVERED BY THE UE :

- To master the computer tools for modelling and simulating processes
- To know how to model and simulate a complex industrial problem which is not necessarily completely defined

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EP9MS1	Modeling Process Operation II	0.21	Proj(Rap)
EP9MS2	Computation Fluid Mechanics	0.21	Proj(Rap)
EP9MS3	Industrial Process Simulation	0.21	Proj(Rap)
EP9MS4	Batch Proceses	0.16	TP(PA)1/3 + TP(PA)1/3 + TP(CR)1/3
EP9MS5	MODELLING, SIMULATION AND OPTIMISATION USING GPROMS	0.21	CC(EM,2h)

EC : Modeling Process Operation II

EP9MS1

coeff : 0.21

Teacher In Charge : Marias F.

CM : 2 h

TD : 22 h

TP : 0 h

Proj : 42 h

Language Fr/En

## OVERVIEW

This lecture gives insights on the skills and knowledge in the topic of modelling process operation. In this subject, students will be able to derive a mathematical model for a multistage and multi components distillation column.

## LEARNING OUTCOMES

After the lecture, students must know how

- to derive equations translating mass, species and energy conservation in a distillation column.
- to write the model in such way that it can be solved using a Newton Raphson algorithm/model
- to use the numerical tool (developed during the lecture) to strengthen their knowledge in the field of distillation

## DESCRIPTION

Reminding on numerical skills for solving of linear systems

Modelling of multistage and multi components separation process

Solving

Conclusion

## RECOMMENDED READING

Techniques de l'ingénieur (J1076, J1021, J 2623)

Process modeling simulation and control for chemical engineers, W.L. Luyben, Mc Graw-Hill 1990

## PREREQUISITE

Thermodynamique-Operations unitaires, Modélisation des opérations unitaires I

## ASSESSMENT

Proj(Rap)

EC : Computation Fluid Mechanics		EP9MS2	coeff : 0.21
Teacher In Charge : David M. (INRIA)			
CM : 4 h	TD : 16 h	TP : 0 h	Proj : 44 h
Language Fr/En			

## OVERVIEW

Computational Fluid Dynamics is a recent tool which is commonly used for the design of new unitary operations (reactors, separators, heat exchangers...). The knowledge of such a tool is important for students that aim at designing new processes.

## LEARNING OUTCOMES

After the course the students will be able to:

- Know the numerical methods used in Computational Fluid Dynamics
- Know the main mathematical models allowing the description of physical phenomena
- Handle a complete simulation using Fluent (sketching,, CAD, Meshing, solving)
- Know the influence of the main parameters allowing the simulation to converge (meshing, relaxation, interpolation)
- Analyse et validate the results

## DESCRIPTION

### 1) Introduction to computational Fluid Dynamics

- Main goals of CFD
- Main strategies used in CFD
- Discretisation using finite volume methods
- Examples
- Turbulence modeling

### 2) Software environment Ansys WorkBench

### 3) Case Studies

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### **RECOMMENDED READING**

An Introduction to Computational Fluid Dynamics : 2nd Edition (H. Henk Kaarle Versteeg, Weeratunge Malalasekera) Pearson Education

Ansys Fluent User Guide

### **PREREQUISITE**

Notions de mécanique des Fluides. Méthodes numériques

### **ASSESSMENT**

Proj(Rap)

EC : Industrial Process Simulation

EP9MS3

coeff : 0.21

Teacher In Charge : Baudouin O.

CM : 20 h

TD : 0 h

TP : 0 h

Proj : 32 h

Language Fr/En

## OVERVIEW

The main objective of this course is to let students perform some relatively complex problems of steady state process simulation. This course is built around the process simulation of a gas treatment unit. Several thermodynamics models will be used and students will use different complexity level of models of unit operation in the process. ProSimPlus ® will be the steady state process simulation software that will be used.

## LEARNING OUTCOMES

After this course, abilities acquired by students:

- Distillation curves (TBP, ASTM...) and pseudo-components
- Selection of thermodynamics models
- Phase envelope and equilibrium curves analysis (retrograde condensation)
- Methodology for modelling of complex units with a steady state process simulation software (numerous cycling networks, process constraints, absorbers, distillation columns, user defined unit operations...)

## DESCRIPTION

During this course, students will think about the material system modelling, which is linked to unit operations used in the simulation file (streams characteristics from a distillation curve, acid gas treatment with amine solutions, liquid phase splitting with water presence...).

A methodology for the creation of a complex simulation file will be presented, the complexity of the units operation modelling will be introduced step by step. An example of a user defined unit operation with a windows script module (VBS language) will also be done by students (this kind of unit operation is often used in the industry to introduce its know-how in a commercial simulation software).

Analysis tools, particularly thermodynamics tools, available in the process simulation software will be widely used.

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## **RESSOURCES RECOMMANDÉES**

### **PREREQUISITE**

Language Visual Basic

### **ASSESSMENT**

Proj(Rap)

EC : Batch Processes

EP9MS4

coeff : 0.16

Teacher In Charge : Serin J-P., Contamine F., Cézac P.

CM : 8 h

TD : 0 h

TP : 16 h

Proj : 0 h

Language Fr/En

## OVERVIEW

The aim of this course is to familiarize students with the simulation of a batch process. The coupling of the simulation with two practical examples ( distillation column, reactor) will allow them to compare the numerical approach and experimental constraints

## LEARNING OUTCOMES

At the end of this course, students should be able to use simulators (BATCHREACTOR©and BATCHCOLUMN©) to simulate the operation of a distillation column and a reactor in batch mode.

## DESCRIPTION

- Modelling

- Presentation of batchreactor©and batchcolumn©

- Application:

Dynamic simulation of the thermal runaway of a reactor

Simulation and optimization of a distillation column for the mixture Acetone

- Water / IPA

## RECOMMENDED READING

Process modeling, simulation, and control for chemical engineers W.L. Luyben McGraw-Hill, 1990

## PREREQUISITE

Modélisation, distillation, cinétique, thermodynamique des solutions, thermochimie

## ASSESSMENT

TP(PA)1/3 + TP(PA)1/3 + TP(CR)1/3

EC : MODELLING, SIMULATION AND OPTIMISATION USING GPROMS EP9MS5 coeff : 0.21

Teacher In Charge : Nauta M.

CM : 10 h

TD : 20 h

TP : 0 h

Proj : 0 h

Language Anglais

## OVERVIEW

This course introduces the students to the use of the gPROMS software tool for the modelling of the steady-state and transient behaviour of chemical processes.

## LEARNING OUTCOMES

At the end of the course, the students should be able to :

- translate a mathematical model expressed in terms of a mixed system of integral, ordinary and partial differential, and algebraic equations (IPDAEs) to a working gPROMS model
- use the above model to perform steady-state and dynamic simulations
- express operating procedures in the gPROMS language
- perform steady-state and dynamic optimisation calculations in gPROMS
- estimate model parameters using data from steady-state and dynamic experiments
- use the gPROMS ModelBuilder to build, debug and manage model.

## DESCRIPTION

This involves a number of topics that are closely aligned with the above Learning Outcomes.

## RECOMMENDED READING

gPROMS Introductory Training Course notes

gPROMS Dynamic Optimisation/Parameter Estimation Training Course notes.

## PREREQUISITE

Modélisation des Opérations Unitaires (I)

## ASSESSMENT

CC(EM,2h)



## TEACHING UNIT (UE) :

Industry 4.0 S9

ECTS : 4

Code UE : EP9OI

## SKILLS COVERED BY THE UE :

- Understand the digital tools and methods being implemented for the design, management and monitoring of industrial production units
- To discern the interest of their implementation and the associated feasibility

### Accessible to students of the EN speciality: CPAO

#### LIST OF COMPONENT ELEMENTS (EC)

#### CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EP9OI1	Machine Learning and Data Science	0.25	Proj (Rap, Sout)
EP9OI2	Artificial Intelligence and Industrial Systems	0.25	Proj(Rap)
EP9OI3	Industry 4.0 cyber-physical Systems Engineering	0.5	Proj (Rap, Sout)

EC : Machine Learning and Data Science

EP9OI1

coeff : 0.25

Teacher In Charge : Kobayashi M.

CM : 10 h

TD : 4 h

TP : 0 h

Proj : 5 h

Language Français

## OVERVIEW

## LEARNING OUTCOMES

- Master the use of the main Machine Learning techniques
- Apply these techniques to industrial production situations

## DESCRIPTION

### 1. Data Science at the service of Process Modelling (1/2)

- o What can a process engineer learn from statistics, machine learning, and data analysis?
- o How can a process engineer take part in the digital transformation?
- o How is the "Industry 4.0" changing our daily activities and companies' organizational charts?
- o How important is data and what is its Technology Readiness Level in the energy sector?
- o principles of AI, machine learning, and deep learning;
- o other use cases outside the industrial sector;
- o discovering some existing online free tools to start a project;
- o Understand Process Modeling using:
  - Process modeling software: using physical and chemical-based
  - Mathematical expressions: physical and chemical-based and statistical-based
  - Machine learning: data-based

### 2. Data Science at the service of Process Modelling (1/2)

- o Process optimization
- o How process models are integrated into the economic optimization chain
- o How AI models can improve industrial profitability
- o How to optimize the supply chain using linear programming
- o Digital twin: the importance of process models

### 3. Data Driven Strategy Project

In this workshop students will solve an industrial and business problem applying a data-driven solution method. They will first identify the real problem, the scope of the project, pertinent features, necessary data, and usefull technologies. They will apply a mathematical and/or machine learning algorithm to solve the proposed problem. Students will work individually or in pairs and will have a couple of days to complete the project.

#### **RECOMMENDED READING**

In this hands-on session, students will work individually or in pairs. We will need one computer for each student/group. We will focus on process modeling using:

1. Mathematical expressions. We will do some exercises using Excel.
  - a. physical and chemical-based models
  - b. statistical-based models
2. Machine learning. We'll apply Python to analyze industrial data, using Google Notebook Colab, a free and online tool. Students will receive a Python start guide to be able to use right away some functions and visualizations.
  - a. data-based models, so called black-box models

#### **PREREQUISITE**

#### **ASSESSMENT**

Proj (Rap, Sout)

EC : Artificial Intelligence and Industrial Systems

EP9OI2

coeff : 0.25

Teacher In Charge : Lenir Y., JOURDAN A.

CM : 10 h

TD : 4 h

TP : 0 h

Proj : 5 h

Language Français

## OVERVIEW

Introduction to machine learning techniques, machine learning trees and networks and deep learning neural networks

## LEARNING OUTCOMES

- the notion of learning from data
- the need to prepare the input data
- the different types of supervised learning
- the evaluation of the quality of the learning
- the specificities of deep learning

## DESCRIPTION

- History of AI
- Generalities of machine learning
- Learning by decision trees and random forests
- Learning by neural networks
- Learning by deep neural networks
- Notebook in Python

## RECOMMENDED READING

## PREREQUISITE

- Know the basics of algorithmic (variables, functions, conditions, loops)
- Have a gmail address and use google colab: <https://colab.research.google.com/>

## ASSESSMENT

Proj(Rap)

EC : Industry 4.0 cyber-physical Systems Engineering

EP9OI3

coeff : 0.5

Teacher In Charge : Alexandrouiu F., Baron T.

CM : 40 h

TD : 0 h

TP : 0 h

Proj : 5 h

Language Français

## OVERVIEW

Evolution of the organization of industrial activity with the fast arrival of new technologies including the treatment of large amounts of information (big data, algorithms for learning systems & artificial intelligence, digital twins, etc...)

## LEARNING OUTCOMES

- Methodology to implement new technologies into an industrial organization
- Different project management and risk analysis aspects to succeed

## DESCRIPTION

- Factory X.0: general view, what could it be? Why? How? Data science for dums!
- Maintenance and unmanned installations: how to move from traditional maintenance to predictive maintenance then to remote-operated and ultimately autonomous interventions?
- Safety: same approach to avoid human intervention / exposure on site, how to move from traditional safety to preventive safety then to remotely operated and ultimately autonomous interventions?
- Operational philosophy to be completely overhauled: real-time control without field access with weak signals taking into account the entire industrial context (not just the process but weather...). What information sent to whom to do what? Human Centered Design methodology, capitalization of operational experience, cognitive and neuroscience aspects to support decision ...
- Human and operational factors: how the introduction of this new paradigm (technos, data, philosophy) leads to a fundamental modification of the organization of the activity so that it is successful (accepted and used)

## RECOMMENDED READING

## PREREQUISITE

Formal presentation & Use cases

- Remote operation of offshore platforms at Total in the Netherlands,

- 
- European gas production units of Air Liquide in Lyon,  
Industrial early anomaly detection implementation on an oil rig...

### **ASSESSMENT**

Proj (Rap, Sout)

## SPECIALITE GEII

3rd Year - Semestre 9 - GEII															
High Voltage Processes (HT)															
UE Name	Code		EC Name	Hours (h)										ECTS / Coef.	
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA	Proj.	ECTS UE	Coef. EC		
Apprenticeship S9	EG9AP	EG9AP1	Skills developed in the company	0	0	0	0	0	0	0	5	6	0.80		
		EG9AP2	Project management		0	0	0	0	0	0	0		0.20		
Culture of the Engineer S9	EG9CI	EG9CI1	Human Ressource Management	158	36	18	14	4	0	18	0	6	0.23		
		EG9CI2	Costs evaluation in industrial processes		22	8	4	4	0	14	6		0.14		
		EG9CI3	Design Project		100	0	0	0	0	100	100		0.63		
High tension	EG9HT	EG9HT1	High voltage	204	40	20	10	10	0	20	0	8	0.20		
		EG9HT2	High Voltage Measurements		24	12	12	0	0	12	0		0.12		
		EG9HT3	Rail traction		40	20	20	0	0	20	0		0.20		
		EG9HT4	Transmission of electrical energy		32	16	8	8	0	16	0		0.16		
		EG9HT5	HT design tools		68	24	0	4	20	44	20		0.32		
Pulsed Power	EG9PP	EG9PP1	Pulsed Power	168	60	30	20	10	0	30	0	6	0.4		
		EG9PP2	Conference series		12	12	12	0	0	0	0		0.1		
		EG9PP3	Electromagnetic compatibility		44	24	8	8	8	20	0		0.2		
		EG9PP4	TP electromagnetic simulations		52	16	0	4	12	36	20		0.3		
Safety, protection and industrial processes	EG9SP	EG9SP1	Plasma processes and applications	104	40	20	10	10	0	20	0	4	0.40		
		EG9SP2	Lightning and Protection of networks and buildings		20	10	10	0	0	10	0		0.24		
		EG9SP3	Safety in an industrial environment		44	22	18	4	0	22	0		0.36		
Total GEII (TC + Spé)				634	634	252	146	66	40	382	151	30			
Total TC + Parcours				634		252						30			

## TEACHING UNIT (UE) :

### Apprenticeship S9

ECTS : 6

Code UE : EG9AP

## SKILLS COVERED BY THE UE :

- Validate previously designed and built devices in order to certify compliance with all the requirements of the specifications.
- Study specific electrical energy supply or conversion devices, based on specifications, in order to ensure a secure continuous service, in compliance with environmental standards, in accordance with the challenges of sustainable development, and guaranteeing the safety of goods and people.
- Write design and validation reports in order to ensure traceability, which is essential for a continuous improvement process.
- Know and understand a complex and interdisciplinary scientific and technical field of specialisation in order to ensure the interface between the different partners by communicating on the progress of the work/project with both internal and external partners.
- Understand how to work in an international context, by mastering one or more foreign languages, by being culturally open, by taking into account all the constraints (managerial, environmental, CSR.) in order to favour synergy within the team.
- Mastering communication techniques adapted to the situation and the people involved in order to lead the development of a project in accordance with the company's strategy.
- Leading a multicultural team by adapting to the constraints and specificities of each person, taking into account the cultural mix in its interactions, using adapted communication tools and methods, in order to establish an environment conducive to the success of the project in compliance with regulations, ethics, safety and health.

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)



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CODE EC	INTITLED EC	COEF	EVALUATION
EG9AP1	Skills developed in the company	0.8	EvalC (entreprise)*0.6 + PA (entreprise)*0.4
EG9AP2	Project management	0.2	EvalC (Rap)

EC : Skills developed in the company

EG9AP1

coeff : 0.8

Teacher In Charge : Pécastaing L.

CM : 0 h

TD : 0 h

TP : 0 h

Proj : 5 h

Language Français

## INTRODUCTION

During this nine-week period in the company, including a five-week period that extends the 2AS8 period, the apprentice will be confronted with a potentially multidisciplinary project that he will be able to organise and structure. In the management of his project he will emphasise the sustainable development issues he has taken into account.

## TARGETED SKILLS

- Know and understand a complex and interdisciplinary scientific and technical field of specialisation in order to ensure the interface between the different partners by communicating on the progress of the work/project with both internal and external partners.
- Understand how to work in an international context, by mastering one or more foreign languages, by being culturally open, by taking into account all the constraints (managerial, environmental, CSR.) in order to favour synergy within the team.
- Mastering communication techniques adapted to the situation and the people involved in order to lead the development of a project in accordance with the company's strategy.
- Leading a multicultural team by adapting to the constraints and specificities of each person, taking into account the cultural mix in its interactions, using adapted communication tools and methods, in order to establish an environment conducive to the success of the project in compliance with regulations, ethics, safety and health.

## CONTENT

The activities developed in this EC are established according to the specific needs of the company and in order to complete the targeted skills.

## RESSOURCES

## PREREQUISITE

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## EVALUATION PROCEDURES

EvalC (entreprise)\*0.6 + PA (entreprise)\*0.4

EC : Project management

EG9AP2

coeff : 0.2

Teacher In Charge : Pécastaing L.

CM : 0 h

TD : 0 h

TP : 0 h

Proj : 0 h

Language Français

## INTRODUCTION

From the beginning of their career, engineers join project teams and can quickly become project managers. The aim of this course is to prepare them for managerial tasks, in order to control the quality, cost and deadline aspects of projects.

## TARGETED SKILLS

- Understand the organisations of industrial projects (client, project manager, service provider, supplier, subcontractor).
- Draw up a schedule.
- Assessing risks,
- Build a management plan.
- Monitor a project in terms of quality, cost and deadlines.
- Establish the progress of the work and the financial balance sheets.

## CONTENT

The apprentice will submit a written report that will allow the level of project management skills acquired to be judged.

In this report he/she will also highlight the sustainable development issues that he/she has taken into account.

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

EvalC (Rap)

## TEACHING UNIT (UE) :

### Culture of the Engineer S9

ECTS : 6

Code UE : EG9CI

## SKILLS COVERED BY THE UE :

- Demonstrate the ability to fit into an organization, to animate it and to develop it: project management, human resource management, financial management, business management and/or legal management
- Understand the basic methods concerning process economic assessment
- Demonstrate the ability to simultaneously master all the scientific and human sciences skills (written and oral communication, economic evaluation, English ...) acquired during his studies at the ENSGTI as well as the aptitude for teamwork and project management.

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EG9CI1	Human Ressource Management	0.23	CC(Ee, 2h)
EG9CI2	Costs evaluation in industrial processes	0.14	CC(Ee, 1h, da : cours, ca)x1/2 + Proj(Rap)x1/2
EG9CI3	Design Project	0.63	Proj(rap, sout)x1/4 + Proj(rap, sout)x3/4

EC : Human Ressource Management		EG9CI1	coeff : 0.23
Teacher In Charge : Fall A.			
CM : 14 h	TD : 4 h	TP : 0 h	Proj : 0 h
Language Français			

## OVERVIEW

This course is an introduction to Human Resource Management (HRM). The aim of this lecture is to teach students the key concepts and techniques required for decision making in this area.

## LEARNING OUTCOMES

- Master the tools for the development of management for jobs and skills
- Know the steps of recruitment and optimization tools
- Know the different devices for professional training.
- Being able to have critical look at the remuneration system of a company
- Master the tools of individual evaluation
- Know the characteristics of teams and Management
- Being able to analyze an HR policy and taking measures of adjustment required

## DESCRIPTION

General Introduction to HRM

Chapter 1 : Personnel Administration

Chapter 2 : Recruitment - process optimization

Chapter 3: Profesional training

Chapter 4: Pay systems

Chapter 5: Individual evaluating

Chapter 6: GPEC

Chapter 7: Team management

## RECOMMENDED READING

- Encyclopédie des Ressources Humaines, sous la direction de José Allouche, Vuibert, 2006
- Fonction RH, Thévenet et ali., Pearson, 3ieme édition, 2012

- 
- Gestion des ressources humaines, de Jean-Marie Peretti, Vuibert, 2007
  - Organisation et gestion de l'entreprise, de Richard Soparnot, Dunod, 2006

### **PREREQUISITE**

### **ASSESSMENT**

CC(EF, 2h)

EC : Costs evaluation in industrial processes

EG9CI2

coeff : 0.14

Teacher In Charge : Rouch F.

CM : 4 h

TD : 4 h

TP : 0 h

Proj : 6 h

Language Français

## OVERVIEW

The goal of this course is to present evaluation of methods of investments and process operating costs. This theoretical education is completed by feedback from industrial partners.

## LEARNING OUTCOMES

- To know the basic methods of economic evaluation of processes.
- To be able to carry out the economic evaluation of a process.

## DESCRIPTION

Chapter 1: Elements of economic calculation

- Study of the profitability of projects: Taxes and duties; Profitability criteria
- Operating cost and cost price: Definition and breakdown of the operating cost / cost price
- Investments: The various investment charges
- Labour costs

Chapter 2: Investments at the limits of the manufacturing units (ILUF)

- UBLI: average structure, evaluation and estimation
- Accuracy of investment calculation methods
- Adaptation of investment data

Chapter 3: Investment calculation methods

- Exponential (global) methods
- Factorial methods
- Pre-estimated IFP method: examples

## RECOMMENDED READING

Manuel d'évaluation économique des procédés, A. Chauvel et al - Technip Cost Engineering Analysis, W.R. Park, D.E. Jackson - John Wiley & Sons



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Plant Design and Economics for Chemical Engineers, Peters, Timmerhaus - Mc Graw Hill

**PREREQUISITE**

**ASSESSMENT**

CC(EF, 1h, da : cours, ca)x1/2 + Proj(Rap)x1/2

EC : Design Project		EG9CI3	coeff : 0.63
Teacher In Charge : Rivaletto M.			
CM : 0 h	TD : 0 h	TP : 0 h	Proj : 100 h
Language Français			

## INTRODUCTION

This project consists of proposing to students, in groups of 2 to 3, research topics related to the activities developed by the "High Voltage Processes" team of the SIAME laboratory. The proposed projects are only design projects but this does not rule out a partial or even total realization of the designed device. The projects will take place at the SIAME laboratory or on the GEII TP technical platform.

## TARGETED SKILLS

- Demonstrate the ability to simultaneously master all the scientific and human sciences skills (written and oral communication, economic evaluation, English ...) acquired during his studies at the ENSGTI as well as the aptitude for teamwork and project management.
- This design project is positioned at the end of the cycle in order to complement the critical learning defined in the third year. It thus allows students who have not yet reached the required skill levels to validate all the skill blocks of the training.

## CONTENT

1. Developing high-tech industrial electrical devices
2. Study and design electrical energy supply and conversion equipment
3. Design and operate automated systems in industrial environments
4. Design and build systems in supervised electrical engineering, potentially in high voltage
5. Managing multidisciplinary projects in an international context

## RECOMMENDED READING

## PREREQUISITE

## ASSESSMENT

Proj(rap, sout)x1/4 + Proj(rap, sout)x3/4

## TEACHING UNIT (UE) :

High tension

ECTS : 8

Code UE : EG9HT

## SKILLS COVERED BY THE UE :

- Understand how continuous HV generators work
- Master the circuits for generating strong impulse currents
- Know how to implement HV measurement devices and strong currents
- Mastering the environment of a railway powertrain
- Understand the problem of semiconductor module / traction motor combinations
- Know, understand and analyze an adjustment mechanism for electricity production
- Know the principles of building a daily production program based on projected consumption
- Know how to simulate the main HT generators and associated measuring devices using electronic circuit design software

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EG9HT1	High voltage	0.2	CC (EE, 1h30)
EG9HT2	High Voltage Measurements	0.12	CC (EE, 1h30)
EG9HT3	Rail traction	0.2	CC (EE, 1h30)
EG9HT4	Transmission of electrical energy	0.16	CC (EE, 1h30)
EG9HT5	HT design tools	0.32	TP (PA)*0.5 + Proj (Rap)*0.5

EC : High voltage

EG9HT1

coeff : 0.2

Teacher In Charge : Reess T., Pécastaing L.

CM : 10 h

TD : 10 h

TP : 0 h

Proj : 0 h

Language Français

## INTRODUCTION

The objective of this module is to provide engineering students with knowledge about the main DC high voltage generators and current shock wave generators.

## TARGETED SKILLS

At the end of this module, students must:

- Acquire knowledge in the field of high voltages and strong currents
- Understanding the influence of electric field distribution on dielectric stiffness
- Know the standards on impact testing
- Know how to size a generator of high current

## CONTENT

Overview of high voltage

Electric fields

Electrostatic generators and static rectifiers

Design of high current generators

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)

EC : High Voltage Measurements		EG9HT2	coeff : 0.12
Teacher In Charge : Reess T.			
CM : 12 h	TD : 0 h	TP : 0 h	Proj : 0 h
Language Français			

## INTRODUCTION

Measurements of high currents and high DC and impulse voltages require the implementation of specific devices. The objective of this course is to present these different devices and highlight their limitations of use.

## TARGETED SKILLS

At the end of this module, students must:

- Understand the physical laws involved in the measurement of current and voltage
- Know and understand high voltage measurement techniques
- Know how to determine the frequency limits of a measurement chain
- Know how to design HT measuring devices by integrating transmission and acquisition elements

## CONTENT

Principle of a spintermeter and the electrostatic voltmeter  
 The resistive divisor - Principle and frequency limitations  
 The capacitive divisor - Principle and frequency limitations  
 Trade compensated probes  
 Principle of measuring strong currents

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)

EC : Rail traction		EG9HT3	coeff : 0.2
Teacher In Charge : Guilloux P.			
CM : 20 h	TD : 0 h	TP : 0 h	Proj : 0 h
Language Français			

## INTRODUCTION

The objective of this course is to present students with a concrete approach to the problems encountered in major industrial sectors, which call on skills in electrical engineering, such as railway traction. This teaching is provided by an engineer from Alstom

## TARGETED SKILLS

At the end of this module, students must:

- Understand the fundamental functions of electric rail traction.
- Master the environment of a railway powertrain.
- Understand the problem of semiconductor module / traction motor combinations.

## CONTENT

The basics of the railway system  
General information on electric traction.  
Converters  
Power semiconductor modules.  
Semiconductor cooling  
Traction motors .

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)

EC : Transmission of electrical energy

EG9HT4

coeff : 0.16

Teacher In Charge : Sierra F.

CM : 8 h

TD : 8 h

TP : 0 h

Proj : 0 h

Language Français

## INTRODUCTION

The purpose of this course is to introduce students to the main principles of electrical energy transport.

## TARGETED SKILLS

At the end of this module, students must:

- Describe the operation of the electrical network and its protections
- Understand the adjustment of the network (frequency, production, consumption)

## CONTENT

Part 1: Basic knowledge: market participants and means of production

Part 2: The energy transition

Part 3: The structure of the French electricity network

Part 4: The protections of the electricity network

Part 5: Inspection of the installations (200kV Marsillon substation)

## RESSOURCES

### PREREQUISITE

Electrical safety balance

Energy Transition for Green Growth Act

### EVALUATION PROCEDURES

CC (EE, 1h30)

EC : HT design tools

EG9HT5

coeff : 0.32

Teacher In Charge : Reess T., Rivaletto M.

CM : 0 h

TD : 4 h

TP : 20 h

Proj : 20 h

Language Français

## INTRODUCTION

PSpice software is an electronic circuit design software that simulates major high voltage (HV) shock generators and transmission line HV generators. It is also very useful for dimensioning the constituent elements of HT dividers by taking into account the parasitic elements as well as the entire measuring chain.

## TARGETED SKILLS

At the end of this module, students must:

- Strengthen their knowledge of HPP generators using a circuit-type simulation tool
- Know how to determine the frequency limits of a measurement chain
- Be able to design normalized shock generators
- Be able to simulate generators with training lines and oscillating transformers

## CONTENT

Simulation of a 10kA shock generator standardized 8/20 $\mu$ s

Simulation of a single-stage shock generator associated with a complete capacitive divider

Simulation of a 3-stage Marx: sizing of a shock 150kV standardized 1.2/50 $\mu$ s

Simulation of pulse formation lines: the Blumlein generator

Simulation of oscillating HT transformers: Tesla and Pichugin

## RESSOURCES

## PREREQUISITE

High Voltage, HV Measurements and High Pulsed Powers

## EVALUATION PROCEDURES

TP (PA)\*0.5 + Proj (Rap)\*0.5



## TEACHING UNIT (UE) :

### Pulsed Power

ECTS : 6

Code UE : EG9PP

## SKILLS COVERED BY THE UE :

- Master the principles of high power pulses and the associated technological specificities
- Know how to implement the main high power pulsed generators
- Know the coupling modes and the effects of parasites on the systems
- Master the means of shielding and protection against EM fields
- Learn how to use electrostatic and electromagnetic simulation software and carry out simple simulations

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EG9PP1	Pulsed Power	0.38	CC (EE, 1h30)*0.5 + CC (EE, 1h30)*0.5
EG9PP2	Conference series	0.08	CC (EE, 1h30)
EG9PP3	Electromagnetic compatibility	0.21	CC (EE, 1h30)*0.7 + TP (CR)*0.3
EG9PP4	TP electromagnetic simulations	0.33	TP (PA)*0.5 + Proj (Rap)*0.5

EC : Pulsed Power		EG9PP1	coeff : 0.38
Teacher In Charge : Pécastaing L., Reess T.			
CM : 20 h	TD : 10 h	TP : 0 h	Proj : 0 h
Language Français			

## INTRODUCTION

The principle of Pulsed Power consists in switching, towards a load, a quantity of energy but minimising the switching time so as to deliver instantaneous powers of a few kilowatts up to several Terawatts, even Petawatts. This course presents the principles and technologies implemented in this field.

## TARGETED SKILLS

At the end of this module, students should

- Master the principles of Pulsed Power
- Know the technological specificities associated with Pulsed Power
- Know how to implement the main Pulsed Power generators
- Be familiar with the main areas of application of Pulsed Power
- Know the fields of application of high power microwaves in pulsed mode

## CONTENT

### Introduction to HPP

- The main power switches (gas, solid, liquid)
- Voltage surge testing
- Mathematical definition of the voltage surge
- The Marx generator
- Transmission lines in transient mode
- High voltage (HV) devices based on transmission lines
- High power pulsed microwaves and applications
- Other devices generating transient HV

## RESSOURCES

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## **PREREQUISITE**

## **EVALUATION PROCEDURES**

CC (EE, 1h30)\*0.5 + CC (EE, 1h30)\*0.5

EC : Conference series		EG9PP2	coeff : 0.08
Teacher In Charge : Reess T.			
CM : 12 h	TD : 0 h	TP : 0 h	Proj : 0 h
Language Français			

## INTRODUCTION

Various researchers from the socio-economic world intervene to present their activities in the field of high voltage. These are mainly engineers from the CEA and the company ITHPP specialized in switching and generation of very high voltages (THT) of several MVs, MA.

## TARGETED SKILLS

At the end of this module, students must:

- Be informed of the activities of the CEA and ITHPP in the field of HV generation
- Strengthen their knowledge of High Pulsed Power machines
- Understand the physical laws involved in the fields of power switching

## CONTENU

Presentation of CEA/DAM/CESTA and ITHPP

Solid state modulators with HPP

The HBPs integrated into the Laser Megajoule (LMJ) installation

HBPs for curing (CESAR generator - Diodes and electron beams - Z pinch)

HPP for flash radiography

Induction technologies, ltd

HPP for flash radiography

Electron beam sterilization

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)

EC : Electromagnetic compatibility

EG9PP3

coeff : 0.21

Teacher In Charge : Pécastaing L.

CM : 8 h

TD : 8 h

TP : 8 h

Proj : 0 h

Language Français

## INTRODUCTION

Electromagnetic compatibility (EMC) is the ability of an electrical or electronic device or system to function satisfactorily in its electromagnetic environment without itself producing electromagnetic disturbances that are detrimental to anything in that environment. This course is a pragmatic introduction to EMC. It aims to expose the origins, to describe the modes of coupling, to outline the effects of the parasites on the systems and finally to present the way to shield a device and to protect it.

## TARGETED SKILLS

At the end of this module, students should:

- Understand the issues and acquire the basics of electromagnetic compatibility (EMC)
- Take into account all the key EMC parameters when designing equipment
- Know the orders of magnitude of potential electromagnetic interference
- Understand the concepts of shielding and optimise protection methods

## CONTENT

- Sources of disturbance
- Propagation vectors - Coupling
- Effects on victims - Susceptibility
- Electromagnetic shielding

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)\*0.7 + TP (CR)\*0.3

EC : TP electromagnetic simulations

EG9PP4

coeff : 0.33

Teacher In Charge : Pécastaing L.

CM : 0 h

TD : 4 h

TP : 12 h

Proj : 20 h

Language Français

## INTRODUCTION

The objective of this course is to demonstrate to students the value of electromagnetic simulation through the use of the 3D electromagnetic (EM) analysis software solution CST Studio Suite®. This solution is dedicated to the design, analysis and optimisation of electromagnetic components and systems. The electromagnetic field solvers for applications are offered over the entire EM spectrum. Solvers can be combined to perform hybrid simulations, giving engineers the flexibility to analyse entire systems with many components efficiently and easily.

## TARGETED SKILLS

At the end of this module, students should

- Be able to use the basic features of the CST Studio Suite software solution
- Understand the issues and potential benefits of electromagnetic and multiphysics simulation
- Be able to analyse electrostatic and electromagnetic simulation results and critically assess their veracity

## CONTENT

- Potential of the CST Studio Suite software solution
- Getting to grips with static and transient solvers
- Electrostatic system simulations - Electric field distribution
- Transient simulation of EM emission systems

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

TP (PA)\*0.5 + Proj (Rap)\*0.5

## TEACHING UNIT (UE) :

Safety, protection and industrial processes

ECTS : 4

Code UE : EG9SP

## SKILLS COVERED BY THE UE :

- Understanding the basic principles of ionized gases
- Know the main processes using plasma
- Know the risks related to lightning and the associated electrical quantities
- Know the lightning protection devices and their sizing
- Mastering the challenges of safety in an industrial environment
- Master the means of electrical protection

## LIST OF COMPONENT ELEMENTS (EC) CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EG9SP1	Plasma processes and applications	0.4	CC (EE, 1h30)*0.3 + CC (EE, 1h30)*0.7
EG9SP2	Lightning and Protection of networks and buildings	0.24	CC (EE, 1h)
EG9SP3	Safety in an industrial environment	0.36	CC (EE, 30min)*0.3 + CC (EE, 1h)*0.7

EC : Plasma processes and applications

EG9SP1

coeff : 0.4

Teacher In Charge : Paillol J.

CM : 10 h

TD : 10 h

TP : 0 h

Proj : 0 h

Language Français

## INTRODUCTION

This module presents the basics of partially ionized gas physics, both microscopically and macroscopically, the various types of cold plasma reactors, and the main industrial applications.

## TARGETED SKILLS

At the end of this module, students must:

- Master the physical mechanisms of the operation of a cold plasma reactor.
- Acquire basic notions about plasma reactivity and active species created in a reactor
- To know the main uses of plasmas in the treatment of gases, liquids and solids

## CONTENT

1. Microscopic phenomena in a partially ionized gas.
2. Statistical laws, macroscopic phenomena.
3. Ionization, transport, influence of walls, sheaths.
4. Types of electric shocks and reactors.
5. Active species, kinetic in the landfill.
6. Applications of cold plasmas in the health field.
7. Applications to the treatment of gases, liquids and solids

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

CC (EE, 1h30)\*0.3 + CC (EE, 1h30)\*0.7



EC : Lightning and Protection of networks and buildings		EG9SP2	coeff : 0.24
Teacher In Charge : Sigogne C.			
CM : 10 h	TD : 0 h	TP : 0 h	Proj : 0 h
Language Français			

## INTRODUCTION

The purpose of this course is to introduce students to the development of lightning, the consequences on electrical networks and buildings as well as the means to be implemented to protect themselves from it.

## TARGETED SKILLS

At the end of this module, students must:

- Be able to identify the phenomena involved in the lightning of an installation.
- Be able to understand the parameters necessary for the designing protections of electrical network and a building against lightning.
- Understand the experiments and models developed for the study of lightning.

## CONTENT

Phenomenology of lightning  
Direct protection of buildings  
Indirect protection of power grids

## RESSOURCES

### PREREQUISITE

- Rakov and Uman, Lightning : Physics and Effects, Cambridge University Press
- Norme NF EN 62305 : Protection against lightning
- Norme IEC 61643-11 : Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods

## EVALUATION PROCEDURES

CC (EE, 1h)

EC : Safety in an industrial environment

EG9SP3

coeff : 0.36

Teacher In Charge : Rey-Bethbeder F., Hertzberg J.

CM : 18 h

TD : 4 h

TP : 0 h

Proj : 0 h

Language Français

## INTRODUCTION

Security, whether physical or digital, is a key issue in the sustainable development of the industry. This course, positioned at the end of the engineering cycle, takes up and completes the issues on safety at work, especially electrical, presented at the beginning of the formation. It also introduces the basics of corporate cybersecurity. The objective is thus to give a first level of competence on security needs in the professional environment both in terms of engineering activities and in terms of Information System (IS) and risks related to the Internet.

## TARGETED SKILLS

At the end of this module, students must:

- Understand and analyze the different electrical risks ,
- Master the means of prevention,
- Identify collective and individual means of protection
- Understand the company's Information System and its security needs
- Know the main types of cyberattacks that can affect the company
- Know the basics of personal data protection (GDPR)
- Manage your usernames and passwords
- Know how to analyze Internet links to identify malicious cyber intent
- Understand the principles of computer encryption

## CONTENT

1. Electrical risks for humans
2. Prevention of electrical risk
3. Protection of workers
4. Static electricity risks

- 
5. Security Awareness
  6. Cyberattacks
  7. Protect your computer
  8. GDPR and protection of personal data (PD)
  9. Usernames and passwords
  10. Internet addresses and links

### **RESSOURCES**

Video Server  
Online Forum

### **PREREQUISITE**

### **EVALUATION PROCEDURES**

CC (EE, 30min)\*0.3 + CC (EE, 1h)\*0.7

## Semestre 10

### LIST OF TEACHING UNITS (UE) OF THE SEMESTER

TC, Spe ou Path- ways	Code UE	Entitled UE	ECTS
GP-EN	ECOSS	Final Internship S10	30
GEII	EG0AP	Apprenticeship or international mobility S10	30

## Tronc Commun GP et EN

3rd Year - Semestre 10 -GP+EN										
UE Name	Code		EC Name	Hours (h)						
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA Proj
Final Internship S10	EC30SS	EC30SS1	Specialised engineer work placement			-				
Total TC				0		0	0	0	0	0
										30

TEACHING UNIT (UE) :

Final Internship S10

ECTS : 30

Code UE : EC0SS

SKILLS COVERED BY THE UE :

**COMPETENCIES COMMON TO ALL COURSES:**

1. Integrate into the organisation, lead it and make it evolve in order to ensure the interface with the "sponsor" (R&D department, customer or other...) by managing the commercial, technical and financial aspects throughout a project, up to, eventually, the implementation and start-up of the industrial unit.
2. Communicate in a way that is adapted to the situation and the people involved, in order to support the development of a project in accordance with the company's strategy.
3. Apply the principles of economic intelligence in the context of your activities in order to ensure, among other things, their protection.
4. Apply the principles of sustainable development in the context of your activities in order to respond to the major issues targeted by your company.

**SPECIFIC SKILLS DEPENDING ON THE TYPE OF INTERNSHIP:**

Energetic:

- Apply the basic principles of energy (material, energy and momentum balances; mass or momentum transfer; coupled heat transfer) to determine the topology, sizing and operation of systems and different technologies, by formulating a wide variety of problems and solving them analytically, numerically or graphically.
- Use computerised CAD/CAM, simulation (possibly dynamic), optimisation and control tools for energy systems to ensure that technical, economic, environmental and safety issues are taken into account.
- Manage a portfolio of customers and prospects in collaboration with the relevant departments (technical and sales departments) with the aim of promoting the range of services and products by taking part in communication actions and following up employees with customers.

- Analyse and understand the needs of clients in order to provide appropriate technical and financial solutions by managing negotiations and ensuring compliance with regulatory, legal, administrative and financial procedures.
- Identifying, designing and responding to consultations or invitations to tender in collaboration with the company's areas of expertise in order to carry out and supervise energy and/or sustainable development studies.
- Keeping an economic and commercial watch on the market (following the latest news from clients and prospects) in order to detect threats and commercial opportunities by monitoring competitors' offers to identify their advantages and weaknesses.
- Develop an interdisciplinary vision to ensure the interface between the various stakeholders in the project, both internal (technical services, management, etc.) and external (customers, suppliers, sub-contractors, etc.).

#### Processes:

- Use the basic principles of process engineering (material, energy and momentum balances; concept of equilibrium; notion of chemical kinetics; mass, heat or momentum transfer) to :
  - item determine the topology, the dimensioning and the functioning of the processes and the various unit operations,
  - propose improvements in the performance of industrial production installationsby formulating a wide variety of problems and solving them analytically, numerically or graphically.
- Implement computerised flowsheeting, optimisation, simulation (possibly dynamic) and control tools for industrial processes to ensure that technical, economic, environmental and safety issues are taken into account.
- Implement experiments (physical or virtual) to validate proposals while respecting safety requirements for personnel, production tools and the environment.
- Design and implement metrology and control systems to ensure nominal and safe operation of production facilities subject to disturbances.
- To interface with Production and external stakeholders (suppliers, subcontractors, etc.) to communicate on progress (achievements, objectives, etc.) using communication techniques adapted to the situation.

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LIST OF COMPONENT ELEMENTS (EC)  
CONSTITUTING THE TEACHING UNIT (UE)

CODE EC	INTITLED EC	COEF	EVALUATION
EC0SS1	Specialised engineer work placement	1	Sta(Tr, Rap, Sout)



EC : Specialised engineer work placement

EC0SS1

coeff : 1

Teacher In Charge : Kousksou T., Vaxelaire J.

CM : h

TD : h

TP : h

Proj : h

Language Français

## OVERVIEW

6-month internship in a company, with engineering assignments or end-of-study project

## LEARNING OUTCOMES

Defined on the UE

## DESCRIPTION

**Preliminary work to identify the specific skills to be developed during the internship must be carried out during the first month of the internship and will be passed on to the academic and industrial tutors in order to demonstrate a good understanding of the expectations of the internship.**

Different skills are identified according to the speciality and type of placement in the EU syllabus. 4 competences are common to all placements and, depending on the type of placement, the student will have to choose one or several other specific competences, possibly in a partial way.

**Among the 4 competences common to all courses, two items will be developed**

### 1. Economic intelligence, protection constraints

Economic intelligence is the whole of the coordinated activities of collection, treatment and diffusion of the useful information to the economic actors, to which are added the actions of influence and notoriety. Within this complex field, the student must describe the protection within the company

1/ Data protection:

What are the measures to protect data?

How are employees made aware of this?

2/ The protection of innovation

Does the company protect its innovation by legal action (patent, trademark registration, etc.)?

Personal analysis: for example, what is the interaction between economic intelligence and the internship and/or the team (department) in which the internship took place? What are your remarks on economic intelligence and protection within the company?

## 2. Sustainable development

The student must describe the company's policy on one or more of the following themes: environmental policy and LCA (life cycle analysis), circular economy and/or social policy, disability, with regard to the company's own activities (and not the product or service sold) and indicate the impact of this policy on his/her mission, his/her workstation and the team in which the course is being carried out.

With regard to disability (mainly for companies with more than 20 employees), the student should know

- the rate of employment of people with a RQTH (Recognition of Disabled Worker Status) in the company
- the amount of the contribution paid to AGEFIPH (Association Nationale de Gestion du Fonds pour l'Insertion Professionnelle des Personnes Handicapées)
- FIPHFP (fund for the integration of disabled people in the civil service)
- agreements signed with AGEFIPH or FIPHFP
- the policy for recruiting disabled staff, raising awareness of disability, the procedures for maintaining employment and the existing links with the occupational medicine service for the adaptation of workstations.

### **The student must:**

- **After one month's work placement, have identified the specific skills to be developed during the internship and have communicated this to the academic and industrial tutors**
- **in their report and during the internship defence, demonstrate the acquisition of specific skills by relying on their achievements**
- **develop the two compulsory items in their placement report (approximately 2 pages per item), firstly in a general manner, then they will develop their own analysis of these subjects by making the link (as far as possible) between these two aspects and their own activities.**

### **RECOMMENDED READING**

<https://travail-emploi.gouv.fr/emploi/emploi-et-handicap/>

<https://www.agefiph.fr/>

<http://www.fiphfp.fr/>

### **PREREQUISITE**

### **ASSESSMENT**

Sta(Tr, Rap, Sout)

## SPECIALITE GEII

3rd Year - Semestre 10 - GEII												
UE Name	Code		EC Name	Hours (h)							ECTS / Coef.	
	UE	EC		Tot UE	Tot EC	Tot Prés.	CM	TD	TP	TA Proj	ECTS UE	Coef. EC
Apprenticeship or international mobility S10	EG0AP	EG0AP1	Skills developed the company or during mobility	0	0	0				5	30	0.70
		EG0AP2	Mission in the company or during mobility									0

TEACHING UNIT (UE) :

Apprenticeship or international mobility S10

ECTS : 30

Code UE : EG0AP

SKILLS COVERED BY THE UE :

- Specify industrial manufactured devices involving electrical engineering and industrial computing, based on established and anticipated needs, in order to establish requirements essential to their design.
- Understand the general operation of electrical energy supply or conversion equipment, in order to determine the constraints of continuity of service and safety.
- Document the study and design of the equipment concerned in order to explain its operation, monitor its implementation or have it maintained.
- Understand the general operation of systems in supervised electrical engineering potentially under high voltage, in order to understand the operating and safety constraints.
- Know and understand a complex and interdisciplinary scientific and technical field of specialty to ensure the interface between the different partners by communicating on the progress of the work / project with both internally and with partners of the company.
- Apprehend a job in an international context, by mastering one or more foreign languages, by having a cultural openness, taking into account all the constraints (managerial, environmental, HR, CSR.) in order to promote synergy in the team.
- Master communication techniques adapted to the situation and the interlocutors in order to lead the development of a project in accordance with the company's strategy.
- Lead a multicultural team by adapting to the constraints and specificities of each, taking into account the cultural mix in its interactions, using adapted communication tools and methods, in order to establish an environment conducive to the success of the project in compliance with regulations, ethics, safety and health.

LIST OF COMPONENT ELEMENTS (EC)  
CONSTITUTING THE TEACHING UNIT (UE)

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CODE EC	INTITLED EC	COEF	EVALUATION
EG0AP1	Skills developed the company or during mobility	0.7	EvalC (entreprise)*0.6 + PA (entreprise)*0.4
EG0AP2	Mission in the company or during mobility	0.3	EvalC (Rap*0.5 + sout*0.5)

EC : Skills developed the company or during mobility

EG0AP1

coeff : 0.7

Teacher In Charge : Pécastaing L.

CM : h

TD : h

TP : h

Proj : 5 h

Language Français

## INTRODUCTION

During this last period of twenty-nine weeks in the company, which includes the longest continuous period of the cycle (27 weeks), the apprentice will be confronted with a multidisciplinary project that he will be able to manage and organize.

## TARGETED SKILLS

The level of development of the 5 targeted skills must be reached at the end of the cycle:

- Developing complex industrial electrical devices
- Develop and implement electrical energy equipment
- Automate industrial environments
- Design and monitor potentially high-voltage systems
- Mobilizing a multidisciplinary team in an international context

## CONTENT

The activities developed in this EC are established according to the specific needs of the company and with the aim of finalizing the acquisition of the targeted skills.

## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

EvalC (entreprise)\*0.6 + PA (entreprise)\*0.4

EC : Mission in the company or during mobility

EG0AP2

coeff : 0.3

Teacher In Charge : Pécastaing L.

CM : h

TD : h

TP : h

Proj : h

Language Français

## INTRODUCTION

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## RESSOURCES

## PREREQUISITE

## EVALUATION PROCEDURES

EvalC (Rap\*0.5 + sout\*0.5)