CHIMIE PARISTECH - PSL

Syllabus

3rd year of the engineering cycle

Chimie Paris
ParisTech

PSL

Engineering path

The student follows the management module (6 ECTS). He/She chooses a field of study, consisting of two or three courses of 40 hours (6 ECTS) each. In order to validate 30 ECTS in the semester, students must take one or two courses from another field of study in addition.

1st semester :

Science education :

Choice of a minimum of 4 UE (5 allowed) from the table below (each UE = 6 ECTS)

Common Core Engineering Culture (6 ECTS)

Management & Leadership seminar
Management and economics
Entrepreneurship, professional project
Scientific and business English
PSL Week

Additional courses

French as Foreign Language
Foreign languages
Sport

2nd semester :

Engineering end-of-study project (30 ECTS)

Table of the teaching units

BIO2	Drugs : from design to patient	**Biotechnologies** O. Ploux
BIO3	Biotechnologies and biological drugs	
PFC1	Formulation for pharmaceutics	**Physico-chimie pour la formulation et cosmétologie** K. Bouchemal
PFC5	Physicochemistry and formulation	
PFC6	Cosmetology for engineers	
MAT3	Selection and design of materials of tomorrow	**Processes and Sustainable Materials** G. Aka
MAT2	Materials of the Cultural Heritage and durability	
MAT8	Materials and Environement	
PRO1	Introduction to Equipment Technology	**Industrial Processes** C. Guyon
PRO2	Process Control and Scaling	
PRO3	Risk management and process simulation	
ENE5	A world without CO2?	**Energy** V. Lair
ENE6	Nuclear Energy	
CVE1	Valorization of bioresources	**Green Chemistry and Ecodesign** F. de Montigny
CVE4	From ecodesign to recycling	
MIC4	Innovation and Entrepreneurship	**Management, Innovation and Consulting** P. Vernazobres
MIC7	Consulting and Strategic Analysis	
IND5	Data Science	**Industry 4.0** J. Ciaffi
IND6	Machine learning	

Timetable

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	Management	1 CVE1 PFC1 PRO1	5 PFC5 ENE5 IND5	3 MAT3 BIO3 PRO3	Management
PM	Presentations 3A 7 MIC7	2 MAT2 BIO2 PRO2	6 PFC6 ENE6 IND6	4 CVE4 MIC4	8 MAT8

3A S5	MH35TC.ML	**MANAGEMENT & LEADERSHIP SEMINAR** *Key words :* managerial and leadership skills, soft skills, group dynamics, team, meeting, negotiation, conflict, emotional intelligence, political and power issues, complexity.

Responsible : Philippe Vernazobres Maître de conférences
philippe.vernazobres@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* attendance, participation
		25 h	h		

Course outline :

This seminar consists in putting students in a situation of learning by doing, in order to develop their managerial, leadership, teamwork and communication skills.

Students are divided into groups of twenty, supervised by a teacher/consultant for 3,5 days. They are confronted with real professional and managerial situations, and play different professional roles. Debriefings of these scenarios allow the development of skills through action and reflective analysis. Additional contributions on managerial tools and concepts are provided by the facilitators.

Learning objectives :

At the end of the seminar, the student will be able to:

- Implement managerial and leadership skills.
- Implement the basics of interpersonal and managerial communication.
- Leading a group, cooperating and communicating within a team, understanding group dynamics
- Lead meetings and working groups.
- Implement the basic postures and processes of negotiation and conflict management.
- Understand and act in a complex, multicultural and organized system.
- Apply political, relational and emotional intelligence and political skills.
- To better integrate into professional life, to integrate into an organization and a team: exercise of responsibility, team spirit, commitment and leadership, communication with different interlocutors.
- Know yourself better, self-assess, manage and develop your skills (interpersonal skills, soft skills).

Prerequisites :

Attending and validation of the school's 1st and 2nd year management courses. Or equivalent for students entering the 3rd year of the school.

Teaching language : french

Documents, website : tool sheets

3A S5	MH35TC.MEG	**MANAGEMENT AND ECONOMICS** *Key words :* marketing, corporate finance, market finance, management control, complex issues, cross-functional

Responsible : Delphine Bourland Enseignante, Chimie ParisTech
delphine.bourland@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* Written final check
	24 h	0 h	0 h		

Course outline :

This UE aims to train and professionalize engineers capable of taking into account the challenges of the company in its competitive economic environment, in compliance with social and societal requirements and ecological imperatives

The UE consists of two modules - Courses
- A mandatory module of international economics (12 hours)
World flows and markets, ecological issues and international economy, financial globalization and systemic risks, European integration, energy and sovereignty issues

- A module to choose from 3 themes (12 hours):
Finance - corporate finance, market finance
Marketing - customers, markets, strategic marketing, operational marketing
Management control - costs, performance, decision support, budgets

Learning objectives :

By the end of this EU, students will have developed their ability to:
- Take into account the company's economic, financial, competitiveness and productivity issues and its commercial and marketing requirements, while respecting social and environmental issues
- Define the main terms specific to these dimensions, handle the key concepts
- Understand the issues of power and communicate with professionals
- Decipher, analyze, implement solutions specific to these dimensions

Prerequisites :

Teaching language : french
Documents, website : handouts

3A S5	MH35TC.MEP	**ENTREPRENEURSHIP, PROFESSIONAL PROJECT** *Key words :* team, start-up, business model, business plan, initiative, professional project, CV, motivation letter, interview, networking

Responsible : Philippe Vernazobres Maître de Conférences Chimie ParisTech
philippe.vernazobres@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* Entrepreneurship : Final Business Plan: written + presentation to a jury
	45 h	0 h	0 h		

Course outline :

Entrepreneurship (initiation) - Learning by doing - Tutoring

Imagine an innovative project in a team, carry out an entrepreneurial process over 6 weeks in order to be able to write and present a business plan.

Assessment methods: Final Business Plan: written + presentation to a jury

Professional project - Teaching through experience - Workshops, interviews, round tables

- 2 half-day modules per group of 20 to 25 students to finalize one's professional project at the end of the school, to think about different professional tracks, to rework one's documents (cover letter, CV...), to prepare for recruitment interviews and to conduct a network approach. Work in groups and in self-guided groups.
- A half-day of round tables organized in partnership with alumni to exchange with experienced professionals on their careers

Learning objectives :

Entrepreneurship: At the end of this module, students will have experienced an entrepreneurial process. They will have developed their ability to:

- Entrepreneurship and innovation with an iterative approach
- Collaborate with autonomy in a team, communicate with resource persons
- Listen to the needs, take into account the uses and the societal and environmental dimensions
- Take into account the cross-cutting issues of the value proposition, marketing, financing and legal dimension of an innovative project
- Design a business model and a business plan
- Present and defend their project in writing and orally

Professional project: At the end of this module students will be able to:

- Know themselves well enough to manage their skills, make professional choices, project themselves into the future and act to build their career paths after graduation
- Enter into recruitment processes: launch a job search, a thesis; apply for additional training courses...- Set up a network approach

Prerequisites :

Teaching language : french

Documents, website : handouts

3A S5	MH35 TC.AN G	**SCIENTIFIC AND BUSINESS ENGLISH** *Key words :* English, Scientific, Business, Individual or Team Projects, Intercultural Skills	
Responsible : Daria Moreau , Head of Languages and Cultures Department daria.moreau@chimieparistech.psl.eu			
	Course	*Tutorials* 24 h	*Evaluation method:* At least B2 (CEFR guideline) linguistic skills validation by : a TOEIC exam (800 points) or valid equivalents of IELTS, TOEFL, Cambridge CA… and by one of the required assignments : either by participating in virtual exchanges proposed by Soliya (EV) or in group projects (EV). The apprentices need to attend face-to-face English classes (P) (EV).

Course outline :

Project Based Language Learning is proposed to the 3rd year students. This method is directed to create an artifact (or artifacts), to present their gained knowledge and to work in the language they are learning.

The 3rd year students can choose between:

- face-to-face English classes,
- virtual exchanges with a tutor within the framework of international projects proposed by Erasmus +,
- or between group writing projects.

The English courses aim at:

- preparing to the international English test (TOEIC),
- analysing and synthetizing scientific, technical, and cognitively demanding documents in English, whether written, audio or video,
- writing high quality technical, professional, or scientific texts in English,
- gaining in-depth cultural knowledge of at least one English-speaking country in order to grasp the psycholinguistic nuances of English (innuendo, cultural allusions)
- communicating in multicultural team projects,
-developing team-working skills while working in English

Learning objectives :

- The student will deepen and apply an in-depth knowledge of grammar, thematic and scientific vocabulary to communicate perfectly in written and oral English in a professional situation within a multicultural company.
- The student will report on the experience of the international internship, compare cultural similarities and differences, and self-assess his/her ability to adapt into international environments.
- The student will participate, argue and defend his/her point of view in a debate on a topic of everyday life, a technical or a scientific one.
- The student will answer factual questions relating to a given topic.
- The student will understand, analyse, and synthesize a scientific, a technical, and a cognitively challenging material in English whether written, audio, or video.
- The student will identify the contextual, grammatical, and lexical indicators to understand the mood, intention of the speaker.
- The student will analyse the structure of the TOEIC exam and develop his/her personal strategy to optimize the score during the official exam

Prerequisites : B2

Teaching language : English

Documents, website : audio and video documents, factual documents https://coursenligne.chimie-paristech.fr/course/view.php?id=333

3A	MH35TC.PSL	PSL Week			
Responsible : Pierre Haquette Maître de conférences pierre.haquette@chimieparistech.psl.eu					
ECTS :					

Course outline :
During the PSL week, students follow one week of classes at Chimie ParisTech or in another PSL establishment: ESPCI, la Femis or Mines Paristech. This week of courses is an opening week where engineering students can study a field related to chemistry, in fundamental or applied sciences, but also in project management, such as Drugs and pathologies, Technologies and Innovation, History of science, Design of innovative products, The value of water, Processes and microfluidics... .. The form, content and assessment of each week depend on the course week chosen.

Learning objectives :
Acquisition of skills and knowledge complementary to their field of specialization
- mobility of students between PSL schools
- to encourage interaction between engineering students in PSL schools

Nature of lessons: Cours, conférences, projets

Teaching language : French and/or English

3A S5	BIO2	**Drugs : from design to patient** *Key words :* Drugs, pharmaceutical industries, drug design, therapeutic targets, medicinal chemistry

Responsible : PLOUX Olivier Professeur
olivier.ploux@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method:* Oral exam of 30 min or written exam of 1h30
6	36 h	0 h	0 h		

Course outline :

This course aims to give a general background in modern medicinal chemistry at the interplay of chemistry and biology, to third year students in chemical engineering. The course / lectures will be given by actors of the academic or industrial world and will focus on drug design, describe the main therapeutic targets and main available drugs and their mode of action. Modern in silico methods will be presented together with the modern medicinal chemistry principles and applications.

Learning objectives :

After attending this session, the students will be able to grasp the challenges met when designing a new drug targeting a particular therapeutic target. They should be able to join a research team working in the general field of medicinal chemistry either in academics or in the industrial world.

Prerequisites :

Fundamentals in organic chemistry and biochemistry (L2-L3 level).

Teaching language : french
Documents, website : pdf documents

3A S5	BIO3	**Biotechnologies and biological drugs** *Key words :* biotechnology, biotherapy, recombinant protein			
Responsible : Pascal Bigey Maître de Conférences Pascal.bigey@chimieparistech.psl.eu					
ECTS : 6	*Course* 39 h	*Tutorials* 0 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* written exam 100% or oral presentation 100%

Course outline :

This course, at the chemistry-biology interface, aims at explaining to a chemist all the basic concepts needed to understand a biotechnology project. Currently half of the new approved drugs are small molecules obtained by chemical synthesis, the other half being issued from biotechnologies. These products are nucleic acids or recombinant proteins. They are used both as drugs, and as diagnostic tools. However, chemistry is still a necessity for formulations purposes, or for chemical modifications aiming at improving the pharmaco-kinetics properties. It seems important that a chemical engineer has some knowledge about biologics drugs, which are currently the most important for the pharmaceutical industry : what they are, how to produce them and their main uses.

Learning objectives :

In the end, students should be able to :
- know enough biology concepts to understand how biotherapies work.
- Know the different biologic drug classes, and their main uses
- read and understand a project or scientific article in the field of biotherapies

The aim is to allow a chemistry student to quickly be functional in the chemistry part of a biotherapy project in the indystry, or to pursue their studies by a PhD program in biology.

Prerequisites :

the ENSCP biochemistry course

Teaching language : french
Documents, website : pdf documents

3A S5	PFC1	**Physicochimie et formulation des produits de santé** *Mots clés : formulation ; opérations pharmaceutiques ; formes pharmaceutiques ; cosmétologie*

Coordinator : BOUCHEMAL Kawthar Professeure des universités
kawthar.bouchemal@chimieparistech.psl.eu

ECTS :	*Lecture*	*TD*	*Practical*	*Tutorial*	*Test mode :* 50% written 50% oral presentation
6	39 h	h	h		

Course outline :

Health product formulation is the science of transforming an active substance into a form that can be administered in a living organism. It deals with the physicochemical and physical properties of active substances and excipients, the manufacturing processes of the different pharmaceutical and cosmetic forms, the routes of administration (e.g., cutaneous, oral, buccal, parenteral...), the properties of the materials used for the primary packaging of the obtained form, and the conditions of preservation.

During this course, the main pharmaceutical operations will be covered (e.g., compression, mixing, granulation, freeze-drying...). The preparation processes of pharmaceutical or cosmetic forms will be detailed (e.g., creams, gels, tablets, capsules...). Particular attention is paid to the controls of drug forms prescribed by the Pharmacopoeia and the constraints they induce in the formulation and manufacture of a drug.

Learning objectives:

At the end of these courses, students should:
- Acquire the basic concepts of galenic pre-formulation of pharmaceutical and cosmetic forms (tablets, capsules, granules, creams, lotions...)
- Know how to make a judicious choice of excipients to effectively formulate a health product.
- To master the operations allowing the transformation of an active substance into a product that can be administered in the living organism.
- - To understand the role of the controls prescribed by the European Pharmacopoeia and the constraints they induce in the formulation and manufacturing of a drug.

Prerequisite :

Basic knowledge of general chemistry, physical chemistry, physical chemistry and analytical chemistry as well as knowledge of all areas of chemistry from the first and second year of the engineering curriculum.

Course language : French
Documents, link : course documents

3A S5	PFC5	**Physicochemistry and formulation** *Key words :* formulation, polymers, surfactants, dispersions, emulsions, foams			
Coordinator : Carine ROBERT - Assistant professor carine.robert@chimieparistech.psl.eu					
ECTS : 6	*Course* 24 h	*Tutorials* 6 h	*Practical work* 10 h	*Mentoring*	*Evaluation method :* written examination (3h)

Course outline :

This course introduces the concepts necessary to understand the complex formulated systems of colloidal dispersions, surfaces/interfaces and self-organized systems that are part of soft matter. The multi-scale approach will allow us to understand how the control of interactions occurring at the interface scale often determines the properties of dispersed systems.

This course is intended for students interested in the scientific and technical basics of soft matter formulation. It is used in cosmetology but also in many other fields of application such as pharmaceuticals, food processing, petroleum, detergents, bitumen and materials in general...

Learning objectives :

At the end of the EU, the student must be able to identify the scientific aspects behind a recipe for formulating a complex system (principles of colloidal scale interactions, mixing and stabilization methods).

He masters physical phenomena, in particular those at mesoscopic scales that allow him to move from his knowledge as a chemist to the development of complex industrial systems.

Prerequisites :

at least bachelor level in physical chemistry

Teaching language : french

Documents, website :

3A S5	PFC6	**Cosmetology for engineers** *Key words :* cosmetology, formulation, skin physiology			

Responsible : Carine ROBERT - Assistant professor
carine.robert@chimieparistech.psl.eu

ECTS : 6	*Course* 32 h	*Tutorials* 4 h	*Practical work* 4 h	*Mentoring*	*Evaluation method :* written examination

Course outline :

The cosmetics industry is a major source of employment for chemical engineers, particularly in the research and development of innovative products and production processes.

The objective is to provide a basic understanding of the major chemical classes of cosmetic ingredients (surfactants, pigments and dyes, polymeric texture agents, other active ingredients, etc.), the biological tissues on which they are supposed to act (skin, hair, nails, etc.) and current industrial issues (eco-design of processes, new "natural" ingredients, aspects of the engineer's job in this field, etc.).

Program: as the course calls for a large number of industrial speakers, its content is likely to change depending on their availability.

1- The skin: structure and functions; The hair and hair products.
Effects of the environment (sun, pollution, etc.) on the body.
2- Raw materials and active ingredients of vegetable origin; Emulsions and surfactants; Mineral pigments and dyes; Regulatory elements.
3- Introduction to rheology.
4- Sensoriality and cosmetics.
5- Production processes: Example of industrial production by biotechnological means.
6- Practical work and lectures.

Learning objectives :

At the end of this course the student

- Knows the principles of skin functioning (biology, physiology).

- Can apply their knowledge of chemistry and physics to cosmetic formulation in a pragmatic way.

- Understands the trade-offs between product efficacy and safety.

- He/she is familiar with the production processes of vegetable raw materials or by biotechnological means.

- He has understood and experienced the importance of sensoriality for cosmetic products.

Prerequisites :

at least bachelor degree in physical chemistry and molecular chemistry

Teaching language : french
Documents, website :

3A S5	MAT3	**Selection and design of materials of tomorrow** *Key words :* material selection, performance, composition-microstructure-property relationships, material design

Responsible : Frédéric PRIMA Professeur
frederic.prima@chimieparistech.psl.eu

ECTS : 6	*Course + laboratory visit + case study* 39 h	*Evaluation method :* oral presentation on project

Course outline :

This course is the core of the chemical engineer's job. It gives the tools to match the need (function and specifications) and the properties of the materials, in order to select the most efficient one. Ashby's material selection strategy method is explained in theory and through case studies. The properties of materials depend on their composition and chemical bonds, but also to a large extent on their microstructure. The composition-microstructure-properties relationships are studied in outline and through examples for the main materials of the city: cementitious materials, ceramics, glasses and glass-ceramics, metallic alloys, polymers. Composite materials and architectural materials (whose characteristic dimension is of the order of one millimeter) are discussed as materials capable of combining properties that are a priori not very compatible, and with the idea of training the student to imagine new possibilities. The examples also allow to evoke the environmental functions of materials: in particular lightening, or thermal insulation.

Learning objectives :

- To Know and practice the Ashby method of material selection
- To know the mechanical and thermal properties of the main classes of materials: ceramics (including cements), glasses and glass ceramics, metallic materials, polymers.
- To know the definition and examples of composite or architectural materials
- Be aware of the needs in the design of new materials, in particular for the sustainable city
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Prerequisites :

master level in material science

Teaching language : french

Documents, website :

3A S5	MAT2	**Materials of the Cultural Heritage and durability** *Key words :* complex materials, elaboration, alteration, conservation, multi-scale analytical methods, cultural heritage

Responsible : Odile Majérus, Maitre de conférences
odile.majerus@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* Written examination with general questions on materials and a case study:50%. Report on an interview with a specialist:50%
6	27 h	3 h	3 h		

Course outline :

The dominance of materials contributes to drive human civilizations. The materials of Cultural heritage have been first produced by humans in a given historical context, then they have evolved in their conservation environment. These materials keep the memory of their origin and of their evolution, which is printed in their multi-scale structure (nano to macro). They are witnesses of our history and should be conserved for the future generations. Studying these materials also helps in anticipating the evolution of current modern materials. This course is multi-materials and multi-disciplinary, encompassing the domains of materials sciences, analytical physical chemistry, human and social sciences. It enriches the general knowledge of students about materials and gives to them tools and examples to predict and evaluate the durability of materials in a given environment. It consists in interactive lectures relying on the basic knowledge of students on materials, in a 3 hours tutorial and in a series of research conferences.

Learning objectives :

At the end of the course, students :

- Have a consolidated knowledge of the specificities of different classes of materials (composition domain, chemical bond, structure, microstructure, elaboration process),
- Have developed their culture of materials, thanks to the historical point of view,
- Are able to propose an analytical approach adapted to a specific material,
- Are able to anticipate the probable evolution of a material in a given environment.

These abilities are evaluated by a final written examination containing general questions on materials and the resolution of a case study from the literature. In addition, students conduct an interview with a specialist of Cultural Heritage, and they have to report on the experimental approach and results of a study of this specialist.

Prerequisites :

M1 level in Materials Chemistry and Analytical Physical Chemistry

Teaching language : french

Documents, website : slide presentation, technical documentation https://coursenligne.chimie-paristech.fr/enrol/index.php?id=235

3A S5	MAT8	**Materials and Environment** *Key words:* materials, sustainable development, resources, energy transformation			
Responsable : Anne-Laure Joudrier, Lecturer anne-laure.joudrier@chimieparistech.psl.eu					
ECTS : 6	*Cours* 39 h	*TD*	*TP*	*Tutorat*	*Evaluation methods: Two oral presentations and a written exam (MCQ). Active participation during the courses is also taken into account.*

Description :

The major issues of the sustainable world are related to energy, to disappearance of many mineral resources and to environmental pollution related to transport and housing.
The module will consist of theoretical courses, a company visit, and tutored projects presented by the students in the entire class on the following themes:
- Reduction of environmental impacts in the production of materials and in their uses
- Materials with environmental functions
- Increasing the lifespan of materials
- Recycling and saving non-recyclable materials.

Learning objectives :

The objectives of this module are as follows:
-to define the technical, economic, scientific and environmental issues to be addressed around a theme linking materials and sustainable development;
-describe the processes, techniques or technologies, and materials used in the state of the art, or already marketed;
-analyze these processes/techniques/materials in a scientific manner, taking into account their physico-chemical principles;
-transmit analyses and conclusions to the class in a concise and scientific manner;
-identify limitations and possible actions to address one of the issues;
-understand and analyze presentations (class, outside speakers, classmates) and raise scientific/technical or societal questions from these presentations.

At the end of this course, the student will have a general knowledge of the major issues related to materials and sustainable development. He/she will have documented existing and developing technologies on a particular issue that will constitute the subject of his/her tutored project. He/she will be able to manage a documentation project in a small group and over a semester. The final presentation will allow him/her to present and explain this project orally to the entire class. The presentation will be illustrated by a synthetic written support (type .ppt).

Prerequisite:

Bachelor's level in general chemistry, inorganic and solid state chemistry.

Course language: English
Documents, link :

3A S5	PRO1	**Introduction to Equipment Technology** *Key words :* Sizing - Equipment - Process diagram - Fluid transport - Heat exchangers

Responsible : Cédric Guyon maître de conférences Chimie Paristech
Cedric.guyon@chimieparistech.psl.eu

ECTS : 6	*Course* 42 h	*Tutorials* 0 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* 100% written exam

Course outline :
In the production field, manufacturing installations handling fluids, equipment used in energy transfer (pumps, compressors, turbines, heat exchangers) have an important weight in terms of both technical and economic performance. In this course, the main devices used in fluid transport and heat exchange, their operating principle, operating conditions and their role in processes will be presented. Based on the results obtained by simulation, the objective of the course is to size the materials and equipment concerned, to evaluate their operating and investment costs.

Learning objectives :
Students who have completed this course will be able to:
- Make preliminary calculations, as part of a pre-feasibility study, for a simple industrial installation
-Propose a coherent process flow diagram
-Search for the physico-chemical data necessary for all the calculations of a pre-feasibility study
-Calculate the flows (pressure drops) and select the corresponding equipment
-Sizing, within the framework of a pre-study, the main rotating equipment (pump and compressor) and selecting the associated technologies
-Sizing the main static materials (exchangers, balloon,...) and selecting the associated technologies
-To make an economic estimate of the changes

Prerequisites :
Chemical Engineering 1&2 year

Teaching language : french
Documents, website : handouts

3A S5	PRO2	**Process Control and Scaling** *Key words :* Sizing - Control - Distillation column			
Responsible : Cédric Guyon Maître de conférences Chimie Paristech Cedric.guyon@chimieparistech.psl.eu					
ECTS : 6	*Course* 42 h	*Tutorials* 0 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* 100% written exam

Course outline :
The management of industrial processes requires a dynamic approach to risk and major safety and regulatory variables in order to approach the notion of real-time production. The approach can only be achieved through simulators of real industrial units, capable of providing young engineers with experience and an understanding of the problems encountered in operation. Within the framework of this course, attention is paid to the study on a dynamic simulator of the regulation strategies applied to an industrial distillation column.

Learning objectives :
Students who have completed this course will be able to:
- Propose a coherent process flow diagram
- Search for the physico-chemical data necessary for all calculations
- Dimension a column to be distilled (Height - Size and nature of the trays - Reboiler...)
-Set up all control barriers in a production unit
-Make an economic evaluation of the installation (investment cost - labour - depreciation - variable costs...)

Prerequisites :
Chemical Engineering 1&2 year

Teaching language : french
Documents, website : handouts

3A S5	PRO3	**Risk management and process simulation** *Key words :* Chemical hazards, process safety, regulation, thermal runaway,dynamic process simulation (Aspen), hazard analysis methods

Responsible : Cédric Guyon Maître de conférences Chimie Paristech
Cedric.guyon@chimieparistech.psl.eu

ECTS : 6	*Course* 12 h	*Tutorials* 0 h	*Practical work* 30 h	*Mentoring*	*Evaluation method :* written 50%, TP 30%, Oral 20%

Course outline :

The objective of this teaching is to sensitize students to the concepts of thermal stability of substances, thermal runaway, operating conditions (real-time simulation) and process safety (risk analysis methods).
The first part of the course will be in the form of lectures on the risks of thermal runaway of products and chemical reactions, on the implementation of transient simulations and on hazard analysis methods.
The second part of the teaching will consist of a supervised project, implementing the reactions studied. The aim will be to design and manage a transient production unit (Aspen plus®, Aspen Hysys® dynamic) and to validate the operational safety of the process in terms of chemical risks using hazard analysis methods

Learning objectives :

Students who have completed this course will be able to:
- Determine the important parameters of a chemical reaction (enthalpy of reaction and decomposition, reaction rate, TMRad : Time to Maximun Rate under adiabatic conditions).
- Know how to simulate an industrial process on a large real-time software (Aspen plus, Aspen Hysysys dynamic) in order to predict any process drifts.
- Know how to make a chemical process safe by validating its operational integrity (start-up, steady state, shutdown of the installation) using hazard analysis methods (HAZOP method, cause tree, butterfly knot...).

Prerequisites :

Process simulation base acquired during the 2nd year practical work

Teaching language : french
Documents, website : handouts

3A S5	ENE5	**A world without CO2?** *Key words :* decarbonation processes, alternative fuels, batteries, recycling			
Responsible : Virginie LAIR virginie.lair@chimieparistech.psl.eu					
ECTS : 6	*Course* 33 h	*Tutorials* 3 h	*Practical work* 0 h	*Mentoring* 3 h	*Evaluation method :* Personal project with report and oral presentation

Course outline :

This course is intended for students wishing to acquire a broad overview of the challenges of decarbonation, a driver at the core of current environmental and societal issues. This course calls for multi-disciplinary skills and requires knowledge in molecular chemistry, chemical processes, catalysis, materials and physical chemistry. It is mainly a series of lectures given by academic lecturers but also by numerous industrial lecturers from the energy sector, from start-ups to multinationals.

Following a general introduction on the main challenges of the energy transition and its objectives, particularly at the European stage, a focus will be provided on the various CO2 capture and storage processes. CO2 will also be presented as a molecule to be exploited and valorised. Thus, different recovery routes will be presented and discussed, focusing mainly on chemical transformation routes. The paths will be discussed from an industrial point of view, as well as from a research and development or innovation point of view.
In addition to these talks on ways of reducing CO2 emissions and in the light of the energy mix and electrification, the role of alternative fuels, among which biogas, biomass and also hydrogen, will be addressed. Also, the various battery technologies, their advances and prospects for transport and lifecycle will help to imagine a way of storing electricity in the context of sustainable development without CO2.
Finally, among the concrete actions to decarbonise, the notions of material efficiency and recycling will be discussed.

Where possible, a site visit is organised.

Learning objectives :

- Identify and describe the different possibilities of CO2 energy valorisation, capture and storage.
- Analyse and assess the different types of alternative fuels to decrease dependence on fossil fuels and reduce CO2 emissions
- Explain the operation of energy systems such as batteries in this context.
- Build decarbonisation strategies

Prerequisites : Materials chemistry, solution chemistry, electrochemistry, chemical process engineering

Teaching language : French or English
Documents, website : pdf documents on Moodle website

3A S5	ENE6	**Nuclear Energy** *Key words :* nuclear-based electricity, nuclear fuel : from mine to wastes			
Responsible : Grégory Lefèvre Research Director gregory.lefevre@chimieparistech.psl.eu					
ECTS : 6	*Course* 21 h	*Tutorials* 9 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* Groupe project (oral defense) and written exam

Course outline :
This course provides an overview of the nuclear fuel cycle, detailing the steps where chemistry has an important role. It provides students with the key elements to understand the nuclear power cycle. It is not aimed at a public wishing to pursue a career in this field (in which case, the Nuclear Energy Master's degree is more appropriate), but enriches general knowledge on energy and environmental issues.
A visit to an industrial site or research centre is planned.

Learning objectives :
The student will be able to understand nuclear power generation.
The student will be able to describe the recycling of nuclear fuel, and the choices for storing final waste.
The student will have understood the biological effects of ionizing radiation.

Prerequisites :
Solution and material chemistry

Teaching language : french and/or english
Documents, website : slide presentation

3A S5	CVE1	**Valorization of bioresources** *Key words :* biomass, biofuels, lignocellulose pre-treatment, biosourced platform molecules, other molecules of biosourced interest, biomater

Responsible : Frédéric de Montigny Maître de Conférences
frederic.de-montigny@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* written exam + oral
6	24 h	15 h	0 h		

Course outline :

- Presentation of the issues related to plant chemistry and concepts ranging from biomass to biomaterials and platform molecules...
- Presentation of the concepts of plant chemistry allowing to replace fossil carbon by plant carbon, either by a substitution strategy or by the development of new biosourced materials.
- The concepts covered will include: biomass, biofuels, lignocellulose pre-treatment, biosourced platform molecules, other molecules of biosourced interest, biomaterials.

Learning objectives :

Presentation of tools for the design and the implementation of industrial processes that meet the challenges of sustainable development: use of renewable materials from biomass, improvement of eco-compatibility of processes, development of industrial synthesis strategies considering all sustainability criteria.

Prerequisites :

Teaching language : french

Documents, website :

3A S5	CVE4	**From ecodesign to recycling** *Key words :* circular economy, life cycle analysis, eco-design, recycling

Responsible : Anne Varenne Professeur
anne.varenne@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :*
6	24 h	12 h	0 h		Written report and oral presentation of the project

Course outline :

This course is intended to raise awareness among students of the importance of taking into account the environmental impact, related to the use of a particular material or process, during the design stages of a finished or semi-finished system. It is based on a macroeconomic vision of the environmental problems to be taken into account when designing. The notions of the life cycle of materials will be addressed in order to acquire the knowledge essential to the realization of eco-audits. The different strategies for selecting materials or processes will then be applied, based as much as possible on concrete case studies.

Teaching is a continuum between courses, seminars (actors from the professional world of eco-design, recycling, circular economy), active participation of students around a project and a restitution of the acquisition of skills in the form of presentations. The project work will start with a product. A reflection of the upstream and downstream aspects of this product will lead the group to a description of the life cycle of this compound. The objective of this training is to deepen the concepts through criticism and the construction of a thorough and global reflection on eco-design, waste management, recycling and the circular economy in a more global way

Learning objectives :

Provide the main keys to tackle eco-design and recycling, through a scientific, technical, economic and societal vision, so that future chemical engineers become actors of innovation which is a challenge in this field. The working approach in project format will give rise to a critical reflection of the existing situation in order to identify innovative ways that need to be explored further.

Prerequisites :

Notions in all fields of chemistry in the first and second year courses of the engineering program.

Teaching language : french
Documents, website : french and english documents

3A S5	MIC4	**INNOVATION AND ENTREPRENEURSHIP** *Key words :* project, team, innovation, start-up, business model, business plan, investors, commitment, initiative

Responsible : Delphine Bourland, en partenariat avec Audra Shallal Boss Consulting, Chimie ParisTech
delphine.bourland@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :*
6	39 h	0 h	0 h		nterim reports - Final Business Plan: written + presentation to a jury of capital providers

Course outline :
Design and implement an innovative entrepreneurial project in teams for 4 months with the support of coaches and professional mentors.
Modalities: Learning by doing
- Have an entrepreneurial attitude and develop entrepreneurial skills, which can then be practiced in different professional environments
- Defend your project and business plan in front of investors
- Develop your network
- Be able to continue your project in the PSL-PEPITE pre-incubator, as a student entrepreneur

Learning objectives :
At the end of the course, the student will be able to:
- Cooperate and communicate within a team and with experts, in person and remotely
- Design innovative projects, select the most relevant ones (feasibility, desirability, viability, sustainability)
- Contribute to the digital, energy and environmental transitions, by integrating ecological and climate issues
- Design and implement a marketing strategy, analyse the project environment and the market
- Build and develop a business model, build a startegic vision
- Carry out financial planning (plan, cost), integrate legal elements (intellectual property, company form)
- Write a business plan and an executive summary
- Convince a jury of business angels and capital providers, integrate feedback

Prerequisites : Attending and easy validation of the school's 1st and 2nd year management courses. Or equivalent for students entering the 3rd year.

Teaching language : french and english
Documents, website : handouts

3A S5	MIC7	**CONSULTING AND STRATEGIC ANALYSIS** *Key words :* Consulting, strategy, customer relationship, demand analysis, technical and commercial proposal, work methodology in project mode, change management

Responsible : Philippe VERNAZOBRES Maître de Conférences
philippe.vernazobres@chimieparistech.psl.eu

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* carrying out a mission for a consulting firm and oral + attendance and individual report
6	9 h	0 h	0 h		

Course outline :

The overall objective of this module is to introduce students to the consulting professions, by familiarizing them with the functioning of firms and the conduct of consulting assignments. It aims to promote the integration of graduates into the professions of consulting, or the professions of studies and business consulting in firms.
Modalities: Conferences and learning by doing (workshops, case studies, projects...) in collaboration with consulting firms

- Understand the challenges and professions of consulting.
- Understand how a firm operates and how to conduct an advisory engagement.
- Understand the concepts and main reading grids of strategic analysis.
- Develop analytical and intervention skills on different types of missions.
- Develop a service proposal and problem-solving posture.

Learning objectives :

At the end of the course, the student will be able to:

- Work in a project team in order to lead a consulting mission and deliver a service to a client.
- Master the methods, processes and tools necessary to conduct a consulting assignment: analysis of the request, writing a proposal, planning and execution of the assignment, design of deliverables and presentation to the client.
- Manage a customer relationship, from demand analysis to project delivery.
- Find relevant information to respond to the customer's request, evaluate and implement it.
- Write a presentation and defend it in front of clients
- Understand a field of knowledge and develop analytical and synthesis skills in the fields of consulting and strategic analysis
- Take into account the stakes of the company and society : economic stakes, commercial requirements, economic intelligence, ethical and environmental issues, principles of sustainable development...
- Helping to support digital, energy and environmental transitions, by integrating economic and climate issues

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Prerequisites :

Attending and easy validation of the school's 1st and 2nd year management courses. Or equivalent for students entering the 3rd year.

Teaching language : french
Documents, website : handouts

3A S5	IND5	**Data science** *Key words : Python, data analysis, Industry 4.0, graphs*

Responsable, Coordinator	Julien CIAFFI, PRAG, Chimie Paristech Julien.ciaffi@chimieparistech.psl.eu

ECTS	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Written exam*				
6		*39h*			*100%*				

Course outline

We are accumulating an ever-increasing amount of data (Big Data). In this course you will learn how to manipulate, analyse and summarize this data with beautiful charts.

We will follow courses 1 and 2 of this MOOC: https://www.coursera.org/specializations/data-science-python

We will use Python notebooks and the Pandas and Matplotlib libraries. Knowledge of Python is not required. Each student progresses at his own pace. Students can (re-)learn Python during the first sessions.

Approximately 10 hours will be devoted to lectures where experts in chemistry, biology, materials and Industry 4.0 will tell you how data science is revolutionizing these fields.

Learning objectives :

You will be able to use Python to :

- Merge, clean up, arrange data provided as .csv files.
- Conduct simple statistical tests on these data.
- Summarize them with charts.

You will be able to give examples of how data science is used in the fields of chemistry, biology and materials, in research and industry.

Prerequisites :

none

Teaching language: French and English

Documents, website : https://moodle.psl.eu/

3A S5	IND6	**Machine learning** *Key words : machine learning, Python*

Responsable, Coordinator	Julien CIAFFI, PRAG, Chimie Paristech Julien.ciaffi@chimieparistech.psl.eu

ECTS	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Written exam*				
6		*39h*			*100%*				

Course outline

Machine learning uses Big Data to train machines to become "intelligent": playing go, driving a car, investing in the stock market, monitoring the population,...

You will discover the main algorithms of "machine learning". You will implement them in Python programs to build your own artificial intelligences.

We will follow courses 3, 4 and 5 of this MOOC: https://www.coursera.org/specializations/data-science-python

- Applied Machine Learning in Python
- Applied Text Mining in Python
- Applied Social Network Analysis in Python (for the fastest students)

Learning objectives :

You will know the advantages and disadvantages of the main machine learning algorithms.
You will know how to use them to build intelligent machines in Python.

Prerequisites :

- English: all or part of the course and practical materials will be in English.
- Data Science (IND5)

Teaching language: French and English

Documents, website : https://moodle.psl.eu/

3A	UH36PFE	**Engineering end-of-study project** *Key words :* project management at engineering level

Responsible : Pierre Haquette Maître de conférences
pierre.haquette@chimieparistech.psl.eu

ECTS : 30	*Course* h	*Tutorials* h	*Practical work* h	*Mentoring*	*Evaluation method :* report 50% Oral presentation 50%

Course outline :

The student completes a six-month internship during which he/she must demonstrate that he/she is able to mobilize all the knowledge and skills acquired during his/her schooling for the purpose of generating innovative work. The internship must correspond to the professional level of an engineering executive, whether in the performance of technical work (research, analysis, production, etc.) or in the management of a project in a company requiring responsibility.

For engineering students only: At least one of the two second or third year internships must be completed in a company. At least one long-term international experience (at least 5 months) is also required, either in the form of one of the two internships 2A or 3A or a mobility of at least one semester to follow theoretical courses abroad.

Learning objectives :

The student must demonstrate the ability to take initiative. They must be able to document, identify, model and solve even unfamiliar and not fully defined problems. They must demonstrate organizational skills, planning and the ability to manage a project.

He must demonstrate his ability to take into account the issues of work relations, ethics, safety and health at work. It must also respect societal and environmental issues, in particular by applying the principles of sustainable development.

He must demonstrate his ability to integrate into professional life, to integrate into an organization, to show his ability to take responsibility, his team spirit, his commitment. He must show a capacity for project management while knowing how to communicate with specialists as well as non-specialists

Prerequisites :

scientific and technical knowledge at master level

Teaching language :

Documents, website :

2A, 3A S3S4	**French as Foreign Language - FLE** *Mots clés : Français Langue Etranger, Général, Scientifique, Professionnel, Compétences Interculturels*

Responsable : Daria Moreau, responsable des enseignements Langues et Cultures : daria.moreau@chimieparistech.psl.eu

	Tutorat 20 h	At the end of each term validation of 5 skills of the CEFRL grid (CC) and of personal work (CC), cross-cultural communication skills (CC), motivation (CC), course participation (CC), attendance (P). A test de Connaissance du Français (TCF) is compulsory for all international students at the end of the 3rd year of studies (EX) and B2 level in French is required by the CTI from all international students.

Presentation and Content:

The objective of these courses is to help all students get at least the B2 level in FLE.

During the classes, the focus will be put on helping students:

1) fully follow and participate in science courses: comprehension, production, interaction, mediation, and

2) communicate with French students and integrate into the social life at Chimie ParisTech.

Before arriving in France

Before arriving at Chimie ParisTech, international students take an online placement test and oral interviews are organised to assess their oral and written skills in French. This evaluation allows us to accompany the students beforehand by offering remote linguistic tools for self-studying while they are still in their countries of origin.

Before the beginning of studies

- **FLE summer classes**

Upon international students' arrival in France and before the beginning of their studies, intensive summer courses (3 hours per day/3 weeks) are offered to those who have an inferior to B2 level in French, to better integrate them into the professional, administrative and daily French-speaking environment. Students receive 2 ECTS for these intensive pre-entry FLE courses.

- **Conferences on Studying in France**

Then all international students participate in conferences preparing them to engineering studies in France and they visit our school labs.

At Chimie ParisTech

- **FLE classes**

During the academic year, students who have an inferior to B2 level in FLE according to the results of the placement test must attend weekly FLE classes in groups corresponding to their levels according to the Common European Framework of Reference for Languages (CEFRL). B2 and C1 FLE classes are also highly recommended to all international students. FLE classes take place at Ecole de Mines in common PSL languages center.

- **Additional resources**

Cultural and gastronomic outings are proposed by PSL Welcome Desk. Students have also access to numerous linguistic and cultural resources available on school's Moodle platform.

- **French Speaking Workshops**

In addition to the courses given by qualified teachers in FLE, some French-speaking students organise conversation workshops (1hx1/week). These optional workshops, composed of 3 international students and one French-speaking student, create a space for a daily language practice and are also a means of integration.

To acquire more fluency in speaking and developing the ability to work in a group, international students can also participate in a theatrical group led by their French-speaking classmates.

Exam

At the end of the 3rd year of studies the level in FLE is verified by an external TCF (Test des Competences du Français) test and by an internal evaluation. The level B2 at the TCF test is required by CTI to validate the engineering diploma.

Teaching objectives :

At the end of the course students will:

- develop linguistic and cross-cultural skills,
- integrate a professional, academic, and social French-speaking environment,
- work in a French-speaking team,
- answer in French factual questions and discuss a given topic,
- hold a conversation and express themselves with ease on a wide range of subjects,

- synthesize a scientific or general text or an audio document by extracting relevant information and presenting it to an audience,
- communicate in writing and orally on a subject of everyday life, a technical or a scientific one,
- give a clear presentation on a subject with cultural, civilizational, technical or scientific content, prepared in advance.

Course Prerequisites ***:*** A2+

Language of instruction*:* French
Course documents: Handouts, articles, newspapers, audio, and video documents; examples of authentic, factual documents.Website links : https://coursenligne.chimie-paristech.fr/course/view.php?id=76