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

Sport
Langue vivante 2

2nd semester :

Engineering end-of-study project (30 ECTS)

Table of the teaching units

BIO1	Applied microbiology and industrial bioprocesses	**Biotechnologies** O. Ploux
BIO2	Drugs : from design to patient	
BIO3	Biotechnologies and biological drugs	
PFC5	Physicochemistry and formulation	**Physico-chimie pour la formulation et cosmétologie** M. Minier
PFC6	Cosmetology for engineers	
MAT3	Selection and design of materials of tomorrow	**Processes and Sustainable Materials** O. Majerus*
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 BIO1 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 TOEIC

3A S5	MH35TC.ML	**MANAGEMENT & LEADERSHIP SEMINAR** *Key words :* management, leadership, group dynamics, team, meeting, negotiation, conflict, emotional intelligence, complexity, systems

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

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :* attendance, participation
	h	28 (tutorat) 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 4 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.
- Understand group dynamics, lead a team.
- Lead meetings and working groups.
- Implement the basic postures and processes of negotiation and conflict management.
- Understand and act in a complex 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, transdisciplinary vision

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 having a global and transdisciplinary vision of their environment. It is a question of giving them tools to enable them to integrate the economic challenges of the company and cross-functional issues.

The UE consists of two modules - Courses

- A mandatory module of international economics (12 hours)

World flows and markets, environmental and knowledge economy, regulation in a globalised world

- 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 challenges in its economic dimensions
- Understand vocabulary and 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
	56 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 reflect on different professional paths, work on the cover letter, CV, recruitment interviews and the network approach, work in sub-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
- Work in a team with resource persons
- Take into account the cross-cutting issues of the value proposition, marketing, financing and legal dimension of an innovative project
- Present and defend their project in writing and orally

Professional project: At the end of this module, students will have acquired the ability to get to know themselves better and manage their skills. They will be able to:

- Better understand the recruitment process
- Set up a network approach
- Make professional choices

Prerequisites :

Teaching language : french
Documents, website : handouts

3A S5	MH35 TC.ANG	**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

ECTS :	*Course*	*Tutorials*	*Evaluation method :* Validation of linguistic competences of the CEFRL grid at least at the B2 level verified by: the TOEIC exam (800) or a valid IELTS, TOEFL, Cambridge CAE certificate attesting the same level (EX), a chosen module outcome (CC), self-evaluation of students' cultural awareness (CC), participation in courses or in chosen projects (P).
At least B2 (CEFR guideline) linguistic skills validation by : a TOEIC exam (800 points) or valid equivalents IELTS, TOEFL, Cambridge CA… and by one of the required assignments : either by participating in virtual exchanges proposed by Soliya or in group projects. The apprentices need to attend face-to-face English classe		24 h	

Course outline :

The courses aim to improve English language skills and teach linguistic autonomy in order to prepare students to work in teams with technical and scientific English in an international and multicultural context. These courses also aim to help students prepare for the official TOEIC exam required by the CTI to obtain the Chimie ParisTech-PSL engineering diploma. In order to improve students' linguistic skills and their authonomy, students can choose between the following 'learning by doing' offers :

-face-to-face English classes for the apprentices,

-virtual exchanges with international students proposed by the Soliya program,

-team based projects.

Students can also benefit from personalized help and various TOEIC preparation tools crafted to their needs.

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 get an in-depth knowledge of grammar, thematic and scientific vocabulary to be able 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 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 be able to understand, analyse, and synthesize a scientific, a technical, and a cognitively challenging material in English whether written, audio, or video.
- The student will be able to identify the contextual, grammatical, and lexical indicators to understand the mood, intention of the speaker.
- The student will understand 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	BIO1	**Applied microbiology and industrial bioprocesses** *Key words :* living cell, metabolism, microbial kinetics, bioproduction			
Responsible : MINIER Professeur michel.minier@chimieparistech.psl.eu					
ECTS : 6	*Course* 34 h	*Tutorials* 2 h	*Practical work* 4 h	*Mentoring*	*Evaluation method :* 50% written 50% oral presentation

Course outline :

This course aims to familiarize students with the implementation of microbial bioprocesses. The topics covered by academic or industrial lecturers are :

- the structure and physiology of living cells, in particular microbial cells

- energy production by different cells and their metabolism,

- the monitoring and representation of growth and production kinetics,

- the application of the previous knowledge to the implementation of bioprocesses.

All the teaching will be linked, whenever possible, to industrial applications in the fields of energy, fine chemistry, agri-food, cosmetics, health, environment, etc.

Learning objectives :

The student acquires a basic skill, complementary to his training as a chemist, in the field of microbiology applications. He knows how to set up a bioreactor and follow the evolution of its culture in various cases.

Prerequisites :

bachelor level in chemistry

Teaching language : french

Documents, website :

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 :*
6	40 h	0 h	0 h		Oral exam of 30 min or written exam of 1h30

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	PFC5	**Physicochemistry and formulation** *Key words :* formulation, polymers, surfactants, dispersions, emulsions, foams			
Responsible : Michel MINIER Professeur michel.minier@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 : Michel MINIER Professeur michel.minier@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).

- Know how to 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 :* housing materials, mineral resources, energy processing			
Responsible : Philippe Barboux Professeur des Universités philippe.barboux@chimieparistech.psl.eu					
ECTS : 6	*Course* 12 h	*Tutorials* 12 h	*Practical work* 24 h	*Mentoring*	*Evaluation method :* three oral presentations (brainstorming, mid-term, final)

Course outline :

The module covers new technologies applied to environmental materials and especially those for housing. The major problems of the sustainable world are linked to energy, the disappearance of many mineral resources and environmental pollution. The course will include a part of theoretical courses (12h), company visits and a part of tutored projects (20h) presented by the students themselves and covering the following aspects:

- Environment and energy: materials for energy storage and transformation (photovoltaics, batteries, thermoelectricity…) materials for housings
- Strategic resources: save, substitute, recycle

Learning objectives :

The student should be familiar with the latest developments in materials for the environment and environmentally friendly processes. He knows how to manage a documentation project throughout the semester and present it to his classmates during several brainstorming sessions.

Prerequisites :

mineral and solid state chemistry, general chemistry at least bachelor level

Teaching language : french

Documents, website :

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, 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 :* CO2 capture, storage and recovery

Responsible : Virginie LAIR
virginie.lair@chimieparistech.psl.eu

ECTS : 6	*Course* 33 h	*Tutorials* 6 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* Personal project with report and oral presentation

Course outline :

This UE proposes to train Chemical Engineers in the field of energy involving processes without CO2-free processes or the valorisation of the latter. It calls for multidisciplinary skills in chemistry, one of the characteristics of our students, because it requires knowledge in molecular chemistry, processes, catalysis, materials and physical chemistry. Many industrial speakers from the energy sector are involved in this course.

After a general introduction on the energy transition and the current stakes in particular at the European level, a focus will be given on the processes of capture (in particular by chemical absorption) and storage of CO2 (in particular the underground storage). In addition, CO2 will be presented as a molecule of value and several industrial, innovation and research processes will be presented and discussed (e.g. methanation, mineralization, ...)

Finally, in the context of reducing CO2 emissions, an important part of the course will be devoted to alternative fuels such as biogas, biomass and also hydrogen, especially in terms of production and use.

Finally, the different battery technologies, their advances and their perspectives for transport and their life cycle will allow to consider a mode of electricity storage in the framework of a sustainable development without CO2.

When possible, a site visit is organized.

Learning objectives :

- Describe, list and analyze (advantages/disadvantages, ...) the different possibilities of CO2 energy recovery, capture and storage.
- Evaluate and compare the different types of alternative fuels available to reduce dependence on fossil fuels and CO2 emissions
- Describe the functioning of energy systems such as batteries or fuel cells in this context.

Prerequisites : General Chemistry, Chemical Engineering

Teaching language : french

Documents, website : pdf documents, handouts
https://coursenligne.chimie-paristech.fr/course/index.php?categoryid=18

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 :* Project

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
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	25 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 : 6	*Course* 24 h	*Tutorials* 12 h	*Practical work* 0 h	*Mentoring*	*Evaluation method :* 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, start-up, business model, business plan, investors, commitment, initiative

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

ECTS :	*Course*	*Tutorials*	*Practical work*	*Mentoring*	*Evaluation method :*
6	45 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

- Develop your entrepreneurial spirit and entrepreneurial skills, which can then be practiced in different professional environments
- Present your project and business plan to investors
- Develop your network
- Be able to continue your project in the PSL-PEPITE pre-incubator

Learning objectives :

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

- Form a team and design innovative projects, select the most relevant ones (feasibility, desirability, viability)
- Design and implement a marketing strategy, analyse the project environment and the market
- Build and develop a business model
- Carry out financial planning (plan, cost), integrate legal elements (intellectual property, company form)
- Write and defend a business plan before a jury of Business Angels and capital providers

Prerequisites :

Teaching language : french
Documents, website : handouts

3A S5	MIC7	**CONSULTING AND STRATEGIC ANALYSIS** *Key words :* Consulting, strategy, customer relationship, demand analysis, technical and commercial proposal

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	35 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, projects...).

- 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.
- 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...
- 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.

Prerequisites :

Attending and 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, graph*

Responsible,	Julien CIAFFI, PRAG, Chimie ParisTech Julien.ciaffi@chimieparistech.psl.eu

ECTS *6*	*Tutorials* *42h*								

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

- English: course and practical materials will be in English..

Teaching language : French and English

Documents, website : https://www.coursera.org/specializations/data-science-python

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

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

ECTS *6*	*Tutorials* *42h*								

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: course and practical materials will be in English.
- Data Science (IND5)

Teaching language : French and English
Documents, website : https://www.coursera.org/specializations/data-science-python

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 :

ADDITIONAL COURSES

• *Additionnal foreign language(s):*

French as Foreign Language :

Description : Lectures focus on:

1)the ability to follow and participate in science courses: oral and written comprehension, written and oral production

2) communication with French students and social life in France, in order to facilitate integration into the School and in France

Cultural activities (museum visits) may be organised to help student learning French

Objective : To get at least B2 level in French or C1

Knowledge : Depends on the level

Skills : Understanding of the everyday language through film, radio or television broadcasts

Improvement of writing skills through writing and rewriting workshops.

Ability to listen and express oneself is encouraged through exercises to summarize audio-visual programmes, and debates, the presentation of cultural "PowerPoints" given to students in small groups - 2 groups (B1 and B2) – 2h per week per semester

Spanish
German
Chinese
Japanese
Russian
Portuguese
Italian
Arabic

Responsible: Daria Moreau daria.moreau@chimieparistech.psl.eu

ECTS credits: 1

• *Sport*

ECTS credits: 1