ParisTech
INSTITUT DES SCIENCES ET TECHNOLOGIES
PARIS INSTITUTE OF TECHNOLOGY

MSc in Engineering

ESPCI 3Ã¨me annÃ©e

Program Language: French

Aims:

La troisiÃ¨me annÃ©e est une annÃ©e de spÃ©cialisation et d'initiation Ã la recherche commenÃ§ant par un stage industriel de 4 Ã 6 mois, suivi par des enseignements scientifiques en trois dominantes : physique, chimie ou physico-chimie. Les enseignements magistraux sont complÃ©tÃ©s un stage en laboratoire de 10 semaines Ã temps plein.

MSc in Engineering

ESPCI 3Ã¨me annÃ©e Tronc Commun

Program Language: French

Last Modification: Fri 26 June 2009

FF3 Corporate finance fundamentals

Lectures: 12 h - Tutorials: 2 h
ObjectivesUnderstand and analyze corporale P&L and Balance Sheet statements. Link between P&L and B/S - Free Cash Flow. Notions of assets valorization and investment decisions making.

Syllabus
Profit & Loss (EBIT, EBITDA)
Notions concerning the Balance Sheet (essentially working capital)
Links between P&L and B/S and Free Cash Flow
NPV (Net Present Value of an asset)
TutorialsSimple examples.

Requirements
Basic mathematics (algebra, analysis); mass and energy balance.

Evaluation mechanism
Home examination.

Term : core curriculum
Number of hours : 14
ECTS Credits : 1,5
Last Modification : Wednesday 31 May 2017

MSc in Engineering

ESPCI 3Ã¨me annÃ©e Option Chimie

Program Language: French

Content:

- Quatre cours obligatoires :
SynthÃ¨se organique (3 ECTS)
SynthÃ¨se des polymÃ¨res (1,5 ECTS)
RÃ©activitÃ© (1,5 ECTS)
ChimiomÃ©trie (1,5 ECTS)

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- Des cours de spÃ©cialitÃ© Ã choisir parmi :
RhÃ©ologie (1 ECTS)
Chimie Inorganique AvancÃ©e (2 ECTS)
SynthÃ¨se Organique AvancÃ©e (3 ECTS)
Biophysique (1,5 ECTS)
Biochimie (1,5 ECTS)

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- Des cours d'option Ã choisir (pour un total compris entre 3 et 4,5 ECTS) parmi :
Microfluidique (3 ECTS)
Introduction au GÃ©nie NuclÃ©aire, (3 ECST)
TÃ©lÃ©coms AvancÃ©s (1.5 ECTS)
Physique des composants microÃ©lectronique (1.5 ECTS)
Environnement et dÃ©veloppement Durables, (1.5 ECTS)
Etats ColloÃ¯daux et Bio-colloÃ¯des, (1.5 ECTS)
Biotransformation et gÃ©nie des procÃ©dÃ©s (1.5 ECTS)
ou
GÃ©nie Chimique (option 2 mutualisÃ©e avec lâ€™ENSCP) (2 ECTS)

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- un Â« enseignement dâ€™ouverture Â» au choix parmi les modules suivants qui sont ouverts Ã toutes les dominantes : (5 ECTS)
Chimie Fine et Biologie
SystÃ¨mes Ã©nergÃ©tiques
Informatique
MatÃ©riaux sur mesures (option mutualisÃ©e avec lâ€™X)
MÃ©thodes et Instrumentation pour imagerie mÃ©dicale
RelativitÃ© et ElectromagnÃ©tisme

Program Contents :

- Advanced selective organic synthesis
- Polymer chemistry
- Advanced inorganic chemistry
- Synthetic methods in molecular chemistry
- Molecular biotechnology
- Microfluidics
- Colloidal Matter and Biomolecules
- External courses: ENSCP_OPT_GC2 (Link to ParisTech)
- Advanced materials
- Medical imaging: from measurements to images

Last Modification: Tue 30 June 2009

ASOS Advanced selective organic synthesis

Lectures : 20 h - Tutorials: 4 h
ObjectivesFine organic chemistry is everywhere, in medicinal products, perfumes, cosmetics, materials, etc. Knowing the bases of organic synthesis is essential for a chemist.This course is intended for chemists and aims to introduce them to the new reactions used in organic synthesis, for example. This work is applied in the study of major syntheses of biologically active products. These studies additionally constitute a first relative approach to Organic Chemistry synthesis strategies.

Syllabus
Chemoselective alkylation reactions
Organocatalytic reactions
Organometallic coupling reactions
Metathesis and applications
Organometallic coupling reactions with palladium, iron and copper
Catalytic oxydation and reduction reactions
Functional group interconversions
Radical reactions
Rearrangement reactions
Aromatic and non-aromatic heterocycle syntheses

Requirements
To have mastered the first year CHO module

Evaluation mechanism
Written exam with course questions and problems

Teaching coordinator : Amandine GuÃ©rinot, Christophe Meyer, VÃ©ronique Bellosta, Domingo Gomez-pardo

Term : biotechnologies option
Number of hours : 24
ECTS Credits : 4
Last Modification : Saturday 08 December 2018

CP Polymer chemistry

Lectures: 12 h - Tutorials: 4 h
ObjectivesThis course aims at providing the concepts and tools used in macromolecular engineering to design and prepare polymers at will.
To this aim, the general characteristics of the two main polymerization families are presented, i.e. chain growth and step growth polymerizations, and the most significant examples of each family are discussed in great details, namely radical polymerization and polycondensation, respectively.
The concepts presented during lectures and tutorials (synthetic methodology, structure/reactivity relationship, reaction mechanisms, kinetics, polymerization processes) should allow for the rational design and synthesis of polymers while taking into accounts structural parameters such as molar masses, dispersity, composition, topology and functionality.

Syllabus
Introduction
Thermoplastics / Thermosets
Chain-growth polymerization / Step-growth polymerization
Few properties of polymers
Macromolecular engineering
Radical polymerization
Structure/reactivity relationship
Elementary steps
Initiation
Propagation
Termination
Transfer and telomerization
Degree of polymerization
Copolymerization
Controlled radical polymerization
Concepts and characteristics
Nitroxide-mediated radical polymerization (NMP)
Atom transfer radical polymerization (ATRP)
Reversible addition-fragmentation chain-transfer polymerization (RAFT)
Radical polymerization processes
Bulk polymerization
Solution polymerization
Suspension polymerization
Emulsion polymerization
Step-growth polymerization
Degree of polymerization
Molar masses and molecular weight distribution
Gel point and networks
Kinetics of step-growth polymerizations

Main families of polymers obtained by polycondensation and polyaddition
Macromolecular engineering
Molar masses and molecular weight distribution
Composition: copolymers
Topology: grafted polymers
Topology: branched polymers
Topology: dendrimers
Functionality: chemical modification
Tutorials
Radical and controlled radical polymerizations
Polycondensation and polyaddition

Requirements
Basic concepts in organic chemistry.

Evaluation mechanism
Written examination.

Teaching coordinator : Renaud NicolaÃ¿
Term : core curriculum
Number of hours : 16
ECTS Credits : 2
Last Modification : Monday 05 June 2017

CIA Advanced inorganic chemistry

Lectures: 12 h
ObjectivesMore than 80% of manufacturing processes include at least one catalysed reaction. Catalysis generally makes it possible to reduce costs (energy, separation, reprocessing, etc.) and limit the use of toxic and hazardous materials. The economic and environmental stakes are thus obvious.
In order to thoroughly understand the phenomena involved, the course presents the different types of catalysis through the study of major industrial processes and basic living cycles.
The problems related to the performance and optimisation of a catalytic system, its cost and environmental impact are highlighted and explained via a mechanistic kinetic approach.
The course is based on the knowledge acquired in the second year in Chemistry and Inorganic materials.

Syllabus
Industrial catalysis
Catalysis: fundamental concepts
Catalysis and major industrial processes
Heterogeneous catalysis mechanisms and kinetics
Heterogeneous catalytic system performances
Biocatalysis
Elements of the biosphere
Acidic catalysis, zinc enzyme
Redox catalysis
Industrial processes using biocatalysts

Requirements
Basics of Inorganic and organometallic chemistries, basics of homogeneous catalysis.

Evaluation mechanism
Two homeworks (biocatalysis + homogeneous and heterogenous catalyses) based upon a scientific paper.

Teaching coordinator : Corinne SouliÃ©, Sophie Norvez
Term : chemistry option
Number of hours : 12
ECTS Credits : 1,5
Last Modification : Friday 22 February 2019

SMMC Synthetic methods in molecular chemistry

Lectures: 16 h - Tutorials: 4 h
ObjectivesThe goal of this course is to illustrate how the understanding of the reactivity of organic compounds at the molecular level is essential for the design and elaboration of simple to more complex molecular architectures, which can find applications in various domains (biology, material science...). The course will focus on important chemoselective synthetic tools in organic chemistry, fundamental operations including oxidation and reduction reactions, functional group interconversions, as well as strategies for the formation of carbon-carbon or carbon-heteroatom bonds. The key contribution of heteroelements main group organometallic chemistry and transition metal-catalysis to the field of organic synthesis will be outlined. Selected applications in polymer chemistry, drug discovery, medicinal chemistry and chemical biology will be presented.

Syllabus
Introduction
Oxidation
Alcohols oxidation
Epoxidation
Dihydroxylation, oxidative cleavage
Beckmann rearrangement
Baeyer-Villiger rearrangement
Functional groups interconversion
Conversion of alcohols into sulfonate esters and halides
Nucleophilic substitutions
Mitsunobu reaction
Acid derivatives interconversion (esterification, amidation)
Reductions
Reductive agents
Acid derivatives and nitriles reduction
Aldehydes and ketones reduction
Reduction of alpha,beta unsaturated aldehydes and ketones
Stereoselective reduction (Felkin-Anh, Cram-chelate models)
Reductive amination
Halides reduction
Radical deoxygenation and decarboxylation
Alkenes and alkynes reduction

Main group organometallic chemistry
Synthesis and reactivity of Grignard reagents and organolithium reagents
Synthesis and reactivity of organozinc reagents
Synthesis and reactivity of organocuprates
Palladium-catalyzed cross-coupling reactions
Catalytic cycle and elementary steps
Suzuki-Miyaura cross-coupling
Sonogashira cross-coupling
Hartwig-Buchwald cross-coupling

Requirements
A knowledge of the fundamentals of organic chemistry is required. The student should be aware of the basic reactivity profiles of the most important functional groups in organic synthesis (alkenes, alkynes, carbonyl compounds, carboxylic acid derivatives) and be able to write reasonable mechanisms.

Evaluation mechanism
Written exam with course questions and problems

Teaching coordinator : Renaud NicolaÃ¿, Amandine GuÃ©rinot, Christophe Meyer, VÃ©ronique Bellosta
Term : chemistry option
Number of hours : 14
ECTS Credits : 1,5
Last Modification : Saturday 08 December 2018

BTM Molecular biotechnology

Lectures: 12 h - Tutorials: 5 h
ObjectivesUnderstanding of state-of-the art methods in biotechnology and their application for fundamental and applied research.

SyllabusThe lectures will cover state-of-the-art recombinant DNA techniques, including:
amplification
cloning
synthesis
sequencing (including next-generation sequencing)
mutagenesis (directed and random)
recombination
targeted genome editing (e.g. using CRISPR/Cas9)
overexpression of recombinant proteins
screening and selection
directed evolution
These techniques will be exemplified by presenting a number of important applications of molecular biotechnology:
protein engineering for fundamental studies and industrial applications of enzymes
protein engineering for therapeutic applications (e.g. therapeutic antibodies)
engineering of diagnostic systems
engineering of vaccines
TutorialsAssistance with group projects to prepare a short educational course (Powerpoint) to be presented

to the rest of the class (15 min presentation + 5 min for questions).

Requirements
Basic knowledge of biochemistry/molecular biology.

Evaluation mechanism
Two hour written exam (70% of marks) + group project (30% of marks).

Teaching coordinator : Andrew Griffiths
Term : biotechnologies option
Number of hours : 17
ECTS Credits : 2
Last Modification : Monday 12 June 2017

MIF Microfluidics

Lectures: 12 h - Preceptorship: 6 h
ObjectivesThe aim is to introduce students to the multidisciplinary realm of microfluidics. The course includes a general introduction to microsystems, MEMS, the "lab on a chip", DNA chips, etc. We will explain how the equilibria of "ordinary" systems are upset by miniaturisation. We will then concentrate on flow in microsystems, and the phenomena of adsorption, dispersion and separation in microfluidic systems. There will follow a description of electrokinetic phenomena, often exploited in microsystems for fluid transport or molecular separation. Finally, at an elementary level, we will present the current microfabrication techniques based on silicon or other materials which enable microsystems to be built.

Syllabus
General introduction to microsystems
The physics of miniaturisation
Flow in microsystems
Adsorption and mixing phenomena; applications to separation in microsystems
Electrokinetic phenomena: electro-osmosis, electrophoresis, dielectrophoresis
Introduction to microfabrication techniques
Preceptorship
Analysis of an article and demonstration of the corresponding experiment, for example:
Analysis of a chemical reaction in a microchannel
Breakup of droplets in a microchannel
Structure of microdroplets in a microchannel

Requirements
Basics of physics, hydrodynamics, biology, physico-chemistry.

Evaluation mechanism
Written exam based on an article study given before to the students.

Teaching coordinator : Patrick Tabeling
Term : core curriculum
Number of hours : 18
ECTS Credits : 2

Last Modification : Wednesday 31 May 2017

COB Colloidal Matter and Biomolecules

Lectures: 11 h
ObjectivesThis course deals with the dynamics and the microscopic behaviour of colloids and more particularly bioactive colloids, such as proteins, enzymes and antibodies. The three first parts are theoretical and provide methods to rationalize and model interacting systems with specificity and catalysis. The last part describes how the evolution of the colloidal science has been exploited to design new health diagnostic devices from the 20th century to the last discoveries and strategies currently developed by start-ups.

SyllabusKey question that are adressed in this course are:
How do colloids diffuse in their environment via Brownian motion?
How do biomolecules and colloids react and associateÂ in a complex medium? How can we model the interactions between a ligand and a receptor on cell membranes?
What are the dynamics of dissociation of bio-complexesÂ and how can we study the properties of these associations?
How to apply colloidal science to medical diagnostic

Requirements
Diffusion, chemical kinetics.

Evaluation mechanism
Written examination.

Teaching coordinator : JÃ©rÃ´me Bibette
Term : physical chemistry option
Number of hours : 11
ECTS Credits : 1,5
Last Modification : Monday 10 July 2017

MA Advanced materials

Lectures: 24h - Visit of a Saint-Gobain plant: one day
ObjectivesThe objective of this conference series in English is to give an opportunity to the students to learn about research activities in academics or industry in the field of materials sciences.

SyllabusThis series of lectures is common with Ecole Polytechnique students within the activities of the Saint-Gobain/Ecole Polytechnique/ESPCI Chair. It consists in a series of 8 lectures (3 hours) given by professors in various fields of materials sciences. In addition a visit of a Saint-Gobain plant is scheduled for a one day trip.

The program changes every year, below is the 2017 program:E. WimmerÂ (Materials design): ab initio numerical simulations to predict materials properties
U. Steiner (EPFL): photonic materials obtained by self assembly

P. Van Mechelen (ABB corp): Hydrogen transport in materials
J.-M. TarasconÂ (CollÃ¨ge de France): 20 years of development of materials for batteries
P. Ohashi (NIMS, Japan): Challenges in materials sciences for energy and sustainable development
K. Scrivener (EPFL): Cementitious materials, green chemistry in action
A. Saint-Jalmes (Institut Physique de Rennes): physics and chemistry challenges involved in the stabilization of aqueous foams
S. Granick (Korean center for basic research): For those who are bored with thermodynamics: physics of active colloids
Visit of Sully Saint-Gobain plant: production of glass for aeronautics industry

Evaluation mechanism
Summary of the conferences and personal literature review on a topic related to one of the conferences.

Term : physical chemistry option
Number of hours : 30
ECTS Credits : 4
Last Modification : Thursday 23 February 2017

IM Medical imaging: from measurements to images

Lectures: 18 h
ObjectivesTo understand image formation from measured signals.

SyllabusThe first part of the course deals with routine imaging techniques (MRI, ultrasound, CT). The second part introduces more recent techniques, some of which still being the topic of very active research fields (elastography, photoacoustic imaging, optical nanoscopy).

Requirements
Fourier Transform. Bases on acoustic and electromagnetic wave propagation.

Evaluation mechanism
Personal homework, either based on documents to read or problems to illustrate with matlab code. Choice left to each students (amonst 3 articles or 3 problems to code).

Teaching coordinator : Emmanuel Bossy
Term : physics option
Number of hours : 18
ECTS Credits : 3
Last Modification : Tuesday 30 May 2017

MSc in Engineering

ESPCI 3Ã¨me annÃ©e Option Physique

Program Language: French

Content:

- Trois cours obligatoires : Physique du solide, physique de la mesure, apprentissage statistique.

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- Deux cours de spÃ©cialitÃ© Ã choisir parmi :

Biophysique
Ondes en milieux complexes
Introduction Ã la CFD

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- Cours d'option Ã choisir (pour un total compris entre 3 et 4,5 ECTS) parmi :

Microfluidique (3 ECTS)
Introduction au GÃ©nie NuclÃ©aire, (3 ECST)
TÃ©lÃ©coms AvancÃ©s (1.5 ECTS)
Physique des composants microÃ©lectronique (1.5 ECTS)
Environnement et dÃ©veloppement Durables, (1.5 ECTS)
Etats ColloÃ¯daux et Bio-colloÃ¯des, (1.5 ECTS)
Biotransformation et gÃ©nie des procÃ©dÃ©s (1.5 ECTS)
ou
GÃ©nie Chimique (option 2 mutualisÃ©e avec lâ€™ENSCP) (2 ECTS)

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- un Â« enseignement dâ€™ouverture Â» au choix parmi les modules suivants qui sont ouverts Ã toutes les dominantes : (5 ECTS)

Chimie Fine et Biologie
SystÃ¨mes Ã©nergÃ©tiques
Informatique
MatÃ©riaux sur mesures (option mutualisÃ©e avec lâ€™X)
MÃ©thodes et Instrumentation pour imagerie mÃ©dicale
RelativitÃ© et ElectromagnÃ©tisme

Program Contents :

- Solid State Physics
- Physics of measurement
- Waves in complex media
- Microfluidics
- Colloidal Matter and Biomolecules
- External courses: ENSCP_OPT_GC2 (Link to ParisTech)
- Advanced materials
- Medical imaging: from measurements to images

Last Modification: Tue 30 June 2009

PS3 Solid State Physics

Lectures: 18 h

ObjectivesWhen we seek to describe the electrical, magnetic, optical or thermal behaviour of solids, taking into account the large number of atoms per unit volume, it is not possible to carry out a precise analysis based on the behaviour of each atom.
Solid state physics makes it possible to construct models which, when experimentally verified, may be considered as representative.
The formalism constructed to this end has numerous applications. Examples in diverse fields and which sometimes appear to be far removed from solid state physics will be given.

Syllabus
Diffraction
Elastic vibrations in solids
Dispersion relations
Phonons
Specidic heat
The Debye model
Phonon phonon interaction
Electronic properties of solids
Free electron models, nearly free electron models, and strongly bound electron models
Band models
Electrical properties of solids
Different types of solid
Non-equilibrium phenomena
Transport equation
Application examples
Superconductivity
Magnetism
Tutorials
Periodic systems
Vibrations and phonons
Specific heat, paramagnetic susceptibility, the nearly-free electron
Electronic structure of graphene
Semiconductors and the P-N junction - applications
The field effect transistor and the 2-D electron gas
The quantum Hall effect

Requirements
M1 level in physics

Evaluation mechanism
written exam (2-3 hours)

Teaching coordinator : Dimitri Roditchev
Term : physics option
Number of hours : 18
ECTS Credits : 2
Last Modification : Wednesday 05 July 2017

PM Physics of measurement

Lectures: 13 h - Laboratory sessions: 11 h
ObjectivesThe goals of this lectures are as follows :
Provide technical bases of signal filtering
Evidence the many uses of Fourier Transform for linear systems
Introduce to non-linear problems and some of their characteristics.

Syllabus
Non-linear systems and introduction to chaos
Classical concepts on signal processing
Laws of probability and applications to noisy signals
Central limit theorem
Its direct application to an experimental signal does not work!
Correlation time of an experimental signal
Averaging and lock-in detection
1D Fourier transform
Signal decomposition on an orthogonal basis, example
orthogonal polynomials
Harmonics, Dirac signal, importance of phase
Fourier, an ideal basis for linear equations
Discrete transform and periodic signals. Principle of 2N FFT algorithm
Artefacts in FFT
Filtering, correlation, convolution, applications
Digitising and Shannon's theorem
Filtering before digital conversion, aliasing
Case of a camera, consequence of the lack of filtering in the time domain
2D Fourier transform
Convolution and deconvolution, sharpening a blurred photograph
Reconstructing an image in Fourier space
X-rays - Principle of tomography
New microscopy techniques with a greater optical resolution than that given by the Rayleigh criterion
Physics of noise
Different types of noise and their physical origins
Shot noise and measurement of the elementary charge
Noise of a resistor, analogy with Brownian motion. Fluctuation-dissipation theorem
Spectral characteristics of physical noise. Spectral density of noise. 1/f noise
Noise variation with temperature
Adaptation of an amplifier in a measurement system
Laboratory sessions
Three half-day sessions are devoted to:
Image and signal processing : rotation of images either simulated or recorded in tiff and jpeg formats.
Filtering applied to signals, simulated images (fractals from Julia and Mandelbrot) and real images.
Particle Image Velocimetry algorithm (PIV): this method enables to measure the velocity field of small particles advected by a fluid flow using video recording.
Tomography reconstruction: reconstructing a 2D image using a set of 1D projections performed at different angles around the same axis.

Evaluation mechanism
a 2h written examination, and a report + matlab program illustrating one of the themes of the laboratory sessions.

Teaching coordinator : Vincent Croquette, Isabelle Rivals
Term : physics option
Number of hours : 24
ECTS Credits : 3,5
Last Modification : Wednesday 08 March 2017

OMC Waves in complex media

Lectures: 12 h
ObjectivesUnderstand the phenomena of wave scattering in disordered media (eg soft matter, biological tissues). Introduce the imaging techniques based on measurements of average diffuse intensity (transport) or speckle (interferences). The main thread of the course is optical imaging, but emphasis is placed on the generality of concepts and methods and many references are made to acoustics and electronic transport.

Syllabus
Scattering of light by particles
Multiple scattering and transport in a scattering medium
Speckle
Dynamic light scattering
Links to other course modulesThe lecture is transversal by nature. Although the course is organized around optical propagation and imaging in scattering media (Optics course), the connection is established with acoustic propagation (Waves and acoustics course) and electronic transport (Solid state physics course). The statistical approach used to model transport and speckle links to the Statistical mechanics course. The lecture naturally opens up applications for the characterization of soft matter (dynamic light scattering) and biomedical imaging.

Requirements
Wave propagation and light-matter interaction (electromagnetic waves, optics and wave and acoustics courses).

Evaluation mechanism
Homework.

Teaching coordinator : Emmanuel Bossy
Term : physics option
Number of hours : 12
ECTS Credits : 1,5
Last Modification : Tuesday 05 September 2017

MIF Microfluidics

Lectures: 12 h - Preceptorship: 6 h
ObjectivesThe aim is to introduce students to the multidisciplinary realm of microfluidics. The course includes a general introduction to microsystems, MEMS, the "lab on a chip", DNA chips, etc. We will explain how the equilibria of "ordinary" systems are upset by miniaturisation. We will then concentrate on flow in

microsystems, and the phenomena of adsorption, dispersion and separation in microfluidic systems. There will follow a description of electrokinetic phenomena, often exploited in microsystems for fluid transport or molecular separation. Finally, at an elementary level, we will present the current microfabrication techniques based on silicon or other materials which enable microsystems to be built.

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Structure of microdroplets in a microchannel

Requirements
Basics of physics, hydrodynamics, biology, physico-chemistry.

Evaluation mechanism
Written exam based on an article study given before to the students.

Teaching coordinator : Patrick Tabeling
Term : core curriculum
Number of hours : 18
ECTS Credits : 2
Last Modification : Wednesday 31 May 2017

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Requirements
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Evaluation mechanism
Written examination.

Teaching coordinator : JÃ©rÃ´me Bibette
Term : physical chemistry option
Number of hours : 11
ECTS Credits : 1,5
Last Modification : Monday 10 July 2017

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Evaluation mechanism
Summary of the conferences and personal literature review on a topic related to one of the conferences.

Term : physical chemistry option
Number of hours : 30
ECTS Credits : 4
Last Modification : Thursday 23 February 2017

IM Medical imaging: from measurements to images

Lectures: 18 h
ObjectivesTo understand image formation from measured signals.

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Requirements
Fourier Transform. Bases on acoustic and electromagnetic wave propagation.

Evaluation mechanism
Personal homework, either based on documents to read or problems to illustrate with matlab code. Choice left to each students (amonst 3 articles or 3 problems to code).

Teaching coordinator : Emmanuel Bossy
Term : physics option
Number of hours : 18
ECTS Credits : 3
Last Modification : Tuesday 30 May 2017

MSc in Engineering

ESPCI 3Ã¨me annÃ©e Option Physico-Chimie

Program Language: French

Content:

- Trois cours obligatoires :
Physique du solide (4 ECTS)
Chimie Inorganique AvancÃ©e (2 ECTS)
Apprentissage statistique ou ChimiomÃ©trie (1 ECTS)

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- Des cours de spÃ©cialitÃ© Ã choisir parmi des cours de physique et de chimie pour un total de 11 Ã 13 ECTS (5 Ã 8 ECTS de physique/5 Ã 8 ECTS de chimie).

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Enseignements de chimie :
RhÃ©ologie (1 ECTS)
Chimie Inorganique AvancÃ©e (2 ECTS)
SynthÃ¨se des polymÃ¨res (3 ECTS)
Biochimie (1,5 ECTS)
RÃ©activitÃ© (1,5 ECTS)
SynthÃ¨se Organique (3 ECTS)

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Enseignements de physique :
Physique de la mesure (3 ECTS)
Ondes en milieux complexes (1,5 ECTS)

Biophysique (1,5 ECTS)

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- Des cours d'option Ã choisir (pour un total compris entre 3 et 4,5 ECTS) parmi :
Microfluidique (3 ECTS)
Introduction au GÃ©nie NuclÃ©aire, (3 ECST)
TÃ©lÃ©coms AvancÃ©s (1.5 ECTS)
Physique des composants microÃ©lectronique (1.5 ECTS)
Environnement et dÃ©veloppement Durables, (1.5 ECTS)
Etats ColloÃ¯daux et Bio-colloÃ¯des, (1.5 ECTS)
Biotransformation et gÃ©nie des procÃ©dÃ©s (1.5 ECTS)
ou
GÃ©nie Chimique (option 2 mutualisÃ©e avec lâ€™ENSCP) (2 ECTS)

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- un Â« enseignement dâ€™ouverture Â» au choix parmi les modules suivants qui sont ouverts Ã toutes les dominantes : (5 ECTS)
Chimie Fine et Biologie
SystÃ¨mes Ã©nergÃ©tiques
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MatÃ©riaux sur mesures (option mutualisÃ©e avec lâ€™X)
MÃ©thodes et Instrumentation pour imagerie mÃ©dicale
RelativitÃ© et ElectromagnÃ©tisme

Program Contents :

- Solid State Physics
- Advanced inorganic chemistry
- Chemometrics
- Advanced inorganic chemistry
- Polymer chemistry
- Molecular biotechnology
- Advanced selective organic synthesis
- Physics of measurement
- Waves in complex media
- Microfluidics
- Colloidal Matter and Biomolecules
- External courses: ENSCP_OPT_GC2 (Link to ParisTech)
- Advanced materials
- Medical imaging: from measurements to images

Last Modification: Tue 30 June 2009

PS3 Solid State Physics

Lectures: 18 h

ObjectivesWhen we seek to describe the electrical, magnetic, optical or thermal behaviour of solids, taking into account the large number of atoms per unit volume, it is not possible to carry out a precise analysis based on the behaviour of each atom.
Solid state physics makes it possible to construct models which, when experimentally verified, may be considered as representative.
The formalism constructed to this end has numerous applications. Examples in diverse fields and which sometimes appear to be far removed from solid state physics will be given.

Syllabus
Diffraction
Elastic vibrations in solids
Dispersion relations
Phonons
Specidic heat
The Debye model
Phonon phonon interaction
Electronic properties of solids
Free electron models, nearly free electron models, and strongly bound electron models
Band models
Electrical properties of solids
Different types of solid
Non-equilibrium phenomena
Transport equation
Application examples
Superconductivity
Magnetism
Tutorials
Periodic systems
Vibrations and phonons
Specific heat, paramagnetic susceptibility, the nearly-free electron
Electronic structure of graphene
Semiconductors and the P-N junction - applications
The field effect transistor and the 2-D electron gas
The quantum Hall effect

Requirements
M1 level in physics

Evaluation mechanism
written exam (2-3 hours)

Teaching coordinator : Dimitri Roditchev
Term : physics option
Number of hours : 18
ECTS Credits : 2
Last Modification : Wednesday 05 July 2017

CIA Advanced inorganic chemistry

Lectures: 12 h
ObjectivesMore than 80% of manufacturing processes include at least one catalysed reaction. Catalysis generally makes it possible to reduce costs (energy, separation, reprocessing, etc.) and limit the use of toxic and hazardous materials. The economic and environmental stakes are thus obvious.
In order to thoroughly understand the phenomena involved, the course presents the different types of catalysis through the study of major industrial processes and basic living cycles.
The problems related to the performance and optimisation of a catalytic system, its cost and environmental impact are highlighted and explained via a mechanistic kinetic approach.
The course is based on the knowledge acquired in the second year in Chemistry and Inorganic materials.

Syllabus
Industrial catalysis
Catalysis: fundamental concepts
Catalysis and major industrial processes
Heterogeneous catalysis mechanisms and kinetics
Heterogeneous catalytic system performances
Biocatalysis
Elements of the biosphere
Acidic catalysis, zinc enzyme
Redox catalysis
Industrial processes using biocatalysts

Requirements
Basics of Inorganic and organometallic chemistries, basics of homogeneous catalysis.

Evaluation mechanism
Two homeworks (biocatalysis + homogeneous and heterogenous catalyses) based upon a scientific paper.

Teaching coordinator : Corinne SouliÃ©, Sophie Norvez
Term : chemistry option
Number of hours : 12
ECTS Credits : 1,5
Last Modification : Friday 22 February 2019

CMT Chemometrics

Lectures: 12 h
ObjectivesThis course aims at the acquisition of the chemometric tools required for the rational design of experiments and allowing an optimal processing of the results. A special care is brought to the links between statistical conclusions, their physico-chemical interpretation and resulting practical conclusions.

Syllabus
Oneway ANOVA (Analysis of Variance)
Principle and purpose
Statistical tests
ANOVA table and interpretation
Case studies

Linear regression
Principle and purpose
Regression statistics
Confidence and prediction hyperbols
Model matching
Case studies
Designs of experiments
Principle and purpose
2n factorial designs
Significance of effects
2n-p fractional factorial and screening designs
Response surface designs

Requirements
Applied Statistics course.

Evaluation mechanism
Two hours and written examination (including the evaluation of Applied statistics).

Teaching coordinator : JÃ©rome Vial
Term : chemistry option
Number of hours : 12
ECTS Credits : 1,5
Last Modification : Wednesday 31 May 2017

CIA Advanced inorganic chemistry

Lectures: 12 h
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Biocatalysis
Elements of the biosphere
Acidic catalysis, zinc enzyme
Redox catalysis
Industrial processes using biocatalysts

Requirements
Basics of Inorganic and organometallic chemistries, basics of homogeneous catalysis.

Evaluation mechanism
Two homeworks (biocatalysis + homogeneous and heterogenous catalyses) based upon a scientific paper.

Teaching coordinator : Corinne SouliÃ©, Sophie Norvez
Term : chemistry option
Number of hours : 12
ECTS Credits : 1,5
Last Modification : Friday 22 February 2019

CP Polymer chemistry

Lectures: 12 h - Tutorials: 4 h
ObjectivesThis course aims at providing the concepts and tools used in macromolecular engineering to design and prepare polymers at will.
To this aim, the general characteristics of the two main polymerization families are presented, i.e. chain growth and step growth polymerizations, and the most significant examples of each family are discussed in great details, namely radical polymerization and polycondensation, respectively.
The concepts presented during lectures and tutorials (synthetic methodology, structure/reactivity relationship, reaction mechanisms, kinetics, polymerization processes) should allow for the rational design and synthesis of polymers while taking into accounts structural parameters such as molar masses, dispersity, composition, topology and functionality.

Syllabus
Introduction
Thermoplastics / Thermosets
Chain-growth polymerization / Step-growth polymerization
Few properties of polymers
Macromolecular engineering
Radical polymerization
Structure/reactivity relationship
Elementary steps
Initiation
Propagation
Termination
Transfer and telomerization
Degree of polymerization
Copolymerization
Controlled radical polymerization
Concepts and characteristics
Nitroxide-mediated radical polymerization (NMP)
Atom transfer radical polymerization (ATRP)
Reversible addition-fragmentation chain-transfer polymerization (RAFT)
Radical polymerization processes
Bulk polymerization

Solution polymerization
Suspension polymerization
Emulsion polymerization
Step-growth polymerization
Degree of polymerization
Molar masses and molecular weight distribution
Gel point and networks
Kinetics of step-growth polymerizations
Main families of polymers obtained by polycondensation and polyaddition
Macromolecular engineering
Molar masses and molecular weight distribution
Composition: copolymers
Topology: grafted polymers
Topology: branched polymers
Topology: dendrimers
Functionality: chemical modification
Tutorials
Radical and controlled radical polymerizations
Polycondensation and polyaddition

Requirements
Basic concepts in organic chemistry.

Evaluation mechanism
Written examination.

Teaching coordinator : Renaud NicolaÃ¿
Term : core curriculum
Number of hours : 16
ECTS Credits : 2
Last Modification : Monday 05 June 2017

BTM Molecular biotechnology

Lectures: 12 h - Tutorials: 5 h
ObjectivesUnderstanding of state-of-the art methods in biotechnology and their application for fundamental and applied research.

SyllabusThe lectures will cover state-of-the-art recombinant DNA techniques, including:
amplification
cloning
synthesis
sequencing (including next-generation sequencing)
mutagenesis (directed and random)
recombination
targeted genome editing (e.g. using CRISPR/Cas9)
overexpression of recombinant proteins
screening and selection

directed evolution
These techniques will be exemplified by presenting a number of important applications of molecular biotechnology:
protein engineering for fundamental studies and industrial applications of enzymes
protein engineering for therapeutic applications (e.g. therapeutic antibodies)
engineering of diagnostic systems
engineering of vaccines
TutorialsAssistance with group projects to prepare a short educational course (Powerpoint) to be presented to the rest of the class (15 min presentation + 5 min for questions).

Requirements
Basic knowledge of biochemistry/molecular biology.

Evaluation mechanism
Two hour written exam (70% of marks) + group project (30% of marks).

Teaching coordinator : Andrew Griffiths
Term : biotechnologies option
Number of hours : 17
ECTS Credits : 2
Last Modification : Monday 12 June 2017

ASOS Advanced selective organic synthesis

Lectures : 20 h - Tutorials: 4 h
ObjectivesFine organic chemistry is everywhere, in medicinal products, perfumes, cosmetics, materials, etc. Knowing the bases of organic synthesis is essential for a chemist.This course is intended for chemists and aims to introduce them to the new reactions used in organic synthesis, for example. This work is applied in the study of major syntheses of biologically active products. These studies additionally constitute a first relative approach to Organic Chemistry synthesis strategies.

Syllabus
Chemoselective alkylation reactions
Organocatalytic reactions
Organometallic coupling reactions
Metathesis and applications
Organometallic coupling reactions with palladium, iron and copper
Catalytic oxydation and reduction reactions
Functional group interconversions
Radical reactions
Rearrangement reactions
Aromatic and non-aromatic heterocycle syntheses

Requirements
To have mastered the first year CHO module

Evaluation mechanism
Written exam with course questions and problems

Teaching coordinator : Amandine GuÃ©rinot, Christophe Meyer, VÃ©ronique Bellosta, Domingo Gomez-pardo
Term : biotechnologies option
Number of hours : 24
ECTS Credits : 4
Last Modification : Saturday 08 December 2018

PM Physics of measurement

Lectures: 13 h - Laboratory sessions: 11 h
ObjectivesThe goals of this lectures are as follows :
Provide technical bases of signal filtering
Evidence the many uses of Fourier Transform for linear systems
Introduce to non-linear problems and some of their characteristics.

Syllabus
Non-linear systems and introduction to chaos
Classical concepts on signal processing
Laws of probability and applications to noisy signals
Central limit theorem
Its direct application to an experimental signal does not work!
Correlation time of an experimental signal
Averaging and lock-in detection
1D Fourier transform
Signal decomposition on an orthogonal basis, example
orthogonal polynomials
Harmonics, Dirac signal, importance of phase
Fourier, an ideal basis for linear equations
Discrete transform and periodic signals. Principle of 2N FFT algorithm
Artefacts in FFT
Filtering, correlation, convolution, applications
Digitising and Shannon's theorem
Filtering before digital conversion, aliasing
Case of a camera, consequence of the lack of filtering in the time domain
2D Fourier transform
Convolution and deconvolution, sharpening a blurred photograph
Reconstructing an image in Fourier space
X-rays - Principle of tomography
New microscopy techniques with a greater optical resolution than that given by the Rayleigh criterion
Physics of noise
Different types of noise and their physical origins
Shot noise and measurement of the elementary charge
Noise of a resistor, analogy with Brownian motion. Fluctuation-dissipation theorem
Spectral characteristics of physical noise. Spectral density of noise. 1/f noise
Noise variation with temperature
Adaptation of an amplifier in a measurement system
Laboratory sessions

Three half-day sessions are devoted to:
Image and signal processing : rotation of images either simulated or recorded in tiff and jpeg formats. Filtering applied to signals, simulated images (fractals from Julia and Mandelbrot) and real images.
Particle Image Velocimetry algorithm (PIV): this method enables to measure the velocity field of small particles advected by a fluid flow using video recording.
Tomography reconstruction: reconstructing a 2D image using a set of 1D projections performed at different angles around the same axis.

Evaluation mechanism
a 2h written examination, and a report + matlab program illustrating one of the themes of the laboratory sessions.

Teaching coordinator : Vincent Croquette, Isabelle Rivals
Term : physics option
Number of hours : 24
ECTS Credits : 3,5
Last Modification : Wednesday 08 March 2017

OMC Waves in complex media

Lectures: 12 h
ObjectivesUnderstand the phenomena of wave scattering in disordered media (eg soft matter, biological tissues). Introduce the imaging techniques based on measurements of average diffuse intensity (transport) or speckle (interferences). The main thread of the course is optical imaging, but emphasis is placed on the generality of concepts and methods and many references are made to acoustics and electronic transport.

Syllabus
Scattering of light by particles
Multiple scattering and transport in a scattering medium
Speckle
Dynamic light scattering
Links to other course modulesThe lecture is transversal by nature. Although the course is organized around optical propagation and imaging in scattering media (Optics course), the connection is established with acoustic propagation (Waves and acoustics course) and electronic transport (Solid state physics course). The statistical approach used to model transport and speckle links to the Statistical mechanics course. The lecture naturally opens up applications for the characterization of soft matter (dynamic light scattering) and biomedical imaging.

Requirements
Wave propagation and light-matter interaction (electromagnetic waves, optics and wave and acoustics courses).

Evaluation mechanism
Homework.

Teaching coordinator : Emmanuel Bossy
Term : physics option
Number of hours : 12

ECTS Credits : 1,5
Last Modification : Tuesday 05 September 2017

MIF Microfluidics

Lectures: 12 h - Preceptorship: 6 h
ObjectivesThe aim is to introduce students to the multidisciplinary realm of microfluidics. The course includes a general introduction to microsystems, MEMS, the "lab on a chip", DNA chips, etc. We will explain how the equilibria of "ordinary" systems are upset by miniaturisation. We will then concentrate on flow in microsystems, and the phenomena of adsorption, dispersion and separation in microfluidic systems. There will follow a description of electrokinetic phenomena, often exploited in microsystems for fluid transport or molecular separation. Finally, at an elementary level, we will present the current microfabrication techniques based on silicon or other materials which enable microsystems to be built.

Syllabus
General introduction to microsystems
The physics of miniaturisation
Flow in microsystems
Adsorption and mixing phenomena; applications to separation in microsystems
Electrokinetic phenomena: electro-osmosis, electrophoresis, dielectrophoresis
Introduction to microfabrication techniques
Preceptorship
Analysis of an article and demonstration of the corresponding experiment, for example:
Analysis of a chemical reaction in a microchannel
Breakup of droplets in a microchannel
Structure of microdroplets in a microchannel

Requirements
Basics of physics, hydrodynamics, biology, physico-chemistry.

Evaluation mechanism
Written exam based on an article study given before to the students.

Teaching coordinator : Patrick Tabeling
Term : core curriculum
Number of hours : 18
ECTS Credits : 2
Last Modification : Wednesday 31 May 2017

COB Colloidal Matter and Biomolecules

Lectures: 11 h
ObjectivesThis course deals with the dynamics and the microscopic behaviour of colloids and more particularly bioactive colloids, such as proteins, enzymes and antibodies. The three first parts are theoretical and provide methods to rationalize and model interacting systems with specificity and catalysis. The last part describes how the evolution of the colloidal science has been exploited to design new health

diagnostic devices from the 20th century to the last discoveries and strategies currently developed by start-ups.

SyllabusKey question that are adressed in this course are:
How do colloids diffuse in their environment via Brownian motion?
How do biomolecules and colloids react and associateÂ in a complex medium? How can we model the interactions between a ligand and a receptor on cell membranes?
What are the dynamics of dissociation of bio-complexesÂ and how can we study the properties of these associations?
How to apply colloidal science to medical diagnostic

Requirements
Diffusion, chemical kinetics.

Evaluation mechanism
Written examination.

Teaching coordinator : JÃ©rÃ´me Bibette
Term : physical chemistry option
Number of hours : 11
ECTS Credits : 1,5
Last Modification : Monday 10 July 2017

MA Advanced materials

Lectures: 24h - Visit of a Saint-Gobain plant: one day
ObjectivesThe objective of this conference series in English is to give an opportunity to the students to learn about research activities in academics or industry in the field of materials sciences.

SyllabusThis series of lectures is common with Ecole Polytechnique students within the activities of the Saint-Gobain/Ecole Polytechnique/ESPCI Chair. It consists in a series of 8 lectures (3 hours) given by professors in various fields of materials sciences. In addition a visit of a Saint-Gobain plant is scheduled for a one day trip.

The program changes every year, below is the 2017 program:E. WimmerÂ (Materials design): ab initio numerical simulations to predict materials properties
U. Steiner (EPFL): photonic materials obtained by self assembly
P. Van Mechelen (ABB corp): Hydrogen transport in materials
J.-M. TarasconÂ (CollÃ¨ge de France): 20 years of development of materials for batteries
P. Ohashi (NIMS, Japan): Challenges in materials sciences for energy and sustainable development
K. Scrivener (EPFL): Cementitious materials, green chemistry in action
A. Saint-Jalmes (Institut Physique de Rennes): physics and chemistry challenges involved in the stabilization of aqueous foams
S. Granick (Korean center for basic research): For those who are bored with thermodynamics: physics of active colloids
Visit of Sully Saint-Gobain plant: production of glass for aeronautics industry

Evaluation mechanism

Summary of the conferences and personal literature review on a topic related to one of the conferences.

Term : physical chemistry option
Number of hours : 30
ECTS Credits : 4
Last Modification : Thursday 23 February 2017

IM Medical imaging: from measurements to images

Lectures: 18 h
ObjectivesTo understand image formation from measured signals.

SyllabusThe first part of the course deals with routine imaging techniques (MRI, ultrasound, CT). The second part introduces more recent techniques, some of which still being the topic of very active research fields (elastography, photoacoustic imaging, optical nanoscopy).

Requirements
Fourier Transform. Bases on acoustic and electromagnetic wave propagation.

Evaluation mechanism
Personal homework, either based on documents to read or problems to illustrate with matlab code. Choice left to each students (amonst 3 articles or 3 problems to code).

Teaching coordinator : Emmanuel Bossy
Term : physics option
Number of hours : 18
ECTS Credits : 3
Last Modification : Tuesday 30 May 2017