ParisTech
INSTITUT DES SCIENCES ET TECHNOLOGIES
PARIS INSTITUTE OF TECHNOLOGY

MSc in Engineering

ESPCI 1Ã¨re annÃ©e

Program Language: French

- Biochemistry/Cell biology
- Quantum Physics
- Statistical mechanics: methods and applications
- Communication and social relations

BIO Biochemistry/Cell biology

Lectures: 24 h - Tutorials: 8 h - Preceptorship: 8 h - Laboratory sessions: 38 h
ObjectifsBasic concepts of biochemistry, molecular and cellular biology and current challenges in these disciplines. Introduction to the major classes of biomolecules (sugars, lipids, nucleic acids and proteins), biological catalysis, signal transduction, energy transformation, information storage and replication by genes, and how genes code for RNAs (transcription) which in turn code for proteins (translation). Introduction to the concept of mechanotransduction and its implication for tissue engineering.

Syllabus
Basic concepts of biochemistry, molecular and cellular biology and current challenges in these disciplines. Introduction to the major classes of biomolecules (sugars, lipids, nucleic acids and proteins), biological catalysis, signal transduction, energy transformation, information storage and replication by genes, and how genes code for RNAs (transcription) which in turn code for proteins (translation). Introduction to the concept of mechanotransduction and its implication for tissue engineering.
TutorialsBioinformatics: data banks, DNA and protein sequence analysis.
PreceptorshipArticle analysis: central dogma of molecular biology / membranes / cell and its environment / biotechnology.
Laboratory sessionsCloning and expression of green fluorescent protein (GFP).

Requirements
None.

Evaluation mechanism
Course: written exam (course questions + article analysis). TP report of experiments.

Teaching coordinator : Pascale Dupuis-Williams, Andrew Griffiths, Yann Verdier
Term : core curriculum
Number of hours : 78
ECTS Credits : 6
Last Modification : Wednesday 31 May 2017

PQ Quantum Physics

Lectures: 25 h - Tutorials: 7 h - Preceptorship: 8 h
ObjectifsThe goal of this course is to introduce the fundamental principles of quantum physics, which are needed to understand the theoretical and experimental basis of modern science and technology including

materials science, electronics, quantum chemistry, quantum engineering, nanotechnology and photonics. The course emphasizes conceptual understanding but also relies on the necessary amount of mathematical formalism, which is essential for understanding quantum mechanics. Numerous examples of practical use of quantum mechanics are given during the lectures and are studied in more details in preceptorship sessions. Tutorial classes allow the students to put into practice the concepts seen during the lectures.

Syllabus
Introduction to quantum physics
Waves mechanics
General formalism of quantum Mechanics
The postulates of quantum mechanics
Perturbation theories
Harmonic oscillator
Angular Momentum
Hydrogen atom
Addition of two angular momentums
Quantum statistics
Tutorials
Rectangular potential barrier, the infinite and finite quantum wells
The parity operator
Application of the measurement postulate
Harmonic oscillator with a stationary perturbation and with a time-dependent perturbation
Spin in a rotating frame, Nuclear Magnetic Resonance
Interaction between two spins
Addition of two spins
Preceptorship
Preceptorship sessions will deal with numerous areas of contemporary physics, both fundamental and applied, where quantum mechanics plays a major role.
Wave-particle duality. Application to matter probes and to atom-scale optics.
Colour centres in ionic crystals (F-centres).
WKB method. Application to the tunnel effect and the Gamow alpha emission model.
Formation of interstellar molecular hydrogen.
Neutron interferometry. Application to spin rotation and gravitational effect.
Factorisable quantum states, entangled quantum states. Application to quantum cryptography and to principles of qubit teleportation.
The NH3 MASER.
Zeeman effet and Stark effect on hydrogen atom.
Superconducting quantum bit.

Requirements
Classical physics: mechanics and electromagnetism. Mathematics: vector spaces, matrices, differential equations.

Evaluation mechanism
Written examination.

Teaching coordinator : Nicolas Bergeal, ChÃ©ryl Palma
Term : core curriculum
Number of hours : 40

ECTS Credits : 3
Last Modification : Wednesday 31 May 2017

PSA Statistical mechanics: methods and applications

Lectures: 30 h - Tutorials: 15 h - Laboratory sessions: 45 h
ObjectivesThis course is an introduction to the general ideas of statistical physics. Particular attention is paid to basic concepts (entropy, temperature) and to pertinent methods used in other disciplines. We will discuss classical examples (e.g perfect gas, paramagnetism, elasticity of polymers) along with the physics of phase transitions and collective phenomena and quantum statistics. We will attempt to maintain a (difficult) balance between an intuitive approach to phenomena and more rigorous calculation.

Syllabus
Introduction and basic thermodynamics
Probability and random walks
Statistical physics of isolated systems: microcanonical ensemble
Statistical physics at constant temperature: canonical ensemble
Statistical physics of classical systems with no interactions
Ideal quantum gases
Phase transitions, mean field approximations
Langevin equation and fluctuation-dissipation theorem
Laboratory sessions
Emulsion
4 main experiments are proposed to the students :
Solide-gaz phase diagram, sorting based on depletion mechanism
Metastable systems, drainage, coalescence, Oswald ripening
Absorption of a surfactant at a liquid-air interface
Measurement of the chemical activity of salted water
These four experimental cases are good examples of the importance of the interfaces in divided matter.

Simulation and analysis of the thermodynamical properties of hard spheres and hard disks
In this lab, we explore some of the consequences of the atomist hypothesis, by studying, for a hard spheres system, the equation of state of the gaz and its phase transitions, the Brownian motion of a macromolecule, and the depletion interaction between two macromolecules. We use numerical simulations whose results are analyzed with programs written in Python.

Phase transitions of simple liquid and polymers observed by differential scanning calorimetry (DSC)
Experimental approach of the glass transition of polymers
Liquid-crystal phase transition in confined geometry : fusion and crystallization of water

Requirements
A knowledge of Classical thermodynamics and of basic mathematics are required for this course

Evaluation mechanism
Lectures: written exam; lab sessions: mark for the involvement in the session + mark on a written report to be delivered 15 days after the end of the sessions.

Teaching coordinator : Annie Colin, Anthony Maggs, HÃ©lÃ¨ne Montes

Term : core curriculum
Number of hours : 90
ECTS Credits : 7,5
Last Modification : Wednesday 06 September 2017

CRS1 Communication and social relations

Workshops: 15 h
ObjectivesThe main objectives of this first module are:
Discover the main functions within a company
Discover the meaning of social relations within a company
Understand the managerial relationship
Establish students' career plans and provide a clearer idea of their responsibilities as future managers (entitlements and obligations)
How to work with Human Resources

Syllabus
Company position in the French economic market
Company organisation
HR position in the company and relationship with engineers
Recruitment process
Learn to write covering letters and resume
The sessions include case studies, simulations and active student participation.

Teaching coordinator : Brigitte Beaussart
Term : core curriculum
Number of hours : 15
ECTS Credits : 1
Last Modification : Friday 10 March 2017