Option Bio-engineering and nanotechnology

OPTION BIO-ENGINEERING AND NANOTECHNOLOGY

Specific courses for Bio-engineering and nanotechnology

CONFÉRENCES ET VISITES

CONFERENCES AND VISITS

Lecturers: **Emmanuelle LAURENCEAU, Virginie MONNIER-VILLAUME**

| Lecturers : 20 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The objective is to make students discover the numerous possibilities of jobs linked to the bio-engineering and nanotechnologies fields. The different thematics will be présented in the form of seminars and conferences by researchers and professionals in these fields. Visits of industrial sites (STMicroelectronic, Sanofi-Pasteur, Becton-Dickinson) and research centers (CEA-LETI, CEA-INES, Synchrotron ESRF) will be also organized.

Keywords : Bio-engineering, nanotechnologies, jobs, conferences, visits.

Programme

- Challenges of medical imaging techniques
- Damage to prostheses
- Big-data and genomics
- Large-scale data processing
- The AURA industrial fabric in bioengineering and nanotechnologies
- Clinical trials in silico

Learning outcomes

- Identify/analyze the needs and social-economics constraints linked to health and nanotechnologies.
- Take into account the international dimension of research in bio- and nanotechnologies.
- Adopt a global vision and apprehend the field into its complexity.
- Enlarge scientific and technical knowledge.

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Assessment

100% for participation.

PROJET OPTION BIO-INGÉNIERIE ET NANOTECHNOLOGIES

PROJECT OPTION BIO-ENGINEERING AND NANOTECHNOLOGY

Lecturers: Emmanuelle LAURENCEAU, Virginie MONNIER-VILLAUME

| Lecturers : 0.0 | TC : 0.0 | PW : 50 | Autonomy : 0.0 | Study : 0 | Project : 0.0 | Language : FR

Objectives

Through (transdiciplinary or not) projects proposed by industrial partners or by research labs, students will identify technological hurdles, propose solutions and set up experiments. They will also learn how to present their results (in a written and oral report).

Keywords : Projects, industrial, research.

Programme

Learning outcomes

- Elaborate and apprehend a scientific and technical project.
- Identify the technological hurdles and set up the technological solutions.
- Achieve a synthesis of informations and a presentation of the results.

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

35% (written report), 35% (oral), participation (30%)

OPTION BIO-ENGINEERING AND NANOTECHNOLOGY

Specialisation Bio-engineering and nanotechnology

BIO-INGÉNIERIE

BIO-INGÉNIERIE

Lecturers: **Emmanuelle LAURENCEAU**

| Lecturers : 0.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

IMAGERIES MÉDICALES

IMAGERIES MÉDICALES

Lecturers: Emmanuelle LAURENCEAU, Christelle YEROMONAHOS

| Lecturers : 6 | TC : 0.0 | PW : 9 | Autonomy : 6 | Study : 8 | Project : 0.0 | Language : FR

Objectives

Through this course, 3 main imaging and image processing techniques will be discussed: electronic cryo-tomography, X-ray imaging and ultrasound imaging. Concrete examples of image reconstruction and modeling as well as manipulations on devices (RX, US) will help to understand the complete chain of image formation and its interpretation.

Keywords :

Programme

Course (6h):
- Principle of electronic cryo-tomography
- Principle of X-ray imaging
- Principle of Ultra-sound imaging

Practical work (9h): 1 pratical to choose on one of the 3 imaging techniques

Learning outcomes

- Understand the scientific challenges of medical imaging in terms of information extraction
- Understand the difficulties associated with reconstructing images from physical measurements and know the methods to overcome them
- Know the signal processing techniques used in ultrasound imaging

Independent study

Objectifs :

Méhodes : - Processing of electronic cryo-tomography images from free software (eman2 and Jsubtomo)
- Bibliographic studies
- Processing of data acquired on a research ultrasound system

Core texts

Assessment

75% knowledge (practical report), 25% know-how (oral presentation)

INTERACTIONS MATÉRIAU-VIVANT

INTERACTIONS MATÉRIAU-VIVANT

Lecturers: Emmanuelle LAURENCEAU, Vincent FRIDRICI

| Lecturers : 3 | TC : 2 | PW : 6 | Autonomy : 6 | Study : 4 | Project : 0.0 | Language : FR

Objectives

Through this course, the fundamental aspects linked to the biological, physicochemical and mechanical phenomena involved during the contact between a surface and a biological medium will be treated. The link with the bioengineering of interfaces and its application will be approached in various forms: analysis of articles, realization of devices, design office

Keywords :

Programme

Course (3h):
- Physico-chemistry of interfaces
- Biomechanics of interfaces

BE (4h): Tribo-mechanics of living tissue

Practical work (6h): Realization of a glucose biosensor

TD (2h): Restitution of the analysis of scientific articles

Learning outcomes

- Understanding the biomechanical challenges of aging and prosthetic medicine
- Know some techniques for characterizing living tissue
- Establishment of an experimental protocol
- Write a complete technical report, correctly referenced

Independent study

Objectifs :

Méhodes : Analysis of scientific articles

Core texts

Assessment

50% knowledge (oral presentation of review articles), 50% know-how (practical report)

BIOPRODUCTION

BIOPRODUCTION

Lecturers: **Emmanuelle LAURENCEAU**

| Lecturers : 4 | TC : 0.0 | PW : 7 | Autonomy : 2 | Study : 4 | Project : 0.0 | Language : FR

Objectives

This course will allow engineering students to identify the stages of production of a recombinant protein as well as the different purification methods, their roles and interests in bioproduction processes. The production of recombinant proteins by genetic engineering methods is a common process in most areas of biotechnology. Using perfectly mastered methods, this process makes it possible to obtain specific proteins, in particular of therapeutic interest, with a very high yield.

Keywords :

Programme

Course (4h):
- Principle of genetic engineering
- Production and purification of recombinant protein

BE (4h): Biofermenter

Practical (7h): Microbrewery

Learning outcomes

- Know the techniques of bio-production and characterization of biomolecules
- Set up an experimental protocol
- Present results in a relevant, rigorous and critical manner for analysis
- Write a complete technical report, correctly referenced

Independent study

Objectifs :

Méhodes : Preparatory work for the practical

Core texts

Assessment

50% knowledge (course exam and BE), 50% know-how (practical report)

BIO-INFORMATIQUE, BIO-STATISTIQUE ET MODÉLISATION

BIO-INFORMATIQUE, BIO-STATISTIQUE ET MODÉLISATION

Lecturers: Emmanuelle LAURENCEAU, Christelle YEROMONAHOS

| Lecturers : 0.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 15 | Project : 0.0 | Language : FR

Objectives

Through this course, basic statistical tools as well as modeling concepts and techniques will be discussed to allow engineering students to analyze and model data in the life sciences. From concrete examples, analysis and modeling strategies will be studied, and the development of a complete model will be worked out.

Keywords :

Programme

BE 1 (4h): Modeling of living tissue
BE 2 (4h): Cell membrane modeling in molecular dynamics
BE 3 (4h): Epidemiology and vaccination
BE 4 (3h): Statistical tools for life sciences

Learning outcomes

- Understanding modeling
- To be able to simulate and analyze a model
- Recognize the application contexts of statistical methods and implement them on datasets
- Understand the principle of molecular dynamics simulations

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Assessment

1 written report for each BE, each counting for 25% of the final mark

OPTION BIO-ENGINEERING AND NANOTECHNOLOGY

Specialisation Nanotechnologies

NANOTECHNOLOGIES

NANOTECHNOLOGIES

Lecturers: **Virginie MONNIER-VILLAUME**

| Lecturers : 0.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Nanotechnologies receive each year tremendous investments in research and development. Therefore it is a business sector in strong growth. Nanosciences and nanotechnologies are crossing several scientific fields such as electronics, mechanics, chemistry, optics, biology that manipulate objects at the nanometer size. The objective here is to allow generalist engineers to acquire both technical and scientific knowledges to manage transverse projects and technology transfer. Mixing sciences for the engineer and life sciences, this diploma field proposes high level training in strong interaction with industrial needs in information and communication technologies.

Keywords :

Programme

NANO3.1 – Memories for the Internet of Things
NANO3.2 – Smart surfaces
NANO3.3 – Photonics guiding
NANO3.4 – Nano-optics

Learning outcomes

- Model and set up a multidimensional system with interdependent and/or non deterministic components.
- Set hypotheses and evaluate their impacts/their limits.
- Apply knowledges to the resolution of pluridisciplinar problems.
- Analyze in a critical way good practices and progress opportunities.

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

Students must follow the two first courses and make a choice between the two last courses. NANO3.1 : 33% ; NANO3.2 : 33% ; NANO3.3 : 33% or NANO3.4 : 33%.

MÉMOIRES POUR L'INTERNET DES OBJETS

MÉMOIRES POUR L?INTERNET DES OBJETS

Lecturers: Virginie MONNIER-VILLAUME, Bertrand VILQUIN, Emmanuelle

| Lecturers : 0.0 | TC : 0.0 | PW : 16 | Autonomy : 0.0 | Study : 4 | Project : 0.0 | Language : FR

Objectives

During this course, the students will have to understand the different physical properties that can be found inside a unic ferroelectric material with high potential for innovating applications. They will also elaborate, characterize and use miniaturized and ultrafast digital memories pour the Internet of Things (IoT).
The higher electronic mobility will be one of tomorrow challenges, such as IoT. In the future, the interaction with objects will not be done only using electronic chips or specific commands transmitted by a touch screen, but also by objects themselves.

Keywords : Ferroelectric material, digital memories, internet of things, elaboration, characterization.

Programme

BE1 (2h): clean room technologies, X-Ray diffraction.
TP1 (4h): nanomaterials deposition in clean room and elaboration of integrated digital memories.
TP2 (2h): structural characterization of ferroelectric digital memories.
TP3 (2h): electrical characterization of ferroelectric digital memories.
TP4 (8h): conception of electrical systems from digital memories.
BE2 (2h): presentation of the results and scientific discussions.

Learning outcomes

- Understand the challenges and problematics of the Internet of Things.
- Know and use clean room techniques and structural/electrical characterization methods.
- Conceive the architecture of an electrical system.
- Present results in a relevant, rigourous and critical manner, in view of an analysis.

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Assessment

Final mark = 30% Knowledge + 70% Know-how
Knowledge = 100% written report of the work
Know-how = 40% continuous assessment (active involvement and participation) + 60%

SURFACES INTELLIGENTES

SURFACES INTELLIGENTES

Lecturers: Magali PHANER GOUTORBE, Emmanuelle LAURENCEAU, Stephane

| Lecturers : 0.0 | TC : 0.0 | PW : 16 | Autonomy : 0.0 | Study : 4 | Project : 0.0 | Language : FR

Objectives

In this course, the students will have to elaborate bio-inspired surfaces with specific functionalities (superhydrophobic, super-adhesive,..) thanks to nano/microtexturation. These surfaces will be characterized and analyzed regarding the two specific properties, their wettability and their adhesive potential.

Keywords : Bio-inspired surfaces, surface texturation, wettability, adhesion.

Programme

TP1 (4h): elaboration of functional surfaces.
TP2 (4h): topographic characterization (nanometric scale)
TP3 (4h): characterization of the wettability of textured surfaces
TP4 (4h): mechanical characterization of the adhesion
BE (2h): presentation of the results and scientific discussions

Learning outcomes

- Understand the challenges and problematics of functional surfaces.
- Know and use surface elaboration techniques.
- Characterization of surfaces at different scales.
- Set up an experimental protocol.

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Assessment

Final mark = 100% Know-how
Know-how = 50% work during practical sessions + 50% oral presentation

GUIDAGE PHOTONIQUE

GUIDAGE PHOTONIQUE

Lecturers: **Emmanuel DROUARD, Pedro ROJO ROMEO, Virginie MONNIER-VILLAUME**

| Lecturers : 0.0 | TC : 0.0 | PW : 18 | Autonomy : 0.0 | Study : 2 | Project : 0.0 | Language : FR

Objectives

During this course, the students will experiment different aspects of the conception and realization of nanophotonic components in guided optics, on silicon substrate.
After an introduction (about the context of integrated photonics on silicon, challenges), using specific simulation tools, students will conceive the different photonic building blocks necessary to the elaboration of complex systems for routing./guiding light on silicon. They will workin clean room on the different aspects of elaboration (optical and electronic lithography, plasma-assisted etching,...). The elaborated structures will be then characterized by optical and electronic microscopies.

Keywords : Nano-photonics, photonic components, guided optics, lithography, microscopy.

Programme

BE1 (2h): context, challenges of nanophotonics on silicon, description of tools and methods (simulation, elaboration in clean room)
TP1 (4h): simulation of structures and basic components
TP2 (10h): elaboration of guided optics components in clean room
TP3 (4h): structural characterization (electron microscopy) and optical microscopy (guided optics characterization set-up) of elaborated components

Learning outcomes

- Understand the challenges and problematics of photonics on silicon.
- Know and use several techniques and equipments used in nanotechnologies.
- First approach of working in clean room environment.
- Conceive and achieve a photonic integrated system.

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

30% for theoretical questions, 30% for involvement and active participation, 40% of methodology and experimental report

NANO-OPTIQUES

NANO-OPTIQUES

Lecturers: Virginie MONNIER-VILLAUME, Christelle MONAT, Emmanuelle

| Lecturers : 0.0 | TC : 0.0 | PW : 16 | Autonomy : 2 | Study : 2 | Project : 0.0 | Language : FR

Objectives

This training will be devoted to the elaboration, of nano-optical devices using with particular diffraction/reflection properties due to their periodic structuration at the wavelength scale. Different kinds of periodic systems will be studied and elaborated using physical routes from thin films (clean room technology) and chemical routes (from colloidal dispersions). Their structural and optical properties will be simulated and characterized.

Keywords : Photonic crystals, thin films, nanostructured periodic systems, opals, simulation, spectroscopy.

Programme

BE (2h): periodic structures, photonic crystals and synthetic opals.
TP1 (4h): simulation of optical properties of photonic crystals.
TP2 (4h): elaboration of synthetic opales by chemical route.
TP3 (4h): fabrication of Bragg mirrors in the clean room.
TP4 (2h): optical characterization by reflectivity.
TP5 (2h): structural characterization by scanning electron microscopy.
Autonomy (2h).

Learning outcomes

- Understand the challenges and problematics of photonic crystals and the origin of periodic structures properties.
- Know and use clean room techniques, colloidal chemistry and structural/optical characterizations.
- Simulate optical properties of some photonic structures.

Independent study

Objectifs : Writing of the report.

Méhodes : Write a full technical report, with correct references.

Core texts

Assessment

Final mark = 30% Knowledge + 70% Know-how
Knowledge = 100% answer to theoretical questions
Know-how = 40% continuous assessment (active involvement and participation) + 60 %