INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

5th YEAR APPLIED PHYSICS

Practical info

Location(s)

Toulouse

Instrumentation Lab

ECTS
5 crédits

Hourly volume
35h

Practical info

Location(s)

Toulouse

Nanobioengineering

ECTS
5 crédits

Hourly volume
27h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

- Nanotechnological processes for the investigation, the sensing and the quantification of biomolecular specific interactions, basis of all biosensing technologies.

- The principle of some of these technologies: Fluorescence, soft lithography, surface biofunctionalization, single molecule assays, biochips, 3D lithography, microfluidic.

The student will be able to:
- Formulate nanoscale mechanisms and give precise examples of biomolecular specific interactions
- Master nanoscale technics for transducing a molecular event into a measurable signal
- Analyze any kind of biosensor
- Implement a scientific experimental investigation
-Implement these nanotechnological and fluidic processes
- Discuss results, give interpretations and set the l advantages as well as limitations,
- Gather different concepts; assimilate them for being able to extract them from their context in order to face adidactical situations.

Necessary prerequisites

- Initiation to micro/nano-biotechnologies
- Scientific M1 in Chemistry, Biology or Physics

Practical info

Location(s)

Toulouse

Gas Sensor

ECTS
5 crédits

Hourly volume
34h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

- the approach and the different steps for the conception and realization of a micro- and nano-electronic by integration of nano-objects synthesized as a colloidal solution;
- the operating model of a nano-sensor

the student will have understood and be able to explain:
- the main concepts and the experimental practices about nano-object synthesis and stabilization of colloidal solutions;
- the main concepts and the experimental practices about deposition of nano-objects from a solution into 2D and 3D arrays on a surface;
- the physical principles of nanoparticles based sensors (gaz sensor, strain sensor ¿).

The student will be able to:
- produce a sensor relying on nanoparticle arrays with particles synthesized and assembled during the project;
- measure the sensor properties and describe how it works;
-discuss the results obtained and suggest improvements..

The student will be able to:
- suggest a reasonable solution for the realization of a sensor gathering the different concepts described above;
- produce an expertise on the conception and the practical realization on a novel sensor.

Necessary prerequisites

Master 1 in Physics, Applied Physics, Chemistry or Material Science or equivalent

Practical info

Location(s)

Toulouse

Micro-nano-electro-mechanical systems ¿ Nanotechnology Engineering

ECTS
5 crédits

Hourly volume
42h

Practical info

Location(s)

Toulouse

New 2D matérials

ECTS
5 crédits

Hourly volume
68h

Practical info

Location(s)

Toulouse

Charged particle optics

ECTS
5 crédits

Hourly volume
30h

Introducing

Objectives

Charged particle optics (CPO) is a science that compiles under a common theoretical base all the laws governing the transport, focusing, mass/energy dispersion, etc. of charged particles that can be electrons, positrons, ions or molecules. It allows the description of the optical properties of all the usual individual optical elements (lenses, energy filter, magnetic sector, etc.) and thanks to the multiple combinations of these elements, it allows the creation of a wide range of tools for the characterisation of innovative materials. For years, applications in this field have been considerable: development of increasingly powerful electron microscopes, focused ion beams that have opened the way to nano-manufacturing, secondary ion mass spectrometers (SIMS), an essential tool for characterising dopants in semiconductors, and also large instruments such as synchrotrons and particle accelerators.For several years, the demand for engineers with solid skills in this field has been significant and has been increasing regularly.

Indeed, the companies providing state-of-the-art analysis instruments are in a permanent race to innovate, on the one hand to meet the needs of the original market of increasingly small and complex semiconductor devices, but also to meet new markets such as the characterisation of chemical materials (pharmaceutical molecules, etc.) or biological materials (viruses, etc.) and the development of medical instruments (proton therapy for example). The development in the early 2000s of spherical aberration correctors for electron microscopes, whose innovative optics are based on the symmetry properties of magnetic multipoles, is an emblematic example that has revolutionised the use of these instruments.

In order to respond to this craze and to the demand for innovation that will enable the instruments of the future to be imagined, the industrial world is looking for engineering schools that can offer a modern approach to OPC adapted to their needs.

This module will aim to develop the theoretical foundations of OPC by insisting on the practical aspects useful for the development of new innovative optical instruments. The course will insist in particular on the strength of the general formalism of the OPC which gathers under the same logic all the elements which can transport, focus or disperse charged particles. The tutorials around simulations using the SIMION software (https://simion.com/docs/simion8brochure.pdf) and practical work will allow the engineering students to put this knowledge into practice around a design project of a concrete optical system such as, for example

- the manufacture of an electrostatic electron microscope whose elements, previously dimensioned with SIMION, can be manufactured with a 3D printer.

We would like to focus this module on aspects of the OPC that are of interest to industry and we will be in contact with Orsayphysics, a French manufacturer of focused ion beams. A visit to the company may even be considered, depending on requests and availability.

Necessary prerequisites

Electromagnetism, GP 4A Advanced Geometrical Optics, Fourier optics, quantum mechanics, and an approach to point mechanics problems using Lagrange's variational principle would be a plus.

Practical info

Location(s)

Toulouse

NanoPhysics and Nanochemistry

ECTS
4 crédits

Hourly volume

Practical info

Location(s)

Toulouse

Innovative technologies, devices and materials

ECTS
5 crédits

Hourly volume
54h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain:

- plasma processes
- new technologies and materials for the microelectronics applications
- concepts of the physics of continuous media
- quantum phenomena such as diffusion, electron paramagnetic resonance, and quantum cryptography: entangled states, single-photon and pairs of entangled states source based on semiconductors quantum dots.

The student will be able to apply the quantum mechanics formalism to describe innovative devices at the nano-scale.

The student will be able to:
- choose the kind of scanning probe microscopy well adapted to a specific application/characterization
- analyze and interpret basic images of scanning probe microscopy.

Necessary prerequisites

Electromagnetism
Quantum Mechanics (I4GPPM11)
Mathematics: matrix calculus and differential equations
Physical Metallurgy (real crystal, diffusion, precipitation, nucleation and growth)
Basic knowledge of symbolic computational tool like Maxima.

Practical info

Location(s)

Toulouse

Physics Engineering and Economic Development

ECTS
5 crédits

Hourly volume
75h

Introducing

Objectives

This educational unit is composed of three distinct lectures. Two of them are technological: Physics of semiconductor heterostructures and Telecommunication satellites/RF Functions, the third being centered on the impact of modern science: Nano Cultures.

Multiple objectives are targeted:

- Acquire the fundaments of the recent innovations in semi-conductor devices for microelectronic industry
- Understanding and modelling of semiconductor heterostructures
- To be able to describe the basic Telecommunication payload architecture by understanding the functional description of a bent-pipe transponder
- To acquire good understanding of each RF equipment (Requirements, RF drivers, technologies and associated tips)
- Develop a personal thinking on the impact of sciences on society fin relation with global environemental changes
- Analyse and criticize the nature of Science and technology
- Construct a research project forming sense with respect to personal values and societal challenges

Necessary prerequisites

- Course on "semiconductors" given in 3IMACS.
- Use of decibel units
- RF basics (noise, gain¿)

Practical info

Location(s)

Toulouse

Applied physics and Scientific Communication

ECTS
5 crédits

Hourly volume
28h

Practical info

Location(s)

Toulouse

Human relations

ECTS
6 crédits

Hourly volume
78h

Introducing

Location(s)

Toulouse

Objectives

L'étudiant devra être capable de :
-Analyser des situations de groupe avec des concepts issus de la psychologie sociale
-Identifier les dimensions éthiques de ces situations et prendre position
-Repérer et comprendre des informations liées aux RH
-Analyser une situation de management d¿équipe en référence à un cadre théorique
-Formuler et argumenter des solutions managériales
-Agir dans un milieu naturel : analyser, décider, agir ; mettre en œuvre la sécurité, utiliser du matériel spécifique. découvrir un site.
-Respecter et s'intégrer dans un environnement différent de ses habitudes
-S'engager avec cohérence dans le projet d'activités
-Prendre part activement au collectif
-Valider son projet professionnel et construire une stratégie pour trouver un emploi

Necessary prerequisites

None

Practical info

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

rapport bibliographique

ECTS
1 crédits

Hourly volume

Practical info

Location(s)

Toulouse

Instrumentation Lab

ECTS
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Hourly volume
35h

Practical info

Location(s)

Toulouse

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ECTS
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Toulouse

Micro-nano-electro-mechanical systems ¿ Nanotechnology Engineering

ECTS
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Hourly volume
42h

Practical info

Location(s)

Toulouse

New 2D matérials

ECTS
5 crédits

Hourly volume
68h

Practical info

Location(s)

Toulouse

Charged particle optics

ECTS
5 crédits

Hourly volume
30h

Introducing

Objectives

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Practical info

Location(s)

Toulouse

Advenced intrumentation 1

ECTS
5 crédits

Hourly volume
62h

Practical info

Location(s)

Toulouse

Instrumentation advanced 2

ECTS
4 crédits

Hourly volume
58h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
Real Time : Real time concept, scheduling, rules to develop a real time application, determinism and jitter concepts
Can Bus : General CAN concept, from concept to protocol
Network : Interest of local network for tests and measurements applications.

The student will be able to:
Real Time : Develop a real time application running on National Instruments Compact RIO
Can Bus : Manage communication between two CAN nodes
Network : Manage network technologies to realise a simple project

Necessary prerequisites

General computing
LabVIEW programming
Labwindows/CVI programming

Practical info

Location(s)

Toulouse

Physics Engineering and Economic Development

ECTS
5 crédits

Hourly volume
75h

Introducing

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Necessary prerequisites

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- Use of decibel units
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Practical info

Location(s)

Toulouse

Applied physics and Scientific Communication

ECTS
5 crédits

Hourly volume
28h

Practical info

Location(s)

Toulouse

Human relations

ECTS
6 crédits

Hourly volume
78h

Introducing

Location(s)

Toulouse

Objectives

L'étudiant devra être capable de :
-Analyser des situations de groupe avec des concepts issus de la psychologie sociale
-Identifier les dimensions éthiques de ces situations et prendre position
-Repérer et comprendre des informations liées aux RH
-Analyser une situation de management d¿équipe en référence à un cadre théorique
-Formuler et argumenter des solutions managériales
-Agir dans un milieu naturel : analyser, décider, agir ; mettre en œuvre la sécurité, utiliser du matériel spécifique. découvrir un site.
-Respecter et s'intégrer dans un environnement différent de ses habitudes
-S'engager avec cohérence dans le projet d'activités
-Prendre part activement au collectif
-Valider son projet professionnel et construire une stratégie pour trouver un emploi

Necessary prerequisites

None

Practical info

Energy production from renewable resources

ECTS
5 crédits

Hourly volume
32h

Practical info

Location(s)

Toulouse

Technologies and architectures for the conversion and storage of electrical energy

ECTS
5 crédits

Hourly volume
47h

Practical info

Location(s)

Toulouse

Innovative materials for the energy

ECTS
5 crédits

Hourly volume
15h

Practical info

Location(s)

Toulouse

Combination of multi-sources of energy platform

ECTS
9 crédits

Hourly volume
161h

Practical info

Location(s)

Toulouse

The different generation technologies and energy management

ECTS
5 crédits

Hourly volume
7h

Practical info

Location(s)

Toulouse

Human relations

ECTS
6 crédits

Hourly volume
78h

Introducing

Location(s)

Toulouse

Objectives

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-Formuler et argumenter des solutions managériales
-Agir dans un milieu naturel : analyser, décider, agir ; mettre en œuvre la sécurité, utiliser du matériel spécifique. découvrir un site.
-Respecter et s'intégrer dans un environnement différent de ses habitudes
-S'engager avec cohérence dans le projet d'activités
-Prendre part activement au collectif
-Valider son projet professionnel et construire une stratégie pour trouver un emploi

Necessary prerequisites

None

Practical info

Qualitative Approach

ECTS
4 crédits

Hourly volume
45h

Practical info

Location(s)

Toulouse

Quantitative Approach

ECTS
5 crédits

Hourly volume
45h

Practical info

Location(s)

Toulouse

Designing for safety

ECTS
5 crédits

Hourly volume
42h

Practical info

Location(s)

Toulouse

Process Safety

ECTS
5 crédits

Hourly volume
45h

Practical info

Location(s)

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Functional Safety

Practical info

Location(s)

Toulouse

[FRANCAIS] Structural Safety

Practical info

Location(s)

Toulouse

Human relations

ECTS
6 crédits

Hourly volume
78h

Introducing

Location(s)

Toulouse

Objectives

L'étudiant devra être capable de :
-Analyser des situations de groupe avec des concepts issus de la psychologie sociale
-Identifier les dimensions éthiques de ces situations et prendre position
-Repérer et comprendre des informations liées aux RH
-Analyser une situation de management d¿équipe en référence à un cadre théorique
-Formuler et argumenter des solutions managériales
-Agir dans un milieu naturel : analyser, décider, agir ; mettre en œuvre la sécurité, utiliser du matériel spécifique. découvrir un site.
-Respecter et s'intégrer dans un environnement différent de ses habitudes
-S'engager avec cohérence dans le projet d'activités
-Prendre part activement au collectif
-Valider son projet professionnel et construire une stratégie pour trouver un emploi

Necessary prerequisites

None

Practical info

Toxic risks

ECTS
5 crédits

Hourly volume
42h

Practical info

Location(s)

Toulouse

Smart Devices

ECTS
5 crédits

Hourly volume

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

SMART SENSORS AND ACQUISITION CHAIN:
- The criteria for the design and use of a "smart device" and an acquisition chain
It will be capable of handling:
- The physical principles of sensors operation
- The concepts used in metrology
- Procedures implemented,
- electrical "conditioners"
- The design of an acquisition chain and a "smart device".
MICROCONTROLERS AND OPEN SOURCE HARDWARE: the elements necessary for the design and implementation of concrete applications in Open Source Hardware,

DESIGN OF A CIRCUIT IN ANALOG ELECTRONICS:
It will be able to design and simulate an amplification stage dedicated to the measurement of the sensor realized

DESIGN OF AN ELECTRONIC BOARD OF THE SENSOR:
He will be able to design and build an electronic board containing the sensor, its conditioning electronics and the communication elements necessary to send the data on a low speed network such as LoRa.

NANO-SENSOR:
- The approach of making nano devices and micro-electronic methods by integrating low-cost nano-objects prepared in solution;
- The operation of a nano-sensor.

The student will have understood and be able to explain:
- Experimental concepts and practices to synthesis nano-objects in liquid phase; Stabilization of colloidal solutions;
- Experimental concepts and practices of deposits of these nano-objects as 2D and 3D networks;
- The physical principles of sensors based on nanoparticles (gas sensors, stress ...)
The student will be able to:
- Experimentally produce a nanoparticle-based sensor that will be synthesized and assembled between two electrodes;
- Measure the properties of the sensor and describe its operation;
- Discuss experimental results and suggest improvements

Necessary prerequisites

General physic and electronic lectures. C et C++ programming

Practical info

Location(s)

Toulouse

Communication

ECTS
5 crédits

Hourly volume

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

-the communication architectures and protocols for wireless sensors networks and Internet of Things (IoT)
-the quality of services for adaptative networks (routing layer, MAC layer, beamforming algorithms)
- the functioning of adaptative networks and adaptative communication services
-the Software Defined Radio (SDR) and cognitive radio principles (reconfigurability in mobile networks)
-the functioning and the services of 4G and 5G networks
-the overall architecture of an energy management system, capturing or not ambient energy.
-the difficulties to assure the integrity, the availability and the confidentiality of the deployed equipment on a large scale, in different environments using heterogeneous communication interfaces

The student will be able to:

-design, dimensioning and deploying a wireless sensor networks depending on the applications
- having strong knowledges about quality of service on the MAC layer and beamforming algorithms
-having strong knowledges on 4G and 5G networks and adaptative networks
-identify the information to protect in IoT with respect to the security properties
-analyse the communication interferences to characterise the weakness of the system
-propose or modify the communication architectures to take into account the security problems
-design the energy management of a connected object

Practical info

Location(s)

Toulouse

Middleware and services

ECTS
5 crédits

Hourly volume
62h

Introducing

Objectives

This training consists of 3 parts, the following concepts will be discussed:
- Service oriented architectures
- Middlewares
- The Middleware for the Internet of Things through standards and the deployment of an architecture of sensors networks.
- The concept of Cloud and especially Infrastructure As A Service.
- Dynamic management through the principles of autonomic computing

The student will be able to:
- Design and develop a service oriented architecture
- Implement Web services SOAP and Rest
- Develop a service composition (orchestration) via BPEL
- Know the main standards of the Internet of Things
- Deploy an architecture according to a standard and implement a sensor network system services
- Understand the concept of cloud
- Use a cloud infrastructure in Infrastructure as a Service
- Recognise the different architecture types (type 1 and type 2) of cloud hypervisors
- Provision service-based (develop, deploy, manage) in cloud environment using Docker containers
- Deploy and adapt an Internet of things platform on cloud and manage it with autonomic concept

Necessary prerequisites

Java programming, Object Oriented design, base notion on network, XML and XML schema, NodeJS

Practical info

Location(s)

Toulouse

Analysis and data processing, business applications

ECTS
4 crédits

Hourly volume
37h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

Data management:
Exploratory/confirmatory data analysis. Algorithmic Complexity vs. development costs, parallelism, software engineering notions (life cycle of a data analysis pipeline).
Data visualisation techniques.

Semantic manipulation:
- What an ontology is
- What are the main constituting elements of an ontology
- What are the perks of enriched data compared to raw data

Software engineering:
- Software project lifecycle
- The challenges of software development
- Project management methods, including agile method

The student will be able to:
- Explore a dataset, leverage it to answer specific questions, and present the results of this analysis -incl. Its limits- in a synthetic written report.
- Design an ontology to capture domain knowledge
- Discover and reuse knowledge sources (ontologies, knowledge bases) online
- Enrich a dataset with semantic metadata
- Control the conduct of a software development project with a team by following the agile method
- Perform requirement analysis: expression, analysis and transformation into technical requirements

Necessary prerequisites

- Algorithms and programming
- Statistics (notions)
- Java programming
- Web technologies background knowledge

Practical info

Location(s)

Toulouse

Innovative project

ECTS
5 crédits

Hourly volume
76h

Introducing

Objectives

The student will be able to:
(English course)
- present their scientific research in a clear, logical, and organized manner, both orally and in a written report
- adapt their register to their audience and follow standard scientific publication standards with respect to format and appropriate style
- quote scientific sources according to international citation standards
- use specific technical vocabulary and terms relevant to their field of study

Regarding the innovative project, students will be able to carry out an innovative project using the skills learnt during this semester. The project will cover the specification, design, implementation and a presentation to a jury of academia and industry.

Necessary prerequisites

(English) Students must master general English and follow strict standard scientific guidelines for both oral presentations and written abstracts and reports.

Practical info

Location(s)

Toulouse

Innovation and humanity

ECTS
6 crédits

Hourly volume
76h

Introducing

Objectives

Aims
The student will learn how to:
¿ Analyze group situations using social psychology concepts
¿ Identify the ethical dimensions of these situations and take a stance
¿ Identify and understand HR-related information
¿ Analyze a team management situation in a theoretical context
¿ Formulate and justify managerial decisions
¿ Operate in a natural environment: analysis, decision, action, safety implementation, use of specific equipment, site exploration
¿ Respect and adapt to an environment that is different from their own
¿ Consistently commit to the activity project
¿ Take an active role within the group
¿ Fulfill their career objectives, build a strategic plan and acquire job searching skills.

Necessary prerequisites

Prerequisites
None

Practical info

Location(s)

Toulouse

Human relations

ECTS
6 crédits

Hourly volume
78h

Introducing

Location(s)

Toulouse

Objectives

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-Valider son projet professionnel et construire une stratégie pour trouver un emploi

Necessary prerequisites

None

Practical info

[FRANCAIS] Projet énergie

ECTS
19 crédits

Hourly volume
15h

Practical info

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