# INFORMATION SHEET EC

| | | | |
|---|---|---|---|
| **Title EC** | | | |
| Title of the EC | Circuit design under CADENCE environment | **ECTS** | 3 |
| Title of UE | UE 14 : Circuit design under CADENCE environment | | 3 |
| Title of the BCC | BCC2 - M2 - SYSCOM : Mastery of CAD and Characterization tools. | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | Also indirectly concerns the BCC - M1 - SYSCOM : Design of Circuits and Communicating Electronic Systems | | |
| **General information** | | | |
| Semester in which the course is offered | **S1 ▢ S2 ☒ S3 ▢ S4 ▢** | | |
| *Compulsory* course / *Elective course* | **Mandatory ☒ Elective ▢** | | |
| Pre-requisite UE(s) | Connaissances de base en électronique analogique et numérique | | |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face ☒ Hybrid ▢ Remote ▢** | | |
| Teaching *Unique / Offered / Borrowed* | **Unique ☒ Offered ▢ borrowed ▢** | | |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | | | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | | | |

| **Hourly distribution** | CM | C-TD | TD | TP | Remote | Total |
|---|---|---|---|---|---|---|
| Supervised teaching hours | 4 | | | 24 | | 28 |
| Personal student work | | | | | | 46 |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the course**

Objectives (in terms of know-how):

- *To know the different stages of design of a specialized analog or digital integrated circuit or mixed.*
- *Initiation to circuit design under the CADENCE platform environment.*

Brief program :

- *Basics of CMOS integrated circuit technology and design (analog and digital)*
- *Presentation of the CADENCE platform tools*
- *Design kit and design steps (flow) of a circuit (from schematic to layout)*
- *Practical work under CADENCE environment: familiarization with the tools, learning of the development stages of a specialized circuit, physical implementation of a ring oscillator (DRC, LVS, parasite extraction) and complete characterization (corners, PVT variations), optimizations)*

Skills acquired (direct/indirect):

*Design specialized electronic circuits from specifications to layout.*
*Ability to set up a design flow (design kit, schematic, simulation, layout, post-simulation) using professional CAD tools such as those available in the CADENCE platform*

CNU section(s) of teaching : 63

If applicable, other useful information(s):

**Person in charge of the UE** (Name First, Status, Component) :
FRAPPE Antoine, Teacher-researcher, Yncréa Hauts-de-France

If applicable, other useful information

| **Evaluation methods** (CC, CT, report, oral defense,... + weightings) | |
|---|---|
| Continuous monitoring:<br>- State of progress in the practical sessions (Validation of the mastery of the tools).<br>- Experience reports in TP | |
| If applicable, other useful information | |

# INFORMATION SHEET EC

| **Title EC** | | | |
|---|---|---|---|
| Title of the EC | Composants actifs de l' électronique millimétrique et THz | **ECTS** | 3 |
| Title of UE | UE16 : mmW and THz technologies for 5G and beyond ( Electronique-Photonique + systèmes) ou "Advanced wireless and wired for UHD communications" | | 6 |
| Title of the BCC | BCC1 : S'approprier les technologies nouvelles et innovantes | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | | | |

| **General Informations** | |
|---|---|
| Semester in which the course is offered | **S1 ▢ S2 ▢ S3 ☒ S4 ▢ S5 ▢ S6 ▢** |
| *Compulsory* course / *Elective course* | **Mandatory☒▢ Elective▢** |
| Pre-requisite UE(s) | |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face☒ Hybrid▢ Remote▢** |
| Teaching *Unique / Offered / Borrowed* | **Unique☒ Offered▢ borrowed▢** |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | |

| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
|---|---|---|---|---|---|---|
| Supervised teaching hours | 15 | | | 12 | | 27 |
| Personal student work | | | | | | 20 |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the teaching**

**Objectives (in terms of know-how)**:

To know the state of the art of active components for millimeter and THz applications

**Brief program :**

- Silicon, III-V, Nitride materials
- Schottky, Gunn, Impact diodes
- Active components HEMT, MOSFET, HBT
- MMIC: propagation lines, passive elements
- Practical work: S-parameter measurements under the tip of a HEMT, NF50 and extraction of 4 noise parameters from HEMT and Silvaco-Atlas Schottky, HEMT

**Skills acquired** (direct/indirect):

Understanding of the physical and electrical phenomena of a transistor. Choosing a component die. Knowledge of the state of the art

CNU section(s) of the teaching : 63

If applicable, other useful information :

**Person in charge of the UE (**Name First name, Status, Component) : Sylvain BOLLAERT, Pr, FST

If necessary, other useful information

| **Modalités d'évaluation** (CC, CT, rapport, soutenance orale,... + pondérations) | |
|---|---|
| 1 Final exam and a make-up session if necessary: 2/3 final grade<br>Practical work review: 1/3 final grade | |
| If necessary, other useful information | |

# INFORMATION SHEET EC

| **Title EC** | | | |
|---|---|---|---|
| Title of the CE | Technologies Neuromorphiques pour réseaux de neurones à impulsions (IA 3ème génération) | **ECTS** | 3 |
| Title of the EU | UE17 : Neuromorphic technologies for impulse neural networks (3rd generation AI) | | 3 |
| Title of the CCO | BCC1 : Appropriate the novel and innovative technologies | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | | | |

| **Informations générales** | |
|---|---|
| Semester in which the course is offered | **S1 ▢ S2 ▢ S3 ■ S4 ▢ S5 ▢ S6 ▢** |
| *Compulsory* course / *Elective course* | **Mandatory ■ Elective ▢** |
| Pre-requisite EU(s) | UE 4.1 – EC « Information processing and Artificial Intelligence » M1 |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face ■ Hybrid▢ Remote▢** |
| Teaching *Unique / Offered / Borrowed* | **Unique ■ Offerred▢ borrowed▢** |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | |

| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
|---|---|---|---|---|---|---|
| Supervised teaching hours | 16 | | | 12 | | 28h |
| Personal student work | | | | | | 20h |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the course**

Objectives (in terms of know-how):

The objective is to teach students Neuromorphic Technologies for Impulse Neural Networks (ANN), the keystone of "third generation artificial intelligence". The student will understand the basic building blocks (neurons, synapses) required for the deployment of SNNs, acquire a culture related to neuromorphic technologies all CMOS or co-integrating synapses from nanoelectronics: organic or non-organic, magneto-electric. The coupling with bioinspired artificial sensors (retina, cochlea, ...) will be addressed.

An opening to more exploratory directions aiming at reproducing the principles of information processing observed in biological systems using emerging technologies will also be proposed. This approach is particularly interested in reproducing intelligent sensor networks, exploiting the properties of complex systems at the nanoscale (i.e. reservoir computing) and exploring the coupling of electronics and biology for information processing.

**Brief program :**

1. Bioinspired information processing:
   - Nerve impulse recall in the living (characteristics of the brain, neurons, coding, biological membrane)

2. Artificial Neural Networks (ANN): brief history, architectures, software/hardware approaches, plasticity, supervised/unsupervised learning

3. Pulse Neuron Networks (PNN) - hardware implementations - for 3rd generation AI: (i) interest (response to the energy challenge, for which applications), description of the neuromorphic technologies (NT) used - all CMOS or integrating synapses from nanoelectronics - (ii) use of the PNNs in the development of AI

4. Coupling of NNS with bioinspired artificial sensors (retina, cochlea)

5. Bioinspired computing for hybrid biology / technology applications for information processing

Skills acquired (direct/indirect) :

- *Consolidate the scientific culture of Master 2 students concerning neuromorphic technologies dedicated to 3rd generation AI*

CNU Section(s) of teaching : 63

If applicable, other useful information

**Person in charge of the UE** (Name, First name, Status, Component) :

François Danneville, PU, EEA Department - FST, Laboratories : IEMN & Ircica
Fabien Alibart, CR CNRS, Laboratory : IEMN

If applicable, other useful information

| **Evaluation methods** (CC, CT, report, oral defense,... + weightings) | |
|---|---|
| **Grade = 2/3 DS + 1/3 TP** | |
| If applicable, other useful information | |

# INFORMATION SHEET OF EC

| | | | |
|---|---|---|---|
| **Title EC** | | | |
| Title of the EC | Nano-characterizations | **ECTS** | 2 |
| Title of UE | UE 18 : Micro-nano-fabrication techniques | | 6 |
| Title of the BCC | BCC3 : To appropriate new and innovative technologies | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | | | |
| **General information** | | | |
| Semester in which the course is offered | **S1 ▢ S2 ▢ S3 ☒ S4 ▢ S5 ▢ S6 ▢** | | |
| *Compulsory* course / *Elective course* | **Mandatory☒ Elective▢** | | |
| Pre-requisite UE(s) | | | |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face☒ Hybrid▢ Remote▢** | | |
| Teaching *Unique / Offered / Borrowed* | **Unique☒ Offered▢ borrowed▢** | | |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | | | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | | | |

| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
|---|---|---|---|---|---|---|
| Supervised teaching hours | | 10 | | 8 | | 18 |
| Personal student work | 10 | | | | | |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the teaching**

Objectives (in terms of know-how): this CE is part of the UE micro-nano-fabrication techniques and comes in complement of the CE "micro-nano devices fabrication". The objective is to provide skills on nanocharacterization tools, which are essential tools for the monitoring of technologies and the development of micro-nano devices.

**Brief program:**

Nanocharacterization

1. Problematic of nanocharacterization
2. Near field characterization
a. STM, AFM
3. Other nanocharacterization techniques (SEM, SNOM, RAMAN spectroscopy, ...)

**Acquired skills (direct/indirect)** :
Mastering micro and nano imaging techniques in near field. Physico-chemical characterization of a material by Raman spectroscopy.

CNU section(s) of the teaching : 63

If necessary, other useful information :

**Person in charge of the UE** (Name First name, Status, Component) : HAPPY Henri, PR, FST-EEA

| **Evaluation methods (CC, CT, report, oral defense,... + weightings)** | |
|---|---|
| Practical work: Report + self-evaluation<br>CC Examination 1H, including the questions of TP<br>Weighting : 2/3 CC + 1/3 TP<br>If applicable, other useful information | |
| If applicable, other useful information | |

# INFORMATION SHEET OF EC

| | | | |
|---|---|---|---|
| **Title EC** | | | |
| Title of the EC | Nano-characterizations | **ECTS** | 2 |
| Title of UE | UE 18 : Micro-nano-fabrication techniques | | 6 |
| Title of the BCC | BCC3 : To appropriate new and innovative technologies | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | | | |
| **General information** | | | |
| Semester in which the course is offered | **S1 ▢ S2 ▢ S3 ☒ S4 ▢ S5 ▢ S6 ▢** | | |
| *Compulsory* course / *Elective course* | **Mandatory☒ Elective▢** | | |
| Pre-requisite UE(s) | | | |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face☒ Hybrid▢ Remote▢** | | |
| Teaching *Unique / Offered / Borrowed* | **Unique☒ Offered▢ borrowed▢** | | |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | | | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | | | |

| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
|---|---|---|---|---|---|---|
| Supervised teaching hours | | 10 | | 8 | | 18 |
| Personal student work | 10 | | | | | |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the teaching**

Objectives (in terms of know-how): this CE is part of the UE micro-nano-fabrication techniques and comes in complement of the CE "micro-nano devices fabrication". The objective is to provide skills on nanocharacterization tools, which are essential tools for the monitoring of technologies and the development of micro-nano devices.

**Brief program:**

Nanocharacterization

1. Problematic of nanocharacterization
2. Near field characterization
a. STM, AFM
3. Other nanocharacterization techniques (SEM, SNOM, RAMAN spectroscopy, ...)

**Acquired skills (direct/indirect)** :
Mastering micro and nano imaging techniques in near field. Physico-chemical characterization of a material by Raman spectroscopy.

CNU section(s) of the teaching : 63

If necessary, other useful information :

**Person in charge of the UE** (Name First name, Status, Component) : HAPPY Henri, PR, FST-EEA

| **Evaluation methods (CC, CT, report, oral defense,... + weightings)** | |
|---|---|
| Practical work: Report + self-evaluation<br>CC Examination 1H, including the questions of TP<br>Weighting : 2/3 CC + 1/3 TP<br>If applicable, other useful information | |
| If applicable, other useful information | |

# INFORMATION SHEET EC

| | | | |
|---|---|---|---|
| **Title EC** | | | |
| Title of the EC | Energy for the Internet-of-Things | **ECTS** | 3 |
| Title of UE | UE19: Energy for the Internet-of-Things | | 3 |
| Title of the BCC | BCC1 – Appropriate the novel and innovative technologies | | |
| If applicable, other useful information<br>(Indicate here if the CCO is subject to a CU) | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **General information** | | | | | | |
| Semester in which the course is offered | **S1 ☐ S2 ☒ S3 ☐ S4 ☐** | | | | | |
| *Compulsory* course / *Elective course* | **Mandatory ☒ Elective ☐** | | | | | |
| Pre-requisite UE(s) | UE – « Fundamental Physic and material sciences » | | | | | |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face ☒ Hybrid ☐ Remote ☐** | | | | | |
| Teaching *Unique / Offered / Borrowed* | **Unique ☒ Offered ☐ borrowed ☐** | | | | | |
| Formation is promising if the teaching is borrowed<br>(Component, Mention, Course, Semester, UE) | | | | | | |
| If applicable, other useful information<br>(Indicate here if teaching is in English) | | | | | | |
| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
| Supervised teaching hours | | 18 | | 10 | | 28 |
| Personal student work | | | | | | 13 |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information<br>(Specify *Other* category here) | | | | | | |

**Description of the course**

Objectives (in terms of know-how):

- To know the notions of thermodynamics, semiconductor physics and mechanics useful for the study of energy conversion systems.
- To know the typical orders of magnitude of the recoverable powers (and densities) for various energy sources. (Photovoltaic, Thermoelectric, Piezoelectric in particular). To know for these different sources what are the materials, technologies and constraints in terms of size, efficiency and availability
- Take in hand a development kit for connected objects, use the various energy sources, report on the experimental work

Brief program :

1. Physics of energy conversion:
   - Thermodynamics: notion of thermal machine, efficiency, Carnot's efficiency, first, second principle, heat transfers (conductive, conducto-convective, radiative), Fourier's law, analogy between thermal and electricity, notion of coupled dissipative transfers (Onsager's relations)
   - Mechanics: notions of elasticity, displacement, deformation, Hooke's law (useful for the Piezo)

2. Issues and applications:
   Photovoltaic energy, vibrational and piezoelectric energy, thermoelectricity, rectification and energy storage

3. Practical aspects:
   The proposed development kit uses different energy recovery modalities (mechanical, push button), solar (photovoltaic). Radio transmission modules and a programming interface are also available.

   The student will have to realize a chain of recovery, sensor/measurement, transmission

Skills acquired (direct/indirect):

- *Use the concepts of efficiency and coupled transport to describe different energy conversion mechanisms within a single theoretical framework. Be able to compare the efficiency and operation of these mechanisms.*
- *To be able to compare, with respect to a given use case, the potential of different energy sources.*
- *To be able to understand the state of the art research of micro sources of energy recovery*
- *Implement existing components to create an energy autonomous object.*

CNU section(s) of teaching : 28

If applicable, other useful information(s):

**Person in charge of the UE** (Name First, Status, Component) :
Jean-François ROBILLARD, Yncréa Hauts-de-France, Associated Professor

If applicable, other useful information

Pre-requisites in semiconductor physics

| **Evaluation methods** (CC, CT, report, oral defense,... + weightings) | |
|---|---|
| 1 Final exam and a make-up session if necessary<br>1 Personal work on the basis of a scientific article and a make-up session if necessary<br>1 Note of practical work (realization and report) | |
| If applicable, other useful information | |

# INFORMATION SHEET EC

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|---|---|---|---|
| **Title EC** | | | |
| Title of the EC | Antennas for Mobile Networks and Connected Objects-2 | **ECTS** | 3 |
| Title of UE | UE20 : Antennas for Mobile Networks and Connected Objects-2 | | 3 |
| Title of the BCC | BCC4 : Design of communicating objects | | |
| If applicable, other useful information (Indicate here if the CCO is subject to a CU) | In relation with BCC of M2 – SYSCOM : Design of circuits and Communicating Electronic systems | | |

| | |
|---|---|
| **General information** | |
| Semester in which the course is offered | **S1** ☐ **S2** ☒ **S3** ☐ **S4** ☐ |
| *Compulsory* course / *Elective course* | **Mandatory** ☒ **Elective** ☐ |
| Pre-requisite UE(s) | UE of M1 : Antennas for Mobile Networks and Connected Objects-1 |
| Teaching : *Presential / Hybrid / Distance learning* | **Face-to-face** ☒ **Hybrid** ☐ **Remote** ☐ |
| Teaching *Unique / Offered / Borrowed* | **Unique** ☒ **Offered** ☐ **borrowed** ☐ |
| Formation is promising if the teaching is borrowed (Component, Mention, Course, Semester, UE) | |
| If applicable, other useful information (Indicate here if teaching is in English) | |

| **Hourly distribution** | **CM** | **C-TD** | **TD** | **TP** | **Remote** | **Total** |
|---|---|---|---|---|---|---|
| Supervised teaching hours | | | | 30 | | 30 |
| Personal student work | | | | | | 30 |
| Supervised or tutored project | | | | | | |
| Internship (range of hours) | | | | | | |
| If applicable, other useful information (Specify *Other* category here) | | | | | | |

**Description of the course**

Objectives (in terms of know-how):

This UE is mainly based on practical teaching which builds on the notions seen in semester 2 of M1. The objective is the study and design of particular antennas based on the use of professional CAD software.

**Brief program** :

Understand and know the operation of particular antennas using the CST Microwave Studio software. Through the simulation of some particular antenna structures, the following points will be addressed

- near field and far field
- excitation techniques (lines, proximity or slot coupling, baluun, matching,...)
- multi-band or wide-band antennas.
- miniaturization techniques (choice of materials, quarter-wave, PIFA, resonator resonator, notch and meander, antennas loaded by passive components, ...)
- high gain antennas ( Parabola, BIE structure, ...)
- active antennas (for high gain or frequency agility)

**Skills acquired (direct/indirect):**

- Ability to design specific antennas according to engineering rules and specifications for the intended application.
- Ability to use a professional CAD tool based on a global electromagnetic approach.

CNU section(s) of teaching : 63

If applicable, other useful information(s):

**Person in charge of the UE** (First Name, Name, Status, Component) :
Luc DUBOIS, Associated Professor, FST – EEA Department

If applicable, other useful information

| **Evaluation methods** (CC, CT, report, oral defence,... + weightings) | |
|---|---|
| Continuous assessment :<br>- Grading of the practical work reports<br>- 1 QCM (Multiple choice questions) on the practical work<br><br>Grade UE = 1/2. (Report ) + 1/2. QCM | |
| If applicable, other useful information | |