

# UE Advanced semiconductor devices



Level  
Baccalaureate  
+5



ECTS  
3 credits



Component  
UFR PhITEM  
(physique,  
ingénierie, terre,  
environnement,  
mécanique)



Semester  
Automne

- > **Teaching language(s):** English
- > **Open to exchange students:** Yes
- > **Code d'export Apogée:** PAX9NPAK

## Presentation

### Description

The first part will give an overview of semiconductor devices trends and evolutions for calculations. Limits of traditional architectures as transistors and memories will be studied. Then we will describe emerging solutions for calculations and memories including devices and architectures for advanced computing and artificial intelligence. The second part will address the physics of light emitting diodes.

#### **Part I Semiconductor devices trends and evolutions for calculation**

##### I.1 Moore's law limits and solutions

- MOSFET nano-transistors basics
- Static and dynamic power
- New architectures (Finfet, Nanowires)
- Dynamic power regulation
- Variability at ultimate scaling

##### I.2 Memories

- Volatile memories
- DRAM
- SRAM
- Non-volatile memories : Flash memories

##### I.3 Emerging non-volatile memories

- Resistive random access memories (OxRAM, CBRAM, PCRAM)

- Crossbar and 3D architectures
- Magnetic random access memories and spintronics
- I.4 3D Technologies for heterogeneous integration
  - 2D integration limitations
  - Parallel 3D
  - Sequential 3D
  - Applications to advanced calculations, smart imagers, photonics.
- I.5 From CMOS to single electron devices
  - New phenomena at ultimate scaling
  - Low temperature electronics
  - Single electron transistor
  - Toward (single) spin electronics and quantum calculations
- I.6 Emerging computing paradigms for AI
  - Some basics of neuromorphic computing
  - Convolutional neuronal networks
  - Spiking neurones using resistive memories
  - Fading the limits between memory and calculation.

**Part II Light emitting diodes: Physics and devices**

- II.1 Fundamentals of radiative recombination in semiconductors.
- II.2 Homojunction vs heterojunction Light emitting diodes.
- II.3 Light emitting diode materials: growth and fabrication techniques.
- II.4 Light emitting diode efficiency (injection, extraction).
- II.5 Specificity of III-nitride Light emitting diodes (e.g. internal electric field, disorder).

## Course parts

UE Advanced semiconductor devices - CMTD	Lectures (CM) & Teaching Unit (UE)	18h
UE Advanced semiconductor devices - TP	Practical work (TP)	8h

## Recommended prerequisites

For part I: from M1: Basic principles (documents can be provided)

Diode, MOS Capacitance , MOSFET, Electronic transport in a semiconductor and in and oxide.

for part II: p-n junction, electronic structures, quantum wells.

**Period** : Semester 9

## Useful info



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## Campus

› Grenoble - University campus