

FUNDAMENTALS OF AUTOMATION AND ELECTRONICS 1 FIELD_12 ECTS

Introducing

Description

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

 Toulouse

In-depth study of electronic circuits

Introducing

Description

Electrical characteristics of diodes and transistors (MOSFETs, JFETs and bipolar transistors). Biasing circuits and corresponding amplifying classes. Models of active components and equivalent small-signal electrical schemes for LF and/or HF signal analysis. Main functions and associated circuitry (current generation, current mirrors, differential amplifiers, etc. ...). Amplifying, filtering and impedance adaptation. Implementation of models in an electrical circuit simulator.

Objectives

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

- The electrical characteristics of diodes and transistors.
- The concept of static biasing and the principle of small signal behaviour around the bias point.
- The different amplification classes for transistors based circuits.
- The concepts of low and high frequency modelling in order to design advanced functional circuits.

The student will be able to:

- Design and realise a bias circuit which is well adapted to a given function.
- Extract the equivalent small signal scheme suited for low or high frequency signal analysis.
- Recognize and implement the basic circuitry such as differential amplification, current generators and

mirrors.

- Know how to use an electrical circuit simulator and the suited models of active components as well as their limitations.
- Know how to build an amplifying and filtering chain with a view to integration.
- Conceive circuits especially adapted to sensors.
- Conceive a power amplifying stage taking into account the power dissipation.

Necessary prerequisites

Fundamentals of electricity, Kirchhoff's laws, Thévenin and Norton's and superposition theorems, voltage and current sources. Fourier's and Laplace's transforms.

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Practical info

Location(s)

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Semiconductors

Introducing

Description

Part 1: Fundamentals of Materials Physics

Presentation of quantum mechanics concepts underlying the electronic structures of the atom.

Introduction to chemical bonding and the organization of matter.

Study of crystalline structures.

Understanding band diagrams to distinguish insulators, semiconductors, and metals, as well as the concept of density of states within a material.

Review of elementary statistical physics to explain how to modify charge densities in a semiconductor material through doping.

Part 2: Doping and PN Junction

Understanding different types of semiconductor doping.

Construction of a simple component like the PN junction, introducing band diagrams of these structures at thermodynamic equilibrium and non-equilibrium (under bias or illumination).

Study of charge carrier diffusion laws to establish the laws governing current levels observed in PN junctions under bias.

Part 3: Bipolar Transistors

Understanding the operation of the PN junction and its integration within a bipolar transistor.

Explanation of various physical properties of bipolar transistors, particularly their role as amplifiers.

Highlighting the links between the electronic properties of components and physical phenomena, such as the current gain parameters Alpha and Beta of bipolar

transistors.

Part 4: CMOS Technologies

Emphasizing the physical links between materials and the electronic operation of MOS capacitors, MOS transistors, and their integration through CMOS technologies.

This course aims to provide students with the fundamental knowledge and practical skills necessary to understand and apply the principles of materials physics and components in information technologies.

Part 5: Practical Work

As part of our module on semiconductor materials and their characterization, you will have the opportunity to participate in 7 hours of practical work in a cleanroom at AIME. These sessions will allow you to implement the knowledge acquired in lectures and tutorials. During these practical sessions, students will construct and electrically characterize photovoltaic cells following the Lumelec procedure developed at AIME. For more details, the Lumelec manual for this practical work is available at the following link: https://www.aime-toulouse.fr/wp-content/uploads/2024/04/FasciculeLumelec_EN_2024-2.pdf

These practical sessions are an excellent opportunity to enhance your technical skills and understand the practical applications of the theoretical concepts covered in the course.

Objectives

This course introduces the physics of materials and components involved in technologies associated with the transmission, processing, and storage of information. It focuses on timeless fundamental

principles in a rapidly developing field.

Expected Competencies:

By the end of this course, the student will be able to:

- 1- Clearly describe and express the various physical principles involved in the processing, transmission, and storage of information.
- 2- Comprehend the overall technologies based on semiconductors, from the atomic level to the application of components.
- 3- Enhance their understanding of the physical properties of semiconductors, particularly the PN junction, which serves as the basic technological building block present in all modern components, whether discrete (such as diodes or bipolar transistors) or integrated (such as field-effect transistors).

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Practical info

Location(s)

 Toulouse

Modeling and Analysis of Continuous Linear Systems

Introducing

Description

This course introduces the notion of state-space representation of dynamic systems. The link with other models (transfer function, differential equation) is particularly discussed, as is how to obtain a model by linearization. Several representation bases are discussed: modal forms, control companion and observation companion. We then look at how to analyze a linear time-invariant system in terms of time response and stability properties.

Objectives

This module focuses on the representation and analysis of continuous linear dynamic systems using the state-space formalism. Students will learn how to change the representation basis, analyze stability and calculate the time response of a linear time-invariant system.

Necessary prerequisites

- Course of 2nd year IMACS « Systèmes bouclés »

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Practical info

Location(s)

 Toulouse

Digital filtering

Introducing

Description

Digital Filtering

- 1.Signal conversion and processing (Analog / Digital, Digital / Analog, Difference equation)
- 2.Discrete-Time linear systems (Z-transform, transfer function, impulse response)
- 3.Filter structure and Design. (FIR and IIR Filters, stability, Bilinear transform)

Objectives

Understanding of discrete time signals and discrete systems,
principles of signal theory and methods of signal processing, with emphasize on spectral analysis and digital filter design

Necessary prerequisites

- Fourier transform and series
- Laplace transform and transfer functions
- Bode diagrams

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