2EL2520 – Electronics for biomedical and communication applications

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Department: DÉPARTEMENT ÉLECTRONIQUE ET ÉLECTROMAGNÉTISME
Language of instruction: ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : Yes

Description
Analog electronic systems are presents in everyday life devices (Smart Phone, biomedical devices, RFID sensors…), but also in more specific and advanced applications (devices for spatial environment, radar/telemetry, aeronautical devices...). The purpose of this course is to provide design methodologies for analog systems based on specification and the basics to be able to analyze an existing circuit.
The proposed approach is based on the study of practical cases. After several theoretical lecture, the student develops his skills through useful everyday life application example like the ElectroCardioGramm, radio transceiver, pulse-oximeter. Every example seen allows to initiate the student to a particular concept in electronics.

For students already passionate by electronics, it is possible to replace the practical works by a personal project. It is mandatory for these students to contact the responsible of the module at the very beginning of the course to check the available material (components, devices, specific software…).

The contexts highlighted in this course are radio communication and biomedical with for example the design of an ECG (ElectroCardioGram) circuit.

Quarter number
SG8

Prerequisites (in terms of CS courses)
The first objective of this course is to introduce and sensitize the students to electronics through step-by-step real application cases. There is no need of a high theoretical level in electronics to follow this course. Nevertheless, it is recommended to master the very basics of electronic circuits to attend

this course (Kirchhoff voltage and current laws, Ohms law).

Syllabus

CM = Lecture
PC = Tutorial
Cours PC = between lecture and tutorial

CM1 : initiation to integrated circuits
Introduction to CMOS integrated techologies, cross sectional view of the transistor, rough explanation of the transistor physics
CM2 : Model of integrated components
Model of passive compoents. Model of the MOS transistor in the different functioning mode.
CM3 : Fundamental circuits for amplification
Analysis of fundamental circuits based on MOS transistors (common source, common drain, common gate).
Cours PC1 : Study of circuits containing one or two transistors
PC1 : First study of a circuit containing one or two transistors
CM4 : Association of fundamental circuits
Design of fundamental blocks: bias current source, current mirror, voltage reference….
Cours PC2 : Study of circuits composed of...circuits
PC2 : Study of a transonductance amplifier (OTA)
CM5 : Gm-C Filter synthesis
Cours PC3 & cours PC4 : Design of a Gm-C filter with LtSpice
CM6 : Transistor as a switch. Electronic circuits based on transistors used as a switch.

The rest of the course is based on a mix of tutorial, small theoretical presentation and practical work.

PC3 : TP1-2 preparation
TP 1-2 : Design of ECG circuit
PC4 : TP 3-4 preparation
TP 3-4
PC4 : TP 5-6 preparation
TP 5-6

Class components (lecture, labs, etc.)

The course mixes theoretical approach with tutorials presenting classical practical cases commented by a teacher. This way the students get familiar

with the reasoning methodology and will be able to reproduce these reasoning on other cases.

Grading

Quiz + homework + TP evaluation (powerpoint). The presence in practical work is mandatory as the work done during the session (calculation, solution search…) is part of the evalutation. The presence is also mandatory for personal project.

Course support, bibliography

Tony Cahn Carusone, David A. Johns, Kenneth W. Martin "Analog Integrated Circuit Design" Wiley

R. Jacob Baker « CMOS Circuit Design, Layout and Simulation" IEEE Series on Microelectronics Systems and Wiley

Resources

It is highly recommended to practice in order to master electronics. This is why this course mixes theoretical approach with tutorials presenting classical practical cases commented by a teacher. Most of the practical cases are illustrated by a LtSpice circuits available to the students, so they can be simulated simultaneously during the courses and increase the understanding of the phenomena.

Learning outcomes covered on the course

After this course, the students will be capable of:
- designing an electronic assembly to achieve an analog signal processing chain for biomedical or communication application
- analyzing an electronic assembly based on opamp, transistors and passive elements

Description of the skills acquired at the end of the course

C1.4 Specify, design, build and validate all or part of a complex system
C6.2 Practice collaborative design through design or prototyping tools (CAD, 3D printers...)
C8.1 Work in team/collaboration
C2.1 Have developed a field or discipline related to the basic engineering sciences