COURSE DESCRIPTION
POWER DEVICES AND CIRCUITS

SSD: ELETTRONICA (ING-INF/01)

DEGREE PROGRAMME: INGEGNERIA ELETTRONICA (M61)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: NOT APPLICABLE
MODULE: NOT APPLICABLE
CHANNEL: A-Z
YEAR OF THE DEGREE PROGRAMME: II
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER I
CFU: 9

REQUIRED PRELIMINARY COURSES

none

PREREQUISITES

Basics of semiconductor devices physics. Characteristics of the MOSFET, the BJT and the diode.

LEARNING GOALS

The Power Devices and Circuits course aims to present the main problems, together with the related circuit solutions, connected to the conditioning of electric power in all those applications in which the conversion efficiency is of fundamental importance, regardless of the amount of power actually managed, and therefore in voltage regulators used in the microchips as well as in the power supplies for large electrical loads. As a matter of fact, if on the one hand the growing diffusion of battery-powered portable electronic devices raises the problem of the limited energy available inside them and the consequent target of maximizing efficiency to prolong their functioning for as long as possible, on the other hand the global climate emergency requires more

and more attention to the efficient use of electricity in large appliances or industrial plants. In these, as in many other applications in between, modern solid state devices and electronic circuits play an essential role, and their knowledge and optimization are the central object of this course.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

After passing the exam, the student possesses advanced knowledge of the most modern semiconductor electronic devices used in power electronics and their optimal use in circuits for the conversion of static power. Furthermore, it is possible to understand the impact of the physical and operational limits of these devices on the fundamental electrical characteristics of the power conditioning circuits, and to identify the most efficient solutions depending on the application in question. Finally, it is possible to understand the impact of temperature control techniques on the correct operation of said devices and circuits.

Applying knowledge and understanding

In order to pass the exam, it is necessary to be able to explain the operation of modern semiconductor devices used in power electronics, illustrating, even in a comparative way, their respective electrical characteristics, physical limits, advantages and disadvantages that can derive from their use in various contexts. It is also necessary to know the properties of the main power conditioning circuits, understanding each time which of these properties are most relevant depending on the required application. Finally, it is necessary to have acquired good familiarity with the computer aided design (CAD) tools normally used in power electronics (SPICE and similar environments).

COURSE CONTENT/SYLLABUS

Power semiconductor devices. Rectifiers: PiN diode and Schottky diode. Controlled rectifiers: SCR, GTO. Bipolar controller devices: BJT. Voltage controller devices: MOS and IGBT. Current and voltage limitations. Superjunction devices. Transient behavior for power semiconductor devices. Integrated power devices. Wide bandgap materials. GaN power devices. Safe Operating Area. Power amplifiers. Power conversion. Power efficiency. Static and dynamic power dissipation. Circuits: linear regulators, Low Drop Out (LDO) regulators, bandgap reference circuits, DC/DC converters, Buck, Boost, Bridge. Inverters DC/AC. Isolated converters: flyback and forward. Driving circuits. Device ratings. Thermal impedance and thermal resistance. Device cooling starategies. Case studies: maximum power point trackers (MPPT) for photovoltaic applications, inverters for automotive powertrains, wireless power chargers, circuits for energy harvesting.

READINGS/BIBLIOGRAPHY

Slides used during the lectures, notes provided by the teacher, video recordings of lessons

TEACHING METHODS OF THE COURSE (OR MODULE)

The teacher will use: a) lectures for about 70% of the total hours, b) exercises for the application and deepening of theoretical aspects, both numerical and based on the use of circuit simulators.

There will also be short seminars held by experts in the field of circuit design for power management.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

- [ ] Written
- [x] Oral
- [ ] Project discussion
- [ ] Other

In case of a written exam, questions refer to

- [ ] Multiple choice answers
- [ ] Open answers
- [ ] Numerical exercises

b) Evaluation pattern