



Course guide

240257 - 240EN39 - Electric Energy Conversion

Last modified: 19/05/2025

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: MASTER'S DEGREE IN ELECTRIC POWER SYSTEMS AND DRIVES (Syllabus 2021). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Albernaz Lacerda, Vinícius

Others:

PRIOR SKILLS

Basic knowledge on electric circuits and control and basic knowledge of simulation of electric circuits.

REQUIREMENTS

None

TEACHING METHODOLOGY

Masterclasses for main concepts, combining theoretical concepts, exercises and simulations.

LEARNING OBJECTIVES OF THE SUBJECT

- Understand the working principles of power electronic devices and systems
- Know the basic topologies and their relations
- Size and select the main components of a power converter

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	36.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Introduction to power electronics and its elements

Description:

- Definition and Applications of power electronics. Commutation.
- Components in power electronics: sources. Basic rules of sources connection. Basic components in power electronics: ideal switch.
- Diode. Thyristor. MOSFET. IGBT. Other types. Losses and drivers

Full-or-part-time: 18h

Theory classes: 6h

Self study : 12h

Power converters

Description:

Module 1 - Diode rectifiers: introduction and applications of uncontrolled rectifiers.

Module 2 - Controlled rectifiers: introduction and applications of controlled rectifiers.

Module 3 - DC/DC converters: Introduction and Applications of DC/DC converters. Buck converter. Boost converter. 2 quadrant converter. H-bridge: 4 quadrant converter. Three-level switching.

Module 4 - AC/DC converters: current converters: Introduction and applications of AC/DC converters. Synthesis of AC/DC converters. Single and three phase rectifiers.

Module 5 - DC/AC converters: inverters: Introduction and applications of AC/DC converters. Synthesis of DC/AC converters. Single phase inverter. Three phase inverters. SVPWM.

Full-or-part-time: 80h

Theory classes: 30h

Self study : 50h

Converter control and applications

Description:

Module 1 Auxiliary control elements

Voltage and current sensors. Analog and digital control. PWM modulation. Analog to digital conversion.

Module 2 Model and converter control

Modelling of converter: average model and switched model. Control tuning. Digital implementation.

Module 3 - Applications of power electronics

Renewable Energy applications: wind, PV, microgrids

Motor control applications: industrial VFD, EV powertrain, railway, ships

Power supplies: Uninterruptible Power Supplies, power supplies

Transport and distribution of Energy: HVDC, FACTS, STATCOM, active filters and reactive power compensation

Other applications: induction heating, soldering, electrolysis, lighting

Full-or-part-time: 27h

Theory classes: 9h

Self study : 18h

GRADING SYSTEM

Final mark = 0,7 final exam + 0,3 simulation activities

In case the reevaluation exam is necessary for you, the same methodology for computing the final mark will be used, but substituting the final exam mark by the mark in the reevaluation exam.



EXAMINATION RULES.

The final exam will be on the dates fixed by the school. The final exam and reevaluation exam consist of theoretical aspects, but also the aspects seen in the simulations.

BIBLIOGRAPHY

Basic:

- Rashid, Muhammad H.. Power electronics : devices, circuits and applications. 4th ed.. Boston: Pearson, 2014. ISBN 9780273769088.
- Hart, Daniel. Power electronics. New York: McGraw Hill, 2011. ISBN 9780071289306.
- Barrade, Philippe. Électronique de puissance : méthodologie et convertisseurs élémentaires. Lausanne: Presses polytechniques et universitaires romandes, cop. 2006. ISBN 9782880745660.
- Mohan, Ned; Robbins, William P; Undeland, Tore M. Power electronics : converters, applications, and design. 3rd ed. New York [etc.]: John Wiley & Sons, cop. 2003. ISBN 9780471226932.
- Buso, Simone ; Mattavelli, Paolo. Digital control in power electronics [on line]. [San Rafael, Calif.]: Morgan & Claypool Publishers, cop. 2006 [Consultation: 14/09/2022]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=881367>. ISBN 9781598291124.
- Blaabjerg, Frede; Kazmierkowski, Marian P; Krishnan, Ramu. Control in power electronics : selected problems [on line]. Amsterdam [etc.]: Academic Press, cop. 2002 [Consultation: 14/09/2022]. Available on: <https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780124027725/control-in-power-electronics>. ISBN 0124027725.