UNIVERSITÀ DI PAVIA

## Anno Accademico 2020/2021

# ELECTRONICS FOR INDUSTRY

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| **Enrollment year** | 2018/2019 |
| **Academic year** | 2020/2021 |
| **Regulations** | DM270 |
| **Department** | DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING |
| **Course** | INDUSTRIAL ENGINEERING |
| **Curriculum** | Energia |
| **Year of study** | 3° |
| **Period** | Annual (28/09/2020 - 14/06/2021) |
| **ECTS** | 12 |
| **Language** | Italian |
| **Prerequisites** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |
| **Learning outcomes** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |
| **Course contents** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |
| **Teaching methods** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |
| **Reccomended or required readings** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |
| **Assessment methods** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia. |

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| | Please refer to these two modules for information. |
| **Further information** | This course is composed by two modules: Elettronica and Conversione statica dell'Energia.<br>Please refer to these two modules for information. |

**The activity is split**

504062 - **STATIC ENERGY CONVERSION**

500544 - **ELECTRONICS**

UNIVERSITÀ DI PAVIA

## Anno Accademico 2020/2021

# STATIC ENERGY CONVERSION

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|---|---|
| **Enrollment year** | 2018/2019 |
| **Academic year** | 2020/2021 |
| **Regulations** | DM270 |
| **Academic discipline** | ING-IND/32 (POWER ELECTRONIC CONVERTERS, ELECTRICAL MACHINES AND DRIVES) |
| **Department** | DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING |
| **Course** | INDUSTRIAL ENGINEERING |
| **Curriculum** | Energia |
| **Year of study** | 3° |
| **Period** | 2nd semester (08/03/2021 - 14/06/2021) |
| **ECTS** | 6 |
| **Lesson hours** | 45 lesson hours |
| **Language** | Italian |
| **Activity type** | ORAL TEST |
| **Teacher** | ZANCHETTA PERICLE - 6 ECTS |
| **Prerequisites** | Basic theory of passive linear networks. Principles of electrical engineering. |
| **Learning outcomes** | The first module of this course is focused on the main analog linear and non-linear applications of junction diodes, field effect transistors and operational amplifiers. Moreover, it offers a basic knowledge of MOS logical families and digital circuits. The final goal of the course is to teach the students how to analyze and perform measurements on analog circuits, and the design of simple circuits with op-amps and discrete MOS devices. The second module of this course is focused on the analisys of the characteristics of semiconductor power devices, electronic power converters and related industrial applications. |
| **Course contents** | This course includes two modules: Electronics (prof. Annovazzi Lodi) |

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| | and Static energy conversion (prof. Dallago). The first module is an introduction to linear and non-linear analog electronics, and to digital electronics. The second module is an introduction to static power converters and their industrial applications.<br><br>Programme of the module of Static energy conversion<br><br>Introduction. The electrical energy and applications . The electrical energy processing. Static conversions. Electromagnetic transformer. The power electronic converter. Thermal problems and cooling.<br>Electronic devices. The silicon and pn junction. Static characteristics of power electronic devices: diode. Bipolar junction transistor, thyristors (SCR, TRIAC, GTO), mosfet, insulated gate bipolar transistor. Assembly of diodes and SCRs.<br>AC/DC conversion Introduction: loads and direct current employment. Assumptions on which is based the study of rectifier circuits. Monophase rectifiers. Poliphase rectifiers. Three-phase transformers and interphase transformers. The phase control. The natural commutation of diodes and SCRs. Voltage drops. Harmonics. Applications: dc electrical drives and High Voltage Direct Current (HVDC) transmission.<br>DC/DC conversion. Working principle of the chopper. SCR chopper and GTO chopper. Application of the chopper in electrical traction.<br>DC/AC conversion. Introduction. The monophase inverter: output voltage- frequency control. Voltage source three-phase inverter. Current source inverter. Square wave three-phase inverter. The pulse width modulation technique.<br>AC/AC conversion The cycloconverter. Applications. |
| **Teaching methods** | Lectures (hours/year in lecture theatre): 68<br>Practical class (hours/year in lecture theatre): 36<br>Practicals / Workshops (hours/year in lecture theatre): 12 |
| **Reccomended or required readings** | A.Sedra, K.Smith. Microelectronic Circuits, III or newer ed. Oxford University Press .<br><br>G. Moeltgen.. I tiristori: circuiti di conversione, teoria ed impiego. . Etas libri. .<br><br>J. Schaefer. . Rectifier Circuits: Theory and Design.. John Wiley & Sons. .<br><br>B. W. Williams. . Power Control Electronics. . Prentice-Hall. . |
| **Assessment methods** | Electronics: Written examination consisting of the analysis of an amplifier stage with discrete devices, and of a circuit with an operational amplifier. Oral examination on the whole program. Static energy conversion: Oral examination on the whole program. |
| **Further information** | Electronics: Written examination consisting of the analysis of an amplifier stage with discrete devices, and of a circuit with an operational amplifier. Oral examination on the whole program. Static energy conversion: Oral examination on the whole program. |

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| **Sustainable development goals - Agenda 2030** | $lbl_legenda_sviluppo_sostenibile |

UNIVERSITÀ DI PAVIA

## Anno Accademico 2020/2021

| ELECTRONICS | |
|---|---|
| **Enrollment year** | 2018/2019 |
| **Academic year** | 2020/2021 |
| **Regulations** | DM270 |
| **Academic discipline** | ING-INF/01 (ELECTRONICS) |
| **Department** | DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING |
| **Course** | INDUSTRIAL ENGINEERING |
| **Curriculum** | Energia |
| **Year of study** | 3° |
| **Period** | 1st semester (28/09/2020 - 22/01/2021) |
| **ECTS** | 6 |
| **Lesson hours** | 80 lesson hours |
| **Language** | Italian |
| **Activity type** | WRITTEN AND ORAL TEST |
| **Teacher** | ANNOVAZZI LODI VALERIO (titolare) - 6 ECTS |
| **Prerequisites** | Basic theory of passive linear networks. Principles of electrical engineering. |
| **Learning outcomes** | This module is focused on the main analog linear and non-linear applications of junction diodes, field effect transistors and operational amplifiers. Moreover, it offers a basic knowledge of MOS logical families and digital circuits. The final goal of the course is to teach the students how to analyze and perform measurements on analog circuits, and the design of simple circuits with op-amps and discrete MOS devices. |
| **Course contents** | The course of Electronics for Industrial Engineering includes two modules: 'Elettronica' (Electronics) by prof. Annovazzi Lodi and Static energy conversion by prof. Zanchetta.<br>The first module, described here, is an introduction to linear and non-linear analog electronics, and to digital electronics. |

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| | Programme of the module of Electronics<br><br>Operational amplifiers.?<br>Ideal operational amplifier. Adder, subtractor, integrator, differentiator. Network synthesis with op-amps. Bias currents and voltage offset. Multivibrators.<br><br>?Junction diodes.<br>Avalanche and Zener diodes. Voltage regulators. Rectifiers.<br><br>JFET and MOS devices.<br>Biasing. Small signal model. Basic amplifier stages. Current mirrors. The MOSFET as a switch.<br><br>Digital circuits?<br>Basic digital gates. MOS integrated gates: n-MOS inverters; the CMOS inverter. The latch and the Flip-flop. Memories. D/A and A/D converters.<br><br>Linear networks.<br>?Amplifiers and their circuit models; Theorems of Norton, Thevenin, Miller. Time and frequency response of single time constant circuits. Bode diagrams. |
| **Teaching methods** | The course includes classroom lessons where the theory of active elements and electronic circuits of the course is developed; classroom exercises where numerical examples are performed on analysis and synthesis of amplifiers and signal processing circuits with discrete elements and operational amplifiers; finally, laboratory activity consisting in measurements on active and passive, linear and nonlinear electronic circuits, selected from those presented during lessons. |
| **Reccomended or required readings** | A.Sedra, K.Smith. Microelectronic Circuits, III or newer ed. Oxford University Press. |
| **Assessment methods** | The exam for the Module 'Elettronica' consists of a written test with circuits using discrete active elements and operational amplifiers, to evaluate the candidate's ability to apply the analysis methodologies presented during the course. The maximum mark of the written test 24/30, and can be increased by giving an oral test to evaluate the knowledge of the main analog and digital circuits presented in this course. The oral test is compulsory to fix an insufficient mark of the written test.<br>For students giving also the module Conversione statica dell'energia, the final mark of the full course Elettronica per Ingegneria Industriale is the mean of the marks of the two modules. |
| **Further information** | The exam for the Module 'Elettronica' consists of a written test with circuits using discrete active elements and operational amplifiers, to evaluate the candidate's ability to apply the analysis methodologies presented during the course. The maximum mark of the written test 24/30, and can be increased by giving an oral test to evaluate the knowledge of the main analog and digital circuits presented in this course. The oral test is compulsory to fix an insufficient mark of the |

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| | written test.<br>For students giving also the module Conversione statica dell'energia, the final mark of the full course Elettronica per Ingegneria Industriale is the mean of the marks of the two modules. |
| **Sustainable development goals - Agenda 2030** | $lbl_legenda_sviluppo_sostenibile |