Syllabus

Course Description

Course Title	Applied Mechanics and Technologies for Energy Efficiency
Course Code	45531
Course Title Additional	
Scientific-Disciplinary Sector	
Language	English
Degree Course	Master in Energy Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Dr. Erwin Rauch, Erwin.Rauch@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/17786 Dott. Roberto Belotti, Roberto.Belotti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38331 Dott. Davide Don, Davide.Don@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/49990
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	12
Teaching Hours	68
Lab Hours	48
Individual Study Hours	0
Planned Office Hours	36
Contents Summary	Module 1 - Basic knowledge about the main features of power generation, storage, and distribution plants.

	Module 2 - The course aims to give guidelines for the functional design of automatic machines, in particular taking into account mechanical efficiency. Criteria and methods to analyze and choose mechanical devices, design motion laws and evaluate the best system to minimize energy dissipation in electromechanical systems will be addressed.
Course Topics	Module 1: Technologies and Production Processes for Energy Engineering provides students the basics for designing sustainable and energy efficient manufacturing processes, machines, factories and production networks. Further the course allows students to learn and practice methods and software systems for applying lifecycle assessment (LCA) and energy audits. Theory Part: 1) Introduction in sustainable manufacturing 2) Overview of general manufacturing technologies 3) Green manufacturing technologies and systems 4) Resources: Materials, Circular Economy, Zero Waste Management in Production 5) Energy: Energy types and Energy Efficiency in Manufacturing Industry 6) Standards, Sustainability reporting, KPIs in manufacturing and data-based monitoring 7) Theory to Lifecycle Assessment (LCA) 8) Theory to Energy Audit according to ISO 50001 Practical Part (2 assignments): 1) Assignment 1: Lifecycle Assessment (LCA) using OpenLCA software. Data collection at a case study company and assignment work in small groups 2) Assignment 2: Energy Audit according ISO 50001. Data collection at a second case study company and assignment work in small groups Module 2: The course aims at giving the guidelines for the functional design of automatic machines, in particular taking into account mechanical efficiency.

	Criteria and methods to analyze and choose mechanical devices, design motion laws and to evaluate the best system to minimize the energy dissipation in electromechanical systems will be addressed. • Comparison of mechanisms • Energy efficiency • Mechanical transmissions • Electric motors • Selection of components (electric motor and transmission) • Trajectory planning • Energy storage systems and energy recovery
Keywords	Sustainable manufacturing, lifecycle assessment, energy audit, mechanical functional design; automatic machines
Recommended Prerequisites	Module 1: students should be familiar with the basic knowledge of manufacturing engineering. Module 2: Some knowledge of electrical machines is preferred, e.g. the content of the course "Electric Power Conversion Equipment".
Propaedeutic Courses	
Teaching Format	Frontal lectures Excursion to companies Guest lectures from practitioners Exercises/assignments with computational software tools The professor can be contacted by students for questions and clarifications by appointment.
Mandatory Attendance	Strongly recommended.
Specific Educational Objectives and Learning Outcomes	- Module 1: Knowledge and understanding: Students will 1. acquire a knowledge about some important production processes used for the fabrication of the main mechanical assemblies and components in the energy industry. 2. be able to identify the advantages and limitations of these industrial production processes. 3. acquire a basic knowledge of the production process Applying Knowledge and understanding: 4. Students will be able to select some manufacturing processes to

	be used in the energy industry. 5. Students will have the ability to apply their knowledge to identify which are the main systems and issues of a production process. 6. The exercises in the classroom, progress tests, conversations with the teacher, and the performance of specific tasks would allow us to assess and evaluate the student's ability to apply his knowledge and understanding of the topics covered during the course. Making judgments: Students will acquire an autonomy of judgment that will allow him. 7. to select proper manufacturing processes for the fabrication of some mechanical assemblies and components in the energy engineering field. 8. to examine objectively the results obtained from analytical processing, numerical simulations or experimental laboratory tests. 9. to make use of technical and scientific literature. Communication skills: 10. Students will have the ability to structure and prepare scientific and technical documentation inherent to the selection of some manufacturing processes used in the energy engineering field. 11. students will have the ability to present, communicate, discuss and argue the topics covered in the course. Learning skills: 12. The students will develop learning skills through the individual study of the topics dealt with in the lecturing and exercise hours. In addition, the analysis of different problems related to the fabrication of mechanical components for the energy engineering field will also be addressed by group discussions. 13. The students will have the opportunity to extend the knowledge of the topics of the course by consulting scientific literature, specialized texts, technical standards and international standards that the professor will provide during the course. - Module 2: The course aims to give guidelines for the functional design of automatic machines, in particular taking into account mechanical

	efficiency. Criteria and methods to analyze and choose mechanical devices, design motion laws and evaluate the best system to minimize energy dissipation in electromechanical systems will be addressed. 1. Knowledge and Understanding • Identify the main components of transmission systems and sources of inefficiency • Understand the basic principles of energy storage, recovery and redistribution systems. 2. Applying knowledge and understanding • Evaluate and select the proper transmission system considering mechanical and energy efficiency. 3. Making judgments • Select and design an effective motion law under different working conditions and targets. • Choose a suitable combination of mechanical and electric components for energy transformation and transfer 4. Communication skills • Ability to structure and prepare scientific and technical documentation 5. Learning skills • Ability to independently build upon the knowledge acquired during the study course by reading and understanding scientific and technical documentation.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Module 1: Written exam means exam with review questions and exercises (Duration 3h) 50% weight. The learning outcomes covered are 1, 2, 3, 5. Assignments in lab exercises means: case study work, group work in small groups and subsequent presentation of the results. Assignments cover the following learning outcomes: 2, 3, 4, 5 25% weight for Assignment 1 25% weight for Assignment 2 - Module 2:

	- Formative assessment In-class exercises: continuosly in exercise courses; ILOs assessed: 1, 2, 3, 4, 5. - Summative assessment Written exam: 3 h; ILOs assessed: 1, 2, 3, 4, 5.
Evaluation Criteria	- Module 1: The grade is calculated 50% from the results of the written exam and 50% from the results of the project work performed in assignments. Criteria for the evaluation of the written examination: completeness and correctness of the answers. Criteria for the evaluation of the project work / case study: accuracy and completeness as well as creativity in structuring of the proposed solution, the quality of the results and quality of presentation. Final Mark of the Course "Applied Mechanics and Technologies for energy Efficiency" Mathematical average of the marks obtained in the Module 1 and 2.
Required Readings	Module 1: There is no single textbook that covers the entire course. A collection of suggested readings from various sources will be announced during the course. Module 2: Slides provided to the students after each lecture and notes taken by students during lecture
Supplementary Readings	Module 1: A collection of suggested readings from various sources will be announced during the course. Such sources will be papers, manuals, technical notes, and excerpts from textbooks. Module 2: A collection of suggested readings from various sources will be announced during the course. Such sources will be papers, manuals, technical notes, and excerpts from textbooks, including Biagiotti, Luigi, and Claudio Melchiorri. Trajectory planning for automatic machines and robots. Springer Science & Business

	Media, 2008. Norton, Robert L. Kinematics and dynamics of machinery. McGraw Hill Higher Education, 2009. Filizadeh, S. Electric Machines and Drives: Principles, control, modelling and simulation. CRC Press, 2013
Further Information	
Sustainable Development Goals (SDGs)	Affordable and clean energy, Climate action, Responsible consumption and production, Industry, innovation and infrastructure

Course Module

Course Constituent Title	Technologies and Production Processes for Energy Engineering
Course Code	45531A
Scientific-Disciplinary Sector	IIND-04/A
Language	English
Lecturers	Prof. Dr. Erwin Rauch, Erwin.Rauch@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/17786 Dott. Davide Don, Davide.Don@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/49990
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18

Contents Summary	
Course Topics	Module 1 (Technologies and Production Processes for Energy Engineering) provides students the basics for designing sustainable and energy efficient manufacturing processes, machines, factories and production networks. Further the course allows students to learn and practice methods and software systems for applying lifecycle assessment (LCA) and energy audits. Theory Part: 1) Introduction in sustainable manufacturing 2) Overview of general manufacturing technologies 3) Green manufacturing technologies and systems 4) Resources: Materials, Circular Economy, Zero Waste Management in Production 5) Energy: Energy types and Energy Efficiency in Manufacturing Industry 6) Standards, Sustainability reporting, KPIs in manufacturing and data-based monitoring 7) Theory to Lifecycle Assessment (LCA) 8) Theory to Energy Audit according to ISO 50001 Practical Part (2 assignments): 1) Assignment 1: Lifecycle Assessment (LCA) using OpenLCA software. Data collection at a case study company and assignment work in small groups 2) Assignment 2: Energy Audit according ISO 50001. Data collection at a second case study company and assignment work in small groups
Teaching Format	Frontal lectures Excursion to companies Guest lectures from practitioners Exercises/assignments with computational software tools The professor can be contacted by students for questions and clarifications by appointment.
Required Readings	There is no single textbook that covers the entire course. A collection of suggested readings from various sources will be

	announced during the course.
Supplementary Readings	Additional textbooks, lecture notes, research papers and readings may be provided by the professor. • Schebek, L., Herrmann, C., & Cerdas, F. (Eds.). (2019). Progress in Life Cycle Assessment (Sustainable Production, Life Cycle Engineering and Management). Cham, Switzerland: Springer International Publishing. • Thiede, S., & Herrmann, C. (Eds.). (2019). Eco-factories of the Future. Springer International Publishing. • David A. Dornfeld, Editor. Green Manufacturing - Fundamentals and Applications. Springer (2013). ISBN 978-1-4419-6015-3.

Course Module

Course Constituent Title	Functional Mechanical Design for Energy Efficiency
Course Code	45531B
Scientific-Disciplinary Sector	IIND-02/A
Language	English
Lecturers	Dott. Roberto Belotti, Roberto.Belotti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38331
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	32
Lab Hours	24
Individual Study Hours	94
Planned Office Hours	18
Contents Summary	The course aims to give guidelines for the functional design of automatic machines, in particular taking into account mechanical efficiency. Criteria and methods to analyze and choose mechanical devices, design motion laws and evaluate the best system to

	minimize energy dissipation in electromechanical systems will be addressed.
Course Topics	• Comparison of mechanisms • Energy efficiency • Mechanical transmissions • Electric motors • Selection of components (electric motor and transmission) • Trajectory planning • Energy storage systems and energy recovery
Teaching Format	Frontal lectures, hand-calculation exercises, computer-assisted exercises.
Required Readings	Slides provided to the students after each lecture and notes taken by students during lecture.
Supplementary Readings	A collection of suggested readings from various sources will be announced during the course. Such sources will be papers, manuals, technical notes, and excerpts from textbooks, including • Biagiotti, Luigi, and Claudio Melchiorri. Trajectory planning for automatic machines and robots. Springer Science & Business Media, 2008. • Norton, Robert L. Kinematics and dynamics of machinery. McGraw Hill Higher Education, 2009. • Filizadeh, S. Electric Machines and Drives: Principles, control, modelling and simulation. CRC Press, 2013