Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Applied Mechanics and Technologies for Energy Efficiency
Course code	45531
Scientific sector	Ing-Ind/16 and Ing-Ind/13
Degree	Master Energy Engineering
Semester	I
Year	2
Academic year	2019/20
Credits	12
Modular	Yes

Total lecturing hours	Module 1: 34 – Module 2: 36
Total lab hours	-
Total exercise hours	Module 1: 22 – Module 2: 24
Attendance	-
Prerequisites	Module 1: students should be familiar with the basic knowledge of mathematical analysis. Some knowledge of electrical machines is preferred, e.g. the content of the course “Electric Power Conversion Equipment”
Course page	https://www.unibz.it/en/faculties/sciencetechnology/master-energy-engineering/

Specific educational objectives	**Module 1: Technologies and production processes for energy engineering** The course deals with the fundamentals of design of industrial plants and of some production processes used to manufacture the main components and assemblies needed for the production, processing, storage, and transportation of energy, obtained from both renewable (solar, wind) and fossil resources (natural gas, oil, and coal). In this context, the course aims to provide students some skills in the design of industrial plants and to develop their understanding of technical, economic, environmental, safety and health, risk and legislative issues. Moreover, basic knowledge about production processes (both conventional and advanced) used to fabricate wind turbines, gas and hydraulic turbines, solar photovoltaic panels, electric cables and so forth. Besides theoretical knowledge, practical examples and company visits will permit students to reflect on the peculiar characteristics of certain production processes, also in terms of environmental impact and materials recycling, used to yield components and assemblies in the

	energy engineering field. **Module 2:** The course aims at giving the guidelines for the functional design of automatic machines, in particular taking into account mechanical and energetic efficiency. Criteria and methods to analyze and choose mechanical devices, design motion laws and to evaluate the best system to minimize the energy consumption in electromechanical systems will be addressed.

Module 1	**Technologies and Production Processes for Energy Engineering**
Lecturer	*Dr. Pasquale Russo Spena* Faculty of Science and Technology mail pasquale.russospena@unibz.it
Scientific sector of the lecturer	Ing-Ind/16 Manufacturing Technology and Systems
Teaching language	English
Office hours	By appointment
Teaching assistant *(if any)*	-
Office hours	-
List of topics covered	1. Manufacturing processing of: a) Gas turbine blades; b) Windmill blades for eolic plants; c) Tanks and pressure containers; d) Pipings and fittings, welds; e) Rotor and shaft; f) Metal cables for electric energy distribution; g) Solar and photovoltaic panels. 2. Basic knowledge of plant systems: a) Piping and water systems b) Building services plants c) Fire protection plants d) Steam, compressed air and refrigeration plants
Teaching format	The course is based on hours of frontal lectures and hours dedicated to classroom and/or laboratory activities, and visits to companies. The topics of the course are reported in the lecture notes provided by the professor, as well as in the textbooks of the bibliography. After each lecture, the corresponding pdf presentation will be posted in the Reserve Collection database. The professor can also provide additional material (e.g., research papers). The professor can be contacted by students for questions and clarifications by appointment.

Module 2	**Functional Mechanical Design for Energy Efficiency**
Lecturer	*Dr. Roberto Belotti* Faculty of Science and Technology Office K2.11, Building K mail roberto.belotti@unibz.it tel. +39 0471 017760
Scientific sector of the lecturer	ING-IND/13 Applied Machanics
Teaching language	English
Office hours	By appointment
Teaching assistant *(if any)*	-
Office hours	-
List of topics covered	• Introduction: The functional design. Introduction to functional design, classification of the mechanisms and motion systems. • Basic concepts and definitions. Mechanical efficiency, performance, energy efficiency and energy savings in automatic machines. Retrograde motion and motor-load systems. • Mechanical components for transfer and transformation of energy. Classification based on function, working principle and performance/efficiency. • Optimization aimed at improving the quality of motion and efficiency. • Energy storage systems and energy recovery. Classification (working principle and scope of use). • Classification of motion laws implemented in automatic machines. Analysis of the main requirements in the design of a motion law and its optimization.
Teaching format	Frontal lectures, exercises, labs.

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 systems of an industrial plant. **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 an industrial plant. 6. The exercises in the classroom, progress tests,

	conversations with the teacher, and the performance of specific tasks would allow to assess and evaluate the students 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 critically identify and select the systems necessary to an industrial plant; 9. to examine objectively the results obtained from analytical processing, numerical simulations or experimental laboratory tests; 10. to make use of technical and scientific literature. **Communication skills:** 11. Students will have the ability to structure and prepare scientific and technical documentations inherent to the selection of some manufacturing processes and systems used in the energy engineering field; 12. students will have the ability to present, communicate, discuss and argue the topics covered in the course. **Learning skills:** 13. The students will develop learning skills through the individual study of the topics dealt in the lecturing and exercise hours. In addition, the analysis of different problems relative to industrial plants and the fabrication of mechanical components for the energy engineering field will also be addressed by group discussions. 14. The students will have the opportunity to extent 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** **Knowledge and Understanding** 1. Identify the main components and sources of inefficiency in motor-transmission-load systems 2. Understand the basic principles of the main energy storage, recovery and redistribution systems; **Applying knowledge and understanding** 3. Evaluate and select, from the mechanical and energy efficiency point of view, the proper transmission system; **Making judgments** 4. Select and design an effective motion law under different working conditions and targets; 5. Choose suitable and proper mechanical components for energy transformation and transfer

	Communication skills 6. Ability to structure and prepare scientific and technical documentation **Learning skills** 7. Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.
Assessment	**MODULE 1** *Formative assessment* In class discussion about the topics covered during the course (ILOS assessed 1,2,3,6,13). *Summative assessment* The assessment of the course is: • Oral exam (ILOS assessed 4,5,7,8,9,12) The oral exam consists in 2 or 3 open-end questions to assess the knowledge and understanding of the topics of the course and the ability of the student to present, communicate, discuss and argue the basics of industrial plant systems and of some industrial processes used in energy industry. Moreover, the student will should reflect on the characteristics of a production process and its limitations in terms of product quality, cost and so forth. **MODULE 2** *Formative assessment* In class exercises and activities (ILOs assessed 2,3,4,5) *Summative assessment* The assessment of the course is: • Written exam (ILOs assessed 1,2,3,4). Written exam with exercises and questions to test the ability to use and transfer the acquired knowledge as well as to make judgement and use a proper technical language. • Project work (ILOs assessed 4,5). Short essay on a topic of interest, to be agreed upon with the lecturer.
Assessment language	English
Evaluation criteria and criteria for awarding marks	**MODULE 1** The evaluation criterion of the oral exam is based on the knowledge of the topics of the course, the clarity of the response and the properties of language of the student (in relation to the language of the course), the pertinence and the relevance of the response, and the autonomy of judgment. **MODULE 2**

	The final grade is the written exam grade, augmented or diminished by at most 1 point, according to the project work evaluation. N.B. The written exam grade must be ≥18 anyway. **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** The course material is mainly collected from research papers and web notes. The student can also refer to the following textbooks (even if not exhaustive of the whole course): 1) S. Kalpakjian, Manufacturing engineering and technology, Prentice Hall. 2) M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems; Wiley. 3) A. Monte, Elementi di Impianti Industriali Vol.I e Vol.II, Ed. Libreria Cortina Torino 4) A. Pareschi, Impianti Industriali, Ed. Progetto Leonardo Bologna. **MODULE 2** 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	**MODULE 1** Additional textbooks, lecture notes, research papers and readings may be provided by the professor.