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 in Energy Engineering LM-30
Semester	I
Year	1
Academic year	2017/2018
Credits	12
Modular	Yes

Total lecturing hours	Module 1: 34 – Module 2: 36
Total lab hours	
Total exercise hours	Module 1: 24 – Module 2: 22
Attendance	
Prerequisites	Module 1: students should be familiar with the basic knowledges of solid mechanics and mathematical analysis.
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, Building K, Office K1.12 mail pasquale.russospena@unibz.it tel. +39 0471 017112
Scientific sector of the lecturer	Ing-Ind/16 Manufacturing Technologies and Systems
Teaching language	English
Office hours	from Monday to Friday 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 plants e) Compressed air plants f) 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 the students for questions and clarifications by appointment.
Learning outcomes	**Knowledge and understanding:** The student i) will acquire a knowledge about some important production processes used for the fabrication of

	the main mechanical assemblies and components in the energy industry; ii) will be able to identify the advantages and limitations of these industrial production processes; iii) will acquire a basic knowledge of the systems of an industrial plant. **Applying Knowledge and understanding:** The student will be able to select some manufacturing processes to be used in the energy industry. Moreover, he/she will have the ability to apply their knowledge to identify which are the main systems and issues of an industrial plant. The exercises in the classroom, progress tests, conversations with the teacher, and the performance of specific tasks would allow to assess and evaluate the student ability to apply his knowledge and understanding of the topics covered during the course. **Making judgments:** The student will acquire an autonomy of judgment that will allow him i) to select proper manufacturing processes for the fabrication of some mechanical assemblies and components in the energy engineering field; ii) to critically identify and select the systems necessary to an industrial plant; iii) to examine objectively the results obtained from analytical processing, numerical simulations or experimental laboratory tests; and iv) to make use of technical and scientific literature. **Communication skills:** The student 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. Moreover, he will have the ability to present, communicate, discuss and argue the topics covered in the course. **Learning skills** The student 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. The student 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.
Assessment	The final exam is an oral examination. The oral exam consists in 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.
Assessment language	English
Evaluation criteria and criteria for awarding marks	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.

Required readings	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.
Supplementary readings	Additional textbooks, lecture notes, research papers and readings may be provided by the professor.

Module 2	Functional Mechanical Design for Energy Efficiency
Lecturer	Roberto Belotti
Scientific sector of the lecturer	ING-IND/13
Teaching language	English
Office hours	By appointment
Teaching assistant *(if any)*	Davide D'Amico
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. • Energy storage systems and energy recovery. Classification (working principle and scope of use). • Mechanical components for transfer and transformation of energy. Classification based on function, working principle and performance/efficiency.

	• Transmissions, articulated mechanisms and mechanisms for machine tools and assembly lines. • Transmissions, gears and brakes for renewable energy systems (e.g. wind). • Optimization aimed at improving the quality of motion and efficiency. • Motion planning and optimization. Classification and choice. • Motion laws implemented in automatic machines: analysis of the main requirements in the design of a motion law (e.g. acceleration, velocity, vibration, torque limits) and optimization (e.g. modified laws, polynomial, minimum time, jerk, energy). • Motion planning and optimization for renewable energy systems (e.g. tracking, guidance, active and passive systems).
Teaching format	Frontal lectures, exercises, labs
Learning outcomes	**Knowledge and Understanding** • Identify the main components and sources of inefficiency in motor-transmission-load systems • Understand the basic principles of the main energy storage, recovery and redistribution systems; **Applying knowledge and understanding** • Evaluate and select, from the mechanical and energy efficiency point of view, the proper transmission system; **Making judgments** • Select and design an effective motion law under different working conditions and targets; • Choose suitable and proper mechanical components for energy transformation and transfer **Communication skills** • Ability to structure and prepare scientific and technical documentation **Learning skills** • Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.
Assessment	Written exam and written project work
Assessment language	English
Evaluation criteria and criteria for awarding marks	The final grade is the written exam grade, augmented or diminished by at most 3 points, according to the project work evaluation. N.B. The written exam grade must be ≥18 anyway.

Required readings	Lecture/Course notes
Supplementary readings	