Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Power Production, CHP and District Heating Systems
Course code	45510
Scientific sector	ING-IND/08 – ING-IND/10
Degree	Master Energy Engineering
Semester	1
Year	2
Academic year	2019/20
Credits	12
Modular	Yes (6 + 6)

Total lecturing hours	72
Total lab hours	-
Total exercise hours	48
Attendance	Not compulsory
Prerequisites	Engineering Thermodynamics, Heat and Mass Transfer Fluid Machine Engineering
Course page	

Specific educational objectives	The Power Production, CHP and District Heating Systems course is a core teaching in the context of the Master in Energy Engineering and, specifically, it deals with the industrial plants used for electric and thermal power production both for small scale and community scale appliances. The course consists of two modules. The first module starts with the description of the main energy resources with particular focus on renewable sources. Then, fundamentals of energy conversion are presented, along with the working principles and the main operational aspects of the most used cogeneration plants both for large scale and for small scale distributed generation. Thermochemical processes in particular are analyzed by means of thermodynamic and kinetic approaches, as well as direct conversion technologies. Technical aspects of power generation systems and solutions to improve their energy and environmental performance are presented, dealing also with constructive aspects, plant operation and management issues and heat distribution networks. The second module introduces the fundamental concepts of cogenerations and presents the most used cogeneration solutions for civil and industrial applications. The working principles of the core devices of power production plants are presented. The main mechanical, fluid-dynamic and energy conservation principles and

	equations will be described and applied to the presented components of the power production plant. In particular, the following educational objectives will be addressed: constructive aspects, behavior of the fluid machines employed in power production plants, components, thermo-fluid-dynamic laws, evaluation of the plant performance in design and off-design operating conditions.

Module 1	Thermal Power Production and Distribution – 6 CFU
Lecturer	Marco Baratieri
Scientific sector of the lecturer	ING-IND/10
Teaching language	English
Office hours	Mondays to Thursdays, by appointment
Teaching assistant ***(if any)***	
List of topics covered	The Thermal Power Production and Distribution module is intended to give the students the fundamentals of energy conversion processes from fossil or renewable sources to thermal power in centralized and distributed generation systems. The course will cover the following topics: • Fuels and energy vectors • Fundamentals of thermochemical conversion • Fundamentals of direct conversion • Cogeneration and polygeneration systems • Thermal energy distribution
Teaching format	The course consists of lectures in which the topics are presented by the professor. There are also classes (exercises) that will give practical examples of the application of the theoretical topics. Course topics will be presented at the blackboard and using electronic slides. Teaching material and additional materials will be provided by the Professor during the semester.

Module 2	Thermal engines – 6 CFU
Lecturer	Massimiliano Renzi
Scientific sector of the lecturer	ING-IND/08
Teaching language	English
Office hours	Tuesdays, from 18:00 to 20:00; Wednesdays, from 16:00 to 18:00. Other hours by appointment.
Teaching assistant ***(if any)***	
List of topics covered	The Thermal Engine module is intended to give the students the design solutions for both large scale plants and small micro-cogeneration units for the local and distributed generation. The traditional fossil fuel feeding and the alternative or renewable energy feeding of the generation devices will be presented. The course will cover the following topics: • Energy auditing and cogeneration indexes

	• Gas turbine plants design and microturbines • Internal combustion engine co-generators • Traditional and low temperature steam cycles • Combined cycles • External combustion thermal engine co-generators
Teaching format	This is a lecture course in which topics are presented by the Professor. Practical parts are explained by the Professor and the Teaching Assistants (if present). Power Point presentations will be given to the students in pdf format before each single lecture. Additional material will be provided by the Professor.

Learning outcomes	**Intended Learning Outcomes (ILO)** Knowledge and understanding Students should acquire the knowledge and the understanding of: 1. the most important separate-generation and co-generation plant configurations for centralized or small and community scale power production, considering their energy and environmental performance 2. the fundamental plant components used in power production plants and their operative function 3. the fundamental design principles of the core components, their integration in a complex plant and the use of power plants in industrial and civil applications Applying knowledge and understanding 4. the ability to apply basic thermodynamic, kinetic and fluid-dynamic laws to the design of the components of power production plants 5. the ability to apply the studied power production plants to industrial and civil users Making judgements 6. to be able to make autonomous judgements in the choice of the design solutions, of the suitable machines and of the plant solutions in relation to their applications Communication skills 7. the ability to correctly and properly present the concepts acquired in the course both in written and oral form 8. the ability to use the proper technical terms to describe the design solutions of the power production plants. Ability to learn 9. the ability to acquire lifelong learning skills in the field

	of power production plants and cogeneration by applying the methods and the concepts acquired in the course
Assessment	The student is asked to produce a project work on the design of an energy system (also integrating the topics of the other module of the course); this part of the assessment evaluates the ability of the student to apply the topics of the course in practical applications, the comprehension of the theoretical concepts and the ability to make judgments. The student is also asked to carry out an oral exam for each module of the course. The oral examination includes questions to assess the knowledge and understanding of the course topics and questions designed to assess the ability to transfer these skills to case studies of energy plants and thermal and electric energy production devices.

Formative assessment

Form	Length / duration	ILOs assessed
In class exercises	24 X 60 minutes	3,4,5

Summative assessment

Form	%	Length / duration	ILOs assessed
Oral exam – theory	70%	2 or 3 open-end questions per each module (1 hour)	1,2,3,4,5,7,8
Project work presentation	30%	Presentation and discussion (30 minutes)	4,5,6,7,8,9

Assessment language	English
Evaluation criteria and criteria for awarding marks	Students regularly enrolled at the 2nd year of the Master in Energy Engineering are eligible for the attendance of the lessons and the exam. Other exceptional cases have to be discussed with the Professor. **Oral exam – theory** (open-end questions) The oral exam on the theory assesses the knowledge and understanding of the course topics, the knowledge of the fundamentals of conversion technologies, of the operating principle and the design choices of energy production plants for community scale and small scale cogeneration,

as well as the ability to transfer these skills to case studies and to make judgment. The following criteria will be taken into account:

- Correctness of the design choices
- Correctness of the dimensioning procedure
- Correctness of the numerical solution
- Appropriate use of measurement units
- Theoretical knowledge
- Ability to provide examples/applications of the theoretical concepts

Project work presentation
The following criteria will be taken into account:

- Theoretical knowledge
- Ability to provide examples/applications of the theoretical concepts
- Communication skills and master of the technical language

The final mark will be weighted as follows: oral exam (70%, equally weighted for each module), project work presentation (30%). It will not be possible to pass the exam if the oral exam of both the modules has not been positively evaluated.

Required readings	Slides of the courses
Supplementary readings	G. Rogers, Y. Mayhew. Engineering Thermodynamics: Work and Heat Transfer. LongmaN Scientific. F. P. Incropera, D.P. DeWitt, T. L. Bergman, A. S. Lavine. Fundamentals of Heat and Mass Transfer. John Wiley & Sons. J.M. Smith, H. C. Van Ness, M. Abbott. Introduction to Chemical Engineering Thermodynamics. McGraw-Hill Series in Civil and Environmental Engineering. J. Warnatz, U. Maas, R. W. Dibble. Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation. Springer. H. Spliethoff, Power generation from solid fuels. Springer. R. Kehlhofer, F. Hannemann, F. Stirnimann, B. Rukes, Combined cycle Gas and Steam Turbine Power Plants, PennWell, 2009. J. Heywood, Internal Combustion Engine Fundamentals, Mcgraw Hill, 1988. G. Negri di Montenegro, M. Bianchi, A. Peretto, Sistemi energetici e loro componenti. Considerazioni teoriche e valutazioni numeriche, Pitagora Editrice, Bologna, 2003. S. Sandrolini, G. Naldi, Macchine. Vol. 3: Gli impianti motori termici e i loro componenti, Pitagora Editrice, Bologna, 2003.