Syllabus

Course Description

Course Title	District energy systems design
Course Code	45549
Course Title Additional	
Scientific-Disciplinary Sector	IIND-07/A
Language	English
Degree Course	Master in Energy Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. - Ass. Maurizio Grigiante, Maurizio.Grigiante@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/33952 dr. Giuseppe Roberto Pisaturo, GiuseppeRoberto.Pisaturo@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/38803
Teaching Assistant	
Semester	Second semester
Course Year/s	2
CP	6
Teaching Hours	50
Lab Hours	10
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	The main educational objectives of the DHSD course are: 1. analysis and methodology calculation of the main technical indexes pertaining to the performance parameters of a District Heating (DH) grid implementation including dedicate energy scenarios and configurations. 2. to train the students in the use of consolidate methodology

	and engineering tools for the design and management of a DH network. 3. propose evaluations of both technical and economic analysis of a DH network integrating conventional and/or innovative energy plants.
Course Topics	- Energy analysis of DH networks integrated with suitable energy plants including Renewable Energies facilities. - District heating procedures and methodologies adopted for the design and testing of a DH network. - Procedures adopted for the determination of the thermal loads involved in DH systems. - Analysis of the control systems and the facilities involved in DH management. - Economic energy analysis aiming at estimating the most important parameters (Pay Back Time, VAN, Proficiency Index) applied to real case of DH networks including the connected energy plant facilities.
Keywords	district heating, network, energy, hot water, cold water
Recommended Prerequisites	Basic knowledge of physics, thermal processes, heat transfer and energy systems analysis.
Propaedeutic Courses	
Teaching Format	Lecture materials will be provided to the students by the teachers and will be as well proposed and discussed as class lectures utilizing both blackboard and slides. Calculations and design methods will be used to integrate the class lectures with the use, for some applications, of suitable software.
Mandatory Attendance	Not mandatory although recommended for examples, practical analysis and DHSD projects analysis.
Specific Educational Objectives and Learning Outcomes	(1) Knowledge and Understanding: 1. Fundamentals knowledge regarding the energy balance of a DH network including the global energy evaluation of the connected plants. 2. Capability of applying the procedures conventionally adopted for the design of a DH pipelines network both from a thermal and mechanical point of view. 3. Detailed analysis of a generic energy power plant facility involving heating, cooling and power production including CHP engines.

	4. Determination procedures were adopted to calculate the most relevant parameters and indexes pertaining to the performances of the DH network. (2, 3) Applying Knowledge and Understanding & Making Judgements: 1. Knowledge pertaining the operative tools utilized for the design of a DH network: central plant potentiality estimation, design of the DH network involving the definitions of the geometrical parameters of the pipelines and evaluation of the most important fluid flow parameters (mass flow rate, pressure drop...). 2. Sensibility analysis aims at evaluating the impact and the technical meaning of the indicated parameters and indexes pertaining the performances of the designed DH including those derived from the economical evaluation. 3. Setting up of the economic analysis of the global DH plant and simulations of different scenarios to evaluate the impact of the main cost variations terms in the expected management profitability. (4) Communication Skills: 1. Enhancing the capability and the ability of proposing and discussing complex negotiation dealing with the decision and the realization of a DH including also the presentation of management competences including technical and economic issues. 2. Capability in communicating the proposed design solutions based on the local conditions to which the DH proposal must be addressed. (5) Ability to Learn 1. Lifelong learning capability through the acquisition of critical tools and critical evaluation of systems.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The assessment is based on the presentation of the DH design project selected by the student in accordance to the constraints and indications of the teachers. The questions aim at evaluating both the basic and applied knowledge acquired during the course.

	Particular attention is paid to verifying the capability of the student to critically discuss the analysis of different solutions both from a technical, design and economic point of view. Furthermore, the evaluation is extended to test the global competences of the topic issue proposed during the course. Attention will be paid to the personal technical judgment capacity of the student, the mastery of technical concepts and the correct use of the technical language. - Formative assessment (assessed ILOs: 2, 3, 5): - Analysis and discussion of the criteria to be adopted for the DH design project: during the first part of the course (first weeks); - discussion of the basic elements of the selected project: second month of the course; - interactive classroom questions pertaining both the relevant topics of the selected projects and the main subjects of the course: during the entire duration of the course; - classroom presentation of the guidelines followed to design the DH project: final part of the course - Summative assessment (assessed ILOs: 1,2,3,4): Presentation of the DH project based on the discussion of the topics a), b), c), d) indicated in the following section: About 1 hour following the schedule exam sections.
Evaluation Criteria	The final mark will be determined as an average of the mark evaluation referred to the selected project elaboration (70%) and the mark of the oral (30%) presentation and discussion. The global mark must be at least 18. The oral exam is focused on testing the knowledge (80%) of the topic's issues proposed during the course, the capability of providing a critical overview of the choices adopted for the selected project. Furthermore, further aspects like clarity of presentation, correctness in use of technical terms and language, capability of providing simply numerical elaborations and energy conversions, is constitutive (20%) of the oral mark. The project evaluation is dedicated to testing the capability of the student in the following topics: a) fundamental knowledge and applications of the procedures studied in the selected project. b) critical evaluation of the consistency between the preliminary

	analysis and the obtained results of the project elaborations. c) the completeness of the design project includes the accuracy of technical details of both the design and the corresponding economic analysis. d) novelties and originality introduced in different steps of the global development of the project. The awarding marks are equally subdivided among the indicated points of the evaluation.
Required Readings	Lessons, digital documents and slides provided by the teachers.
Supplementary Readings	Books: • District Heating and Cooling, S. Freederiksen, S. Werner, Studentlitteratur AB, LUND 2017. • Advanced District Heating and Cooling (DHC) Systems, Editorial Reviews, Woodhead Publishing 2015. • Il Riscaldamento Urbano, ANNUARIO 2021, Associazione Italiana Riscaldamento Urbano (AIRU). • Teleriscaldamento e Sistemi Energetici Integrati, ENEA 2008. Scientific Literature: Selected papers published in the years 2021-26 in peer review scientific journals among which Energy, Applied Energy, Sustainable Energy Technologies and Assessments.
Further Information	Connections with other courses: The DHSD course presents interactions with courses pertaining the evaluations of the Energy Balance in Buildings (Advanced Application of Building Physics), Electrical Systems (Electrical Power Conversion Equipment) and includes integrations with renewable energy topics. Professional applications of the covered topics: The skills acquired attending this course provide to the students a relevant and extended background of competences widely expected by energy companies specifically dedicated to DH design, energy service companies (ESCO), industries producing DH components and control devices. Furthermore, the competences covered by this course allow the student to pursue a career as

	energy management by applying to dedicated master/courses aiming at integrating the acquired basic background in economic and management issues proposed during the course.
Sustainable Development Goals (SDGs)	Clean water and sanitation, Affordable and clean energy, Climate action, Sustainable cities and communities, Responsible consumption and production, Industry, innovation and infrastructure