Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Building HVAC Systems
Course code	45528
Scientific sector	ING-IND/11 "Building Physics and Building Energy Systems"
Degree	Master Energy Engineering
Semester	2
Year	1
Academic year	2021/2022
Credits	9
Modular	no

Total lecturing hours	60
Total lab and exercise hours	30
Attendance	Not mandatory but strongly recommended
Recommended preliminary knowledge	It is recommended that the students have attended the course "Engineering Thermodynamics, Heat and Mass Transfer"
Connections with other courses	This course presents the engineering application of topics studied in the the courses "Engineering Thermodynamics, Heat and Mass Transfer" and "Advanced Applications of Building Physics" (it is recommended the simultaneous attendance of the course "Advanced Applications of Building Physics"). In addition there are some connections with the course "Special Issues of Building Physics"
Course page	

Specific educational objectives	This course consists of 60 hr of frontal lectures and 30 hr of practical design applications. The first part of the course will deal with the determination of heating and loads and occupants comfort in order to properly size the HVAC systems of a building. Then the preparation of the energy balance of a building according to the technical standards will be dealt with. Finally, the various type of HVAC systems (all water, mixed air-water and all air) will be presented and in the final part the fundamentals of HVAC design will be outlined. In parallel with the course lectures, the student will be required to prepare design work about a simple HVAC system (e.g. heating system for a residential building).

Lecturers	Prof. Paolo Baggio Prof. Alessandro Prada
Scientific sector of the lecturers	ING-IND/11

Teaching language	English
Office hours	Tuesday 18:30 – 20:00 - Check online updates
Teaching assistant *(if any)*	-
Office hours	-
List of topics covered	The course will cover the following topics: Heating design load calculation • Heating load calculations, natural and mechanical ventilation, user profiles and operation schedules, occupant comfort and health. Energy Balance of a Building • Preparation of the energy balance of a building, heat losses due to transmission and ventilation, effects of solar radiation, heat gains, HVAC systems efficiency, basics of energy performance evaluation and certification. HVAC Systems • Design of heating, cooling, ventilating and air conditioning systems: hydronics, all air and mixed air/water systems. Distribution network (piping and air ducts) terminal units. Heat recovery equipment • Equipment for heating and cooling: boilers, unitary air conditioners, water chillers storage tanks, circulation pumps. Renewable energy equipment: thermal solar panels and heat pumps. Equipment operating curves and partial load operation. Safety devices and introduction to safety standards.
Professional applications of the covered topics	Engineering professions involving the energy performance of buildings and the control of building internal microclimate: HVAC Systems design and operation, HVAC components design, building energy performance optimization, etc.
Teaching format	Class lectures (blackboard and/or slides) and design exercises using spreadsheets. Some of the lecture material (slides) will be available for download by the students.

Learning outcomes (ILO)	The learning outcomes need to refer to the Dublin Descriptors: **1. Knowledge and understanding:** By the end of the course, students should be able to: a) master the most important concepts about heating and cooling loads of a building and its energy performance; b) have a clear understanding of the operation of HVAC systems. **2. Applying Knowledge and understanding:** Apply the above concepts to the correct design of HVAC

systems.

3. Making judgments:
Evaluate the heating and cooling load of a building, evaluate the performance of an HVAC system and the energy use of a building.

4. Communication skills:
Being able to express engineering concepts also with the aid of technical drawings, schematic diagrams and technical reports.

5. Learning skills
Being able to self-train and stay up to date with the evolution of the technical standards and with the market innovations.

Assessment

Oral examination with questions aimed at verifying the knowledge and the capability to understand the topics of the course and to master of the technical language. Discussion of the design report aimed to ascertain the capability to apply the aforementioned competences together with engineering judgment to the preparation of the HVAC design report

Formative assessment

Form	Length /duration	ILOs assessed
Development of the HVAC design report	During the course	(2), (3), (5)

Summative assessment

Form	%	Length /duration	ILOs assessed
Oral examination, including presentation and discussion of the design report	100	About 40 min.	All except (5)

Assessment language

English

Evaluation criteria and criteria for awarding marks	Coursework will be weighted as follows: final oral examination (50%), student design report about a HVAC system. (50%). In order to take the oral examination the project work must be completed. The oral exam will consider the knowledge of the topics presented during the course (max 20 points), the ability to synthesize information, the clarity and appropriateness of the technical language(max 5 points), and the capability to perform simple engineering evaluations (max 6 points). The discussion of the design report will assess the quality of the analysis of the design problem (max 15 points) the quality of the proposed technical solution (HVAC system) (max 8 points), the appropriate use of technical language and engineering concepts (use of physical quantities, units, technical standards and references) as well as the clarity and efficacy of the presentation (max 5 points), and the ability to autonomously obtain further knowledge consulting other sources a for the design (max 2 points).

Required readings	• (UNI) EN ISO 12831 and other relevant (UNI) EN ISO standards (in particular of the (UNI) EN ISO 52000 family) • Notes taken during the lessons
Supplementary readings	• W. T. Grondzik, Air-Conditioning System design Manual, ASHRAE/Butterworth, 2007. • ASHRAE, HANDBOOK - Vol. 1-4 ed. ASHRAE 2017-2020 (or later). • T. E. Mull, HVAC Principles and Application Manual, McGraw-Hill, 1997.