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	2nd
Year	1
Academic year	2025/26
Credits	9
Modular	no

Total lecturing hours	90
Total lab hours	
Total exercise hours	
Attendance	Strongyl reccomended
Prerequisites	All students officially enrolled in the first year of the master's Program in Energy Engineering are eligible to take this course. Exceptional cases should be discussed with the instructor. It is recommended that students also attend the "Applied Energetics" course. This course covers the engineering applications of topics studied in "Applied Energetics" and "Advanced Applications of Building Physics" (concurrent enrolment in "Advanced Applications of Building Physics" is advised). Additionally, there are connections with the "Special Issues of Building Physics" course.
Course page	https://www.unibz.it/en/faculties/engineering/master-energy-engineering/

Specific educational objectives	This course comprises hours of lectures and practical design applications. In the initial part, students will focus on determining heating loads and ensuring occupant comfort to accurately size HVAC systems for buildings. Following this, they will learn to prepare a building's energy balance by technical standards. The course will then cover various types of HVAC systems, including all-water, mixed air-water, and all-air systems. The fundamentals of HVAC design will be outlined in the concluding part of the course. Additionally, students will complete a design project, such as developing an HVAC

	system for a building.

Lecturer	Prof. Prada Alessandro Dr. Benedetti Vittoria
Scientific sector of the lecturer	ING-IND/11
Teaching language	English
Office hours	By appointment upon prior notice via email
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 a building's energy balance • Heat losses due to transmission and ventilation • Effects of solar radiation • Heat gains • HVAC systems efficiency • Basics of energy performance evaluation and certification **Domestic Hot Water System:** • Energy needs • System design and integration **HVAC Systems:** • Design of heating, cooling, ventilation, and air conditioning systems • Hydronics, all-air, and mixed air/water systems • Distribution networks (piping and air ducts) • Terminal units and heat recovery equipment • Equipment for heating and cooling, including boilers, unitary air conditioners, water chillers, storage tanks, and circulation pumps • Renewable energy equipment such as thermal solar panels and heat pumps • Equipment operating curves and partial load operation • Safety devices and an introduction to safety standards
Teaching format	Class lectures will be conducted using a combination of blackboard instruction and slide presentations,

	supplemented by design exercises utilizing spreadsheets and building simulation software (e.g., EnergyPlus, Trnsys). All lecture materials will be made available for students to download via Teams. In addition to attending classes, students will be required to work in teams to prepare a report on the design, sizing, and performance evaluation of a basic HVAC system.

Learning outcomes	**Knowledge and understanding:** By the end of the course, students should be able to: 1. Master key concepts related to heating and cooling loads and the overall energy performance of buildings. 2. Understand the operation and functionality of various HVAC systems. 3. Acquire knowledge on the content of the main technical standards on the topics currently in force. **Applying Knowledge and Understanding:** • Apply the learned concepts to the practical design and implementation of HVAC systems. **Making Judgments:** • Assess the heating and cooling loads of buildings, evaluate HVAC system performance, and analyze the energy usage of buildings. **Communication Skills:** • Effectively convey engineering concepts using technical drawings and reports. **Learning Skills:** • Self-train and stay current with evolving technical standards and market innovations.
Assessment	The evaluation comprises two components: • **Group project**: this involves sizing an HVAC system and calculating its energy efficiency and indoor comfort performance. • **Individual oral examination**: in this segment, the student will discuss his/her design choices and demonstrate his/her theoretical understanding of HVAC systems.

Formative assessment

Form	Length /duration	ILOs assessed
Development of the team project	During the course	2,3,5

Summative assessment

Form	%	Length /duration	ILOs assessed
Oral exam – theory	50%	2 or 3 open-end questions	1,2,3,4
Project work presentation	50%	Presentation and discussion (30 minutes)	3,4,5,6,7,8

Assessment language	English
Evaluation criteria and criteria for awarding marks	The coursework will be assessed as follows: • HVAC system project work: 50% • Final oral examination: 50% Completion of the project work is a prerequisite for taking the oral examination.

Required readings	• EN ISO 12831 and other relevant EN ISO standards (especially the EN ISO 52000 family) • Notes taken during the lessons • W. T. Grondzik. "Air-Conditioning System Design Manual" 2nd ed-, ASHRAE/Butterworth, 2007 • J.W. Mitchell and J.E. Braun "Principles of Heating, Ventilation and Air Conditioning in Buildings" Wiley 2013
Supplementary readings	• ASHRAE, HANDBOOK - Vol. 1-4 ed. ASHRAE 2017-2020 (or other recent editions). • G.F. Hundry, A.R. Trott, and T.C. Welch. "Refrigeration, Air Conditioning and Heat Pumps" 5th ed, Butterworth-Heinemann. 2016 • I. Beausoleil-Morrison "Fundamentals of Building Performance Simulation" Routledge. 2021 • L. Socal and B. Grassi. "Compendium of hydraulics for heating technicians". IVAR 2018 • R. McDowall. "Fundamentals of HVAC systems". ASHRAE/Elsevier 2007 • R. Montgomery and R. McDowall. "Fundamentals of HVAC Control Systems". ASHRAE/Elsevier 2007