Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Advanced Applications of Building Physics
Course code	45506
Scientific sector	ING-IND/11 "Building Physics and Building Energy Systems"
Degree	Master Energy Engineering
Semester	2
Year	1
Academic year	2025/2026
Credits	9
Modular	no

Total lecturing hours	56
Total lab and exercise hours	30
Attendance	Not mandatory
Recommended preliminary knowledge	-
Connections with other courses	The course "Advanced Applications of Building Physics" introduces several building physics topics necessary for a more comprehensive and effective understanding of other courses related to building energy efficiency (i.e., "Building HVAC Systems" and "Special Issues of Building Physics").
Course page	https://www.unibz.it/en/faculties/engineering/master-energy-engineering/

Specific educational objectives	Learning objective of the course: 1. mastering the most important concepts about heat and mass transfer through the building envelope and the corresponding equations 2. mastering the most important concepts about environmental comfort and indoor air quality and their quantitative expressions 3. applying these concepts to the calculation and simulation of components and buildings 4. applying numerical and analytical approaches to the design of building envelope structures 4. understanding and using building simulation

Lecturer	Prof. Andrea Gasparella
Scientific sector of the lecturer	ING-IND/11
Teaching language	English
Office hours	On appointment
Teaching assistant *(if any)*	tbd

Office hours	On appointment
List of topics covered	Psychrometrics Fundamentals of thermodynamics of moist air. Relevant quantities and processes. Psychrometric diagrams. Modeling: Introduction to modelling. Finite difference approaches and characterization. Building Energy Balance: Steady state and dynamic calculations of the heating and cooling peak load and energy need profiles of a building. Air node heat balance. Surface balance and terms: conduction, convection, radiation (long and short wave), gains, infiltration and ventilation. Unsteady state conduction. Numerical solution. Dynamic transfer properties. Long wave radiation. Radiosity network. Radiant gains. Solar radiation. Radiosity network. Solar gains. Moisture migration: Heat and mass transfer through building structures, interstitial and surface condensation. Moisture verifications and appropriate design practices. Environmental quality: Energy balance of human body, sensible and latent heat exchanges with the environment, thermal comfort, relevant factors affecting comfort in winter and summer, evaluation indices, effective temperature. Indoor air quality and evaluation indexes. Measurement and instruments. European and international standards: Contents and application of the European and international standards about the calculation of energy use for space heating and cooling and the energy performance of buildings.
Professional applications of the covered topics	The topics presented in this course can be applied in all those professional activities involving the design and the re-design of the building system, such as those performed in building engineering offices and companies, as well as for the assessment of energy performance and indoor environmental quality of the built environment.
Teaching format	Lectures (blackboard and/or slides) and spreadsheet implementation.

Learning outcomes	**(1) Knowledge and understanding:** - Building energy balance terms - Building envelope behavior (heat and mass transfer)

	- Occupants' thermal comfort - Indoor air quality **(2) Applying Knowledge and understanding:** - Solving the main energy balance calculation aspects and using simulation - Calculating heat and mass transfer in building components - Assessing thermal comfort - Sizing ventilation systems **(3) Making judgments:** - Comparing different building envelope configuration and contrasting their performance - Optimizing the envelope design as for heat and mass transfer - Assessing thermal comfort and making decisions about improvement strategies - Assessing and improving indoor air quality **(4) Communication skills:** - Using the appropriate technical vocabulary related to the topic - Preparing a report representing and summarizing complex results and providing appropriate interpretation **(5) Learning skills** - Decomposing a complex problem into sub-problems, finding the analytical expression and the numerical solution - Comparing different methods and sources - Consulting technical standards and keeping up to date with regulation
Assessment	Case study project (report discussion) and oral exam on the different topics of the course. **Formative assessment** **Form** / **Length /duration** / **ILOs assessed** Development of the case-study project / During the course / (2), (3), (5)

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<tr><td></td><td>Summative assessment
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<tr><th>Form</th><th>%</th><th>Length /duration</th><th>ILOs assessed</th></tr>
<tr><td>Project work presentation</td><td>50</td><td>20 min x 3 times</td><td>(2), (3), (4)</td></tr>
<tr><td>Oral examination, including discussion of the report</td><td>50</td><td>About 1 hour</td><td>All except (5).</td></tr>
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<tr><td>Assessment language</td><td>English</td></tr>
<tr><td>Evaluation criteria and criteria for awarding marks</td><td>Marks are attributed according to the following assessment aspects:
- Synthesis ability to explain the fundamental aspects of the problem (0= nothing, 1= insufficient; 2=sufficient; 3 = full)
- Analysis ability to describe details and specific formulas/models (0= nothing, 1= insufficient; 2=sufficient; 3 = full)
- Application ability to implement the principles and formulas and to solve practical cases (0= nothing, 1= insufficient; 2=sufficient; 3 = full)
- Reporting ability to represent and summarize the main results and to provide an appropriate interpretation</td></tr>
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Required readings	- Teaching material, handouts, booklets from the reserve collection
Supplementary readings	- H. Hens, 2012, Building Physics: Heat, Air and Moisture, Fundamentals and Engineering Methods with Examples and Exercises, Second Edition - Carl-Eric Hagentoft, 2001, Introduction to Building Physics, Professional Pub Service - ASHRAE, HANDBOOKS - Vol. 1-4 ed. ASHRAE 2009-2012. - (UNI) EN ISO 52016-1, 13791 and other relevant UNI EN ISO standards