Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Special Issues of Building Physics
Course code	45529
Scientific sector	ING-IND/11 "Building Physics and Building Energy Systems"
Degree	Master Energy Engineering
Semester	1
Year	2
Academic Year	2022/2023
Credits	6
Modular	No

Total lecturing hours	40
Total lab and exercise hours	20
Attendance	Not mandatory but recommended, especially as far as the exercises are concerned
Recommended preliminary knowledge	Basic knowledge of building physics, building energy balance, and indoor environmental quality
Connections with other courses	The course "Special Issues of Building Physics" integrates the knowledge offered by previous courses related to building energy efficiency and building HVAC systems (i.e., "Advanced Applications of Building Physics" and "Building HVAC Systems"), discussing the topics of indoor lighting and daylighting design and visual comfort. The course shows also some applications to the artificial lighting systems of some control solutions seen in the course "Electric Power Conversion Equipment". Finally, part of the course is dedicated to the modelling of the visual spectrum of solar radiation, integrating the knowledge offered in "Advanced Applications of Building Physics" about solar radiation models for building energy simulations.
Course page	

Specific educational objectives	The course deals with the topic of indoor lighting and visual comfort in the built environment, presenting requirements and methodologies for the design of lighting systems able to ensure proper levels of visual comfort while minimizing the energy uses. The students attending this course are expected to learn how to specify system requirements, design a building lighting system integrating electrical and natural lighting and assess its impact with respect to the building total energy performance.

Lecturer	Dr. Giovanni Pernigotto
Scientific sector of the lecturer	ING-IND/11
Teaching language	English
Office hours	Appointment by email
Teaching assistant	Federico Battini
Office hours	Appointment by email
List of topics covered	(1) Light and vision: • Human perception of electromagnetic waves; definition and measurement of photometric and radiometric quantities; the human eye and the visual perception; colorimetry. (2) Solar radiation and daylighting: • Solar irradiation and daylight; irradiance and illuminance components (beam and diffuse) and distribution; types of skies (clear, intermediate, overcast) and sky models. (3) Daylighting modelling: • Fundamentals of optics (reflection, refraction); global illuminance models (radiosity, ray-tracing, split-flux, photon mapping methods); software (Radiance, Daysim, EnergyPlus, DIALUX). (4) Daylighting and artificial lighting control and systems: • Fenestration systems: envelope components for passive and active daylight and solar control; artificial lighting sources, luminaires, and control systems; Glare discomfort and metrics (UGR, DGI, CGI; VCP); control strategies, energy performance and daylighting metrics (DF; DA; cDA; UDI; sDA). (5) Technical standards currently in force about lighting and daylighting: • EN 12464-1:2021; EN 16798-1:2019; EN 15193-1:2017+A1:2021; EN 17037:2018+A1:2021.
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, and can be of particular interest in the framework of building voluntary rating systems and minimum environmental criteria for buildings. Furthermore, professional applications can be found in companies designing and manufacturing lighting systems, fenestration systems, shading devices for windows and automation control devices and controls for smart buildings.

Teaching format	Class lectures (blackboard and slides) and design exercises using spreadsheets and lighting, daylighting and/or energy simulation software. Lecture material (slides) will be available for download by the students.

Learning outcomes (ILOs)	The learning outcomes need to refer to the Dublin Descriptors: <u>Knowledge and understanding</u> 1. Knowledge of light, vision, solar radiation, daylight models and artificial lighting systems and controls, as well as the content of the main technical standards on the topics currently in force. <u>Applying knowledge and understanding</u> 2. Capability of defining the requirements for visual comfort in the built environment, daylight modelling, designing of artificial lighting systems, with controls aimed at optimizing energy and visual comfort performances. Furthermore, students will be able to understand how the lighting system interacts with the rest of the building systems in the framework of total energy efficiency. <u>Making judgements</u> 3. The student will be able to assess the quality of existing lighting systems, identify critical aspects and suggest redesign solutions and improvements on both visual comfort and energy efficiency. <u>Communication skills</u> 4. The student will be able to discuss the learned knowledge with vocabulary and technical terms of the discipline, describing efficiently the outcome of the design activity and the features of different solutions. <u>Ability to learn</u> 5. Lifelong learning capability through the acquisition of critical tools and critical evaluation of product and systems specifications.

Assessment

Oral examination with questions aimed at verifying the knowledge and the capability to understand the topics of the course and the mastery of the technical language. The capability to transfer these competences to applicative cases and the developed autonomy of judgment will be evaluated through the discussion of the group design work assigned during the course. A report will be prepared and then presented and discussed.

Formative assessment

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

Summative assessment

Form	%	Length /duration	ILOs assessed
Oral examination, including presentation and discussion of the design work report	100	About 1 hour	All except (5).

Assessment language

English

Evaluation criteria and criteria for awarding marks

A single final mark will be calculated according to a weighted average of the mark of the oral exam (35 %) and the mark for the design work and its discussion (65 %). Both marks must be at least 18.
The oral exam will consider the knowledge of the topics presented during the course (max 20 points), the ability to synthesize information, the correctness of the technical terms and clarity (max 5 points), and the capability of applying the course knowledge and make simple evaluations (max 6 points).
With reference to the developed design work, the capability to analyze the proposed problem choosing the proper tools (max 15 points) and to formulate a cost-effective and technically advantageous solution (max 6 points) will be taken into account, as well as correctness of knowledge (correct use of quantities, units of measurements, technical standards and references; max 3

	points), and technical terms and language clarity (max 5 points) in the project report and presentation. During the project development, the ability to learn, to consult further knowledge and data sources and tools for the design will be assessed (max 2 points).

Required readings	Lessons and slides of the course.
Supplementary readings	**European and Italian technical standards and laws:** • EN 12464-1:2021 - Lighting of work places - Indoor work places; • EN 16798-1:2019 - Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics - Module M1-6 • EN 15193-1:2017+A1:2021: Energy performance of buildings. Energy requirements for lighting; • EN 17037:2018+A1:2021 - Daylight in buildings; • D.P.R. n. 303 del 19/3/1956 – "Norme generali per l'igiene del lavoro" • Circ. Min. LL. PP. n. 3151 del 22/5/1967 – "Criteri di valutazione delle grandezze atte a rappresentare le proprietà termiche, igrometriche, di ventilazione e di illuminazione delle costruzioni edilizie" • Circ. Min. LL. PP. n. 13011 del 22/12/74 – "Requisiti fisico-tecnici per le costruzioni edilizie ospedaliere. Proprietà termiche, igrometriche, di ventilazione e di illuminazione" • D.M. 5/7/75 – "Modificazioni alle istruzioni ministeriali del 20/6/1896 relative altezza minima dei locali ed ai requisiti igienico sanitari principali dei locali di abitazione" • D.M. 18/12/75 – "Norme tecniche aggiornate relative all'edilizia scolastica, ivi compresi gli indici minimi di funzionalità didattica, edilizia e urbanistica da osservarsi nella esecuzione di opere di edilizia scolastica" • Norma UNI 10840:2007 - Locali scolastici–Criteri generali per l'illuminazione artificiale e naturale. **Books** • Illuminotecnica, Gino Moncada Lo Giudice, Andrea De Lieto Vollaro, CEA, 2007; • Daylighting Handbook I, Christoph Reinhart – 2014; • Daylighting Handbook II, Christoph Reinhart – 2018; • Illuminating Engineering: From Edison's Lamp to the LED, Joseph Murdoch, Visions Communications, 2003.

Documents

- Tutorial on the Use of Daysim Simulations for Sustainable Design, Christoph F. Reinhart

Scientific papers

Carlucci, S. et al., 2015. A review of indices for assessing visual comfort with a view to their use in optimization processes to support building integrated design. *Renewable and Sustainable Energy Reviews*, 47, pp.1016–1033.

Galatioto, A. & Beccali, M., 2016. Aspects and issues of daylighting assessment: A review study. *Renewable and Sustainable Energy Reviews*, 66, pp.852–860.

Pierson, C., Sarey Khanie, M., Bodart, M., Wienold, J., 2019. Discomfort glare cut-off values from field and laboratory Studies. *Proceedings of the 29th CIE SESSION,* Washington D.C., USA.

Wienold, J., 2009. Dynamic daylight glare evaluation. In *Eleventh International IBPSA Conference: Building Simulation*. pp. 944–951.

Wienold, J. & Christoffersen, J., 2006. Evaluation methods and development of a new glare prediction model for daylight environments with the use of CCD cameras. *Energy and Buildings*, 38(7), pp.743–757.

Wienold, J. & Christoffersen, J., 2005. Towards a new daylight glare rating. *Lux Europa,* Berlin, pp.1–8.