UCLouvain

# licar2801i

*2023*

# Theory and research in the physical sciences: sustainable building - Theory and research in physical sciences: sustainable construction

| 4.00 credits | 40.0 h | Q1 |
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| Language : | French<br>> English-friendly |
| Place of the course | Louvain-la-Neuve |
| Main themes | This teaching unit questions the way in which the constructive aspects and those related to the atmospheres can contribute to "making architecture" and support the comfort and the well-being of the occupants and the rational use of the resources in a holistic approach of architecture. sustainable. As part of a desire for continuous improvement of buildings, it aims to acquire knowledge and skills related to:<br>• The technological design of architectural works,<br>• The evaluation and control of their impact on the interior environment, the comfort and well-being of the occupants, and the environment in the broad sense,<br>• The development of new knowledge leading to more sustainable architectural designs.<br>Starting from a critical analysis of traditional and current practices, it leads the student to structure new research proposals in one of the sub-fields concerned. As such, it covers the following contents:<br>• Physical environments (thermal, light and air quality), comfort and well-being;<br>• Spatial and technological design strategies for indoor climate control (heating, cooling, ventilation, lighting), including regulatory and sizing aspects;<br>• Architectural integration of technical distribution networks (water, sewage, electricity, people, etc.); • Passive fire risk management (compartmentalization, escape route, etc.);<br>• The flows of materials and energy generated by the design, implementation, renovation and deconstruction of buildings, including the methods for evaluating these flows and their environmental impacts;<br>• Putting building analysis methods into practice, including monitoring, survey and data analysis methods, and the use of digital modeling and environmental assessment tools;<br>• The general research approach and the research methods used for the purpose of producing new knowledge in connection with this content.<br>The course prepares for a Master Thesis Research oriented to applied sciences, and the integration of the technical dimensions and environmental impacts of the act of building in the Master Thesis project. |
| Learning outcomes | **At the end of this learning unit, the student is able to :**<br>*Learning outcomes and contribution to the LO reference system :*<br>At the end of the teaching unit, the student will be able to:<br>• Document and model an interior physical atmosphere and comment on its potential impact on the occupants and the environment in the broad sense;<br>• Design a combination of architectural and technological measures guaranteeing the comfort and interior well-being of the occupants for a minimal environmental impact;<br>• Explain the building's equipment (passenger transfer, water supply and evacuation, electricity);<br>• Integrate the techniques into a general coherence of the project that they help to discover and/or consolidate;<br>• Quantify with the tools currently available on the market the flows of energy and materials related to the production, operation and deconstruction of buildings;<br>• Identify the limits of knowledge in the targeted field and derive a rigorous research or development proposal. |
| Evaluation methods | The assessment of this module is based on two deliverables:<br>1. A reflective journal (individual, 20%)<br>2. A research proposal (individual, 80%) |
| Teaching methods | Ex-cathedra lectures, worksops and seminars. |
| Content | The programme of this module is based on the following contents:<br>- Research methods<br>- Climate Analysis and Psychrometrics |

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| | - Comfort and well-being<br>- Natural and artificial light<br>- Ventilation Strategies and Techniques<br>- Heating and cooling<br>- Electricity in buildings<br>- Life cycle assessment - Material flow analysis<br>- Energy performance<br>- Active systems for solar energy<br>- Water and fire systems |
| Inline resources | ***On-Line Resources***<br>Energie plus: https://energieplus-lesite.be/<br>Weather Data: https://energyplus.net/weather<br>ARUP Drivers of Change: https://www.arup.com/perspectives/publications/research/section/drivers-of-change<br>WELL v2.0: https://v2.wellcertified.com/<br>EPiC database and resource hub: http://www.epicdatabase.com.au/<br>***Software Download***<br>Climate Consultant 6.0: https://energy-design-tools.sbse.org/<br>CBE Clima Tool : https://clima.cbe.berkeley.edu/<br>CBE Thermal Comfort Tool: https://comfort.cbe.berkeley.edu/<br>Climate Studio: https://www.solemma.com/climatestudio<br>VELUX Daylight Visualizer: https://www.velux.com/what-we-do/digital-tools/daylight-visualizer<br>DIAL+: https://www.dialplus.ch/<br>Ladybug tools for Rhino and Grasshopper : https://www.ladybug.tools/ |

Bibliography

***Recommended readings***

*Research methods*


- Fellows, R. and Liu, A. (2015) *Research methods for construction*, Fourth ed., John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex , United Kingdom.
- Naoum, S. G. (2013) *Dissertation research & writing for construction students*, Third ed., Routledge, New York.
- Silverman, D. (2016) *Qualitative research*, Fourth ed., Sage, Los Angeles.
- Yin, R. K. (2018) *Case study research and applications: design and methods*, Sixth ed., SAGE, Los Angeles.


*Environmental design principles*


- Brown, G.Z., Dekay, M. (2000). *Sun, Wind and Light*. John Wiley and Sons Ltd: New York.
- Kwok, A., Grondzik, W. (2007). *The Green Studio Handbook: Environmental Strategies for Schematic Design*. 2nd Edition. Elsevier Architectural Press: Oxford.
- La Roche, P., (2012), *Carbon Neutral Architectural Design*. Taylor and Francis: New York.
- Meek, C., Van Den Wymelenberg, K.G. (2015). *Daylighting and integrated lighting design.* Routledge: Oxon.
- Pelsmakers, S. (2012). *The environmental design pocketbook*. RIBA Publishing: London.
- Rheinhart, C. (2015) *Daylighting Handbook* I and II. http://www.daylightinghandbook.com
- Szokolay, S. (2007). *Introduction to Architectural Science: The Basis of Sustainable Design*. Architectural Press: Oxford, 2nd edition.
- Tregenza, P., Loe, D. (2014). *The Design of Lighting*. Routledge: Oxon
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*Other references*


- Altomonte, S., Allen, J., Bluyssen, P.M., Brager, G., Heschong, L., Loder, A., Schiavon, S., Veitch, J.A., Wang, L., Wargocki, P. (2020). Ten questions concerning well-being in the built environment. *Building and Environment*. doi: https://doi.org/10.1016/j.buildenv.2020.106949
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- Altomonte, S., Saadouni, S., Kent, M., Schiavon, S. (2017). Satisfaction with indoor environmental quality in BREEAM and non-BREEAM rated office buildings. *Architectural Science Review* , 60(4): 343-355.
- Altomonte, S., Schiavon, S. (2013). Occupant satisfaction in LEED and non-LEED certified buildings. *Building and Environment*. 68, 66-76.
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- DePlazes, A. (2005). *Constructing Architecture: Materials, Processes, Structures: A Handbook*, Birkhäuser: Basel.
- Herzog, T., et al. (2008). *Façade Construction Manual*. Birkhäuser: Basel.
- Hindrichs, D.U. (2007). *Plusminus 20/40 Latitude: Sustainable Building Design in Tropical and Subtropical Regions*. Edition Axel Menges: London.
- Kleinbaum, D. G., Kupper, L. L., Nizam, A. and Rosenberg, E. S. (2013) *Applied regression analysis and other multivariable methods*, Fifth ed., Cengage Learning, Boston, MA.
- Kline, P. (1994) *An easy guide to factor analysis*, Routledge, London ; New York.
- Kline, R. B. (2016) *Principles and practice of structural equation modeling, Methodology in the social sciences*, Fourth ed., The Guilford Press, New York.
- MacLean, W., William, P. (2008), *Introduction to Architectural Technology*, London: Laurence King Publishing.
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- McGregor, A., Roberts, C., Cousins, F. (2013). *Two Degrees. The Built Environment and our Changing Climate*. Routledge: New York.
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- Moser, C. A. and Kalton, G. (1979) *Survey methods in social investigation*, Second ed., Gower, Aldershot, Hants, England; Brookfield, Vt., U.S.A.
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- Stephan, A., Crawford, R. H., & de Myttenaere, K. (2013). A comprehensive assessment of the life cycle energy demand of passive houses. *Applied Energy, 112*, 23-34. doi:http://dx.doi.org/10.1016/j.apenergy.2013.05.076
- Stephan, A., & Stephan, L. (2016). Life cycle energy and cost analysis of embodied, operational and user-transport energy reduction measures for residential buildings. *Applied Energy, 161*, 445-464. doi:http://

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| Other infos | Overall, students are assessed based on the following criteria:<br>- Present information clearly, adequately and concisely, annotated where necessary, with explicit content, and properly referenced;<br>- Evaluate and critically reflect on your work by identifying your specific learning needs;<br>- Demonstrate your knowledge and understanding of the principles and strategies of environmental and architectural physics (thermal, lighting and air quality) and how their holistic design and control can influence human comfort, health and well-being;<br>- Demonstrate your knowledge and understanding of active and passive systems (e.g. heating, cooling, lighting, and ventilation) as well as building services (e.g. water, drainage, electricity, fire, etc.) and their integration into architectural design and standards, following a sustainable and circular approach to energy and material flows.<br>- Develop coherent and original research proposals, recognising priorities and avenues for development in the physical sciences, using appropriate and rigorous research methods. |
| Faculty or entity in charge | LOCI |

## Programmes containing this learning unit (UE)

| Program title | Acronym | Credits | Prerequisite | Learning outcomes |
|---|---|---|---|---|
| Master [120] in Architecture (Tournai) [International Master - in English] | ARCT2M | 4 | | |
| Master [120] in Architecture (Bruxelles) [International Master - in English] | ARCB2M | 4 | | |