Name of the module (English): Sustainability in Building Design					
Module code (UP): M12 (provisional)		**Name of the module (Portuguese):** Sustentabilidade no Projeto de Edifícios			
Module code (THM): IMTM (provisional)		**Name of the module (German):** Nachhaltigkeit in der Gebäudeplanung			
Module code (UC): M12 (provisional)		**Name of the module (Spanish):** Sostenibilidad en el diseño de edificios			
Credits: 6 ECTS	**Module status:** Obligatory	**Duration:** 1 semester	**Semester:** 2	**Year:** 1	**Frequency:** Every year
Type of tuition: Classroom-based		**Workload:** 180 h	**Attendance time:** 60 h	**Self-study time:** 120 h	
Usability: Master (Degree in Sustainable Design, Construction and Management of the Built Environment)			**Classification:** Engineering / Architecture	**Teaching language:** English	
Module responsibility: Jorge Manuel Fachana Moreira da Costa (FEUP)		**Lecturers:** Maik Werner Neumann (THM)			

Description / Observations:

The syllabus introduces the various frameworks of sustainability under the perspective of the development of a building design, this under a Life Cycle Analysis point of view. The students will be made aware of the diverse issues pertinent to sustainability – without going into detail, that will be addressed in other more specific units – and the impact they may have in the stages of design development, so that a design team manager can successfully plan when these contributions should come into play, discussed and decided upon. Tools for the assessment of the efficiency of both the developed work and of the final output will be explained, as well as methods enabling the balancing between technical issues and economic impacts and constraints, as well as decision upon these.

Recommended Requirements

Basic knowledge about sustainable concepts in design, construction and managements of buildings and infrastructures.

Basic competences:

- Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
- Students are able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
- Students are able to integrate knowledge and deal with the complexity of making judgments based on information that is incomplete or limited, including reflections on the social and ethical responsibilities associated with applying their knowledge and judgments.
- Students are able to communicate their findings and the ultimate knowledge and reasons behind them to specialist and non-specialist audiences in a clear and unambiguous manner.
- Students possess the learning skills to enable them to continue studying in a largely self-directed or autonomous manner.

Transverse competences:

None of the subjects that will be addressed is completely straightforward in its formulation; therefore the use of open but directed discussion over courseworks and case studies will be the best way for the students to explore these issues and be aware that several options are usually on the table and how to reach a sound decision. The larger part devoted to courseworks and discussion in relation to the final exam will foster this view.

Specific competences:

To know and be able to evaluate the best sustainable technical solutions in a building and to be able to apply them at a preliminary project level by carrying out a cost-benefit analysis of different alternatives.

Learning outcomes:
On successful completion of this module, the students will be able to:

- Understand the diverse framework concepts concerning sustainability in buildings;
- Identify the issues arising from the implementation, during the design stage, of sustainable approaches concerning energy, water, air quality, space use, selection of materials, post-occupancy building life;
- Plan and manage input and output for the development of the building project brief, expertise design, construction strategy and directions for the evolution under use.
- Assess the expected performance of the building from inception and design until commissioning and use.
- Understand and apply economic metrics for the assessment of the design proposals and its implementation in construction and use.
- Understand and be aware the main tools of Life Cycle Analysis and the associated standards, as well as its application to study cases.

Content:
1. Sustainable Building Design (SBD) Framework: definitions; beyond energy and materials; social and physical communities.
2. Requirements for sustainability in construction and design of sustainable buildings. Drivers of sustainability: the construction industry, profile of products, users' behaviour. Environmental constraints - comfort, energy, emissions-, Economic - use of local materials and resources, maintenance, operation-, Social - image, adaptability, safety.
3. Requirements for energy, water, refurbishment under SBD.
4. Requirements and selection of materials under SBD: sustainable origin, application of Life Cycle Analysis – sourcing of materials and production of products, use/maintenance, reuse, transformation, deconstruction, recycling and waste management. ISO standards 14040:2006 and 14044:2006.
5. Tools for Life Cycle Analysis: focus on strategy, focus on materials, focus on buildings, focus on integrated systems. LCA phases: (i) objective and scope; (ii) inventory of information and data; (iii) impact assessment (indicators, models, benchmarks); (iv) interpretation, conclusions, recommendations.
6. Energy and Buildings: energy efficiency and monitoring, CO2 reduction and renewable energy.
7. Buildings and Environment: urban climate, pollution, air quality, moisture control and mechanical systems issues.
8. Space Planning and Optimization: areas, distribution, user flow, material-concerned modularity, adaptation and evolution.
9. Stages of Design development: Programme/Briefing, Design/Design Review, Construction/Commissioning, Reuse/Recycling.
10. Performance of Buildings: Metrics for the assessment of Design stages' output and Post-occupancy user behaviour; Sustainable systems in use.
11. Design Economics: Impacts on costs and benefits; WLC concepts; Design for Value; Productivity and Procurement strategies.
12. Sustainable performance and the effect of the behaviour of stakeholders and of the building. The Performance Gap. The duality between Life Cycle Cost and Immediate Investment Budget.

Teaching methodology:
Mix of practical/theoretical classes, with a mix of short classes followed by analysis of specifically developed work and case studies. It will be evaluated through a number of group and individual works and with a brief final exam (indicative weight 75-25%).

Training activities:

	Number of hours	% Attendance
Theory	30	100
Classroom practice	30	100
Tutorials	5	100
Evaluation	5	100
Group work	30	0
Self-directed work	50	0

Assessment method:

	Minimum weighting	Maximum weight
Continuous classroom evaluation	0%	10%
Final written work	25%	40%
Oral presentation	0%	10%
Theoretical exam	0%	25%
Practical exercises	40%	50%

Grading system:

U.PORTO	20	19	18	17	16	15	14	13	12	11	10	9	...	0
Portugal	Very Good with distinction			Good with distinction		Good		Sufficient				Fail		
U.CANTABRIA	10.0	9.9	9.0	8.9	...		7.0	6.9	...		5.0	4.9	...	0.0
Spain	Sobresaliente			Notable				Aprobado				Suspenso		
THM	100	...	88	87	73	72	58	57	...		50	49	...	0
Germany	Excellent			Good with distinction		Satisfactory		Sufficient				Fail		

Bibliography:

Robinson, H; Symonds, B; Gilbertson, B; Ilozor, B. (2015). **Design Economics for the Built Environment: Impact of Sustainability on Project Evaluation**. Wiley-Blackwell, ISBN 978-047065909

Goodhew, S (2016). **Sustainable Construction Processes: A Resource Text**. Wiley-Blackwell, ISBN 978-1405187596

Mumovic, D; Santamouris, M (2015). **A Handbook of Sustainable Building Design and Engineering (BEST Buildings Energy and Solar Technology)**. Routledge, ISBN 978-1138965546

Preiser, W; Vischer, J (2005). **Assessing Building Performance**. Elsevier, ISBN 0-7506-6174-7

Changall,S; Mohammad, A; van Nieuwland, M (2015). **The construction productivity imperative**. McKinsey & Company.

HM Treasury (2015). **Fixing the foundations: Creating a more prosperous nation**. HM Treasury, ISBN 978-1474123006

Barbosa, F et al (2017). **Reinventing Construction: A route to higher productivity**. McKinsey Global Institute, McKinsey & Company.

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