



# 大数据与城市规划：节能建筑及能源系统设计

Big Data & Urban Design: Efficient Buildings  
and Energy Systems Design Through Dynamic  
Performance Simulations



#1. 课程背景及简介



大数据工程建模/城市设计是一门以城市规划和环境工程为核心的交叉工程学科，其关注的是建筑设计中的节能系统的设计和应用，旨在减少能源消耗和温室气体排放，实现建筑行业的零排放。

在这种情况下，学生需具备在建筑、环境及能源设计系统中等多方面发展知识，技能和能力。跨学科设计的研究方法可以提高学生在建筑环境中解决复杂设计挑战的能力，同时将科学层面的“了解”和开放设计的“为什么”结合在一起。同时，授课老师在教学上也进行相应创新，利用和发展相关设计的模式，在创造性设计过程中利用工程工具，以先进的工程，探索和实验的设计方案，完成实验设计的核心。本课题旨在向学生展示对环境设计的理解：建筑分析中关键的环境因素、被动式设计、节能系统设计、装配式建筑服务的需求以及评估各种设计方案的预测能源使用模型等。

#2. 学习目标



本课程将解决许多挑战，如：

- ★ 如何设计可持续性能的建筑？
- ★ 如何解决能源消耗和温室气体排放的挑战？
- ★ 如何提高城市环境质量？
- ★ 如何探索和实验的设计方案并完成实验设计的核心？
- ★ 如何评估各种设计方案的预测能源使用模型？

#3. 任课教师信息



Dr. D M

授课教师目前为伦敦大学学院巴特莱特建筑学院讲师，同时担任 LEEDR（能源项目）数据监测分析负责人。继获得米兰大学理工学院建筑环境科学与技术（BEST）博士学位后，于爱尔兰国立大学从事博士后研究员工作，曾任职 Petcor 国际公司工程师。



#4.课程设置



周期	时间	课程设置内容	课时
第一周 学习指南 教授及助教辅导	1月28日 周六	什么是PBL教学方法	1
		PBL教学的常见形式	1
	1月29日 周日	教授课-1 交叉学科PBL课程设计及知识点学习 学习目标：建筑和能源专业知识 导论：为什么要进行模拟？模拟的作用：减少能源消耗和碳排放 描述：第一节课我们将从建筑和能源消耗的背景讨论开始；同时继续解释为什么要进行模拟，以及模拟在减少能源消耗和碳排放方面的作用是什么？	3
	1月30日 周一	助教课-1 知识点查漏补缺	2
	1月31日 周二	教授课-2 制定项目方向 学习目标：如何使用模型数据？ 根据练习或相关案例数据进行模拟操作 描述：在第二阶段，老师将提供相关专业指导，以帮助学生获得知识，并了解更多的模型数据； 学生将了解建筑，开口，组件等并学习如何选择模板、更改时间表、数据编辑系统的构造、运行模拟和检查结果等相关专业技能	3
	2月1日 周三	助教课-2 知识点查漏补缺	2



第二周 教授及助教辅导	2月2日 周四	教授课-3 交叉学科课程知识点学习 学习目标：如何使用（DB）模拟进行供热和制冷负荷计算 描述：在这一阶段将为学生系统介绍：如何使用软件进行冷热设计的相关计算，并如何建立一个简单的暖通空调系统到模型中，并探索采光和遮阳对负荷及舒适性的影响；学生在课堂中也会有相应的联系，例如在自己的学习时间里通过运行模型和探索模拟结果，并在发生变化时进行专业比较	3
	2月3日 周五	助教课-3 知识点查漏补缺&跟进项目调研进度	2
	2月4日 周六	教授课-4 互动与项目设计跟进答疑	1.5
	2月6日 周一	助教课-4 跟进项目调研进度	2
	2月7日 周二	教授课-5 交叉学科课程知识点学习 学习目标：计算自然通风的影响及其与其他模型设置的整合特点 描述：在第四阶段，学生能够理解 DB 模拟中更高级的计算，并且进行遮阳分析和自然及混合模式通风。在本课程中，同学们也将练习如何建模和模拟预定的自然通风、渗透和混合模式通风方法；最后，课程结束时将有一个练习，学生可以通过独立练习如何使用自然通风来降低建筑内过热风险，运行计算自然通风并进行评估供热和通风带来的相关问题。	2
第三周 教授及助教辅导 未来展望	2月8日 周三	助教课-5 跟进项目调研进度	2
	2月9日 周四	教授课-6 交叉学科课程知识点学习 学习目标：了解详细的 HVAC 设	2



		置（供暖通风与空气调节），手动添加部件并比较模拟 描述：在本章节中，学生将被介绍和展示建模详细的暖通空调设计，课堂将重点讨论单个 HVAC 系统，如散热器或包装热泵系统；旨在帮助学员进行相关练习，以运行一个详细的 HVAC 模拟与散热器装置	
	2 月 10 日 周五	助教课-6 知识点查漏补缺& 指导项目成果展示	2
	2 月 11 日 周六	教授课-7 教授点评项目成果	1.5
	2 月 12 日 周日	升学与就业方向展望	1
		个人规划及发展建议	1
总课时	32		

#5.阅读材料



- 1.LETl: Climate Emergency Design Guide
- 2.UK GBC: Net Zero Carbon Buildings
- 3.Twidell and Weir: Renewable Energy Resources
- 4.BSRIA Guide BG 6/2018: A Design Framework for Building Services
- 5.BSRIA Guide BG 1/2006: Model Demonstration Project
- 6.Tymkow et al.: Building Services Design for Energy Efficient Buildings
- 7.Chadderton: Building Services Engineering

#6.项目主题



本课程使用 PBL 教学法，PBL 即项目式学习，是一种以学生为中心的教学方法，教师提供关键素材构建学习环境，学生通过在此环境里解决一个开放式项目的经历来学习。以下为本课程可选的项目主题：

- 建立建筑性能规范及内外部条件设计
- 建筑的供暖和制冷系统设计及分析

- 建筑物及其环境案例分析
- 排气系统设计及空气循环系统的案例研究

英文版教学大纲

PBL

Course Title	Big Data & Urban Design: Efficient Buildings and Energy Systems Design Through Dynamic Performance Simulations
Credit Hours	32 (one credit hour is 45 minutes)
Course Objectives	<p>This class will address many challenges such as:</p> <ol style="list-style-type: none"><li>1.How to use model data and manipulate them as needed for their exercises or case studies?</li><li>2.How to use the software to carry out heating and cooling design calculations?</li><li>3.How to model and simulate scheduled natural ventilation and infiltration and mixed mode ventilation methods?</li><li>4.How to create and model detailed HVAC design and calculation?</li></ol> <p>How to connect a HVAC system to the zone equipment radiators or air handling units?</p>
Course Description	<p>The default environmental design goal is “nearly zero-energy”, which is defined a building that has a very high energy performance, as determined in accordance with Annex I of the Energy Performance Building Directive (EPBD) legislation. The nearly zero or very low amount of energy required should be achieved by designing sustainable building, designing energy efficient Heating, Ventilation and Air Conditioning (HVAC) systems and the rest of energy demand should be covered to a very significant extent from renewable energy sources produced on-site or</p>

	<p>nearby. A good sustainable energy engineer or architect should consider environmental design goals and: decide if an alternative goal, such as “net zero operational carbon emission” or “life-cycle carbon neutrality”, maybe more appropriate; decide if other goals should be included, e.g. enhanced indoor environmental quality for health and well-being, and provide elements in Leadership in Energy and Environmental Design (LEED) and/or Building Research Establishment Environmental Assessment Method (BREEAM) standards; be aware of the skills and tools required for carrying out analyses towards chosen goals.</p>
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**Brief introduction of the course**

The buildings and construction sector including heating, cooling, and ventilation system account for 36% of final energy use and 39% of carbon dioxide (CO2) emissions globally<sup>1</sup>. Reduction of energy consumption and green-house gas emissions are the key challenges for coming decades. The UK Government has committed itself to reduce CO2 emission by 80\% in 2050 relative to the 1990 levels with the objective towards zero emission from building sector<sup>2</sup>. The default environmental design goal is “nearly zero-energy”, which is defined a building that has a very high energy performance, as determined in accordance with Annex I of the Energy Performance Building Directive (EPBD) legislation. The nearly zero or very low amount of energy required should be achieved by designing sustainable building, designing energy efficient Heating, Ventilation and Air Conditioning (HVAC) systems and the rest of energy demand should be covered to a very significant extent from renewable energy sources produced on-site or nearby. A good sustainable energy engineer or architect should consider environmental design goals and: decide if an alternative goal, such as “net zero operational carbon emission” or “life-cycle carbon neutrality”, maybe more appropriate; decide if other goals should be included, e.g. enhanced indoor environmental quality for health and well-being, and provide elements



in Leadership in Energy and Environmental Design (LEED) and/or Building Research Establishment Environmental Assessment Method (BREEAM) standards; be aware of the skills and tools required for carrying out analyses towards chosen goals.

	<b>Topics</b>
<b>Module 1</b>	<p>Objective: : Introduction to building simulation, software installation guide and get starting to use software with simple geometry models.</p> <p>Description: During this session, an introduction to (DB) software will be given, introducing the user interface and geometric modelling fundamentals, understand zoning, model data input for activity, constructions, and openings (including schedules) and presumably finish by running a simple simulation to enable you to get started use (DB). You would need access to (DB) software to practice your learning and for progress development. The free evaluation version (one moth) can be used for your development (direction and instruction will be provided to download and install). By the end of the session, will be given an exercise (to develop in your time) that you ask to create a building in (DB) using the provided DXF drawings and support your development by giving some useful instructions.</p>
<b>Module 2</b>	<p>Objective: Equip learners with skills how to use model data and manipulate them as needed for their exercises or case studies.</p> <p>Description: In session two, instructions will be provided to help learners to gain knowledge and to understand more on model data. You will understand construction, openings, component blocks and timing schedules as will be demonstrated during the video session. At the end of the session, you should be equipped with the skills to undertake an exercise to learn how to select template, change schedules, edit construction data, run simulation, and check results.</p>
<b>Module 3</b>	<p>Objective: Explain how undertake heating and cooling loads calculations with (DB) simulations.</p> <p>Description: During this session explanation will be provided for learners where you will use the software to carry out heating and cooling design calculations, setting up a simple HVAC system into the model, and understand impact of daylighting</p>





	and solar shading on the loads and comfort. An exercise will be given to you where you can practice on your own learning time by running the model and exploring the simulation results and comparing them as the changes take place thought.
Module 4	<p>Objective: Understand impact of using calculated natural ventilations and its integration with other model settings.</p> <p>Description:</p> <p>In the session four it is expected that learners understand more advanced calculations in (DB), undertaking shading analysis and natural and mixed-mode ventilation. You are expected that during this session to learn how to model and simulate scheduled natural ventilation and infiltration and mixed mode ventilation methods. An exercise will be given by the end of session where learners can practice independently how to use natural ventilation to reduce overheating risk in the building and run calculated natural ventilation and assess simultaneous heating and ventilation issues.</p>
Module 5	<p>Objective: Understand Detailed HVAC settings, manually adding components and quick simulation comparisons</p> <p>Description: During this session, learners will be introduced and shown the workflow of creating and modelling detailed HVAC design and calculation and analyse the results. This session will focus on individual HVAC systems such as with radiators, or packaged heat pumps systems. The session is expected to help learners to undertake an exercise to run a detailed HVAC simulation with a radiator and defined settings.</p>
Module 6	<p>This session will be a continuation of the section five where it will be demonstrated how it can be modelled a detailed HVAC system with hot water loop, boiler and how it can be connected to the zone equipment radiators or air handling units. At the end a case study building might be presented as an illustration example to show important aspects to be considered when designing comfort and efficient building and HVAC systems.</p>

Required Readings

Please see below a suggested reading list, obvious this is not limited to learners can search for a similar topics.  
LETI: Climate Emergency Design Guide



UK GBC: Net Zero Carbon Buildings  
Twidell and Weir: Renewable Energy Resources  
BSRIA Guide BG 6/2018: A Design Framework for Building Services  
BSRIA Guide BG 1/2006: Model Demonstration Project  
BSRIA Guide BG 71/2017: Building Services Reports  
Tymkow et al.: Building Services Design for Energy Efficient Buildings  
Oughton and Wilson: Faber & Kell's Heating and Air-Conditioning of Buildings  
Chadderton: Building Services Engineering  
BSRIA Guide BG 1/2010: The Illustrated Guide to Mechanical Cooling  
CIBSE KS17 Indoor Air Quality  
BSRIA Guide BG 2/2009: The Illustrated Guide to Ventilation  
BSRIA Guide BG 31/2017: The Illustrated Guide to Mechanical Building Services  
BSRIA Guide BG 4/2007: Design Checks for HVAC

**Suggested list of the topics for the final project**

- 1.Establish performance specification for a case study project and communicate internal and external design psychrometric conditions for the specific location Performance analysis of massive MIMO networks
- 2.Develop a DesignBuilder model and determine heating and cooling design loads for the building
- 3.Provide a concise summary of the potential active environmental systems overview that can be consider and designed for the case study building
- 4.Discussion, justification and explanation of ‘all air’ system outline design and air distribution method for the case study including system psychrometry.

**Criteria**

- Quality of the sources used by students
- Participation in class discussion
- Contribution to group presentation
- Final project

**Class Expectation**

In this context, it will be required for him/her to develop knowledge, skills, and abilities in the synthesis of architectural, building, and environmental energy systems design. An interdisciplinary design studio approach can enhance the learner’s ability to address complex design challenges in the built environment by bringing together ‘know what’ of science and ‘know why & how’ of open design. Pedagogically innovative, this module will harness and evolve the design studio model to utilise engineering tools in the creative design process



to augment design proposals with advanced engineering, exploration, and experimentation at the heart of the design practice studio. The objective will be to demonstrate an understanding of environmental design. This includes analysis and application of key environmental aspects of building analysis, including emphasis on passive design, energy efficient systems design, reduce the need for active building services and evaluation of predicted energy use modelling of various design options.