MEEB504 Energy Design of Buildings and Energy Audits

Course Title	Energy Design of Buildings and Energy Audits				
Course Code	MEEB 504				
Course Type	Elective				
Level	Masters (2nd Level)				
Year / Semester	1st year/ 2nd semester or 2nd year/ 3rd semester				
Teacher's Name	Dr.-Ing. Paris A. Fokaides, Mr. Xenis Flouri				
ECTS	10	Lectures / week	2	Laboratories/week	1
Course Purpose	The aim of this module is to provide an understanding of the building's design principles and approach so that it can achieve the best possible energy performance, whilst it ensures high indoor environmental quality standards. This includes the integration of architectural design principles, of HVAC systems, if automation and controls, but also of the adaptation of the building to the local climate, topology and operational and habitual conditions. Furthermore, the aspects of energy renovation and rehabilitation are particularly important, as the management of the existing building stock becomes a dominant issue. This module also aims to provide an in depth understanding of the theoretical background, the methodological approach and the practical aspects of energy audits. Particular emphasis is being placed on the measurements' protocols, instrumentation, procedure and practice and the expertise needed in carrying out a complete and integrated energy audit. The students will be introduced to topics like the theory behind the various parameters measured, the possibilities and limitations of the measurement techniques and the assessment of the results. Finally, they will learn how to utilize the audits as a tool for the determination of a building's energy performance and indoor environmental quality and a base for the elaboration of energy renovation measures				
Learning Outcomes	By the end of the course, students must be able to: 1. Describe the background of energy conscious design of buildings. 2. Outline the role and the impact of the parameters determining the energy performance of buildings. 3. Explain the balance between architectural design, building services, operational patterns and the users' attitudes. 4. Interpret the balance between the resulting additional initial cost, energy savings and the added value as incorporated in the buildings' commercial value. 5. Reproduce the legislative, regulatory and normative framework. 6. Design solutions for improving the buildings' energy performance, both of new and of existing buildings. 7. Apply energy design simulation software tools. 8. Describe the background of how audits have to be planned, carried out and assessed. 9. List the different types of energy audits and knowing how to choose the appropriate for each case. 10. Identify the role and the impact of the parameters determining the energy performance of buildings. 11. Summarize how the main parameters that determine indoor thermal comfort, air quality, lighting and acoustics function and can be measured 12. Outline how the thermal protection and air-tightness of the building's envelope can be measured 13. Explain how instrumentation has to be chosen, calibrated, maintained and used. 14. Apply appropriate software tools for the calculative types of audits				
Prerequisites	MEE520			Corequisites	None
Course Content	**1. Introduction** - Climatic conditions, - Urban microclimate, - Solar radiation - Daylight analysis				

	2. Energy balance of buildings - Heat transfer phenomena in buildings - Solar and internal loads - Daily, monthly and annual energy demand for heating and cooling **3. Thermal insulation** - Insulation materials and their properties - Insulation solutions for the various building elements **4. Passive solar systems** - Direct gain, Thermal storage walls, Attached Greenhouse - Sun protection - Natural lighting - Natural Ventilation and passive cooling - Thermal, Acoustic and Visual Comfort - Indoor air quality **5. Integration of the building's shell, the buildings' services and the indoor environmental quality requirements.** - Thermal inertia of the building elements - Thermal transmissivity and diffusivity of building materials - Operational principles of heating and air-conditioning systems - Operational principles of passive systems - The impact of the user **6. Energy Audits** - Types of energy audits, data acquisition and measurements - Strategy and procedure for energy audits for various building types - Residential buildings, Office buildings, Commercial buildings, Schools and Educational buildings, Mixed Use buildings - Design and completion of energy audit questionnaires **7. Collection, processing and evaluation of energy consumption and buildings' operational data** - Measurement and evaluation of indoor climate parameters - Air temperature and relative humidity - Radiative surface temperature - Air Velocity **8. Measurement and evaluation of indoor environmental quality parameters and building envelope** - Air quality (CO2, CO, PMs, chemical pollutants, biological pollutants) - Lighting (Luminance and lighting quality) - Acoustics (Noise level) - Infrared photography, Measurement of U-Value, - Measurement and evaluation of the building envelope's air-tightness - Tracer gas analysis, Blower door method - Measurement and evaluation of heating system's efficiency - Energy design and simulation software tools - Measurement and evaluation of air-conditioning system's efficiency **9. Energy performance evaluation by computational methods** - Asset based method - Operational method - Energy certification of buildings - Procedures and software tools
Teaching Methodology	The course will be presented through theoretical lectures in class. The lectures will present to the student the course content and allow for questions. Part of the material will be presented using visual aids. The aim is to familiarize the student with the different and faster pace of presentation and also allow the instructor to present related material that would otherwise be very difficult to do. The learning process will be enhanced with the requirement from the student to solve exercises. These include self-evaluation exercises which will be solved in class. These exercises will not be graded. Exercises will also be given as homework (final project) which will be part of their assessment.

	Besides from the notes taken by students in class, all of the course material will be made available through the class website and also through the eLearning platform. The instructor will also be available to students during office hours or by appointment in order to provide any necessary tutoring. A course project will be carried out on the energy design of buildings, in order to understand the impact of the parameters and the role of building elements and systems, by using the Energy Plus or a similar tool. The students will carry out measurements on the various parameters in the laboratory and in real buildings. A course project will be carried out, which will consist of carrying a full energy audit of a buildings and the production of the respective report and certificate
Bibliography	**Textbooks:** 1. Energy Simulation in Building Design, Clarke J.A., Butterworth-Heinemann, 2001, ISBN 13: 978-0-7506-5082-3 **References:** Papadopoulos M., Axarli K. (1992) "Energy Design of Buildings", Kyriakides, Thessaloniki, (in Greek) ISBN 978-960-343-330-9 Building, Energy and the Environment, (Kosmopoulos P., ed.), 2008, University Studio Press
Assessment	Students will be assessed through: - A course project will be carried out on the energy design of buildings, in order to understand the impact of the parameters and the role of building elements and systems, by using the Energy Plus or a similar tool. - The students will carry out measurements on the various parameters in the laboratory and in real buildings - A course project will be carried out, which will consist of carrying a full energy audit of a buildings and the production of the respective report and certificate The weights of the course assessment are as follows: Assignment: 30% Midterm Exams: 20% Final Exams: 50%
Language	English