



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Modeling and simulations in Environmental Engineering

Course

Field of study

Environmental Engineering Second-cycle Studies

Area of study (specialization)

Heating, Air Conditioning and Air Protection

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

1/1

Profile of study

general academic

Course offered in

polish

Requirements

compulsory

Number of hours

Lecture

15

Laboratory classes

45

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

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Instytut Inżynierii Środowiska i Instalacji

Budowlanych

Berdychowo 4, 61-131 Poznań

Responsible for the course/lecturer:

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Instytut Inżynierii Środowiska i Instalacji

Budowlanych

Berdychowo 4, 61-131 Poznań

Prerequisites

Basic knowledge about Windows operating system.

Basics of building physics and heating systems (hygrothermal properties of buildings, operation principles of heating systems).

Basics of thermodynamics and fluid mechanics (heat and mass transfer, laminar and turbulent fluid flow).

Spatial imagination, ability to edit and create technical drawings using CAD / CAM software.



Ability to work in a team. Awareness of the constant need to update and supplement one's knowledge and skills.

Course objective

Learning about the latest methods and software used for computer modeling and simulation in the field of Environmental Engineering.

Course-related learning outcomes

Knowledge

Methodology of static and dynamic energy modeling of buildings and thermal systems.

Numerical modeling methodology for typical heat- and fluid flow problems considered in the field of Environmental Engineering.

Fundamentals of Integrated Design Process.

The latest computer programs used for modeling and simulation in Environmental Engineering.

Skills

Student can indicate correct modeling method for solving clearly defined technical problem (in the scope described in Programme Content).

Student can state basic assumptions and define boundary conditions necessary to build valid model for specific numerical simulation.

Student can use specific modeling/simulation software (THERM, TRNSYS, Ansys Fluent).

Social competences

Awareness of the need to constantly acquire and expand one's knowledge in order to competently pursue the career in engineering.

Awareness of responsibility associated with participation in complex engineering projects.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written test at the end of the term. The student must obtain a minimum of 50% of the possible points.

Laboratory classes: checking and grading specific tasks performed by student during classes. The student must achieve a minimum of 50% advancement in each task.

Programme content

Lecture:

Dynamic numerical simulations of heat and mass transfer in buildings and between buildings and its surroundings.



Building energy simulations performed during design.

Boundary conditions, input variables for building performance simulation.

Passive house analysis in terms of energy performance.

Basics of modeling external and internal building environment using Computational Fluid Dynamics (CFD).

Resources and databases useful for numerical simulations - and available on the Internet.

Laboratories:

2D analysis of thermal bridging (THERM).

Air-flow network model of building (CONTAM).

Dynamic simulation of 1D partition wall; thermal dynamics of the building (Excel).

Numerical simulation of air flow through ventilation damper (CFD).

Multi-zone energy analysis of a building; energy system analysis (TRNSYS).

Modeling energy demand for ventilation purposes: Introduction; work schedule, heat recovery; components: pre-heater, post-heater, heat recovery exchanger frosting; ground heat exchanger; analysis of demand for EU, EK and EP

Teaching methods

Lecture: multimedia presentation.

Laboratory classes: multimedia presentation and practical tasks performed by students (practical use of simulation software).

Bibliography

Basic

Hensen, J. L. M. & Djunaedy, E. „Jak niewidzialne uczynić widzialnym - zastosowanie symulacji budynku na przykładzie przepływów powietrza”. W: Popiołek, Z. (red.), Energooszczędne kształtowanie środowiska wewnętrznego, Gliwice, Politechnika Śląska, 2005

Lain, M., Bartak, M., Drkal, F., & Hensen, J. L. M. „Wykorzystanie symulacji komputerowej do oceny niskoenergetycznych systemów chłodzenia w Czechach”, w: Popiołek, Z. (red.), Energooszczędne kształtowanie środowiska wewnętrznego, Gliwice, Politechnika Śląska, 2005

TRNSYS 18 Documentation



Advanced Building Simulation, Ali . Malkawi and Godfried Augenbroe -

<http://117.3.71.125:8080/dspace/bitstream/DHKTDN/7136/1/4887.advanced%20building%20simulation.pdf>

Budynki efektywne energetycznie – zintegrowane metody symulacji i projektowania, Górka A., Bandurski K., Szczechowiak E. (63 Konferencja Naukowa Komitetu Inżynierii Lądowej i Wodnej PAN oraz Komitetu Nauki PZITB, Krynica 2017), Warszawa 2017, ISBN 978-83-249-8485-5

Nagórski Z., Modelowanie przewodzenia ciepła za pomocą arkusza kalkulacyjnego : MRS Excel -> KM3R, Oficyna Wydawnicza PW, 2001 ISBN: 83-7207-226-4

IBPSA-USA, „Building Energy Software Tools Directory” <http://www.buildingenergysoftwaretools.com/>

Additional

Beausoleil-Morrison I., Fundamentals of Building Performance Simulation, Routledge, 2020

Building Performance Simulation for Design and Operation, red. J. L. M. Hensen, R. Lamberts, Son Press, 2011, 2019

De Wilde P., Building Performance Analysis, Wiley Blackwell, 2018

Komputerowa fizyka budowli: komputerowa symulacja procesów wymiany masy i energii w budynku: przykłady zastosowań, red. Gawina D., Wyd. PŁ, 1998

On the thermal interaction of building structure and heating and ventilation systems, Jan L.M. Hensen - http://www.esru.strath.ac.uk/Documents/PhD/hensen_thesis.pdf

Passive House Institute, PHPP 9 – the energy balance and Passive House planning tool”, 2015 http://passivehouse.com/04_phpp/04_phpp.htm

Training materials provided by the developers of the software.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes, preparation for tests, additional homework prescribed by the teacher) ¹	40	1,5

¹ delete or add other activities as appropriate