# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modeling and simulations in Environmental Engineering I [S2IŚrod2-ZwCKiOP>MI]

## Course

Field of study
Environmental Engineering

Year/Semester
1/2

Area of study (specialization)
Heating, Air Conditioning and Air Protection

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
0

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
15

## Number of credit points

2,00

## Coordinators

dr inż. Karol Bandurski
karol.bandurski@put.poznan.pl

## Lecturers

## 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

The ability to share one's skills with people in the team, understanding the need for continuous learning and updating one's knowledge.

## 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 state basic assumptions and define boundary conditions necessary to build valid model for specific numerical simulation.
Student can use specific modeling/simulation software.

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:

Laboratories: evaluation of the tasks performed in class. Perform the basic scope of each task presented.
Project: evaluation of the solution of the design problem formulated at the beginning of the semester, taking into account:
- the correctness of the prepared model and assumptions regarding boundary conditions,
- The advancedness and scope of the simulation analyses performed,
- discussion of the limitations of the approach used,
- presentation of the obtained results.

The files and description of the model and analysis should be submitted to the lecturer for evaluation, and the complete work should be presented at the last class.

## Programme content

Laboratories:
Learning ways to model selected thermal and mass transfer problems in built environment engineering.

Project:
Modeling and simulation analysis of the performance of a selected system.

## Course topics

Laboratories:
Annual hourly modeling energy demand for ventilation purposes (work schedule, heat recovery, pre-heater, post-heater, heat recovery exchanger frosting, ground heat exchanger)
Monthly and annual hourly modeling of building thermal dynamics including central heating and cooling systems (Excel).
2D analysis of thermal bridging (THERM).
Air-flow network model of building (CONTAM).
Project:
Building energy performance simulations in the design process.
Resources and databases available on the intrenet used for simulation analysis.
Modeling and simulation of the system solution with hourly time step:
- description of the operation of the system, formulation of the design problem and selection of analyzed variants,
- determination of how to evaluate the analyzed solutions - performance indicators,
- determination of boundary conditions,
- selection of thermal-fluid models of installation elements,
- simulation analysis,
- solution of the design problem.

## Teaching methods

Laboratories: multimedia presentation and practical simulation tasks performed by students.
Project: multimedia presentation and problem-based learning.

## Bibliography

Basic:
Hensen, J. L. M. & Djunaedy, E., Building simulation for making the invisible visible - air flow in particular, https://www.researchgate.net/publication/254892279_Building_simulation_for_making_the_invisible_visible_-_air_flow_in_particular
Lain, M., Bartak, M., Drkal, F., & Hensen, J. L. M., Use of computer simulation for the evaluation of low energy cooling in the Czech Republic, https://www.researchgate.net/publication/252129995_Use_of_computer_simulation_for_the_evaluation_of_low_energy_cooling_in_the_Czech_Republic
IBPSA Education Webinars Series 1:
https://www.youtube.com/playlist?list=PLX95PEAoM5YPEdIenaZAarVNcvUBmEBC5
IBPSA Education Webinars Series 3:
https://ibpsa.org/collection/ibpsa-education-webinars-series-3-2021-22/
Górka A., Bandurski K., Szczechowiak E., Budynki efektywne energetycznie - zintegrowane metody symulacji i projektowania, (63 Konferencja Naukowa Komitetu Inżynierii Lądowej i Wodnej PAN oraz Komitetu Nauki PZITB, Krynica 2017), Warszawa 2017, ISBN 978-83-249-8485-5
J. Walkenbach, Microsoft Excel 2013 PL BIBLIA
IBPSA-USA, Building Energy Software Tools Directory https://www.ibpsa.us/best-directory-list/

Additional:
Bandurski K., Amanowicz Ł., Cholewa T., Metoda statyczna, dynamiczna czy pomiarowa - jak rzetelnie oceniać efektywność energetyczną budynków?, Ciepłownictwo, Ogrzewnictwo, Wentylacja 10/2023
Bandurski K., Amanowicz Ł., Pawlak F., Nowa metoda wyboru rozwiązań instalacyjnych i założeń architektonicznych spełniających wymagania WT 2021 dotyczące EPmax w budynkach wielorodzinnych, Rynek Instalacyjny 4/2023
Bandurski K., Koczyk, H., Symulacyjna analiza parametrów komfortu cieplnego i zapotrzebowania na energię wybranych rozwiązań wentylacji mieszkania. Cz. 1., Ciepłownictwo, Ogrzewnictwo, Wentylacja 2/2013
Sinacka J., Szczechowiak E., Żabicka P., Wpływ profilu użytkowania pomieszczenia na zapotrzebowanie na energię do ogrzewania i chłodzenia w budynku ze stropami grzewczo-chłodzącymi, Instal 10/2019
Nagórski Z., Modelowanie przewodzenia ciepła za pomocą arkusza kalkulacyjnego : MRS Excel -> KM3R, Oficyna Wydawnicza PW, 2001 ISBN: 83-7207-226-4
Vellei et al., Documenting occupant models for building performance simulation: a state-of-the-art, Journal of Building Performance Simulation (2022)
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
Jan L.M. Hensen, On the thermal interaction of building structure and heating and ventilation systems, - http://www.esru.strath.ac.uk/Documents/PhD/hensen_thesis.pdf
Materiały szkoleniowe udostępniane przez autorów oprogramowania.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 50 | 2,00 |
| Classes requiring direct contact with the teacher | 30 | 1,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 20 | 1,00 |