| Title | Code |
|---|---|
| **(Wymiana ciepła i masy)** | **1010102211010130559** |
| Field | Year / Semester |
| **Environmental Engineering Second-cycle Studies** | **1 / 1** |
| Specialty | Course |
| **Heating, Air Conditioning and Air Protection** | **core** |
| Hours | Number of credits |
| Lectures: **3** Classes: **1** Laboratory: **2** Projects / seminars: **-** | **6** |
| | Language |
| | **polish** |

## Lecturer:

Prof. Czesław Oleśkowicz-Popiel (C.O. Popiel)
Institute of Environmental Engineering
Faculty of Civil and Environmental Engineering
ul. Piotrowo 5
60-965 Poznań
tel. 061 6652-537, fax. 061 6652-439
e-mail: czeslaw.oleskowicz-popiel@put.poznan.pl

## Faculty:

Faculty of Civil and Environmental Engineering
ul. Piotrowo 5
60-965 Poznań
tel. (061) 665-2413, fax. (061) 665-2444
e-mail: office_dceeaf@put.poznan.pl

## Status of the course in the study program:

Course for students for specialization: Heat supply, air conditioning and air protection.

## Assumptions and objectives of the course:

The main aim of the course is to present and discuss general principles and method used in heat and mass transfer. Students should gain basic knowledge on heat and mass transfer, and gain an ability to use the theoretical knowledge in practice, especially in the field of energy balances of heat engineering devices and systems. To learn the principles of basic measurement techniques used in heat transfer.

## Contents of the course (course description):

Thermal properties of matter. Mechanisms of heat transfer, overall heat transfer. Heat conduction: temperature field, Fourier?s law. One dimensional steady conduction across flat and cylindrical walls, heat bridges and fins. 2-D steady conduction: analytical and numerical methods, shape factor, electrical analogy. Unsteady state conduction, lumped capacitance method, analytical and numerical methods, Biot and Fouriers numbers, superposition of solutions. Convective heat transfer, dimensional analysis, governing equations, thermal boundary layer, nondimensional equations, Nusselt, Reynolds and Prandtl similarity numbers. Laminar and turbulent heat convection. Forced heat convection: analytical solutions, methods of measurements and experimental data (plat plate, circular pipe, cylinder, banks of tubes), correlation equations for external and internal flows. Free heat convection: governing equations (Boussinesq approximation), classic solutions, Grashof and Rayleigh numbers, laminar-turbulent transition, recommended correlation equations (vertical and horizontal plates and cylinders, shere, gaps and fins). Boiling: mechanism and boiling curve, critical heat flux, correlation equations. Condensation: mechanism of dropwise and film condensation, Nusselt theory for laminar film condensation, correlation equation, effect of neutral gas, enhancement methods. Radiation heat transfer: mechanisms and basic laws, radiative properties of matter, radiation exchange between surfaces (configuration factor), heat radiation in typical systems. Heat radiation in gases and transparent matter. Solar and environment radiation, energy balance and efficiency of solar collectors, temperature of collector absorber. Heat exchangers: types, theory of parallel and counter flow heat exchangers, crosflow and multipass and another heat exchangers. Log-mean temperature and e-NTU methods of heat exchanger calculations, rating and sizing problems of heat exchangers. Pressure losses and optimization of heat exchangers.

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Recuperators, regenerators, thermal energy storage, ground heat exchangers. Heat pipes: principle and application. Experiments in heat transfer. Mass transfer: mechanism, Fick?s law and diffusion, mass transfer equation. Mechanism of moisture transfer in porous materials (ground and building materials). Convective mass transfer: governing equations, similarity Sherwood and Schmidt numbers, correlation equations, convective heat and mass transfer analogy. Convective heat and mass transfer in natural environment.

## Introductory courses and the required pre-knowledge:

Fundamentals of mathematics, physics and chemistry. Basic knowledge of fluid mechanics and heat engineering gained during previous semesters.

## Courses form and teaching methods:

Lectures, tutorials, laboratory experiments illustrating selected topics of the course.

## Form and terms of complete the course - requirements and assessment methods:

Tests, solving problems: written and oral examination.

## Basic Bibliography:

## Additional Bibliography:

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