
# HEAT AND MASS TRANSFER WITH PHYSICAL ADSORPTION IN SUSTAINABLE APPLICATIONS

**Ph.D. Program – Mechanics and Advanced Engineering Sciences – 8 hours**

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| | Date | Classroom | Session Title |
|---|---|---|---|
| 1 | 10/09/25 14:00–17:00 | 5.5 v. Risorgimento 2 + DIMSAI virtual aula (TEAMS) | Modeling heat and mass transfer with physical adsorption |
| 2 | 11/09/25 14:00–17:00 | 5.5 v. Risorgimento 2 + DIMSAI virtual aula (TEAMS) | Application: dehumidification and sustainable cooling |
| 3 | 15/09/25 14:00–16:00 | 0.8 v. Risorgimento 2 + DIMSAI virtual aula (TEAMS) | Application: contaminant removal & carbon capture |

## Learning outcomes

Students will learn the basic principles of heat and mass transfer and understand the fundamentals of physical adsorption, including its application to sustainable technologies such as carbon capture and energy-efficient dehumidification and cooling systems. Using Wolfram Mathematica, they will develop skills in modeling, simulating, and visualizing thermal and mass transport processes. These outcomes will prepare them to apply advanced engineering concepts in both academic research and practical sustainability contexts.

## Course contents

The course covers essential topics in heat and mass transfer, including conduction, convection, mass diffusion, and coupled transport phenomena. It also introduces the fundamentals of physical adsorption, including adsorption isotherms and breakthrough curve modeling. Throughout

the course, Wolfram Mathematica will be used to perform simulations, solve governing equations, and visualize transport processes in sustainable systems such as carbon capture units and low-energy thermal applications.

## Detailed contents

- **Heat and mass transfer in porous media**
  - Mass, momentum, and energy balance equations
  - Thermodynamics of gas mixtures
  - Applications to packed beds, mini-channels, and regenerators
- **Modeling physical adsorption**
  - Fundamentals of adsorption processes
  - Adsorption isotherms: Langmuir, Freundlich, and others
  - Coupled heat and mass transfer in porous and adsorptive systems
- **Applications in sustainable development**
  - Dehumidification and energy-efficient cooling
  - Carbon capture and pollutant removal systems
  - Use of Wolfram Mathematica for simulation and visualization