

**University of Biskra** 2024-2025



# Building Physics

**LEVEL: 1 YEAR BACHELOR**

**SPECIALTY: COP**

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**COURS 01**

**INTRODUCTION TO BUILDING PHYSIC**



**University of Biskra**

2024-2025



# Welcome to Building Physics: An Introduction

Welcome to the fascinating world of Building Physics! This course is designed to provide you with a comprehensive understanding of the fundamental principles governing the interactions between buildings and their environment. Over the next few weeks, we will explore various core disciplines, including thermodynamics, heat transfer, fluid mechanics, acoustics, and lighting.

By the end of this course, you will be equipped with the knowledge and skills necessary to analyse and optimise building performance, ensuring energy efficiency, occupant comfort, and sustainability in modern construction. Join us as we delve into the science behind building design and explore innovative solutions for creating high-performance buildings.

Let's embark on this exciting journey together and unlock the potential of building physics!

# What is Building Physics?

## Definition and Scope

Building physics explores the complex interactions between buildings and their surrounding environment. It encompasses how buildings respond to weather, climate, and human usage. Understanding these interactions is crucial for designing efficient and comfortable buildings.

## Core Disciplines

The field integrates thermodynamics, heat transfer, fluid mechanics, acoustics, and lighting. These disciplines help us understand how energy and matter flow through buildings. Effective integration ensures optimal performance.

## Historical Context

Building physics has evolved from passive design strategies to active systems. Early designs focused on natural ventilation and materials, while modern designs incorporate sophisticated technologies for control and efficiency.

While building physics focuses on understanding the physical phenomena affecting buildings, building services engineering involves the design, installation, and maintenance of mechanical, electrical, and plumbing systems.

# Key Principles: Thermal Performance

## Heat Transfer Mechanisms

Heat transfer occurs through conduction, convection, and radiation. Conduction involves heat transfer through materials, convection involves heat transfer through fluid movement, and radiation involves heat transfer through electromagnetic waves.

## Thermal Resistance and U-Value

Thermal resistance (R-value) measures a material's resistance to heat flow, while the U-value measures the rate of heat transfer through a building component. Lower U-values indicate better insulation.

## Building Insulation

Various insulation materials are available, including mineral wool, PIR, and vacuum insulation panels. These materials reduce heat transfer, improving energy efficiency and comfort.

Thermal bridging, where heat flows more easily through certain building elements, can significantly impact energy efficiency. The Passivhaus standard, with a U-value less than  $0.15 \text{ W/m}^2\text{K}$ , represents a high level of thermal performance.

# Key Principles: Moisture Control

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## Psychrometry

Understanding air humidity and its effects is crucial for moisture control. Psychrometry helps us analyse air's thermodynamic properties, including humidity and dew point, to manage condensation risks.

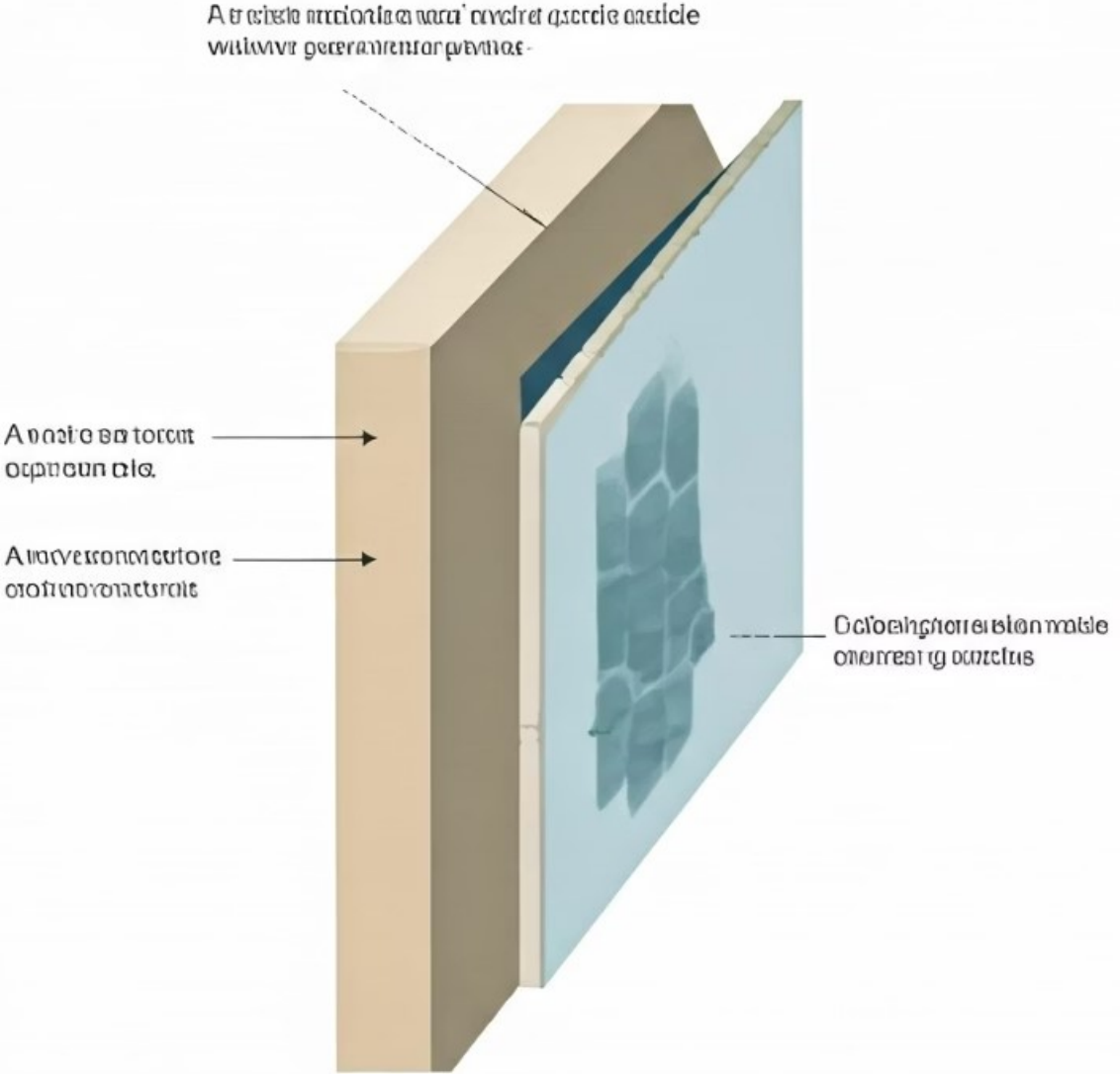
## Condensation Risk Assessment

Assessing dew point and surface temperature helps prevent condensation. When the surface temperature drops below the dew point, moisture condenses, leading to potential damage and mould growth.

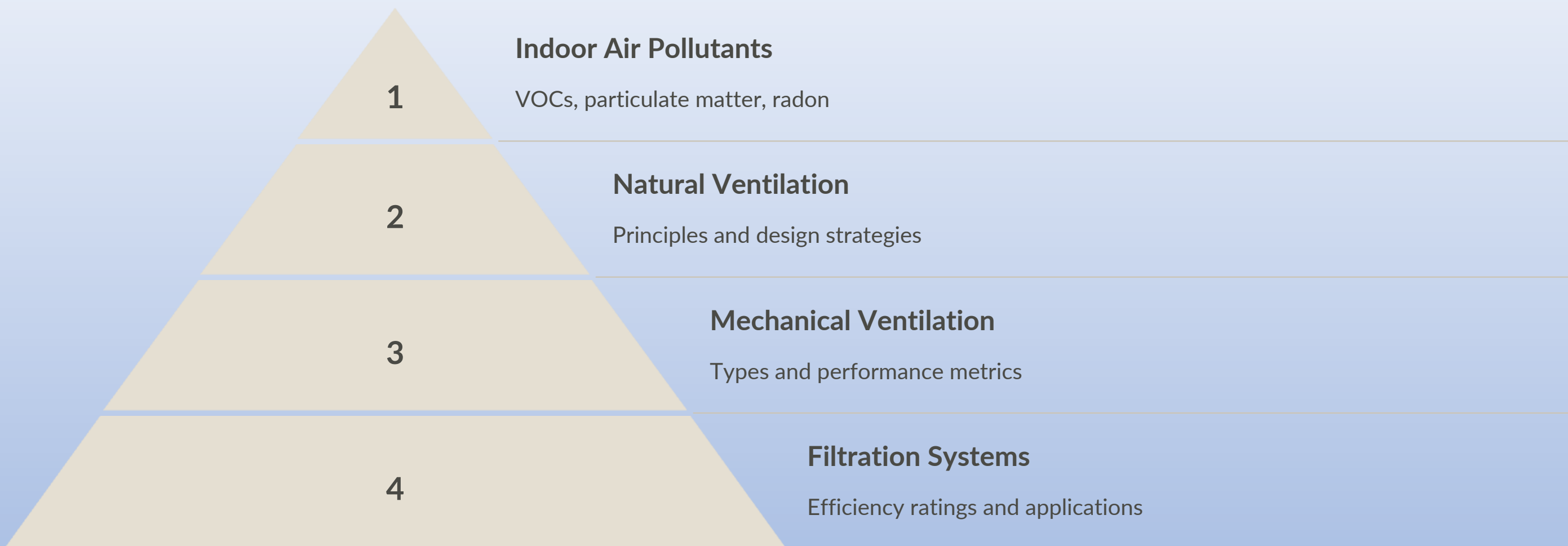
## Moisture Sources

Moisture enters buildings through various sources, including leaks, occupant activities, and ground moisture. Understanding these pathways is essential for implementing effective moisture control strategies.

Ventilation strategies, whether natural or mechanical, play a vital role in removing moisture. Material properties, such as hygroscopic behaviour and moisture buffering, also influence moisture control.



# Key Principles: Ventilation and Air Quality



Indoor air pollutants, such as VOCs, particulate matter, and radon, can significantly impact health. Natural ventilation relies on passive airflow, while mechanical ventilation uses fans.

Filtration systems, including HEPA and activated carbon filters, remove pollutants. Approved Document F and EN 16798 are key standards. Good ventilation is essential for occupant health.

# Key Principles: Building Acoustics



Sound transmission refers to how sound travels through building elements. Sound absorption materials reduce sound reflection. Room acoustics, including reverberation time, affects speech intelligibility. Noise control strategies involve sound insulation, absorption, and vibration damping.

Approved Document E and BB93 outline regulations and standards for building acoustics, ensuring adequate sound insulation and noise control in buildings. Understanding these principles is crucial for creating comfortable and productive indoor environments.



# Key Principles: Electricity



## Energy Efficiency

Optimizing energy use to reduce consumption and costs



## Renewable Sources

Integrating solar, wind, and other clean energy solutions



## Smart Systems

Using automation and IoT to manage electrical loads

Effective electricity management is essential for sustainable building design. Energy efficiency focuses on reducing consumption. Renewable energy sources, like solar and wind, offer clean alternatives.

Smart systems use automation to optimise electrical loads. These practices ensure buildings operate efficiently, reducing environmental impact and lowering operational costs. Embracing these principles supports a more sustainable future.



# Practical Applications and Case Studies



**Energy Efficiency**



**Sustainable  
Materials**



**Simulation Tools**

Energy-efficient design involves strategies and technologies to reduce energy consumption. Retrofitting existing buildings presents challenges and opportunities for improvement. Sustainable building materials minimize environmental impact.

Simulation tools, like IESVE and DesignBuilder, help analyse building performance. BedZED demonstrates zero carbon emissions, and The Crystal showcases sustainable technologies. These case studies highlight practical applications of building physics principles.





# Future Directions in Building Physics

Smart Buildings and IoT	Advanced Materials	Climate Change Adaptation
Sensor technologies for building monitoring and control	Phase change materials, aerogels, and self-healing concrete	Designing for resilience and extreme weather events

The future of building physics involves smart buildings using IoT, advanced materials like phase change materials, and climate change adaptation strategies. Emerging trends include self-healing concrete and designing for extreme weather. Research and development continue to drive innovation in the field.

Thank you for participating in this course! We hope that you have gained a solid foundation in building physics and are inspired to apply these principles in your future endeavors.