Unit 10: Principles of Ventilation and Air Conditioning Design & Installation

Unit code	**D/615/1926**
Unit level	**4**
Credit value	**15**

Introduction

The demands of modern living as well as the potential impact on the environment has meant that the building services engineer has become a key member of the building design team. The spaces that we occupy must be provided with ventilation to allow us to function and, where required, the addition of cooling helps to avoid the building overheating and maintains a comfortable environment for the occupants.

This unit will introduce students to the principles of the design and installation of these ventilation and air conditioning systems that are present in all of the buildings we use in everyday life.

Subjects included in this unit are: the production of pre-design/design briefs, design data, cooling loads, total cooling loads, cooling plant capacity, building overheating, peak summertime temperatures, sizing and specification of ventilation and air conditioning system components, and the commissioning, testing and handover procedures.

On successful completion of this unit students will understand the principles of ventilation and air conditioning systems.

Learning Outcomes

By the end of this unit students will be able to:

1. Identify pre-design information required for a non-domestic ventilation and air conditioning system.
2. Analyse cooling load for non-domestic buildings.
3. Present a design for a non-domestic ventilation and air conditioning system for a given building type.
4. Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy.

Essential Content

LO1 **Identify pre-design information required for a non-domestic ventilation and air conditioning system**

The design process:

Design stages and tasks.

Legislation.

Health & safety considerations.

Possible design constraints.

Sustainability.

Pre-design/design brief:

Building form and orientation to optimise the impact of solar gain.

Building air tightness to reduce infiltration.

Fabric insulation.

Optimisation of glazing.

Balancing daylighting needs against thermal performance.

Building thermal mass.

Required functional performance.

Occupancy.

Usage details.

Potential internal gains.

Internal design conditions.

Cost plan.

Design data:

External design data.

Internal design condition.

Selection of ventilation rates.

Publications and guides.

Statutory requirements.

LO2 **Analyse cooling load for non-domestic buildings**

Cooling loads due to solar radiation:

Solar geometry and terminology.

Direct and diffuse solar radiation.

Calculation of solar irradiance on vertical, horizontal and pitched surfaces.

Transmission of solar radiation on building structures.

Total cooling load and cooling plant capacity:

Factors contributing to cooling plant capacity.

Assessment of total heat gains to the interior.

Effect of building construction and orientation.

Use of tables.

Reference data and software to determine cooling loads for rooms, zones and buildings.

Strategies to prevent building overheating:

Effect of shadows and shading.

Passive and active cooling measures.

Peak summertime temperatures:

Calculation and assessment of peak summertime temperatures in rooms.

Use of tables.

Reference data and computer software.

LO3 **Present a design for a non-domestic ventilation and air conditioning system for a given building type**

Possible strategies:

Natural ventilation.

Types of mechanical ventilation systems.

Mechanical comfort cooling and close control air conditioning systems.

Interrelationship of ventilation and air conditioning with other mechanical and electrical building services.

Ventilation systems:

Natural ventilation systems.

Mechanical ventilation systems.

Mixed mode and displacement ventilation systems.

Process, fume and dust extraction systems.

Free cooling and night purging.

Mechanical ventilation heat recovery (MVHR) systems.

Air conditioning systems:

Properties and characteristics of comfort cooling and close control application.

Humidity control.

Cooling coils: direct expansion (DX) and chilled water.

Centralised and local plant selection.

Air conditioning systems, including: constant volume (CV), variable air volume (VAV), fan coils units, chilled beams, chilled ceilings, room-based heat pumps (versatemp systems), split systems, heat pumps, variable refrigerant flow (VRF) systems.

LO4 **Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy**

Sizing and specification of ventilation system components:

Duct sizing.

Fan sizing.

Fan selection and fan laws.

Damper sizing and selection.

Air handling unit (AHU) sizing and selection.

Grille and diffuser sizing and selection.

Sizing and specification of air conditioning system components:

Psychrometric principles.

Use of psychrometric charts to size cooling and heating coils and humidification requirements.

Refrigeration principles.

Plotting refrigeration cycles and calculation of coefficient of performance (COP).

Sizing and specification of heat pumps and VRF systems.

Commissioning, testing and handover procedures:

Current standards and procedures for commissioning ventilation and air conditioning systems.

Commissioning procedures for ventilation and air conditioning system components.

Commissioning schedules and handover documentation.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Identify pre-design information required for a non-domestic ventilation and air conditioning system</td><td rowspan="5">LO1 LO2

D1 Analyse health & safety and environmental legislation relevant to the design, installation and operation of a non-domestic ventilation and air conditioning system.</td></tr>
<tr><td>P1 Explain the design process stages and tasks for the design of a non-domestic ventilation and air conditioning system.

P2 Discuss the information included in a design brief for a non-domestic ventilation and air conditioning system design.

P3 Produce design data for a ventilation and air conditioning system in a given building.</td><td>M1 Evaluate the design considerations and constraints for the design of a non-domestic ventilation and air conditioning system for a given building.</td></tr>
<tr><td colspan="2">LO2 Analyse cooling load for non-domestic buildings</td></tr>
<tr><td>P4 Calculate the heat gains for a room within a given building.

P5 Calculate the total cooling load for a given building.

P6 Calculate the peak summertime temperature for rooms in a given building.</td><td>M2 Analyse strategies that could be used to reduce the total cooling load calculated for the given building.

M3 Analyse the peak summertime temperatures calculated, making suitable recommendations.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Present a design for a non-domestic ventilation and air conditioning system for a given building type		
P7 Discuss ventilation strategies for a given building. **P8** Present a ventilation and air conditioning design proposal for a given building type.	**M4** Compare different ventilation strategies to determine best practice.	**LO3 LO4** **D2** Evaluate sustainable options for inclusion in a ventilation and air conditioning strategy for a given building type.
LO4 Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy		
P9 Specify ventilation and air conditioning components, including ductwork sizing for a given building. **P10** Justify the selection of components for a non-domestic ventilation and air conditioning system.	**M5** Discuss the effect of different duct sizing on the performance of a ventilation and air conditioning installation.	

Recommended Resources

Textbooks

CHADDERTON, D. (2013) *Building Services Engineering*. 6th Ed. Abingdon: Routledge.

CHADDERTON, D. (2014) *Air Conditioning: A Practical Guide*. 3rd Ed. Abingdon: Routledge.

CIBSE (2015) *CIBSE Guide A: Environmental design.* 8th Ed*.* London: CIBSE.

CIBSE (2005) *CIBSE Guide B: Heating, ventilating, air conditioning and refrigeration.* London: CIBSE.

JONES, W. (2001) *Air Conditioning Engineering*. 5th Ed. Oxford: Elsevier.

RACE, G. L. (2012) *CIBSE Knowledge Series: KS20, Practical Psychrometry*. London: CIBSE.

Links

This unit links to the following related units:

Unit 2: Construction Technology

Unit 8: Mathematics for Construction

Unit 9: Principles of Heating Services Design & Installation

Unit 17: Principles of Public Health Engineering

Unit 31: Advanced Heating, Ventilation and Air Conditioning Design & Installation

Unit 43: Hydraulics