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

Unit code F/615/1417

Unit level 5

Credit value 15

Introduction

Modern high-rise, and multi-zone, buildings have complex requirements for heating and cooling. Their scale, number of occupants, and need for better performance and efficiency, means that the design and installation of systems for heating, cooling and ventilation are critical.

This unit is designed to introduce students to the principles of Advanced Heating, Ventilation and Air-conditioning Design & Installation.

Upon completion of this unit, students will be able to understand a broad application of technologies and design techniques used to satisfy the requirements within large commercial or complex/multi-zone buildings.

Topics included in this unit include hydraulic and control strategies for heating, sustainable technologies, ventilation systems for forced air and passive ventilation, complex distribution and plan strategies for air-conditioning, and related deisgn and installation factors.

Learning Outcomes

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

1. Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings.
2. Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning.
3. Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems.
4. Present a proposal for an advanced HVAC system for a complex/multi-zone building.

Essential Content

LO1 **Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings**

Heating:

Sources of heat.

Distribution.

Heat exchange.

Types of heating methods/emitters.

Efficient design principles.

Renewables.

Fuel sources.

Ventilation:

Central, zonal and local systems.

Supply, extract and combined systems.

Air handling plan.

Filtration.

Ductwork.

Pressure cascades/containment.

Heat recovery and efficient operation.

Air conditioning:

Sources of cooling.

Water and refrigerant distribution.

Water-based systems.

Refrigerant-based systems.

Air-distributed systems.

Means of cooling air, dehumidifying, and humidifying.

Terminal devices.

Design and installation factors.

LO2 **Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning**

Heating:

Centralised vs decentralised plant.

Temperature grades.

Pumps, valves.

Boiler selection.

Typical schematics for system types.

Ventilation:

Requirement for ventilation.

Identify specialist air handling components.

Air handling unit configuration and build quality.

Specialist filtration or extract systems.

Constant volume vs variable- or demand-based systems.

Specialist HVAC systems.

Consider the material requirements for cleaning, hygiene, chemical resistance and fire rating.

Air conditioning:

Distribution distance.

Terminal devices.

Combined ventilation and cooling systems.

Temperature and humidity, setpoints.

LO3 **Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems**

General:

National and international regulations and compliance requirements.

Improving Energy Performance Certificates and Display Energy Certificates.

Theoretical vs actual energy use, and design considerations against client use.

BREEAM and LEED: what are they and what do they mean?

Identify credits that may have implications on advanced HVAC designs and plant selections.

Heating:

Renewable and biofuel sources.

Combined heat and power (CHP).

Heat pumps.

Solar collectors.

Waste heat.

Condensing boilers.

Ventilation:

Heat recovery.

Fan and motor technologies.

Variable air volume systems and active demand-based.

Cooling:

Tri-generation.

Links to CHP and waste heat.

Adiabatic cooling.

F-gas regulations.

Compressor and control technologies.

Free-cooling.

High-efficiency refrigerant systems.

High-efficiency water systems.

Air source vs ground/water, source heat pumps.

LO4 **Present a proposal for an advanced HVAC system for a complex/multi-zone building**

Heating:

Plant sizing for large-scale projects.

Delta Ts throughout network.

Control and turndown of plant.

Schematic arrangements for complex and large-scale projects.

Ventilation:

Plant sizing for large-scale projects.

Air volumes.

Operation and control of plant.

Schematic arrangements for complex and large-scale projects.

Cooling:

Plant sizing for large-scale projects.

Water-based cooling.

Limitations in refrigerant pipework distances.

Control and turndown of plant.

Schematic arrangements for complex and large-scale projects.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings		
P1 Discuss the common HVAC systems for commercial buildings. **P2** Review common plant items and distribution methods for advanced HVAC systems.	**M1** Illustrate the operation of a given large or complex building type.	**D1** Critically evaluate different advanced HVAC systems and plant choices and how such choices may impact on the building's construction and performance.
LO2 Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning		
P3 Discuss the current legislation and codes of practice that influence the design and selection of advanced HVAC systems. **P4** Present an evaluation of the key design principles and fundamentals that are required to select advanced HVAC schemes for buildings.	**M2** Analyse the critical relationship between the design fundamentals and legislative requirements that are needed for an effective advanced HVAC design within large and complex buildings.	**D2** Critically evaluate and select the key design and legislative criteria that are required for advanced HVAC engineering design within differing types of buildings and their intended uses.
LO3 Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems		
P5 Discuss the economic and legislative drivers for sustainable design in advanced HVAC systems. **P6** Assess the main sustainable design considerations for advanced HVAC.	**M3** Demonstrate how sustainable strategies inform the operation and efficiency characteristics of a HVAC system.	**D3** Critically analyse the impact of incorporating sustainable technologies into a HVAC system.

Pass	Merit	Distinction
LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building.		
P7 Investigate the design considerations and system components that inform the design process for advanced HVAC services. **P8** Assess the key design calculations and plant selections that are needed to propose a system design. **P9** Produce a design package of work, correctly sized plant and distribution for an advanced HVAC system for a given building type.	**M4** Evaluate the efficiency of a HVAC system proposed for a given building type.	**D4** Critically evaluate design proposals for HVAC systems to confirm suitability for a given building type.

Recommended Resources

Textbooks

CHADDERTON, D. (2012) *Building Services Engineering*. 6th Ed. Routledge.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. 8th Ed. Routledge.

Links

This unit links to the following related units:

Unit 8: Mathematics for Construction

Unit 9: Principles of Heating Services Design & Installation

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

Unit 14: Building Information Modelling

Unit 17: Principles of Public Health Engineering

Unit 28: Further Mathematics for Construction

Unit 40: Alternative Energy Systems Design & Installation

Unit 43: Hydraulics