Liverpool John Moores University

Title:	HEATING, VENTILATION & AIR CONDITIONING
Status:	Definitive
Code:	**5504BEFDS** (118447)
Version Start Date:	01-08-2011
Owning School/Faculty:	Built Environment
Teaching School/Faculty:	Built Environment

Team	Leader
Derek King	

Academic Level:	FHEQ5	**Credit Value:**	24.00	**Total Delivered Hours:**	111.00
Total Learning Hours:	240	**Private Study:**	129		

Delivery Options
Course typically offered: Standard Year Long

Component	Contact Hours
Lecture	72.000
Tutorial	24.000
Workshop	12.000

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Report	Report	Project based assignment	20.0	
Exam	Exam	Formal examination	60.0	3.00
Portfolio	Labwork	Record of practical laboratory based work	20.0	

Aims

The aim of this module is to further develop the student's understanding of the principles and applications of heating, ventilation and air conditioning installations. This is achieved by developing the students understanding and experience of the more specialised forms of space and process heating, ventilation and air conditioning which tend to be associated with the large and complex installations.

Learning Outcomes

After completing the module the student should be able to:

1 Determine energy requirements using data related to climate, building envelope, occupancy and use.
2 Produce and analyse designs for steam and high pressure hot water systems and select and specify appropriate heating plant and primary energy sources for heating and hot water generation for space and process heating.
3 Evaluate the use of district heating schemes.
4 Design and evaluate the use of electrical heating systems for commercial/industrial buildings.
5 Produce designs for fire and smoke management and process ventilation systems in buildings.
6 Design multi-zone air conditioning systems for complex buildings.
7 Investigate the engineering, economic and design factors relating to the use of high pressure/velocity air distribution systems.
8 Analyse and evaluate the principles, application and operational characteristics of refrigeration and heat pump plant and equipment.
9 Design cooling and chilled water distribution systems and select and specify appropriate cooling and chilled water plant for air conditioning applications.

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Project based report	1	2	5	9
Exam	3	4	6	7
Practical laboratory work	8			

Outline Syllabus

Energy Requirements: Seasonal climatic variations: use of weather data. Application and use of Degree Days.
Heat gain and loss data: operating profiles for occupancy movement, lighting, machinery/equipment, infiltration/ventilation etc.
Loadings: heating and cooling loads, diversity for central cooling plant, use of thermal analysis /simulation software.

Properties of steam: heat content of pressurised water, wet, dry and superheated steam
Design of steam systems: layouts, plant arrangements, types, operation and requirements for steam traps, relay points, pressure reducing valves. Design of steam systems. Steam for process work. Use and design of flash steam recovery systems. Use of steam to water heat exchangers. Plant and equipment sizing and selection.
High Pressure Hot Water:: methods of pressurisation, Analysis of safe working

temperatures/pressures. Anti-flash margins. Effect of pump location. Design of HPHW Systems: system design, installation and control arrangements. Expansion volumes, sizing and selection of plant including pressurisation plant, use of high temperature hot water, comparison with the use of low temperature hot water and steam systems. Conversion from high temperature hot water to low temperature hot water.

District heating schemes: Use and application of district heating, comparison with the use of individual plants. Alternative primary heat sources/fuels inc waste incineration, CHP schemes, geothermal sources. Distribution methodologies, operating temperatures, design of distribution networks, distribution ducting. Plant for district heating schemes Consumer charging and energy metering.

Heating plant, appliances and equipment: arrangements for saturated and superheated steam and high temperature hot water systems. Steam super-heaters. Thermal efficiency of steam and high temperature hot water boiler plant. Boiler feed-water treatment, Blow-down rates, feed pumps.
Primary Heat sources: use of renewable low grade heat within primary heat source plant i.e. heat pumps, seasonal operating characteristics of heat pumps. Implications, risk, justification and financial incentive for the use of renewable low grade heat sources. Design, selection and specification of installations utilising low grade heat sources and systems using a combination of low and medium grade heat. Design selection and specification of installations incorporating CHP and micro CHP plant. Cost v benefit justification of CHP plant, maintenance requirement and costs. Design, selection and specification of CHP installations

Electrical heating : application of electrical space heating equipment. Immersion heaters, electrode boilers, thermal storage, trace heating, quartz/luminous heaters, embedded resistance cables. Energy requirements: active store, daily design energy requirement and charge acceptance in storage heating. Pressurised electro-thermal storage systems: plant size and power requirements.

Fire and Smoke Control Ventilation: requirements of buildings, types of smoke ventilation system, pressure regimes. Design of smoke ventilation systems. Process ventilation for specialist applications: Process ventilation for applications such as laboratory fume extract, hospitals, research establishments clean rooms etc. provision and control of make up air for extract ventilation.
Commissioning and testing requirements: setting systems to work, commissioning and testing.

Air conditioning: Operational characteristics, psychrometric cycles and design of systems for complex commercial and industrial applications e.g., chilled ceilings/beam, VRV and other single and multi zone packaged/refrigeration systems) Heat recovery and waste minimisation, selection and application of heat recovery plant and equipment. filtration of contaminants, control system requirements.
Use of software to simulate the building/system performance.

High and Low Velocity Ductwork distribution networks: Design of ductwork installations for aerodynamic efficiency and noise minimisation. Economic and engineering factors in the specification and design of high velocity systems;

attenuation requirements. Sizing high velocity systems, static regain method of duct sizing. Selecting fans for ductwork installation.

Vapour compression refrigeration cycles: investigation of the major components in refrigeration/heat pump installations. Lubrication requirements and principles. Sizing and selection of refrigeration, ground and air source heat pump plant. Control systems for refrigeration and heat pump systems
Refrigerant properties: performance, health & safety and environmental implications of commercially available refrigerants. Legislation and standards, handling and disposal of refrigerants Criteria for selection. Procedures for charging and evacuating systems. Leak detection in refrigeration systems.
Refrigeration plant performance: thermodynamics, operational features and application of vapour compression, absorption, evaporative and other refrigeration cycles and processes.
Practical and performance characteristics of : various refrigeration cycles, refrigerants, compressors, condensers and evaporators.
Design of cooling processes for air conditioning applications: determination of plant loads, safety and operating controls, VRF systems; plant configuration, operational characteristics, applications and limitations..
Chilled water Installations: types of chiller, plant arrangements, use of ground and air source heat pumps within chilled water networks, use of buffer vessels, pumping arrangements, design of chilled water networks.
Selection and specification of refrigeration and chilled water plant and equipment.
Commissioning: testing requirements.

Learning Activities

Lectures, tutorials, case studies, lab-work, workshops, site visits.

References

Course Material	Book
Author	Moss, K.
Publishing Year	2003
Title	Heating and Water Services Design in Buildings
Subtitle	
Edition	
Publisher	Spon Press
ISBN	0-415-29185-2

Course Material	Book
Author	Moss, K.
Publishing Year	1998
Title	Heat and Mass Transfer in Building Services Design
Subtitle	
Edition	

Publisher	Spon Press
ISBN	0-419-22650-8

Course Material	Book
Author	Underwood, C.
Publishing Year	1998
Title	HVAC Control
Subtitle	Modelling, Analysis and Design
Edition	
Publisher	Spon Press
ISBN	0-419-20980-8

Course Material	Book
Author	Chartered Institution of Building Services Engineers
Publishing Year	2006
Title	Guide A
Subtitle	Environmental Design
Edition	
Publisher	CIBSE, London
ISBN	1903287669

Course Material	Book
Author	Chartered Institution of Building Services Engineers
Publishing Year	2005
Title	Guide B
Subtitle	Heating, Ventilation, Air Conditioning & Refrigeration
Edition	
Publisher	CIBSE, London
ISBN	1903287588

Course Material	Book
Author	Chartered Institution of Building Services Engineers
Publishing Year	2004
Title	Guide F
Subtitle	Energy Efficiency in Buildings
Edition	
Publisher	CIBSE, London
ISBN	1903287340

Course Material	Book
Author	Chartered Institution of Building Services Engineers
Publishing Year	2003
Title	Comfort
Subtitle	
Edition	
Publisher	CIBSE, London
ISBN	1903287677

Notes

This module is a key component for those students wishing to complete the programme following a 'mechanical' building services pathway. It aims to develop the students depth of understanding of heating, ventilation and air conditioning by analysing some of the core concepts and exploring some of the more specialised applications and processes within building services.