

Liverpool John Moores University

Title: MECHANICAL SERVICE SYSTEMS A
Status: Definitive
Code: **5089UG** (102661)
Version Start Date: 01-08-2011

Owning School/Faculty: Built Environment
Teaching School/Faculty: Built Environment

Team	Leader
Derek King	Y

Academic Level: FHEQ5 **Credit Value:** 24.00 **Total Delivered Hours:** 75.00
Total Learning Hours: 240 **Private Study:** 165

Delivery Options

Course typically offered: Semester 1

Component	Contact Hours
Lecture	48.000
Tutorial	24.000

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Exam	AS1	Formal.	50.0	3.00
Report	AS2	Assignments.	50.0	

Aims

To develop the student's understanding of the principles and practices for the design, operation and commissioning of distribution services associated with public health, fire engineering and fuel installations in medium sized and large complex public sector, commercial and industrial buildings.

To develop the student's understanding of the principles and practices of heating, ventilation and air conditioning in medium sized and large complex public sector, commercial and industrial buildings.

To provide students with the knowledge and skills necessary for them to interpret the

needs and requirements of those buildings requiring heating, ventilation and air conditioning to develop practical schemes for a range of environments and evaluate the effectiveness of alternative schemes.

To enable the student to evaluate the heating and cooling loads in buildings and explore methods of reducing loads and improving the reliability of the maintained comfort levels.

To enable the student to rationalise the need for air conditioning and consider alternative strategies for cooling buildings.

Learning Outcomes

After completing the module the student should be able to:

- 1 Analyse buildings and identify the need for water and gas distribution services, fire fighting and fire protection services.
- 2 Produce and evaluate detailed designs for cold and hot water supply systems, fire fighting systems and fuel gas installations for medium sized and large complex public sector, commercial and industrial buildings.
- 3 Analyse buildings and identify the needs for heating, ventilation and air conditioning and determine energy requirements using data related to climate, building envelope, occupancy and use.
- 4 Analyse buildings to determine heating and cooling loads and thus energy requirements for heating and air conditioning schemes in medium sized and large complex public sector, commercial and industrial buildings.
- 5 Evaluate alternative heating, ventilation and cooling proposals and strategies to establish feasible design solutions.
- 6 Produce detailed heating, ventilation and air conditioning system designs to satisfy the needs of medium sized and large complex public sector, commercial and industrial buildings.

Learning Outcomes of Assessments

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

EXAM	2	4	5			
REPORT	1	2	3	4	5	6

Outline Syllabus

Needs analysis and legislative requirements for public health and utility services: client and building operational requirements, legislative constraints, statutory requirements, design standards and relevant publications. Health, safety and welfare arrangements, energy efficiency considerations.

Cold & Hot Water Installations: cold and hot water storage and distribution systems: for complex and multi-storey commercial buildings. Storage capacities and fill rates. System specification. Control systems and valve arrangements. Booster and pumping systems, pressure reduction and control. Impact of legislation and standards on the design, maintenance and commissioning of hot and cold water

installations.

Hot & Cold Water Plant: Comparison of capital and operating costs for storage and non-storage installations. Space requirements for storage plant. Sizing and selection of storage plant, expansion devices, pressure vessels and pipework, use of manufacturers' data, sizing and selection software.

Water systems commissioning maintenance and treatment: water analysis, water treatment for hot and cold water installations. Commissioning and testing of cold and hot water storage and distribution systems.

Integration: water system with mechanical fire fighting, fire protection and other building services installations.

Mechanical fire fighting and fire protection systems:

Fire dynamics: ignition, fire growth, fire parameters, flash over, limiting fire development, smoke hazards, smoke plumes, smoke filling.

Legislation and standards: for fire engineering analysis, current legislation documents, standards and codes of practice, design implications, fire safety strategy.

Fire compartments & Means of escape: behaviour of people, occupancy types, travel distances and times, requirement of compartments.

Fire risk: risk assessment, building designation factors and classification, fire precaution standards.

Specification and requirements for space heating: analysis of client and building needs, heating design standards and publications. Alternative methods of heating buildings.

Thermal comfort: factors effecting thermal comfort, predicting satisfaction. Effect of radiation on comfort.

Steady and non-steady state heat transfer in buildings: steady state energy transfer networks. Steady state heating loads. Transient heat transfer process. Pre-heat periods, heating loads with intermittent and highly intermittent heating.

Total heating loads: assessment of total heat loads and heating plant requirement, Compliance with legislation and energy efficiency targets and standards. Use of thermal analysis software to determine heating loads.

Heat emitters: selection criteria for radiant, convection and mixed output emitters including direct fired, under-floor heating, and heated ceilings.

Design of heating systems: for complex industrial and commercial buildings. Layout, specification and control systems, integration of heating requirements with other services installations. Evaluation of proposed systems.

Commissioning and testing requirements: Commissioning schedules and documentation.

Fuels: properties, characteristics, performance, and environmental implications.

Combustion principles: stoichiometric air fuel ratios, excess air.

Products of combustion: flue gas analysis, air fuel ratios and combustion efficiency.

Firing equipment: construction, types of burners. Control and safety monitoring systems. Air/Fuel adjustment and burner commissioning.

Boilers and hot water generators: construction, types of commercial LPHW boiler and hot water generation plant. Application and control of single and multiple boiler installations. Fuel consumption and operational efficiency. Boiler testing and commissioning

Boiler-room ventilation, draught and flue requirements: legislation and standards of flue systems for single and multiple boiler installations. Legislation and standards design and installation of flue systems for single and multiple boiler installations.

Specification and requirements for ventilation and air conditioning: analysis of client and building operating characteristics, ventilation and air conditioning design standards and publications. Factors influencing the decision to install mechanical air conditioning or ventilation systems. Alternative methods of cooling buildings.

Heat gain and loss data: operating profiles for occupancy movement, lighting, machinery/equipment, infiltration/ventilation, etc.

Cooling loads due to solar radiation: solar geometry, solar irradiance. Transmission of solar radiation through glass and building structures. Strategies for reducing cooling loads. Cooling loads due to solar gain. Impact of alternative design temperature indices and method of cooling on cooling loads.

Total cooling load and cooling plant capacity: factors contributing to cooling plant capacity for an air conditioned building.

Seasonal climatic variations: use of weather data. Loadings: heating and cooling loads, diversity for central cooling plant, use of thermal analysis /simulation software.

Peak summertime temperatures: anticipated in the absence of air conditioning.

Ventilation systems: natural and mechanical ventilation systems for commercial and industrial buildings. Mixed flow and displacement ventilation systems. Fume and dust extraction systems; ventilation systems for fire/smoke control. Combination of ventilation with commercial air conditioning systems. Passive cooling systems.

Air conditioning systems: Single duct, terminal re-heat, VAV multi-zone, fan-coil, perimeter induction, chilled ceilings/beam, VRV and other single and multi zone packaged refrigeration systems). Control systems for the various systems and simulation of building/system performance. Sizing and selection of plant, ductwork and pipework, Implications on space, maintenance and commissioning requirements, capital and operating costs. Centralised v packaged equipment.

Ductwork distribution networks: Design of high velocity systems, economic and engineering factors, attenuation requirements. Sizing high velocity systems, static regain method of duct sizing. Selecting fans.

Learning Activities

Lectures, tutorials, case studies, site visits.

References

Course Material	Book
Author	Abbas, T.
Publishing Year	1999
Title	Displacement Ventilation & Static Cooling Systems
Subtitle	
Edition	
Publisher	BSRIA
ISBN	0860225364

Course Material	Book
Author	Awbi, H.

Publishing Year	2003
Title	Ventilation of Buildings
Subtitle	
Edition	
Publisher	Spon Press
ISBN	0415270561

Course Material	Book
Author	Bownass, D.
Publishing Year	2000
Title	Building Services Design Methodology
Subtitle	
Edition	
Publisher	Spon Press
ISBN	0419252800

Course Material	Book
Author	Chadderton, D.
Publishing Year	2004
Title	Building Services Engineering
Subtitle	
Edition	
Publisher	Spon Press
ISBN	0415315352

Course Material	Book
Author	Day, A.R., Ratcliffe, M.S. & Shepherd, K.J.
Publishing Year	2003
Title	Heating Systems Plant & Control
Subtitle	
Edition	
Publisher	Blackwell Publishing (UK)
ISBN	0632059370

Course Material	Book
Author	Hall, F. & Greeno, R.
Publishing Year	2005
Title	Building Services Handbook
Subtitle	
Edition	
Publisher	Butterworth Heinemann
ISBN	0750664606

Course Material	Book
Author	Jones, W.P.
Publishing Year	2001
Title	Air Conditioning Engineering

Subtitle	
Edition	5th Edition
Publisher	Butterworth-Heinemann
ISBN	0750650745

Course Material	Book
Author	Moss, K.
Publishing Year	2003
Title	Heating and Water Services Design in Buildings
Subtitle	
Edition	2nd Edition
Publisher	Spon Press
ISBN	0415291852

Course Material	Book
Author	Moss, K.
Publishing Year	1998
Title	Heat and Mass Transfer in Building Services Design
Subtitle	
Edition	
Publisher	Spon Press
ISBN	0419226508

Course Material	Book
Author	Mitchell, S. & Race, G.L.
Publishing Year	2003
Title	Practical Guide to HVAC Building Services Calculations
Subtitle	
Edition	
Publisher	BSRIA
ISBN	0860226182

Course Material	Book
Author	Shepherd, K.
Publishing Year	1999
Title	Variable Air Volume Air Conditioning Systems
Subtitle	
Edition	
Publisher	Blackwell Science
ISBN	0632042761

Course Material	Book
Author	Underwood, C.
Publishing Year	1998
Title	HVAC Control
Subtitle	Modelling, Analysis and Design
Edition	

Publisher	Spon Press
ISBN	0419209808

Course Material	Book
Author	Watson, R. & Chapman, S.
Publishing Year	2000
Title	Radiant Heating & Cooling Handbook
Subtitle	
Edition	
Publisher	McGraw Hill Education
ISBN	0070684995

Course Material	Book
Author	Young, L. & Mays, G.
Publishing Year	2001
Title	Water Regulations Guide
Subtitle	
Edition	2nd Edition
Publisher	WRC Publications
ISBN	0953970809

Course Material	Book
Author	BSI
Publishing Year	2000
Title	Hot and Cold Water Supply
Subtitle	
Edition	
Publisher	Blackwell Science (UK)
ISBN	0632049855

Course Material	Book
Author	CIBSE
Publishing Year	2006
Title	Guide A
Subtitle	Environmental Design
Edition	
Publisher	CIBSE
ISBN	1903287669

Course Material	Book
Author	CIBSE
Publishing Year	2005
Title	Guide B
Subtitle	Heating, Ventilation, Air Conditioning & Refrigeration
Edition	
Publisher	CIBSE
ISBN	1903287588

Course Material	Book
Author	CIBSE
Publishing Year	2004
Title	Guide G
Subtitle	Public Health Engineering
Edition	
Publisher	CIBSE
ISBN	1903287421

Course Material	Book
Author	CIBSE
Publishing Year	2003
Title	Guide E
Subtitle	Fire Engineering
Edition	
Publisher	CIBSE
ISBN	1903287316

Course Material	Book
Author	CIBSE
Publishing Year	2004
Title	Guide F
Subtitle	Energy Efficiency in Buildings
Edition	
Publisher	CIBSE
ISBN	1903287340

Course Material	Book
Author	CIBSE
Publishing Year	2002
Title	TM8
Subtitle	Minimising The Risk of Legionnaires Disease
Edition	
Publisher	CIBSE
ISBN	1903287235

Course Material	Book
Author	CIBSE
Publishing Year	2006
Title	Comfort
Subtitle	
Edition	
Publisher	CIBSE
ISBN	1903287677

Course Material	Book
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Author	CIBSE
Publishing Year	2002
Title	Displacement Ventilation in Non Industrial Buildings
Subtitle	
Edition	
Publisher	CIBSE
ISBN	0825942363

Notes

This module offers a detailed appreciation of the principles associated with the design of all the most common mechanical engineering services systems in buildings for students studying Building Services Engineering or associated disciplines. The module covers the public health engineering systems such as hot and cold water, fuel gas and fire fighting systems, and links these with the design of heating systems and ventilation and air conditioning. Students are taught to analyse buildings and building energy usage in detail, such that mechanical services design solutions are sustainable and energy efficient, whilst being practical, realistic and effective.