Liverpool John Moores University

Title:	MECHANICAL ENGINEERING AND SERVICES SYSTEMS
Status:	Definitive
Code:	**5118BEUG** (118153)
Version Start Date:	01-08-2014
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: Standard Year Long

Component	Contact Hours
Lecture	48.000
Tutorial	24.000

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Exam	AS1		70.0	3.00
Report	AS2		30.0	

Aims

To develop the student's understanding of the principles and applications of mechanical engineering, fluid dynamics, heat transfer and thermodynamic cycles and appreciation of sustainability in the design and operation of buildings and mechanical building services plant and installations.
To provide students with the knowledge and skills necessary to interpret the mechanical building services needs and requirements of a range of buildings and develop practical schemes, paying due regard to sustainable development and

energy efficiency.
To develop the student's understanding of the principles and practices for the sustainable design, operation and commissioning of mechanical building services systems associated with cold and hot water, heating, ventilation, air conditioning and utility installations in a range of buildings.

Learning Outcomes

After completing the module the student should be able to:

1	Analyse a variety of buildings ranging from simple domestic buildings to complex commercial and industrial buildings, to identify, evaluate and justify the need for mechanical building services systems, paying due regard to sustainable development, legislation and design guidance;
2	Analyse the range of buildings to evaluate heating loads, cooling loads and energy requirements;
3	Produce detailed designs for a range of mechanical building services systems for a range of buildings and evaluate these in terms of utility, building user requirements, sustainability and energy efficiency;
4	Evaluate alternative strategies for the mechanical building services systems across the range of buildings to encourage energy efficiency and sustainable design
5	Apply the principles of mechanical engineering, fluid dynamics, heat transfer and thermodynamic cycles to the operation of common items of mechanical building services plant.

Learning Outcomes of Assessments

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

EXAMINATION	2	4	5
REPORT	1	3	

Outline Syllabus

Mechanical Engineering Principles
Convection: bulk, arithmetic mean temperature difference (AMTD) and log mean temperature difference (LMTD) in free and forced convection processes. Grashoff, Nusselt, Reynolds, Prandtl dimensionless groups.
Radiation: Reflectivity, transmissivity, absorptivity, emissivity for different surfaces. Wave characteristics and parameters associated with electromagnetic radiation. Asymmetric radiation and discomfort asymmetry. Applications of radiant heat transfer in building services.
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 exchangers: Identification of modes of heat transfer within building services equipment and applications; heat exchanger construction, characteristics, fluid flow paths, pressure drop, design, types and classification. (e.g. Shell and Tube, Shell and Coil, Tube in Tube and Plate etc). Rate of heat exchange in parallel flow and counterflow. Cross flow heat exchangers.
Heat gain data and cooling loads: solar gains, solar geometry, solar irradiance, transmission of solar radiation through glass and building structures. Heat gains from occupancy, lighting, machinery/equipment, infiltration/ventilation, etc. Seasonal climatic variations and use of weather data.
Psychrometrics: psychrometric properties of air, pyschrometric cycles for heating and cooling processes, evaluation of cooling and heating plant duties.
Heating and cooling loads: use of thermal analysis/simulation software to determine loads.
Mechanical Building Services
Analysis of client and building needs related to heating, air conditioning, ventilation, public health and utility services, legislative constraints, statutory requirements, design standards and relevant publications. Health, safety and welfare arrangements, energy efficiency considerations.
Cold & hot water installations for the range buildings: storage capacities and fill rates, system specifications, control strategies, systems and valve arrangements, boosted and pumped systems for multi-storey buildings.
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.
Drainage: building drainage systems, above and below ground, legislation and standards, systems, sizing.
Design of low temperature hot water heating systems for the range of buildings. Layout, specification and control systems, integration of heating requirements with other services installations. Evaluation of proposed systems.
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. Firing equipment: construction, types of burners. Control and safety monitoring systems. Air/Fuel adjustment and burner commissioning. Fuel consumption and operational efficiency. Boiler testing and commissioning
Fuels: properties, characteristics, performance, environmental implications, sustainable alternatives.
Design of specialist heating systems: high temperature hot water, methods of pressurisation, analysis of safe working temperatures/pressures, anti-flash margins, pump location. Steam systems, layouts, plant arrangements, types, operation and requirements for steam traps, relay points, pressure reducing valves. 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.
Specialist heating plant, appliances and equipment: arrangements for saturated and superheated steam and high temperature hot water systems, steam superheaters, thermal efficiency of steam and high temperature hot water boiler plant. Boiler feed-water treatment, Blowdown rates, feed pumps.

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.
Ventilation of buildings: ventilation strategies, natural & mechanical ventilation. Selection of plant, air handling units, filters, fans (fan laws) etc.. Design of systems, recirculation and heat recovery techniques, control systems, ductwork layouts, sizing.
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.
Vapour compression refrigeration cycles: investigation of the major components in refrigeration/heat pump installations. Lubrication requirements and principles. Sizing and selection of refrigeration 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.
Refrigeration plant performance: vapour compression, absorption and other refrigeration cycles, refrigerants, compressors, condensers, evaporators. Chilled water installations, plant requirements, design of chilled water networks.
Commissioning and testing requirements: setting systems to work, commissioning and testing, commissioning schedules and documentation.

Learning Activities

Lectures, tutorials, case studies, site visits.

References

Course Material	Book
Author	Rogers, G. & Mayhew, Y.
Publishing Year	1994
Title	Thermodynamic and Transport Properties of Fluids: S. I. Units
Subtitle	
Edition	5th
Publisher	Blackwell
ISBN	9780631197034

Course Material	Book
Author	Sherwin, K. & Horsley, M.
Publishing Year	1996
Title	Thermofluids

Subtitle	
Edition	
Publisher	Chapman & Hall
ISBN	9780412598005

Course Material	Book
Author	Jones W.P
Publishing Year	2001
Title	Air Conditioning Engineering
Subtitle	
Edition	5th
Publisher	Butterworth-Heinemann
ISBN	9780750650748

Course Material	Book
Author	Moss K
Publishing Year	2003
Title	Heating and Water Services Design in Buildings
Subtitle	
Edition	2nd
Publisher	Spon Press
ISBN	9780415291859

Course Material	Book
Author	CIBSE
Publishing Year	2006
Title	Guide A :Environmental Design
Subtitle	
Edition	7th
Publisher	CIBSE
ISBN	9781903287668

Course Material	Book
Author	CIBSE
Publishing Year	2005
Title	Guide B: Heating, Ventilation, Air Conditioning & Refrigeration
Subtitle	
Edition	
Publisher	CIBSE
ISBN	9781903287583

Course Material	Book
Author	CIBSE
Publishing Year	2004
Title	Guide G: Public Health Engineering
Subtitle	

Edition	
Publisher	CIBSE
ISBN	9781903287422

Course Material	Book
Author	CIBSE
Publishing Year	2012
Title	Guide F: Energy Efficiency in Buildings
Subtitle	
Edition	3rd
Publisher	CIBSE
ISBN	9781906846220

Notes

This module seeks to contextualize a range of common underpinning mechanical engineering principles in realistic applications in the building services industry. Students are required to interpret the mechanical building services needs and requirements of a range of buildings and develop practical designs, paying due regard to sustainable development and energy efficiency.