Unit 5022: Industrial Services

Unit Code: **K/615/1525**

Level: **5**

Credits: **15**

Introduction

Behind the scenes in many modern-day manufacturing facilities there lies a complex system of services that powers production, both day and night. The underlying aim of this unit is to enhance the students' understanding of the electrical supply systems, industrial air compressors, steam services, refrigeration systems and heat pumps that are used in an array of industrial engineering environments.

This broad-based methodology reflects the fact that operations engineering encompasses many disciplines and, as such, engineers must be conversant in the wide scope of service provision. The intention is to encourage students to develop a holistic approach to the design, operation, installation and maintenance of both industrial services and operating equipment.

The student will be introduced to the fundamental principles of electrical power and lighting systems, the rudiments of industrial compressed air systems, the provision of steam for both power generation and process plant, and the applications and precepts of refrigeration plant and heat pumps.

On successful completion of this unit students will be able to manage and maintain a wide range of commonly encountered industrial systems.

Learning Outcomes

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

LO1 Apply the operating principles of electrical power and lighting systems

LO2 Investigate the applications and efficiency of industrial compressors

LO3 Discuss provision of steam services for process and power use

LO4 Review industrial refrigeration and heat pump systems.

Essential Content

LO1 **Apply the operating principles of electrical power and lighting systems**

Electrical power:

Construction, starting and speed control of polyphase induction motors

Three-phase transformers: construction, clock number and group, parallel operation

Electrical distribution: power system topologies, efficiency, power factor causes and correction, effect on cost of supplies, circuit protection.

Lighting systems:

Lighting fundamentals: SI units, energy efficient circuit design and layout.

LO2 **Investigate the applications and efficiency of industrial compressors**

Industrial compressors:

Types and applications of industrial compressors

Role of intercoolers, dryers and air receivers

Efficiency and performance of air compressors

Hazards and faults: safety consideration and associated legislation.

LO3 **Discuss the provision of steam services for process and power use**

Steam power plant:

Use of tables and charts to analyse wet and dry saturated steam

Circuit diagrams showing steam raising plant

Process steam: enthalpy of evaporation, available energy

Overall plant efficiencies for process

Power steam: superheated steam, turbine efficiency, Rankine cycle, cooling towers

Overall plant efficiency for power

Efficiencies and improvements.

LO4 **Review industrial refrigeration and heat pump systems.**

Heat pumps and refrigeration:

Typical industrial heat pump and refrigeration systems

Application of the second law of thermodynamics

Reversed heat engines: reversed Carnot cycle

Vapour compression cycle

Refrigerant fluids: environmental impact

Refrigeration tables and charts (p-h diagrams)

Coefficient of performance for heat pumps and refrigerators.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Apply the operating principles of electrical power and lighting systems		
P1 Illustrate the construction and modes of connection of three-phase transformers. **P2** Discuss the applications and operating characteristics of polyphase induction motors. **P3** Apply the principles of good lighting design to produce a lighting scheme for a given application.	**M1** Compare the economics of single-phase and three-phase distribution, and assess the methods of speed control applied to polyphase induction motors.	**D1** Analyse the approaches available for reducing electrical energy consumption/costs in an industrial production facility.
LO2 Investigate the applications and efficiency of industrial compressors		
P4 Compare three types of industrial compressor and identify justifiable applications for each. **P5** Review potential industrial compressor faults and hazards. **P6** Determine the performance characteristics of an industrial compressor.	**M2** Calculate the isothermal and polytropic work of a reciprocating compressor and thus deduce the isothermal efficiency. Explain any discrepancies.	**D2** Stating any assumptions, provide an explanatory derivation of the volumetric efficiency formula for a reciprocating compressor.

Pass	Merit	Distinction
LO3 Discuss the provision of steam services for process and power use		
P7 Demonstrate the need for superheated steam in a power generating plant. **P8** Discuss the requirements for process steam and determine overall plant efficiencies for steam process and power systems.	**M3** Illustrate why the Rankine cycle is preferred over the Carnot cycle in steam production plants around the world.	**D3** Evaluate the modifications made to the basic steam raising systems to improve their overall efficiency.
LO4 Review industrial refrigeration and heat pump systems.		
P9 Discuss the operating principles of both heat pumps and industrial refrigeration systems. **P10** Calculate COP, heating effect and refrigeration effect of reversed heat engines, making use of refrigeration tables and pressure/enthalpy charts.	**M4** Assess the limiting factors that impact on the economics of heat pumps. **M5** Discuss the apparent contradiction between refrigeration cycles and the second law.	**D4** Conduct a cost-benefit analysis on the installation of a ground source heat pump on a smallholding. Present your findings in the form of academic poster/ presentation.

Recommended Resources

Note: See HN Global for guidance on additional resources.

Print Resources

Anderson A. (2020) *Wind Turbines: Theory and Practice*. Cambridge University Press.

Cibse. (2002) *Code for lighting*. Butterworth-Heinemann.

Dunn, D. (2001) *Fundamental Engineering Thermodynamics*. Longman.

Eastop, T.D. and McConkey, A. (1996) *Applied Thermodynamics for Engineering Technologists*. 5th Ed. Prentice Hall.

Hughes, A. (2013) *Electric Motors and Drives: Fundamentals, Types and Applications.* 4th Ed. Newnes.

Giampaolo T. (2024) *Compressor Handbook: Principles and Practice.* 2nd Ed. Routledge.

Rogers, G.F.C. and Mayhew, Y.R. (1994) *Thermodynamic and Transport Properties of Fluids: S. I. Units*. 5th Ed. Wiley-Blackwell.

Melkebeek, J.A. (2018) *Electrical Machines and Drives.* Springer.

Websites

http://www.freestudy.co.uk/	Free Study (Tutorials)

Links

This unit links to the following related units:

Unit 4013: Fundamentals of Thermodynamics and Heat Engines

Unit 5005: Further Thermodynamics

Unit 5023: Thermofluids.