Unit 30: Operations and Plant Management

Unit code	**R/615/1499**
Unit level	**4**
Credit value	**15**

Introduction

The challenges of modern manufacturing industries require today's operations engineers to adopt a multi-skilled methodology when dealing with the array of complex engineering problems they are faced with. Long gone are the days of 'pure' mechanical or electrical maintenance staff; operations engineers may well specialise within one discipline, but they must have the knowledge and ability to safely tackle problems that could encompass many varied engineering fields, if they are to keep the wheels of industry in motion.

The underlying aims of this unit are to develop the students' knowledge of the engineering fundamentals that augment the design and operation of plant engineering systems, and to furnish them with the tools and techniques to maintain the ever more technological equipment.

The students are introduced to the concept of thermodynamic systems and their properties in the first learning outcome; this will provide a platform for the topic of heat transfer in industrial applications (as covered in learning outcome four) and underpin their future studies in subsequent units. The second learning outcome examines common mechanical power transmission system elements found in numerous production/manufacturing environments, whilst the third learning outcome investigates fundamental static and dynamic fluid systems.

On completion of this unit students will be able to describe the fundaments that underpin the operation of the systems they deal with on a daily basis and apply these fundamentals to the successful maintenance of these systems.

Learning Outcomes

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

1. Analyse fundamental thermodynamic systems and their properties.
2. Investigate power transmission systems.
3. Determine the parameters of static and dynamic fluid systems
4. Examine the principles of heat transfer in industrial applications.

Essential Content

LO1 **Analyse fundamental thermodynamic systems and their properties**

Fundamental system:

Forms of energy and basic definitions

Definitions of systems (open and closed) and surroundings

First law of thermodynamics

The gas laws: Charles' Law, Boyle's Law, general gas law and the Characteristic Gas Equation

The importance and applications of pressure/volume diagrams and the concept of work done

Polytropic processes: constant pressure, constant volume, adiabatic and isothermal processes

LO2 **Investigate power transmission systems**

Power transmission:

Flat and v-section belts drives: maximum power and initial tension requirements

Constant wear and constant pressure theories

Gear trains: simple and compound gear trains; determination of velocity ratio; torque and power

Friction clutches: flat, single and multi-plate clutches; maximum power transmitted

Conical clutches: maximum power transmitted

LO3 **Determine the parameters of static and dynamic fluid systems**

Fluid flow theory:

Continuity equations

Application of Bernoulli's Equation

Reynolds number; turbulent and laminar flow

Measuring devices for fluids: flow, viscosity and pressure

Determination of head loss in pipes by D'Arcy's formula, use of Moody diagrams

Immersed surfaces: centre of pressure, use of parallel axis theorem for immersed surfaces

Hydrostatic pressure and thrust on immersed surfaces

LO4 **Examine the principles of heat transfer in industrial applications**

Heat transfer:

Modes of transmission of heat: conduction, convection and radiation

Heat transfer through composite walls; use of U and k values

Recuperator, regenerator and evaporative heat exchangers

Application of formulae to heat exchangers

Heat losses in thick and thin walled pipes: optimum lagging thickness

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse fundamental thermodynamic systems and their properties		**D1** Illustrate the importance of expressions for work done in thermodynamic processes by applying first principles
P1 Examine the operation of thermodynamic systems and their properties **P2** Explain the application of the first law of thermodynamics to appropriate systems **P3** Explain the relationships between system constants for a perfect gas	**M1** Identify the index of compression in polytrophic processes	
LO2 Investigate power transmission systems		**D2** Compare the 'constant wear' and 'constant pressure' theories as applied to friction clutches
P4 Calculate the maximum power which can be transmitted by means of a belt **P5** Calculate the maximum power which can be transmitted by means of a friction clutch **P6** Determine the power and torque transmitted through gear trains	**M2** Discuss the factors that inform the design of an industrial belt drive system	

Pass	Merit	Distinction
LO3 Determine the parameters of static and dynamic fluid systems		**D3** Compare the practical application of three different types of differential pressure measuring device
P7 Determine the head losses in pipeline flow **P8** Calculate the hydrostatic pressure and thrust on an immersed surface **P9** Determine the centre of pressure on an immersed surface	**M3** Explore turbulent and laminar flow in Newtonian fluids	
LO4 Examine the principles of heat transfer in industrial applications		**D4** Differentiate differences between parallel and counter flow recuperator heat exchangers
P10 Determine the heat transfer through composite walls **P11** Apply heat transfer formulae to heat exchangers	**M4** Explore heat losses through lagged and unlagged pipes	

Recommended resources

Textbooks

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

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

MASSEY, B.S. and WARD-SMITH, J. (2011) *Mechanics of Fluids*. 9th Ed. Oxford: Spon Press.

Websites

http://www.freestudy.co.uk/	FREESTUDY Tutorials on Engineering (Tutorials)

Links

This unit links to the following related units:

Unit 29: Electro, Pneumatic and Hydraulic Systems

Unit 31: Electrical Systems and Fault Finding