Unit 4025: Operations and Plant Management

Unit Code: H/651/0747

Level: 4

Credits: 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 learn about 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 the systems.

Learning Outcomes

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

LO1 Analyse fundamental thermodynamic systems and their properties

LO2 Investigate power transmission systems

LO3 Determine the parameters of static and dynamic fluid systems

LO4 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, isolated) and surroundings

First and second laws 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

Use problem solving tools for analysis where relevant – for example, as Root Cause Analysis (RCA) Process Failure Modes Effects Analysis (PFMEA), Fishbone, Practical Problem Solving (PPS) and Advanced Product Quality Planning (APQP)

Relate knowledge and skills on thermodynamics systems to operations and plant management through real-world industry scenarios.

LO2 **Investigate power transmission systems**

Power transmission:

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

Types of power transmissions: mechanical, hydraulic, pneumatic, electrical

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

Relate knowledge and skills on power transmission systems to operations and plant management through real-world industry scenarios.

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

Relate knowledge and skills on fluid systems to operations and plant management through real-world industry scenarios.

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; example case studies

Recuperator, regenerator, and evaporative heat exchangers

Application of formulae to heat exchangers

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

Case studies:

Example industry applications (e.g., applications relevant to management of abnormal conditions, emergency management and recovery).

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
LO3 Determine the parameters of static and dynamic fluid systems		
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.	**D3** Compare the practical application of three different types of differential pressure measuring device.
LO4 Examine the principles of heat transfer in industrial applications		
P10 Examine the heat transfer through composite walls. **P11** Apply heat transfer formulae to heat exchangers.	**M4** Explore heat losses through lagged and unlagged pipes.	**D4** Differentiate between parallel and counter flow recuperator heat exchangers.

Recommended Resources

Note: See HN Global for guidance on additional resources.

Print Resources

Badescu V., Lazaroiu G.C. and Barelli L. (Editors) (2019) *Power Engineering – Advances and Challenges Part B: Electrical Power.* 1st Ed. CRC Press.

Berkshire F.H. (2021) *Introductory Incompressible Fluid Mechanics* Paperback. Kindle Edition. Cambridge University Press.

Cachon G. and Terwiesch C. (2023) *Operations Management.* 3rd Edition. McGraw-Hill

Chowdhury T., Chakrabarti A. and Chanda C.K. (2021) *Power Transmission System Analysis Against Faults and Attacks.* 1st Ed. CRC Press.

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

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

Hanlon R.T. (2020) *Block by Block: The Historical and Theoretical Foundations of Thermodynamics Paperback.* Kindle Edition. OUP Oxford.

Ghojel J. (2023) *Heat Transfer Basics: A Concise Approach to Problem Solving* (Hardback). Wiley.

Iloyd E. (Editor) (2023) *Handbook of Heat Transfer and Fluid Flow* (Hardback). Willford Press.

Massey B.S. and Ward-Smith J. (2011) *Mechanics of Fluids*. 9th Ed. Oxford: Spon Press.

Moran M. J., and Tsatsaronis G. (2017) 'Engineering Thermodynamics'. In *CRC Handbook Of Thermal Engineering* (pp. 1-112). Abingdon: CRC Press.

Pokrovskii V.N. (2020) *Thermodynamics of Complex Systems: Principles and applications – IOP ebooks* (Hardback). Institute of Physics Publishing.

Sarkar D. (2015). *Thermal power plant: design and operation*. Elsevier.

Stevenson W.J (2021) *Operations Management*. 14th Edition. McGraw-Hill.

Vera J.H. and Wilczek-Vera G. (2021) *Classical Thermodynamics of Fluid Systems: Principles and Applications (Paperback).* CRC Press.

Journals

Note: Example journals listed below provide a broad range of articles related to unit content and those relevant for the qualification. Staff and students are encouraged to explore these journals and any other suitable journals to support the development of academic study skills, and subject specific knowledge and skills as part of unit level delivery.

IEEE Transactions on Power Systems

International Journal of Heat and Mass Transfer

International Journal of Operations and Production Management

International Journal of Services and Operations Management

Journal of Operations Management

Links

This unit links to the following related units:

Unit 4024: Electro, Pneumatic and Hydraulic Systems

Unit 4026: Electrical Systems and Fault Finding.