Unit 3: Engineering Science

Unit code	**T/615/1477**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

Engineering is a discipline that uses scientific theory to design, develop or maintain structures, machines, systems, and processes. Engineers are therefore required to have a broad knowledge of the science that is applicable to the industry around them.

This unit introduces students to the fundamental laws and applications of the physical sciences within engineering and how to apply this knowledge to find solutions to a variety of engineering problems.

Among the topics included in this unit are: international system of units, interpreting data, static and dynamic forces, fluid mechanics and thermodynamics, material properties and failure, and A.C./D.C. circuit theories.

On successful completion of this unit students will be able to interpret and present qualitative and quantitative data using computer software, calculate unknown parameters within mechanical systems, explain a variety of material properties and use electromagnetic theory in an applied context.

Learning Outcomes

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

1. Examine scientific data using computational methods.
2. Determine parameters within mechanical engineering systems.
3. Explore the characteristics and properties of engineering materials.
4. Analyse applications of electromagnetic principles and properties.

Essential Content

LO1 **Examine scientific data using computational methods**

International system of units:

The basic dimensions in the physical world and the corresponding SI base units.

SI derived units with special names and symbols.

SI prefixes and their representation with engineering notation.

Interpreting data:

Investigation using the scientific method to gather appropriate data.

Summarising quantitative and qualitative data with appropriate graphical representations.

Using presentation software to present data to an audience.

LO2 **Determine parameters within mechanical engineering systems**

Static and dynamic forces:

Representing loaded components with space and free body diagrams.

Calculating support reactions of objects subjected to concentrated and distributed loads.

Newton's laws of motion, D'Alembert's principle and the principle of conservation of energy.

Fluid mechanics and thermodynamics:

Archimedes' principle and hydrostatics.

Continuity of volume and mass flow for an incompressible fluid.

Heat transfer due to temperature change and the thermodynamic process equations

LO3 **Explore the characteristics and properties of engineering materials**

Material properties:

Atomic structure of materials and the structure of metals, plastics and composites.

Mechanical and electromagnetic properties of materials.

Material failure:

Destructive and non-destructive testing of materials.

The effects of gradual and impact loading on a material.

Degradation of materials and hysteresis.

LO4 **Analyse applications of electromagnetic principles and properties**

D.C. circuit theory:

Voltage, current and resistance in D.C. networks.

Exploring Ohm's law and Kirchhoff's voltage and current laws.

A.C. circuit theory:

Waveform characteristics in a single-phase A.C. circuit.

RLC circuits.

Magnetism:

Characteristics of magnetic fields and electromagnetic force.

The principles and applications of electromagnetic induction.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine scientific data using computational methods</td><td rowspan="2">D1 Prepare a presentation of scientific data aimed towards a suitable audience using appropriate computer software.</td></tr>
<tr><td>P1 Describe SL units and prefix notation.
P2 Recognise quantitative and qualitative data with appropriate graphical representations.</td><td>M1 Explain various test procedures for their application of the scientific method.</td></tr>
<tr><td colspan="2">LO2 Determine parameters within mechanical engineering systems</td><td rowspan="2">D2 Measure the thermal efficiency of a heat transfer process from given parameters.</td></tr>
<tr><td>P3 Indicate the support reactions of a beam carrying a concentrated load and a uniformly distributed load.
P4 Factor Archimedes' principle in contextual engineering applications.
P5 Explain the change within a solid material when exposed to temperature variations.</td><td>M2 Review unknown forces using D'Alembert's principle applied to a free-body diagram.</td></tr>
<tr><td colspan="2">LO3 Explore the characteristics and properties of engineering materials</td><td rowspan="2">D3 Establish metal and non-metallic material properties using destructive and non-destructive test methods.</td></tr>
<tr><td>P6 Describe the material properties for the classification of metals and non-metals.
P7 Explain the types of degradation found in metals and non-metals.</td><td>M3 Distinguish elastic, electrical and magnetic hysteresis in different materials.</td></tr>
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Pass	Merit	Distinction
LO4 Analyse applications of electromagnetic principles and properties		**D4** Examine problems on series-parallel R, L, C circuits using A.C. theory.
P8 Calculate currents and voltages in circuits using circuit theorems. **P9** Describe how complex waves are produced from sinusoidal waveforms. **P10** Solve problems on series R, L, C circuits with A.C. theory. **P11** Calculate currents and voltages in circuits using Kirchhoff's laws.	**M4** Contrast principles and applications of electromagnetic induction.	

Recommended Resources

Textbooks

BIRD, J. (2012) *Science for Engineering*. 4th Ed. London: Routledge.

BOLTON, W. (2006) *Engineering Science*. 5th Ed. London: Routledge.

TOOLEY, M. and DINGLE, L. (2012) *Engineering Science: For Foundation Degree and Higher National*. London: Routledge.

Journals

International Journal of Engineering Science.

International Journal of Engineering Science and Innovative Technology.

Electronic

https://www.khanacademy.org/science/physics

Links

This unit links to the following related units:

Unit 9: Materials, Properties and Testing

Unit 3: Engineering Science