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 both quantitative and computational methods.
2. Determine parameters within mechanical engineering systems.
3. Explore the characteristics and properties of engineering materials.
4. Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties.
Essential Content

LO1  **Examine scientific data using both quantitative and 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
- Test procedures for physical (destructive and non-destructive) tests and statistical tests that might be used in gathering information
- 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
- Effects of sensible/latent heat of 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 A.C./D.C. circuit theorems, electromagnetic principles and properties**

*D.C. circuit theory:*
- Voltage, current and resistance in D.C. networks
- Exploring circuit theorems (Thevenin, Norton, Superposition), 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
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<thead>
<tr>
<th>Learning Outcomes and Assessment Criteria</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Examine scientific data using both quantitative and computational methods</td>
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<td><strong>P1</strong> Describe SI units and prefix notation</td>
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<td><strong>P2</strong> Examine quantitative and qualitative data with appropriate graphical representations</td>
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<td><strong>M1</strong> Explain how the application of scientific method impacts upon different test procedures</td>
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<tr>
<td><strong>D1</strong> Present an analysis of scientific data using both computational and qualitative methods</td>
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<tr>
<td><strong>LO2</strong> Determine parameters within mechanical engineering systems</td>
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<tr>
<td><strong>P3</strong> Determine the support reactions of a beam carrying a concentrated load and a uniformly distributed load</td>
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<td><strong>P4</strong> Use Archimedes’ principle in contextual engineering applications</td>
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<td><strong>P5</strong> Determine through practical examples the change within a solid material when exposed to temperature variations</td>
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<td><strong>M2</strong> Determine unknown forces by applying d’Alembert’s principle to a free body diagram</td>
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<td><strong>D2</strong> Critically compare how changes in the thermal efficiency of a heat transfer process can affect the behavioural characteristics of a mechanical systems</td>
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<td><strong>LO3</strong> Explore the characteristics and properties of engineering materials</td>
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<td><strong>P6</strong> Describe the structural properties of metals and non-metals with reference to their material properties</td>
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<td><strong>P7</strong> Explain the types of degradation found in metals and non-metals</td>
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<td><strong>M3</strong> Review elastic, electrical and magnetic hysteresis in different materials</td>
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<tr>
<td><strong>D3</strong> Compare and contrast theoretical material properties of metal and non-metallic materials compared with values obtained through destructive and non-destructive test methods</td>
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<tr>
<td><strong>LO4</strong> Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties</td>
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<td><strong>P8</strong> Calculate currents and voltages in circuits using circuit theorems.</td>
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<td><strong>P9</strong> Describe how complex waves are produced from sinusoidal waveforms.</td>
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<td><strong>P10</strong> Solve problems on series R, L, C circuits with A.C. theory.</td>
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Recommended Resources

Textbooks

Journals

Websites
https://www.khanacademy.org/ Khan Academy
Physics
(Tutorials)

Links
This unit links to the following related units:
Unit 9: Materials, Properties and Testing
Unit 3: Engineering Science