

Unit 102

Properties of engineering materials

Unit summary

This unit is about the structures, properties and an application of a range of materials used in engineering and includes metals and non-metals.

Aims

The unit aims to develop the candidates' knowledge and understanding of materials for use in engineering applications.

Prerequisites

The structure of atoms, elementary particles, atomic number and isotopes.

The nucleus, electronic configuration, periodic table of elements.

Learning outcomes

There are **four** outcomes to this unit. The candidate will be able to:

- Recognise the structures of metals, polymers and ceramic materials
- Assess the mechanical and physical properties of engineering materials
- Understand the relationships between the structure of a material and its properties
- Select materials for specific engineering applications

Guided learning hours

It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills

This unit contributes towards the Key Skills in the following areas:

PS4.1

Develop a strategy for using skills in problem solving over an extended period of time.

PS4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required when tackling one complex problem with at least three options.

PS4.3

Evaluate your overall strategy and present the outcomes from your work using a variety of methods

Occupational Standards

This unit has been mapped to the following National Occupational Standards:

- 1.1.1 Identify the requirements of clients for engineering products or processes
- 1.1.2 Produce specifications for engineering products or processes
- 1.3.1 Undertake research into engineering products or processes
- 1.3.2 Evaluate the results of research
- 1.4.4 Evaluate designs for engineering products or processes
- 2.1.1 Determine the production requirements of engineering products and processes
- 2.2.2 Solve production problems with engineering solutions
- 2.3.2 Evaluate the production process
- 4.1.1 Determine the operational requirements of engineering products or processes
- 4.1.2 Specify operational methods and procedures to achieve operational requirements
- 4.2.2 Solve operational problems with engineering solutions
- 5.1.1 Determine the maintenance requirements of engineering products or procedures
- 6.1.1 Analyse the risks arising from engineering products and processes
- 6.2.1 Assure the quality of engineering products or processes
- 8.1.1 Maintain and develop own engineering expertise

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Outcome 1

Recognise the structures of metals, polymers and ceramic materials

Knowledge requirements

The candidate knows how to:

- 1 knows how to recognise materials structures which are
 - a crystalline
 - b glassy / amorphous
- 2 knows how to use and interpret phase diagrams
- 3 knows how to use phase diagrams to predict the materials microstructures
- 4 understands the influence on materials properties of
 - a grain size
 - b phase distribution
 - c molecular linkages
- 5 understands the effect of dislocations and point defects on plastic flow in metals

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Outcome 2

Assess the mechanical and physical properties of engineering materials

Knowledge requirements

The candidate knows how to:

- 1 how to describe the mechanical properties of engineering materials
 - a tensile and shear strength
 - b elastic modulus
 - c hardness
 - d toughness
 - e ductility
- 2 the methods used to perform tests on materials to determine mechanical properties values using
 - a tensile test
 - b impact test
 - c crack tip displacement test
 - d hardness test
 - e fatigue test
 - f creep test
- 3 how to interpret results of the above tests and use as criteria for material selection
- 4 how the mechanical properties of materials are affected by
 - a temperature extremes
 - b environment
 - c age
- 5 how to define and describe the electrical characteristics of engineering materials
 - a conductivity and resistivity
 - b intrinsic and extrinsic semi-conductors
 - c the p-n junction
 - d field effect
 - e diode and transistors
 - f dielectrics and permittivity
 - g magnetism
 - h Hall effect
 - i superconductivity

- 6 the methods used to perform tests to determine the following electrical properties of engineering materials
 - a conductivity and resistivity
 - b permittivity
 - c magnetism
- 7 how to define and describe the thermal properties of engineering materials
 - a conductivity
 - b expansion
 - c heat capacity

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Outcome 3

Understand the relationships between the structure of a material and its properties

Knowledge requirements

The candidate knows how to:

- 1 assess the impact on the structure and properties of a metal due to
 - a alloying
 - b heat treatment
 - c cold working and forming
 - d thermal cutting and joining techniques
 - e mechanical production processes
- 2 interpret phase diagrams for alloy materials
- 3 predict the effect of temperature on the structure and properties of
 - a plastics
 - b cermets
 - c composites
- 4 assess the effect on the hardness of aluminium alloys due to
 - a aging
 - b precipitation
- 5 recognise the effect on the properties of steels of the following heat treatment processes
 - a normalising
 - b annealing
 - c hardening
 - d tempering

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Outcome 4

Select materials for specific engineering applications

Knowledge requirements

The candidate knows how to:

- 1 determine the suitability of a specific material or range of materials for engineering applications involving
 - a mechanical loading
 - b electrical and thermal conductivity
 - c extremes of temperature
 - d structural integrity
 - e strength to weight ratio
 - f wear resistance
- 2 select materials appropriate to their industrial application
 - a aeronautical engineering
 - b mechanical engineering
 - c power generation
 - d heat transfer applications
 - e automotive industry
 - f structural engineering
 - g chemical engineering
 - h electrical engineering
 - i construction industry

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Recommended reading list

Core texts	Author	Publisher	ISBN
Elements of Materials Science and Engineering	Van Vlack	Addison-Wesley	0201093146
Introduction to Materials Science for Engineers	Shackelford	Prentice Hall	0130454257
Materials Science and Engineering	Callister	John Wiley	0471320137