

Unit 103

The principles of engineering science

Unit summary

This unit is about the scientific concepts related to the understanding and resolution of the wide range of problems an engineer might meet in various fields of engineering.

Aims

The unit aims to enable the candidate to solve both simple and complex problems that are encountered on a day-to-day basis by professional engineers. Engineering science mainly constitutes applied mathematics, data analysis, experimental testing and previously investigated phenomena and one of the aims is to develop an analytical approach to problem solving.

Prerequisites

Sufficient mathematical knowledge to carry out basic scientific and engineering calculations. Elementary differential calculus and differential equations. Elementary integral calculus.

Physics to a level broadly equivalent to A-level: although several of the topics below are included in an A-level syllabus, they are to be revised and taken to slightly greater depth here.

Concepts of force, moment and friction. Position and velocity calculations for systems with constant acceleration.

Voltage, current, resistance (Ohm's Law).

Learning outcomes

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

- Develop scientific concepts which aid solutions to engineering problems
- Appreciate the idealisation of physical problems using simple mathematical models

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:

N4.1

Develop a strategy for using application of number skills over an extended period of time.

N4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3

Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

Occupational Standards

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

- 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
- 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

Develop scientific concepts which aid solutions to engineering problems

Knowledge requirements

The candidate knows how to:

- 1 determine equilibrium of
 - a particle
 - b a solid body
- 2 calculate equilibrium forces and reactions
- 3 determine forces in simple statically determinate assemblies of rigid bodies
- 4 construct and use free body diagrams
- 5 determine equations of condition
- 6 calculate
 - a direct stress
 - b extensional strain
 - c Young's modulus
- 7 calculate
 - a shear stress
 - b shear strain
 - c shear modulus
- 8 analyse principle stresses and strains related by elastic stiffness matrix
- 9 solve problems using Poisson's ratio
- 10 solve problems using bulk modulus
- 11 use concepts of
 - a impulse
 - b momentum
 - c work
 - d power
 - e Kinetic and potential energy
- 12 apply Newton's Laws of motion to constant force problems
- 13 apply Newton's Laws for rotation about a fixed axis
- 14 determine the result of collisions between particles

- 15 determine hydrostatic
 - a pressure
 - b static force balances
- 16 solve problems using Archimedes' principle
- 17 Solve thermodynamics problems using The First Law of Thermodynamics or the steady flow energy equation involving
 - a heat and work
 - b temperature
 - c internal energy
 - d enthalpy
 - e flow and non-flow processes
 - f perfect gases
- 18 solve electrical problems involving
 - a charge
 - b capacitance
 - c inductance
 - d reluctance
 - e electric and magnetic fields
 - f principles of electromagnetism
- 19 analyse passive dc circuits
- 20 solve problems using Kirchoff's Laws
- 21 discriminate between ac and dc and understand generation and rectification
- 22 design simple
 - a diode circuits
 - b transistor circuits

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Outcome 2

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Appreciate the idealisation of physical problems using simple mathematical models

Knowledge requirements

The candidate knows how to:

- 1 formulate simple mathematical models that aid the solution of scientific problems in engineering
- 2 ascertain by trial whether a mathematical model is appropriate to a particular engineering problem
- 3 use simple mathematical models as an aid to problem solving

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Recommended reading list

Core texts	Author	Publisher	ISBN
Applied Mechanics All Chapters except 16,17 and 20	Hannah	Hillier Longman Higher Education	0582256321
Electronics: Circuits, Devices and Systems Chapters 1 to 5, 11, 12, 20 & 21	Smith, Dorf	John Wiley	0471839442
Mechanics of Materials, Volume 1 Chapters 1,8 and 9	Hearn	Butterworth-Heinemann	0750632658
Microelectronic Circuits Chapters 1,2,4,5,9 & 10	Sedra, Smith	Oxford University Press	0195116909
Engineering Thermodynamics, Work and Heat Transfer Chapters 1 to 4 and 8	Rogers, Mayhew	Longman Higher Education	0582045665 o/p
Mechanics of Fluids	Massey, Ward-Smith	Chapman & Hall	0748740430 o/p
Other useful texts			
Basic Mechanics with Engineering Applications	Fawcett, Burdess	Butterworth-Heinemann	0713136200
Basic Solid Mechanics	Rees	Palgrave	0333666097
Electrical Technology Chapters 1 to 12 & 17 to 24	Hughes, Smith	Longman Higher Education	0582226961
Fluid Mechanics Chapters 1 to 3	Douglas, Gasiorek, Swaffield	Longman Higher Education	0582234085
Microelectronics Chapters 1 to 4, 10 & 11	Millman, Gabel	McGraw Hill	007100596
Solving Problems in Fluid Mechanics, Vol. 1 Chapters 1 to 4	Hughes	Addison-Wesley	0582226961