Australian Government

MEM23008A Apply advanced algebra and numerical methods to engineering tasks

Release 1

INDUSTRY SKILLS COUNCILS
Creating Australia's Future

MEM23008A Apply advanced algebra and numerical methods to engineering tasks

Modification History

Release 1 (MEM05v9).

Unit Descriptor

This unit of competency covers the application of advanced mathematics and numerical methods techniques to engineering situations. It includes the use and application of advanced mathematics and numerical methods, concepts and modelling methods, such as vectors in 3-D with i, j, k notation; analytical geometry; graphing techniques; complex numbers; linear algebra, including solving matrices, numerical solutions, errors and propagation of errors; plus interpolation and extrapolation.

Application of the Unit

The unit applies to engineering or related activities requiring the specific application of advanced mathematics or numerical methods techniques. It is suitable for people giving technical support to design, operations or maintenance activities and those pursuing technical qualifications and careers at paraprofessional or technician level.

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

MEM23004A	Apply technical mathematics

Employability Skills Information

This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.

Performance criteria describe the performance needed to demonstrate achievement of the element.

Elements and Performance Criteria

1	Determine scope of advanced mathematics and numerical methods required for an engineering application	1.1	Analyse an engineering application for required advanced mathematics or numerical methods tasks
		1.2	Develop systematic methods for layout and solution validation, including any required sign-off of solution
		1.3	Identify advanced mathematics or numerical methods and any software required for analysis and resolution of identified engineering application tasks
2	Apply advanced mathematics techniques to engineering applications	2.1	Apply advanced mathematics concepts and models to solve engineering or manufacturing problems
		2.2	Check answer by appropriate means
		2.3	Interpret answer to determine information required by problem definition
		2.4	Report results and document calculations, graphs and analysis
3	Apply numerical methods to engineering applications	3.1	Apply numerical methods concepts and models to solve engineering problems
		3.2	Check solution is laid out correctly and is error free
		3.3	Review solution to ensure it provides information relevant to resolution of engineering application task
		3.4	Report results and document calculations, graphs and analysis

Required Skills and Knowledge

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- analysing engineering applications to determine relevant algebra and numerical methods
- applying relevant advanced mathematics and numerical methods concepts and tools to engineering situations
- using appropriate software and/or scientific calculators to generate solutions to algebra and numerical methods problems
- establishing appropriate procedures for checking and validating solutions
- logical layout and presentation of data developed using algebra and numerical methods
- reporting and effectively communicating the results of advanced mathematics and numerical methods-based analysis

Required knowledge

Required knowledge includes:

- vectors:
  - vectors in 3-D
  - i, j and k notation
  - magnitude of a vector
  - unit vectors and direction angles
  - scalar or 'dot' product of two vectors
  - vector or 'cross' product of two vectors
  - resolution of vectors
  - differentiation and integration of vectors
- dynamics:
  - Newton's Laws of Motion
  - energy, work and power
  - work-energy theorem
  - moment of a force
- analytical geometry:
  - equation of a plane
  - angle between two planes
  - distance from a point to a plane

    - lines in 3-D space
- graphing techniques:
    - coordinate geometry
    - graphs of exponential growth and decay
    - graphs with logarithmic scales
    - method of least squares
    - polar coordinates and polar graphs
    - graphs of functions of two variables
    - quadric surfaces
- complex numbers:
    - introduction to complex numbers
    - cartesian form
    - the Argand plane
    - trigonometric and polar form
- linear algebra:
    - matrix algebra
    - transformations
    - determinants
- numerical solutions:
    - finite difference techniques
- errors:
    - computer arithmetic
    - propagation of errors
- interpolation and approximation:
    - polynomial interpolation
    - Lagrange form
    - Newton's divide formula
    - error bound

Evidence Guide

The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.

Overview of assessment	A person who demonstrates competency in this unit must be able to apply advanced mathematics and numerical methods techniques to engineering-related problems within the context of specified engineering applications and solution validation and technical

	oversight procedures. The candidate may demonstrate competence through either working individually or as part of a team.
Critical aspects for assessment and evidence required to demonstrate competency in this unit	Assessors must be satisfied that the candidate can competently and consistently: • solve engineering problems using advanced mathematics and numerical methods techniques • validate results of simple examples using advanced mathematics and numerical methods either analytically and/or graphically using appropriate software or scientific calculators • assist decision making processes in industry by analysis of data using advanced mathematics and numerical methods concepts and tools.
Context of and specific resources for assessment	• This unit may be assessed on the job, off the job or a combination of both on and off the job. Where assessment occurs off the job then a simulated working environment must be used where the range of conditions reflects realistic workplace situations. The competencies covered by this unit would be demonstrated by an individual working alone or as part of a team. • Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability. • Access must be provided to appropriate learning and/or assessment support when required. Where applicable, physical resources should include equipment modified for people with disabilities.
Method of assessment	• Assessment must satisfy the endorsed Assessment Guidelines of the MEM05 Metal and Engineering Training Package. • Assessment methods must confirm consistency and accuracy of performance (over time and in a range of workplace relevant contexts) together with application of underpinning knowledge. • Assessment methods must be by direct observation of tasks and include questioning on underpinning knowledge to ensure correct interpretation and application. • Assessment may be applied under project-related conditions (real or simulated) and require evidence of process. • Assessment must confirm a reasonable inference that competency is not only able to be satisfied under the particular circumstance, but is able to be transferred to other circumstances. • Assessment may be in conjunction with assessment of other units of competency where required.
Guidance information for assessment	Assessment processes and techniques must be culturally appropriate and appropriate to the language and literacy capacity of the candidate and the work being performed.

Range Statement

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Engineering applications related to advanced mathematics and numerical methods techniques in this unit	Most engineering disciplines will have applications supported by the advanced mathematics and numerical methods skills described in this unit, including mechanical, manufacturing, maintenance and mechatronics engineering. Examples of engineering applications requiring advanced mathematics and numerical methods skills described in this unit may include: • assisting decision making in industry by analysis of data using advanced mathematics and numerical methods concepts and tools • assisting presentation of data in industry by use of advanced graphical techniques • solution of problems involving rectilinear and rotation motion • solution of problems involving work, energy and power • solution of problems in electrostatics and wave propagation
Scope of advanced mathematics and numerical methods techniques	The scope of advanced mathematics and numerical methods techniques required for an engineering or manufacturing application will vary and may include: • vectors in 3-D, including i, j, k notation, scalar and vector products • dynamics, including Newton's Laws of Motion, energy, work and power and work-energy theorem • analytical geometry • graphing techniques, including coordinate geometry, polar coordinates and polar graphs • complex numbers, including Cartesian, trigonometric and polar form • linear algebra, including matrix algebra • numerical solutions, including finite difference techniques • errors and propagation of errors • interpolation and approximation

Unit Sector(s)

Competency field

Unit sector Engineering science

Custom Content Section

Not applicable.