



Australian Government

Department of Education, Employment and Workplace Relations

MEM234019A Apply finite element analysis in engineering design

Release: 1

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Modification History

New unit

Unit Descriptor

This unit of competency covers the application of finite element analysis (FEA) for engineering design and modification analyses, including stress analysis, displacements and natural frequencies, and temperature and heat distributions in engineering or related applications.

Application of the Unit

This unit applies to engineering or related applications across all forms of manufacturing and engineering. It is suitable for people with structural, plant or equipment design or maintenance responsibilities, and those pursuing engineering or related qualifications and careers.

Prior experience in mechanics, mathematics and computing techniques and computer-aided design (CAD) is required and areas, such as thermodynamics or structures, depending on the application of the FEA.

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Not applicable.

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. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.

Elements and Performance Criteria

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|---|--|-----|---|
| 1 | Integrate requirement for FEA into an engineering design application | 1.1 | Establish functions, features and performance parameters of plant, structure or equipment to be analysed |
| | | 1.2 | Determine parameters to the brief or contract |
| | | 1.3 | Determine occupational health and safety (OHS), regulatory, sustainability and environmental requirements of the application |
| | | 1.4 | Provide initial advice based on discipline knowledge, OHS and regulatory standards relating to the suitability of using FEA as an analytical technique |
| 2 | Apply FEA solution techniques | 2.1 | Set up a finite element model, including internal and external parameters, element mesh and nodes |
| | | 2.2 | Select appropriate solver and adjust parameters for optimum solution |
| | | 2.3 | Generate and assess solution file for warnings or errors |
| | | 2.4 | Interpret results and generate graphics |
| | | 2.5 | Identify areas of excessive stress, deformation, instability and excessive temperatures |
| | | 2.6 | Verify results to the required certainty level |
| | | 2.7 | Apply systems or holistic thinking, contingencies and constraints management, problem solving and decision making techniques in making recommendations to achieve satisfactory functions, features and performance parameters |

- 2.8 Review initial results with client
 - 2.9 Negotiate adjustments to brief or contract parameters, if required
- 3 Embed FEA results in design application
 - 3.1 Report and recommend design improvements or modifications as a result of the FEA analysis
 - 3.2 Document results of investigations, analysis and recommendations
 - 3.3 Obtain sign-off

Required Skills and Knowledge

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

Required skills

Required skills include:

- gathering information relevant to the FEA task
- interpreting and evaluating documentation, specifications and drawings for FEA purposes
- researching FEA, mathematical techniques, applicability and limitations, software and evolving opportunities for FEA
- setting up FEA model, parameters, element mesh and nodes
- using FEA software, including pre- and post-processor, if any, effectively
- constructing models of engineering part or structure suitable for FEA using appropriate software
- determining and setting parameters and conditions for required type of analysis
- applying boundary conditions to suit type of analysis required, including axisymmetric analysis
- choosing, setting up, and running appropriate solvers, such as linear static, linear buckling, non-linear static, natural frequency, steady state, heat, and so on
- interpreting results, generating graphics and identifying significant issues
- validating software outputs
- reporting and documenting results

Required knowledge

Required knowledge includes:

- FEA task parameters for applications, such as:
 - stresses and displacements
 - natural frequencies
 - heat and temperature distribution
- software modelling and validation techniques, including:
 - element type and shape for error minimisation
 - library files
 - geometry importation from other software packages
 - application of boundary conditions
 - validation using comparison with traditional solution of simple examples and reviewing of past successful applications
 - methods for presentation of results, including software-generated graphics
 - measures of excessive stress and/or deformation and to recommend modifications
- software functions and features, such as:
 - deformed displays

- colour contour plots, contour averaging and contour jumps
- peeking, graphing and animating
- multiple views
- coordinate systems:
 - Cartesian
 - polar
 - spherical coordinate systems
- stress concentrations
- structural loads:
 - dead loads, live loads and wind loads
 - structural and non-structural mass
- material libraries:
 - types of beam, plate and brick elements
 - properties of materials, such as stress, strain, modulus of elasticity, modulus of rigidity, Poisson's ratio and allowable stress
- stresses:
 - equivalent stresses based on Von Mises criterion and Tresca criterion
 - shear force and bending moment diagrams, bending stress and torsional stress
 - heat transfer modes (conduction, convection and radiation)
 - thermal stress
- accuracy checking methods, including use of strain gauges and solvers
- software validation techniques

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.

Critical aspects for assessment and evidence required to demonstrate competency in this unit	Assessors must be satisfied that the candidate can competently and consistently: • determine functions, features and performance parameters of plant, structure or equipment to be analysed • determine parameters to the brief or contract, OHS, regulatory, risk management and sustainability requirements • communicate, advise, negotiate and review with stakeholders and client throughout process • apply FEA solution techniques • set up FEA model, parameters, element mesh and nodes • select solver and adjust and optimise parameters
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	• generate and assess solution file • interpret results, generate graphics and identify significant issues • validate software outputs • apply systems or holistic thinking, contingencies and constraints management, problem solving and decision making techniques in making recommendations • report and document results.
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, that is, the candidate is not in productive work, 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 its 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 able not only 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.

FEA	FEA uses numerical techniques to find approximate solutions for engineering problems, such as: • load, stiffness and deflection analysis and animations for vehicle crash simulations • hopper and bin designs • piping systems • heat flow, such as in in cavity moulds, load distribution, stiffness and strength in structures
Parameters to the brief	The design brief may include the design of new equipment or fault analysis, rectification or modification to an existing design. Parameters to the design brief may include: • determination of the degree of innovation and creativity expected by the client • design process limits and budgets • product cost limits and budgets • performance specifications • equipment availability, capacities and restrictions • specified administrative, communication and approval procedures • other special features and limits in the design brief
Standards and codes	Standards and codes refer to all relevant Australian and international standards and codes applicable to a particular design task
OHS, regulatory, sustainability and environmental requirements	OHS, regulatory, sustainability and environmental requirements may include: • OHS Acts and regulations • relevant standards • industry codes of practice • risk assessments • registration requirements • safe work practices • minimising ecological and environmental footprint of process, plant and product • maximising economic benefit of process plant and product to the organisation and the community • minimising the negative OHS impact on employees, community and customer • state and territory regulatory requirements

Appropriate solver	Appropriate solver may include: • sparse • preconditioned conjugate gradient (PCG) • incomplete cholesky conjugate gradient • frontal
Client	Client may be: • internal or external to the organisation

Unit Sector(s)

Engineering practice

Custom Content Section

Not applicable.