Queensland Curriculum and Assessment Authority

Engineering 2019 v1.1

IA1: Sample assessment instrument

Project — folio

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name

Student number

Teacher

Issued

Due date

Marking summary

Criterion	Marks allocated	Provisional marks
Retrieving and comprehending	5	
Analysing	7	
Synthesising and evaluating	9	
Communicating	4	
Overall	**25**	

Conditions

Technique	Project — folio
Unit	Unit 3: Statics of structures and environmental considerations
Topic/s	Topic 1: Application of the problem-solving process in Engineering Topic 2: Civil structures and the environment Topic 3: Civil structures, materials and forces
Duration	5–7 weeks
Mode/length	Part A — Documents the development of an engineered solution: • Multimodal: 7–9 single-sided A3 pages or equivalent digital media Part B — Summary report • Multimodal: 2–3 single-sided A4 pages or equivalent digital media
Individual/group	Individual
Other	The table of contents and reference list are not included in the page count.

Context

A civil construction company requires an electronic variable message sign and sign support structure to upgrade a section of busy arterial roadway. Once constructed and commissioned, the electronic sign will be operated by a traffic management centre to provide motorists with travel information about upcoming events, hazards and traffic delays. The concept design requires a cantilever truss-type gantry support structure to be installed to maximise motorist visibility on the upgrade of a straight roadway section.

Details relevant to the development of the sign gantry are:

- the foundation of the cantilever gantry is to be positioned 3 m from the left roadway kerb with a safety barrier installed to reduce the risk of high-speed collision with the structure
- the geographic location receives a very high yearly rainfall, has high humidity during the summer months and experiences quite low temperatures in winter, i.e. minimums of 5–10 °C
- the structure should be developed considering the Wind Region B ultimate design wind speed of 51.9 m/s or 186.84 km/h experienced at the location
- the sign must be positioned at least 6.5 m above the roadway to allow clearance for oversize vehicles and span 6 m to provide road kerb clearance and an over-lane sign location
- the fixed electronic sign, with a mass of 200 kg, will cover an area 6 m wide x 1.5 m high on the oncoming traffic side of the gantry structure
- the cantilever sign gantry must efficiently withstand the weight force of the electronic sign and a 1.5 factor of safety loading as judged using the beam performance index
- the geological engineers have not yet received the results of the borehole logs and geotechnical soil testing for the sign's location. Therefore, the type of footings needed for the new structure have not been supplied with the concept design.

Task

Your task is to use the problem-solving process in Engineering to:

- develop a truss-style cantilever sign gantry that meets the requirements of the concept design provided to the civil construction company and those of the geographic location
- document the problem-solving process used to predict the solution in a folio
- provide the construction company's project manager with a summary report for their consideration.

The folio will include the use of a prototype sign gantry constructed using balsa wood and limited amounts of other materials, as required to withstand the specified weight force of the electronic sign and the factor of safety loading, each scaled to 1:20 for prototype development, and include only a consideration of the region B wind loading on the structure. (Note: Detailed calculations of the torsional forces resisted by the structure are not required.)

Given the geotechnical uncertainty of the foundation, the base of the prototype gantry will be mounted securely to a fixed location to be no greater than 200 mm x 200 mm x 19 mm plywood.

To complete this task, you must:

Part A

- recognise and describe
  - the characteristics of the cantilever sign gantry problem, including knowns, unknowns, assumptions and boundaries
  - the engineering mechanics and materials science fundamentals of the cantilever sign gantry problem
  - mitigation of environmental and sustainability impacts, including corrosion, habitat loss, erosion and life-cycle assessment associated with the geographical location of the cantilever sign gantry
- symbolise and explain ideas and the solution to the cantilever sign gantry problem using annotated sketching, drawings including basic drawing standards (hand or CAD), force vectors, free-body diagrams, graphs, tables and/or schemas
- analyse the cantilever sign gantry problem and engineering mechanics, materials science, technology and research information in relation to structures to identify the elements, components and features, and their relationship to the structure of the problem, including project management milestones, i.e. resource and time constraints
- determine solution success criteria, considering the identified elements, components and features, and their relationship to the structure of the cantilever sign gantry problem, including for example beam performance index
- synthesise engineering mechanics, materials science, technology and research information and ideas to predict a possible solution to the cantilever sign gantry problem
- evaluate and refine idea and solution development in relation to solution success criteria including
  - testing of materials and processes, e.g. cross-beam experiment to determine beam performance index, compression testing
  - calculations using mechanics concepts and principles to predict prototype solution performance
  - evaluation of prototype solution performance data and the reliability of the prototype solution, including use of the beam performance index
- generate the prototype solution for testing including
  - virtual and/or physical manipulation of materials, scaled modelling, 3D printing, laser cutting
  - annotations on photographs or screen captures of the prototype solution prior to and after testing
  - performance of destructive, non-destructive and/or virtual testing of the prototype solution to provide performance data
- recommend and justify future modifications or enhancements to ideas and the solution to the cantilever sign gantry problem
- communicate the development of ideas and the solution for the cantilever sign gantry problem using written and visual features, e.g. PMI (plus, minus, interesting) charts, sketches, drawings, diagrams, graphs, tables and/or schemas
- communicate data using diagrams, tables and/or spreadsheets.

Part B

- develop a summary report for the civil construction company's project manager, drawn from Part A documentation. The summary report includes key pictures, tables, graphs, sketches and drawings that provide a concise account of the preferred solution to the cantilever sign gantry problem, including key features and any recommendations made to inform future solution development.

Checkpoints

☐ A student draft will be required for submission during week 3 of the allocated assessment time and will include an exploration of the cantilever sign gantry problem, the development of ideas and an indication of a proposed solution.

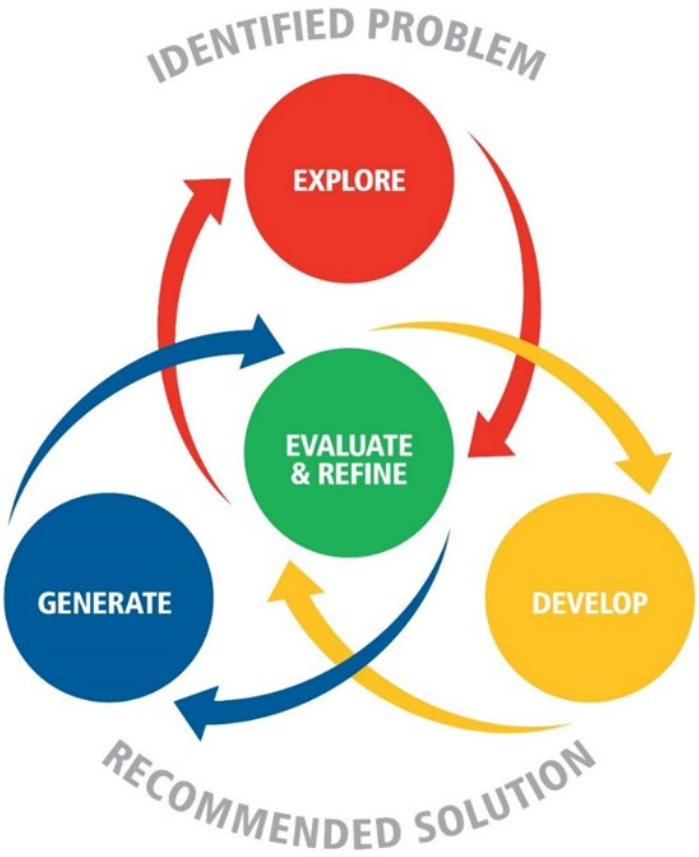
Authentication strategies

- The teacher will provide class time for task completion.
- Students will each produce a unique response through teacher monitoring of student problem identification and problem-solving.
- Students will provide documentation of their progress at the indicated checkpoint.
- The teacher will collect and annotate one draft.
- The teacher will conduct interviews or consultations with each student as they develop the response.
- Students must acknowledge all sources.
- Students must submit a declaration of authenticity.
- The teacher will ensure class cross-marking occurs.

Scaffolding

In this unit, the student is required to prepare a folio documenting how they apply the problem-solving process in Engineering in response to an identified real-world structural problem.

The problem-solving process in Engineering



The response will include the following folio and referencing conventions:

- headings that organise and communicate the student's thinking through the iterative phases of the problem-solving process in Engineering
- a table of contents page
- a reference list and a recognised system of in-text referencing.

Instrument-specific marking guide (IA1): Project — folio response (25%)

Criterion: Retrieving and comprehending

Assessment objectives

1. recognise and describe the structural problem, engineering technology knowledge, and mechanics and materials science concepts and principles in relation to structures
2. symbolise and explain ideas and a solution in relation to structures

The student work has the following characteristics:	Marks
• accurate and discriminating recognition and discerning description of the structural problem, engineering technology knowledge, and mechanics and materials science concepts and principles in relation to structures • adept symbolisation and discerning explanation of ideas and a solution in relation to structures with sketches, drawings, diagrams, graphs, tables and/or schemas.	4–5
• accurate recognition and appropriate description of the structural problem, engineering technology knowledge, and some mechanics and materials science concepts and principles in relation to structures • competent symbolisation and appropriate explanation of some ideas and a solution in relation to structures with sketches, drawings, diagrams, graphs, tables and/or schemas.	2–3
• variable recognition and superficial description of aspects of the structural problem, concepts or principles in relation to structures • variable symbolisation or superficial explanation of aspects of ideas or a solution in relation to structures.	1
• does not satisfy any of the descriptors above.	0

Criterion: Analysing

Assessment objectives

3. analyse the structural problem and information in relation to structures
4. determine solution success criteria for the structural problem

The student work has the following characteristics:	Marks
• insightful analysis of the structural problem, and relevant engineering mechanics, materials science, technology and research information in relation to structures, to identify the relevant elements, components and features, and their relationship to the structure of the problem • astute determination of essential solution success criteria for the structural problem.	6–7
• considered analysis of the structural problem, and relevant engineering mechanics, materials science, technology and research information in relation to structures, to identify the relevant elements, components and features, and their relationship to the structure of the problem • logical determination of effective solution success criteria for the structural problem.	4–5
• appropriate analysis of the structural problem, and engineering mechanics, materials science, technology and research information in relation to structures, to identify some of the elements, components or features of the problem • reasonable determination of some solution success criteria for the structural problem.	2–3
• statements about the structural problem or information in relation to structures • vague determination of some solution success criteria for the structural problem.	1
• does not satisfy any of the descriptors above.	0

Criterion: Synthesising and evaluating

Assessment objectives

5. synthesise information and ideas to predict a possible structural solution
6. generate a structural prototype solution to provide data to assess the accuracy of predictions
7. evaluate and refine ideas and a solution to make justified recommendations

The student work has the following characteristics:	Marks
• coherent and logical synthesis of relevant engineering mechanics, materials science, technology and research information, and ideas to predict a possible structural solution • purposeful generation of a structural prototype solution to provide valid performance data to critically assess the accuracy of predictions • critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence.	8–9
• logical synthesis of relevant engineering mechanics, materials science, technology and research information, and ideas to predict a possible structural solution • effective generation of a structural prototype solution to provide valid performance data to effectively assess the accuracy of predictions • reasoned evaluation and effective refinement of ideas and a solution using success criteria to make considered recommendations justified by data and research evidence.	6–7
• simple synthesis of engineering mechanics, materials science, technology and research information, and ideas to predict a possible structural solution • adequate generation of a structural prototype solution to provide relevant performance data to assess the accuracy of predictions • feasible evaluation and adequate refinement of ideas and a solution using some success criteria to make fundamental recommendations justified by data and research evidence.	4–5
• rudimentary synthesis of partial engineering mechanics, materials science, technology or research information, or ideas to predict a structural solution • partial generation of a structural prototype solution to provide elements of performance data to partially assess the accuracy of predictions • superficial evaluation of ideas or a solution using some success criteria to make elementary recommendations.	2–3
• unclear combinations of information or ideas • generation of elements of a structural prototype solution • identification of a change about an idea or the solution.	1
• does not satisfy any of the descriptors above.	0

Criterion: Communicating

Assessment objectives

8. make decisions about and use mode-appropriate features, language and conventions to communicate development of the prototype solution

The student work has the following characteristics:	Marks
• discerning decision-making about, and fluent use of, – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – folio and referencing conventions.	3–4
• variable decision-making about, and inconsistent use of, – written and visual features – suitable language – grammar and language structures – folio or referencing conventions.	1–2
• does not satisfy any of the descriptors above.	0