Unpacking the Engineering subject report 2021

Internal assessment

220578

Image: *Ee Lah Roo — Long time ago* by Kargun Fogarty

Presenters

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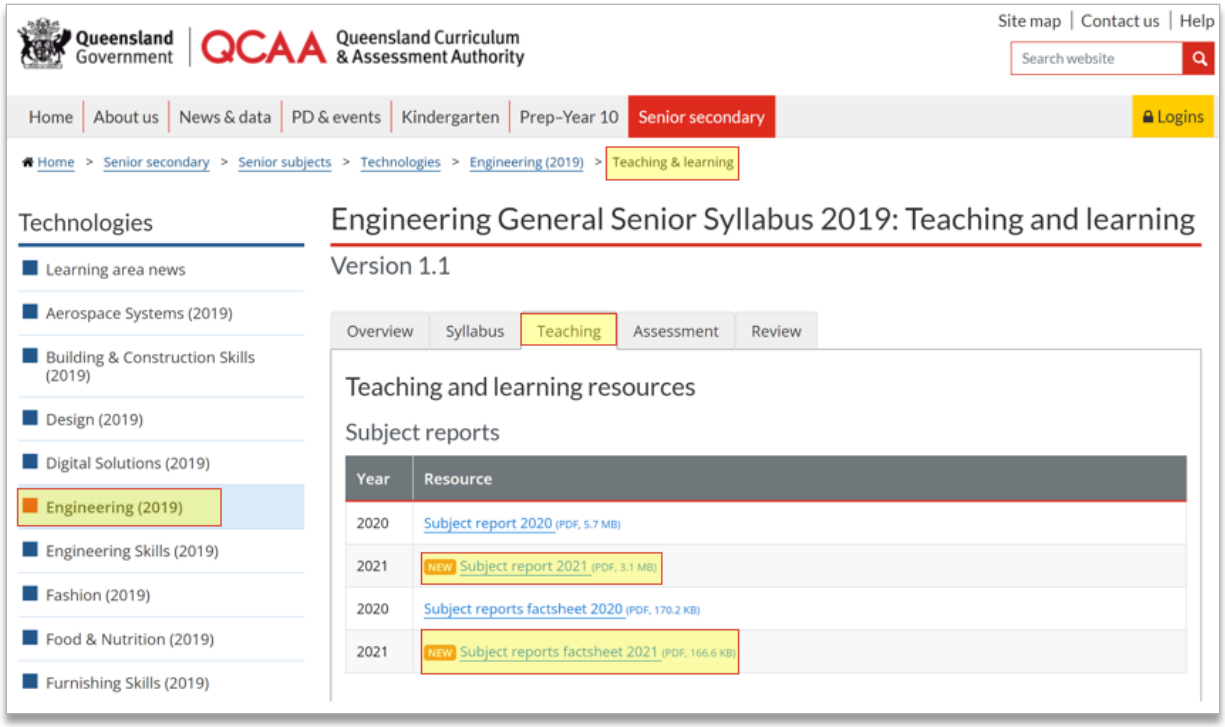
Learning goals

Learn how to use the QCAA Engineering subject report to inform teaching and assessment practice.

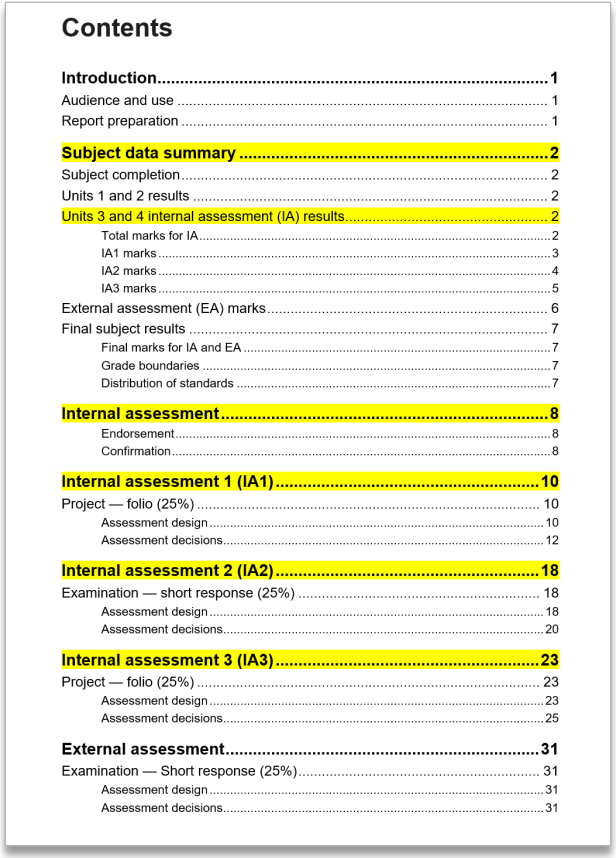
Success criteria

You will know you are successful if you can reflect purposefully on the information provided in the subject report to determine how you can improve your school's internal assessment in Engineering.

Locating the subject report



Sections



Contents

The purpose of the subject report

2021 summative assessment cycle key outcomes:

- Quality assurance: Endorsement and Confirmation
- External assessment results

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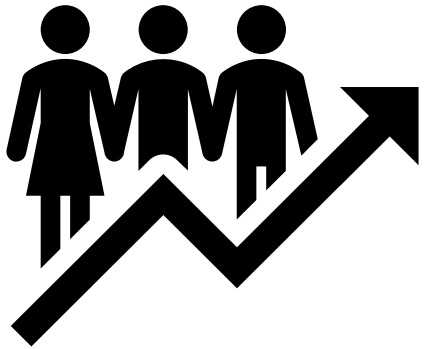
- Effective practices and practices to strengthen
  - Internal assessment
    - Assessment design (validity, accessibility)
    - Assessment decisions (reliability)
  - External assessment
    - Teaching and learning



Structure of the webinar

CELEBRATE

UNPACK

DISCUSS
REFLECT

STRENGTHEN

QUESTIONS

Subject data summary

Subject progress

Year	2020	2021
Growth of Year 12 cohort (+104)	1255	1359
Number of students achieving an A standard (+95)	168	263
Number of students achieving a B standard (+60)	386	446
Number of students achieving a C standard (–36)	576	540

Engineering is a growing subject with a larger number of students achieving an A standard in 2021.

What improvements have you seen at your school? Is there more interest in the subject?

Subject report reference: page 7

Internal assessment

Percentage of instruments endorsed in Application 1

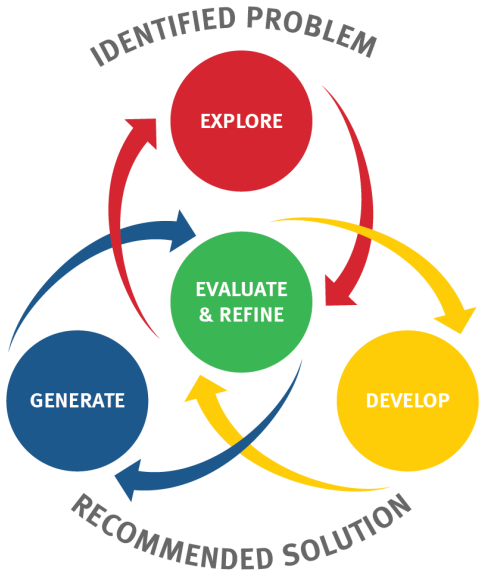
Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	90	89	88
Percentage endorsed in Application 1	54%	28%	84%

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	89	496	154	71.91%
2	89	465	0	100%
3	89	482	164	60.67%

Project — folio: Iterative nature?

The problem-solving process in Engineering



Why have a problem-solving process in Engineering?

Project — folio (IA1 and IA3)

Assessment design: Effective practices

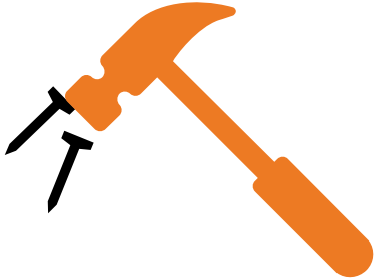
IA1

- Providing well thought out and detailed information about the real-world problem context
- The assessment was developed using local school structural problem contexts.

IA3

- Incorporating the requirement to use Unit 4 subject matter during problem-solving, including control technologies in relation to machines and mechanisms

Project — folio (IA1 and IA3)



Assessment design : Practices to strengthen

IA1 and IA3

- The purpose of the prototype within the problem-solving process, i.e. the prototype supports development of the real-world related solution
- Group work is not a syllabus condition, i.e. individual response including prototype development and testing.
- Quality assure the information included in the instrument, e.g. scaling of the prototype — size and loading.

Project — folio (IA1): Assessment decisions

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Retrieving and comprehending	85.39%	12.36%	0%	2.25%
2	Analysing	77.53%	20.22%	0%	2.25%
3	Synthesising and evaluating	75.28%	20.22%	0%	4.49%
4	Communicating	85.39%	12.36%	1.12%	1.12%

What are the most important areas to strengthen?

Subject report reference: page 12

Project — folio (IA1)

Retrieving and comprehending (4–5 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.

Excerpt 1

Strength of Balsa (prototype):

Only a compressive test data was needed to be used to determine the strength of the balsa as the truss member slenderness causes members to fail by buckling in compression at significantly lower values than tensile tests conducted previously. This is relevant, because it is reasonable also to assume that the primary forces in this tower will unavoidably be compressive. The compression test results showed that the long pieces of balsa tended to buckle and to address this issue, smaller balsa pieces would be needed to reduce the distance between the bracing points in the structure. By shortening unsupported member length (by adding braces) rapidly increases buckling resistance.

The data derived from the testing supported the statement that when the length is decreased the load the material can withstand increases. Thus, by halving the length of balsa it can be said that the members of the structure will be able to withstand higher loads.

Length	Average Compression
150 mm	2513g
125 mm	4160g
112.5mm	4525g

Project — folio (IA1)

Analysing (6–7 marks)

- astute determination of essential solution success criteria for the structural problem

Excerpt 3

Determining Success Criteria:

Success Criteria
Astute and Essential

Success Criteria	*Subtopic If Applicable*	*Description*	*Code*	*Relation to prototype or real-world structure*
Strong	-	The structure needs to strong, and able to withstand force applied from winds and environment	SC1	Mostly real - world structure
Efficient	-	The structure achieves maximum productivity with minimum wasted effort	SC2	Both
Aesthetic	-	The structure is aesthetically pleasing to its client	SC3	Mostly real - world structure
Compliance	-	The structure meets the specifications that are requested by the client	SC4	Both
Cost-effective	Material	The material used is efficient in the aspect of cost	SC5.1	Both
	Structure	The structure does not use too many components to be cost effective	SC5.2	Most - real world structure
Easy to construct	-	The structure is relatively easy to construct	SC6	Both
Sustainable	-	The structure is able to be maintained to certain level	SC7	Real - world structure

Project — folio (IA1)

Synthesising and evaluating (8–9 marks) • critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence	**Excerpt 4** Real-world tower evaluation: The real-world design will be manufactured and constructed differently to the prototype that was made for testing. Firstly, the material used will be completely different, and the production method will be changed to allow an efficient and economic product (SC2). The best material for both the tower and tank will be steel. As researched above, **'Steel is the best option for a truss tower and the tank, as it is strong, cheap, and maintainable'** (SC1, SC5.1 & SC10). The steel used for the structure will: • Be coated to resist corrosion from environment • Be protected from UV rays • Withstand the different weather that occurs in the proposed location The structure will use a simple 'K truss' design; therefore, it will be easy to construct and aesthetic (SC3 & SC6). The joints will be supported by galvanised steel gussets to structure is strong and safe (SC1 & SC9). The structure will be manufactured in a rural town close to the site, and the tower and tank will be transported by shipping or a large transportation truck. Finally, the tower and tank will be manufactured to specifications of the client (SC4).

Project — folio (IA3): Assessment decisions

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Retrieving and comprehending	80.9%	16.85%	0%	2.25%
2	Analysing	69.66%	28.09%	0%	2.25%
3	Synthesising and evaluating	62.92%	35.96%	0%	1.12%
4	Communicating	89.89%	10.11%	0%	0%

What are the most important areas to strengthen?

Subject report reference: page 25

Project — folio (IA3)

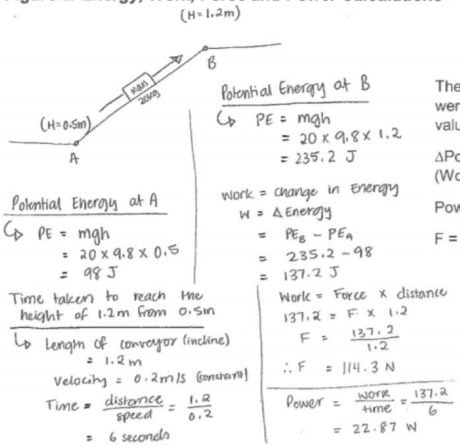
Analysing (6–7 marks)

- insightful analysis of the machine and/or mechanism problem, and relevant engineering mechanics, materials science, control technologies, technology, and research information in relation to machines and/or mechanisms, to identify the relevant elements, components and features, and their relationship to the structure of the problem

Excerpt 1

Basic Calculations & Mechanical Considerations

Figure 2: Energy, Work, Force and Power Calculations



The calculation for 10 kg bags were performed identically; the values are stated below:

ΔPotential Energy = 68.6 J (Work)

Power = 11.43 W

F = 57.17 N

As the bag travels up on the incline, the potential energy changes (figure 2) – however, kinetic energy remains the same as the velocity is consistant. The change in energy means there is 'work' that is taking place; this is occuring at the gears of the inclined conveyor. The force, 114.3 N, is representative of the gear's effort. Figure 2 also shows the power required for the gears to maintain the constant veocity of 0.2 m/s. However, this power only includes one scenario (only 20 kg bag); it does not include the scenario of when the 10 kg bag is also on the conveyor, which will increase the power required.

Project — folio (IA3)

Analysing (6–7 marks)	Excerpt 2
• astute determination of essential solution success criteria for the machine and/or mechanism problem	**Solution Success Criteria (SSC)** **First Priorities: most essential qualities that must be included for the completion of the task.** • The solution must accommodate the addition of 10 kg cement bags in the original system because the task is to increase their production rate by at least 50%. • The conveyor belt must have two separate discharging areas for 10 kg and 20 kg bags with a mechanical control system. It should also provide a 'fail area', where if in case the system fails to operate, the bags disembark in an area where they would be manual separated. This would minimise the chances of any bags being separated in a different zone (e.g., if 10 kg bags accidently are sorted in the 20 kg zone). • There must be at least one electronic logic gate system incorporated in this report – to ensure the bags from the bagging machines do not collide with each other and are only dropped on the conveyor belt when all the hazards are assessed. • The addition of a guiding box under both cement bagging machines (according to their dimensions) will be a priority. This will assist in correct placement of bags on conveyor and also ease the separation process. • The task requires the exploration and possibly the change of paper bags to plastic bags – this reduces mass, enhances sealing, and provides greater benefits (especially in outdoor storage – wet conditions). **Second Priorities: these are qualities that would enhance the solution and its performance.** • Materials used in this project (such as conveyor materials, bags, etc.) must be environmentally friendly, in terms of recyclability and increased material lifespan. • By adding a mass detecting device/scale, the quantity of the cement bags can be ensured; additionally, it could also assist in easing the operation of the mechanical control arm for separation (if the device detects the mass to be 10 kg, then the mechanical arm assigned to discharge those bags will operate – instead of relying on time). • Doubling the velocity (from 0.2 to 0.4 m/s) by altering gear ratios (as the task offers) will increase production and assist in achieving the 50% (or more) increase in output.

Project — folio (IA3)

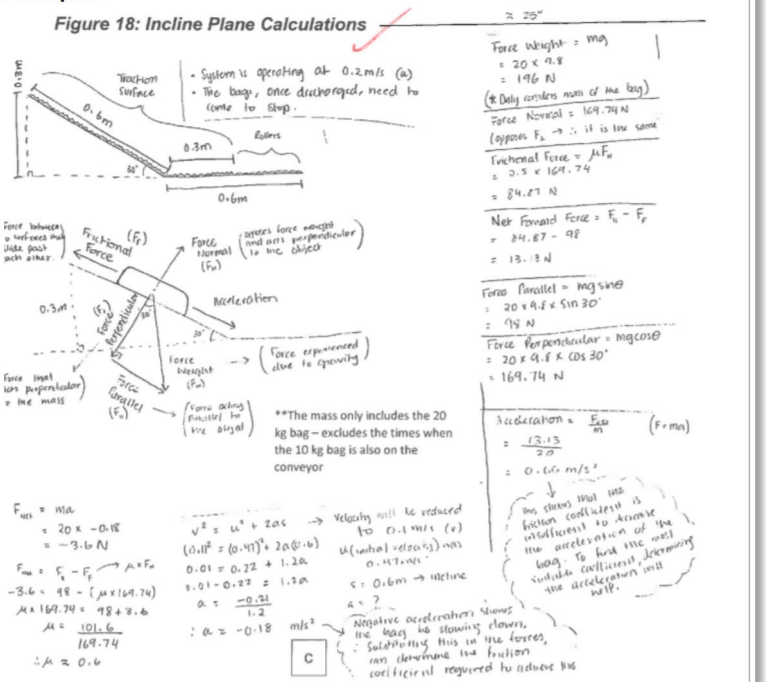
Synthesising and evaluating (8–9 marks) • critical evaluation and discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence	**Excerpt 4** **Refining Solution & Further Calculations** During the prototype simulation stage, it was seen that it takes more energy to push the bag to the separation zone when it is parallel to the ground. To ease this process, it was decided that the separation zone would be set on an incline – however, this would impact the final height set by the project. To resolve this issue the total height by the end of the conveyor would be 1.5m. The decline at the separation zone will be from 1.5 m to 1.2 m, at an angle of 30º. This will allow gravity to assist with the separation of the bag. In terms of slowing the bag's velocity (to get it to rest), the friction of that surface will be increased. The calculations and diagrams in figure 18 show the refined and enhanced solution to the task. In order to perform the calculations using the equations of motion, the velocity of the bag after contacted by the mechanism is important to determine; this is done in figure 17.

Project — folio (IA3)

Synthesising and evaluating
(8–9 marks)

- coherent and logical synthesis of relevant engineering mechanics, materials science, control technologies, technology and research information, and ideas to predict a possible machine and/or mechanism solution

Excerpt 3



Project — folio (IA1 and IA3)

Additional advice

- Response length
- Appendices
- Evidence of class-wide protype performance data
- Ensure all pages are scanned in pdf files and are in order and orientated correctly before uploading

Examination (IA2)

Assessment design: Effective practices

- Marks allocated to each question type reflected the degree of difficulty.
- Cognitions aligned with the question type and required response.

Examination (IA2)

Assessment design: Practices to strengthen

- Subject matter from Unit 1 and 2 should not be included.
- Include diagrams only when necessary.
- Diagrams are accurate.

Examination (IA2): Assessment decisions

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Engineering knowledge and problem-solving	100%	0%	0%	0%

What are the most important areas to strengthen?

Subject report reference: page 20

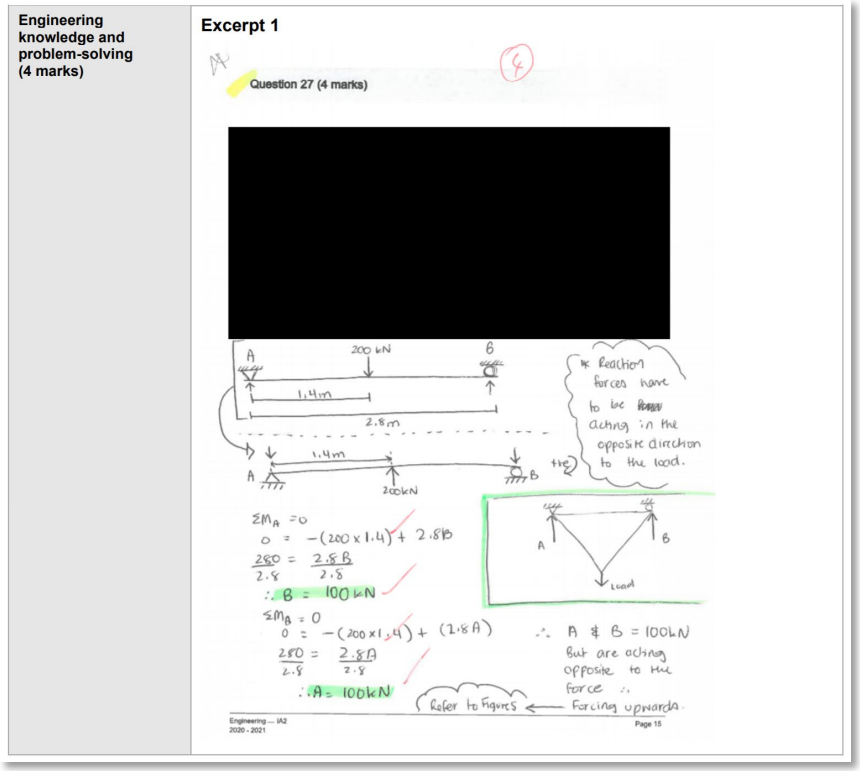
Examination (IA2)

Assessment decisions: Effective practices

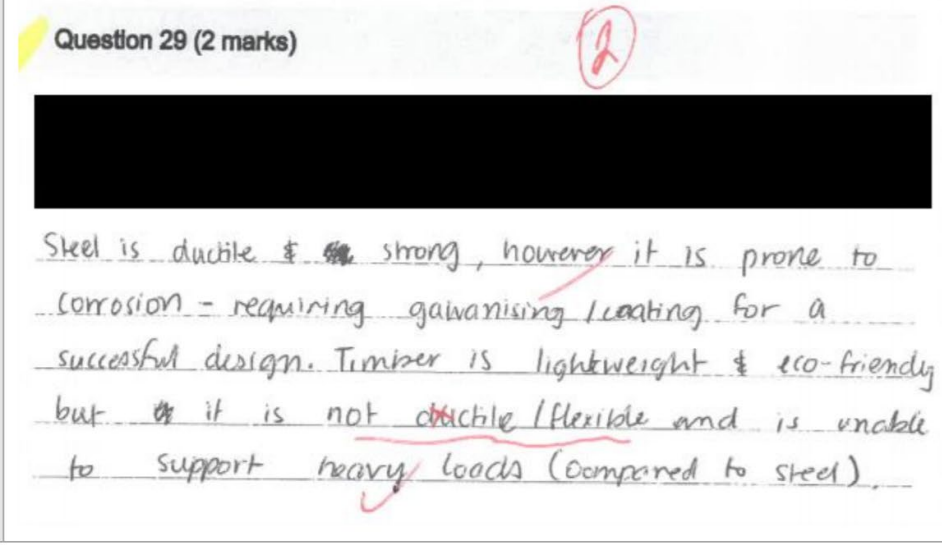
- Marking schemes were well presented and clear.
- Marking schemes were consistently applied across the cohort.

Examination (IA2)

Engineering knowledge and problem-solving (4 marks)	**Excerpt 1**



Examination (IA2)

Engineering knowledge and problem-solving (2 marks)	**Excerpt 2** 

Question 29 (2 marks) 2

[redacted]

Steel is ductile & strong, however it is prone to corrosion - requiring galvanising / coating for a successful design. Timber is lightweight & eco-friendly but it is not ductile / flexible and is unable to support heavy loads (compared to steel).

Examination (IA2)

Assessment decisions: Practices to strengthen

- Update marking schemes to reflect their use.
- Clear use of half marks
- Correct use of percentage cut-offs
- Provide information to reflect the decisions the school has made regarding the marks awarded, i.e. 53/75 = 70.7% = 17.

Additional advice

- Ensure all pages are scanned in pdf files and are in order and orientated correctly before uploading.

Questions

Consider strategies to ensure that students:

- have a clear understanding and ability to apply Unit 4 subject matter
- read the question and attempt to respond

Email questions to: engineering@qcaa.qld.edu.au

Learning goals

Learn how to use the QCAA Engineering subject report to inform teaching and assessment practice.

Success criteria

You will know you are successful if you can reflect purposefully on the information provided in the subject report to determine how you can improve your school's internal assessment in Engineering.

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