Course report 2024

Advanced Higher Engineering Science

This report provides information on candidates' performance. Teachers, lecturers and assessors may find it useful when preparing candidates for future assessment. The report is intended to be constructive and informative, and to promote better understanding. You should read the report with the published assessment documents and marking instructions.

We compiled the statistics in this report before we completed the 2024 appeals process.

Grade boundary and statistical information

Statistical information: update on courses

Number of resulted entries in 2023: 54

Number of resulted entries in 2024: 56

Statistical information: performance of candidates

Distribution of course awards including minimum mark to achieve each grade

A	Number of candidates	5	Percentage	8.9	Cumulative percentage	8.9	Minimum mark required	101
B	Number of candidates	9	Percentage	16.1	Cumulative percentage	25.0	Minimum mark required	83
C	Number of candidates	12	Percentage	21.4	Cumulative percentage	46.4	Minimum mark required	65
D	Number of candidates	13	Percentage	23.2	Cumulative percentage	69.6	Minimum mark required	47
No award	Number of candidates	17	Percentage	30.4	Cumulative percentage	100	Minimum mark required	N/A

We have not applied rounding to these statistics.

You can read the general commentary on grade boundaries in the appendix.

In this report:

- ‘most’ means greater than 70%
- ‘many’ means 50% to 69%
- ‘some’ means 25% to 49%
- ‘a few’ means less than 25%

You can find statistical reports on the Statistics and information page of our website.

Section 1: comments on the assessment

Question paper

Every mark in this year's question paper was accessible. However, Section 2 of the question paper was more demanding than expected, particularly question 9.

Project

All verified centres used the mandatory course assessment task provided on SQA's website, and therefore the assessment instrument they used was valid.

Section 2: comments on candidate performance

Areas that candidates performed well in

Question paper

Most candidates responded with the same degree of success to mechanisms and structures, engineering project management, and electronics and control questions of a comparable notional difficulty.

Question 1(a)(i)	Most candidates understood how to complete timescales on a Gantt chart, although many did not include float correctly.
Question 1(a)(ii)	Most candidates identified critical path from the Gantt chart correctly.
Question 1(b)(i)	Some candidates defined both project cost classifications correctly, while most could define one or the other. Some candidates appeared to confuse ‘on cost’ with ‘indirect cost’.
Question 1(b)(ii)	Most candidates identified examples of ‘direct cost’ and ‘on cost’ correctly.
Question 2	Most candidates calculated overall efficiencies for each system correctly and drew the correct conclusion.
Question 3(a)	Many candidates described ‘peak load’ and ‘base load’ correctly, but some used language that was too vague to be acceptable at Advanced Higher level — both terms relate to energy delivery over a time interval, such as a day.
Question 3(b)	Most candidates identified appropriate generation technology for base load.
Question 3(c)	Most candidates stated the function of step-up and step-down transformers, while some candidates were able to explain the need for high voltage to reduce transmission power loss and low voltage for consumer safety.
Question 4(a)	Many candidates understood what form the shear force diagram should take, although some arithmetic errors were evident in the calculation of the beam reactions.
Question 5	Many candidates could formulate equilibrium expressions using Kirchhoff’s current law and Ohm’s law at circuit nodes, but some of those candidates made subsequent algebraic mistakes in their solutions.
Question 6	Many candidates could manipulate unfamiliar formulae confidently in reaching a value for deflection, but few candidates were able to reach the correct order of magnitude of the value because they were unable

to convert orders of magnitude of pressure, length and Young's modulus for the parameters' units to be consistent.

Question 8(b) Many candidates derived two equilibrium equations for the x-y and x-z planes correctly and went on to calculate a magnitude for the bearing reaction correctly.

Question 8(d)(i) Many candidates calculated the correct value of the required resistor.

Question 8(d)(ii) Many candidates drew an integrator stage but failed to recognise the need for an additional unity gain inverting amplifier for the circuit to meet the specification.

Project

Candidates completed all sections of the project report.

Areas that candidates found demanding

Question paper

Candidates did not answer questions relating to programmable control and drive systems well.

Question 3(d) Most candidates calculated power loss correctly, but few calculated the transmission efficiency correctly; the input power is the sum of the stated output power and the transmission losses.

Question 4(b) Many candidates identified that bending moment is a local maximum at this point, but few linked this to maximum bending stress and possible failure, or to design the beam cross-section or material selection to provide a factor of safety, either of which provides explanation for its importance.

Question 7 Some candidates did not attempt this question, and few candidates answered the question correctly. Most candidates missed the decreasing nature of the variable 'duty' in the outer counted loop, which reduces the output voltage over time.

Question 8(a) Many candidates calculated the torque on the driven gear, but few then went on to correctly calculate the tangential and radial components of the force acting on the gear.

Question 8(b) Many candidates did not correctly calculate the components of the gear contact force in relation to the components of the point load acting at the mid-span of the roller, and most candidates did not clearly indicate the angle at which the bearing reaction force acted in relation to the shaft.

Question 8(c) Few candidates recognised that a reduction in roller diameter would lead to an increase in roller deflection at its mid-span because of a

reduction in second moment of area, and that the additional rollers prevent the deflection.

Question 8(e) Some candidates calculated component values for the D-A converter correctly, but few candidates recognised the need for an additional unity gain inverting amplifier for the circuit to operate as intended.

Question 9(a) Many candidates recognised that the bending moment at the free end of the beam is zero and some candidates were able to write bending moment equations for the other two required locations correctly. However, few candidates calculated the uniformly distributed load and beam reactions correctly.

Question 9(b) A few candidates approached this question correctly by determining the safe working stress and calculating the required ratio of beam depth to second moment of area, but most candidates gained no marks for this question.

Question 9(c) Many candidates either discussed general issues of sustainability rather than the specific area for consideration in the wording of the question, or did not attempt an answer.

Question 9(d) Some candidates did not attempt this question, and few candidates answered it correctly.

Question 9(e) Most candidates either did not attempt this question or did not answer it correctly.

Question 9(f) Few candidates noted that the function is to limit the variable to a range of values with an upper and lower limit, but some candidates discussed one limit or the other, and some made a link between a specified potentiometer angle and the related variable value.

Question 9(g) Most candidates either did not attempt this question or did not answer it correctly.

Project

Specific points are provided below, but attention should be drawn to the candidates' level of response. There were instances where the engineering was not at Advanced Higher level, and where mathematics was not at the equivalent of Higher level.

Outline

Candidates must ensure, contained within their project aims, that the methodology states in detail how they are going to undertake the project.

Candidates' outline specification must contain notes on key resources required, scheduling and/or timings, milestones and contacts.

Research, analysis and specification

Candidates must ensure that the specification shows a list of measurable criteria for each sub-system. There may be more than one iteration of a specification as candidates find more information through research and mathematical modelling. Candidates' research strategies should include the information required, and a stated strategy for each piece of required information to gain full marks.

Production and maintenance of a detailed project plan

Most candidates did not produce a project plan sufficient for Advance Higher level. Candidates must include a list of actions, critical path analysis, and Gantt charts (or another time-management tool). They must detail intermediate and final targets, detailing refinement of the plan as the project progresses.

Mathematical modelling and analysis

Mathematical modelling does not just refer to mathematical calculations: it could also reflect techniques such as circuit simulation. However, it must reflect learning in the course or beyond. Any mathematical calculations must be of a level at least of the demand of SCQF level 6 Mathematics. Page 29 of the project document provided a possible list of activities. The results of the modelling must be relevant and applied to the problem. Any calculations should be appropriately annotated to ensure that the process makes sense to the reader. A detailed description of how simulated sub-systems could be integrated should be included.

Constructing and/or simulating a solution

Projects must include content from the areas of study for both 'electronics and control' and 'mechanisms and structures'. Marks are allocated by sub-system; therefore, if two electronic sub-systems have been constructed and these are totally separate, then marks can only be allocated to one of these.

To gain full marks, candidates must list resources in a detailed way, so that it is clear the exact component required: its type (where relevant), value, and where it could be sourced. Candidates must ensure that the criteria for annotations is met, as well as the criteria for the simulation/construction.

Evaluation

Candidates must evaluate their project to reflect the level of Advanced Higher. Most candidates did not give information to further develop their topic.

Presentation

Candidates' reports should be well presented, in a logical order and should read well. It should make sense to the reader. Diagrams and other figures should be appropriately titled and referred to in the text. The record of progress should be very detailed and reflect the level of Advanced Higher.

Section 3: preparing candidates for future assessment

Teachers and lecturers should be familiar with the recommended entry information for this course as outlined in the Advanced Higher Engineering Science Course Specification.

The Higher Engineering Science course provides the foundation for candidates to progress to Advanced Higher level. This course requires candidates to be familiar with a range of mathematics skills, such as introductory calculus (integration and differentiation in familiar contexts).

More information and supporting documentation on the full course assessment is available on the Advanced Higher Engineering Science subject page. This includes the course specification, past papers, specimen question papers, and previous years' course reports.

Question paper

Candidates should not round their working in calculations until they reach a final value. They should then round to the fewest number of significant figures present in quoted data values in the question, as outlined in the general instructions on the question paper.

The numerical value should be accompanied by the correct units for the quantity calculated and preferably expressed in engineering notation.

In relation to the second point, engineering notation will conflict with candidates' experience of standard (or scientific) notation. However, the 'ENG' button present on most calculators will give any final answer with a power of ten that can be replaced by the appropriate decimal prefix.

When substituting values in formulae, candidates must be able to adjust the orders of magnitude of variables so that their units are consistent with one another. Question 6 from this year's question paper is a good example to consider.

Over several years, candidate responses to questions related to spur gear drives have suggested poor understanding of gear pressure angle and the interrelationship between contact force at the gear mesh, the tangential and radial components of the contact force and the torque that the tangential component produces.

When using formulae in any element of the course, candidates should be encouraged to consider the way in which variations of the parameters in the formula are likely to affect the value of the subject of a formula qualitatively, as well as performing calculations using the formulae. Question 9(c) from this year's paper can be answered considering standard deflection formulae — a reduction in diameter leads to a reduction in the second moment of area, so an increase in deflection, which the larger rollers counteract.

To achieve all available marks, candidates must devote significant time to their own reading to move their subject knowledge beyond Higher-level content and depth of understanding, particularly in relation to the course themes at Advanced Higher level. This is necessary for

the research stage of the project course component, and it will increase candidates' capacity to respond to questions in the question paper that require either explanation or discussion.

Project

Teachers and lecturers should ensure that candidates are not given excessive guidance and, where guidance is given, it must be recorded and reflected in the marks awarded. Teachers and lecturers must ensure that the project is carried out under open-book conditions, but supervised to ensure that the work presented is the candidate's own.

Teachers and lecturers should ensure that work produced by candidates is at an appropriate level for Advanced Higher to allow candidates to access all marks for any given section of the project.

The open nature of the project allows for personalisation and choice; however, teachers and lecturers must take care to ensure that a topic or situation allows candidate responses to be appropriate for Advanced Higher level. In addition, candidates must ensure that it will be possible to access enough appropriate information to carry out sufficient research on their chose topic.

Assessment of the project takes place throughout its delivery, and not just at the end point. This could be supported by reference to regular candidate check-ins, and regular recording of assessment judgements.

Teachers and lecturers should use published materials available on the Understanding Standards website. This resource provides candidate evidence from past question papers with supporting commentary, presentations, and webinar recordings, and newly published materials this year, relating to the project component.

Appendix: general commentary on grade boundaries

SQA's main aim when setting grade boundaries is to be fair to candidates across all subjects and levels and maintain comparable standards across the years, even as arrangements evolve and change.

For most National Courses, SQA aims to set examinations and other external assessments and create marking instructions that allow:

- a competent candidate to score a minimum of 50% of the available marks (the notional grade C boundary)
- a well-prepared, very competent candidate to score at least 70% of the available marks (the notional grade A boundary)

It is very challenging to get the standard on target every year, in every subject, at every level. Therefore, SQA holds a grade boundary meeting for each course to bring together all the information available (statistical and qualitative) and to make final decisions on grade boundaries based on this information. Members of SQA's Executive Management Team normally chair these meetings.

Principal assessors utilise their subject expertise to evaluate the performance of the assessment and propose suitable grade boundaries based on the full range of evidence. SQA can adjust the grade boundaries as a result of the discussion at these meetings. This allows the pass rate to be unaffected in circumstances where there is evidence that the question paper or other assessment has been more, or less, difficult than usual.

- The grade boundaries can be adjusted downwards if there is evidence that the question paper or other assessment has been more difficult than usual.
- The grade boundaries can be adjusted upwards if there is evidence that the question paper or other assessment has been less difficult than usual.
- Where levels of difficulty are comparable to previous years, similar grade boundaries are maintained.

Every year, we evaluate the performance of our assessments in a fair way, while ensuring standards are maintained so that our qualifications remain credible. To do this, we measure evidence of candidates' knowledge and skills against the national standard.

During the pandemic, we modified National Qualifications course assessments, for example we removed elements of coursework. We kept these modifications in place until the 2022–23 session. The education community agreed that retaining the modifications for longer than this could have a detrimental impact on learning and progression to the next stage of education, employment or training. After discussions with candidates, teachers, lecturers, parents, carers and others, we returned to full course assessment for the 2023–24 session.

SQA's approach to awarding was announced in March 2024 and explained that any impact on candidates completing coursework for the first time, as part of their SQA assessments, would be considered in our grading decisions and incorporated into our well-established

grading processes. This provides fairness and safeguards for candidates and helps to provide assurances across the wider education community as we return to established awarding.

Our approach to awarding is broadly aligned to other nations of the UK that have returned to normal grading arrangements.

For full details of the approach, please refer to the National Qualifications 2024 Awarding — Methodology Report.