Course Report 2018

Subject	Engineering Science
Level	Advanced Higher

This report provides information on the performance of candidates. 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. It would be helpful to read this report in conjunction with the published assessment documents and marking instructions.

The statistics used in this report have been compiled before the completion of any Post Results Services.

Section 1: comments on the assessment

Summary of the course assessment

Component 1: project

All verified centres used the project provided on the secure area of SQA's website — meaning that the instruments of assessment used were valid. The open nature of the project allows for personalisation and choice, however, care must be taken to ensure that a topic/situation appropriate to Advanced Higher level is selected. In addition, candidates must ensure that it will be possible to access enough appropriate information in order to carry out sufficient research.

Of the centres verified, the majority were assessing correctly to the national standard.

Centres should ensure candidates are not given excessive guidance and, where guidance is given, it must be reflected in the marks awarded.

Centres are reminded that the assignment is carried out under open book conditions, but supervised to ensure that the work presented is the candidate's own. This means that, for example, project work cannot be carried out at home.

Component 2: question paper

The question paper consists of two sections totalling 60 marks. The first section consists of a number of questions worth 4-7 marks, each requiring specific knowledge and understanding. The second section of the paper consists of two extended questions; both require integration of knowledge and understanding.

A significant number of candidates were not adequately prepared for this question paper, but the question paper performed in line with expectations for the more able candidates. As a whole, candidates found the level of demand testing in terms of content and particularly in terms of time management. A significant proportion of candidates responded well to section A, but relatively poorly to section B. The final extended question, question 8, was poorly attempted and a number of candidates appeared to be short of time by this stage of the question paper — the grade boundary at all levels was affected to redress this.

Section 2: comments on candidate performance

Areas in which candidates performed well

Component 1: project

Candidates performed particularly well in the construction/simulation areas of the project. Flowcharts and mechanical system designs were also relatively well done.

Component 2: question paper

Question 1 A large proportion of candidates answered this question correctly and were able to complete the network diagram from the precedence table, candidates were familiar with the terms ‘float’ and ‘critical path’. Note that, in the second part of the question, specific reference to the critical path identified in the first part of the question would be required for full marks.

Question 2 A large proportion of candidates answered both parts of the question at least partially, but should note that tolerance applies to both component values that appear in the formula for the oscillator’s frequency in the data book, and that the second part of the question is a test of knowledge relating to the oscillator’s operation. Candidates from relatively few centres recognised that the other two resistors have to have a particular ratio (2:1) to produce a gain of 3 in order for an oscillation to be stable. If the ratio is higher, the oscillation grows in amplitude until it saturates: conversely, if the ratio is lower, the oscillation reduces in amplitude until it disappears. This is an idealised circuit, but candidates are expected to recognise that this resistor network is significant to the way that the oscillator behaves.

Question 3 This question was attempted successfully by the majority of candidates, with some doing more work than necessary in supplying a direction for the required reaction force, as well as the magnitude required. Although a straightforward example, this form of analysis of 3D forces appears to be well understood.

Question 5(b) Knowledge of terms used to describe the operation of the National Grid was good and most candidates made use of the information supplied to explain the role that pump storage plays.

Question 6(a) and (b) Although a fairly standard example, the first two parts of this question were very well answered. Shear force diagrams and the determination of maximum magnitude of bending moment appear to be well understood.

Question 7(a) and (b) Second moment of area and elastic beam deflection calculations appear to be well understood.

Areas which candidates found demanding

Component 1: project

Please note that the project is structured section-by-section for assessment purposes only. Candidates may structure their report in any way they choose — marks can be awarded for each section from any part of the report. However, to aid assessment, it may prove helpful to treat sections 1 & 2 (Research & Analysis and Producing a Specification) as one entity and sections 4 & 5 (Mathematical Modelling and Constructing/Simulation) as another.

Aspects of the assignment where candidates found additional demand were:

Sections 1 & 2
Candidates should analyse the problem, detailing top level systems diagram, subsequent sub-systems diagrams, inputs, outputs etc.

Although no marks are allocated to these, candidates should be familiar with this from previous Engineering Science courses. This will allow candidates to identify individual sub-systems, inputs & outputs and areas requiring to be researched.

Once the research factors have been identified, candidates should plan how they are actually going to conduct their research (internet, library, site visits, telephone interviews, questionnaires etc.) A detailed plan of exactly what information they are looking for should be provided — for every factor. Candidates should then carry out the research, providing evidence of this, *referenced* quotations from websites or books, completed questionnaires, collated results etc. Results of the overall research should be provided, drawing meaningful conclusions, relevant to their chosen assignment task. Candidates should then provide a ***detailed*** specification drawn from their relevant research.

Section 3
This section should plan the progress of the project and should be regularly reviewed to ensure that individual milestones are being met. A detailed list of required resources (and how they are going to be sourced) should be included, a Critical Path Analysis to identify the order in which the work will require to be carried out and a Gantt Chart, or similar, detailing timescales, individual milestones etc. The project plan should include evidence of the continual review (annotations, highlights etc) along with any subsequent adaptation as a result of the reviews.

Sections 4 & 5
Please note that Mathematical Modelling does not just refer to mathematical calculations: it could also reflect techniques such as circuit simulation etc. However, it must reflect learning in the course or beyond. Any mathematical calculations must be of a level at least of the demand of Higher (SCQF 6) Mathematics. Page 31 of the project document provides 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.

Section 6
Although no marks are awarded for testing the solution, it would be extremely difficult to compile a detailed evaluation without it. The evaluation should be clear and detailed. It should be of a minimum literacy level of Higher (SCQF 6) English. The evaluation should reflect on the solution when compared to the specification (sub-system by sub-system) and should also evaluate progress through the assignment by reflecting on the project plan and record of progress.

Section 7
The report 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.

Component 2: question paper

Question 4 The operation of a bipolar transistor as an amplifier, when it is not saturated, has not been examined since the course revision. The question was set in a series of stages to guide the candidates through the calculations required to determine component values. A high proportion of candidates attempted part (a), but fewer completed parts (b) and (c).

In part (b), the majority of candidates could determine the base current but few understood that the voltage at the base would be 0.6 V above the emitter voltage, $V_b = V_e + V_{be}$, both values being given explicitly in the question.

In part (c) very few candidates interpreted the base connection as a node. Current through the resistor R_1 would be the sum of the currents through resistor R_2 and the base current for the transistor which, in the question, is defined as 10% of the current through R_2

Question 5(a) A significant number of candidates did not attempt this question. Although in an unfamiliar context, this is an energy audit question: overall efficiency of a system can be determined as a product of the individual efficiencies of sub-systems.

Question 6(c) A significant number of candidates responded to this question in terms of it being the 'weakest' point of the beam. Strength is a defined, quantifiable material property (UTS, UCS) whereas weakness is not and so is open to interpretation. If the beam has a constant cross-section, it will be able to withstand the same magnitude of bending moment (and hence bending stress) before failure at any point along its length, so there is not a 'weakest' point along the length of the beam. 'Weakness' would refer to an ability to resist bending, which is related to material and cross-section, not applied bending moment.

Question 7(a) A high proportion of candidates did not know how to calculate the maximum bending moment for the cantilever.

Question 7(d) Very few candidates attempted this question, apparently finding the layout or context of this question more challenging to interpret than was intended. However, analogue-to-digital conversion is course content and the A-D converter circuit is given in the data booklet. The analogue op-amp circuit in the lower part of the circuit diagram combines elements taught at Higher.

Question 7(e) This question did not test candidates as intended, primarily because of the difficulties many appeared to face with Question 7(d).

Question 8(a) Many attempts at this question suggested a lack of familiarity with tangential and radial components of spur gear transmission forces. The tangential component, F_t, is the force that produces a torque. The radial component, F_r, acts to separate the gears. $F_t = F \cos\theta$, $F_r = F \sin\theta$, where F is the magnitude of the force acting at the point of contact of the meshed gear teeth and θ is the pressure angle.

Question 8(b) Attempts suggested a lack of familiarity with the calculation of torque produced about a point when given force and distance are not perpendicular, which is a progression from the calculation of torque at Higher.

Question 8(c) The question tested understanding of the use of the 555 ic to produce a shaped waveform.

Section 3: advice for the preparation of future candidates

Component 1: project

A variety of solutions would be expected within a cohort, with a range of presentation styles and structures. Pre-built models, either to use in the assessment or to exemplify possible solutions are not permitted. Templates for candidates to use are also not permitted. Assessors should share the marking guidelines with candidates and candidates should then structure ***their*** solution in any way they see fit. Marks can be awarded regardless of where the response is found within the candidates' work.

Component 2: question paper

Working in calculations should not be rounded until a final value is reached, and candidates must follow the guidance given on the use of significant figures (as printed on the front of the question paper) when writing their final answer.

In the context of a question, in order to gain full marks, calculated values must include correct units and engineering notation for the numerical value quoted.

As stated last year, to expect to do well in the Advanced Higher question paper, candidates must be prepared to devote significant time to their own reading in the subject in order to move their own subject knowledge beyond that of Higher, particularly in relation to course themes.

Generally, candidates' responses to questions related to Mechanisms & Structures and in particular shear force, bending moment, 3D forces, second moment of area and deflection have improved and saw more confident responses than questions related to Electronics and Control. However, specific points made about responses to Question 6(c) and Question 8(a), (b) in the previous section of this report should be noted.

Electronics and Control questions will extend Higher course content as well as introducing some new content, an example being the extension of the use of Ohm's Law in circuits to combine with Kirchhoff's Current Law in nodal analysis.

Knowledge of MOSFET transistors used as amplifiers in similar circuit arrangements to the bipolar transistor amplifier of Question 4 is also course content.

Teaching of 555 timer-based circuits should cover both astable and monostable operations.

Grade boundary and statistical information:

Statistical information: update on courses

Number of resulted entries in 2017	79

Number of resulted entries in 2018	59

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

Distribution of course awards	Percentage	Cumulative %	Number of candidates	Lowest mark
Maximum mark				
A	13.6%	13.6%	8	105
B	23.7%	37.3%	14	90
C	30.5%	67.8%	18	75
D	11.9%	79.7%	7	67
No award	20.3%	-	12	-

General commentary on grade boundaries

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

SQA aims to set examinations and create marking instructions which allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional 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 every year for each subject at each level to bring together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.

- The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.
- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.
- Where standards are comparable to previous years, similar grade boundaries are maintained.

Grade boundaries from exam papers in the same subject at the same level tend to be marginally different year to year. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set by centres. If SQA alters a boundary, this does not mean that centres should necessarily alter their boundary in the corresponding practice exam paper.