Course Report 2016

Subject	Engineering Science
Level	Advanced Higher

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

This report provides information on the performance of candidates which it is hoped will be useful to teachers, lecturers and assessors in their preparation of candidates for future assessment. It 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.

Section 1: Comments on the Assessment

Component 1: project

No verification took place for this component.

Component 2: question paper

The question paper consists of two sections totalling 60 marks and was structured in the same way as the specimen question paper (SQP), incorporating a mixture of short response and extended response questions. The second section of the paper consists of two extended questions; both require integration of unit knowledge and understanding.

The question paper performed in line with expectations, and feedback from practitioners suggested that the question paper was fair in terms of course coverage, balance of marks and overall level of demand.

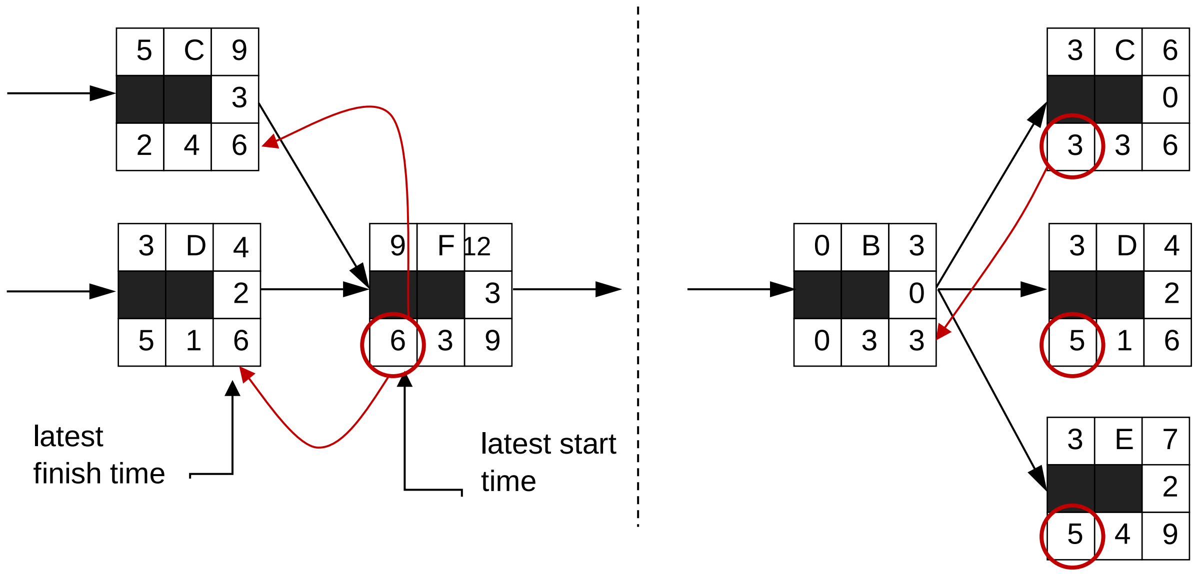
Section 2: Comments on candidate performance

Areas in which candidates performed well

Component 2: question paper

In question 1, most candidates demonstrated an understanding of a network diagram, related terminology and its use in project management.

Question 1 (a) Candidates understood the concepts of ‘float’ and ‘critical path’ in relation to network diagrams. ‘Latest start time’ and ‘latest finish time’ are found by working back from the finish to the start of the network diagram, having worked forward from the start to the finish in order to find ‘earliest start time’ and ‘earliest finish time’ for each node.



If the ‘latest finish time’ depends on the latest start time of two or more nodes, then the lowest value ‘latest start time’ should be taken as the value of ‘latest finish time’

Question 1 (b) Generally well answered, but some responses were either not sufficiently detailed or not sufficiently specific to the project stages in the network diagram to merit full marks.

In **question 2**, most candidates demonstrated some understanding of the concepts of Second Moment of Area and deflection in relation to Elastic Beam Bending Theory.

Question 2 (a) Most candidates selected the correct formula for second moment of area for the square outline geometry, ie rectangular, with b=d, but a number did not then go on to reach a complete solution using subtraction of forms.

In **question 3**, most candidates demonstrated an understanding of the functions of key components within a high-voltage electricity transmission system.

Question 3 (a) Generally well answered, but at Advanced Higher it is not sufficient to merely give the function of the transformer generally. Within the system that the diagram represents, the transformer is a step-up transformer and must be described as such.

Question 4 This was answered well by some candidates, but many did not demonstrate understanding of the two key analytical steps to use in nodal analysis of circuits, namely the application of Kirchhoff's Current Law at the node and, subsequently, the application of Ohm's Law at each resistive element controlling a current to the node. Nodes will arise in resistor networks around transistors and op-amps, as well as in purely resistive networks, as in this question. The approach extends to non-resistive components (eg capacitors, inductors) having other Laws to link current and voltage levels, but will not do so in the assessment of this course

Question 5 Most candidates demonstrated an ability to analyse the equilibrium of non-concurrent forces by considering the action of their components in two perpendicular planes.

Question 6 Calculation of vertical and horizontal force components was largely correct, but a significant number of candidates muddled the numerical values of the horizontal and vertical components.

Clear free-body diagrams tended to assist the development of correct moment equilibrium equations. It is not enough to state the numerical value of the reaction angle; somewhere, the sense of the angle must be clear in relation to the geometry of the system.

A number of solutions that did supply a sense of the angle of action showed the force exerted on the bearing by the shaft, rather than the reaction at the bearing (equal in magnitude, but opposite in direction).

Question 8 (a) Generally well answered, but a number of errors calculating the two reactions, mostly to do with the positioning of the centre of gravity of the beam in relation to the two reactions. Some incorrect representation of the distributed load (slope of -10 kNm^{-1}).

Question 8 (b) Knowledge of the equivalence of shear force and rate of change of bending moment was limited. Candidates should recognise that the condition for min/max bending moment is that the shear force is zero. Candidates should be able to derive an equation for shear force and an equation for bending moment at any point along the length of the beam.

Question 8 (c) Candidates should recognise that the bending moment at free ends of beams is always zero.

Question 8 (d) The problem caused was not readily identified in terms of the context of the question. Otherwise this was relatively well answered; most recognised that the correction was necessary because of the possibility of negative results from the original sample software, in which case a misalignment would not be corrected.

Question 8 (e) Most candidates recognised that one piston stopped while the other kept moving. A number thought one moved down while the other moved up, which is incorrect and suggested candidates might be trying to think about the problem rather than interpreting what the sample software would force the system to do. A number did not mention the tolerance in height variation permitted between the two cylinders; they do not have to remain at exactly the same height at all times. This point was required for full marks.

Areas which candidates found demanding

Component 2: question paper

Question 1 (a) Few candidates were able to determine the ‘latest finish time’ for a node in a network diagram when two or more subsequent nodes depended on the node and had different values of ‘latest start time’.

Question 3 (b) Few candidates were able to calculate the power loss in a transmission line of known resistance which delivers a known amount of power at a known voltage to a consumer.

A proportion of candidates took an incorrect approach: 230V cannot be used to calculate power dissipated along the transmission line; it is the supply voltage level at the property relative to ground, not a voltage drop. The current supplied to the property may be calculated from the ratio of the power supplied and the supply voltage. The power loss along the line may then be calculated using the current and the resistance of the line.

Question 4 Few candidates were able to apply the concepts associated with Kirchhoff’s Current Law and Ohm’s Law to two distinct nodes (points) in a resistive circuit in order to formulate two equations for two unknown values (voltages in this case).

Question 5 (a) Few candidates were able to interpret and synthesise given diagrammatic, graphical and formulaic information in order to calculate a required value.

Many candidates did not determine the correct value for Duty from the graphical data and definition given. Duty was defined in the question in terms of ‘mark’ and ‘period’. The meaning of these terms, along with ‘space’, should be clear to candidates from work with PWM (pulse width modulation) at Higher level, as well as study of the 555 timer at Advanced Higher level. Determining power dissipation in the MOSFET used as a switch was approached correctly by the majority of candidates.

Question 5 (b) Few candidates were able to identify the possibility of short-circuit when considering a circuit diagram and the damage that this might cause within the circuit if it occurred.

The transistors would offer a very low-resistance path between the supply rails (‘short-circuit’) if they were switched on together. This will not damage the motor, but it will not be driven and the transistors are likely to overheat because of the large current. Practical circuit construction from National 5 level onwards should alert candidates to this type of practical hazard.

Question 7 (a)(i) Few candidates were able to develop an equation for voltage as a function of time from a graph — an equation found in National 5 Mathematics.

Question 7 (a)(iv) Few candidates were able to determine the input voltage as a function of time to an op-amp integrator when the output voltage is given as a function of time.

Question 7 (a)(i) A significant number of candidates tried to write down an expression in terms of an integral of VA. The question specifies use of the graph.

Question 7 (a)(iii) A number of candidates wrote a negative expression for part (ii), but then sketched a positively increasing voltage. A significant number of candidates drew linear graphs rather than parabolas, even though the graph for the input to the integrator was given. Few candidates indicated the saturation voltage (a flat line) at 13.5V. Very few candidates attempted to calculate the time at which saturation would occur.

Question 7 (a)(iv) Many candidates recognised that the input voltage must be a constant value, but did not account for the RC value of the integrator correctly.

If Vout = -(1/RC)∫Vindt, then Vin=-RC(dVout/dt)

Question 7 (c) The majority of candidates recognised some of the following points, but few recognised them all. Calculation of torque requires rotational speed to be calculated in revs s^{-1}: the rotational speed required is that of the gear which drives the drum. The belt tension acts at the radius of the drum and is tangential at points of contact; the belt angle is irrelevant when calculating torque. The net tangential force produced by the belt on the drum is the difference between the tensions in the tight and slack side of the belt.

Question 8(b) Few candidates were able to determine position and magnitude of a maximum bending moment acting on a beam subjected to UDL and point loads.

Section 3: Advice for the preparation of future candidates

Component 1: question paper

Working in calculations should not be rounded until a final value is reached, and candidates should follow the guidance on the use of significant figures (as given 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.

Grade Boundary and Statistical information:

Statistical information: update on Courses

Number of resulted entries in 2015	0

Number of resulted entries in 2016	75

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark -				
A	25.3%	25.3%	19	105
B	30.7%	56.0%	23	90
C	21.3%	77.3%	16	75
D	9.3%	86.7%	7	67
No award	13.3%	-	10	0

Decision Making Record Statement:

The course assessment performed as intended and so grade boundaries were set as intended.

General commentary on grade boundaries

- While SQA aims to set examinations and create marking instructions which will 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.

- Each year, SQA therefore holds a grade boundary meeting for each subject at each level where it brings 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.

- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in, say, Higher Chemistry, this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related, as they do not contain identical questions.

- 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.