Commentary on candidate evidence

The candidate evidence has achieved the following marks for each question of this course assessment component.

Candidate 1

Section 1

Question 1

1 (a) (i) The candidate was awarded the full **1 mark** available because their final answer was correct.

1 (a) (ii) The candidate was awarded the full **1 mark** available because their final answer was correct.

1 (b) (i) The candidate was awarded the full **1 mark** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

1 (b) (ii) The candidate was awarded **0 marks** as they incorrectly stated the property.

Question 2

2 (a) The candidate was awarded the full **2 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

2 (b) The candidate was awarded **0 marks** as they incorrectly described how the gain of the op-amp should be decreased. The candidate described how the feedback resistor should be increased, the description should have said decreased as per the marking instructions.

2 (c) The candidate was awarded the **1 mark** as they stated the correct op-amp configuration (inverting).

Question 3

The candidate was awarded the full **3 marks** available because their final answer was correct (the vertical reaction at A), with the correct units and to an acceptable number of significant figures.

Question 4

4 (a) The candidate was awarded the full **2 marks** as they completed the graph correctly, showing a correct ratio to enable the motor to rotate at half speed and showed all the pulses at the same height.

4 (b) The candidate was awarded the full **1 mark** as they correctly described a reason how the speed of the motor could be decreased using pulse-width modulation.

4 (c) The candidate was awarded **0 marks** as they did not describe the advantage that the torque would remain the same at all speeds.

Question 5
The candidate was awarded **1 mark** because they correctly described that a structural engineer would have to have the knowledge of what materials would ensure an appropriate factor of safety.

Question 6
The candidate was awarded **3 marks** because they clearly drew the NAND equivalent for the Boolean equation provided and their connections.

Section 2

Question 7
7 (a) The candidate was awarded **1 mark** for their final answer for energy out but lost a mark for energy in as they provided the incorrect units for the final answer.

7 (b) The candidate was awarded **1 mark**. The final answer is not correct (the final stage of the calculation has not been done) and the follow through error rule was applied to the answer for P_{in}.

7 (c) The candidate was awarded the full **4 marks** available because their final answer was correct to an acceptable number of significant figures. No units are required for factor of safety.

7 (d) The candidate was awarded **0 marks** because they did not provide a correct economic or environmental description to the standard required at Higher.

7 (e) The candidate was awarded the full **2 marks** because their description of the advantage that the system has over a chemical battery system was acceptable to the standard required at Higher.

Question 8
8 (a) The candidate was awarded **7 marks** but lost 1 mark for an incorrect feedback loop from their 'pin1=1' box. 1 mark was awarded for each of the following points:

- X>128
- X<128
- checking of X
- changes to mark and space when X>128
- changes to mark and space when X<128
- brake on and off, for each condition of X
- two pauses/ delays.

All statements were in their correct boxes.

8 (b) The candidate was awarded the full **3 marks** available for providing a fully correct and complete flow chart for the Boolean equation provided.

8 (c) (i) The candidate was awarded the full **4 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

8 (c) (ii) The candidate was awarded **0 marks** because they did not describe an acceptable answer such as 'to increase the variable resistor value' or 'decrease the value of the 1.5 kΩ fixed resistor'.

Question 9

9 (a) The candidate was awarded the full **2 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

9 (b) (i) The candidate was awarded **1 mark** for their final answer being correct by applying the follow through error rule to their calculations. However, the candidate lost a mark for using 6 V instead of 9 V to find V_{outmax} and made a second error by adding 0.7 V to their 4.5 V instead of subtracting 0.7 V.

9 (b) (ii) The candidate was awarded the full **2 marks** available because their final answer was correct for using their answer to **9 (b) (i)**, with the correct units and to an acceptable number of significant figures.

9 (c) The candidate was awarded **2 marks** because they only described that $V_A > V_B$ in the 'Op-Amp and transistor' section and that the motor changes direction in the 'Relay and motor' section.

9 (d) (i) The candidate was awarded **0 marks** as they did not correctly show the output of a two-state control system. The candidate did not show the trace rising towards the desired output or show the correct hunting effect when reaching the desired output.

9 (d) (ii) The candidate was awarded **0 marks** because they did not describe how the motor would constantly be in motion and this would increase wear on the moving parts. The key words in the question were 'mechanical output' which meant the motor.

9 (e) (i) The candidate was awarded **0 marks** as their answer was unclear.

9 (e) (ii) The candidate was awarded **0 marks** because there was no response to this question.

Question 10

10 (a) The candidate was awarded **0 marks** for an incorrect Boolean equation.

10 (b) The candidate was awarded **2 marks** for drawing the correct NOT gate and the correct AND gate from inputs A and B.

10 (c) (i) The candidate was awarded **3 marks** for describing each of the following points in relation to the operation of the pneumatic circuit:

- If valve B or valve C is actuated a signal is sent to change the state of valve F.
- after a delay, cylinder 2 will outstroke
- when valve H is actuated a pilot signal will be sent to valve G and valve F causing both cylinder 1 and cylinder 2 to instroke.

10 (c) (ii) The candidate was awarded **0 marks** as they did not describe why a microcontroller-based system is preferred to a fully pneumatic system to the standard required at Higher.

10 (d) (i) The candidate was awarded the full **1 mark** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

10 (d) (ii) The candidate was awarded **0 marks** as they did not provide the correct calculated answer. The candidate used '6 ÷ 0.7' instead of '6 ÷ (3 + 0.7)'.

Question 11

11 (a) The candidate was awarded **3 marks** for the correct values of Young's modulus and stress, and their final answer for load as the follow through error rule was applied.

11 (b) The candidate was awarded the full **5 marks** available because their final answer for power was correct, with the correct units and to an acceptable number of significant figures.

11 (c) The candidate was awarded the full **6 marks** available because their final answer for the magnitude and angle of force F was correct, with the correct units and to an acceptable number of significant figures.

Question 12

The candidate was awarded **7 marks** because they calculated the magnitude for members AB, AC, BD, and CD correctly with the correct units and to an acceptable number of significant figures. Also, the candidate was able, through their calculations, to state the correct nature of members BC,BD and CD.

Candidate 2

Section 1

Question 1

1 (a) (i) The candidate was awarded **0 marks** because the final answer was incorrect.

1 (a) (ii) The candidate was awarded **0 marks** as there was no response to this question.

1 (b) (i) The candidate was awarded the full **1 mark** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

1 (b) (ii) The candidate was awarded **0 marks** as they did not state 'tensile' in their answer.

Question 2

2 (a) The candidate was awarded **0 marks** as they did not calculate $V_{in} = 1$ V and used $V_{in} = 5$ V which provided an incorrect answer for V_{out}.

2 (b) The candidate was awarded **0 marks** as they did not specify R_f or R_i in their description.

2 (c) The candidate was awarded the **1 mark** as they stated the correct op-amp configuration (inverting).

Question 3

The candidate was awarded the **1 mark** for calculating the correct uniformly distributed load , however, as the candidate did not substitute values correctly, the follow through error rule could not be applied.

Question 4

4 (a) The candidate was awarded **1 mark** for showing the voltage of each pulse being the same but did not gain the second mark as the mark times for each pulse were different.

4 (b) The candidate was awarded **0 marks** as their answer was incorrect.

4 (c) The candidate was awarded **0 marks** as they did not describe the advantage that the torque would remain the same at all speeds.

Question 5

The candidate was awarded **0 marks** because both examples provided did not specify knowledge. The candidate wrote in Example 1 'calculating the forces acting on the materials' and, Example 2 'analyse the properties of the materials', both these answers are skills of a structural engineer.

Question 6

The candidate was awarded **2 marks** because they correctly drew the correct NAND gate from inputs A and B, as well as drawing the correct NAND gates for an OR gate from inputs C and D.

Section 2

Question 7

7 (a) The candidate was awarded **1 mark** for calculating the correct value for E_{out} but was incorrect when calculating E_{in} as they multiplied E_{out} by 0.92 instead of dividing by 0.92.

7 (b) The candidate was awarded **2 marks.** 1 mark for E_{out} and 1 mark forE_{in}..

7 (c) The candidate was awarded **2 marks.** Ultimate tensile strength 1 mark, factor of safety 1 mark. Although the value for stress was incorrect the follow through error rule was applied to the candidate's answer for factor of safety.

7 (d) The candidate was awarded **0 marks** because they did not provide a correct economic or environmental description to the standard required at Higher.

7 (e) The candidate was awarded **0 marks** because their description of the advantage that the system has over a chemical battery system was not to the standard required at Higher.

Question 8

8 (a) The candidate was awarded **6 marks,** 1 mark for each of the following points:

- X>128
- X<128
- checking of X
- changes to mark and space when X>128
- changes to mark and space when X<128
- two pauses/ delays.

All statements were in their correct boxes.

8 (b) The candidate was awarded **0** marks as no part of the flowchart was correct.

8 (c) (i) The candidate was awarded **2 marks.** 1 mark because they substituted values into the formula for a difference amplifier op-amp correctly, and 1 mark for their answer for the variable resistor when the follow through error rule was applied.

8 (c) (ii) The candidate was awarded **0 marks** because they did not specify which resistor was being affected.

Question 9

9 (a) The candidate was awarded the full **2 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

9 (b) (i) The candidate was awarded **0 marks** as their calculated values were incorrect and their final answer had the incorrect units.

9 (b) (ii) The candidate was awarded **1 mark.** The candidate had an incorrect answer for I_c but was awarded 1 mark for their answer for h_{fe} when the follow through error rule was applied.

9 (c) The candidate was awarded **2 marks.** The candidate had the voltage divider the wrong way round, but was awarded 2 marks for their description when the follow through error rule was applied.

9 (d) (i) The candidate was awarded **0 marks** as there was no straight line drawn to the desired output and no hunting effect shown.

9 (d) (ii) The candidate was awarded **0 marks** because they did not describe how the reference speed to the elevator could be increased.

9 (e) (i) The candidate was awarded the full **1 mark** as they stated the correct type of control as being proportional control.

9 (e) (ii) The candidate was awarded **2 marks**. 1 mark was awarded for the candidate showing evidence of a curved line from starting point (proportional graph) as can be seen in their graph 2 (2nd point in the marking scheme) and 1 mark was awarded for the candidate showing the output settling over time towards the desired value as can be seen in their graph 1 (2nd point in the marking scheme).

Question 10

10 (a) The candidate was awarded **0 marks** because their Boolean equation was incorrect for all three Boolean statements.

10 (b) The candidate was awarded the full **4 marks** as their logic circuit contained all four correct gates needed to perform the function of the Boolean equation provided.

10 (c) (i) The candidate was awarded **3 marks** for describing each of the following points in relation to the operation of the pneumatic circuit:

- if valve B or valve C is actuated a signal is sent to change the state of valve F.
- after a delay, cylinder 2 will outstroke
- when valve H is actuated a pilot signal will be sent to valve G and valve F, causing both cylinder 1 and cylinder 2 to instroke.

10 (c) (ii) The candidate was awarded **1 mark** for their description of a microcontroller-based system as being cheaper and smaller.

10 (d) (i) The candidate was awarded the full **1 mark** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

10 (d) (ii) The candidate was awarded **0 marks** as in their calculation for current, they divided 6 by 0.7 rather than 3.7.

Question 11

11 (a) The candidate was awarded **0 marks** because in their calculations they made a rounding error for area and did not provide a value for Young's modulus or stress. Their final answer was incorrect.

11 (b) The candidate was awarded **4 marks.** 1 mark for each of the following calculations: force, radius, torque, and n (units disregarded as n is an intermediate value). No mark for their final answer for power as it was not to the correct number of significant figures.

11 (c) The candidate was awarded **3 marks.** 1 for each of the following calculations:

- F_h as follow through error rule was applied
- resultant force answer as follow through error rule was applied
- final answer for angle of force F as follow through error rule was applied.

Question 12

The candidate was awarded **1 mark** because they provided an answer for the nature of BD although no workings were provided to support the nature of BD. The magnitude and nature of all other members were incorrect.

Candidate 3

Section 1

Question 1

1 (a) (i) The candidate was awarded the full **1 mark** available because the final answer was correct.

1 (a) (ii) The candidate was awarded the full **1 mark** available because the final answer was correct.

1 (b) (i) The candidate was awarded **0 marks because** although the candidate provided correct values for stress and strain from the graph and substituted correctly into the formula for Young's modulus, they made a calculator error in their final answer.

1 (b) (ii) The candidate was awarded the **1 mark** as the property identified was ultimate tensile stress.

Question 2

2 (a) The candidate was awarded the full **2 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

2 (b) The candidate was awarded **0 marks** as they provided an answer incorrectly by saying that decreasing the value of R_{in} was acceptable.

2 (c) The candidate was awarded **1 mark** as they stated the correct op-amp configuration (inverting).

Question 3

The candidate was awarded **2 marks**, 1 mark for the correct uniformly distributed load value although they did not gain a mark for their substitution of the moments equation. The candidate was awarded 1 mark for their final RA answer as the follow through error rule was applied.

Question 4

4 (a) The candidate was awarded the full **2 marks.** 1 mark for their pulses being the correct height and 1 mark for the correct mark/space ratio.

4 (b) The candidate was awarded **0 marks** as they did not describe in detail how the space and mark time could be changed to decrease the speed of the motor.

4 (c) The candidate was awarded **0 marks** as they did not describe how the torque would remain the same at all speeds using pulse-width modulation.

Question 5

The candidate was awarded **1 mark** because their 'Example 2' described how using the knowledge of factor of safety could be used in the design of the new structure.

Question 6
The candidate was awarded **1 mark** as they had the correct NAND equivalent for the OR control from inputs C and D.

Section 2

Question 7
7 (a) The candidate was awarded **1 mark** for the correct value for E_p.

7 (b) The candidate was awarded the full **2 marks,** 1 mark for E_{in} and 1 mark for power.

7 (c) The candidate was awarded the full **4 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

7 (d) The candidate was awarded the full **2 marks,** 1 mark for each of their economic impacts. The candidate was not awarded a mark for their environmental impact as it was too vague and not to the standard required at Higher.

7 (e) The candidate was awarded **0 marks** because their description of advantages was not to the standard required at Higher.

Question 8
8 (a) The candidate was awarded **4 marks,** 1 mark was awarded for each of the following points:

- X>128
- X<128
- checking of X
- brake on and off for each condition of X.

All statements were in their correct boxes.

No mark was given for the pin 1 decision as the loop back was in the wrong place.

8 (b) The candidate was awarded the full **3 marks** for a fully correct flow chart.

8 (c) (i) The candidate was awarded **3 marks.** 1 mark for substitution 1, 1 mark for substitution 2 (follow through error rule applied) and 1 mark for the final answer (0.53 V not awarded due to rounding). Ohm's law was used but too much rounding resulted in an incorrect final answer.

8 (c) (ii) The candidate was awarded **0 marks** because their description of how the reference speed could be increased was incorrect.

Question 9
9 (a) The candidate was awarded the full **2 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

9 (b) (i) The candidate was awarded the full **3 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

9 (b) (ii) The candidate was awarded the full **2 marks** available because their final answer was correct and to an acceptable number of significant figures (no units required).

9 (c) The candidate was awarded **1 mark** because they correctly described that if $V_A > V_B$, the op-amp saturates negatively in the input voltage divider section.

9 (d) (i) The candidate was awarded **0** marks as they did not show the input rising to the desired output or consistently show the hunting effect.

9 (d) (ii) The candidate was awarded **0 marks** because their description was about proportional control and not two-state control.

9 (e) (i) The candidate was awarded **0 marks** because they did not state proportional control which was the correct answer.

9 (e) (ii) The candidate was awarded **0 marks** because there was no response to this question.

Question 10

10 (a) The candidate was awarded **0 marks** because there was no response to this question.

10 (b) The candidate was awarded **1 mark** for the NOT gate drawn from input A.

10 (c) (i) The candidate was awarded **1 mark** for describing that after a delay, cylinder 2 will outstroke.

10 (c) (ii) The candidate was awarded **1 mark** for their reason, ‘easier to make alterations’.

10 (d) (i) The candidate was awarded the **1 mark** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

10 (d) (ii) The candidate was awarded **0 marks** as they subtracted 0.7 from 3 instead of adding 0.7 to 3. This caused the candidate to provide an incorrect final answer.

Question 11

11 (a) The candidate was awarded **3 marks** because they provided a correct calculated answer for Young’s modulus, stress, and force (follow through error rule applied for force). 1 mark for each correct answer.

11 (b) The candidate was awarded **2 marks.** 1 mark for the n value and 1 mark for power (follow through error rule applied). The candidate did not show any working for torque, therefore the follow through error could not be applied.

11 (c) The candidate was awarded the full **6 marks** available because their final answer was correct, with the correct units and to an acceptable number of significant figures.

Question 12
The candidate was awarded **3 marks**. 1 mark for each of the AB and AC magnitudes. 1 mark for the nature of BD as the candidate showed in their diagram for node B on page 37.