Commentary on Candidate 1 Evidence

The evidence for this candidate achieved the following marks for each question in the question paper.

Section 1

Question 1
1 (a) The candidate was awarded the full **3 marks** because they clearly drew the NAND equivalent for all three gates ie OR, AND, NOT, and their correct connections.

1 (b) The candidate was awarded the **1 mark** available because their response had an explanation that spoke about the circuit using NAND GATES only which meant fewer ICs would be needed and the effect this had was a reduction on cost.

Please note: the command word 'explain' requires candidates to give an answer which includes a cause and an effect.

Question 2
2 (a) The candidate was awarded the **1 mark** available because the final answer given was the correct value for V_{out} to the correct significant figures and the correct units.

2 (b) The candidate was awarded the **1 mark** available because they correctly described that the op-amp gain could be increased by 'increasing the value of the feedback resistor' or by 'decreasing' the value of R_i (input resistance).

2 (c) The candidate was awarded the **1 mark** available because they correctly stated that a 'Summing Amplifier' was required to perform the task of combining the signals from a number of microphones and instruments to produce one output signal.

Question 3
The candidate was awarded the full **4 marks** because the final answer given was the correct value for the magnitude of the force at reaction B, with the correct units. The direction of the force at reaction B was clearly annotated in the candidate's answer. The answers were also given to an acceptable number of significant figures.

Question 4
The candidate was awarded **0 marks** because they did not write the correct code for correction 2. For correction 3 they identified the incorrect line of code.

Question 5
The candidate was awarded the full **4 marks** because the final answer given was the correct value for the magnitude of the force R, with the correct units and to an acceptable number of significant figures. The angle of the force R was calculated correctly and their final answer was to an acceptable number of significant figures.

Question 6
The candidate was awarded **2 marks** because both the error detector and the output driver were completed correctly in the control diagram. However, the candidate did not gain a third mark as a "Thermistor" was not accepted in the feedback loop.

Section 2

Question 7
7 (a) 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.

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

7 (c) The candidate was awarded the full **2 marks** because the responses for their economic and their social impacts provided acceptable causes and effects.

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

7 (e) The candidate was awarded the full **2 marks** because they provided an acceptable reason to explain why friction in the bearings had to be minimised. They also provided a cause and effect.

7 (f) The candidate was awarded the full **3 marks** because their final answer had the correct units and was to an acceptable number of significant figures.

Question 8
8 (a) The candidate was awarded the full **2 marks** because their final answer for V_{refA} had the correct units and was to an acceptable number of significant figures.

8 (b) (i) The candidate was awarded the full **3 marks** because their final answer was correct for the base current (Ib), with the correct units and to an acceptable number of significant figures. They showed the correct understanding throughout this question by first finding that output voltage from the op-amp was 85% of 9 V (1 mark), then finding the voltage drop over the base resistor 7.65- 0.7 V (1 mark) and then using Ohm's Law to find the base current.

8 (b) (ii) The candidate was awarded **1 mark** because the final answer for collector current I_c was correct, with the correct units and to an acceptable number of significant figures.

8 (c) The candidate was awarded **4 marks** because they provided enough description of what happens to the LEDs when V_{speed} rises from 0 V to 5 V. They also described the three lighting conditions when the voltage of V_{speed} was between 0-1.67 V, 1.67-3.33 V and 3.33 V-5 V but not in enough detail to gain 6 marks.

8 (d) The candidate was awarded the full **2 marks** because they described how a variable resistor could be used to change the value of the reference voltages as per the marking instruction.

Question 9
9 (a) (i) The candidate was awarded **1 mark** because they described a difference in material B in relation to material A, as it being more brittle.

9 (a) (ii) The candidate was awarded the full **2 marks** because they identified materials A and C with reference to the data booklet correctly, as per the marking instruction.

9 (b) The candidate was awarded the full **7 marks** because they calculated the magnitude of all four members correctly, with the correct units and to an acceptable number of significant figures. They also provided the correct nature of members BC and BD.

Question 10
10 (a) (i) The candidate was awarded the full **4 marks** because their final answer — calculating the FOS — was correct, with NO UNITS and to an acceptable number of significant figures. The candidate correctly calculated the area, stress and, provided a correct UTS value from the data book when tackling this question.

10 (a) (ii) The candidate was awarded **1 mark** because they provided an appropriate comment based on the FOS found in 10(a)(i). They commented on the result of the FOS being low and therefore dangerous, and that the consequence was the risk of injury to humans.

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

10 (b) (i) The candidate was awarded the full **3 marks** because they correctly calculated the magnitude of the force F, with the correct units and to an acceptable number of significant figures.

10 (b) (ii) The candidate was awarded **3 marks** because they correctly calculated the magnitude and direction of the reaction at the hinge, to an acceptable number of significant figures.

11 (a) The candidate was awarded the full **4 marks** because their Boolean equation was correct.

11 (b) The candidate was awarded the full **13 marks** because they provided a correct flow chart.

12 (a) The candidate was awarded the full **7 marks** because they described the operation of the pneumatic circuit, in line with the marking instructions. They provided seven valid points which gained the maximum number of marks available. A full and correct description of the circuit would have more than seven valid points.

12 (b) The candidate was awarded the full **3 marks** because they used the correct resistance value for thermistor 2 which they found on the graph provided which gained 1 mark. They then used a correct formula with the correct values and calculated the fixed resistor value, with the correct units and to an acceptable number of significant figures for the final mark.

12 (c) The candidate was awarded **1 mark** for their description of the skill a mechanical engineer requires to design the system: 'Using a model to test aspects of the drive system'.

12 (d) The candidate was awarded the full **3 marks** because they calculated the correct speed of the motor, with the correct units and to an acceptable number of significant figures.

12 (e) The candidate was awarded the full **3 marks** because they calculated the correct MOSFET drain current, with the correct units and to an acceptable number of significant figures.

Commentary on Candidate 2 Evidence

The evidence for this candidate achieved the following marks for each question in the question paper.

Section 1

Question 1
1 (a) The candidate was awarded the full **3 marks** because they drew the NAND equivalent for all three gates correctly.

1 (b) The candidate was awarded the **1 mark** available because their response had an explanation about the circuit using NAND gates only which meant fewer ICs would be needed and the effect this had was a reduction on cost.

Question 2
2 (a) The candidate was awarded the **1 mark** available because the final answer given was the correct value for V_{out}, to the correct significant figures and the correct units.

2 (b) The candidate was awarded the **1 mark** available because they correctly described that the op-amp gain could be increased by increasing the value of the feedback resistor or by decreasing the value of Ri (input resistance).

2 (c) The candidate was awarded the **1 mark** available because they correctly stated that a summing amplifier was required to perform the task of combining the signals from a number of microphones and instruments to produce one output signal.

Question 3
The candidate was awarded **1 mark**. Although the final value calculated ie the magnitude of R_b was incorrect, the direction of R_b was described correctly for 1 mark. The candidate did not provide a correct value for the length AB or use the moments equation correctly to calculate the magnitude of reaction B therefore, no further marks were gained.

Question 4
The candidate was awarded **0 marks** because both of the corrections they provided were incorrect.

Question 5
The candidate was awarded the full **4 marks.** Although the final answer given was not the exact value for the magnitude of the force R, the candidate's R_V and R_H values were correct. The rounding errors in their intermediate calculations meant that their final calculated answer was not correct. However, the angle of the force R was calculated correctly and their final answer was to an acceptable number of significant figures.

Question 6
The candidate was awarded the full **3 marks** because the control diagram was completed correctly.

SECTION 2

Question 7
7 (a) The candidate was awarded **1 mark** because their final calculated answer was correct, to an acceptable number of significant figures and with the correct units.

7 (b) The candidate was awarded the full **2 marks** because they correctly calculated the time.

7 (c) The candidate was awarded **1 mark** because their response for the economic impact provided an acceptable cause and effect. However, they did not give a cause when explaining the social impact because they did not say why people would be inclined to use a plane.

7 (d) The candidate was awarded **1 mark** for using the difference between 95 and 75 in their calculations. No other marks were awarded.

7 (e) The candidate was awarded the **1 mark** available because their response had a cause and effect when explaining that friction causes heat therefore energy is lost which makes the system less efficient.

7 (f) The candidate was awarded the full **3 marks** because their final answer was correct, had the correct units and was to an acceptable number of significant figures.

Question 8
8 (a) The candidate was awarded the full **2 marks** because their final answer was correct, had the correct units and was to an acceptable number of significant figures.

8 (b)(i) The candidate was awarded **1 mark.** They did not calculate the correct saturation voltage of the op-amp or subtract 0.7 V from a saturation voltage of the op-amp. They were awarded the mark for their final answer in light of a follow through error. They used Ohm's Law to find their calculated answer to I_b, base current.

8 (b)(ii) The candidate was awarded **1 mark** because they calculated I_c correctly using their value for the base current (I_b) in question 8b(i). Although their answer was not correct, the follow through rule was applied and the candidate was awarded the mark.

8 (c) The candidate was awarded **3 marks** for their description of what happens to the LEDs when V_{speed} was greater than 3.33 V and greater than 1.66 V.

8 (d) The candidate was awarded the full **2 marks** because they described that a variable resistor could be used to change the value of the reference voltages.

9 (a)(i) The candidate was awarded the full **2 marks** because they gave a description comparing material B with materials A and C on two different properties, brittleness and ductility.

9 (a)(ii) The candidate was awarded the full **2 marks** because they identified materials A and C correctly with reference to the data booklet.

9 (b) The candidate was awarded **4 marks** because they calculated the magnitude of members AB, AC and BC correctly, with the correct units and to an acceptable number of significant figures. They also provided the correct nature of member BD.

Question 10
10 (a)(i) The candidate was awarded **3 marks**. Although they did not provide a correct FOS for their final answer, they clearly calculated the area and stress correctly, and provided a correct UTS value from the data book.

10 (a)(ii) The candidate was awarded **0 marks** because they did not provide an appropriate comment based on their FOS found in question 10(a)(i).

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

10 (b)(i) The candidate was awarded **2 marks** because they did not calculate the correct UDL and therefore the answer for $F_{cylinder}$ was incorrect. They did apply the principle of moments correctly, although they didn't include the correct UDL. They also substituted the correct values into the moments equation and the follow through rule was applied.

10 (b)(ii) The candidate was awarded **0 marks** because their answers for the magnitude of R_{hinge} and its direction were both incorrect.

Question 11
11 (a) The candidate was awarded **2 marks** because they had B and NOT C and A bar shown correctly in their Boolean equation.

11(b) The candidate was awarded the full **13 marks** as they had the correct flow chart.

Question 12
12(a) The candidate was awarded **6 marks** because they correctly described the operation of the pneumatic system with the following points:

♦ V1 sends pilot air to V9 causing the main air through V9 to be cut off 9
♦ this sends pilot air to V2 which instrokes cylinder A

♦ this actuates V3 which sends pilot air signal through V6 to actuate V4 and outstroke cylinder B
♦ V5 is actuated which sends pilot signal to V6 to cut off the signal to V4 when V4 is actuated, cylinder B instrokes and actuates V7
♦ V7 will send a pilot signal through V8 to V2 causing cylinder A to outstroke.

12 (b) The candidate was awarded the full **3 marks** because they used the correct resistance value for thermistor 2 (found from the graph provided). The candidate then used the correct formula with the correct values to calculate the fixed resistor value, with the correct units and to an acceptable number of significant figures for this question.

12 (c) The candidate was awarded **2 marks** because of their description of the skill and knowledge a mechanical engineer needs to design the system, ie the skill of calculating the speed of drive systems and, knowledge of system/parts to increase efficiency, ie required output.

12 (d) The candidate was awarded the full **3 marks** because they calculated the correct speed of the motor, with the correct units and to an acceptable number of significant figures.

12 (e) The candidate was awarded the full **3 marks** because they calculated the correct MOSFET drain current, with the correct units and to an acceptable number of significant figures.

Commentary on Candidate 3 Evidence

The evidence for this candidate achieved the following marks for each question in the question paper.

Section 1

Question 1
1 (a) The candidate was awarded **2 marks** because they clearly drew the NAND equivalent for both the OR and the AND gates and their connections. They were not awarded a mark for the NOT gate equivalent as this was incorrect.

1(b) The candidate was awarded **0 marks** because their answer did not consist of an explanation. They made a statement which did not give a reason why the circuit was 'more efficient'.

Question 2
2 (a) The candidate was awarded **0 marks** because they did not calculate the output voltage correctly.

2 (b) The candidate was awarded **0 marks** because their response was incorrect. They should have described how the R_f value could be increased **or** R_i decreased **or** ratio of R_f to R_i increased.

2 (c) The candidate was awarded the **1 mark** available because they correctly stated that a summing amplifier was required to perform the task of combining the signals from a number of microphones and instruments to produce one output signal.

Question 3
The candidate was awarded **0 marks** because the magnitude and direction of reaction B, were incorrect. The candidate did not provide a value for length AB or show the moments equation with correct substitution.

Question 4
The candidate identified the same error in both ARDUINO and PBASIC. The candidate was awarded 1 mark because the PBASIC response was correct.

Question 5
The candidate was awarded **0 marks** because the final calculated answer for magnitude and angle of force F was incorrect. No marks were awarded for answers for vertical force R_v and horizontal force R_H.

Question 6
The candidate was awarded **0 marks** because all three elements of the control diagram were incorrect. The error detector had the positive sign in the incorrect position: op-amp and thermistor were not accepted.

Section 2

Question 7

7 (a) The candidate was awarded **0 marks** because their final answer was incorrect. This was due to the incorrect use of the power formula.

7 (b) The candidate was awarded **0 marks** because they calculated an incorrect time.

7 (c) The candidate was awarded **0 marks** because an incorrect response was provided for both an economic and a social impact.

7 (d) The candidate was awarded **1 mark** because they calculated the correct E_k value.

7 (e) The candidate was awarded **1 mark** because their second reason for needing to minimise friction was acceptable and they provided a cause and effect which is required for a question using the command word explain.

7 (f) The candidate was awarded **0 marks** because they incorrectly substituted into an incorrect formula and did not provide a correct final answer.

Question 8

8 (a) The candidate was awarded **1 mark** because the answer provided for V_{refA} was incorrect. They used the incorrect values from the voltage divider ladder but gained a mark because their final answer was calculated correctly taking account of the follow through rule.

8 (b)(i) The candidate was awarded **1 mark.** They did not calculate the correct saturation voltage of the op-amp or subtract 0.7 V from their saturation voltage of the op-amp so no marks were awarded there. However, they gained 1 mark for their final answer. Although the final answer was different to the marking instructions, the follow through rule was applied. They used Ohm's Law to find their calculated answer for the base current I_b.

8 (b)(ii) The candidate was awarded **1 mark** because they correctly used their final answer in question 8 (b)(i) to find the collector current Ib. Although this answer is wrong the follow through rule was applied.

8 (c) The candidate was awarded **0 marks** because the description they provided was insufficiently detailed.

8 (d) The candidate was awarded **0 marks.** Although they stated a variable resistor could be used they did not explain why.

Question 9

9 (a)(i) The candidate was awarded **1 mark** because they gave a comparison saying that material B was more brittle than material A.

9 (a)(ii) The candidate was awarded the full **2 marks** because they identified materials A and C correctly with reference to the data booklet.

9(b) The candidate was awarded **2 marks** because they provided the nature of members BC and BD correctly. The answers for magnitude provided in the table for members AB, AC, BC and BD were calculated incorrectly.

Question 10
10 (a)(i) The candidate was awarded **3 marks.** Their final answer for the FOS was incorrect because they used an incorrect UTS value from the data book, the follow through rule was applied and a mark was awarded. They calculated the area and the stress values correctly and were awarded 1 mark for each of these.

10 (a)(ii) The candidate was awarded **0 marks** because they did not provide an appropriate comment based on the FOS found in question 10 (a)(i).

10 (a)(iii) The candidate was awarded **2 marks.** They did not use the correct value for E 110×10^3 Nmm^{-2}. 1 mark was awarded for the correct stress - no units were required - but strain was calculated incorrectly. The follow through rule was applied and the candidate was awarded a second mark for their answer to the change in length.

10 (b)(i) The candidate was awarded **1 mark** because they calculated the correct UDL. They did not apply the principal of moments correctly. They did not substitute the correct values into the moments equation and therefore 0 marks were awarded for substitution and the final answer.

10 (b)(ii) The candidate was awarded **0 marks** because they did not calculate the magnitude of the reaction at the hinge correctly or provide a direction. They did not provide values for F_v and F_h and then use these values in Pythagoras Theorem to find R_{hinge}.

Question 11
11 (a) The candidate was awarded **3 marks** because they had NOT A with AND, B and NOT C and OR D shown correctly in their Boolean equation.

11 (b) The candidate was awarded **5 marks** because they had the correct box with the correct command on five occasions:

◆ 1 mark for 'Pin 7=1 and Pin 7=0'
◆ 1 mark for decision box and Pin 0 =1
◆ 1 mark for 'Pin 6=1 and Pin 6=0'
◆ 1 mark for wait 3s
◆ 1 mark for correct loop.

Question 12
12 (a) The candidate was awarded **2 marks** because they correctly described the operation of the pneumatic system on two points. 1 mark was awarded for each of the following points:

♦ this actuates V3 which sends pilot air signal through V6 to actuate V4 and outstroke cylinder B. In the candidate's description they do not say that cylinder B outstrokes but credit was given because they described how cylinder B actuates V5 which could only be done by cylinder B outstroking.
♦ when V4 is actuated, cylinder B instrokes and actuates V7.

12(b) The candidate was awarded **1 mark** because they read the resistance value for thermistor 2 correctly at 85 ^{o}C. No other marks were awarded because they did not apply a correct formula with the correct values.

12(c) The candidate was awarded **0 marks** because descriptions of a skill and piece of knowledge were not sufficiently detailed for Higher level.

12(d) The candidate was awarded **0 marks** because they did not provide a correct answer and could not be awarded any marks for the working shown.

12(e) The candidate was awarded **0 marks** because they did not provide the correct motor resistance using the correct substitution or a correct final answer.