Higher
Coursework
Assessment Task

Higher Engineering Science
Assignment
Marking Instructions

These marking instructions are prepared by examination teams for use by SQA appointed markers when marking external course assessments.

Please note, as we were not able to carry out live marking in 2020, these marking instructions are not presented in a final state and have not been referenced against candidate responses.

Marking instructions

Marking instructions are provided for this specimen assessment task. In line with SQA's normal practice, they are addressed to the marker. They will also be helpful for those preparing candidates for course assessment.

Marking instructions **will not** be provided with annual assessment tasks, as candidate evidence will be submitted to SQA for external marking. They will be provided to markers and then published on the SQA website after marking is complete.

General marking principles

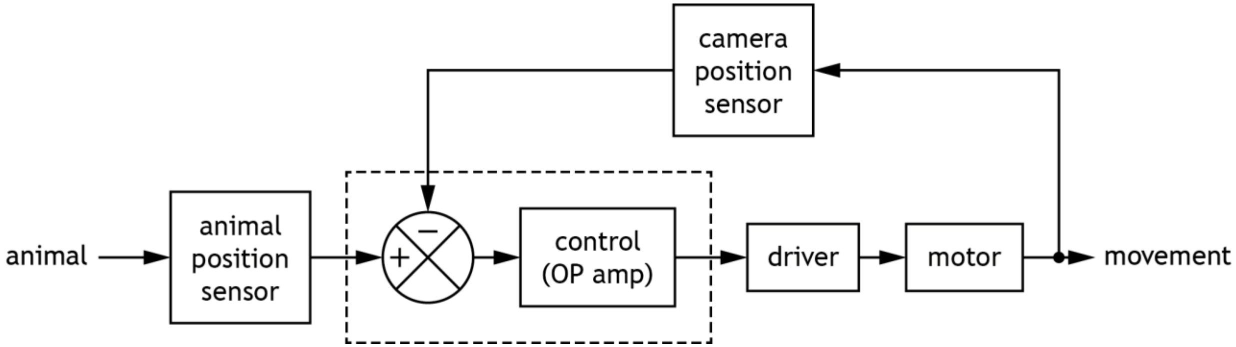
This information is provided to help you understand the general principles that must be applied when marking candidate responses in this assignment. These principles must be read in conjunction with the detailed/specific marking instructions, which identify the key features required in candidate responses.

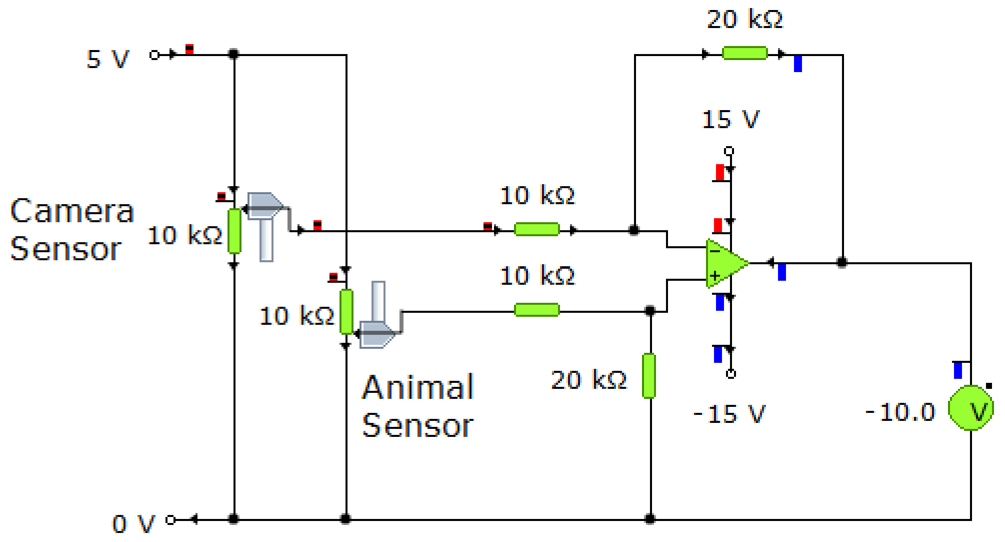
a Marks for each candidate response must **always** be assigned in line with these general marking principles and the specific marking instructions for this assessment.

b Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

c If a specific candidate response is not covered by either the general marking principles or detailed marking instructions, you must seek guidance from your team leader.

Task 1 — Camera tracking system

Task			Expected response	Max mark	Additional guidance
1	**a**			**6**	Control diagram: ♦ animal sensor **(1 mark)** ♦ error detector **(1 mark)** ♦ control box, correct order (**1 mark)** ♦ driver box, correct order (**1 mark)** ♦ motor box, correct order (**1 mark)** ♦ camera position sensor, feedback loop, from correct place and direction **(1 mark)**

Task			Expected response	Max mark	Additional guidance
1	b			2	For simulated circuits; Input —potentiometers and voltmeter. **(1 mark)** Process — op-amp. **(1 mark)** For constructed circuits; Correct components included. **(1 mark)** Correct connections made. **(1 mark)**

<table>
<tr><th colspan="3">Task</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>1</td><td>c</td><td></td><td>
<table>
<tr><th>Planned test</th><th>Expected result</th><th>Actual result</th><th>Amendment made</th></tr>
<tr><td>Set both inputs to their lowest setting (0 V).</td><td>Output on voltmeter should be 0 V.</td><td>Output is 0 V.</td><td>None required.</td></tr>
<tr><td>Set the animal sensor input to its minimum (0 V) and the camera position sensor to its maximum (5 V).</td><td>Output on voltmeter should be +2.5 V.</td><td>Voltage is -10 V.</td><td>Resistances changed to provide correct gain.

Inputs swapped (or additional inverting amp added) to create positive voltage.</td></tr>
<tr><td>Leave the animal sensor at its minimum (0 V) then reduce the camera position sensor gradually from 5 V to 0 V.</td><td>Output on voltmeter should reduce from +2.5 V to 0 V.</td><td>Output reduces as from 2.5 V to 0 V.</td><td>None required.</td></tr>
</table>
</td><td>5</td><td>Actual result 1: 0 V output. (1 mark)

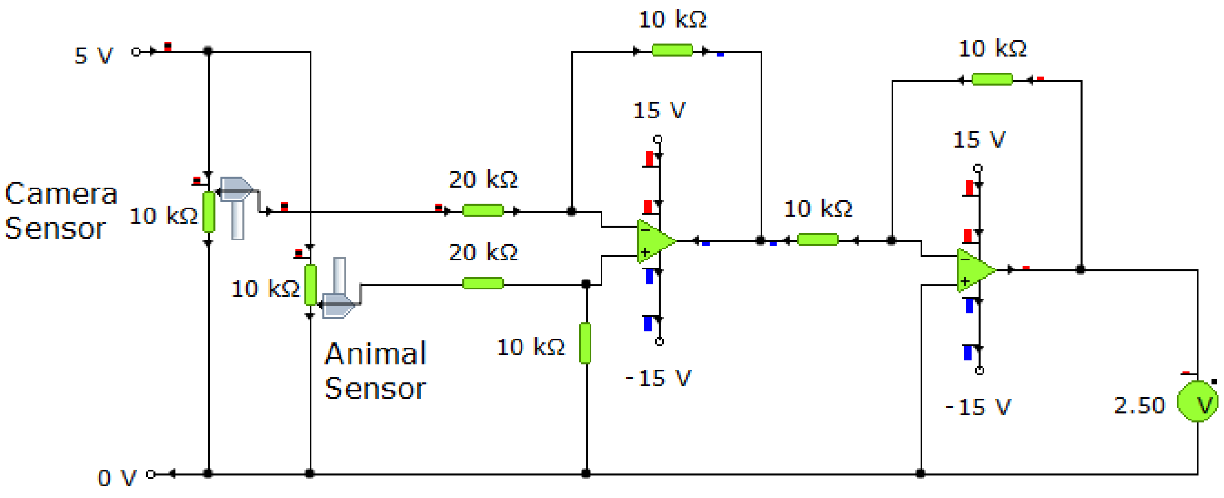
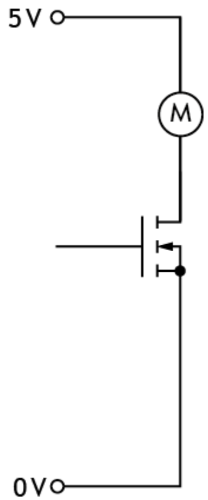
Actual result 2: -10 V. (1 mark)

Amendment made 2: rewire inputs to op-amp (or extra inv). (1 mark)

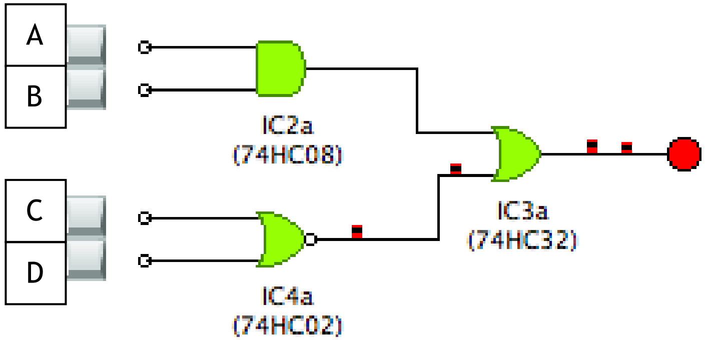
Change resistors appropriately. (1 mark)

Actual result 3: voltage steadily decreasing. (1 mark)

FTE - If the candidate has the voltmeter incorrectly orientated then 1 mark can be awarded for the two ‘non-required’ responses.</td></tr>
</table>

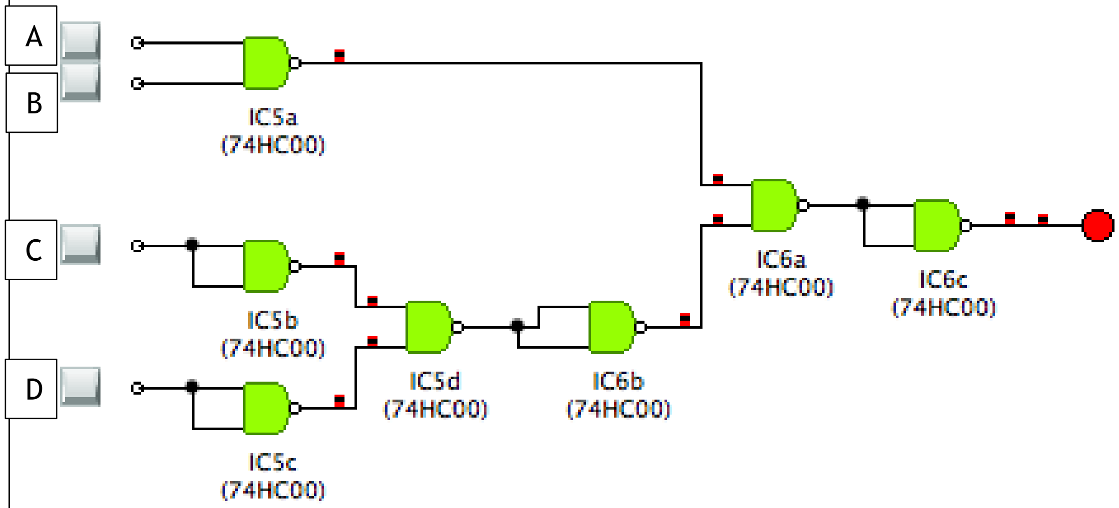
Task			Expected response	Max mark	Additional guidance
1	d			2	1 mark for each correctly implemented correction. **(2 marks)** Allow follow-through error based on candidate's response in test table 1c.
1	e			2	Correct choice of components (motor and mosfet). **(1 mark)** Correct connections to allow operation. **(1 mark)**

Task 2 — Sensing Control System

Task			Expected response	Max mark	Additional guidance
2	a			1	Gates as per design and labels shown. **(1 mark)**

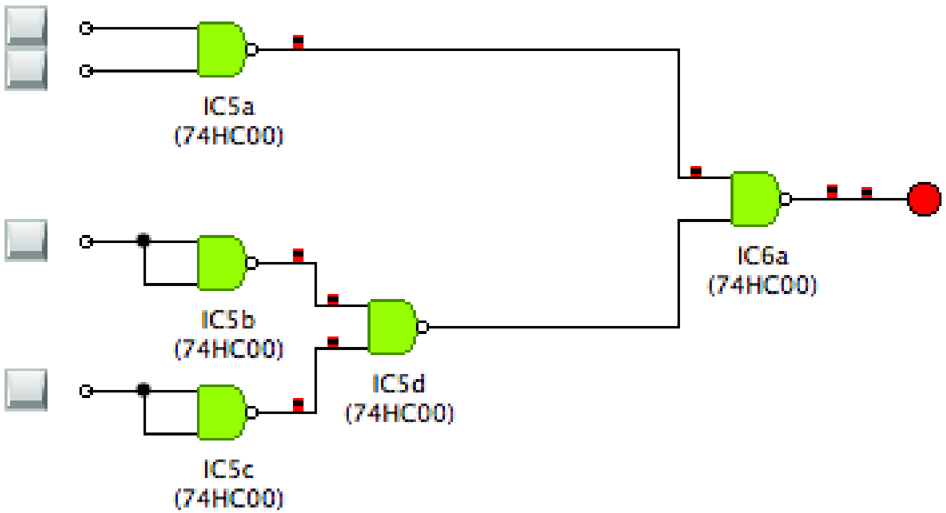
Task			Expected response	Max mark	Additional guidance
2	b		(truth table below)	1	Actual results in truth table. **(1 mark)** Marks cannot be awarded if no evidence of simulation in 2a. Allow follow on error based on final circuit.

A	B	C	D	Z	NAND equivalent
0	0	0	0	1	
0	0	0	1	0	
0	0	1	0	0	
0	0	1	1	0	
0	1	0	0	1	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	0	
1	0	0	0	1	
1	0	0	1	0	
1	0	1	0	0	
1	0	1	1	0	
1	1	0	0	1	
1	1	0	1	1	
1	1	1	0	1	
1	1	1	1	1	

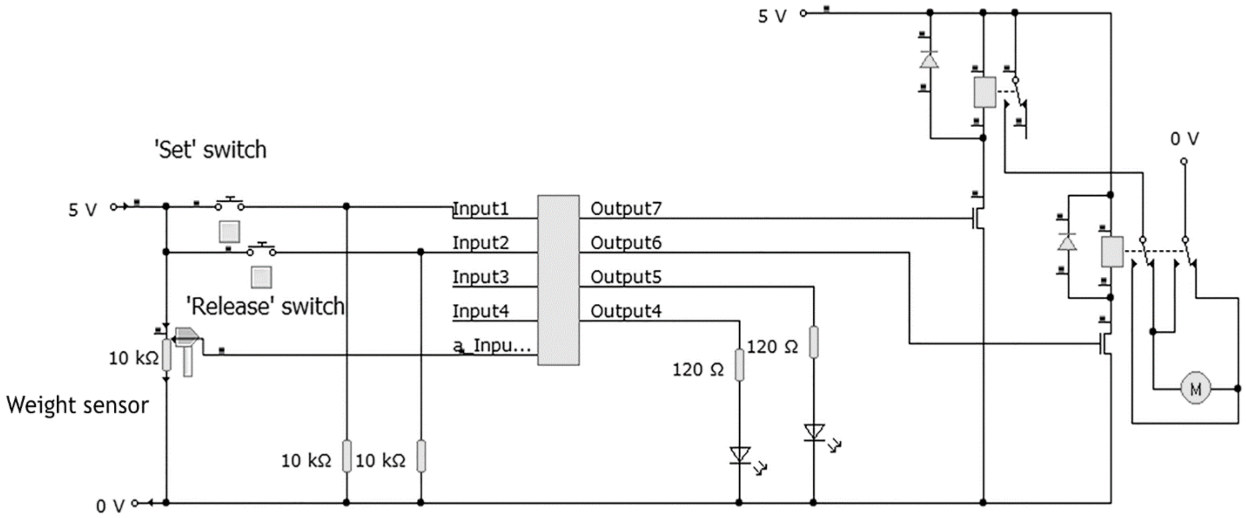
Task			Expected response	Max mark	Additional guidance
2	c			1	Full circuit including inputs and outputs

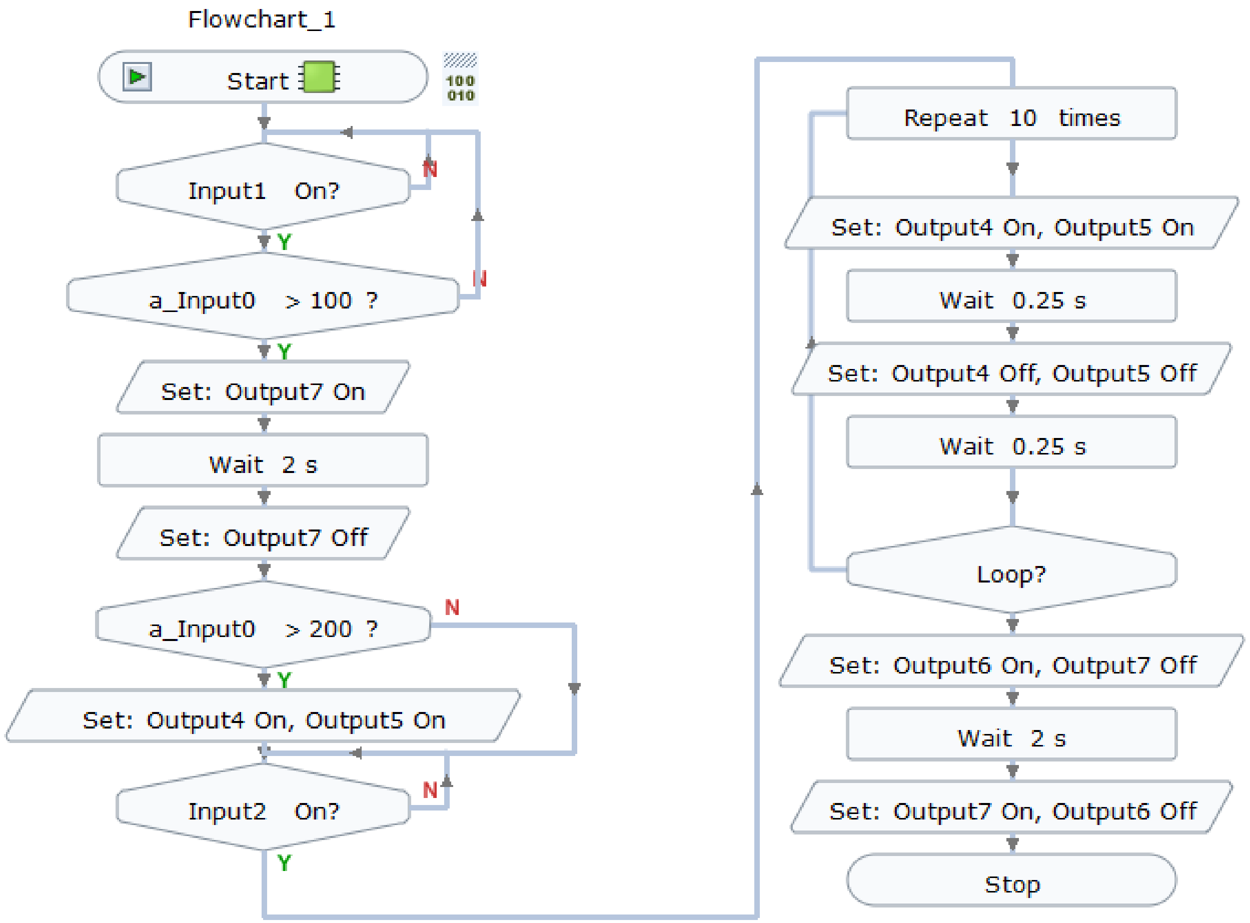
Task			Expected response	Max mark	Additional guidance
2	d		(see table below)	1	Actual results in truth table. **(1 mark)** Marks cannot be awarded if no evidence of simulation in 2c. Allow follow on error based on final circuit.

A	B	C	D	Z	NAND equivalent
0	0	0	0	1	1
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0	0
0	1	0	0	1	1
0	1	0	1	0	0
0	1	1	0	0	0
0	1	1	1	0	0
1	0	0	0	1	1
1	0	0	1	0	0
1	0	1	0	0	0
1	0	1	1	0	0
1	1	0	0	1	0
1	1	0	1	1	0
1	1	1	0	1	0
1	1	1	1	1	0

Task			Expected response	Max mark	Additional guidance
2	e			2	Removal of NAND after OR function. **(1 mark)** Removal of NAND between NOR and OR functions. **(1 mark)** Full marks to be awarded for any other correct NAND equivalent.
2	f	(i)	Initial logic circuit would require 3 separate chips. NAND equivalent 2. Programmable system requiring 1. Fewer chips would result in: reduced construction/manufacturing time, resources and cost; final assembled product would be smaller allowing for cheaper transportation and packaging costs. Programmable control based system would be easier to upgrade or reprogram if operating issues were discovered in the field.	3	1 mark for each evaluative comment. (**up to 3 marks**) Allow follow on error based on final circuit.
		(ii)	Programmable control option would be the preferred solution.	1	Specifying the programmable control option as the preferred solution. **(1 mark)**

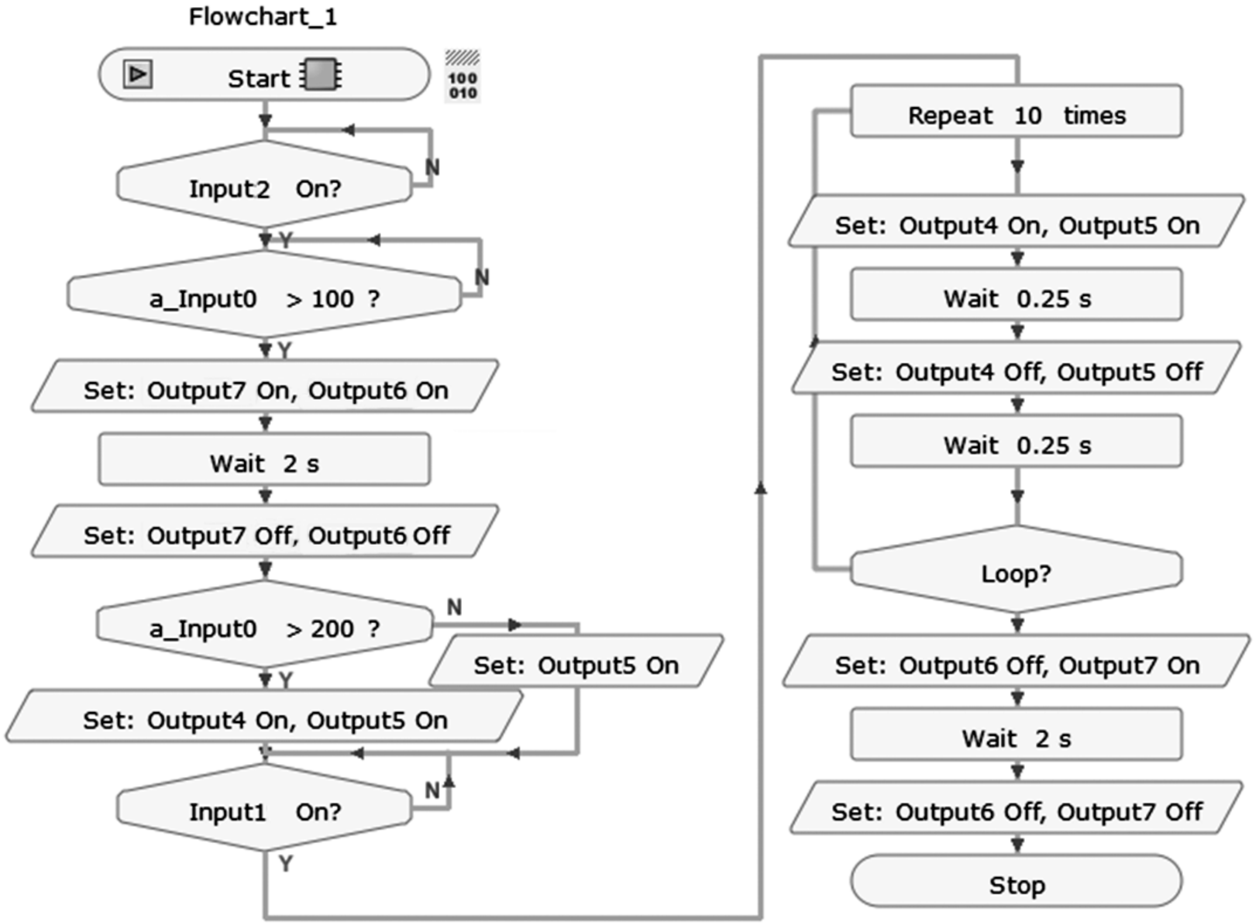
Task 3 — Trapping system

Task			Expected response	Max mark	Additional guidance
3	a			6	Candidate must show that the circuit and flowchart are integrated together. Analogue input correctly connected. **(1 mark)** Digital inputs correctly connected. **(1 mark)** SPST relay and LED outputs connected correctly. **(1 mark)** DPDT relay and motor correctly connected. **(1 mark)** Flowchart boxes and connections correct. **(1 mark)** Flowchart contents correct. **(1 mark)**

Task			Expected response	Max mark	Additional guidance
					

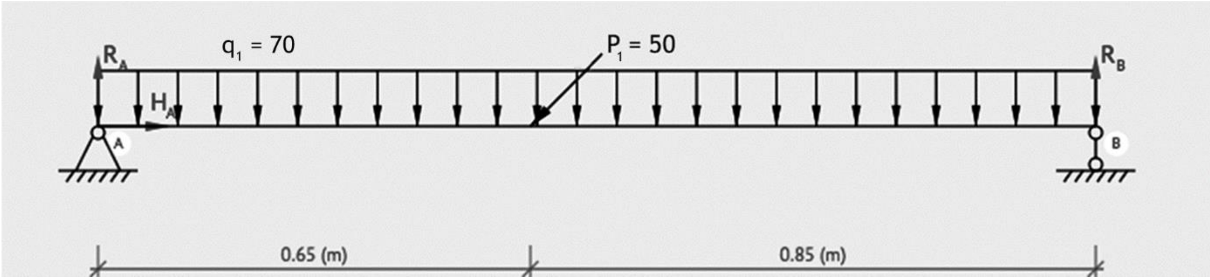
Task			Expected response	Max mark	Additional guidance
3	b		(see table below)	6	1 mark for each correct description of actual results. **(3 marks)** 1 mark for each amendment in test 1. **(2 marks)** 1 mark for amendment in test 3. **(1 mark)** **FTE - if the candidate makes an error in the electronic circuit and makes appropriate amendments during testing this should be credited.**

Planned test	Expected result	Actual result	Amendments
Set analogue input to 0. Press then release 'Set' switch. Adjust analogue input from 0 to over 100 (2 V), but less than 200 (4 V).	Flowchart progresses through first two decisions, motor turns on for 2 seconds, and LED 1 lights.	Chart won't progress unless switch is pressed after the analogue sensor is increased. Motor turns but no LEDs go on.	Change initial AND relationship in first two decision boxes. Add option for 1 LED in third decision box rather than looping back.
Repeat above test but set analogue sensor to 255 (5 V).	As above but LEDs 1 and 2 will both light.	When 'set' pressed the motor spins for 2 seconds then 2 LEDs go on.	None required.
When both LEDs are on, press 'Release' switch.	Both LEDs flash 10 times, then the motor spins in the opposite direction for 2 seconds.	LEDs flash 10 times but motor doesn't immediately turn on. When it does it goes the same way as before.	Change the pin numbers being switched off and on in the last two output boxes.

Task			Expected response	Max mark	Additional guidance
3	c			3	1 mark for each correctly implemented correction. **(3 marks)**

Task			Expected response	Max mark	Additional guidance
3	**d**		When the set switch was activated the flowchart then waited until the animal sensor was adjusted before progressing. When the animal sensor was increased the motor spun for 2 seconds then either one or two LEDs came on depending on whether the sensor was set above 200. While the signal to the motor was stopped, the motor kept spinning for a while longer. When the release switch was pressed the LEDs flashed 10 times over 5 seconds then the motor turned in the opposite direction for 2 seconds then stopped. Again, the motor span for a little longer after the signal was switched off. After the amendments listed in the test phase were completed the system met all the criteria in the specification. In the actual environment the system would need the following improvements – ♦ A longer delay time between the release switch being pressed and the door opening to allow the user to get a safe distance away, or have a remote control trigger to activate the opening. ♦ Additional control would be required to open the door as part of the set up procedure. ♦ The closing of the door would need to be quicker to ensure the animal didn't manage to escape as it was closing. ♦ A suitable battery or portable power supply system would be required as it would not be possible to plug into a mains supply.	**6**	Stating whether the criteria have been met. **(1 mark)** 1 mark for each evaluative comment relating to the performance of the system against the specification. **(3 marks)** 1 mark for each evaluative comment relating to the suitability of the system in a real environment. **(2 marks)**

Task 4 — Camera Track

Task			Expected response	Max mark	Additional guidance
4			 1. A beam is in equilibrium when it is stationary relative to an inertial reference frame. The following conditions are satisfi in equilibrium. **$\Sigma F_x = 0$:** $H_A - P_1*\cos(45) = 0$ **$\Sigma M_A = 0$:** The sum of the moments about the pin support at the point A: $- q_1*1.5*(1.5/2) - P_1*\sin(45)*0.65 + R_B*1.5 = 0$ **$\Sigma M_B = 0$:** The sum of the moments about the roller support at the point B: $- R_A*1.5 + q_1*1.5*(1.5 - 1.5/2) + P_1*\sin(45)*0.85 = 0$ 2. Calculate reaction of roller support at the point B: $R_B = \mathbf{(}\ q_1*1.5*(1.5/2) + P_1*\sin(45)*0.65\mathbf{)}\ \mathbf{/\ 1.5} = \mathbf{(}\ 70*1.5*(1.5/2) + 50*0.70710.65\mathbf{)}\ \mathbf{/\ 1.5} = 67.82$ (N) 3. Calculate reaction of pin support at the point A: $R_A = \mathbf{(}\ q_1*1.5*(1.5 - 1.5/2) + P_1*\sin(45)*0.85\mathbf{)}\ \mathbf{/\ 1.5} = \mathbf{(}\ 70*1.5*(1.5 - 1.5/2) + 50*\sin(45)*0.85\mathbf{)}\ \mathbf{/\ 1.5} = 72.53$ (N) 4. Solve this system of equations: $H_A = P_1*\cos(45) = 50*0.7071 = 35.36$ (N) 5. The sum of the forces about the Oy axis is zero: **$\Sigma F_y = 0$:** $R_A - q_1*1.5 - P_1*\sin(45) + R_B = 72.53*1 - 70*1.5 - 50*0.7071 + 67.82*1 = 0$ R_{Av} = 72.53 N R_{Ah} = 35.36 N R_B = 67.82 N	**2**	Reaction at R_A, horizontal and vertical. **(1 mark)** Reaction at R_B. **(1 mark)** Allow follow-through error for incorrect values simulated/constructed.

[END OF MARKING INSTRUCTIONS]