

Higher Coursework Assessment Task



Higher Engineering Science Assignment Finalised Marking instructions

© Scottish Qualifications Authority 2024

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

The information in this document may be reproduced in support of SQA qualifications only on a non-commercial basis. If it is reproduced, SQA must be clearly acknowledged as the source. If it is to be reproduced for any other purpose, written permission must be obtained from permissions@sqa.org.uk.

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.

Detailed marking instructions

Task		(Expected answer(s)	Max mark	Additional guidance
1	a		The system must: Input: 1. Detect the wind direction 2. Sense the turbine head position 3. Send both signals to the control unit Process: 4. Use proportional control 5. Make use of negative feedback 6. Use closed loop control 7. Compare turbine head position with the wind direction 8. Use a driver to amplify the signal to the motor Output: 9. Start to move the motor/ turbine head quickly	6	1 mark for each correct point (max 6 points).
			 10. Slow the motor as the turbine head position gets closer to the desired position 11. Turn the motor to rotate the turbine head 12. Stop the motor when the turbine head is in the correct position 13. Use a driver to spin the motor in both directions 		





Task		Expected answer(s)				Max mark	Additional guidance	
1	d		Planned test	Expected result	Actual result	Amendments made	4	Marked based on the circuit provided in 1(c).
			Set both V_1 and V_2 to 5 mV.	The output voltage is 0 V.	The output voltage is 0 V.	None required.		1 mark - correct actual result.
			Set V_1 to 10 mV and set V_2 to 0 mV.	The output voltage should be + 300 mV.	The output voltage is -300 mV.	Alter the circuit by adding a further op- amp in an inverting configuration after the first op-amp.		1 mark - correct actual result. 1 mark - correct amendment.
		Set V_1 to 4 mV and set V_2 to 6 mV.	The output voltage should be - 60 mV.	The output voltage is - 60 mV.	OR Swapping the inputs to the op-amp so that V_1 is connected to the non-inverting input and V_2 is connected to the inverting input. None required.		1 mark - correct actual result based on test 2 amendments.	

Task		Ĩ	Expected answer(s)	Max mark	Additional guidance
1	e		iv - the op-amp initially had a gain of 30, achieved by the ratio of $R_{\rm f}$ and $R_{\rm i}$ values, 30:1. The circuit works as specified, and this specification is fully met.	4	1 mark - identification of how specification iv is met.
			v - the op-amp has both a positive and negative supply voltage which allows for a positive or negative output voltage. As the circuit can produce both 300 mV and 60 mV output voltages, this specification point is mot		1 mark - describing how specification v is met.
			Overall, the system performs well to meet the specification after amendments - the voltage changes polarity correctly as V_1 and V_2 are altered, the gain is correct, and the voltage magnitude increases and decreases as required.		1 mark - evaluative comments on overall effectiveness.
			However, the system could be improved with an emergency braking system/ override switch to prevent any damage to parts. The system could be improved by adding warning lights/ buzzer when the turbine head is in motion.		1 mark - practical suggestion for improvement.

Task		Expected answer(s)	Max mark	Additional guidance
2 a		Flowchart_1 Start Set: Output6 On, Output7 Off V a_Input1 = 128 ? Set: Output6 Off, Output7 Off V a_Input1 < 128 ? Set: Output7 On, Output5 Off N a_Input0 2 100 ? Y Set: Output0 Off Set: Output0 Off Set: Output0 Off Set: Output0 Off Set: Output0 Off Set: Output0 Off Set: Output0 Off	4	1 mark - must match flowchart as given in task.



	Task		Expected answer(s)			Max mark	Additional guidance	
2	Ь		Planned test	Expected result	Actual result	Amendments made	7	Marks based on circuit given in the question.
			Activate the flowchart. Press the 'master' switch.	The robot program will run.	The robot program does run, but there is no 'master' switch decision to start it.	Decision box inserted to test input 7 ('master' switch) operation after start terminus.		 1 mark - correct actual result with descriptive reference to the 'master' switch. 1 mark - correct amendment with location of decision.
			Alter analogue input 1 maximum value, then activate the flowchart. Press the 'master' switch.	Output 7 switches on and the motor turns.	Output 6 switches on and the motor turns.	The outputs are inverted ie 'output 6 on, output 7 off' to 'output 6 off, output 7 on' and therefore 'output 6 off, output 7 on' to 'output 6 on, output 7 off'. OR The inequalities are inverted ie '>' to '<' and therefore '<' to '>'.		1 mark - correct actual result. 1 mark - correct first amendment. 1 mark - correct second amendment.

Task		(Expected answer(s)			Max mark	Additional guidance	
2	b		Alter analogue input 0 LDR to the maximum light level, then activate the flowchart. Press the 'master' switch. Repeat this test.	The solenoid will energise and actuate each time.	The solenoid energises once and the transistor fails/ explodes. This was not repeatable.	An 18 kΩ base resistor is added to the transistor, and a diode in parallel with solenoid.		 mark - correct actual result must refer to transistor, solenoid and repeatability. mark - correct amendment with base resistor value 18 kΩ (or greater) and diode. Note: MOSFET can replace transistor along with diode parallel to solenoid. Collector resistor (value minimum 150 Ω) can be used to prevent failure of transistor. Alternative simulation software may require different base resistor values (greater than 7.6 kΩ) and fly away diode parallel to solenoid.

Task		¢	Expected answer(s)	Max mark	Additional guidance
2	с		Specification point i.	4	
			The robot operated without pressing the 'master' switch. There was an error in the flowchart program, which was corrected by adding a decision box to confirm input 7 is on. The robot now works as specified, and specification i is now fully met.		1 mark - evaluative statement including the identification of the error and correction.
			Specification point ii.		
			The input control did enable the motor to switch on and off at the correct levels, but rotated in the wrong direction. This was corrected by changing outputs 6 to 'off' and output 7 to 'on' when analogue input 1's value is greater than 128. After this change, specification ii is fully met.		1 mark - evaluative statement including the identification of the error and correction.
			However, to ensure the flowchart works fully, output 6 was changed to 'on' and output 7 changed to 'off' when analogue input 1's value was less than 128.		1 mark - consequential amendment.
			Specification point iii.		
			The solenoid did not operate as specified as the transistor was damaged as it turns on. This was corrected by adding a base resistor to prevent a large current flowing to the base of the transistor. Specification iv is now fully met.		1 mark - evaluative statement including the identification of the error and correction.



Task			Expected answer(s)	Max mark	Additional guidance
4	a			2	1 mark - both AND gates correct with connections. 1 mark - XOR correct with connections.



Task			Expected answer(s)			Additional guidance
4	4 c		Planned testSet pin 6 high/ actuate V1, and actuate V2.Send a PWM signal with a mark:space ratio of 1:3 (25%) from pin 7.Set pin 4 high/ actuate V4, and unactuate V2.	Expected resultCylinder CA slowly outstrokes.Cylinder CB instrokes and outstrokes repeatedly with the PWM ratio.Cylinder CA instrokes.	3	 1 mark - correct test and expected result (no mark if valve or lever are not described as actuated, or speed of outstroke is not specified). 1 mark - correct test and expected result (must indicate correct duty cycle, must relate signal from pin 7/ valve V₃). 1 mark - correct test and expected result (V₂ unactuated must be specified).

[END OF MARKING INSTRUCTIONS]