



Higher
coursework
assessment task



Higher Engineering Science Assignment Finalised Marking Instructions

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

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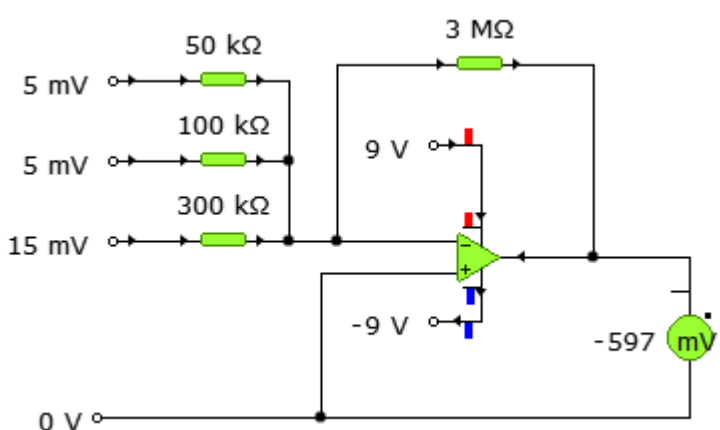


General marking principles

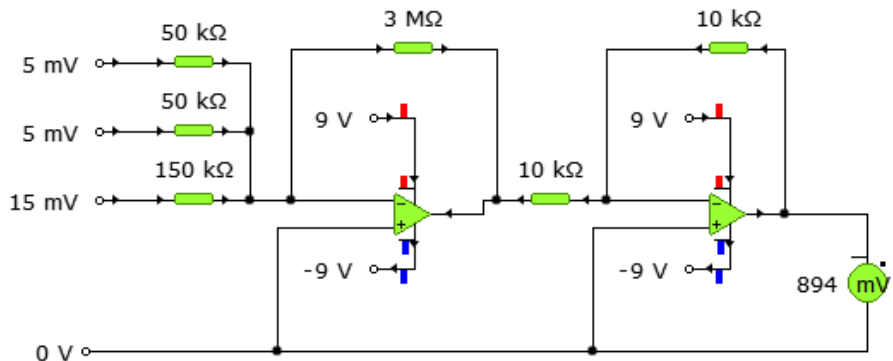
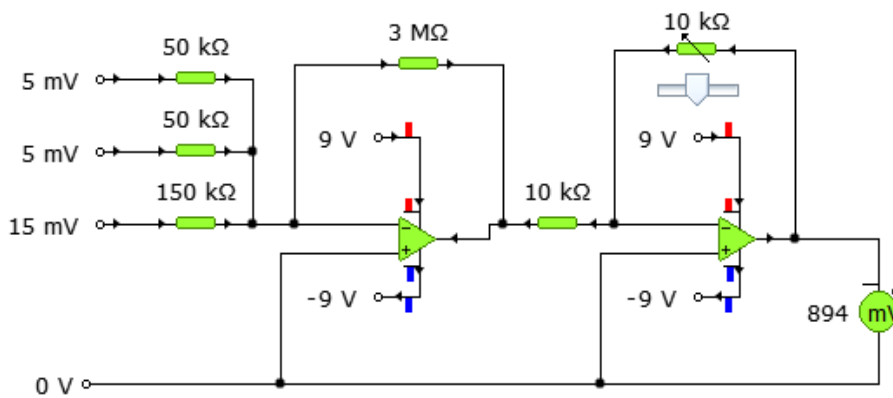
This information is provided to help you understand the general principles that must be applied when marking candidate responses in this assignment. These principles must be read in conjunction with the detailed/specific marking instructions, which identify the key features required in candidate responses.

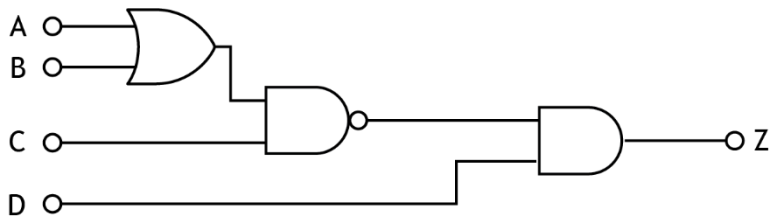
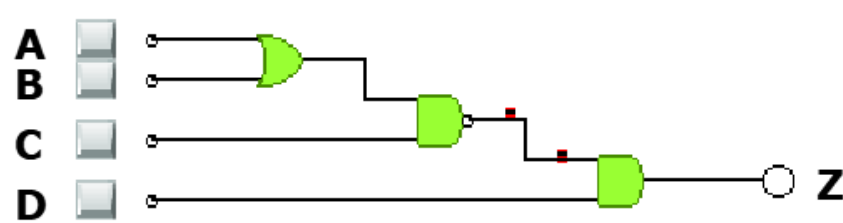
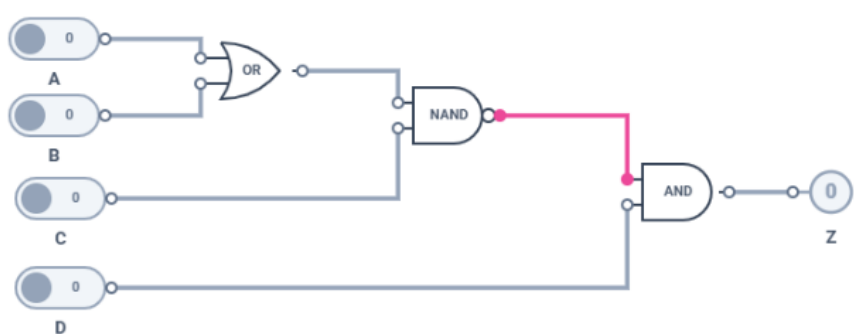
- a Marks for each candidate response must always be assigned in line with these general marking principles and the specific marking instructions for this assessment.
- b Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant 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 .

Detailed marking instructions

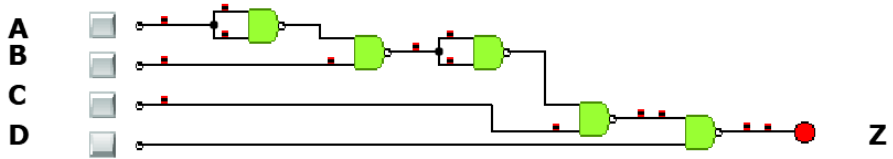
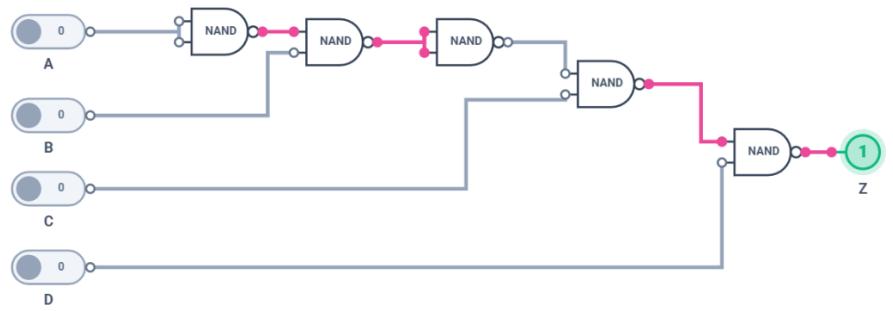
Task			Expected answer(s)	Max mark	Additional guidance
1	a		 The circuit diagram shows an operational amplifier configured as an inverting amplifier. The non-inverting input (+) is connected to ground (0 V). The inverting input (-) is connected to three parallel input resistors: 50 kΩ, 100 kΩ, and 300 kΩ. Each resistor has a corresponding voltage source (5 mV, 5 mV, and 15 mV respectively) connected to its other end. A feedback resistor of 3 MΩ is connected between the output and the inverting input. The output is connected to a voltmeter showing a reading of -597 mV. Power supplies of 9 V and -9 V are indicated for the op-amp.	2	1 mark for correct positioning and connections of all components. 1 mark for correct values of all resistors and voltage supplies. Accept variable voltage inputs at the correct voltages as suitable replacements for the illustrated fixed voltage inputs.

Task			Expected answer(s)	Max mark	Additional guidance										
1	b		<table><tr><th>Actual result</th><th>Amendments made</th></tr><tr><td>-300 mV</td><td>Additional inverting op-amp with gain of -1 added.</td></tr><tr><td>+150 mV</td><td>Change V₂ input resistor to 50 kΩ.</td></tr><tr><td>+750 mV</td><td>Change V₃ input resistor to 150 kΩ.</td></tr><tr><td></td><td></td></tr></table>	Actual result	Amendments made	-300 mV	Additional inverting op-amp with gain of -1 added.	+150 mV	Change V ₂ input resistor to 50 kΩ.	+750 mV	Change V ₃ input resistor to 150 kΩ.			6	Simulated circuits may produce output voltages slightly different from expected results. Take this into account when marking. Apply FTE from circuit produced in Task 1a.
		Actual result	Amendments made												
		-300 mV	Additional inverting op-amp with gain of -1 added.												
		+150 mV	Change V ₂ input resistor to 50 kΩ.												
		+750 mV	Change V ₃ input resistor to 150 kΩ.												
1 st actual result: 1 mark for -300 mV.															
1 st amendment: 1 mark for stating addition of an inverting op-amp with gain of -1. Apply FTE from 1 st actual result.															
2 nd actual result: 1 mark for +150 mV. Apply FTE from 1 st amendment.															
2 nd amendment: 1 mark for V ₂ input resistor changing to 50 kΩ. Apply FTE from 2 nd actual result.															
		3 rd actual result: 1 mark for +750 mV. Apply FTE from 2 nd amendment.													
		3 rd amendment: 1 mark for V ₃ input resistor changing to 150 kΩ. Apply FTE from 3 rd actual result.													

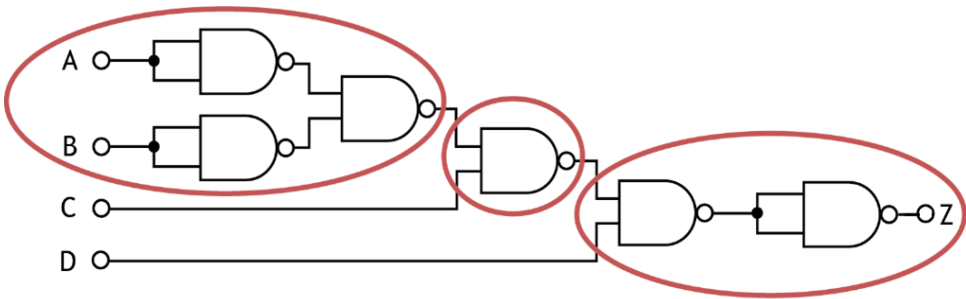
Task			Expected answer(s)	Max mark	Additional guidance
1	c			2	1 mark for correctly connected inverting op-amp with a gain of -1. 1 mark for correctly changing input resistor values for V_2 and V_3. Apply FTE from Task 1b.
	d			2	1 mark for variable resistor. 1 mark for correct positioning of the variable resistor. Accept alternatives that produce the desired effect, such as replacing the $3\text{ M}\Omega$ resistor or the $10\text{ k}\Omega$ input resistor with a suitable variable resistor.

Task			Expected answer(s)	Max mark	Additional guidance
2	a			3	1 mark for A or B connected correctly. 1 mark for NAND (or AND and NOT) connected correctly. 1 mark for AND connected correctly. No marks awarded if simulated or constructed.
	b		Example 1  Example 2 	2	1 mark for suitable input and output devices. 1 mark for correct simulation or construction of logic circuit from Task 2a.

Task			Expected answer(s)						Max mark	Additional guidance
2	c		A	B	C	D	Z	NAND equivalent	1	1 mark for column Z correct. Apply FTE from circuit in Task 2b.
			0	0	0	0	0			
			0	0	0	1	1			
			0	0	1	0	0			
			0	0	1	1	1			
			0	1	0	0	0			
			0	1	0	1	1			
			0	1	1	0	0			
			0	1	1	1	0			
			1	0	0	0	0			
			1	0	0	1	1			
			1	0	1	0	0			
			1	0	1	1	0			
			1	1	0	0	0			
			1	1	0	1	1			
			1	1	1	0	0			
			1	1	1	1	0			

Task			Expected answer(s)	Max mark	Additional guidance
2	d		Example 1  Example 2 	1	1 mark for correct simulation or construction. Input and output devices must be included.

Task			Expected answer(s)						Max mark	Additional guidance
2	e								1	1 mark for NAND equivalent column correct. Apply FTE from Task 2d.
			A	B	C	D	Z	NAND equivalent		
			0	0	0	0	0	1		
			0	0	0	1	1	0		
			0	0	1	0	0	1		
			0	0	1	1	1	0		
			0	1	0	0	0	1		
			0	1	0	1	1	0		
			0	1	1	0	0	1		
			0	1	1	1	0	1		
			1	0	0	0	0	1		
			1	0	0	1	1	0		
			1	0	1	0	0	1		
			1	0	1	1	0	0		
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			1	1	1	1	0	0		

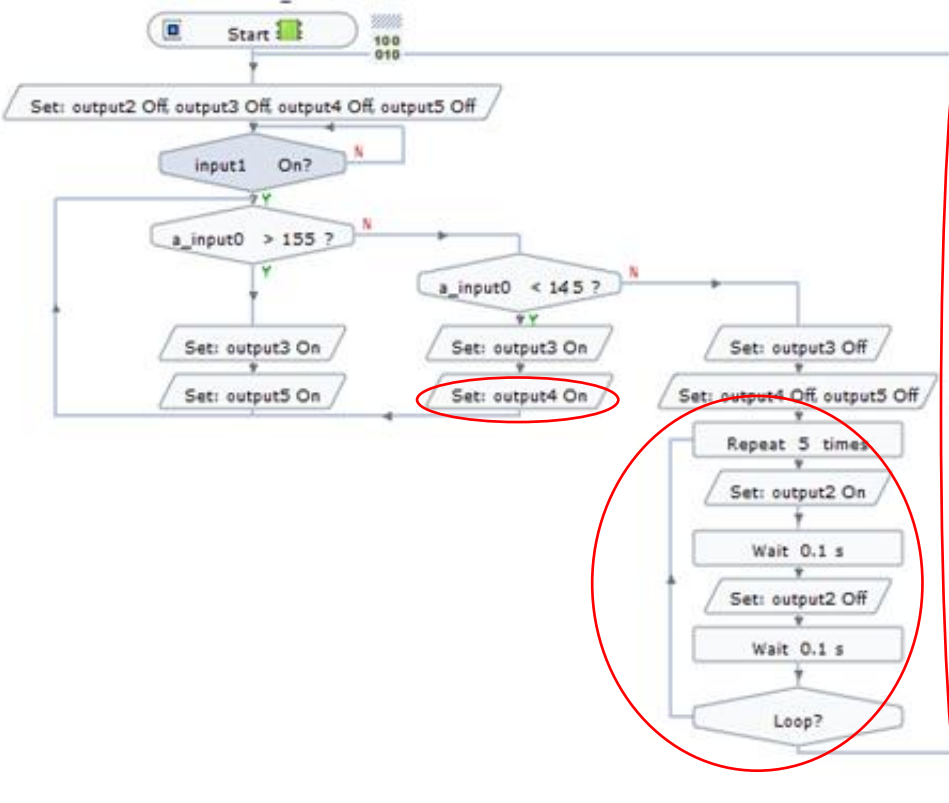
Task			Expected answer(s)	Max mark	Additional guidance
2	f			3	1 mark for correct OR equivalent connected correctly. 1 mark for NAND connected correctly. 1 mark for correct AND equivalent connected correctly. Do not accept simulation or construction evidence.
	g		The original circuit would require three ICs to be constructed whereas the NAND equivalent circuit would only need two. As there are fewer ICs, the cost would be reduced. Fewer ICs reduces manufacturing time due to less complex circuitry.	2	1 mark for identifying that fewer ICs would be required. 1 mark for a suitable comment relating to cost or manufacture. Accept any other correctly described advantages or disadvantages.

Task			Expected answer(s)	Max mark	Additional guidance
3	a			5	1 mark for error detector with negative feedback configuration and dashed control boundary. 1 mark for microcontroller/ control unit in correct order. (do not accept 'control' on its own or 'op-amp'). 1 mark for driver, motor and gear (train) in correct order. 1 mark for vibration (frequency) sensor in correct feedback position. 1 mark for feedback loop with correct direction arrowheads (both lines).

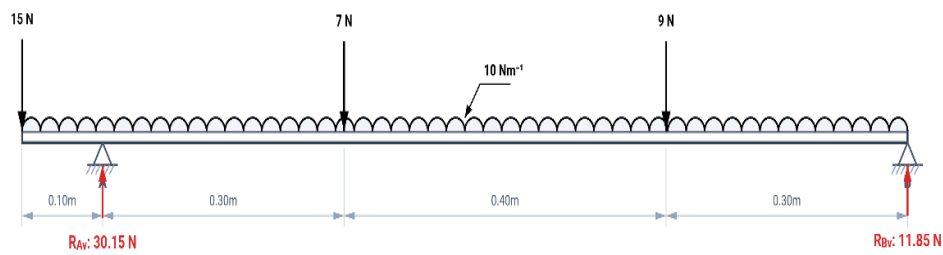
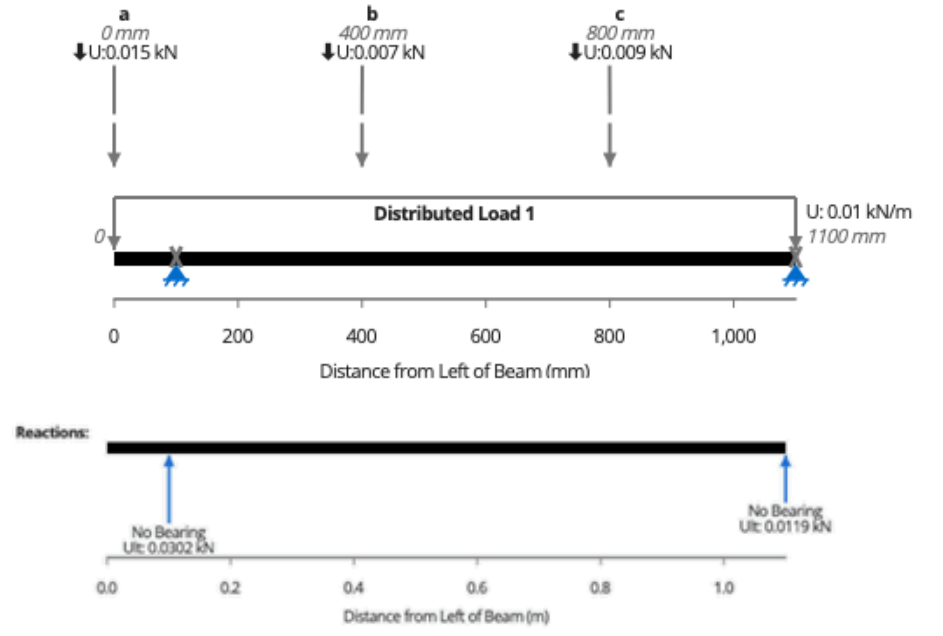
Task			Expected answer(s)	Max mark	Additional guidance
3	b			6	1 mark for digital input connected correctly to input 1 with 5 V supply. 1 mark for variable voltage analogue input connected correctly to input 0. 1 mark for LED outputs with $120\ \Omega$ resistors connected correctly to outputs 2 and 3. 1 mark for MOSFETs connected correctly to outputs 4 and 5, power supplies, and motor.

Task		Expected answer(s)	Max mark	Additional guidance
3	b	(continued)		
		<pre> graph TD Start([Start]) --> Init[/Set: output2 Off, output3 Off, output4 Off, output5 Off/] Init --> Input1{input1 On?} Input1 -- N --> Input1 Input1 -- Y --> A155{a_input0 > 155 ?} A155 -- Y --> Set3On1[/Set: output3 On/] Set3On1 --> Set5On1[/Set: output5 On/] Set5On1 --> A155 A155 -- N --> A145{a_input0 < 145 ?} A145 -- Y --> Set3On2[/Set: output3 On/] Set3On2 --> Set5On2[/Set: output5 On/] Set5On2 --> A145 A145 -- N --> Set3Off[/Set: output3 Off/] Set3Off --> Set4Off[/Set: output4 Off, output5 Off/] Set4Off --> Set2On[/Set: output2 On/] Set2On --> Wait1[Wait 0.1 s] Wait1 --> Set2Off[/Set: output2 Off/] Set2Off --> Wait2[Wait 0.1 s] Wait2 --> Stop([Stop]) </pre>	6	2 marks for fully correct flowchart. 1 mark for maximum two errors. Allow FTE from circuit.

Task			Expected answer(s)		Max mark	Additional guidance
3	c		Actual result	Amendments	5	1st actual result: 1 mark for both red LED and motor switching on. 2nd actual result: 1 mark for motor switches on and turning in same direction and red LED switches on. 2nd amendment: 1 mark for modifying flowchart to switch output 4 on. 3rd actual result: 1 mark for the green LED flashing once, motor stops, and no loop to start. 3rd amendment: 1 mark for addition on 5x loop to make green LED flash and 'stop' replaced with a loop to start.
			Red LED and motor switch on.	No amendments.		
			Motor switches on and turns in the same direction. Red LED switches on.	Modify flowchart so that output 4 switches on and motor turns in the opposite direction.		
			When input voltage is increased, the green LED flashes once, and the motor slows to a halt. Flowcharts stops.	Additon of a loop to make the green LED flash. 'stop' replaced with a loop to the start.		

Task		Expected answer(s)	Max mark	Additional guidance
3	d		1	1 mark for all correct amendments. Apply FTE from Task 3c.

Task			Expected answer(s)	Max mark	Additional guidance
3	e		i - The system does not start until the start switch is pressed. ii - When the reading was above or below the desired range, the red LED switched on. iii - When the reading was above the desired range, the motor turned. iv - When the reading was lower than the desired range, the motor turned in the opposite direction (due to amendment made). v - When the reading was within the desired range, the motor stopped, the red LED switched off, and the green LED flashed five times over one second (due to amendment made). vi - After the green LED flashed, the system returned to the start ready for the next press of the start switch.	5	All comments must be evaluative, reflect the entry in the yes/ no column, and be based on test results and amendments from Task 3c/ Task 3d. 1 mark for points i and ii. 1 mark for point iii. 1 mark for point iv. 1 mark for point v. 1 mark for point vi.

Task		Expected answer(s)	Max mark	Additional guidance
4	a	Example 1  Example 2 	2	1 mark for correct simulation, including forces and distances. 1 mark for correct reaction forces. A= 30.15 N, B= 11.85 N. Apply FTE from candidate simulation. Note: reaction forces rounding will be determined by software used.

Task			Expected answer(s)	Max mark	Additional guidance
4	b		Support A is not strong enough for the situation. Support B is strong enough.	1	1 mark for correctly stating the suitability of both supports. Apply FTE from Task 4a.

[END OF MARKING INSTRUCTIONS]