National
Qualifications
RESOURCE

X823/77/11 **Engineering Science**

Marking Instructions

Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.

General marking principles for Advanced Higher Engineering Science

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

(a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

(b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(c) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages. Do not award marks if the error significantly reduces the complexity of the remaining stages. Apply the same principle in questions which require several stages of non-mathematical reasoning.

(d) SQA presents all units of measurement in a consistent way, using negative indices where required (for example ms^{-1}). Candidates can respond using this format, or solidus format (m/s), or words (metres per second), or any combination of these (for example metres/second).

(e) For numerical questions, candidates should round their answers to an appropriate number of significant figures. However, award marks if their answer has up to two figures more or one figure less than the expected answer.
Note for 2021 only: to support teachers and lecturers in applying the marking instructions for internal assessment in session 2020-21, final answers are shown as the final calculated answer, but are not given to the appropriate number of significant figures. A candidate's answer (whether given to the correct number of significant figures or not) can be awarded marks as detailed in the marking instructions, ie there is no requirement (in this assessment, this session) to round to the correct number of significant figures to be awarded full marks.

(f) Unless a numerical question specifically requires candidates to show evidence of their working, award full marks for a correct final answer (including unit) on its own.

(g) Award marks where a labelled diagram or sketch conveys clearly and correctly the response required by the question.

(h) Award marks regardless of spelling if the meaning is unambiguous.

(i) Candidates can answer programming questions in any appropriate programming language. Award marks where the intention of the coding is clear, even where there are minor syntax errors.

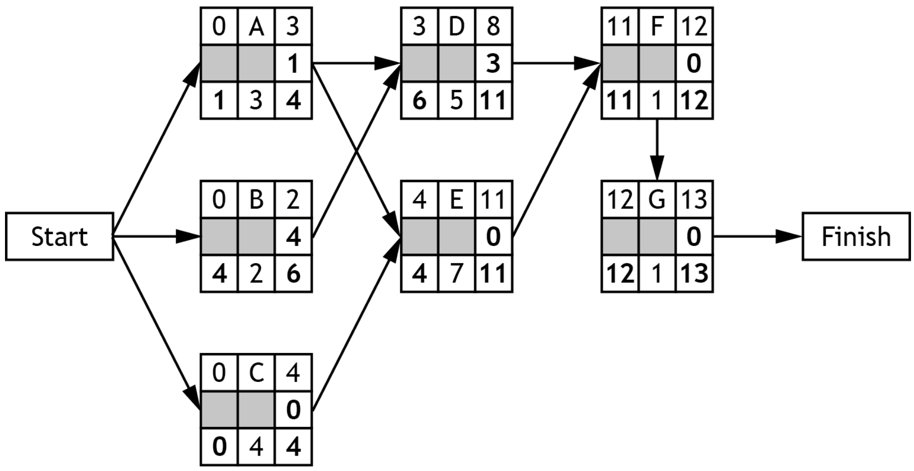
(j) For 'Explain' questions, only award marks where the candidate goes beyond a description, for example by giving a reason, or relating cause to effect, or providing a relationship between two aspects.

(k) Where separate space is provided for rough working and a final answer, only award marks for the final answer. Ignore all rough working.

Marking instructions for each question

Section 1

Question			Expected response	Max mark	Additional guidance
1.	(a)		$12 = -10k\left(\frac{5}{R}+\frac{5}{2R}+\frac{5}{4R}\right)\times\left(-\frac{10k}{10k}\right)$ $12 = 50k\left(\frac{4}{4R}+\frac{2}{4R}+\frac{1}{4R}\right)$ $12 = 50k\left(\frac{7}{4R}\right)$ $12 = \frac{350k}{4R}$ $R = \frac{350k}{48}$ $R = 7\cdot29...\ k\Omega$ $R_2 = 7\cdot3\ k\Omega$ $R_1 = 14\cdot6\ k\Omega,\ R_0 = 29\cdot2\ k\Omega$	**3**	**1 mark** Substitution into summing formula with three resistances represented as multiples of *R*. **1 mark** Correct calculation of *R*. **1 mark** State values for each resistor Recognise the MSB so that R_0 = 4*R* and R_2= *R*. R_1 and R_0 are exact multiples of R_2, defined in the first equation.
	(b)		8 values	**1**	
2.	(a)		An 'oncost' is a cost associated with the meeting of statutory requirements (such as pension contributions and NI contributions for workers during a project). A 'direct cost' is a cost that can be attributed wholly to a cost centre within the management of a project (an example being the purchase of materials for the construction of a bridge).	**2**	**1 mark** Definition of 'oncost'. **1 mark** Definition of 'direct cost'.

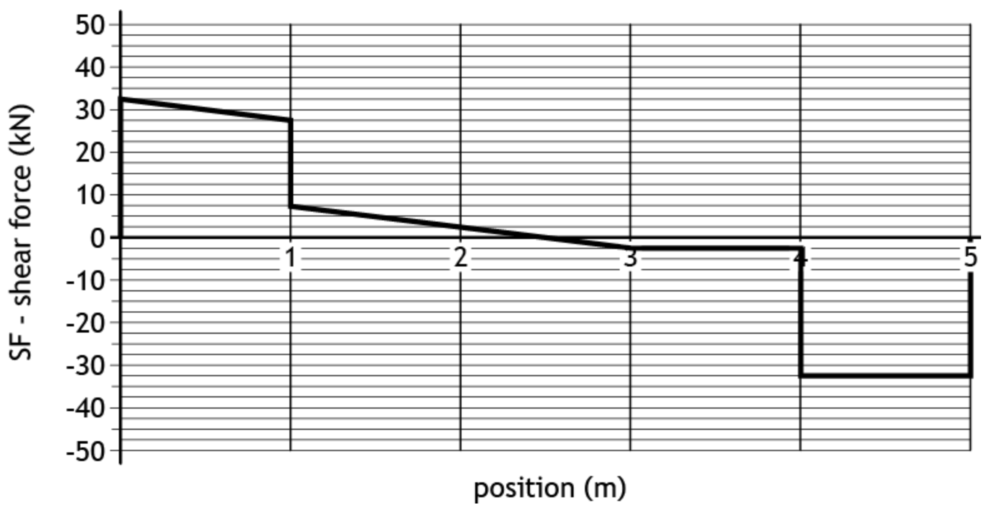
Question			Expected response	Max mark	Additional guidance
2.	(b)		 Critical path: C, E, F, G	3	**1 mark** Complete the diagram to show the interdependencies between nodes. **1 mark** Complete the LFT, LST and float entries. Note: Key point of understanding for second mark is at node A; LFT depends on EFTs of both D and E so lower value must be selected. If this selection has been made, then award this mark. **1 mark** Identify the critical path
3.	(a)		A sine wave	1	
	(b)		Minimum frequency $C_{max} = \frac{1}{2\times\pi\times10\times10^3\times1{\cdot}5\times10^3}$ $= 10{\cdot}610\ldots\times10^{-9}$ $= 11nF$ Maximum frequency $C_{min} = \frac{1}{2\times\pi\times25\times10^3\times1{\cdot}5\times10^3}$ $= 4{\cdot}2441\ldots\times10^{-9}$ $= 4{\cdot}2\,nF$ Range of values $4{\cdot}2nF - 11nF$	2	**1 mark** Calculate maximum capacitance value. **1 mark** Calculate minimum capacitance value.

Question			Expected response	Max mark	Additional guidance
4.			$\delta = \frac{FL^3}{3EI}$ $2 \cdot 1 = \frac{F \times 18^3}{3 \times 0 \cdot 9 \times 10^3 \times 6 \cdot 75}$ $F = \frac{2 \cdot 1 \times 3 \times 0 \cdot 9 \times 10^3 \times 6 \cdot 75}{18^3}$ $= 6 \cdot 6 N$	3	**1 mark** Deflection of cantilevered beam under the action of a point load, equation from data booklet. E value from data booklet. **1 mark** Max deflection is 2·1mm. Correct substitution of values (of correct magnitude) in relation to unknown F. **1 mark** Answer with correct units. Note: Candidate use of 0·9 for E would gain first mark, but not second mark. Final answer of 6·6 mN would gain follow through mark **(2 marks maximum)**
5.	(a)	(i)	It is necessary to step the voltage up using transformers to very-high tension e.g., 400 kV or 132 kV to reduce transmission I^2R (power losses). Very-high tension requires expensive infrastructure to enable safe transmission, which is mainly done over-ground, spanning long distances in typically rural areas. This is not safe in more built-up areas and so voltages must be stepped down using step-down transformers to allow for underground cabling or less intrusive, smaller, overhead lines.	2	**1 mark** Explain the need to step up voltage to reduce I^2R line power loss. **1 mark** Explain that voltage needs to be stepped down to allow cabling to be run under ground or unobtrusively over ground in built-up areas. Tension is commonly used terminology, but its use is not necessary for the first mark
		(ii)	Typical customers at point A are heavy industrial users who require the 132 kV supply. At point B, smaller, industrial customers will use the 33 kV supply, while point C represents domestic customers and small businesses using one of the phases of the 415 V supply (at 230 V).	1	**1 mark** Give examples of typical customers for the various voltages supplied at A, B and C. Accept 2 out of 3 instances for the mark.

Question			Expected response	Max mark	Additional guidance
5.	(b)		Calculate current for secondary winding of transformer: $I = \frac{P}{V} = \frac{110 \times 10^3}{11 \times 10^3} = 10\ A$ Calculate transmission power loss: $P_{loss} = I^2 R$ $= 10^2 \times 494 \times 10^{-6} \times 12 \times 10^3$ $= 593\ W$ Calculate efficiency: $\eta = \frac{P_{out}}{P_{in}} = \frac{P_{in} - P_{loss}}{P_{in}}$ $\eta = 1 - \frac{P_{loss}}{P_{in}}$ $= 1 - \frac{593}{110 \times 10^3}$ $= 0{\cdot}9946.......$ $= 0{\cdot}99\ (2\ s.f)$	3	**1 mark** Determine the current flow in the cable from the transformer. **1 mark** Determine the resistive power loss along the cable. **1 mark** Determine the transmission efficiency.

Question			Expected response	Max mark	Additional guidance
6.			KCL around Node D $I_{DB}+I_{DC}+I_{AD}=0$ $\frac{V_D - V_B}{12\times10^3}+\frac{V_D-0}{3\times10^3}+\frac{V_B-75}{6\times10^3}=0$ $-\frac{V_B}{12\times10^3}+V_D\left(\frac{1}{12\times10^3}+\frac{1}{3\times10^3}+\frac{1}{6\times10^3}\right)=\frac{75}{6\times10^3}$ $-\frac{V_B}{12\times10^3}+V_D\left(\frac{1}{12\times10^3}+\frac{4}{12\times10^3}+\frac{2}{12\times10^3}\right)=\frac{150}{12\times10^3}$ $-\frac{V_B}{12\times10^3}+V_D\left(\frac{7}{12\times10^3}\right)=\frac{150}{12\times10^3}$ Multiply through by 12000 $-V_B+7V_D=150$ **equation 1**	5	**1 mark** KCL statements at D **1 mark** KCL statements at B **1 mark** For equation 1 and equation 2 **1 mark** For correct use of elimination method or substitution method **1 mark** For calculation of current through $12k\Omega$ resistor

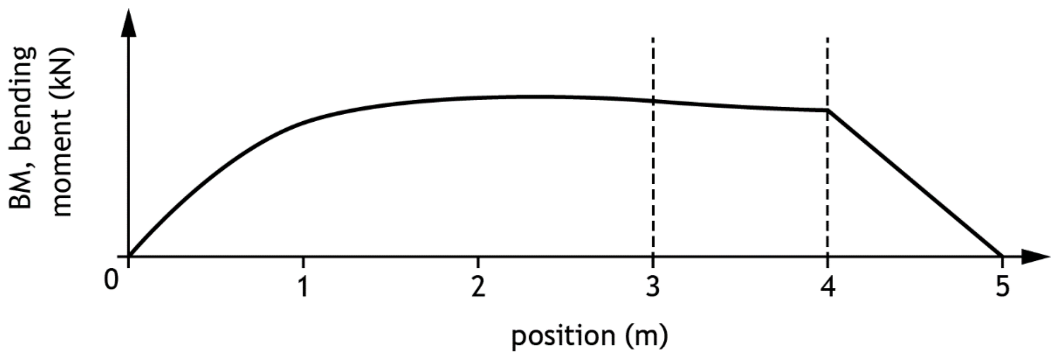
Question			Expected response	Max mark	Additional guidance
6.			KCL around Node B $I_{BC} + I_{AB} + I_{DB} = 0$ $\frac{V_B - 0}{40\times10^3} + \frac{V_B - 75}{60\times10^3} + \frac{V_B - V_D}{12\times10^3} = 0$ $V_B\left(\frac{1}{40\times10^3} + \frac{1}{60\times10^3} + \frac{1}{12\times10^3}\right)$ $-V_D\left(\frac{1}{12\times10^3}\right) = \frac{75}{60\times10^3}$ $V_B\left(\frac{3}{120\times10^3} + \frac{2}{120\times10^3} + \frac{10}{120\times10^3}\right)$ $-V_D\left(\frac{10}{120\times10^3}\right) = \frac{150}{120\times10^3}$ $V_B\left(\frac{15}{120\times10^3}\right) - V_D\left(\frac{10}{120\times10^3}\right) = \frac{150}{120\times10^3}$ Multiply through by 120000 $15V_B - 10V_D = 150$ **equation 2** Multiply equation 1 by 15 $-15V_B + 105V_D = 2250$ **equation 1** Add equations 1 and 2 $15V_B - 10V_D = 150$ $-15V_B + 105V_D = 2250$ $95V_D = 2400$ $V_D = 25\cdot263V$ Substitute V_D in equation 1 $-V_B + 7 \times 25\cdot256 = 150$ $V_B = 26\cdot842V$ $I_{DB} = \frac{26\cdot842-25\cdot263}{12000}$ $I_{DB} = 131.58\dot{3} \times 10^{-6}$ $I_{DB} = 100\,\mu A$		Note: A solution that correctly calculates V_B and V_D but not current I_{DB} scores **4 marks maximum**

Question			Expected response	Max mark	Additional guidance
7.	(a)		To find vertical reaction at end B, take moments about A. $\sum M_A = 0$ (clockwise moments are positive) $(20\times1)+\left(5\times\frac{3^2}{2}\right)+(30\times4)-(R_B\times5)=0$ $R_B = 32\cdot5kN$ To find vertical reaction at end A (R_A). $\sum F_y = 0$ ('up' forces are positive) $R_A - 20 - (5\times3) - 30 + 32\cdot5 = 0$ $R_A = 32\cdot5kN$ Working from left to right, forces on section, SF vertically down are positive, anticlockwise moments are positive.	4	**Shear force diagram** **1 mark** Reactions at supports A and B. Note: Follow through if reactions have not been calculated correctly. **1 mark** Effect of UDL (slope 5 kNm^{-1} for $0<x<3$ m). **1 mark** Effect of two point loads. **1 mark** Constant shear force ($3<x<4$ m, $4<x<5$ m).
			Shear force diagram 		

Question			Expected response	Max mark	Additional guidance
7.	(b)		**Bending Moment** Bending Moment, working from end A, $1 < x < 3$ $M - 32 \cdot 5x + 5\frac{x^2}{2} + 20(x-1) = 0$ $M = 32 \cdot 5x - 5\frac{x^2}{2} - 20(x-1)$ Clockwise moments are positive. Working from end A, $3 < x < 4$ $M - 32 \cdot 5x + 5(3)(x - 1 \cdot 5) + 20(x-1) = 0$ $M = 32 \cdot 5x - 15(x - 1 \cdot 5) - 20(x-1)$	3	**Bending moment values** **1 mark** Bending moment for x = 1 m and x = 2 m. **1 mark** Bending moment for x = 2·5 m and x = 3 m. **1 mark** Bending moment for x = 4 m.

	Position							From left-hand end (A)
	0	**1**	**2**	**2·5**	**3**	**4**	**5**	m
BM	0	30	35	35·6	35	32·5	0	kNm

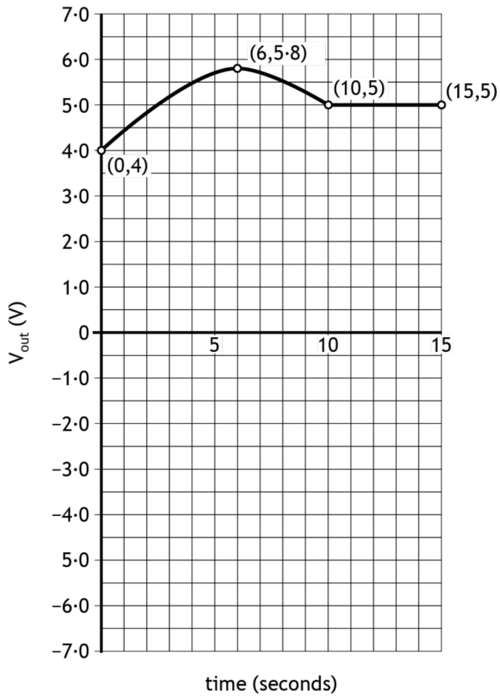
Question			Expected response	Max mark	Additional guidance
	(c)			2	**Bending moment diagram** **1 mark** Parabolic for 0<x<3 m. **1 mark** Straight line for 3<x<4 and 4<x<5 m.



Question			Expected response	Max mark	Additional guidance
8.	(a)		**Condition 1:** extended arm Consider as a cantilever beam. Maximum moment at the built-in end. Take moments at the built-in end. $M_{shoulder} = -490 \times 2 - 44 \times \frac{1 \cdot 9^2}{2}$ $= -1 \cdot 05942\ kNm$ **Condition 2:** reaction force on end of arm sufficient to lift rover. Moment at 2m from the drill reaction force, $M_{shoulder} = 3 \cdot 61 \times 10^3 \times 2 \cdot 0$ $= 7 \cdot 22\ kNm$ OR Moment at 2.25m from the rear (right-hand) wheel	4	Consider as a cantilever beam. Maximum moment at the built-in end. Take moments at the built-in end. **1 mark** Bending moment due to point load. **1 mark** Bending moment due to distributed load. Consider as a simply supported beam with point load at centre of mass. **1 mark** Moment at 2m from the drill reaction force. **1 mark** Statement of largest magnitude of bending moment and which condition produces it.
			$M_{shoulder} = -10 \cdot 3 \times 10^3 \times (4 \cdot 25 - 2 \cdot 0 - 1 \cdot 49) + 6 \cdot 69 \times 10^3 \times (4 \cdot 25 - 2 \cdot 0)$ $= 7 \cdot 2245\ kNm$ Largest bending moment is associated with 'condition 2' Largest bending moment is 7·22 kNm		

Question			Expected response	Max mark	Additional guidance
8.	(b)		Calculation of wall thickness based on a moment on a beam of $6{\cdot}55\,kNm = 6{\cdot}55 \times 10^6\ Nmm.$ $\sigma = \frac{My}{I}, \qquad I = \frac{My}{\sigma}$ $y = \frac{D}{2}, \qquad I = \frac{\pi}{64}D^4$ D is the external diameter and d is the internal diameter. $\sigma = \frac{1000}{1{\cdot}25} = 800\,Nm^{-2}$ $I = \frac{My}{\sigma} = \frac{6{\cdot}55 \times 10^6 \times \frac{50}{2}}{800}$ $I = 204{\cdot}6875 \times 10^3\ mm^4$ $I = \frac{\pi}{64}\left(D^4 - d^4\right)$ $\frac{\pi}{64}d^4 = \frac{\pi}{64}D^4 - I$ $\frac{\pi}{64}d^4 = \frac{\pi}{64} \times 50^4 - 204{\cdot}6875 \times 10^3$ $\frac{\pi}{64}d^4 = 102{\cdot}108\ldots \times 10^3$ $d = 37{\cdot}977\ldots mm$ $t = \frac{1}{2}\left(D - d\right)$ $= \frac{1}{2}\left(50 - 37{\cdot}977\ldots\right) = 6{\cdot}011\ldots$ Required wall thickness: 6 mm	4	**1 mark** Maximum stress occurs when y is the greatest, at $D/2$ Bending moment and y substituted correctly. **1 mark** Use correct stress and determine required value of "I" (second moment of area). **1 mark** Calculate required inner diameter. **1 mark** Determine wall thickness. Candidates should receive marks for working through any incorrect bending moment and may be awarded up to **(4 marks)**.

Question			Expected response	Max mark	Additional guidance
8.	(c)		On Mars gravity is 0·38 g thus the magnitude of the bending moment is reduced as the loads, and by extension the working stresses, are reduced to 38% of original values. The UTS of the material is larger at lower temperatures. Therefore, the factor of safety of the arm when on Mars is greater than on Earth because: $$FOS = \frac{UTS}{SWS}$$ The numerator increases and the denominator decreases, so FOS increases.	**2**	**1 mark** Effect on UTS of lower temperature, effect on working stress of lower gravity. **1 mark** Explanation of how both increase the factor of safety compared to operation on earth.
	(d)		$RC = 20 \times 10^3 \times 100 \times 10^{-6} = 2$ $$V_A = -\frac{1}{2}\int(2 - 0\cdot2t)\,dt$$ $$V_A = -\frac{1}{2}(2t - 0\cdot1t^2) + C$$ When t=0, V_A = 0, so C = 0 $$V_A = -t + 0\cdot05t^2$$	**2**	**1 mark** Integration to produce expression for V_A. This mark is available for $-(2t - 0\cdot1t^2)$ The inversion is recognised, and the function of t is integrated, but the RC factor is omitted. **1 mark** Find V_A by applying the condition for its value when t = 0 Note that this mark is not available if 1. if the integration is completed but without consideration of the initial condition (no constant of integration C) and/or 2. if the RC time constant has been omitted.

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>8.</td><td>(e)</td><td></td><td>


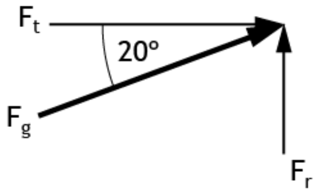
</td><td>3</td><td>
1 mark
Inverted sum

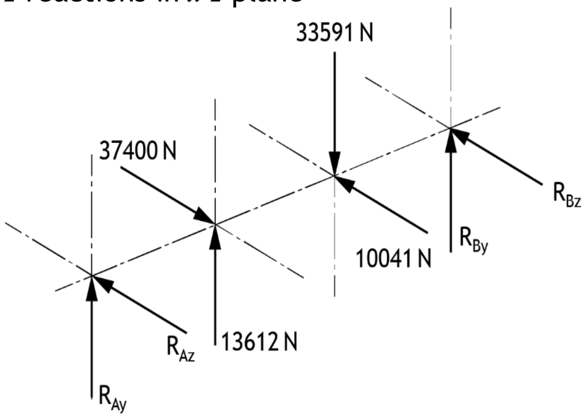
1 mark
Curve and straight sections

1 mark
Plot values

t = 0, 4 V
t = 6, 5·8 V
t = 10, 5 V
t = 15, 5V
</td></tr>
</table>

Question			Expected response	Max mark	Additional guidance
8.	(f)		From the graph V_{GS} = 3·9V I_D = 920μA V_S = 920 × 10^{-6} × 1·5 x 10^3 V_S = 1·38V V_G = 1·38 + 3·9 V_G = 5·28 V $\frac{R_1}{R_2} = \frac{18 - 5 \cdot 28}{5 \cdot 28}$ $R_1 = 2 \cdot 4\dot{0}\dot{9} \times R_2$ Using the design rule $\frac{1}{R_T} = \frac{1}{2 \cdot 4\dot{0}\dot{9} R_2} + \frac{1}{R_2}$ Working with all resistances in kΩ $\frac{1}{100} = \frac{1}{2 \cdot 4\dot{0}\dot{9} R_2} + \frac{1}{R_2}$ $\frac{1}{100} = \frac{3 \cdot 4\dot{0}\dot{9}}{2 \cdot 4\dot{0}\dot{9} R_2}$ R_2 = 141·509 … $R_1 = 141 \cdot 509 \ldots \times 2 \cdot 4\dot{0}\dot{9}$ $R_1 = 340 \cdot \dot{9}\dot{0}$ R_1 = 340$k\Omega$, R_2 = 140$k\Omega$	5	**1 mark** Determine suitable value for V_{GS} and I_D from graph **1 mark** Calculate V_S **1 mark** Calculate V_G (if V_G is the value of V_{GS} from the graph do not award this mark) **1 mark** Calculate resistor ratio. **1 mark** Calculate correct values for R_1 and R_2 Note: V_{GS} – theoretically $3 \cdot 92V \left(\frac{k}{2} = 250 \times 10^{-6}\ AV^{-2} \right)$ Accept $V_{GS} = 3 \cdot 9\text{V} - 3 \cdot 95\text{V}$ Accept $I_{DS} = 910\mu\text{A} - 930\mu\text{A}$ Within these ranges $141k\Omega \le R_1 \le 142k\Omega$ $342k\Omega \ge R_2 \ge 337k\Omega$ Both ranges will round to $R_1 = 340k\Omega, R_2 = 140k\Omega$

Question			Expected response	Max mark	Additional guidance
9.	(a)		$T = Fr$ $T = (15700\text{-}14200) \times \frac{1\cdot2}{2}$ $= 900$ Nm  $F_t = \frac{T}{r_g} = \frac{900}{\left(\frac{0\cdot3}{2}\right)} = 6 \times 10^3$ N $F_r = F_t \tan\theta$ $= 6 \times 10^3 \tan 20^\circ$ $= 2\cdot18....$ kN $= 2\cdot2$ kN	**3**	The torque at the gear must be equal and opposite to the torque applied by the loads on the pulley. **1 mark** Calculate the net torque on the pulley. The gear force F_g can be resolved into a tangential (horizontal), F_t, force and a radial (vertical), F_r, force which are related by the fixed pressure angle of 20°. Tangential force provides the balancing torque. **1 mark** Calculate the tangential component of the gear force. **1 mark** Calculate the radial component of the gear force.
	(b)		The gear force is an action force from a gear pair and therefore acts in the direction of rotation. This means that the gear and the pulley (they are connected) is rotating in a counterclockwise direction, therefore the lift is being raised.	**2**	**1 mark** Gear force is an 'action' force in the direction of rotation – it produces the driving torque. **1 mark** Gear and pulley turn in the direction of the driving torque – anticlockwise.

Question			Expected response	Max mark	Additional guidance
9.	(c)		not to scale y reactions in x-y plane z reactions in x-z plane  To find the force at end B, take moments about end A, $\sum M_A = 0$ Moments of forces in vertical plane (x-y) $-(13612 \times 0 \cdot 1) + (33591 \times 0 \cdot 4) - (R_{By} \times 0 \cdot 7) = 0$ $R_{By} = 17250.28\ldots N$ Moments of forces in horizontal plane (x-z) $(37400 \times 0 \cdot 1) - (10041 \times 0 \cdot 4) - (R_{Bz} \times 0 \cdot 7) = 0$ $R_{Bz} = -394 \cdot 85\ldots N$ Reaction at B, $R_B = \sqrt{R_{By}^2 + R_{Bz}^2}$ $R_B = \sqrt{(17250 \cdot 28\ldots)^2 + (-394 \cdot 85\ldots)^2}$ $= 17254 \cdot 798\ldots N$ $R_B = 17 \cdot 3 kN$	4	**1 mark** Resolve the pulley and gear forces. The vertical 33591 N force is comprised of the 23550 N force due to the lift and the vertical component at 45° of the counterweight, 10041 N. **1 mark** Calculate bearing load in the vertical plane. **1 mark** Calculate bearing load in the horizontal plane. If moment equilibrium is written correctly for both planes, but one or both reactions are miscalculated, then award second mark but not third mark. **1 mark** Calculate magnitude of bearing load. This mark is available as follow through if moments have been attempted in both planes.

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>9.</td><td>(d)</td><td></td><td>For equilibrium
$T = T_L$
$\left(600 + 2n\right) = 80\sqrt{n}$
$(600 + 2n)^2 = 6400n$
$360000 + 2400n + 4n^2 = 6400n$
simplify
$n^2 - 1000n + 90000 = 0$
Solve the quadratic equation for roots of n,
$n = \frac{-\left(-1000\right) \pm \sqrt{(-1000)^2 - \left(4 \times 1 \times 90000\right)}}{2 \times 1}$
$n = \frac{1000 \pm 800}{2} = 100\, or\, 900\, rev\ min^{-1}$</td><td>3</td><td>1 mark
Recognise that system is in equilibrium so torques must balance.
$T = T_L$ OR $\left(600 + 2n\right) = 80\sqrt{n}$

1 mark
Rearrange to form quadratic.

1 mark
Solve for two possible running speeds with units.

Note:
$n^2 - 1000n + 90000 = 0$
$\Rightarrow \left(n^2 - 100\right)\left(n - 900\right) = 0$
$\Rightarrow n - 100 = 0$ OR $n - 900 = 0$
$n = 100$ OR $n = 900$</td></tr>
<tr><td></td><td>(e)</td><td></td><td>$M_a = \frac{4029 - 1664}{2 \cdot 5} = 946$

$M_i = \frac{3357\text{-}1259}{2.5} = 839 \cdot 2$

Gain error = $946 / 839 \cdot 2 = 1 \cdot 127$
Gain error = 1·13</td><td>3</td><td>1 mark
Calculate Ma.

1 mark
Calculate Mi.

1 mark
Calculate the gain error.</td></tr>
<tr><td></td><td>(f)</td><td></td><td>In the first program the status flag is overwritten every time a new button is pressed.

In the second program a bitwise OR operation ensures that the status of each bit is not overwritten.

Example:

10001100 | 00000001
will give 10001101</td><td>2</td><td>1 mark
Identify that flag is overwritten each time

1 mark
Recognise that bitwise OR operation allows flag to be updated without overwriting previous bits</td></tr>
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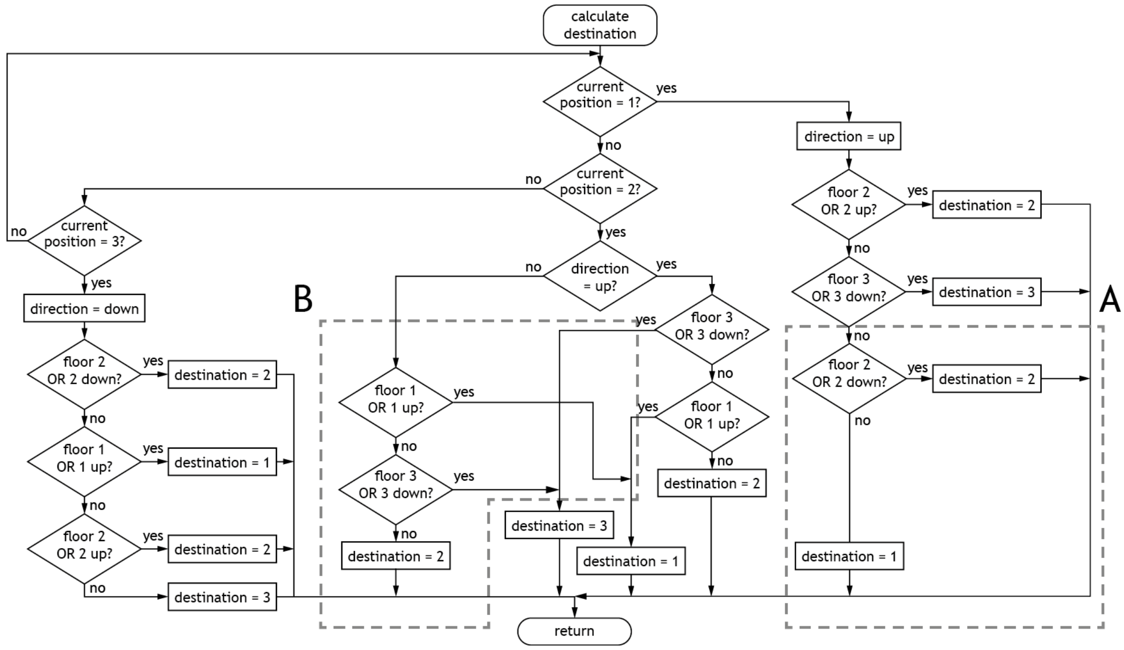
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>9.</td><td>(g)</td><td></td><td colspan="3">



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<tr><td></td><td></td><td></td><td></td><td>3</td><td>

1 mark
Correctly identify that floor 2 and 2 down must be checked and correctly assign destinations for "yes" and "no" conditions – all conditions must "return".

1 mark
Decisions and destinations set correctly at B for both possible calls and in correct order.

1 mark
Destination set correctly at B for case where both test results are "no" conditions which must "return".

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[END OF MARKING INSTRUCTIONS]