2014 Technological Studies

Higher

Finalised Marking Instructions

Part One: General Marking Technological Studies Higher

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

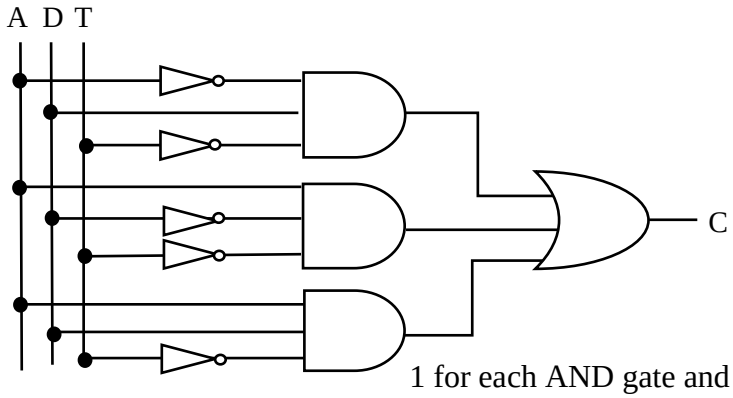
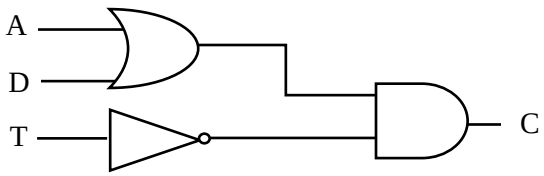
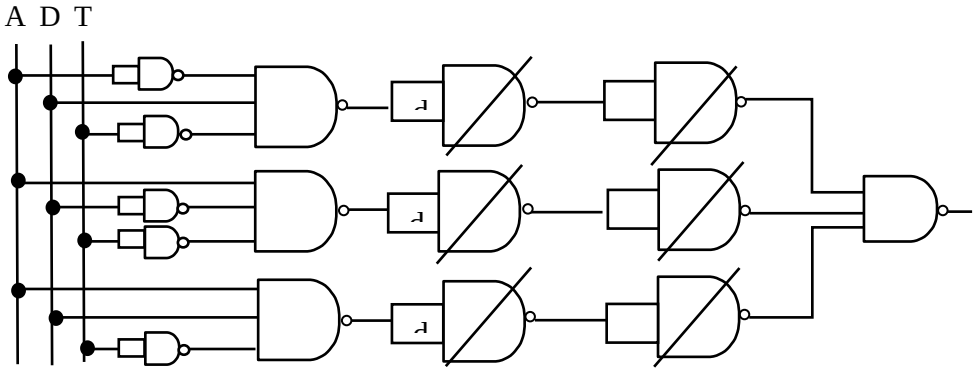
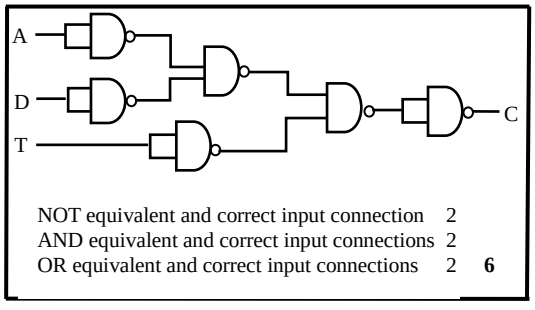
(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

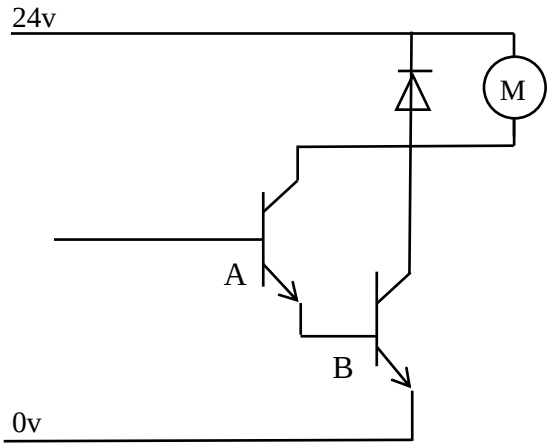
GENERAL MARKING ADVICE: Technological Studies Higher

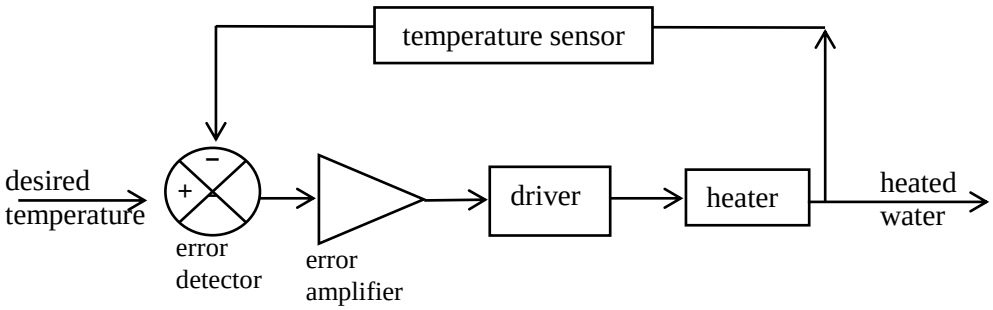
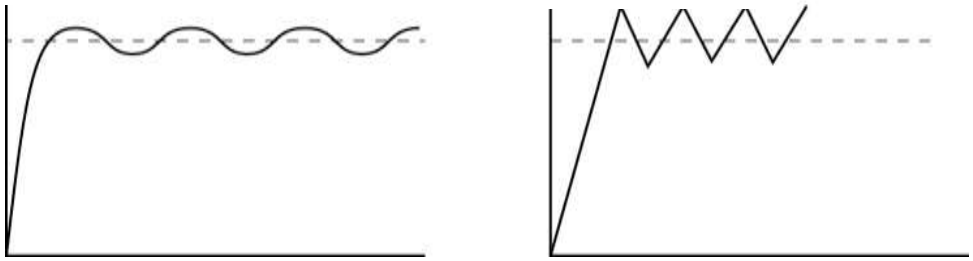
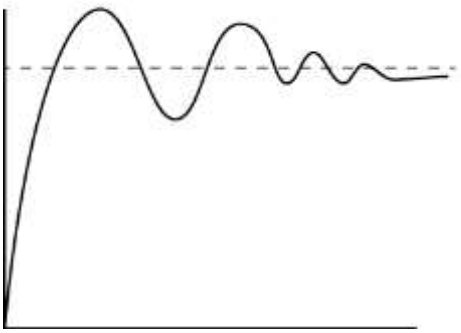
The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

Question			*Mark Allocation*			*Marks*	
1	**a**	**i**	feedspeed:	if pin 1 = 1 then finefeed		2	
				if pin 2 = 1 then draftfeed		2	
				return			
			finefeed:	gosub fine		1	
				return			
			draftfeed:	gosub draft		1	
				return	1 for all 3 returns	1	**7**
		ii	draft:	for b0 = 1 to 255		1	
				high 7			
				pause 10			
				low 7	1 high & low 7	1	
				pause 2	1 both pauses	1	
				next b0		1	
				return	1 including label	1	**5**
	b		time for each counter loop = 3060/255		both substitutions	1	
				= 12ms	answer	1	
				ratio 3:9			
				mark 3ms		1	
				space 9ms		1	**4**
							(16)

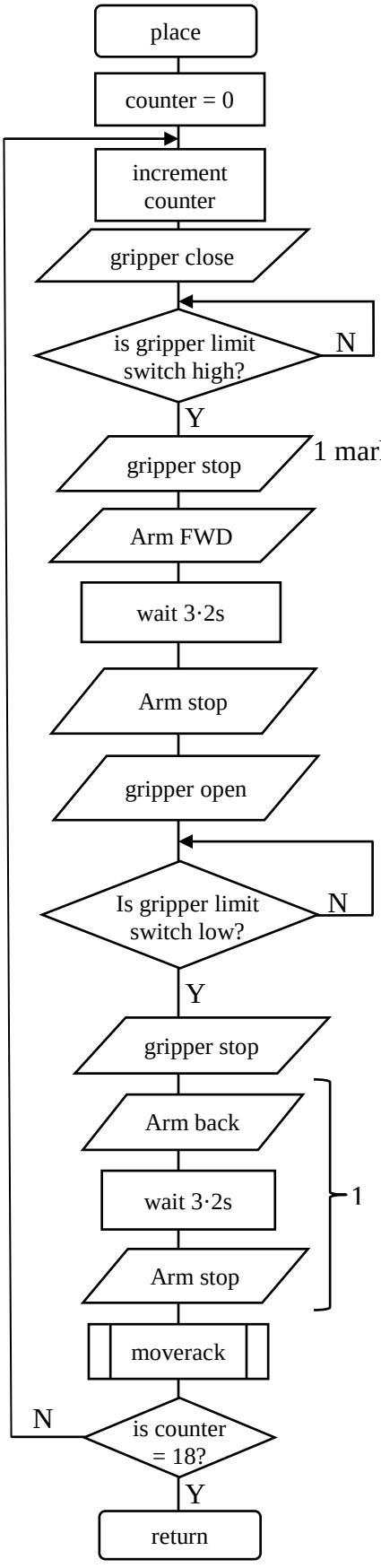
Question			Mark Allocation		Marks	
2	**a**		$C = (\overline{A}.D.\overline{T}) + (A.\overline{D}.\overline{T}) + (A.D.\overline{T})$	1 mark for each item in brackets 1 for linking with OR function	3 1	**4**
			OR			
			$C = \overline{T}.(A + D)$	*(A + D)* *T.* *NOT T*	*2* *1* *1*	
	b		Logic 0	answer	1	**1**
	c			NOT gates 1 for each AND gate and its input connections OR gate	2 3 1	**6**
			OR 	OR gate and correct inputs 2 NOT gate and correct inputs 2 AND gate and correct inputs 2		
	d					
			OR 	NOT equivalent and correct input connections AND equivalent and correct input connections OR equivalent and correct input connections Cancellation of redundant gates	2 2 1 1	
			NOT equivalent and correct input connection 2 AND equivalent and correct input connections 2 OR equivalent and correct input connections 2 **6**			**6**
						(17)

Question			*Mark Allocation*		*Marks*	
3	**a**		forces in balance (1) / structure stationary **<u>or</u>** at rest (1)			**2**
	b		$\Sigma F_V = 0$			
			$R_{AV} = 6 \cdot 9\sin 39 + 0 \cdot 8\sin 12 + 1 \cdot 2\cos 28$	3 components @1 each	3	
			$= 4 \cdot 34 + 0 \cdot 17 + 1 \cdot 06$			
			$= 5 \cdot 57\text{kN}$	answer (units not necessary)	1	
			$\Sigma F_H = 0$			
			$R_{AH} = 6 \cdot 9\cos 39 - 0 \cdot 8\cos 12 - 1 \cdot 2\sin 28$	3 components @1 each	3	
			$= 5 \cdot 36 - 0 \cdot 78 - 0 \cdot 56$			
			$= 4 \cdot 02\text{kN}$	answer (units not necessary)	1	
			$R_A = \sqrt{(5 \cdot 57^2 + 4 \cdot 02^2)}$	formula and calculation	1	
			$= 6 \cdot 87\text{kN}$	answer including units	1	
			$\theta = \tan^{-1}(5 \cdot 57 / 4 \cdot 02)$	formula and calculation	1	
			$= 54 \cdot 2°$	answer including units	1	**12**
						(14)

Question			Mark Allocation		Marks	
4	**a**		Resistance of thermistor at 16°C = 80kΩ		1	
			$R_V/33 = 10/80$	substitutions	1	
			$R_V = 10/80 \times 33$ $= 4{\cdot}13\text{k}\Omega$	answer including units	1	**3**
	b		$85\% \times 6 = 5{\cdot}1\text{V}$		1	
			$I_B = (5{\cdot}1 - 0{\cdot}7)/2000$	substitutions	1	
			$= 2{\cdot}20\text{mA}$	answer	1	
			$P = VI$ $I_C = 20/24$			
			$= 0{\cdot}833\text{A}$	answer	1	
			$h_{FE} = 833/2{\cdot}2$	substitutions	1	
			$= 379$	answer (no units)	1	**6**
	c		Protect transistor (1) / from back e.m.f.(1)			**2**
	d	**i**	$I_C = 50/24$	substitutions	1	
			$= 2{\cdot}08\text{A}$	answer	1	
			$h_{FE} = 2080/1.85$ ($I_B = (5.1 - 1.40/2000)$	substitutions	1	
			$= 1124$	answer (no units)	1	**4**
		ii				
				Transistor A with correct connections	1	
				Transistor B with correct connections	1	
				Motor and diode with correct connections	1	**3**
	e		From table, $h_{FE1} = 120$		1	
			$h_{FE2} = \frac{1124}{120}$	substitutions	1	
			$= \underline{9.37}$	answer (no units)	1	**3**
						(21)

Question			Mark Allocation		Marks
5	**a**	**i**			
			desired position signal & correct connection to error detector	1	
			error detector & error amplifier	2	
			driver	1	
			heater and output	1	
			temp. sensor and correct feedback loop	1	**6**
		ii	Comparator	1	**1**
	b	**i**	TEMPERATURE (°C) **OR** TEMPERATURE (°C) 		
			Two correct axes	1	
			"Desired Temp" line	1	
			1st over shoot around desired temp	1	
			Cycle repeats a few times	1	**4**
	c	**i**	Difference Amplifier	1	**1**
		ii			
			Error reducing	1	
			Steady Output	1	**2**
					(14)

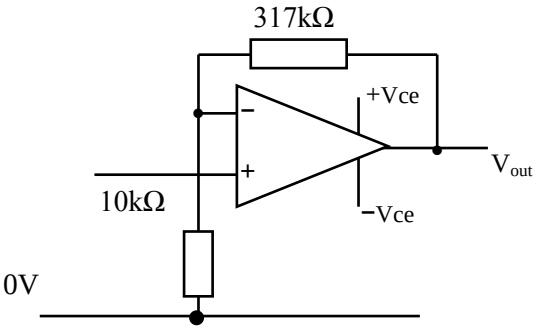
Question			*Mark Allocation*	*Marks*	
6	**a**		$A = 26 \times 6 = 156mm^2$ answer (units not necessary)	1	
			$\sigma = F / A$		
			$= 40/156$ correct substitution of values using a load value within elastic region	1	
			$= 0 \cdot 256 kN/mm^2$ correct calculation (units not necessary)	1	
			$\varepsilon = \Delta l / 1$		
			$= 0 \cdot 2/120$ correct substitution of values using the corresponding extension value	1	
			$= 0 \cdot 00167$ correct calculation	1	
			$E = \sigma / \varepsilon$		
			$= 0 \cdot 256/0 \cdot 00167$ correct substitution into correct formula	1	
			$= 153 kN/mm^2$ correct answer including correct units	1	**7**
	b	**i**	Material stretches elastically then returns to original length		**2**
		ii	stretches elastically until passes yield point, then plastic stretching	1	
			does not return to original length/stays permanently deformed.	1	**2**
					(11)

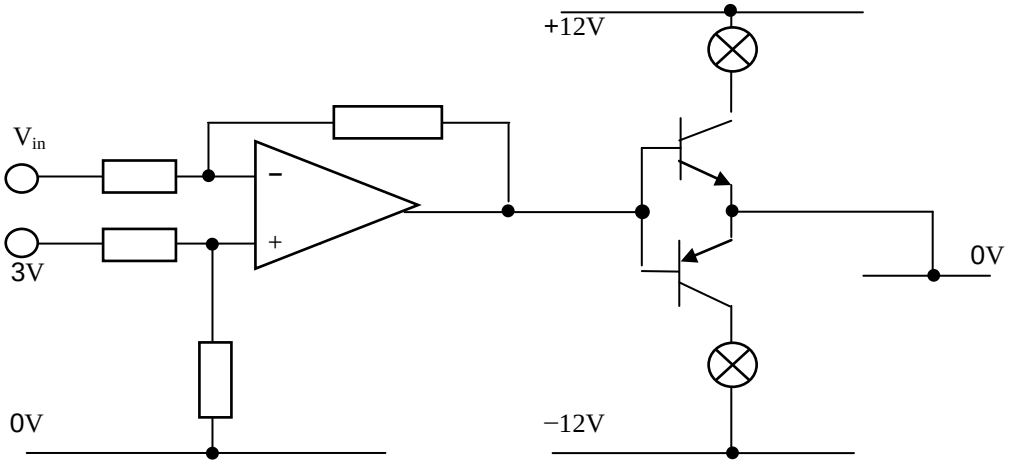
Question	*Mark Allocation*	*Marks*	
7		1 mark for each command with correct connections 1 mark for correct loop back to beginning	14 1 1

(16)

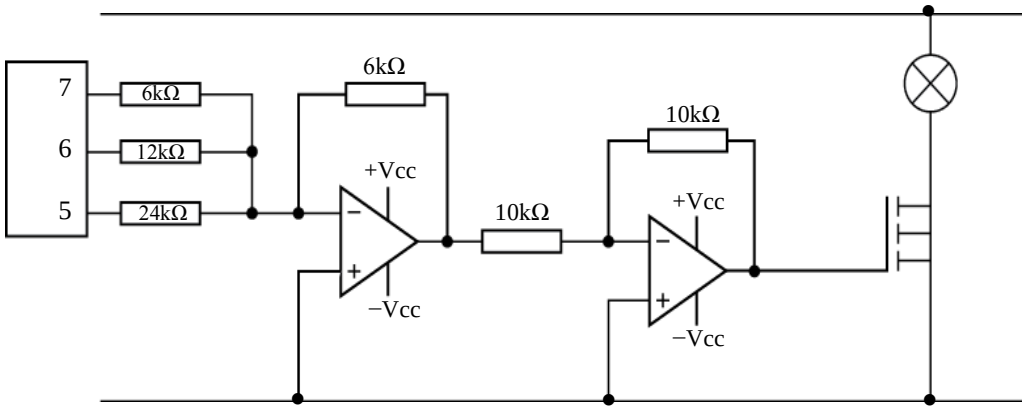
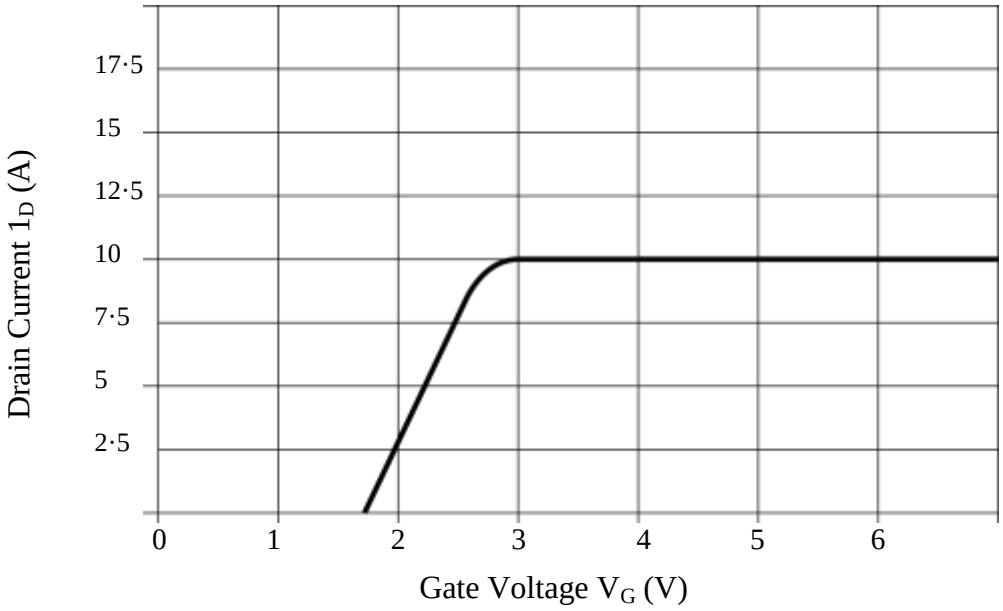
Question			*Mark Allocation*		*Marks*	
8	**a**	**i**	Inverting			**1**
		ii	Increase gain / re-inverts to +ve output			**2**
	b		$V_{out} = 6 \times 0{\cdot}85$			
			$= 5{\cdot}1V$	answer including units	1	
			$A_V = 20/10 = 2$	answer	1	
			$V_1 = 5{\cdot}1/2$	substitutions	1	
			$= 2{\cdot}55V$	answer	1	
			1^{st} amp: $A_V = 2{\cdot}55/0{\cdot}68$	substitutions	1	
			$= 3{\cdot}75$	answer	1	
			$R = 3{\cdot}75 \times 12$	substitutions	1	
			$= 45k\Omega$	answer including units	1	**8**
						(11)

Question			Mark Allocation		Marks	
9	**a**		Distance CD = tan30 × 3·46 = 2m	answer	1	
			Vertical component of 2·9kN force = 2·9 × sin45 = 2·05kN	answer	1	
			$\Sigma M_D = 0$			
			$(C_{horizontal} \times 2) + (2{\cdot}05 \times 1{\cdot}73) = (4 \times 3{\cdot}46)$	3 moments @ 1 each	3	
				use of 1·73m	1	
			$(C_{horizontal} \times 2) + 3{\cdot}55 = 13{\cdot}84$			
			$C_{horizontal} = 5{\cdot}15$kN	answer	1	
			Reaction at C = 5·15/cos30	substitution	1	
			= 5·94kN	answer	1	**9**
	b		<u>Analysing Node A</u>			
			$F_{AB} = 4/\sin 30$	substitution	1	
			= 8kN (STRUT)	magnitude with unit (1) & nature (1)	2	
			$F_{AE} = 8\cos 30^o$	substitution	1	
			= 6·93kN (TIE)	magnitude with unit (1) & nature (1)	2	
			<u>Analysing Node B</u>			
			$\Sigma F_H = 0$ (→ +ve)			
			$F_{BD} \cos 30 - 8\cos 30 + 5{\cdot}94\cos 30 = 0$		1	
			$F_{BD} - 8 + 5{\cdot}94 = 0$		1	
			F_{BD} = 2·06kN (STRUT)	magnitude with unit (1) & nature (1)	2	**10**
	c		Compensates for changes in temperature			**2**
	d		$I_c = 10/12 = 0{\cdot}83$A	substitution (1) answer (1)	2	
			$I_b = 0{\cdot}83/200 = 4{\cdot}15$mA	substitution (1) answer (1)	2	
			V_{drop} across 320Ω = $320 \times 4{\cdot}15 \times 10^{-3}$	substitution	1	
			= 1·328V	answer	1	
			V_{out} = 1·328 + 0·7			
			= 2·028V	answer	1	
			Error = 2·028/20	substitution & gain of 20	1	
			= 0·1014V	answer	1	
			V at inverting input = 12 × 120·03/240·15 = 6.00V	answer	1	
			V at non-inverting input = 5·998 + 0·1014			
			= 6·10V	answer	1	
			R_V = 330 × 6.00/6·10	substitution	1	
			= 325Ω	answer including units	1	**13**
	e		As V_{in} increases, non-inverting input greater than inverting input of op-amp1		1	
			op-amp 1 output switches high		1	
			L_1 switches on		1	
			as voltage increases L_2 turns on		1	
			as L_2 switches on L_1 switches off		1	
			as voltage increases L_3 switches on and L_2 switches off		1	**6**
						(40)

Question			*Mark Allocation*		*Marks*	
10	**a**	**i**	input voltage = 140 × 0·7 = 98mV	answer	1	
			gain = (3·2/98 × 10^{-3}) = 32·7	answer	1	
			R_f/R_i = 32·7 – 1 = 31·7	answer	1	
			R_i = 10kΩ			
			R_f = 317kΩ	two suitable resistors in kΩ range	1	
				non-inverting amp	1	**5**
						
		ii	input to ADC at 0·56N/mm^2 = 3·2 × 0·56/0·7	all substitutions	1	
			= 2·56V	answer	1	
			ADC output = 255 × 2·56/4·8	all substitutions	1	
			= 136	answer	1	
			output as binary 10001000	answer	1	**5**
	b		tyrewarn: low4		1	
			gosub adcread	allocated below		
			(let) TEMP = DATA	let is optional	1	
			high 4		1	
			gosub adcread	both adcread	1	
			(let) PRESS = DATA		1	
			if PRESS < 160 then lowtemp		2	
			if PRESS > 200 then hightemp		1	
			return	including label ‘tyrewarn’	1	
			lowtemp: if TEMP < 30 then incpressure		1	
			lowon: gosub low		1	
			return			
			incpressure: PRESS = PRESS + 20		1	
			if PRESS < 160 then lowon		1	
			return			
			hightemp: if TEMP > 140 then decpressure		1	
			highon: gosub high		1	
			return			
			decpressure: PRESS = PRESS − 20		1	
			if PRESS > 200 then highon		1	
			return	all 4 returns	1	**18**

Question			Mark Allocation	Marks	
10			**(cont)**		
	c		When V_{in} = 0V: T1 is on and Yellow lamp on; T4 is on	2	
			When V_{in} = 2V: T1 is on but Yellow lamp off; T4 is off	2	
			When V_{in} = 3V: T2 is on (T1 off) but Red lamp off; T3 is off	2	
			When V_{in} = 4V: T2 is on and Red lamp on; T3 is now on	2	**8**
	d				
			correct diff amp & connections (incl 3V and V_{in})	1	
			A_V = 0.7	1	
			Resistor values R_f = 7k; R_1 =10k; (or equivalent ratio)	1	
			Diagram of complete push-pull driver	1	**4**
					(40)

Question			*Mark Allocation*		*Marks*	
11	**a**		Holds position/precision/quick stop – start	any 2@1		**2**
	b		crowdspot: gosub adcread		1	
			if data > 182 then movespot		2	
			return	(mark allocated below)		
				calc.no of step loops (144/1·8)/4 = 80/4 = 20	2	
				calc. pause 4000/80 = 50ms	1	
			movespot: for b1 = 1 to 20	incl.*next b1* below	1	
			(let) pins = %1010 0000			
			pause 50			
			(let) pins = %1001 0000			
			pause 50			
			(let) pins = %0101 0000			
			pause 50	correct step sequence	1	
			(let) pins = %0110 0000	all 4 pauses	1	
			pause 50			
			next b1			
			pause 1500		1	
				calc. pause 1600/80 = 20	1	
			for b1 = 1 to 20	incl.*next b1* below	1	
			(let) pins = %0110 0000			
			pause 20			
			(let) pins = %0101 0000			
			pause 20			
			(let) pins = %1001 0000			
			pause 20			
			(let) pins = %1010 0000	correct step sequence	1	
			pause 20	all 4 pauses	1	
			next b1			
			return	both returns	1	**15**
	c	**i**	E = 196kN/mm^2	from data book	1	
			UTS = 430 N/mm^2	from data book	1	
			$\sigma = 430/10 = 43$N/mm^2	answer	1	
			$\varepsilon = \sigma/E = 43/196 \times 10^3$	all substitutions	1	
			$= 0{\cdot}219 \times 10^{-3}$	answer	1	
			$\Delta 1 = \varepsilon \times 1 = 0{\cdot}219 \times 10^{-3} \times 120$	all substitutions	1	
			$= 0{\cdot}026$mm	answer & units	1	**7**
		ii	Force on each bolt = 330/2 = 165 + 50	answer (165)	1	
			=215N	answer	1	
			$A = F/\sigma = 215/43$	both substitutions	1	
			$= 5{\cdot}00$mm^2	answer	1	
			$d = \sqrt{4A/\pi} = \sqrt{4 \times 5{\cdot}00/3{\cdot}14}$	transposition	1	
			$= 2{\cdot}52$mm	answer including units	1	**6**

Question			*Mark Allocation*	*Marks*	
11	**d**		(cont)  6kΩ resistor 1 input resistors — 12kΩ resistor 1 24kΩ resistor 1 inverting amp 1 gain of -1 (resistors in kΩ range) 1		**5**
			 V_T at 1·75V 1 gradient = 10 1 saturation line 1 using straight line on sloping line 1 blended curve between slope and saturation line 1		**5**
					(40)

[END OF MARKING INSTRUCTIONS]