2013 Technological Studies

Advanced Higher

Finalised Marking Instructions

Part One: General Marking Principles for Technological Studies Advanced 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.

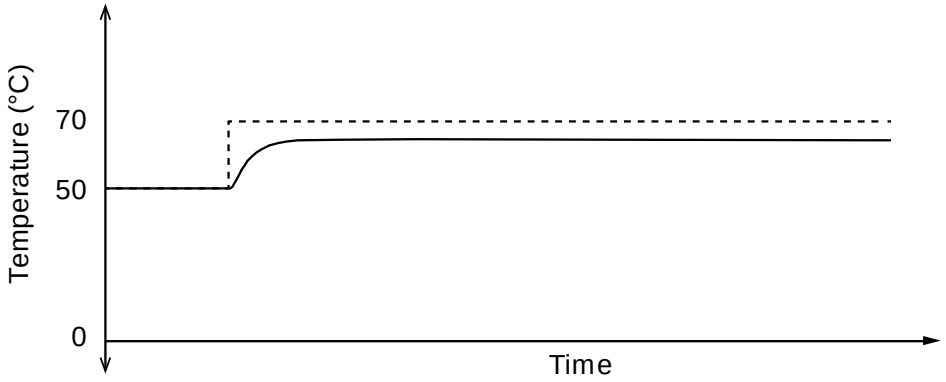
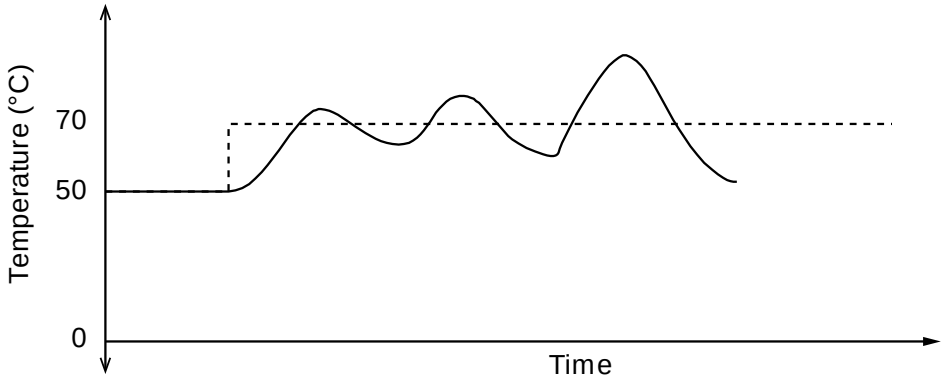
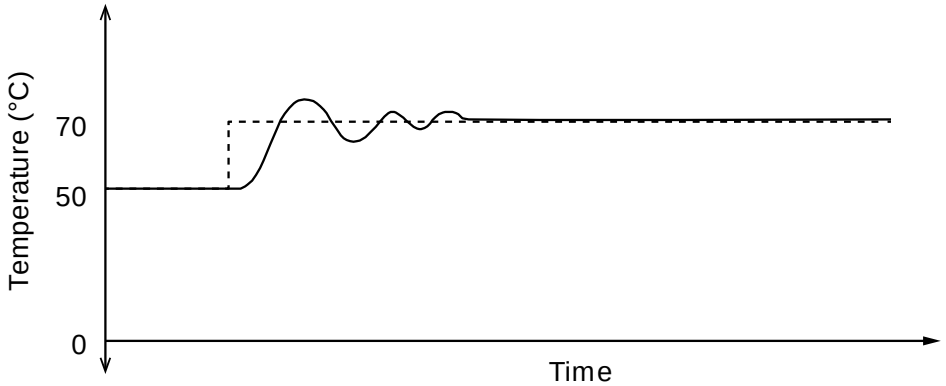
(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

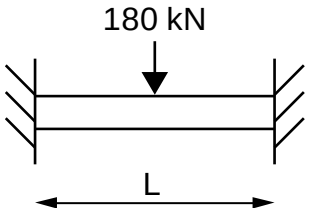
GENERAL MARKING ADVICE: Technological Studies Advanced Higher

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.

Section A

Q1

		Marks
(a) (i)		**2**
(ii)		**2**
(iii)		**2**
(b)	**Integral** removes the offset.	**2**
(c)	**Derivative** reduces hunting.	**2**
		(10)

		Marks	
Q2			
(a)	Rail is not symmetrical on each side of neutral axis		**1**
(b)			
	$M = \frac{FL}{8}$		
	$I = 20{\cdot}1 \times 10^6\ mm^4$		
	$\sigma_{max} = 150N/mm^2$ (tensile)		
	$y_1 = 79{\cdot}3mm$ – compression		
	$y_1 = 74{\cdot}7m$ – tension		
	$\frac{M}{I} = \frac{\sigma}{y}$		
	$M = \frac{\sigma I}{y}$		
	For tension:		
	$M_T = \frac{150 \times 20{\cdot}1 \times 10^6}{74{\cdot}7} = 40\,361\,446\ Nmm$	4	
	$L = \frac{8M}{F}$		
	$L_T = \frac{8 \times 40\,361\,446}{180 \times 10^3}$	2	
	$L_T = 1794mm$		
	Max. Allowable span = 1.79m	1	
			7

Q2

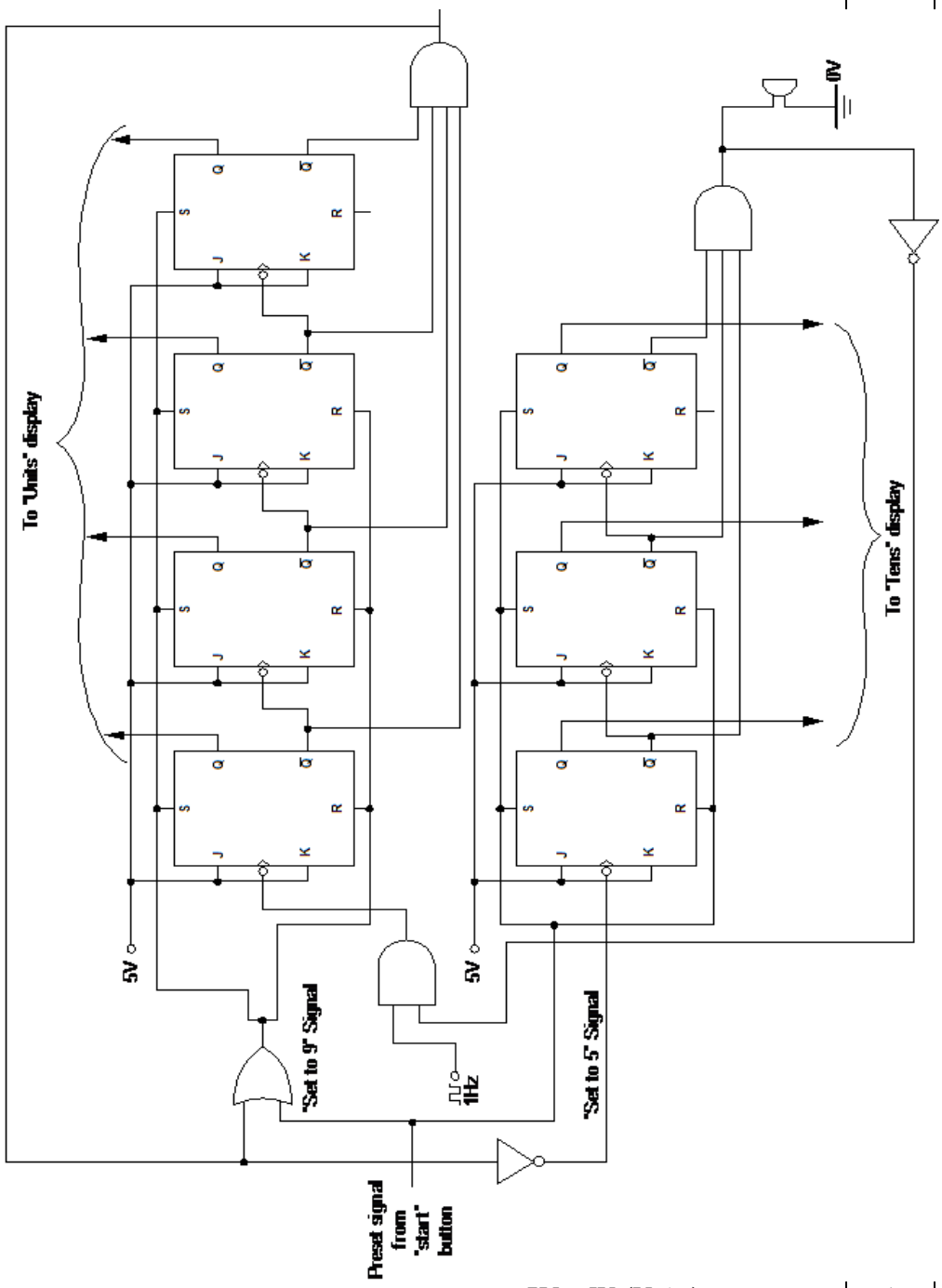
		Marks	
(c)	$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$		
	$R = \frac{EI}{M}$		
	$R_c = \frac{200 \times 10^3 \times 20{\cdot}1 \times 10^6}{38\,020\,176}$	2	
	= 10 5 733 mm = 105m	1	**3**
	OR (alternative answer for full marks)		
	$R_T = \frac{200 \times 10^3 \times 20{\cdot}1 \times 10^6}{40\,361\,446}$		
	= 99 600 mm = 99·6m		
			(11)

Q3

					Marks	
(a)	main:	call	adcread		1	
		movlw	d‘128’		1	
		subwf	DATA		1	
		btfsc	STATUS, Z		1	
		goto	main		1	
		btfss	STATUS, C		1	
		goto	low		1	
		call	RAISE		1	
		goto	main	for both	1	
	low:	call	LOWER		1	
		goto	main	given above		**10**
(b)	RAISE:	movlw	d‘4’		1	
		movwf	COUNTER			
	loop:	movlw	b‘01100000’	1 mark for label	1	
		movwf	PORTB		1	
		movlw	d‘1’		1	
		call	wait		1	
		movlw	b‘01000000’		1	
		movwf	PORTB			
		movlw	d‘199’		1	
		call	wait		1	
		decfsz	COUNTER, F		1	
		goto	loop		1	
		return			1	**11**
						(21)

Q4

	Marks	



5V – JK (Units)		1	
5V – JK (Tens)		1	
$\overline{Q}$ – CLK (Units)		1	
$\overline{Q}$ – CLK (Tens)		1	
$\overline{Q}$ – AND (Units)		1	
AND – CLK (Tens)		1	
AND – OR		1	
Units SET	Set to 9	1	
Units RESET	Set to 9	1	
Tens SET	Set to 5	1	
Tens RESET	Set to 5	1	
Inverter to CLK (Tens)		2	
			(13)

Q5

			Marks	
read:	bcf	STATUS, C	1	
	movlw	d‘8’	1	
	movwf	COUNTER	1	
loop:	bcf	STATUS, C	1	
	btfss	PORTB, 3	1	
	bsf	STATUS, C	1	
	rlf	BUFFER, F	1	
	movlw	d‘3’	1	
	call	pause		
	decfsz	COUNTER, F	1	
	goto	loop	1	
	movlw	d‘4’	1	
	movwf	COUNTER		
loop 2:	bsf	PORTB, 7	1	
	movlw	d‘250’	1	
	call	pause		
	bcf	PORTB, 7	1	
	movlw	d‘250’	1	
	call	pause		
	decfsz	COUNTER, F	1	
	goto	loop 2	1	
	return		1	
				(18)

			Marks	
Q6				
(a)	A	Push switch sets SR, enabling counter;	1	
		disables reset of counter.	1	
	B	Counts clock pulses.	1	
	C	Decodes binary number into decimal .	1	
	D	AND gates cause reset of SR on count 7; disables and clears counter	3	
	E	Logic Array decodes decimal into sequence of machine.	1	**8**

(b)

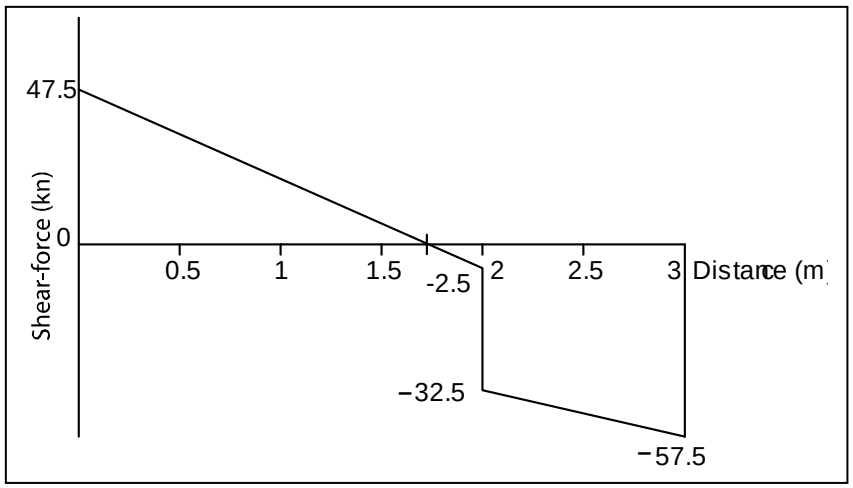
Counter Count	Tail Wag	Walk	Left Eye	Right Eye	Bark	Flip
0	0	0	0	0	0	0
1	1	1	1	0	0	0
2	1	1	0	1	0	0
3	1	1	1	0	0	0
4	1	1	0	1	0	0
5	1	1	0	0	1	0
6	0	0	0	0	0	1
7	RESET					

1 each correct column	6	
1 for reset on 7.	1	**7**
		(15)

	Marks

Q7

(a) (i)



4

(ii) $\frac{47\cdot5}{50}\times 2 = 1\cdot9\text{m From LHE}$

2

(b) From LHE

0·5m : $(47\cdot5\times 0\cdot5) - (0\cdot5\times 25\times 0\cdot25)$ = 20·625 kNm
1m : $(47\cdot5\times 1) - (1\times 25\times 0\cdot5)$ = 35 kNm
1·5m : $(47\cdot5\times 1\cdot5) - (1\cdot5\times 25\times 0\cdot75)$ = 43·125 kNm
2m : $(47\cdot5\times 2) - (2\times 25\times 1)$ = 45 kNm
2·5m : $(47\cdot5\times 2\cdot5) - (2\cdot5\times 2\cdot5\times 1\cdot25) - (0\cdot5\times 30)$ = 25·6 kNm

Distance from left hand end (m)	0m	0·5	1m	1·5m	2m	2·5m	3m
Bending moment (kNm)	0	20·6	35	43·1	45	25·6	0
	1	2	2	2	2	2	1

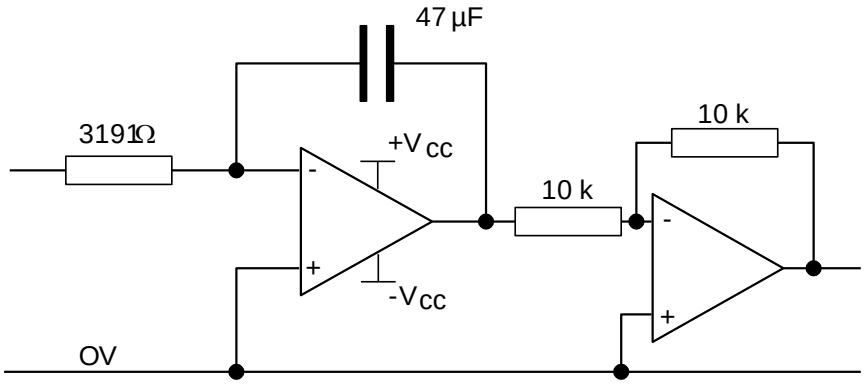
12

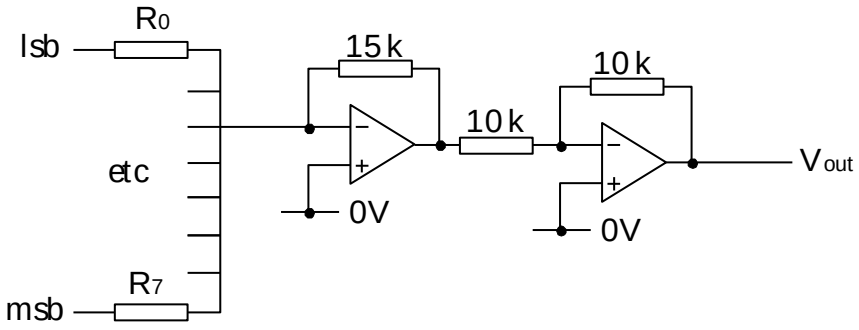
(18)

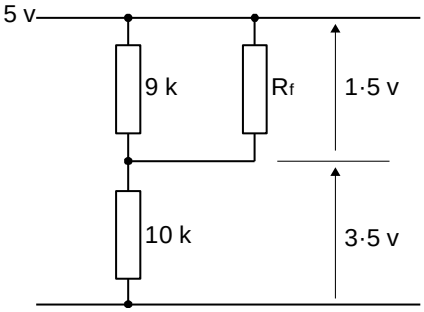
			Marks	
Q8				
(a)	(i)	Three (push to make) switches each send a signal to ss(ii)	1	
	(ii)	Three SR bistables each set by a contestant, lights their lamp.	1	
		All reset by quizmaster	1	
	(iii)	AND gate triggers monostable;	1	
		disables contestant switches.	1	
		One contestant disables other two	1	
	(iv)	Monostable provides a signal to astable,	1	
		when triggered low.	1	
	(v)	When output from (iv) goes high,	1	
		astable is enabled; buzzer sounds,	1	
		at set frequency for a fixed time.	1	
				11
(b)		Frequency: $f = \frac{1 \cdot 44}{(R_1 + 2R_2)C}$		
		$f = \frac{1 \cdot 44}{(1\times10^{3} + 2\times10^{3})\times1\times10^{-6}}$	2	
		f = 480 Hz	1	**3**
				(14)

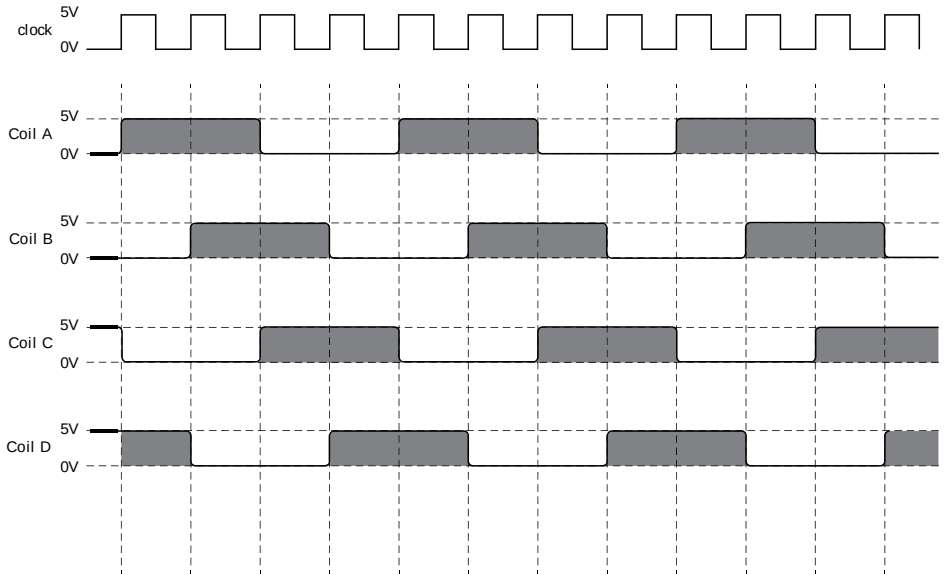
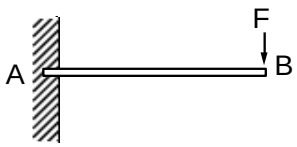
Q9

				Marks	
(a)	main:	btfss	PORTB, 1	1	
		goto	main		
	loop:	bsf	PORTB, 7	1	
		movfw	MARK	1	
		call	pause		
		bcf	PORTB, 7	1	
		movfw	SPACE	1	
		call	pause		
		btfss	PORTB, 4	1	
		goto	decrease	1	
		movlw	d‘2’	1	
		addwf	MARK, F	1	
	decrease:	btfss	PORTB, 3	1	
		goto	opto	1	
		movlw	d‘2’	1	
		subwf	MARK, F	1	
	opto:	btfss	PORTB, O	1	
		goto	opto	1	
		incf	COUNT	1	
		rlf	COUNT, F	1	
		rlf	COUNT, F	1	
		bsf	PORTB, 6	1	
		movfw	COUNT	1	
		call	pause		
		bcf	PORTB, 6	1	
		btfsc	PORTB, 5	1	
		end		1	
		goto	main	1	**24**

			Marks	
Q9				
(b)	(i)	$V_{out} = \frac{1}{RC}\int V_{in}\, dt$		
		$V_{out} = \frac{1}{RC} V_{in} \times t$	1	
		$8 = \frac{1}{R \times 47 \times 10^{-6}} \times 6 \times 0 \cdot 2$	3	
		$R = \frac{6 \times 0 \cdot 2}{8 \times 47 \times 10^{-6}}$	1	
		$R = 3191\Omega = 3 \cdot 19k\Omega$	1	**6**
	(ii)			**2**

		Marks	
Q9			
(c)	$V_{out} = \frac{1}{255} \times 9V = 0 \cdot 03529 V increments$	1	
	$-0 \cdot 03529 = \frac{-15}{Ro} \times 6$	1	
	$R_o = \frac{15 \times 6}{0 \cdot 03529}$	1	
	$R_o = 2550\ k\Omega$	1	
	Resistor ladder is: $R_o = 2550\ k\Omega$ $R_1 = 1275\ k\Omega$ $R_2 = 638\ k\Omega$ $R_3 = 319\ k\Omega$ $R_4 = 159\ k\Omega$ $R_5 = 79 \cdot 7\ k\Omega$ $R_6 = 39 \cdot 8\ k\Omega$ $R_7 = 19 \cdot 9\ k\Omega$	1	
		3	**8**
			(40)

			Marks	
Q10				
(a)	Sub-system A:	The voltage divider (R_1, R_2 and R_f) provide a reference into the non-inverting input.	1	
		When non-inverting > inverting input, output is 5V.	1	
		Rate of charge of capacitor determined by resistance of proximity sensor (frequency).	1	
		When inverting input > non-inverting, output goes low, capacitor discharges and device oscillates.	1	
		Soft Stop is caused by proximity sensor resistance increasing causing frequency to decrease.	1	
	Sub-system B:	Sub-system A clocks the 4 D-types.	1	
		$\overline{Q}$ from B causes a zero on D for two pulses, then two '1's repeating.	1 1	
		Coils are energised by Q going high.	1	
		Any 8 points at 1 mark each		**8**
(b)	Switch-off threshold = 3·5V			
	$\therefore$ V_{out} is presently high: V_{out} = 5V		1	
		9k and R_f in parallel V_{lower} = 3·5V V_{upper} = 1·5V	1 1	
	$\frac{R_p}{10} = \frac{1 \cdot 5}{3 \cdot 5}$		1	
	$R_p = \frac{1 \cdot 5 \times 10}{3 \cdot 5} = 4 \cdot 29\,k\Omega$		1	
	$4 \cdot 29 = \frac{9 \times R_f}{9 + R_f}$			
	$(9 + R_f)\ 4 \cdot 29 = 9\ R_f$		1	
	$38 \cdot 6 + 4 \cdot 29\ R_f = 9\ R_f$		1	
	$4 \cdot 71\ R_f = 38 \cdot 6$			
	$R_f = 8 \cdot 20\ k\Omega$		1	**8**

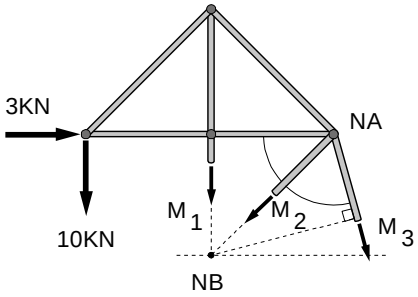
		Marks	
Q10			
(c)		2 2 2 2	**8**
(d)	(i)  = FL at A; $= \frac{FL^3}{3EI}$ at B		
	$M = FL = 2000 \times 1000 = 2 \times 10^6$ Nmm	1	
	$I = My/\sigma = (2 \times 10^6 \times 40)/100 = 800\,000$ mm^4	2	
	$800\,000 = (BD^3/12) - (bd^3/12)$	1	
	$800\,000 = (80^4/12) - (bd^3/12)$	1	
	$800\,000 = (3\,413\,333 - (bd^3/12)$	1	
	$2\,613\,333 = d^4/12$ (b = d)	1	
	$d^4/12 = 2\,613\,333$	1	
	$d^4 = 31\,360\,000$	1	
	$d = 74{\cdot}83$ mm	1	
	$t = \frac{80 - 74{\cdot}83}{2}$	1	
	$t = 2{\cdot}58$ mm	1	**12**
(d)	(ii) $\delta = \frac{FL^3}{3EI}$		
	$\delta = (2000 \times 1000^3)/(3 \times 196\,000 \times 800\,000)$	2	
	$\delta = (2 \times 10^{12})/(470{\cdot}4 \times 10^9)$	1	
	$\delta = 4{\cdot}25$ mm	1	**4**
			(40)

Q11

					Marks	
(a)	alert:	clrf	DISTRESS		1	
		call	S_TEST		1	
		call	O_TEST	(for both 'S')	1	
		call	S_TEST			
		movlw	d'3'		1	
		subwf	DISTRESS		1	
		btfsc	STATUS, Z		1	
		bsf	PORTB, 5		1	
		end			1	**8**
(b)	S_TEST:	clrf	DOTCOUNT		1	
		movlw	d'3'		1	
		movwf	COUNTER			
	loop:	btfss	PORTB, O		1	
		goto	loop		1	
		movlw	d'1'		1	
		call	wait			
		btfss	PORTB, O		1	
		incf	DOTCOUNT, F		1	
		decfsz	COUNTER, F		1	
		goto	loop		1	
		movfw	DOTCOUNT		1	
		xorlw	d'3'		1	
		btfsc	STATUS, Z		1	
		incf	DISTRESS		1	
		return			1	
						14

Q11 Structural Tower

(c)



$$\Sigma M_{NA} = 0 + \circlearrowright$$

$$-(10\times 4)-(M_1\times 2)=0$$

$$M_1 = \frac{-40}{2} = -20\text{kN (STRUT)}$$

4

$$\Sigma M_{NB} = 0 + \circlearrowright$$

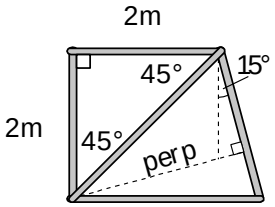
$$-(10\times 2)+(3\times 2)+(M_3\times \text{perp}_1)=0$$

$$-20+6+2\cdot 5M_3 = 0$$

$$M_3 = \frac{+14}{2\cdot 45}$$

$$M_3 = +5\cdot 71\,\text{kN (TIE)}$$

6

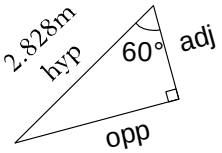


$$\sin 60^\circ = \frac{\text{perp}}{2\cdot 828}$$

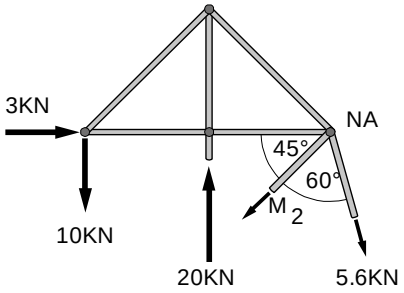
$$\text{perp} = 2\cdot 828\sin 60^\circ$$

$$\text{perp} = 2\cdot 45\text{m}$$

2



hyp = $\sqrt{8}$ = 2·828m



$$\Sigma V = 0 \uparrow +$$

$$-10+20-5\cdot 71\cos 15^\circ - M_2\cos 45^\circ = 0$$

$$-10+20-5\cdot 51 = M_2\times 0\cdot 707$$

$$M_2 = \frac{+4\cdot 49}{0\cdot 707}$$

$$M_2 = +6\cdot 35\,\text{kN (TIE)}$$

6 | **18**

	Marks
	(40)

[END OF MARKING INSTRUCTIONS]