2015 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.

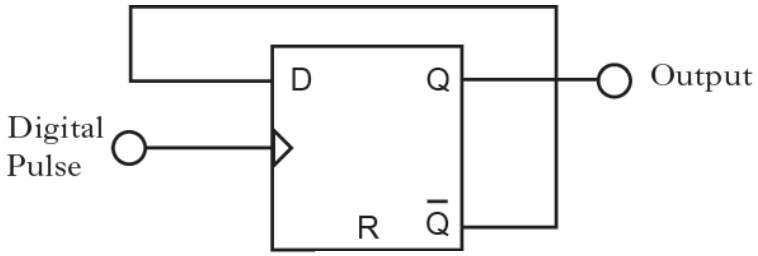
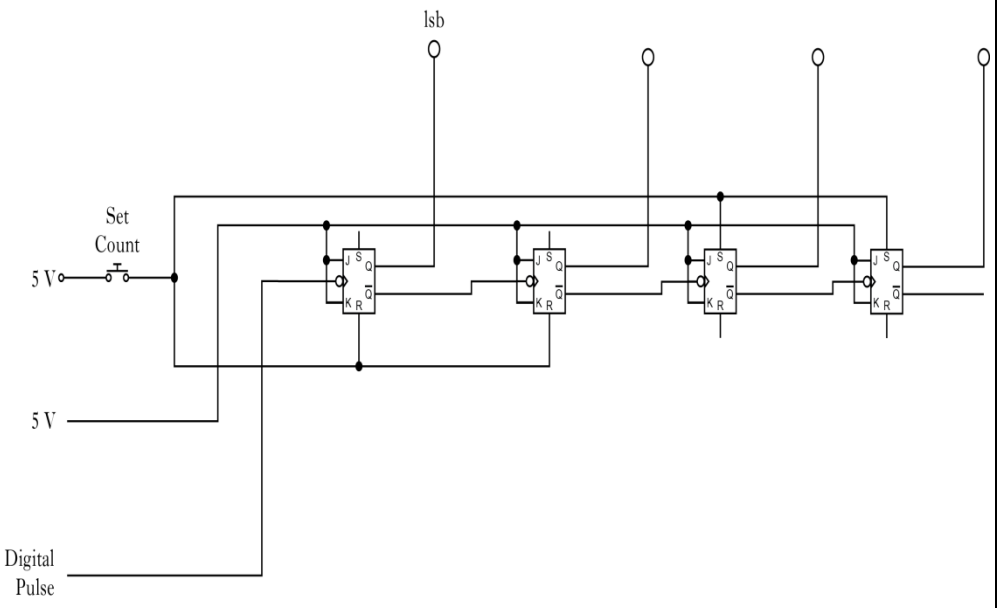
(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

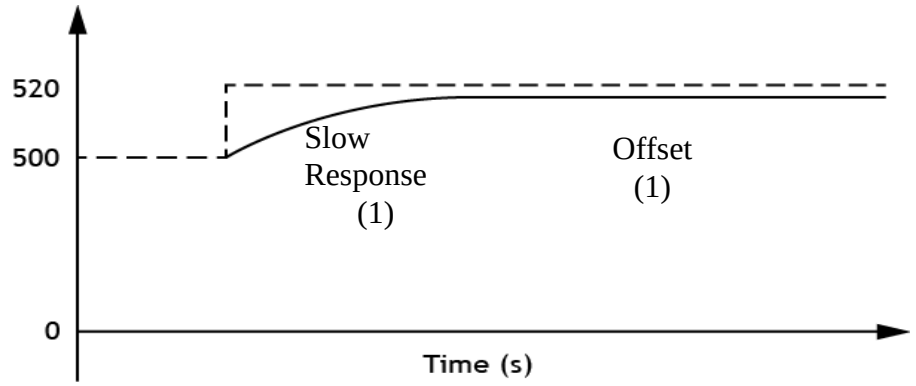
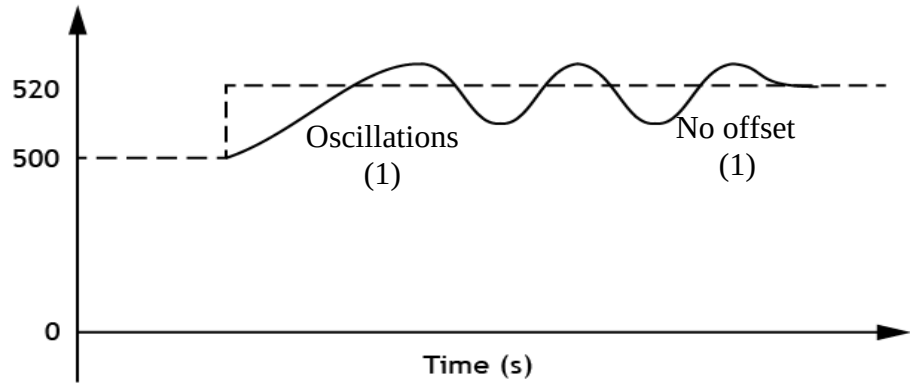
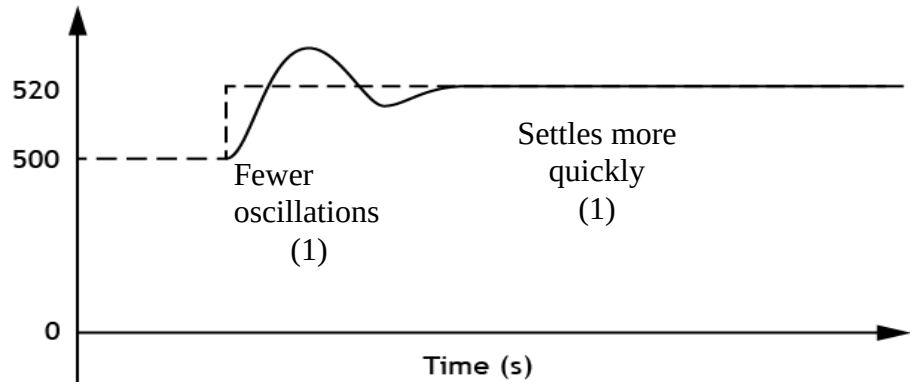
GENERAL MARKING ADVICE: Technological Studies Advanced Higher

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.

Part Two: Marking Instructions for each Question

Section A

		Marks
Q1	**(a)** 	**2**
	(b) 	**6**
	(c) $1024 = 2^{10} = 10$	**2**
		(10)

		Marks
Q2 (a) (i)		**2**
(ii)		**2**
(iii)		**2**
(b) PID control adds extra functions to proportional control in ideal conditions. While proportional tries to minimise the error, PI eliminates it, but PID eliminates it with a faster response time.		**3**
		(9)

			Marks	
Q3	**(a)**	$I = bd^3 / 12$		
		$= 100 \times 100^3 / 12$	1	
		$= 8{\cdot}33 \times 10^6$ mm^4	1	
		$y = 50$ mm		
		$M = \sigma I / y$		
		$= 220 \times 8333333{\cdot}3 / 50$	3	
		$M = 36{\cdot}7 \times 10^6$ Nmm	1	
		$M = \frac{\omega L^2}{8}$		
		$L = [\ 8M/\omega\ ]^{1/2}$	1	
		$= [\ 8 \times 36{,}666{,}666{\cdot}67 / 7{\cdot}65\ ]^{1/2}$	2	
		$L = 6{\cdot}19$ m	1	**10**
	(b)	$M/I = \sigma/y = E/R$		
		$R = (E y) / \sigma$		
		$= (196000 \times 50) / 220$	2	
		$R = 44{\cdot}5$ m	1	**3**
	(c)	Reduced weight	1	
		Increased strength/weight ratio	1	
				2
		Any one point per mark.		
				(15)

				Marks	
Q4	**(a)**	10 digital inputs Analogue input 1 ADC LCD output Flash/EEPROM Internal memory 4 outputs Internal clock			
			Any six points 1 mark each		**6**
	(b)	Plan the program			
		Write the code	text editor		
		Assemble the code	assembler		
		Download to PIC	programmer		
		Test the program	Download cable		
			Any six		**6**
					(12)
Q5	**(a)**	Sub A = RC circuit, charges via 1K & 1M		2	
		Sub B = voltage divider, provides 1/3 & 2/3 reference voltages		2	
		Sub C = two comparators, comparing capacitor voltage with ref voltages		1	
		Sub D = SR bistable, set and reset by comparators		2	
		Sub E = DPDT relay, used to:-		1	
			discharge capacitor when voltage > 2/3,	1	
			charge up capacitor when voltage < 1/3,	1	
			provide flashing switching for lamp	1	
					11
	(b)	Limited frequency range due to being a mechanical device.		1	
		Wear of components means it has a finite life		1	**2**
					(13)

						Marks	
Q6	**(a)**	main:	bcf	PORTB,3	;mux measure left wheel		
			call	adcread			
			movwf	LEFTSPEED			
			bsf	PORTB,3			
			call	adcread			
			movwf	RIGHTSPEED	;mux measure right wheel		
			movfw	RIGHTSPEED	;subtract		
			subwf	LEFTSPEED,W			
			btfsc	STATUS,Z	;zero error		
			goto	main			
			btfss	STATUS,C	;carry bit means + error (or zero)		
			goto	right			
			call	brakeleft			
			goto	main			
		right:	call	brakeright			
			goto	main	1 mark per line		**14**
	(b)	brakeleft:	movwf	ERROR			
			rlf	ERROR,F	Double the error value (gain x2)		
			movfw	ERROR	Use as mark value for PWM		
			movwf	MARK			
					2 marks	2	
			comf	MARK,W			
			movwf	SPACE	Use twos complement of mark value as space value		
					2 marks	2	
			bsf	PORTB,7			
			movfw	MARK	Apply left brake for MARK ms		
			call	pause			
			bcf	PORTB,7	Release left brake for SPACE ms		
			movfw	SPACE			
			call	pause			
					2 marks	2	
		brakeright:	comf	ERROR,F	Do twos complement		
			incf	ERROR,F	Add 1 (correct negative value)		
					2 marks	2	**8**
							(22)

				Marks	
Q7	**(a)**	Serial-In-Parallel-Out			**1**
	(b)	Sub A	2-bit binary up counter plus AND gate; Sends pulse to Sub C when count = 3: this enables display	2	
		Sub B	3-bit SIPO shift register; Stores a 3-bit binary value	2	
		Sub C	binary – 7 seg decoder; converts binary value to decimal; inputs blanked when $\overline{BI}$ low; preventing display of incomplete value	4	
		Sub D	7-seg display, displays decimal of number in SIPO; when binary-7seg decoder is enabled	2	**10**
					(11)
Q8	**(a)**	$M = F \times L = 2500 \times 210 = 525000$ Nmm		2	
		$\sigma = M\,y / I = [\ 525000 \times 25\ ] / 260\,000$		3	
		$= 50{\cdot}5$ N/mm^2		1	**6**
	(b)	E for aluminium alloy = 70×10^3 N/mm^2			
		$\delta = F\,L^3 / 3EI$		1	
		$= 2500 \times 210^3 / 3 \times 70 \times 10^3 \times 260\,000$		2	
		$= 2{\cdot}31525 \times 10^{10} / 5{\cdot}46 \times 10^{10}$			
		$= 0{\cdot}424$ mm		1	**4**
					(10)

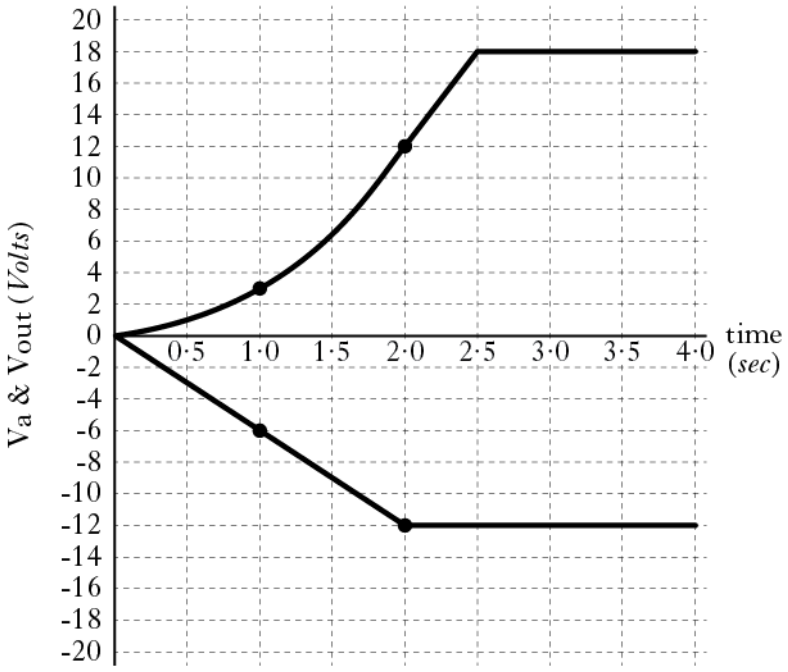
		Marks
Q9	**(a)** $V_a = -1 / (1 \times 10^6 \ \ 1 \times 10^{-6}) \ \times \int 6 \ dt$	
	$= -6t$	**4**
	(b) $V_{out} = -1 / (1 \times 10^6 \times 1 \times 10^{-6}) \ \times \int 6 \ dt$	
	$= +6/2 \ t^2$	
	$= 3 \ t^2$	**4**

(c)

Time	V_a		V_{out}	
0·0	0		0·00	
0·5	−3		0·75	
1·0	−6	1	3·00	1
1·5	−9		6·75	
2·0	−12		12·00	
2·5	−12		15·00	
3·0	−12	1	18·00	1
3·5	−12		18·00	
4·0	−12		18·00	

5

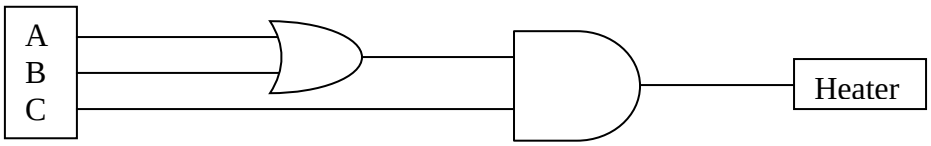
(d)



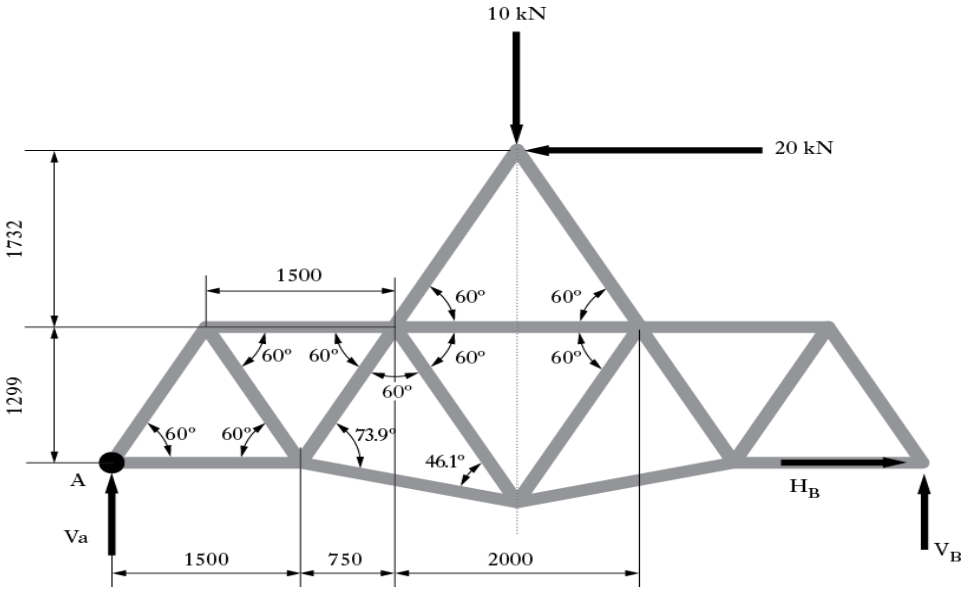
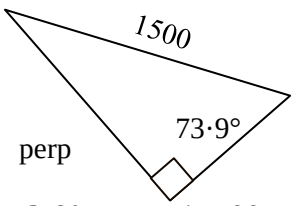
2

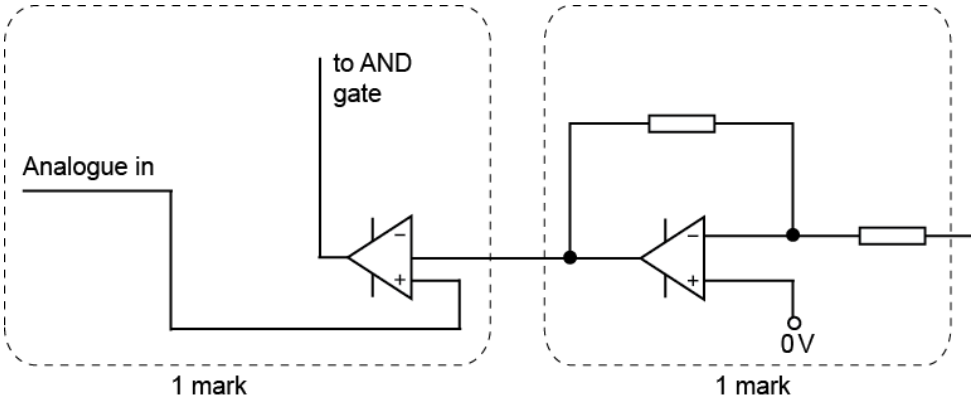
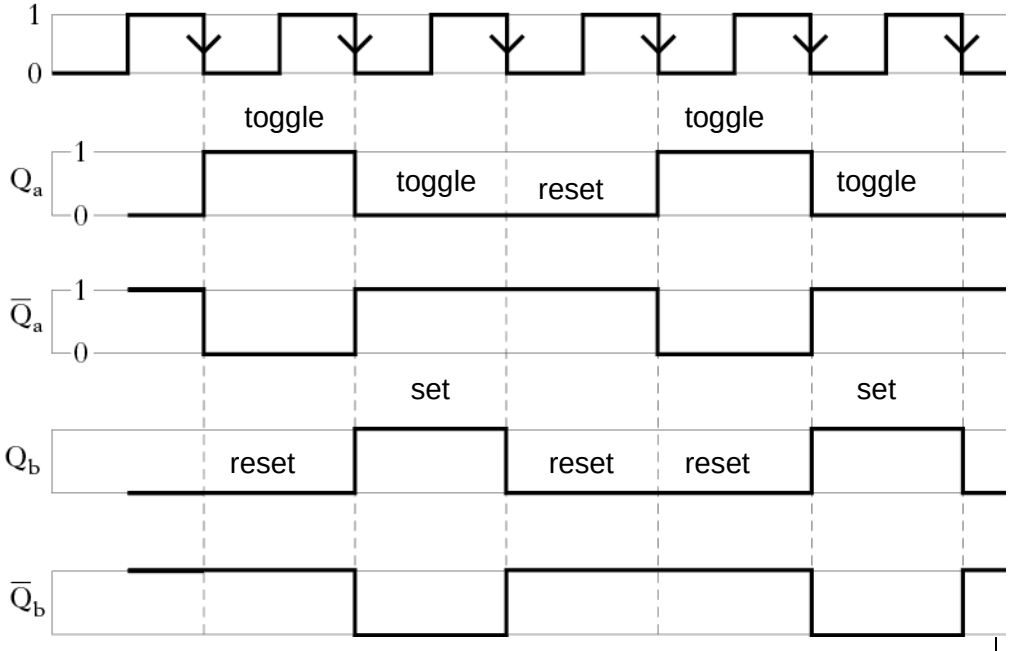
3

(18)

			Marks	
Q10	**(a)**	When any LDR goes dark V across it increases	1	
		Causes Schmitt inverting input to go higher	1	
		When V− reaches 3V Schmitt saturates low	1	
		Triggers 555 in monostable mode	1	
		Pin3 goes high for a time then low	1	
		This clocks the 3-bit counter	1	**6**
	(b)	$\frac{Rp}{7} = \frac{2}{3}$	1	
		$Rp = 4{\cdot}67k\Omega$	1	
		$10R/(10 + R) = 4{\cdot}67$	1	
		$10R = 46{\cdot}7 + 4{\cdot}67R$	1	
		$R = 46{\cdot}7/5{\cdot}33$		
		$R = 8{\cdot}76k\Omega$	1	**5**
	(c)	$H = (A.\overline{B}.C) + (\overline{A}.B.C) + (A.B.C)$ $H = C.(A + B)$		**3**
	(d)			**4**

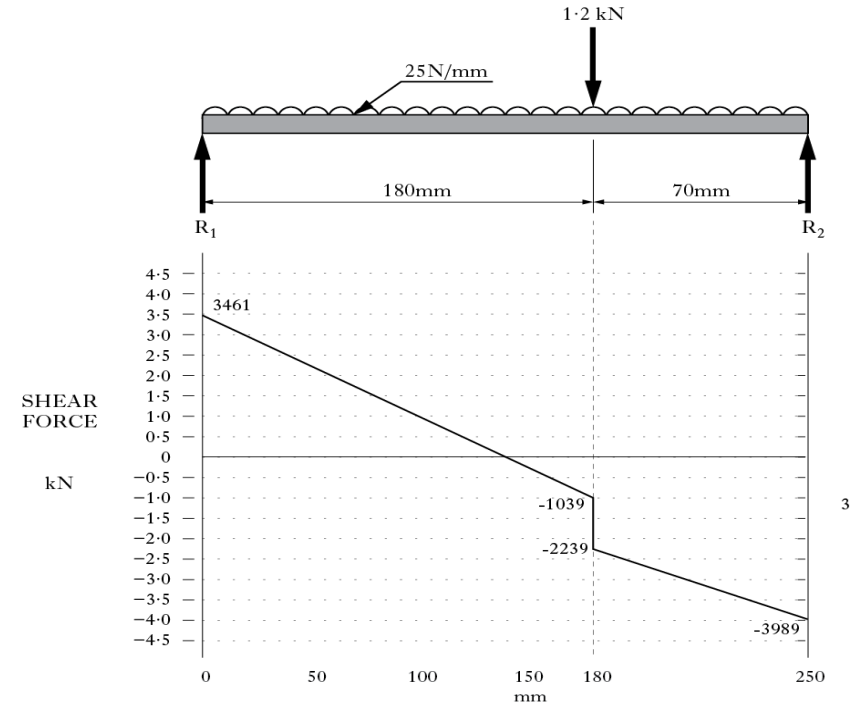
						Marks	
Q10	**(e)**	pack:		btfsc	PORTB,2	1	
				goto	weight	1	
				btfsc	PORTB,1	1	
				goto	plastic	1	
				goto	pack	1	
		weight:		movlw	d'10'	1	
				movwf	COUNT	1	
		loop:	→	bsf	PORTB,7	1	
				movlw	d '25'	1	
				call	pause		
			→	bcf	PORTB,7		
				movlw	d '25'	1	
				call	pause		
				decfsz	COUNT	1	
				goto	loop	1	
			→	return	both "return"	1	
		plastic:		movlw	d '6'	1	
				movwf	COUNT	1	
		loop2:	→	bsf	PORTB,6	1	
				movfw	MARK	1	
				call	pause		
			→	bcf	PORTB,6		
				movfw	SPACE	1	
				call	pause		
				rrf	MARK,F	1	
				rlf	SPACE,F	1	
				decfsz	COUNT,F	1	
				goto	loop2	1	
			→	return			**22**
							(40)

			Marks	
Q11	**(a)**			
		$\underline{\Sigma M_a = 0\ CW+}$ $+ (10 \times 3250) - (20 \times 3031) - (V_B \times 6500) = 0$	3	
		$+ 32500 \quad - \quad 60620 \quad = + 6500V_B$	1	
		$V_B = -28120 / 6500 = -4{\cdot}33\ kN\downarrow$	2	
		$\underline{\Sigma H = 0}$ $H_B = 20kN\rightarrow$	1	**7**
	(b)	$\underline{\Sigma M_q = 0\ CW+}$ $-(F_1 \times 1299) + (4{\cdot}33 \times 1500) = 0$	2	
		$-1299F \quad + 6495 \quad = 0$	1	
		$F_1 = + 5\ kN\ (tie)$	2	
		$\underline{\Sigma M_p = 0\ CW+}$ $+(4{\cdot}33 \times 2250) - (20 \times 1299) + (F_3 \times 1441) = 0$	3	
		$+ 9742{\cdot}5 \quad - 25980 \quad + 1441F_3 \quad = 0$	1	
		$F_3 = \quad + 11{\cdot}27kN\ TIE$	2	
		$\underline{\Sigma V = 0\uparrow+}$ $-11{\cdot}27\sin13{\cdot}9° - 4{\cdot}33 + F_2\sin60° = 0$	3	
		$-2{\cdot}71 \quad - 4{\cdot}33 + 0{\cdot}866F_2 = 0$	1	
		$F_2 = + 8{\cdot}13\ kN\ (\ TIE\ )$	2	
				
		$\sin73{\cdot}9° = perp / 1500$		
		$perp \quad = 1500 \times \sin73{\cdot}9°$		
		$= 1441\ mm$		**17**

		Marks
Q11 (c)		2
	2·555/511 = 0·005 resolution	1
	$(2 / R_0) \times 5 = 0{\cdot}005$	1
	$R_0 = (2 \times 5) / 0{\cdot}005$	1
	$R_0 = 2000\ k\Omega$	1
	$R_0 = 2000\ k\Omega$ $R_1 = 1000\ k\Omega$ $R_2 = 500\ k\Omega$ $R_3 = 250\ k\Omega$ $R_4 = 125\ k\Omega$ $R_5 = 62{\cdot}5\ k\Omega$ $R_6 = 31{\cdot}3\ k\Omega$ $R_7 = 15{\cdot}6\ k\Omega$ $R_8 = 7{\cdot}8\ k\Omega$	2
		8
Q11 (d)		4 1 2 1
		8
		(40)

					Marks	
Q12	**(a)**	main:	movlw	d ‘25’	1	
			movwf	LOOPCOUNT		
		loop:	btfsc	PORTB,0	1	
			incf	PULSECOUNT,F	1	
			movlw	d ‘1’	1	
			call	pause		
			decfsz	LOOPCOUNT	1	
			goto	loop	1	
			movlw	d ‘10’	1	
			subwf	PULSECOUNT,W	1	
			btfss	STATUS,C	1	
			goto	bleep	1	
			movfw	PULSECOUNT	1	
			sublw	d ‘13’	1	
			btfss	STATUS,C	1	
			goto	bleep	1	
			bsf	PORTB,7	1	
			movlw	d ‘80’	1	
			call	pause		
			bcf`	PORTB,7		
		bleep:	bsf	PORTB,6	1	
			movlw	d ‘150’		
			call	pause		
			bcf	PORTB,6		
			movfw	PULSECOUNT	1	
			sublw	d ‘23’		
			btfsc	STATUS,C	1	
			goto	main	1	
			bsf	PORTB,5	1	
			movlw	d ‘2’		
			call	pause		
			bcf	PORTB,5		
			goto	main		**21**
	(b)	$I_{solid} = BD^3/12$				
		$= 11 \times 20^3/12 = 7333$			1	
		$I_{hole} = 9 \times 16^3/12 = 3072$			1	
		$I_{xx} = 4261\ mm^4$			1	**3**

			Marks	
Q12	**(c)**	$\Sigma M = 0$ about R_2:		
		$+(R_1 \times 250) - \left(25 \times 250 \times \frac{250}{2}\right) - (1200 \times 70) = 0$	1	
		$R_1 = 3{\cdot}46$ kN	1	**2**
	(d)	50: $3461 \times 50 - 25 \times 50^2/2 = 141800$ Nmm = 142 kNmm 100: $3461 \times 100 - 25 \times 100^2/2 = 221100$ Nmm = 221 kNmm 150: $3461 \times 150 - 25 \times 150^2/2 = 237900$ Nmm = 238 kNmm 180: $3461 \times 180 - 25 \times 180^2/2 = 217980$ Nmm = 218 kNmm		



3

Plotting:
1 for curve
1 for +ve nature

2

Distance from LHE (mm)	0	50	100	150	180	250
Bending Moment (kNmm)	0	142	221	238	218	0
	1	2	2	2	2	

9

14
(40)

[END OF MARKING INSTRUCTIONS]