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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

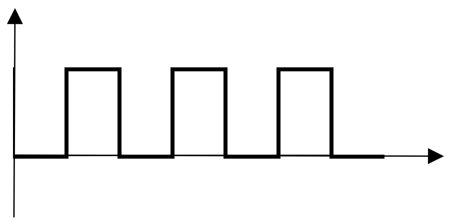
The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments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

Part Two: Marking Instructions for each Question

Section A

Q1

				Marks	
(a)	(i)	Wein-bridge oscillator		1	**1**
	(ii)	Sine wave		1	**1**
(b)		$f = \dfrac{1}{2\pi RC}$			
		$R = \dfrac{1}{2\pi fC} = \dfrac{1}{2 \times 3{\cdot}14 \times 1 \times 10^{-6} \times 1000}$	3 subs	3	
		$R = 159\Omega$	Answer plus unit	1	**4**
(c)		Output fed into a Schmitt trigger **(1)** which would produce a square wave **(1)** which is suitable as a falling edge.			**2**
					(8)



Q2

				Marks	
main:	btfss	PORTB,0	;start switch	1	
	goto	main		1	
water:	btfss	PORTB,3	;float switch	1	
	goto	ALARM		1	
	bsf	PORTB,1	;poll mux for quantity dial	1	
	call	adcread		1	
	movwf	QUANTITY		1	
	bsf	PORTB,7	;heat water	1	
	bcf	PORTB,1	;poll mux for temperature	1	
HEAT:	call	adcread		1	
	movwf	TEMPERATURE		1	
	movlw	d’180’		1	
	subwf	TEMPERATURE,W		1	
	btfss	STATUS,C	;check temp reached 180	1	
	goto	HEAT	;no, so keep heating	1	
	bcf	PORTB,7	;heater off	1	
	rrf	QUANTITY,F	;quantity ÷ 2	1	
	movfw	QUANTITY		1	
	bsf	PORTB,6	;valve on	1	
	call	wait	;time delay	1	
	bcf	PORTB,6	;valve off	1	
	goto	main		1	
ALARM:	bsf	PORTB,5	;bleep on	1	
	movlw call	d’10’ wait	}	1	
	bcf	PORTB,5	;bleep off	1	
	goto	main		1	**26**

	Marks	

Q3

(a) $\Sigma M_A = 0 + \circlearrowright$ — 3

$+ (10\times6) + (5\times12) + (1\times2\times3) - (R_B\times12) = 0$

$+ \quad 60 \quad + \quad 60 \quad + \quad 6 \quad - \quad 12R_B = 0$

$$R_B = +\frac{126}{12} = +10\cdot5\text{kN}\uparrow$$

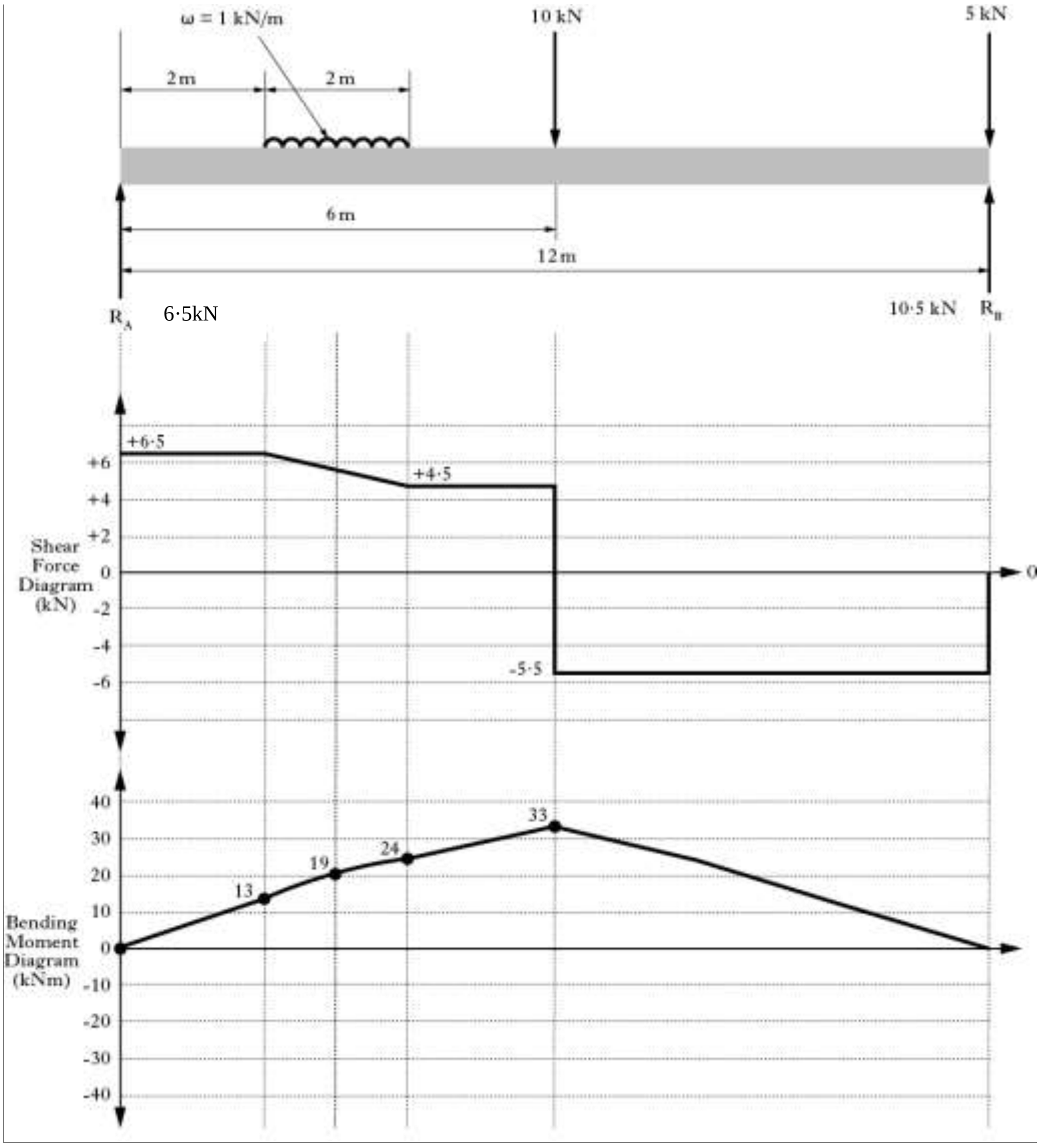
$\Sigma V = 0 \uparrow +$ — 1 — **4**

$+ R_A - (1 \times 2) - 10 - 5 + 10\cdot5 = 0$

$R_A = + 6\cdot5\text{kN}\uparrow$

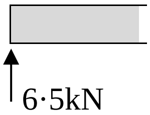
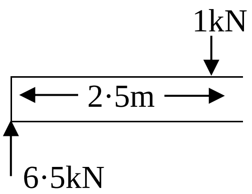
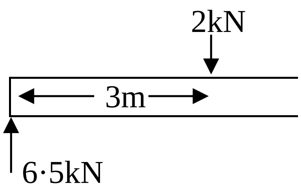
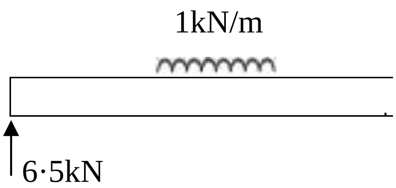
(b) — **6**

(c)



Q3

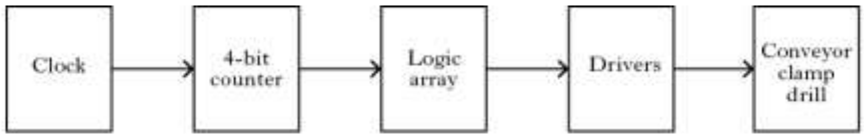
(c) (cont)

	Marks	
<u>0m & 12m</u> BM = 0kNm	1	
<u>2m</u>  BM = + (6·5 × 2) = + 13kNm	1	
<u>3m</u>  BM = + (6·5 × 3) – (1 × 0·5) = + 19·5 − 0·5 = +19kNm	2	
<u>4m</u>  BM = + (6·5 × 4) – (2 × 1) = + 26 − 2 = + 24kNm	2	
<u>6m</u>  BM = + (6·5 × 6) – (1 × 2 × 3) = + 39 – 6 = +33kNm	2	
Plotting line	1	
Nature	1	**10**
		(20)

	Marks	

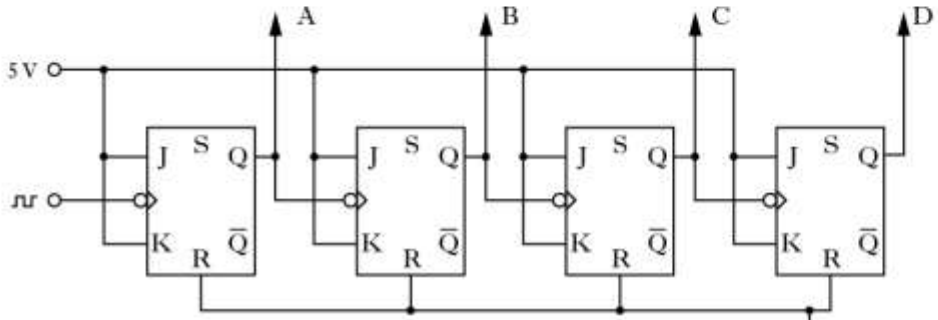
Q4

(a)



1 1 1 1 1 — **5**

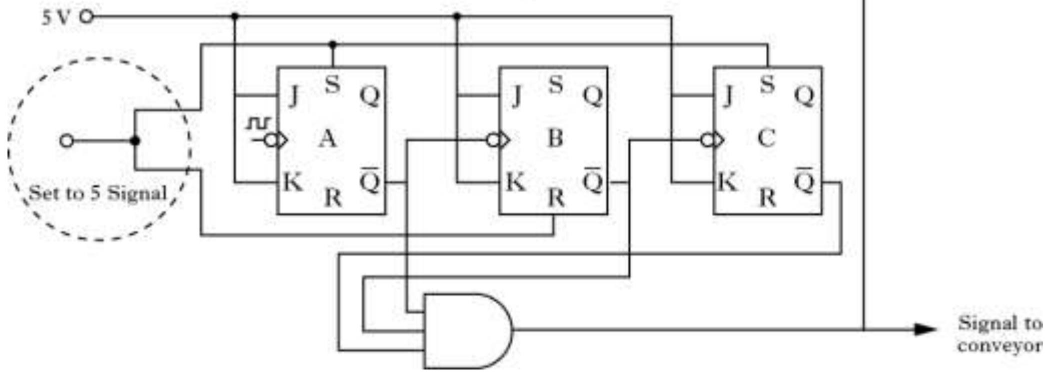
(b)



4 falling edge JKs	1
5V → JK connections (x4)	1
1st Q → clk	1
2nd & 3rd Q → clk	1
Q outputs (x4)	1
4 RESETS linked together	1

6

(c)

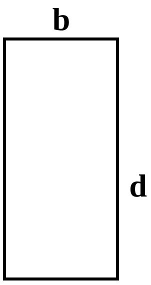


3 falling-edge JKs	1	
5V – J & K(×3)	1	
+5V to A & C Set	1	
+5V to B Reset	1	
$\overline{Q} \rightarrow$ ▷ × 2	1	
$3\times\overline{Q} \rightarrow$ AND	1	**7**
AND → RESET (b)	1	
		(18)

Q5

(a) Neutral Axis **1**

(b)



$$I = \frac{bd^3}{12} = \frac{50 \times 200^3}{12} = 33{\cdot}3 \times 10^6 \text{ mm}^4$$

2

(c)

$$\frac{M}{I} = \frac{\sigma}{y} \qquad \sigma = \frac{My}{I}$$

M = 40kNm
= 40×10^6 Nmm
y = 100mm
I = $33{\cdot}3 \times 10^6$ Nmm

$$\sigma = \frac{40 \times 10^6 \times 100}{33 \cdot 3 \times 10^6}$$

$\sigma = 120\text{N/mm}^2$ **4**

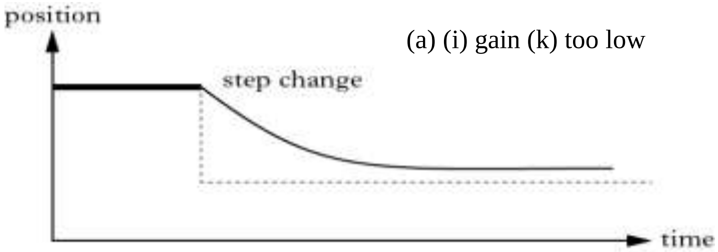
(7)

		Marks	
Q6			
(a)	Binary coded decimal to decimal decoder (1) converts binary to decimal (1)	2	
	Binary coded decimal to 7-segment display (1) decoder converts binary to segment signals. (1)	2	**4**
(b)	When OR gate is high, Counter is enabled	1	
	Counter counts up on each rising edge	1	
	BCD to D decodes binary to decimal	1	
	When BCD to D reaches 3 counter A disabled, buzzer sounds	2	
	When BCD to D reaches 3 AND enabled	1	
	When clock goes high → low 2nd 4-bit counter B counts up.	1	
	The 4-bit output is decoded to drive 7-segment display.	1	
	7-segment display shows a digit equivalent to count	1	
	when count reaches 8:		
	signal is sent to OR	1	
	and counter A is re-enabled	1	
	Decoder continues to 5 and resets counter B to 0.	1	
	Counter A resets at 10 — Any 11 points@1	1	**11**
			(15)

Marks

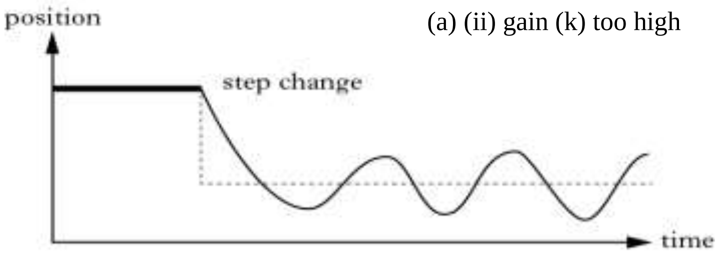
Q7

(a)(i)



2

(a)(ii)

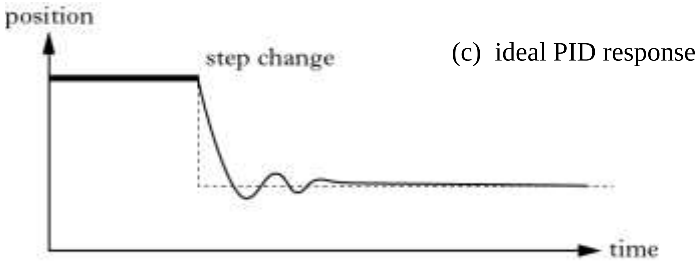


2

(b)(i) Removes offset **1**

(b)(ii) Removes hunting / reduces settling time **1**

(c)



2

(d) <u>**A**</u>

$$\left(\frac{60^\circ}{90^\circ}\times 0\cdot 75\right)+0\cdot 75=1\cdot 25$$ substitutions 1

Position A pulse-time (mark) = 1·25ms — answer 1

<u>**B**</u>

$$\left(\frac{30^\circ}{90^\circ}\times 0\cdot 75\right)+1\cdot 50=1\cdot 75$$

Position B pulse-time (mark) = 1·75ms — 1 **3**

(e) 1·75 − 1·25 = 0·5 ms — 1

0·5 ÷ 0·01 = 50 steps — 1 **2**

Q7 (cont)

	Label	Instruction	Assembler Code		Marks	
(f)	drive:	movlw	d’125’		1	
		movwf	MARK			
		movlw	d’50’		1	
		movwf	COUNTER			
	loop:	bsf	PORTB,4		1	
		movfw	MARK		1	
		call	short			
		bcf	PORTB,4		1	
		movlw	d’20’		1	
		call	pause		1	
		incf	MARK,F			
		decfsz	COUNTER,F		1	
		goto	loop		1	
		movlw	d’50’	for repeat code	1	
		movwf	COUNTER			
	loop2	bsf	PORTB,4			
		movfw	MARK			
		call	short			
		bcf	PORTB,4			
		movlw	d’20’			
		call	pause			
		decf	MARK,F		1	
		decfz	COUNTER,F		1	
		goto	loop2			
		return			1	
						13
						(26)

Q8

					Marks	
(a)	obstruction:	call	adcread		1	
		movlw	d ‘8’		1	
		subwf	DATA,W		1	
		btfsc	STATUS,C	}	1	
		goto	finish			
		bsf	PORTB,6	}		
		movlw	d ‘26’		1	
		call	wait			
		bcf	PORTB,6		1	
	finish:	return			1	**7**
(b)	main:	call	navdata		1	
	loop:	bsf	PORTB,3	}	1	
		bsf	PORTB,7			
		movlw	d ‘10’	}	1	
		call	pause			
		call	obstruction		1	
		decfsz	FORWARDTIME		1	
		goto	loop	(incl. goto main below)		
		movlw	d ‘1’		1	
		subwf	TURN		1	
		btfsc	STATUS,Z		1	
		goto	main		1	
		clrf	TURNTIME		1	
	ACW:	bsf	PORTB,4		1	
		movlw	d ‘8’	}	1	
		call	pause			
		bcf	PORTB,4		1	
		movfw	d ‘19’	}	1	
		call	pause			
		incf	TURNTIME		1	
		movfw	TURNTIME		1	
		subwf	TURNSTOP		1	
		btfss	STATUS,Z		1	
		goto	ACW		1	
		bcf	PORTB,7	} (incl. goto loop above)	1	
		goto	main			**20**

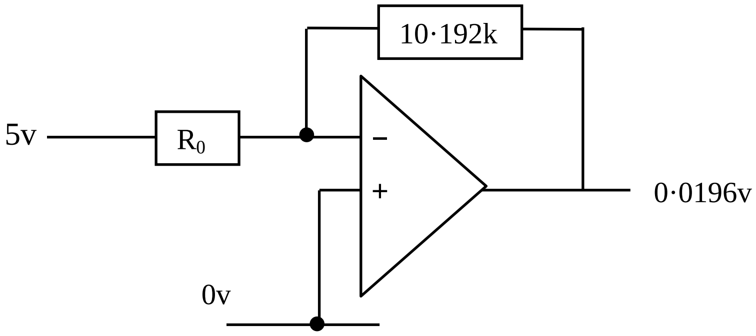
Q8

	Marks	
(c) $I_D = \frac{BD^3}{12} - \frac{bd^2}{12}$		
$= \frac{40\times150^3}{12} - \frac{38\times146^3}{12}$	1	
$= 11250000 - 9855097$	1	
$= 1394903$	1	
$I = \frac{\pi D^4}{64}$		
$= \frac{\pi\times(2\times36)^4}{64} \div 2$	1	
$I_D = 659584$	1	
$I_{total} = 1394903 + 659584$		
$I_{total} = 2054487mm^4$	1	**6**
(d) yield stress aluminium $= 30\ N/mm^2$	1	
$\sigma = \frac{my}{I}$		
$m = \frac{\sigma I}{y}$	1	
$= \frac{30\times2054487}{75}$	1	
$= 821795$	1	
$m = \frac{FL}{4}$ $\quad F = \frac{4m}{L}$	1	
$= \frac{4\times821795}{850}$	1	
$= 3{\cdot}87kN$	1	**7**
		(40)

Marks	

Q9

(a) $2^8 = 0 \rightarrow 255$ $\quad\quad \dfrac{4 \cdot 606}{235} = 0 \cdot 0196$ volt increments



$$V_{out} = -\frac{R_f}{R_i} \times V_1$$

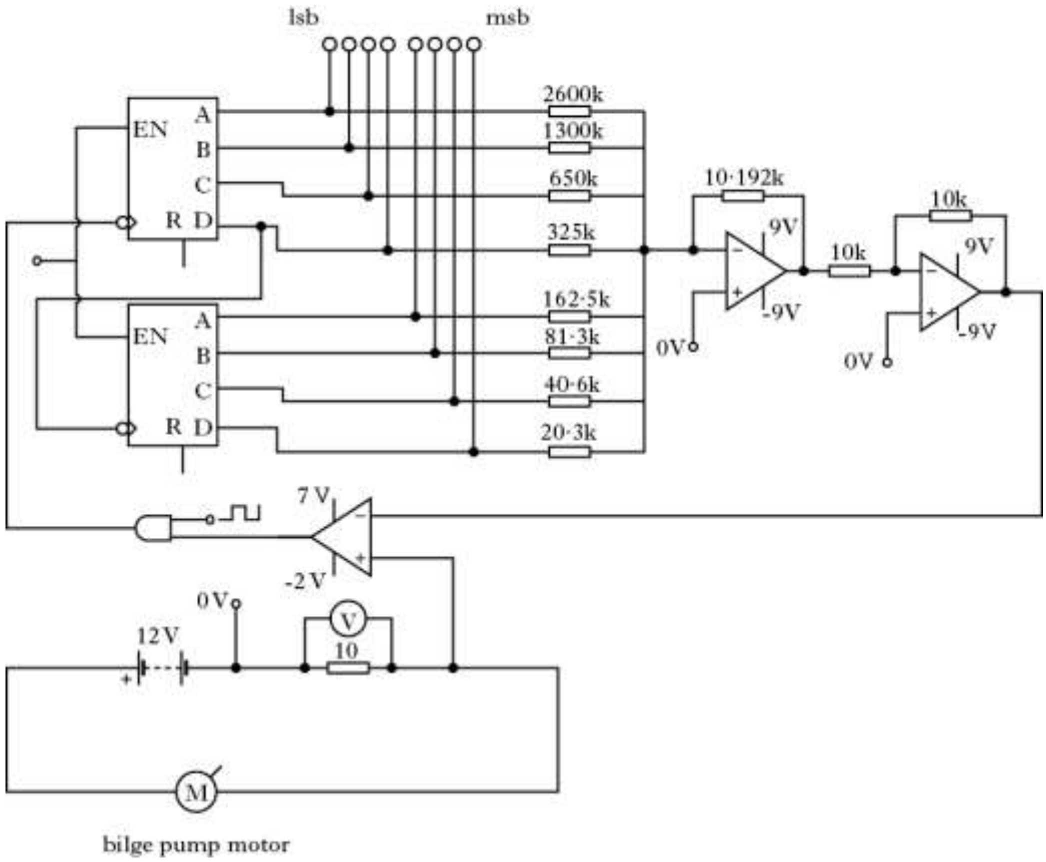
$$0 \cdot 0196 = \frac{-10 \cdot 192}{R_0} \times 5$$

$R_0 = 2600k\Omega$

$R_1 = 1300k\Omega$
$R_2 = 650k\Omega$
$R_3 = 325k\Omega$
$R_4 = 162.5k\Omega$
$R_5 = 81.3k\Omega$
$R_6 = 40.6k\Omega$
$R_7 = 20 \cdot 3k\Omega$

Q9

(a) (cont)



Marks: 10

Q9

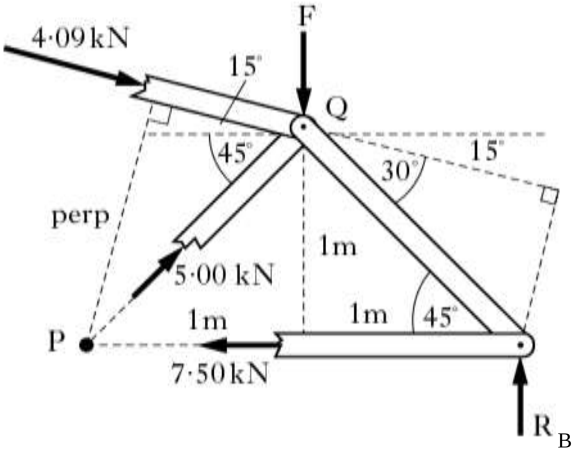
Part	Answer	Marks	
(b) (i)	Voltage controlled Oscillator		**2**
(ii)	SubA = RC circuit,charging time prop to V_{in}	2	
	SubB = volt divider, provides 1 Volt ref	2	
	SubC = comparator compares 1 Volt ref with Cap volt V_{cap} > 1 volt then +ve output	2	
	SubD = npn trans responds to +ve, switches on DPDT relay briefly, disch cap + switches on output	2	
	SubE = lamp and buzz, freqency of outputs prop to current drawn by pump motor	2	**10**
(iii)	V_{in} must be greater than 1 volt, limited frequency of relay, mech life of relay		**2**

(c)

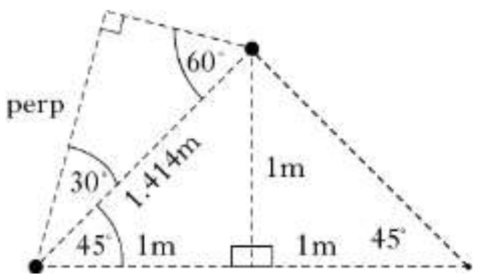
Label	Instruction	Operand	Comment	Marks	
main:	bsf	PORTB,4		1	
	movlw	d‘5’		1	
	call	wait		1	
	bcf	PORTB,4		1	
loop:	call	adcread		1	
	sublw	d’140’		1	
	btfsc	STATUS,Z	(1 for status Z, 1 for clear)	2	
	goto	wet			
	btfss	STATUS,C	(1 for status C, 1 for set)	2	
	goto	wet	(1 for both goto wet)	1	
	bcf	PORTB,4		1	
	call	delay		1	
	goto	main		1	
wet:	bsf	PORTB,4		1	
	goto	loop		1	**16**
					(40)

Q10

(a)



		Marks	
(i)	ΣM_Q (+ clockwise) $=0$		
	$-(R_B \times 1) + (7{\cdot}5 \times 1) = 0$	2 substitutions	2	
	$R_B = +7{\cdot}5$kN ↑	answer	1	3
(ii)	$\Sigma M_Q = 0$ (+ clockwise)		
	$+(4{\cdot}09 \times \text{perp}) + (F \times 1) - (7{\cdot}5 \times 2) = 0$	3 substitutions	3	
	$+(4{\cdot}09 \times 1{\cdot}224) + F - 15 = 0$	calculation	1	
	$F = 10$kN	answer	1	

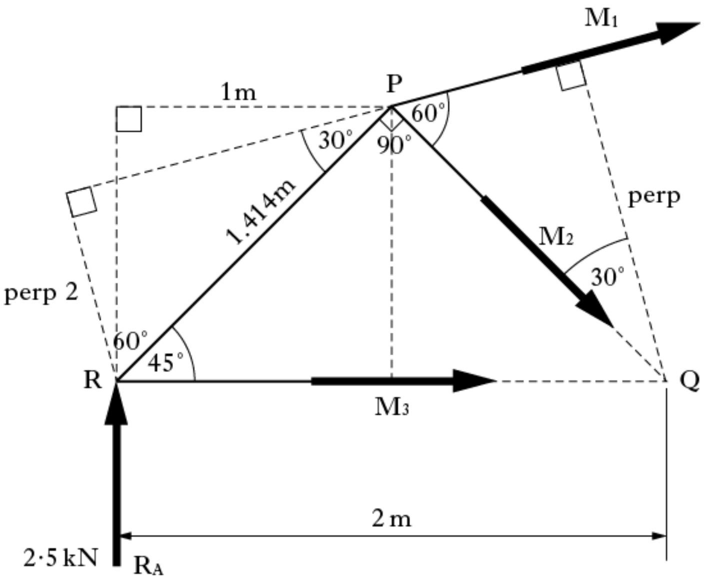


$\text{perp} = 1{\cdot}414\cos 30° = 1{\cdot}224\,\text{m}$ — 1

6

Q10

(b)



Marks

$\Sigma M_P = 0 + \circlearrowright$

$-(M_3 \times 1) + (2 \cdot 5 \times 1) = 0$

$M_3 = +2 \cdot 5\text{kN (TIE)}$ — **3**

$\Sigma M_Q = 0 + \circlearrowright$

$+(2 \cdot 5 \times 2) + (M_1 \times \text{perp}) = 0$

$\text{perp} = 1 \cdot 414\cos 30°$
$= 1 \cdot 224\text{m}$

$$M_1 = \frac{-5}{1 \cdot 224} = -4 \cdot 08$$

$M_1 = 4 \cdot 08\text{kN (STRUT)}$ — **5**

$\text{perp}_2 = 1 \cdot 414\sin 30°$
$= 0 \cdot 707\text{m}$

$\Sigma M_R = 0 + \circlearrowright$

$+(M_1 \times \text{perp}_2) + (M_2 \times 1 \cdot 414) = 0$

$+(-4 \cdot 08 \times 0 \cdot 707) + (M_2 \times 1 \cdot 414) = 0$

$$M_2 = \frac{+4 \cdot 08 \times 0 \cdot 707}{1 \cdot 414}$$

$M_2 = +2 \cdot 04$

$M_2 = 2 \cdot 04\text{kN (TIE)}$

OR

$\Sigma F_h = 0\left(\overrightarrow{+ve}\right):$

$+M_1\cos 15 + M_2\cos 45 + M_3 = 0$

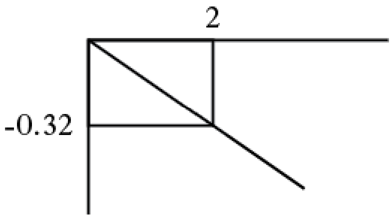
$-4 \cdot 08\cos 15 + M_2\cos 45 + 2 \cdot 5 = 0$

$M_2\cos 45 = 1 \cdot 44$

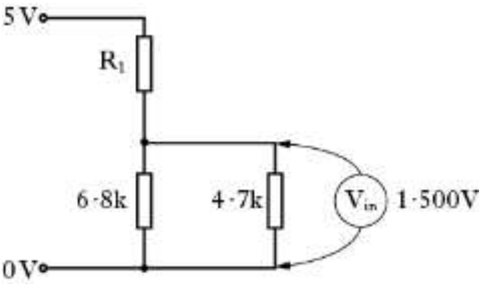
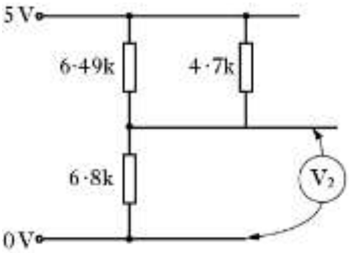
$M_2 = 2 \cdot 04\text{kN (TIE)}.$

5 **13**

Q10

			Marks	
(c)				
	$V_{out} = \frac{-0 \cdot 32}{2} t$		1	
	$V_{out} = -\, 0 \cdot 16t$		1	**2**
(d)	$V_{out} = -\frac{1}{RC}\int V_{in}\ dt$			
	$-0 \cdot 16t = -\frac{1}{2 \cdot 7 \times 10^{6} \times 6 \cdot 8 \times 10^{-6}}\int V_{in}\ dt$	substitutions	2	
	$-0 \cdot 16t = -\frac{1}{18 \cdot 36} \times \frac{V_{in}}{1} \times t$	integration	1	
	$V_{in} = 0 \cdot 16 \times 18 \cdot 36$ $= 2 \cdot 94$ volts		1	**4**
(e)	$V_{out} = -\, 0 \cdot 16t$			
	$-12 = -\, 0 \cdot 16t$	substitutions	1	
	$t = \frac{12}{0 \cdot 16}$			
	t = 75 seconds	answer	1	**2**

Q10

			Marks	
(f)	When V_{in} = 1·5V: lower threshold, ∴ output already low.	correct state	1	
				
	$Rp = \frac{6\cdot 8 \times 4\cdot 7}{6\cdot 8 + 4\cdot 7} = \frac{31\cdot 96}{11\cdot 5} = 2\cdot 78\text{k}\Omega$	substitutions & answer	2	
	$\frac{R_1}{R_P} = \frac{3\cdot 5}{1\cdot 5}$	substitution	1	
	$R_1 = \frac{3\cdot 5}{1\cdot 5} \times 2\cdot 78$		1	
	$R_1 = 6\cdot 49\text{k}\Omega$		1	**6**
(g)	Switch-off voltage: Output already high	correct state	1	
	 $Rp = \frac{6\cdot 49 \times 4\cdot 7}{6\cdot 49 + 4\cdot 7} = 2\cdot 73\text{k}\Omega$	substitution	1	
	$V_2 = \frac{6\cdot 8}{6\cdot 8 + 2\cdot 725}$ = ×5 = 3·57 volts		1	
	V_2 = 3·57 volts		1	**4**
				(40)

[END OF MARKING INSTRUCTIONS]