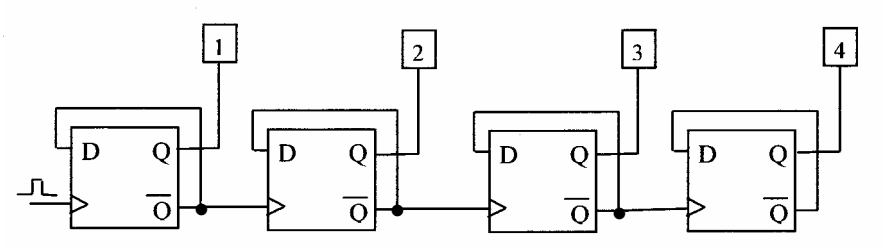
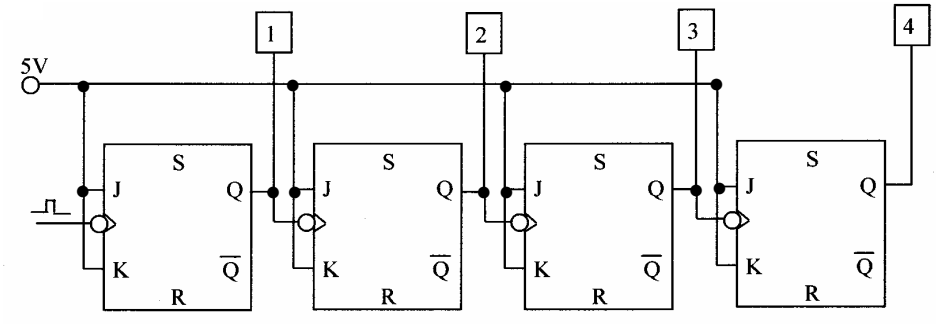
2009 Technological Studies

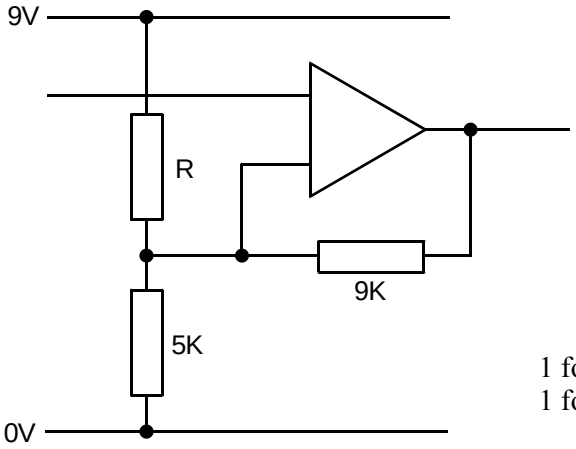
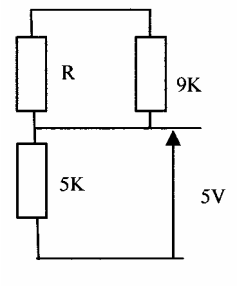
Advanced Higher

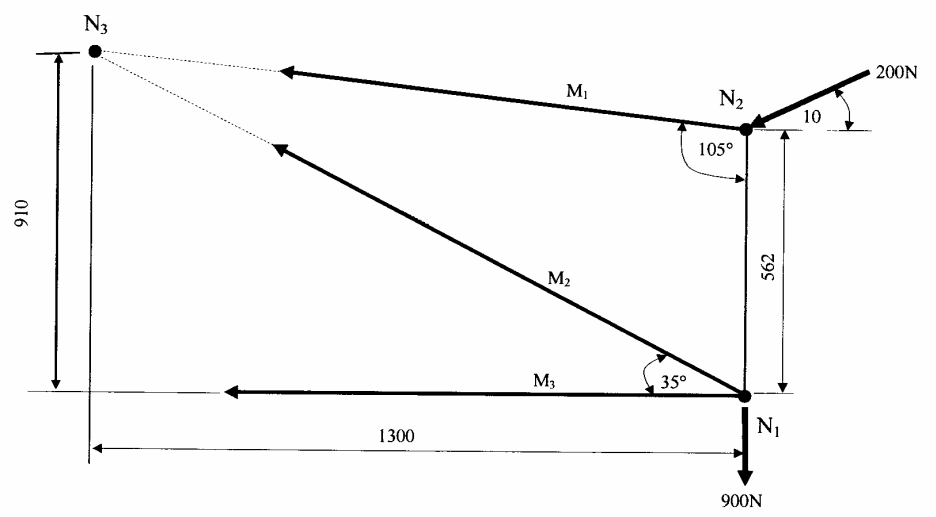
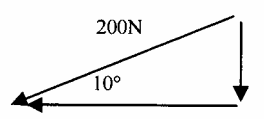
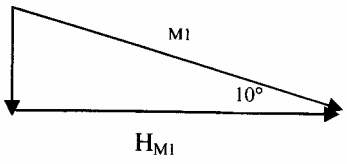
Finalised Marking Instructions

Section A

		Marks	
Q1			
(a)			
	1 for 4 D-types set to toggle (½ for 1-3)	1	
	1 for 3 Q bar to clock connections (½ for 2)	1	
	½ for clock on first D-type	½	
	½ for Q outputs	½	**3**
(b)			
	1 for 4 JKs set to toggle (½ for 1-3)	1	
	1 for 3 Q to clock connections (½ for 2)	1	
	½ for clock on first JK	½	
	½ for Q outputs	½	**3**
			(6)
Q2			
(a)	A-D convertor	½	
	LCD Driver	½	
	Data memory/Flash memory	½	
	Suitable number of I/O pins	½	**2**
(b)	Flowchart – Algorithm	1	
	Write code – Text editor	1	
	Assembly code – Assembler	1	
	Download to PIC – Programmer	1	**4**
			(6)

				Marks	
Q3					
(a)	(i)	The control of the outputs is based on one event happening after another in a sequence.		1	**1**
	(ii)	Time based – each step is controlled by a fixed time pulse. Event based – each step is controlled by a sensed condition.		½ ½	**1**
(b)	IC1 is a 4-bit binary counter which counts from 0-15 in binary IC2 is a binary coded decimal decoder which converts the binary into a decimal value 0-15			½ ½ ½ ½	**2**
(c)	See Worksheet Q3			5	**5**
					(9)
Q4					
(a)	debounce:	movlw	d'200'		
		movwf	LOOPCOUNT	½	
	test:	btfss	PORTB,2	½	
		goto	debounce	½	
		movlw	d'l'		
		call	pause	½	
		decfsz	LOOPCOUNT	½	
		goto	test		
		return		½	**3**
(b)	main:	btfss	PORTB,0		
		goto	main	½	
		movlw	d'100'		
		movwf	CUPCOUNT	½	
		bcf	PORTB,5	½	
	dispense:	call	debounce	½	
		bsf	PORTB,4	½	
		movlw	d'5'		
		call	wait	½	
		bcf	PORTB,4	½	
		bsf	PORTB,6		
		movlw	d'15'		
		call	wait	1	
		bcf	PORTB,6		
		bsf	PORTB,7		
		movlw	d'100'	½	
		call	wait		
		bcf	PORTB,7		
		decfsz	CUPCOUNT,F	½	
		goto	dispense	½	
		bsf	PORTB,5	½	
		goto	main	½	**7**
					(10)

		Marks	
Q5			
(a)	Wein Bridge	1	**1**
(b)	It converts the sine wave to a square waveform. Waveform will have the same frequency.	½ ½	**1**
(c) (i)	 1 for correct diagram 1 for correct annotation	1 1	**2**
(ii)	 $\frac{R_p}{5}=\frac{4}{5}$ $R_p=\frac{4\times5}{5}$ $R_p=4\text{k}\Omega$ $\frac{1}{R_p}=\frac{1}{R}+\frac{1}{9}$ $\frac{1}{R}=\frac{1}{R_p}-\frac{1}{9}$ $\frac{1}{R}=\frac{1}{4}-\frac{1}{9}$ $R=7\cdot2\text{k}\Omega$	1 ½ ½ 1 ½ ½ 1	**5**
(d)	Relaxation Oscillator Voltage Controlled Oscillator (VCO)	½ ½	**1**
			(10)

			Marks	
Q6				
(a)	(i)	To prevent members being subjected to bending.	1	**1**
	(ii)	3	1	**1**
(b)				
				
		$V_{200} = 200\sin10° = 34{\cdot}7N$	½	
		$H_{200} = 200\cos10° = 197N$	½	
		Calc height N_3 = 910	½	
		Height diff $N_3 – N_2$ = 348	½	
		Take moments about N_3 ΣM = 0		
		ΣCWM = ΣACWM		
		$(M_3 \times 910) + (900 \times 1300) + (1300 \times 34.7) + (348 \times 197) = 0$	2	
		M_3 = -1411N	1	
		M_3 = 1411N (strut)		
		Take moments about N_1 ΣM = 0		
		ΣCWM = ΣACWM		
		$0 = (562 \times H_{M1}) + (197 \times 562)$	1	
		H_{M1} = -197N		
		$M_1 = 197/\cos15°$		
		M_1 = 204N (strut)	1	
				
		Take moments about N_2 ΣM = 0		
		ΣCWM = ΣACWM		
		$(M_2 \times 460) – (1411 \times 562) = 0$	1	
		M_2 = 1722N (tie)	1	**9**
				(11)

					Marks	
Q7						
(a)	45 rev/min which is 0.75 rev/sec or 36 steps/sec 1000/36 = 28 ms/step				1	**1**
(b)	(i)	main:	btfss	PORTB,1	½	
			goto	test2	½	
			call	speed1	½	
		test2:	btfss	PORTB,2	½	
			goto	test3		
			call	speed2	½	
		test3:	btfss	PORTB,3	½	
			goto	test3		
			call	speed3	½	
			goto	main	½	**4**
	(ii)	speed2:	movlw	b'11000000'		
			movwf	PORTB	½	
			movlw	d'28'		
			call	pause	½	
			movlw	b'01010000'		
			movwf	PORTB		
			movlw	d'28'	½	
			call	pause		
			movlw	b'00110000'		
			movwf	PORTB		
			movlw	d'28'		
			call	pause	½	
			movlw	b'10100000'		
			movwf	PORTB		
			movlw	d'28'		
			call	pause	½	
			return		½	**3**
						(8)

Section B

		Marks	
Q8			
(a)	$f = \dfrac{1 \cdot 44}{(R_1 + 2R_2)C}$	½	
	$R_2 = \dfrac{1}{2}\left[\dfrac{1 \cdot 44}{0 \cdot 33 \times 1 \times 10^{-6}} - 1000\right]$	1	
	$R_2 =$ 2·18 MΩ	½	**2**
(b)	• A – SR latch initiates flashing sequence	½	
	• A – it is reset by the correct number of flashes	½	
	• B – NAND gate allows the clock to control the Light test input	½	
	• C – BCD-7 segment decoder converts the binary value	½	
	• C – this value is displayed as a digit on the 7 segment display	½	
	• D – shift register will cause digit 1 to flash	½	
	• D – followed by digit 2 etc to flash in sequence	½	
	• D – the data input is provided by the SR bistable	½	
	• E – 3-bit binary counter JK up counter	½	
	• E – it will count up to 6 (before resetting)	½	
	• E – then to clock the shift register	½	
	• F – AND gate allows whole system to be reset after all 3 digits have been flashed.	½	**6**
(c)	See Worksheet Q8	5	**5**
(d)	$BM = \dfrac{FL}{8}$		
	$BM = \dfrac{1000 \times 200}{8}$	½	
	$BM = 25 \times 10^3$ Nmm	½	**1**

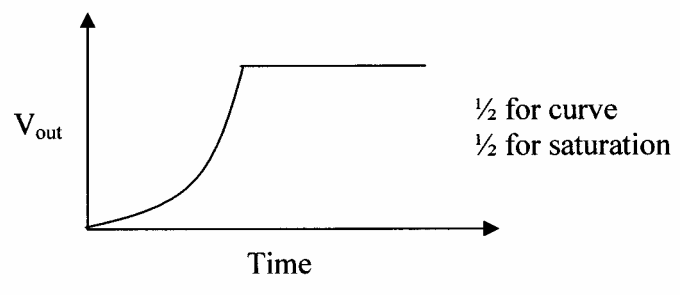
				Marks	
(e)	(i)	$\delta = 100\text{N/mm}^2$	$\delta = \frac{My}{I}$		
		B = 20	$I = \frac{My}{\delta}$	½	
			$I = \frac{25\times10^3 \times \frac{D}{2}}{100}$	½	
			$I = \frac{BD^3}{12}$	½	
			$I = \frac{20D^3}{12}$	½	
			$\frac{20\times D^3}{12} = \frac{25\times10^3 \times D}{100\times2}$	½	
			$D^2 = \frac{12\times25\times10^3}{100\times2\times20}$	1	
			$D = \sqrt{75}$		
			$D = 8\cdot66\text{mm}$	½	**4**
	(ii)	For stainless steel E = 190 – 200kN/mm^2 (any value in this range)			
			$I = \frac{BD^3}{12}$		
			$I = \frac{20\times8\cdot67^3}{12}$		
			$I = 1086$	½	
			$\partial = \frac{FL^3}{192EI}$	½	
			$\partial = \frac{1000\times200^3}{192\times190\times10^3\times1086}$	½	
			$\partial = 0\cdot202mm$	½	**2**
					(20)

Q9

				Marks	
(a)	Testbeam:	btfsc	PORTB,0	½	
		goto	buttonA	½	
		btfsc	PORTB,1		
		goto	buttonB	½	
		btfsc	PORTB,2		
		goto	buttonC	½	
		goto	Testbeam	½	
	ButtonA:	rrf	LOADTIME,F	1	
		goto	Beams		
	ButtonB:	rlf	LOADTIME,F	1	
		goto	Beams		
	ButtonC:	rlf	LOADTIME,F		
		rlf	LOADTIME,F		
		rlf	LOADTIME,F	1	
		goto	Beams		
	Beams:	movlw	b'11000000'	½	
		movwf	PORTB	½	
		call	delay	½	
		clrf	PORTB	½	
		goto	Testbeam	½	**8**
(b)	$\sum M = 0$				
	$(3 \times 0 \cdot 5) + (4 \times 2 \cdot 25) + (0 \cdot 8 \times 3 \times 1 \cdot 5) = (R_2 \times 3)$			½	
	$R_2 = 4 \cdot 7\text{kN}$			½	
	$\sum F_V = 0$				
	$R_1 + R_2 = 3 + (0 \cdot 8 \times 3) + 4$			½	
	$R_1 = 8 \cdot 2 - 4 \cdot 7$				
	$R_1 = 4 \cdot 7\text{kN}$			½	**2**
(c)	See Worksheet Q9				**2**

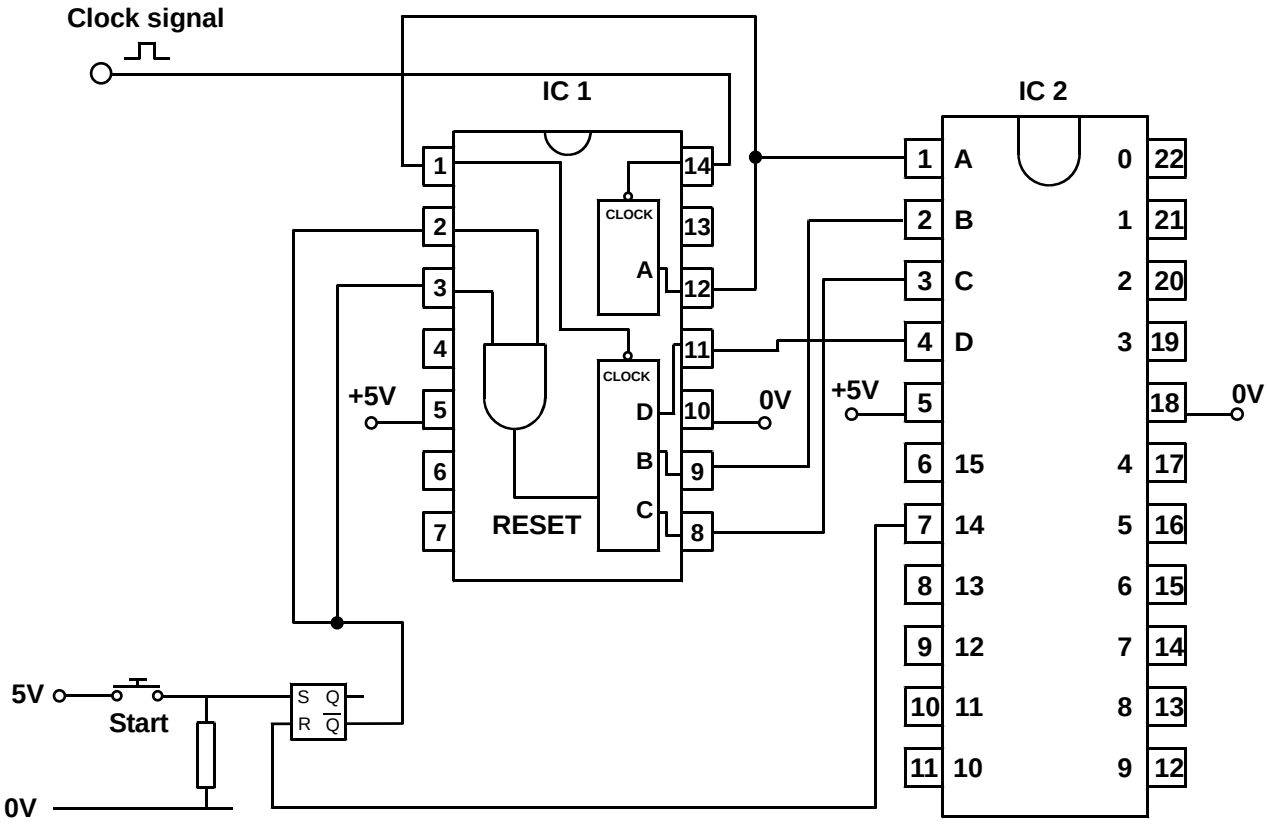
			Marks	
(d)	(i)	Assume L is the distance to the maximum bending moment from the left hand end. At the turning point the differential of the expression will be equal to 0.		
		$M = 4 \cdot 7L - \left(0 \cdot 8 \times \frac{L^2}{2} \right) - 3(L - 0 \cdot 5)$		
		M = $4 \cdot 7L - 0 \cdot 4L^2 - 3L + 1 \cdot 5$		
		$M = 1 \cdot 7L - 0 \cdot 4L^2 + 1 \cdot 5$		
		$\frac{dM}{dL} = 1 \cdot 7 - 0 \cdot 8L = 0$		
		$L = \frac{1 \cdot 7}{0 \cdot 8} = 2 \cdot 125m$	1	
		Max BM = (4·7 × 2·125) – (3 × 1·625) – (0·8 × 2·125 × 1·0625) = 3·31kNm	1	**2**
		Alternatively using the SF diagram the SF at 0·5 from the LHE is 1·3 and the force is 0·8/m. So 1·3 × 0·8 = 1·625 from 0·5 is where SF = 0 (max BM) so max BM is 0·5 + 1·625 = 2·125m		
(ii)		See Worksheet Q9		
		Curve correct polarity	½	
		Correctly plotted points	½	**6**
				(20)

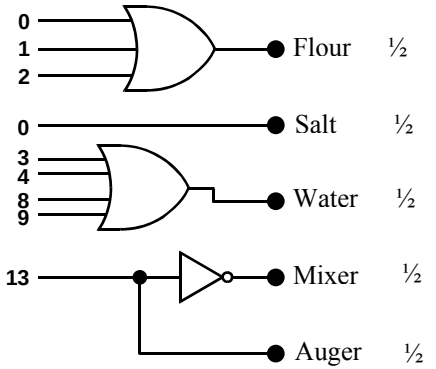
BM from left	Bending moment calculation	
0m & 3m	0kNm	½
0·5m	(4·7 × 0·5) – (0·8 × 0·5 × 0·25) = 2·25kNm	½
1m	(4·7 × 1) – (3 × 0·5) – (0·8 × 1 × 0·5) = 2·8kNm	1
1·5m	(4·7 × 1·5) – (3 × 1) – (0·8 × 1·5 × 0·75) = 3·15kNm	1
2m	(4·7 × 2) – (3 × 1·5) – (0·8 × 2 × 1) = 3·3kNm	1
2·25m	(4·7 × 2·25) – (3 × 1·75) – (0·8 × 2·5 × 1·25) – (0·25 × 4) = 3·3kNm	1

			Marks	
Q10				
(a)	(i)		½ ½	**1**
	(ii)	$V_{in} = 5\text{V}$		
		$V_2 = -\frac{1}{RC}\int V_{in}dt$	½	
		$= \frac{1}{3\times10^3 \times 47\times10^{-6}} \times 5t$	1	
		$V_2 = 35{\cdot}5t$		
		$V_{out} = \frac{1}{11\times10^3 \times C} \times \int 35{\cdot}5t dt$	1	
		$V_{out} = \frac{1{\cdot}61\times10^{-3}t^2}{C}$	½	**3**
(b)	(i)	$t = 0{\cdot}1s$ $V_2 = -35{\cdot}5t$ $V_2 = -35{\cdot}5 \times 0{\cdot}1$ $V_2 = -3{\cdot}55V$	½ ½	**1**
	(ii)	$V_{out} = \frac{1{\cdot}61\times10^{-3}t^2}{C}$	½	
		$2 = \frac{1{\cdot}61\times10^{-3}0{\cdot}1^2}{C}$	½	
		$C = \frac{1{\cdot}61\times10^{-3}0{\cdot}1^2}{2}$	½	
		$C = 8{\cdot}05\times10^{-6}$ $C = 8\mu\text{F}$	½	**2**

					Marks	
(c)	main:	btfss	PORTB,2		½	
		goto	main		½	
		bsf	PORTB,7		½	
		call	getx			
		call	gety		½	
		btfss	PORTB,2		½	
		bcf	PORTB,7		½	
		goto	main		½	
	gety:	movfw	TR		½	
		addwf	TL		½	
		movfw	TL		½	
		movwf	TOPSUM		½	
		movfw	BR			
		addwf	BL	}		
		movwf	BOTTOMSUM	}		
		movfw	BOTTOMSUM	}	½	
		subwf	TOPSUM		½	
		movwf	YPOS		½	**7**
		return				
(d)	testbar:	movlw	d'8'		½	
		subwf	YPOS		½	
		btfss	STATUS,C		½	
		goto	testbar		½	
		movlw	d'39'	}		
		subwf	YPOS	}		
		btfsc	STATUS,C	}		
		goto	testbar	}	½	
		movlw	d'150'		½	
		movwf	COUNTER		½	
	flash:	bsf	PORTB,4		½	
		movlw	d'6'			
		call	wait		½	
		bcf	PORTB,4			
		movlw	d'14'			
		call	wait		½	
		decfsz	COUNTER,F		½	
		goto	flash			
		return			½	**6**
						(20)

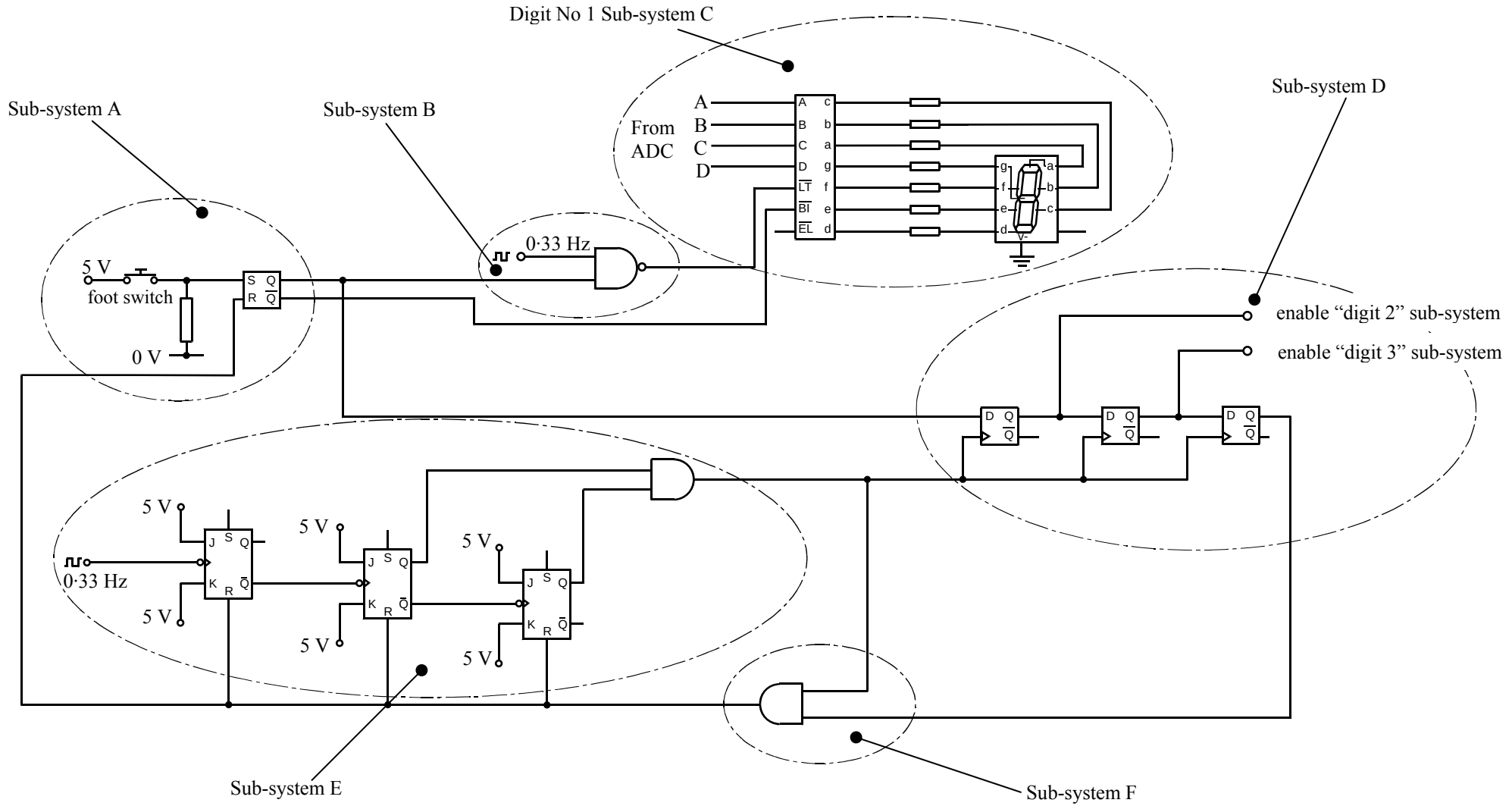
Worksheet Q3



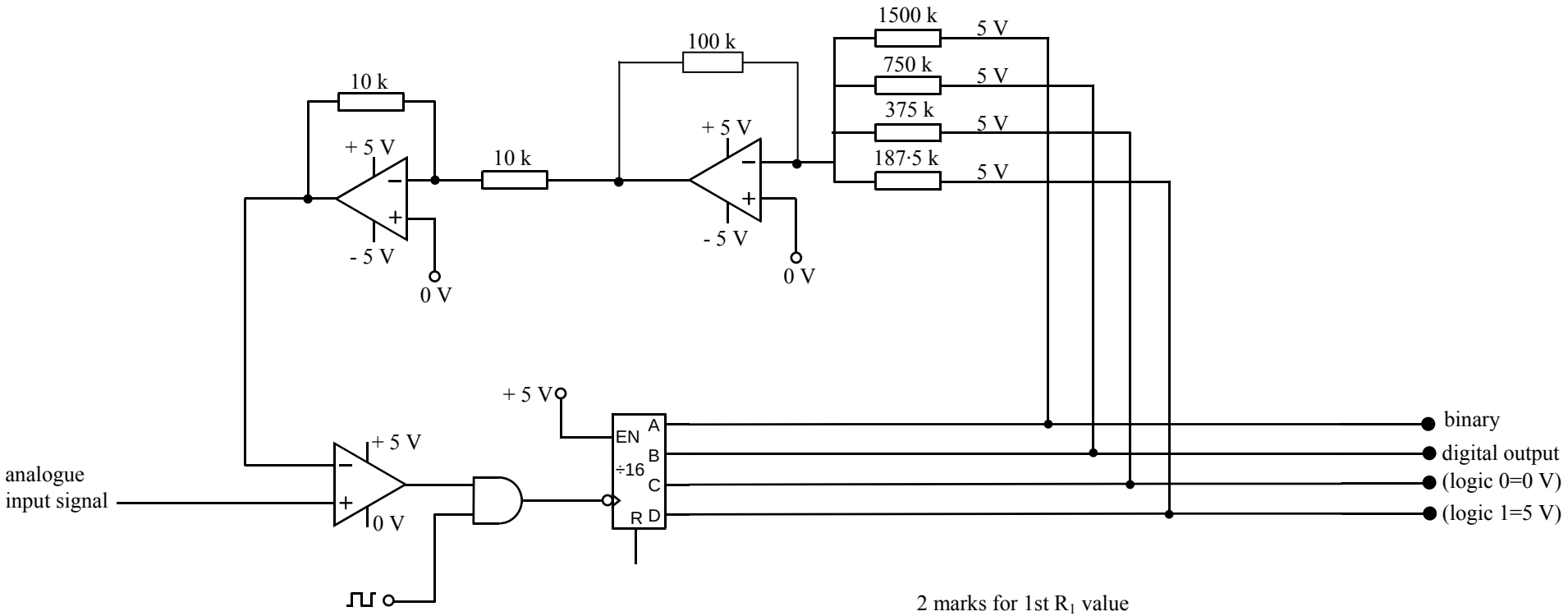


½ for IC1 resets
½ for SR $\overline{Q}$
½ for A B C D connections
½ for CLK → 14
½ IC1 12 → 1

Information Sheet Q8

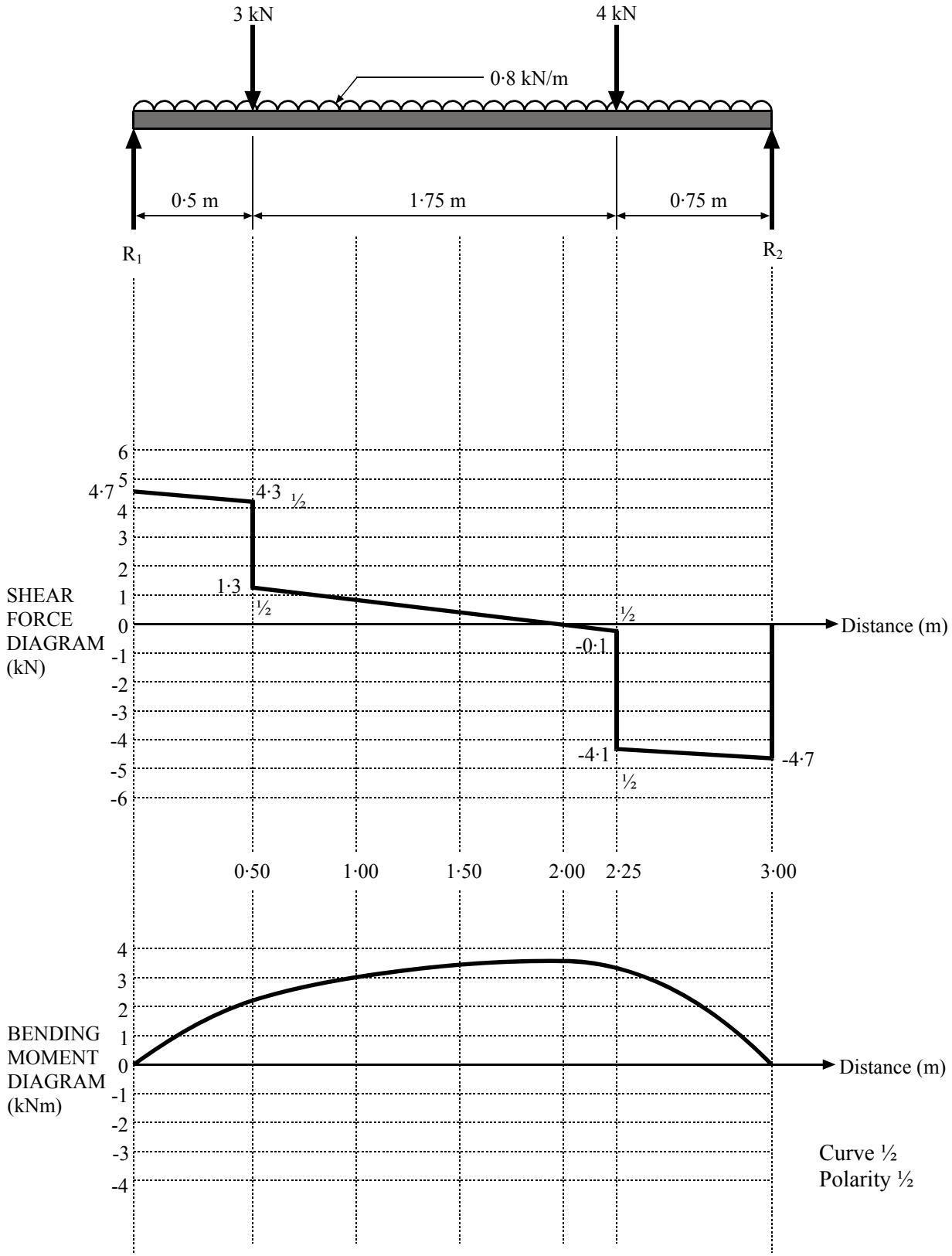


Worksheet Q8



2 marks for 1st R_1 value
½ for ÷ 2 other 3
½ for summing amp diagram
½ power supplies
½ for output connections

Worksheet Q9



DISTANCE FROM LEFT END (m)	0·00	0·50	1·00	1·50	2·00	2·25	3·00
BENDING MOMENT (kNm)	0	2·25	2·8	3·15	3·3	3·3	0

[END OF MARKING INSTRUCTIONS]