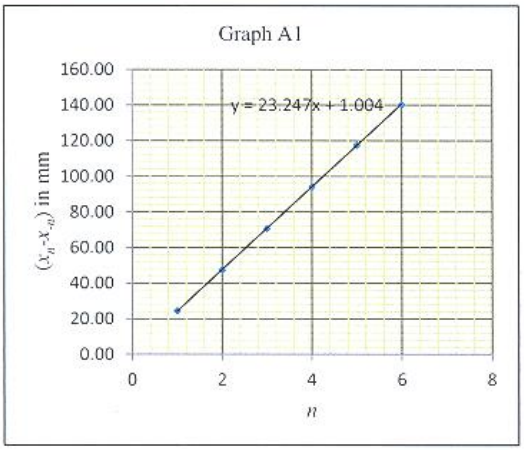
Part A: Determination of geometrical parameters of a helical spring

Tasks	Description	Marks
A1	Number of attached pattern marking sheet(s) for Part A: 2 with label(s): P1, P2 (patterns on page 7)	**0.7**
A2	Table A1: Observations from pattern P1	**0.5**
A3	Graph A1	**0.7**

Sr. No.	Order (n)	$(x_n - x_{-n})$ in mm
1	1	24.40
2	2	47.24
3	3	70.69
4	4	94.08
5	5	117.53
6	6	140.28



Graph A1 for determination of a_1: n versus $(x_n - x_{-n})$

Slope of the graph A1 = 23.25 mm

Calculation of a_1:

$$a_1 = 2 \times \lambda \times \frac{D}{\text{Slope}} = 2 \times \lambda \times \frac{2770}{23.25}$$

$a_1 = 0.151$ mm

A4

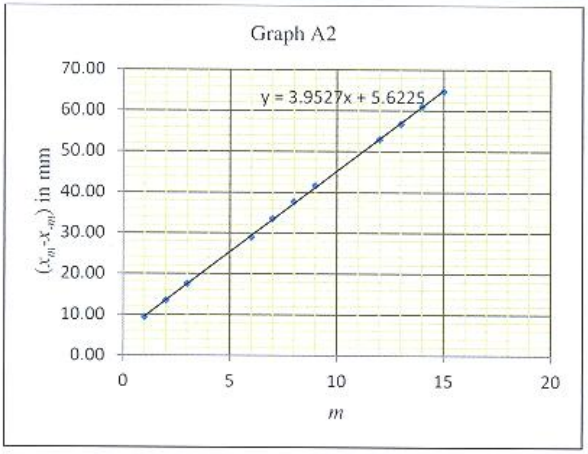
Table A2: Observations from pattern P1

Sr. No.	m	$(x_m - x_{-m})$ in mm
1	1	9.39
2	2	13.43
3	3	17.53
4	6	28.98
5	7	33.53
6	8	37.66
7	9	41.61
8	12	52.93
9	13	56.76
10	14	61.03
11	15	64.74

0.8

A5

Graph A2



Graph A2 for determination of d_1: m versus $(x_m - x_{-m})$

Slope of the graph A2 = 3.95 mm

Calculation of d_1:

$$d_1 = 2 \times \lambda \times \frac{D}{\text{Slope}} = 2 \times 0.000635 \times \frac{2770}{3.95}$$

$$d_1 = 0.89\ mm$$

0.6

A6

$\alpha_1 = 10.96°$

0.2

A7

Expression of P in terms of d_1 and α_1:

$$P = \frac{d_1}{\cos \alpha_1} = \frac{0.89}{\cos 10.96}$$

$P = 0.91$ mm

0.2

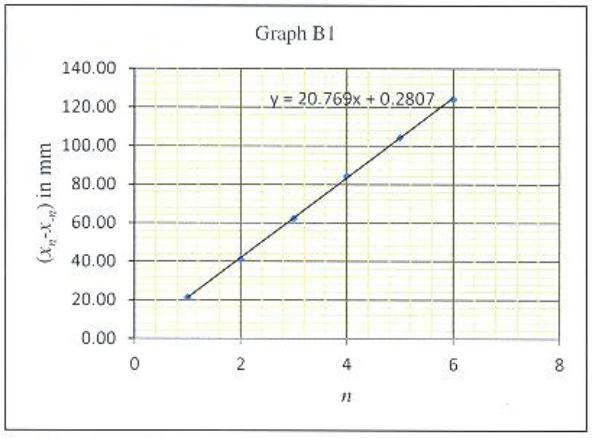
A8	Expression of R in terms of P and α_1: $\tan\alpha_1 = \frac{P}{2\pi R}$ $R = \frac{P}{2\times\pi\times\tan\alpha_1} = \frac{0.91}{2\times\pi\times\tan 10.96}$ $R = 0.75$ mm	**0.2**
	Total	**3.9**

Part B: Determination of geometrical parameters of double-helix-like pattern

Tasks	Description	Marks
B1	Attached pattern marking sheet number(s): 2 with label(s): P3, P4 (patterns on page 7)	**1.1**
B2	Table B1: Observations from pattern P3	**0.5**

Sr. No.	Order (n)	$(x_n - x_{-n})$ in mm
1	1	21.24
2	2	41.12
3	3	62.41
4	4	84.40
5	5	104.41
6	6	124.25

B3 — **0.5**



Graph B1 for determination of a_2: n versus $(x_n - x_{-n})$
Slope of the graph B1 = 20.8 mm
Calculation of a_2: $a_2 = 2\times\lambda\times\frac{D}{\text{Slope}} = 2\times 0.000635\times\frac{795}{20.8}$
$a_2 = 0.049$ mm

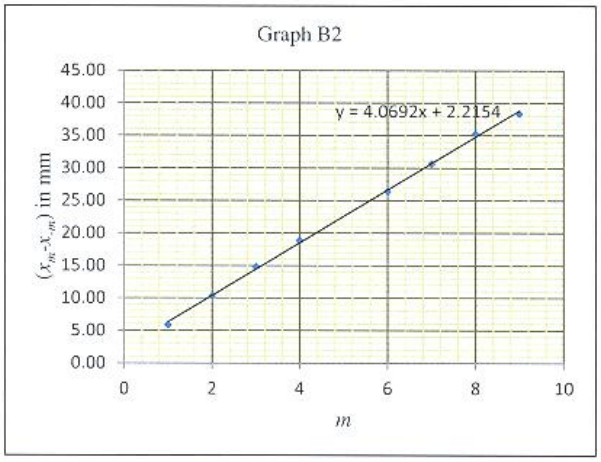
B4

Table B2: Observations from pattern P3

Sr. No.	m	$(x_m - x_{-m})$ in mm
1	1	5.84
2	2	10.29
3	3	14.83
4	4	18.84
5	6	26.44
6	7	30.65
7	8	35.26
8	9	38.34

1.2

B5



Graph B2 for determination of s: m versus $(x_m - x_{-m})$

Slope of the graph B2 = 4.07 mm

Calculation of s: $s = 2 \times \lambda \times \frac{D}{\text{Slope}} = 2 \times 0.000635 \times \frac{795}{4.07}$

$s = 0.248$ mm

0.5

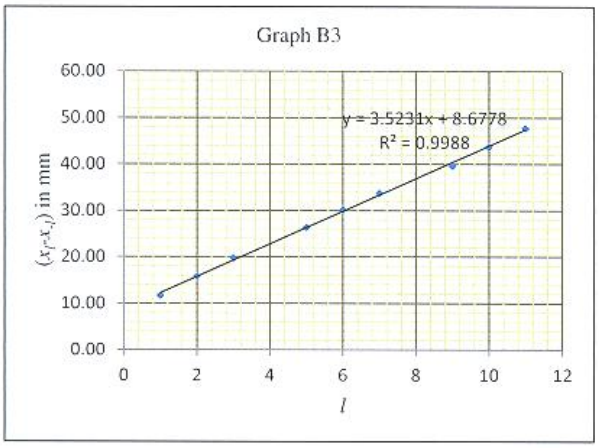
B6

Table B3 Observations from pattern P4

Sr. No.	Order (l)	$(x_l - x_{-l})$ in mm
1	1	11.64
2	2	15.77
3	3	19.71
4	5	26.33
5	6	30.14
6	7	33.69
7	9	39.62
8	10	43.70
9	11	47.75

1.6

B7



Graph B3 for determination of d_2: l versus $(x_l - x_{-l})$

Slope of the graph B3 = 3.52 mm

Calculation of d_2: $d_2 = 2 \times \frac{\lambda \times D}{\text{Slope}} = 2 \times 0.000635 \times \frac{2770}{3.52}$

$d_2 = 1.00$ mm

0.5

B8 $\alpha_2 = 9.88°$ **0.2**

Total **6.1**

Pattern P1 (D = 2770 mm)

$$\tan 2\alpha_1 = \frac{42.43}{105.40}$$
$$\alpha_1 = 10.96\,^\circ$$

Pattern P2

$$\tan 2\alpha_2 = \frac{36.67}{102.04}$$
$$\alpha_2 = 9.88°$$

Pattern P3 (D = 795 mm)

Pattern P4 (D = 2770 mm)

Marking Scheme

- Calculations should be reported up to at least two significant figures. Otherwise 0.1 mark will be deducted.
- Marks for axes labels and units will be given only if at least one data point is correctly plotted.

Part				Maximum Marks	Total Marks
Determination of geometrical parameters of a helical spring					**3.9**
A1	Pattern traced	Drawing of all required patterns (P1,P2)	0.1	0.7	
		Line drawn through points	0.1		
		Marking for a_1 on the pattern marking sheet			
		10 and above markings of minima	0.2		
		6-9 markings of minima	0.1		
		Less than 6 markings	0		
		Marking for d_1 on the pattern marking sheet			
		12 and above markings of minima	0.3		
		8-11 markings of minima	0.2		
		4-7 markings of minima	0.1		
		Less than 4 markings	0		
A2	Observation table for a_1 (Table A1)	5 sets of $(n, 2x_n)$ or (n, x_n) with correct minima orders, proper header and units.	0.5 (0.1 marks for each)	0.5	
		No header	− 0.1		
		No units	− 0.1		
A3	Graph for a_1	X axis with label Y axis with label and units	0.1	0.3	
		Proper marking of points	0.1		
		Slope of fit line with unit	0.1		
	Calculation of a_1	0.145 – 0.155 mm	0.4	0.4	
		0.140 – 0.145 and 0 .155 – 0.160 mm	0.3		
		Outside this range	0		
		If units not written	− 0.1		
A4	Observation table for d_1	8 sets of $(m, 2x_m)$ or (m, x_m) with correct minima orders, proper header and units.	0.8 (0.1 marks for each)	0.8	
		No header	− 0.1		
		No units	− 0.1		
A5	Graph for d_1	X axis with label Y axis with label and units	0.1	0.3	
		Proper marking of points	0.1		
		Slope of fit line with unit	0.1		
	Calculation	0.845 – 0.935 mm	0.3	0.3	

	of d_1	$0.825 - 0.845$ mm and $0.935 - 0.955$ mm	0.2		
		Outside this range	0		
		If units not written	-0.1		
A6	Pitch angle α_1	$9.65° < \alpha_1 < 11.95°$	0.2	0.2	
		$9.65 - 9.10°$ or $11.95 - 12.55°$	0.1		
		Values outside above range	0		
A7	Calculation of P	$P = d_1/\cos\alpha_1$	0.1	0.2	
		Correct calculation based on A5,A6	0.1		
		Otherwise	0		
A8	Calculation of R	$\tan\alpha_1 = P/2\pi R$	0.1	0.2	
		Correct calculation based on A5,A6	0.1		
		Otherwise	0		
Determination of geometrical parameters of double-helix-like pattern					**6.1**
B1	Pattern traced	Drawing of pattern for a_2	0.1	1.1	
		Drawing of pattern for s and d_2	0.1		
		Line drawn through points	0.1		
		Marking for a_2 on the pattern marking sheet			
		10 and above markings of minima	0.2		
		6-9 markings of minima	0.1		
		Less than 6 markings	0		
		Marking for s on the pattern marking sheet			
		12 and above markings of minima	0.2		
		6-11 markings of minima	0.1		
		Less than 6 markings	0		
		Marking for d_2 on the pattern marking sheet			
		12 and above markings of minima	0.4		
		8-11 markings of minima	0.3		
		4-7 markings of minima	0.2		
		Less than 4 markings	0		
B2	Observation table for a_2	5 sets of $(n, 2x_n)$ or (n, x_n) with correct minima orders, proper header and units.	0.5 (0.1 marks for each)	0.5	
		No header	-0.1		
		No units	-0.1		
B3	Graph for a_2	X axis with label Y axis with label and units	0.1	0.3	
		Proper marking of points	0.1		
		Slope of best fit line with unit	0.1		
	Calculation of a_2	$0.043 - 0.051$ mm	0.2	0.2	
		$0.041 - 0.042$ mm and $0.052 - 0.053$ mm	0.1		
		Outside this range	0		
		If units not written	-0.1		

B4	Observation table for s	6 sets of $(m, 2x_m)$ or (m, x_m) with correct minima orders, proper header and units.	1.2 (0.2 marks for each)	1.2	
		No header	− 0.1		
		No units	− 0.1		
B5	Graph for s	X axis with label Y axis with label and units	0.1	0.3	
		Proper marking of points	0.1		
		Slope of best fit line with unit	0.1		
	Calculation of s	$0.235\ \text{mm} < s < 0.255\ \text{mm}$	0.2	0.2	
		$0.230 - 0.235$ mm and $0.255 - 0.260$ mm	0.1		
		Outside this range	0		
		If units not written	− 0.1		
B6	Observation table for d_2	8 sets of $(l, 2x_l)$ or (l, x_l) with correct minima orders, proper header and units.	1.6 (0.2 marks for each)	1.6	
		No header	− 0.1		
		No units	− 0.1		
	Graph for d_2	X axis with label Y axis with label and units	0.1	0.3	
		Proper marking of points	0.1		
		Slope of best fit line with unit	0.1		
B7	Calculation of d_2	$0.960\ \text{mm} < d_2 < 1.050\ \text{mm}$	0.2	0.2	
		0.940-0.960 mm and 1.050-1.10 mm	0.1		
		Outside this range	0		
		If units not written	− 0.1		
B8	Pitch angle α_2	$9.60° < \alpha_1 < 10.30°$	0.2	0.2	
		$9.45 - 9.60°$ or $10.30 - 10.45°$	0.1		
		Values outside above range	0		
				Total	**10**