15

(24)

Lab Report – 03

Name of the Experiment	: Demonstration of Hooke's Law using spiral spring
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Date	: 14/10/2025

Instructor's comments:

Data tables:

Table 1. Static Determination of the Spring Constant, *k*

Mass added to the spring, m (kg)	Force, m×g (N)	Length after stretch, X (m)	Time for 10 Oscillations (sec)		Average Time Period (T_{av}) (sec)	Time Period^2 (T^2) (sec^2)
0.000	0	0	-	-	-	-
0.150	1.472	0.124	-	-	-	-
0.200	1.962	0.132	-	-	-	-
0.250	2.452	0.164	8.30	8.63	0.8465	0.7166
0.300	2.943	0.205	9.52	9.79	0.9655	0.9322
0.350	3.434	0.245	10.59	10.80	1.0695	1.1438
0.400	3.924	0.285	11.29	11.33	1.131	1.279
0.450	4.415	0.328	12.07	12.18	1.2125	1.4701
0.500	4.905	0.365	12.44	12.74	1.259	1.585

For, mass, m = 0.400 kg

Force, $mg = (0.400 \times 9.81) = 3.924\,N$

Avg time Period, $T_{av} = \frac{11.29 + 11.33}{20} = 1.131\,s$

Time Period^2 $(T^2) = 1.279\,s^2$

From graph-1, Slope = $\frac{dX}{dF}$ = 0.074 m/N

Spring constant, k = $slope^{-1}$ = 13.51 N/m

Work done from the F-X graph, W = 0.915 J

Elastic potential energy, U = −0.9048 J

$$\text{Slope} = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{0.366 - 0.292}{5 - 4} = 0.074$$

$$K = \frac{1}{\text{slope}} = \frac{1}{0.074} = 13.51$$

$$W = \frac{1}{2} \times \text{base} \times \text{height}$$
$$= \frac{1}{2} \times 5 \times 0.366$$
$$= 0.915\,J$$

$$U = -\frac{1}{2} k x^2$$
$$= -\frac{1}{2} \times 13.51 \times (0.366)^2$$
$$= -0.9048\,J$$

Table 2. Calculation of Effective mass

Mass of spring by digital balance, M_s	0.0720	kg
Effective mass of the spring (take x intercept from the T^2 vs m graph), m_e	0.02	kg
Mass of the spring, $M_{s,exp} = 3 \times m_e$	0.06	Kg
Percentage Error	16.67%	

Results:

$$\% \text{ error} = \frac{|\text{Theoritical} - \text{Experimental}|}{\text{Theoritical}} \times 100$$

$$= \frac{|0.0720 - 0.06|}{0.0720} \times 100$$

$$= 16.67\%$$

Questions:

1. To what extent does your graph agree with Hooke's Law?

According to Hooke's Law, $F \propto -x$, since the graph passes through the origin, like $y = mx$ (straight line).
The graph completely agree with Hooke's Law.

2. According to your understanding what is the relation between the added mass and frequency of oscillations of the spring mass system?

We know,

$$T = 2\pi\sqrt{m/k}$$
$$\Rightarrow T^2 = 4\pi^2 (m/k)$$
$$\Rightarrow T^2 = \frac{4\pi^2}{k} \cdot m$$
$$\therefore T^2 \propto m$$

$$f = \frac{1}{T}$$
$$\Rightarrow T = \frac{1}{f}$$
$$\Rightarrow T^2 = \frac{1}{f^2}$$
$$\therefore \frac{1}{f^2} \propto m$$

If the mass increase frequency will decrease
& if the mass decrease frequency will increase.

3. Did the m against T^2 graph passes through the origin? If not, interpret the meaning of the intercept in horizontal axis.

No, it is not passes through the origin.

$$T = 2\pi\sqrt{\frac{m_e + m_0}{k}}$$
$$\Rightarrow T^2 = 4\pi^2\left(\frac{m_0 + m_e}{k}\right)$$
$$\Rightarrow T^2 = \frac{4\pi^2 m_0}{k} + \frac{4\pi^2 m_e}{k}$$

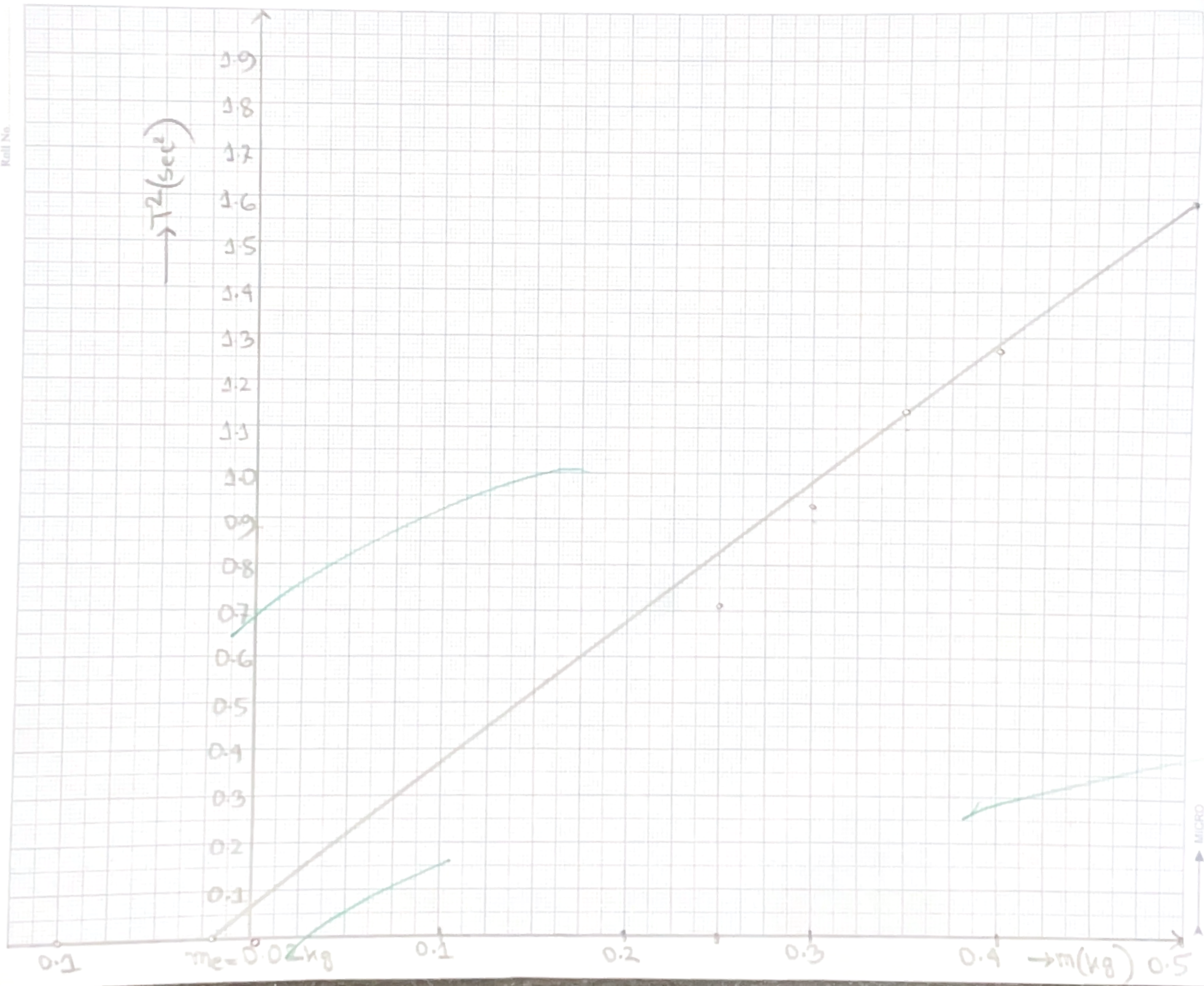
It follows, $y = mx + c$. The c is $\frac{4\pi^2 m_e}{k}$ which is for effective mass. And that's why it is not passes through origin.

4. From your understanding of the spring mass system, what would be the relation between kinetic energy and potential energy during the oscillations?

Here, in our experiment initially spring was on rest, when it stretched. Then potential energy is converted to kinetic energy and then in the reverse way, when the spring compressed kinetic energy converted to potential energy during the oscillation.

Discussion: Today our experiment was Demonstration of Hook's law using sprial spring. Our main object was to know spring constant of a particular spring-mass system and to identify how the restoring force work during oscillation of spring and also calculating the effective mass and how it differs the actual graph than ideal condition. In our first table we calculate restoring force (F) for different different mass and identify the stretch of spring length of the load mass (m_0). Then we identify the time period of every mass. In this whole experiment we rely on our own eye, which cause some deviation in accurate calculation, if we can use slow motion device we can calculate more accurately. Then we plot graph (F vs X) to calculate K, work, and potential energy, where we face some drawback for precision error in taking value. Then, in the second table we calculate effective mass (m_e) using second graph (T^2 vs m_0), where we noticed the line doesn't cross through origin, because of effective mass. There was a small deviation on two system theoritical and experimental which cause a small error.


Extension(m)
x
0.4
0.3
0.2
0.1
0
1
1.97
2
2.453
3
3.434
4
4.415
5
F(N)
(4, 0.292)
(5, 0.366)
Victoria 20 cm x 25 cm
MICRO
Roll No.



Roll No.
$\rightarrow T^2(sec^2)$
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
$m_e = 0.02$ kg
0.1
0.2
0.3
0.4
$\rightarrow m(kg)$
0.5
Victoria 20 cm x 25 cm
MICRO