Experiment No. -1

Universal Vibration Apparatus

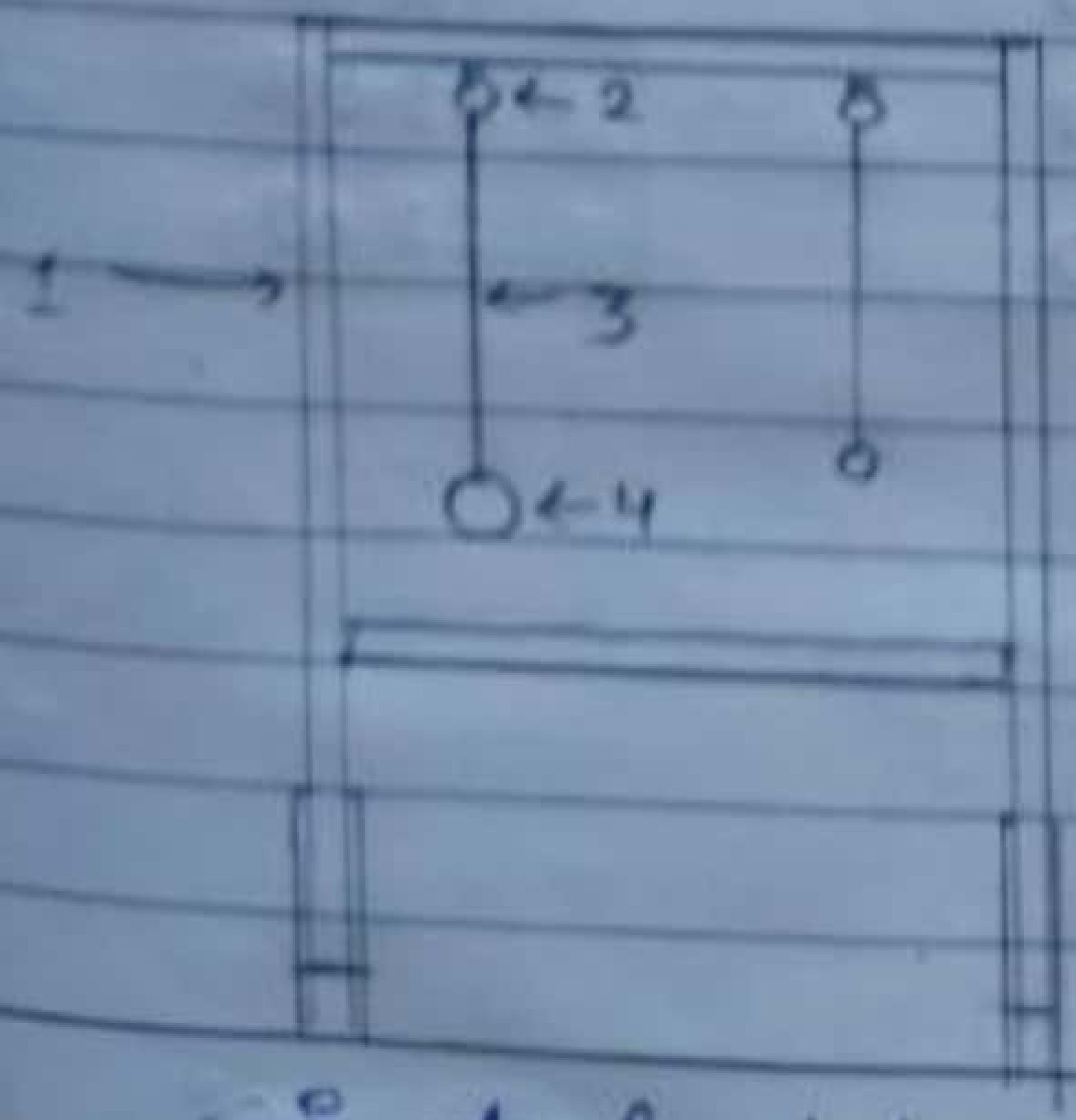
Aim:- To verify the relation of simple pendulum

$$T_{theo} = 2\pi\sqrt{\frac{L}{g}}, \ (s)$$

where

T_{theo} = Theoretical Periodic time is S
L = Length of pendulum in m

Description:- for conduction the experiment, a ball is supported by nylon thread into a chuck. It is possible to change the length of pendulum. This makes it possible to study the effect of variation of length on periodic time. A small ball may be substituted by large ball to illustrate that period of oscillation is independent of the mass of ball.



1 Main Frame
2 Drill Chuck
3 Nylone rope
4 Rubber ball

Simple Pendulum

Utilities Required :-

Space required 2.0 m × 1.0 m

Experimental Procedure :-

1. Attach the ball to one end of the thread.
2. Allow the ball to osillate.
3. Note down the time for 'n' oscillations
4. Repeat the experiment by changing the length
5. Complete the observation table given below.

Observation & Calculation :-

Data := Acceleration due to gravity $g = 9.81\ m/s^2$

Observation Table :-

S.NO.	L (m)	n	t (s)	
1.	0.55 m	10	15.05	
2.	0.47 m	10	13.97	
3.	0.33 m	10	11.69	

Calculations :-

S $T_{act} = \frac{t}{n}$, (s)

$T_{Theo} = 2\pi\sqrt{\frac{L}{g}}$, (s)

T_{act}	T_{theo}
S.No ① $T_{act} = \frac{t}{n} = \frac{15.05}{10} = 1.505\,s$	$T_{Theo} = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{0.55}{9.81}} = 1.487\,s$
S.No ② $T_{act} = \frac{13.97}{10} = 1.397\,s$	$T_{Theo} = 2\pi\sqrt{\frac{0.47}{9.81}} = 1.375\,s$
S.No ③ $T_{act} = \frac{11.69}{10} = 1.169$	$T_{Theo} = 2\pi\sqrt{\frac{0.33}{9.81}} = 1.152\,s$

Calculation Table:-

S.No	T_{act} (s)	T_{theo} (s)
1.	1.509	1.487
2.	1.397	1.375
3.	1.169	1.152

References:-

1. Khurmi, R.S Gupta, J.K. (1992). Theory of machines. 10th Ed ND: Eurasia Publisher House. pp 88-89.
2. Beven, Thomas (1984). The Theory of machines 3rd Ed. Delhi: CBS Publisher. pp 35-36.

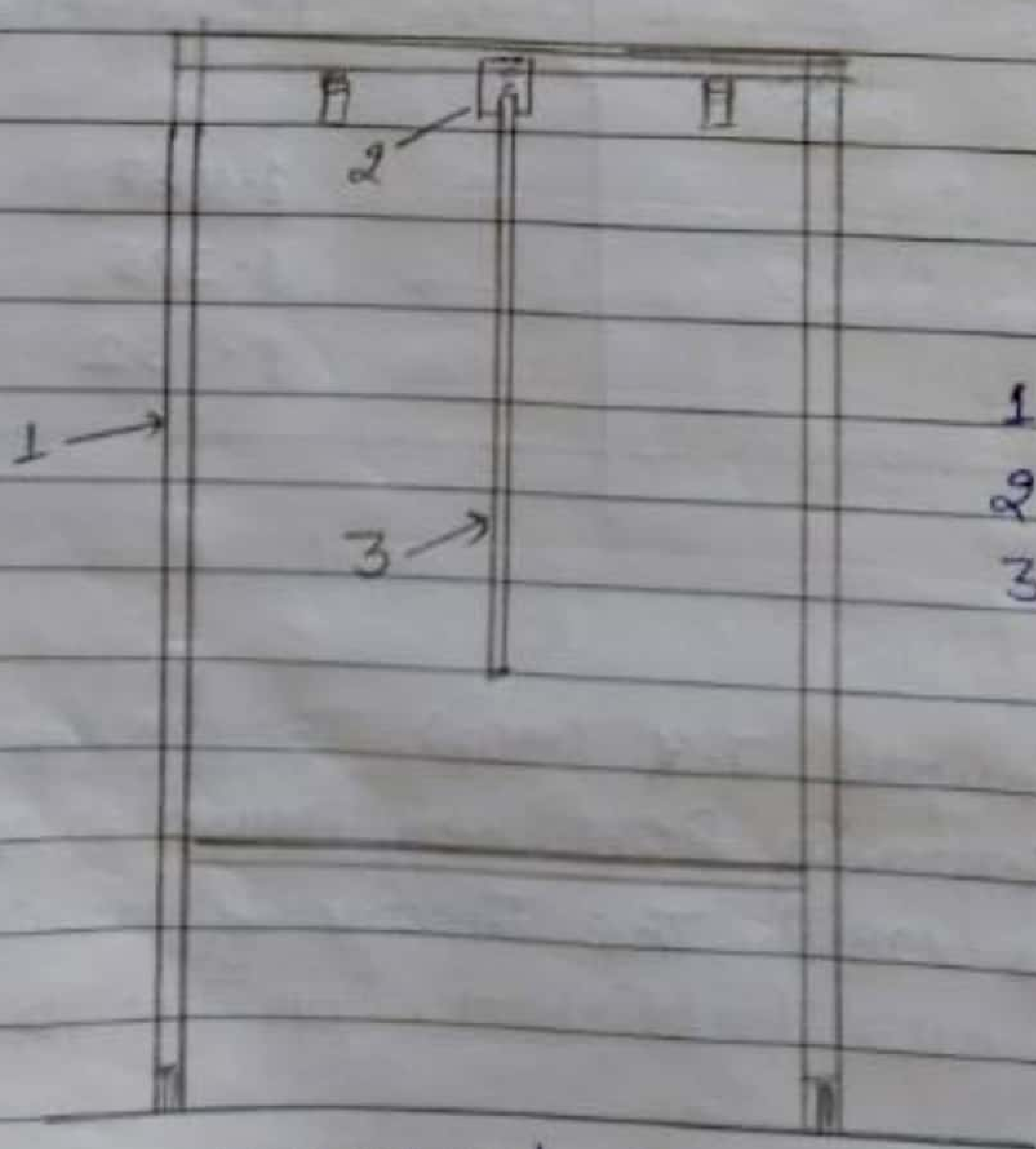
Experiment No. 2.

Aim:- To determine the radius of gyration 'K' of a given compound pendulum
To verify the relation of compound pendulum -

$$T = 2\pi \sqrt{\frac{(K)^2 + (OG)^2}{g\,(OG)}} \quad , (s)$$

Where,

T = Periodic time in s
K = Radius of gyration about the C.G in m
OG = Distance of C.G. of the rod from support in m.
L = Length of suspended pendulum in m



1 Main Frame
2. Holding Bracket
3. Pendulum

compound Pendulum

Description :- The compound pendulum consists of a steel bar. The bar is supported by knife-edge. Two pendulums of different lengths are provided with the set-up.

Experimental Procedure :-

1. Support the rod on knife-edge
2. Note the length of suspended pendulum and determine OG.
3. Allow the bar to oscillate.
4. Note down the 't' for 'n' oscillation.
5. Repeat the experiment with different length of suspension.
6. Complete the observation table given below.

Observation & Calculation :-

Data :- Length of pendulum L = ____ m

gravity $g = 9.81\ m/s^2$

Observation Table :-

S.No.	L(m)	n	t(s)
1.	0.81 m	10	14
2.	0.614 m	10	12

Calculations :-

$T_{act} = \frac{t}{n}$ (s) $\qquad OG = \frac{L}{2}$ m

$K_{act} = \sqrt{\left(\frac{T_{act}}{2\pi}\right)^2 \times g \times OG - (OG)^2}$

$K_{theory} = \frac{L}{2\sqrt{3}}$, m

$T_{act_1} = \frac{t_1}{n} = \frac{14}{10} = 1.4s$

$T_{act_2} = \frac{t_2}{n} = \frac{12}{10} = 1.2s$

K theoritical $\qquad KT_1 = \frac{L_1}{2\sqrt{5}} = \frac{0.81}{3.46}$

$= 0.23$ m

$KT_2 = \frac{L_2}{2\sqrt{3}} = \frac{0.614}{3.46} = 0.177$ m

Kactual : $K_{a1} = \sqrt{\frac{T_{act}}{2\pi} \times g \times OG - (OG)^2}$

$= \sqrt{0.049 \times 9.81 \times 0.405 - (0.405)^2}$

$= 0.175$ m

$K_{a2} = \sqrt{0.036 \times 9.81 \times 0.307 - (0.307)^2}$

$= 0.119$ m

Theott : $2\pi \sqrt{\dfrac{(K)^2+(OG_1)^2}{g(OG_1)}}$

$$6.28 \sqrt{\frac{(0.234)^2+(0.405)^2}{(9.81)(0.405)}} = 1.473$$

Theott 2 : $2\pi \sqrt{\dfrac{(0.177)^2+(1.307)^2}{(9.81 \times 0.307)}} = 1.282$

Calculation Table :-

S.No.	Kexpt (m)	K(theo) (m)
1	0.175m	0.23
2	0.119m	0.177m

References :-

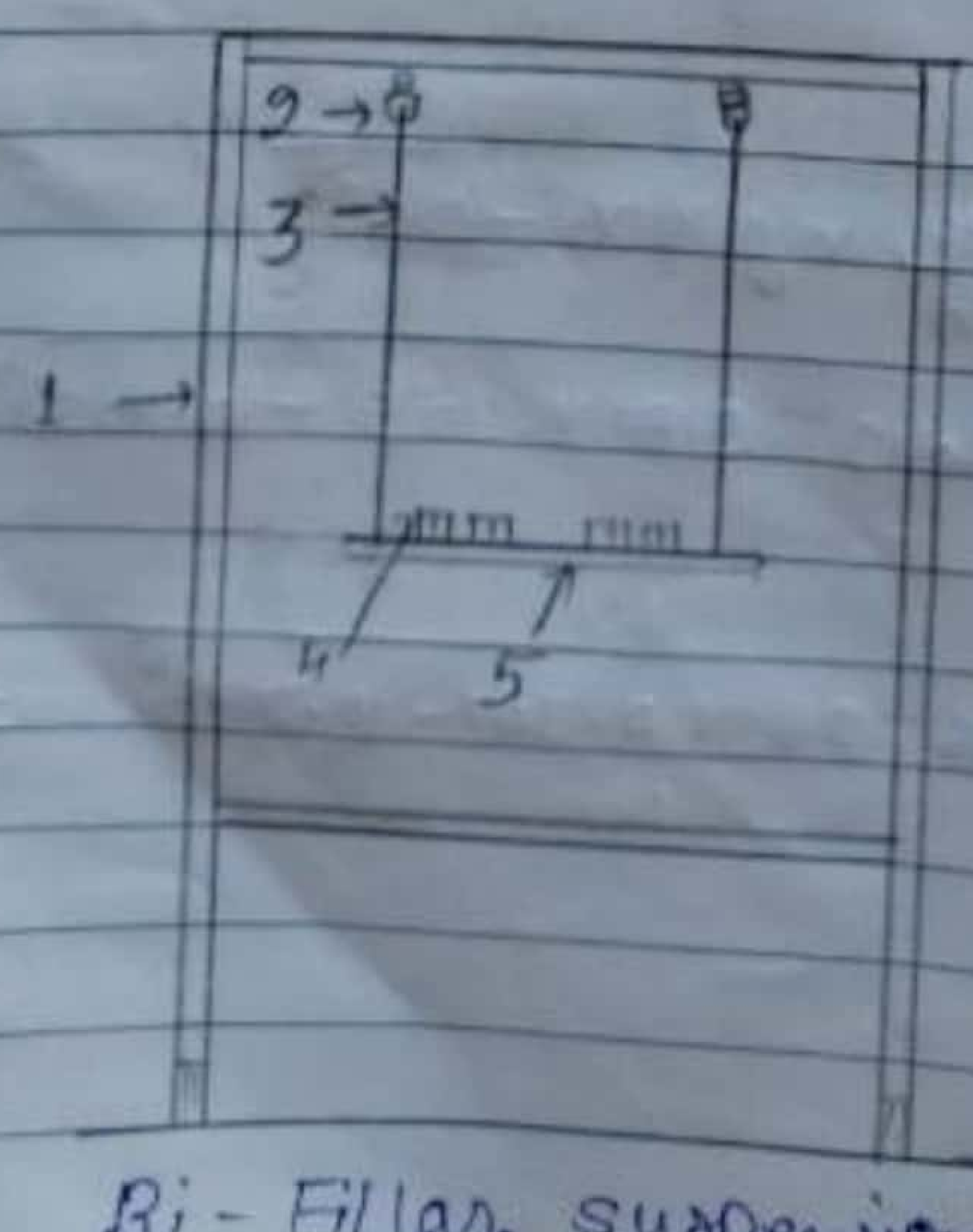
Khurmi, R.S. Gupta, J.K (1992) Theory of machines 10th Ed. ND Eurasia Publisher House pp 91-93

Experiment No. 3.

Aim :- To determine the radius of gyration of given bar by using Bi-Filer suspension.

Descripition :- A uniform rectangular section bar is suspended from the pendulum ~~of~~ support frame by two parallel cords. Top ends of the cords pass through the two small chucks fitted at the top. Other ends are secured in the Bi-Filer bar. It possible to adjust the length of the cord by loosening the chucks

The suspension may be used to determine the radius of gyration of any body. Radius of gyration of the combined bar and body is then determined.



1 Main Frame
2 Drill Chuck
3 Nylone Thread
4 Weight
5 Swinging Plate

Bi - Fillar suspension

Experimental ~~Bodure~~ Procedure :-

1. Suspend the bar from chuck
2. Adjust the same length from both cords
3. Allow the bar to oscillate.
4. Note down the time for 'n' oscillation.
5. Repeat the experiment by putting the weights on bar at equal distance from centre.
6. Complete the observation table given below.

Observation & Calculation :-

Acceleration due to gravity, $g = 9.81\ m/s^2$
Distance b/w the two strings, $2a = 45$ m

Observation Table :-

S.N.	L(m)	n	t(s)	
1.	~~23 inch~~ 0.584 m	15	14.68	(without weight)
2.	0.5461	15	14	
3.	0.5461	15	13.80	(with weigh
~~4~~		~~5~~		

Calculations :-

$$T_{act} = \frac{t}{n}, (s)$$

$$K_{act} = \frac{T_{act} \times a}{2\pi \times \sqrt{\frac{L}{g}}}, (m)$$

$$K_{theo} = \frac{L}{2\sqrt{3}}, (m)$$

Page No.

T_{act_1}	T_{act_2}	t_{act_3}
$\frac{14.68}{15}$	$\frac{14}{15}$	$\frac{13.80}{15}$
$\Rightarrow 0.978$	$\Rightarrow 0.933$	$\Rightarrow 0.92$

$K_{Theo} = \frac{L}{2\sqrt{3}}$ $\quad K_{T_1} = 0.584/2\sqrt{3} = 0.505$ m

$K_{T_2} = 0.5461/2\sqrt{3} = 0.472$ m

$K_{T_3} = 0.5461/2\sqrt{3} = 0.472$ m

$K_{act_1} = \frac{T_{act} \times a}{2\pi \times \sqrt{\frac{L}{g}}}$ $\quad Ka_1 = \frac{0.978 \times \frac{45}{2}}{2 \times 3.14 \times \sqrt{\frac{0.584}{9.81}}} = \frac{22.005}{1.532} = 14.36$

$Ka_2 = \frac{20.99}{1.48} \Rightarrow 14.18$

$Ka_3 = \frac{20.7}{1.48} \Rightarrow 13.98$ (with weight)

Calculation Table :-

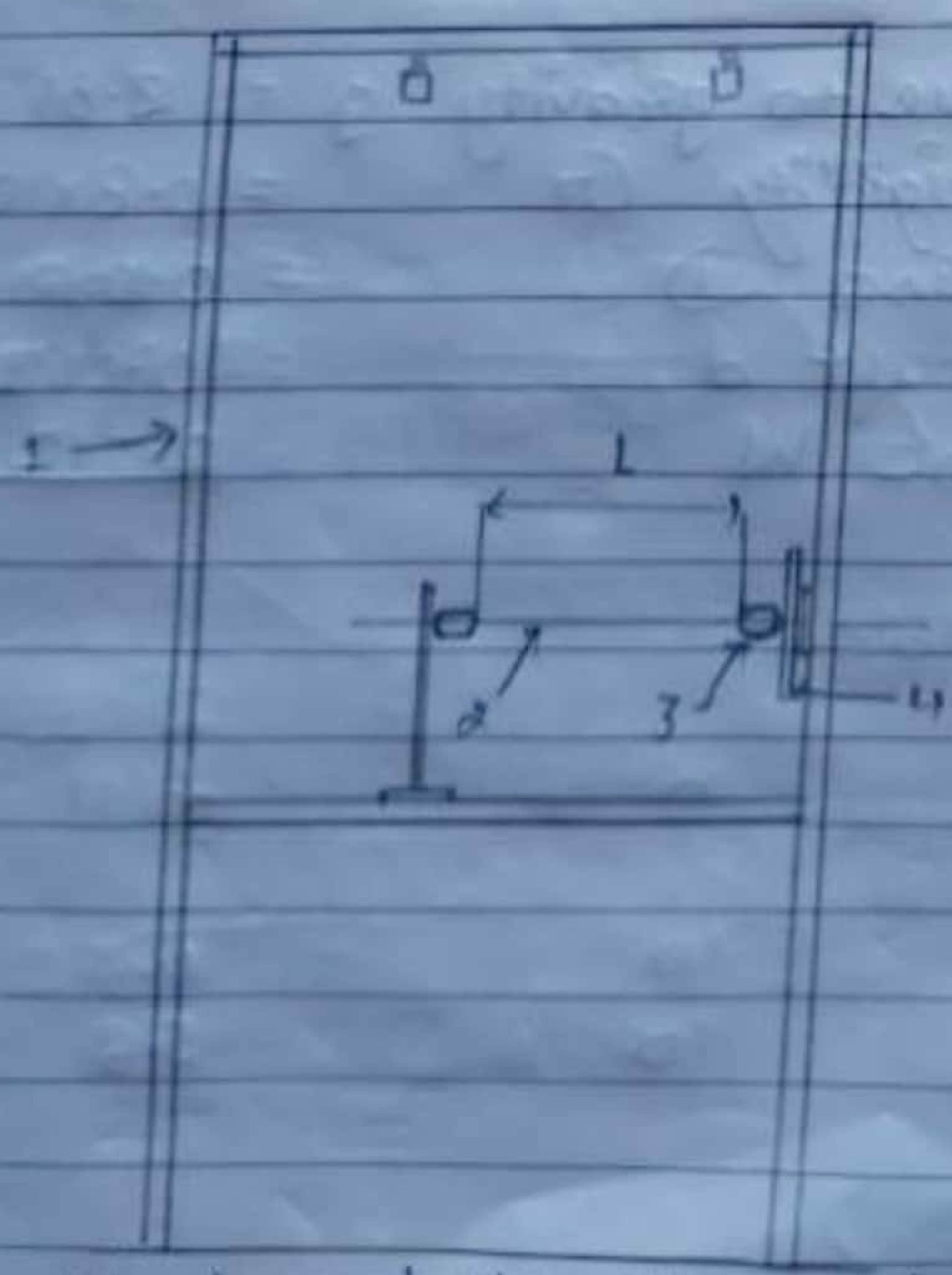
S No.	K_{act} (m)	K_{theo} (m)
1.	14.36 m	0.505 m
2.	14.18 m	0.472 m
3.	13.98	0.472 m (with weight)

References :- Khurmi, R.S. Gupta, J.K. (1992) Theory of Machies, 10th Ed. NO: Ed Eurasia Publisher ~~...~~ House. pp 101-102

Experiment No. - 4

Aim :- To study the torsional Vibrations of single rotor system.

Description :- In this experiment, one end of the shaft is gripped in the chuck & heavy flywheel free to rotate in ball bearing is fixed at the other end of the shaft. The bracket with fixed end of the shaft can be clamped at any convenient position along lower beam. Thus, length of the shaft can be varied during the experiments. The ball bearing support to the flywheel offers negligible damping during the experiment. The bearing housing is fixed to side member of the main frame.



1. Main Frame
2. Shaft
3. Drill Chuck
4. Rotor

Undamped Vibration of single Rotor System.

Experimental Procedure :-

1. fix the braket at convenient position along the lower beam.
2. Grip one end of the shaft at the bracket by chuck.
3. fix the rotor on the other end of shaft
4. Twist the rotor through some angle & release
5. Note down the time required for 'n' oscillation
6. Repeat the procedure for the different length of the shaft.
7. Complete the observation table given below.

Observation & Calculation :-

Data :-

Acceleration due to gravity $g = 9.81\ m/s^2$
Modulus of rigidity $G = 0.8 \times 10^{11}\ N/m^2$
Diameter of disc $D = 0.225\ m$
Diameter of shaft $d = 0.004\ m$
Weight of disc $W = 2.712\ kg$

Observation Table :-

S.N.	L (m)	n	t (s)
1.	0.62	10	4.8
2.	0.705	10	5.8

Calculations:-

$I_p = \frac{\pi}{32} d^4$, (m^4)

$I = \frac{W \times D^2}{8}$ $(kg\ m^2)$

$K_t = \frac{G \times I_p}{L}$ (Nm)

$T_{theo} = 2\pi \sqrt{\frac{I}{K_t}}$, (s)

$T_{act} = \frac{t}{n}$ (s)

$f_{theo} = \frac{1}{T_{theo}}$ (Hz)

$f_{act} = \frac{1}{T_{act}}$ (Hz)

$I_p = \frac{\pi}{32} \times (0.004)^4 = 2.51 \times 10^{-11}\ m^4$

$I = \frac{2.712 \times (0.225)^2}{8} = 0.017\ Kg\ m^2$

$K_{t_1} = \frac{0.8 \times 10^{11} \times 2.51 \times 10^{-11}}{0.62} = 3.238\ Nm$

$K_{t_2} = \frac{0.8 \times 10^{11} \times 2.51 \times 10^{-11}}{0.705} = 2.848\ (Nm)$

$T_{theo_1} = 2\pi \sqrt{\frac{I}{K_{t_1}}}$ $2\pi \sqrt{\frac{0.017}{3.238}} = 0.455\ s$

Page No.

$$T_{theo,2} = 2\pi\sqrt{\frac{I}{K_{t_2}}} = 2\pi\sqrt{\frac{0.017}{2.848}}$$

$$= 0.485 \text{ s}$$

$$T_{act_1} = \frac{t_1}{n} = \frac{4.8}{10} = 0.48$$

$$T_{act_2} = \frac{t_2}{n} = \frac{5.8}{10} = 0.58$$

$$f_{theo_1} = \frac{1}{T_{Theo_1}} = \frac{1}{0.455} = 2.197 \text{ Hz}$$

$$f_{theo_2} = \frac{1}{T_{Theo_2}} = \frac{1}{0.485} = 2.061 \text{ Hz}$$

$$f_{act_1} = \frac{1}{T_{act_1}} = \frac{1}{0.48} = 2.083$$

$$f_{act_2} = \frac{1}{T_{act_2}} = \frac{1}{0.58} = 1.72 \text{ Hz}$$

Theott 1 = $2\pi \sqrt{\frac{(K)^2 + (OG)^2}{g(OG)}}$ =

$6.28 \sqrt{\frac{(0.234)^2 + (0.405)^2}{(9.81)(0.405)}} = 1.473$

Theott 2 = $2\pi \sqrt{\frac{(0.177)^2 + (1.307)^2}{(9.81 \times 0.307)}} = 1.282$

Calculation Table :-

S.No.	Kact (m)	K(theo) (m)
1	0.175m	0.23
2	0.119m	0.177m

References :-

Khurmi, R.S. Gupta, J.K (1992) Theory of machines 10th Ed. ND Eurasia of Publisher House PP 91-93