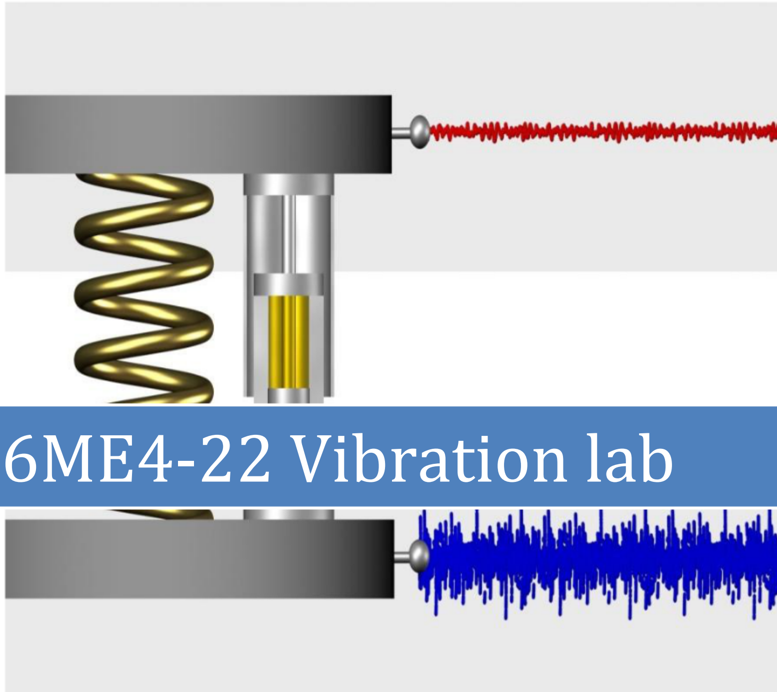


6ME4-22 Vibration lab

3rd year 6 sem

6ME4-22: VIBRATION ENGINEERING LAB.

Credit: 1.5 **Max. Marks: 75**
0L+0T+3P **Exam Hours: 3**

SN	NAME OF EXPERIMENT	CONTACT HOURS
1	To verify relation T = 2π□ (l/g) for a simple pendulum.	
2	To determine radius of gyration of compound pendulum.	
3	To determine the radius of gyration of given bar by using bifilar suspension.	
4	To determine natural frequency of a spring mass system.	
5	Equivalent spring mass system.	
6	To determine natural frequency of free torsional vibrations of single rotor system. i. Horizontal rotor ii. Vertical rotor	
7	To verify the Dunkerley's rule.	
8	Performing the experiment to find out damping co-efficient in case of free damped torsional vibration	
9	To conduct experiment of trifler suspension.	
10	Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.	

Experiment No 1.

AIM: To verify relation T = 2π☐ (l/g) for a simple pendulum.

T=2π ()_

Where T= Periodic Time in Seconds.

l= Length of Pendulum in cms.

DESCRIPTION OF SET UP :

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

THEORY :

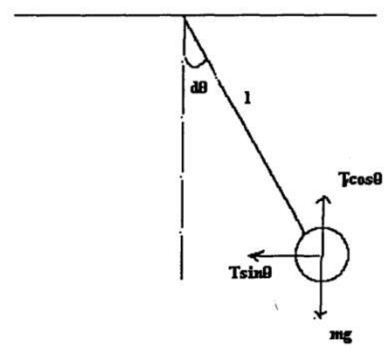


Figure (a)

Simple pendulum

By equilibrium of forces we have;

$mg = T\cos d\theta \approx T$ ……..(1)

By S.H.M equation we have;

$T \sin d\theta = m\omega^2 x$ ……..(2)

we have; $x = l \sin d\theta$

Hence eqn.(2) becomes

$T \sin d\theta = m\omega^2 l \sin d\theta$

$T = m\omega^2 l$ ……..(3)

From (1) and (3)

$mg = m\omega^2 l$

$\omega^2 = (g / l)$; $\omega = \sqrt{(g/l)}$

we have ; $\omega = 2\pi / T$

Hence, $T = 2\pi \sqrt{\left(\frac{l}{g}\right)}$

PROCEDURE:

a] Attach each ball to one end of the thread.

b] Allow the ball to oscillate and determine the periodic time T by knowing time (for say 10 oscillations).

c] Repeat the experiment by changing the length.

d] Complete the observation table given below.

OBSERVATIONS:

Weight of small ball: 112 gms.

Weight of largel ball: 60 gms.

OBSERVATION TABLE :

Sr.No.	Mass of the ball (m) in gms.	Length (L) In cms.	No.of osc. (n)	Time for n oscillation (t) in sec.	Texp = t avg./ n in sec.	Ttheo = $2\pi \sqrt{\left(\frac{l}{g}\right)}$ in sec.
1	112	35.5	10	11.82 11.95 12.06	1.194	1.195
2	112	29.5	10	10.75 10.79 10.90	1.081	1.091
3	60	37	10	11.44 11.59 11.49	1.151	1.22
4	60	25	10	8.41 8.66 8.50	0.885	1

CALCULATIONS :

Sample Calculation for sr. no.1:

Ttheo = 2π $\sqrt{\left(\frac{l}{g}\right)}$

.355

Ttheo = 2π

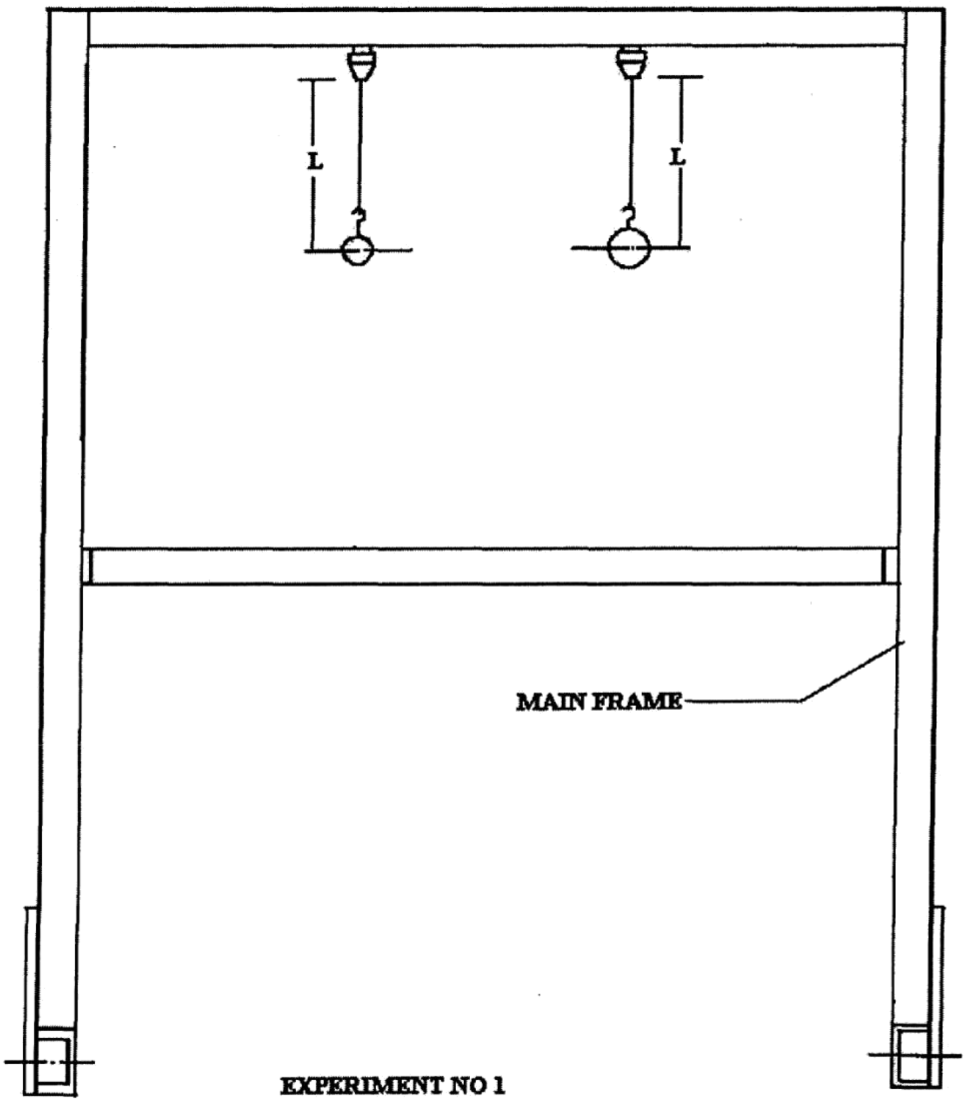
Ttheo = 1.195 secs.

RESULT:

Sr. No.	**Texp = t avg./ n** in sec.	**Ttheo = 2π** in sec.
1	1.194	1.195
2	1.081	1.091
3	1.151	1.22
4	0.885	1.0

CONCLUSION:

The relation T=2π g[l] is verified , the experimental and theoretical values are closer.



EXPERIMENT NO 1

FIG. NO 1

Experiment No 2.

AIM: To determine radius of gyration K of compound pendulum..

T=2π ((**+**) / (g*OG))

Where T= Periodic time in sec.

K=Radius of gyration about C.G in cm.

OG= Distance of CG of rod from support.

L= Length of suspended pendulum in cm.

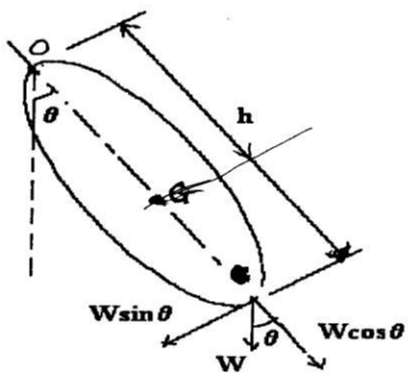
DISCRIPTION OF SET UP:

The compound pendulum consists of steel bar. The bar is supported in the hole by knife edge.

THEORY:

Compound pendulum

The system which is suspended vertically and oscillates with a small amplitude under the action of forvce of gravity , is known as “compound pendulum”. It is an example of undamped single degree of



freedom system.

Let, W = Weight of rigid body.

W = mg , m = W/g

O = Point of suspension.

k = radius of gyration about an axis through the centre of gravity G.

h = distance of point of suspension from G.

I = Moment of inertia of body about O.

$= m^2 + h^2$

If OG is displaced by an angle ‘θ’ , restoring torque T.

T = -h W sin θ

= -mgh sinθ

If θ is very small, then sinθ = θ , then abve equation can be written as,

T = -mgh θ

Inertia torque is given as,

T=-Iθ

Summing up all moments acting on the body,

Iθ + mgh = 0

The natural frequency ω_n can be determined as

$$\omega_n = \sqrt{\left(\frac{h}{\quad}\right)}$$

also,

$$\omega_n = \sqrt{\left(\frac{h}{\ ^2 + h^2}\right)}$$

$$\omega_n = \sqrt{\frac{h}{\ ^2+h^2}}$$

$$f_n = \frac{1}{2}\sqrt{\frac{h}{\ ^2+h^2}}$$

<u>PROCEUDRE:</u>

1] Support the rod knife edge.

2] Note the length of suspended pendulum and determine OG.

3] Allow the bar to oscillate and determine ‘ T ’ by knowing time for 10 oscillations.

4] Repeat the above procedure with the second pendulum.

5] Complete the observation table given below.

<u>OBSERVATIONS:</u>

1. OG = 32cm. for small pendulum.
2. OG = 42cm. for large pendulum.
3. m_{small} = 616 gms.
4. m_{large} = 1.5 ~~k~~g.
5. $k_{theo.}$ = L/2 3

OBSERVATION TABLE :

Sr. No.	L in cm	OG In cm	No. of osc.(n)	Time for n osc (t) in sec	Texp = tavg./n in sec.	k_{expt} .in m	K_{theo} . In m
1	58.5	32	10	12.16 12.88 12.34	1.246	0.145	0.168
2	80	42	10	14.63 14.31 14.25	1.439	0.2	0.2309

CALCULATION :

Sample Calculation for sr. no.1:

1.Finding Kexpt. We have: T=2π ((2+ 2) / (g*OG))

1.246=2π ((2+0.32 2) / (9.81*0.32)) ; **Kexpt. = 0.145 cm**

2.Finding Ktheo.

We have: $k_{theo.}$ = L/2 3

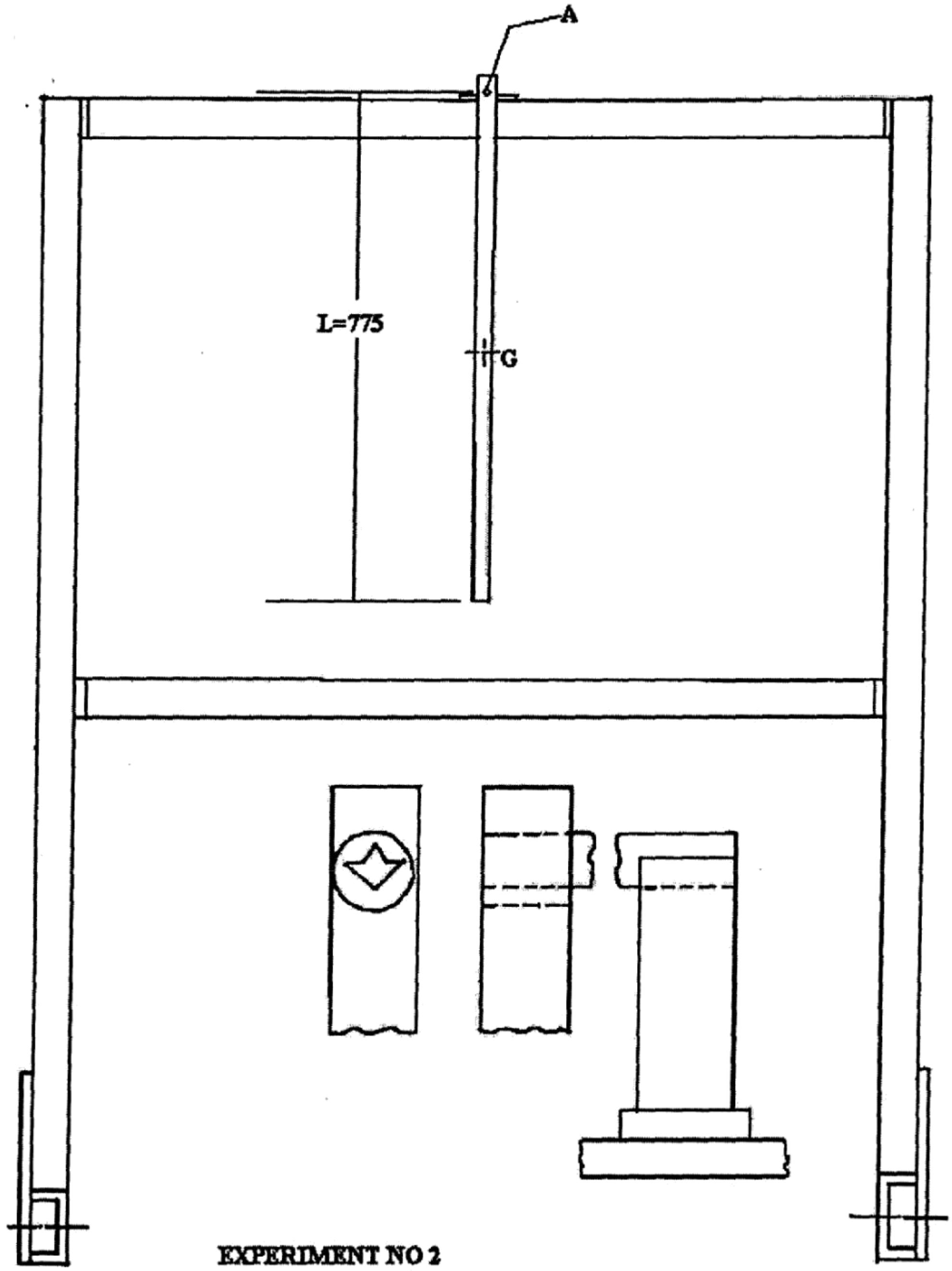
$k_{theo.}$ = 32/2 ; $\mathbf{k_{theo.}}$ **= 9.23 cm**

RESULT:

Sr. No.	kexp = in m.	ktheo = = L/2 3 in m.
1	0.145	0.168
2	0.2	0.2309

CONCLUSION:

Radius of gyration is calculated and found to match with the relation **T=2π ((+) / (g*OG)),** hence experiment is verified.



EXPERIMENT NO 2

FIG. NO 2

Experiment No 3.

AIM: To determine the radius of gyration of given bar by using bifilar suspension.

DESCRIPTION: OF SET UP:

A uniform rectangular section bar is suspended form the pendulum support frame by two parallel cords. Top ends of cords are attached to hooks filed at the top. The other ends are secured in the bifilar bar.It is possible to change the length of cord or decrease its width.

The suspension may also use to determine the radius of gyration of anybody under investigation the body bolted to the centre. Radius of gyration of the combined bar and body is then determined.

THEORY:

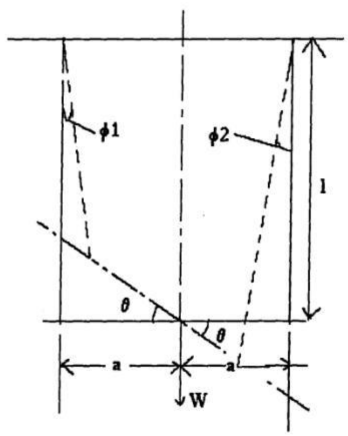


Figure (c)

Bifilar suspension

In bifilar suspension a weight W is suspended by two long flexible strings.

Initially the support and the bar AB are parallel.The bar AB is given a slight twist Θ and then released.

Let the strings are displaced by an angles Φ_1 and Φ_2.If l_1 and l_2 are distance of two ends from the centre of gravity G, then tension T_A and T_B can be written as,

$T_A = (Wl_2)/(l_1 + l_2)$ and $T_B = (Wl_1)/(l_1 + l_2)$ …………(1)

Since the $\Phi_1$and Φ_2 angles are small, so the effects of vertical acceleration can be neglected.Only the horizontal components of tension will be considered which are given as

$T_A \Phi_1$ and $T_B \Phi_2$ and both are perpendicular to AB. $T_A = (Wl_2)/(l_1 + l_2)$ and $T_B = (Wl_1)/(l_1 +$

$l_2)$ From the geometry

$l_1\Theta = l\,\Phi_1$ and $l_2\Theta = l\,\Phi_2$

or $\Phi_1 = l_1\Theta / l$, $\Phi_2 = l_2\Theta / l$ ………………(2)

The resisting torque T for the system can be written as

$T = T_A\, l_1\, \Phi_1 + T_B\, l_2\, \Phi_2$

$=[(Wl_2)/(l_1 + l_2)]*[((l_1\Theta) / l)]*l_1 + [(Wl_1)/(l_1 + l_2)]*[((l_2\Theta) / l)]*l_2$

Substituting T_A and T_B from (1) and Φ_1 and Φ_2 from (2)

$= [(W\, l_2\, l_1\, \Theta) /(l_1 + l_2)l]*[(l_1 + l_2)]$

$= (W\, l_2\, l_1\, \Theta)/ l$ ………..(3)

We know that

$T=I\alpha$

Where , T = torque

I = Moment of inertia = $W\, k^2/ g$

α = angular acceleration

k = radius of gyration\

So, $\alpha=T/I$

$= ((W\, l_2\, l_1\, \Theta)/ l)/ (W\, k^2/ g)$

$= (g\, l_2\, l_1\, \Theta) / l\, k^2$……….(4)

We also know that

ω^2 = Angular acceleration / Angular Displacement

Where, ω = Angular velocity of AB

$\omega^2 = (g\, l_2\, l_1\, \Theta) / l\, k^2\theta$

$\omega^2 = (g\, l_2\, l_1) / l\, k^2$

Here, $l_2 = l_1 = a$

$\omega^2 = (g\, a^2) / l\, k^2$

$\omega = (a/k)$ (/)

We have $\omega = 2\pi/T$

Hence $T = 2\pi * (k/a)$ (/) ....(5)

PROCEDURE:

1] Suspend the bar form hook. The suspension length of each cord must be the same.

2] Allow the bar to oscillate about the vertical axis passing through the center & measure the periodic time't' by knowing time say for 10 oscillations.

3] Repeat expt. by mounting the weight at equal distance form center.

4] Complete the observation table.

OBSERVATIONS:

Weight on the platform : 800 gms

OBSERVATION TABLE :

Sr. no.	Wt. on platform In gms.	L In cm	a in cm	t in sec	No. of oscillations n	T = tavg/n In sec	Kexp. In cm	ktheo = in m. In cm
1	800	32	43	5.56 5.66 5.91	10	0.571	11.57	9.23
2	2400	32	43	5.56 6.5 6.53	10	0.65	13.23	9.23

CALCULATIONS :

Sample Calculation for sr. no.1:

Finding Kexp. $T = 2\pi * (k/a)$ (/)

$0.571 = 2\pi * (k/23)$ (32/9.81)

Kexp. = 11.57 cm

Finding Ktheo.

ktheo = L/2 3

ktheo = 32/2 3

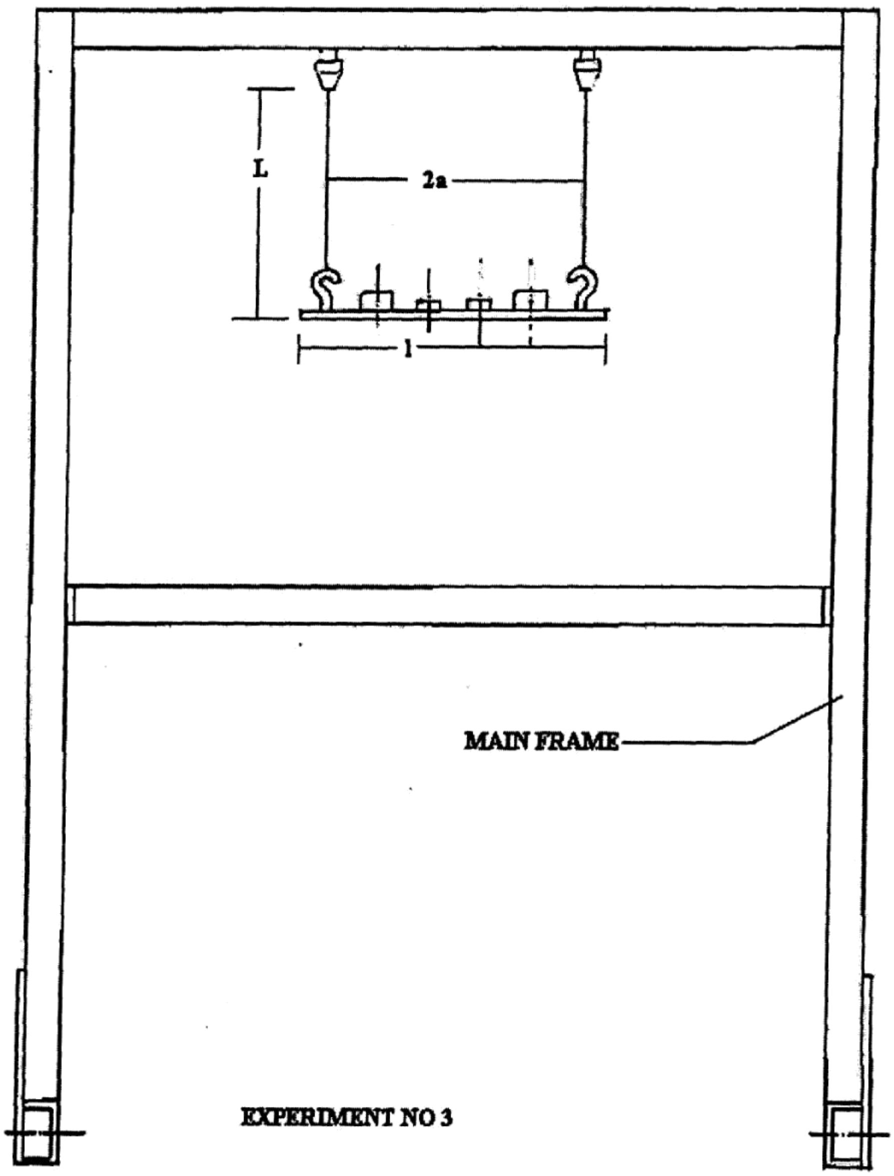
ktheo = 9.23 cm

RESULT:

Sr. no.	**Wt. on platform in gm**	**L. In cm**	**Kexp. In cm**	**Ktheo. In cm**
1	800	32	11.57	9.23
2	2400	32	13.23	9.23

CONCLUSION:

1. As length of cord decreases the radius of gyration decreases.
2. Differences in the theoretical ‘k’ experimental values of ‘k’ are due to error in nothing down the time period.



EXPERIMENT NO 3

FIG NO 3

Experiment No 4

AIM: To determine natural frequency of a spring mass system

DESCRIPTION OF SET UP :

Longitudinal vibration of Helical spring

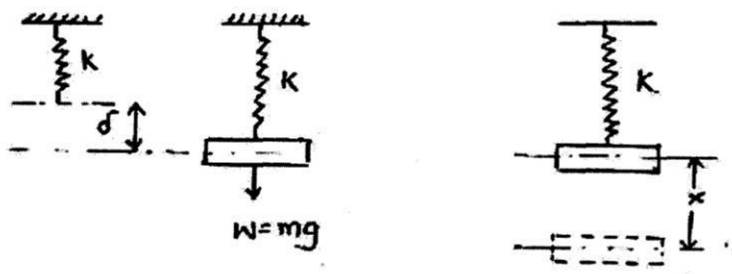


Figure (d)

One end open coil spring is fixed to the screw can be adjusted vertically in any convenient position and then clamped to upper beam by means of lock nuts. Lower end of spring is attached to the platform carrying weights. Thus design of system incorporates vertical positioning of the unit to unit to suit the convenience.

PROCEDURE:

1] Fix one end of vertical spring to the upper screw.

2] Determine free length.

3] Put same weight to platform and down deflection.

4] Stretch the spring through some distance & release.

4] Count the time required (in sec) for some say 10,20, oscillation.

5] Determine the actual period.

6] Repeat the procedure for different weight.

OBSERVATIONS:

Weight on the platform : 800 gms

OBSERVATION TABLE 1 :

Spring no.	Wt attached (kg)	Deflection of spring In cm (δ)	K=W/δ In kg/cm
1	6	1.5	4
2	6	11.5	0.5

OBSERVATION TABLE 2

Spring no.	Obs. No.	Wt attached W in Kg	No. of oscillations n	Time required for n oscillation sec	Periodic time Texpt =tavg/n in sec.	Ttheo In sec
1	1	3	10	2.47 2.53 2.32	0.243	0.174
	2	6	10	3.37 3.19 3.06	0.3	0.246
2	1	3	10	5.32 5.30 5.285	0.525	0.4916
	2	6	10	6.97 7.03 6.88	0.69	0.695

CALCULATIONS:

Sample Calculation for sr. no.1:

1.Finding K

K=W/δ

K = 6/1.5

K = 4 kg/cm

2.Finding Ttheo.;

Ttheo = 2π / km*g

Ttheo = 2π 3/ 4*9.81

Ttheo = 0.174 sec.

3.Finding ftheo. and fexpt..;

ftheo. = 1/ Ttheo

ftheo. = 1/ 0.174

ftheo. = 5.74 cps

fexpt. = 1/ Texpt

fexpt. = 1/ 0.243

fexpt. = 4.115cps

RESULT:

For	Spring wt.in kg	Experimental	Theoretical
		F in cps	F in cps
1	3	4.115	5.74
2	6	3.33	3.33
3	3	1.904	1.904
4	6	1.449	1.449

CONCLUSION:

The difference in F expt & F theoretical is due to

1] Observation human error

2] Damping effect of air.

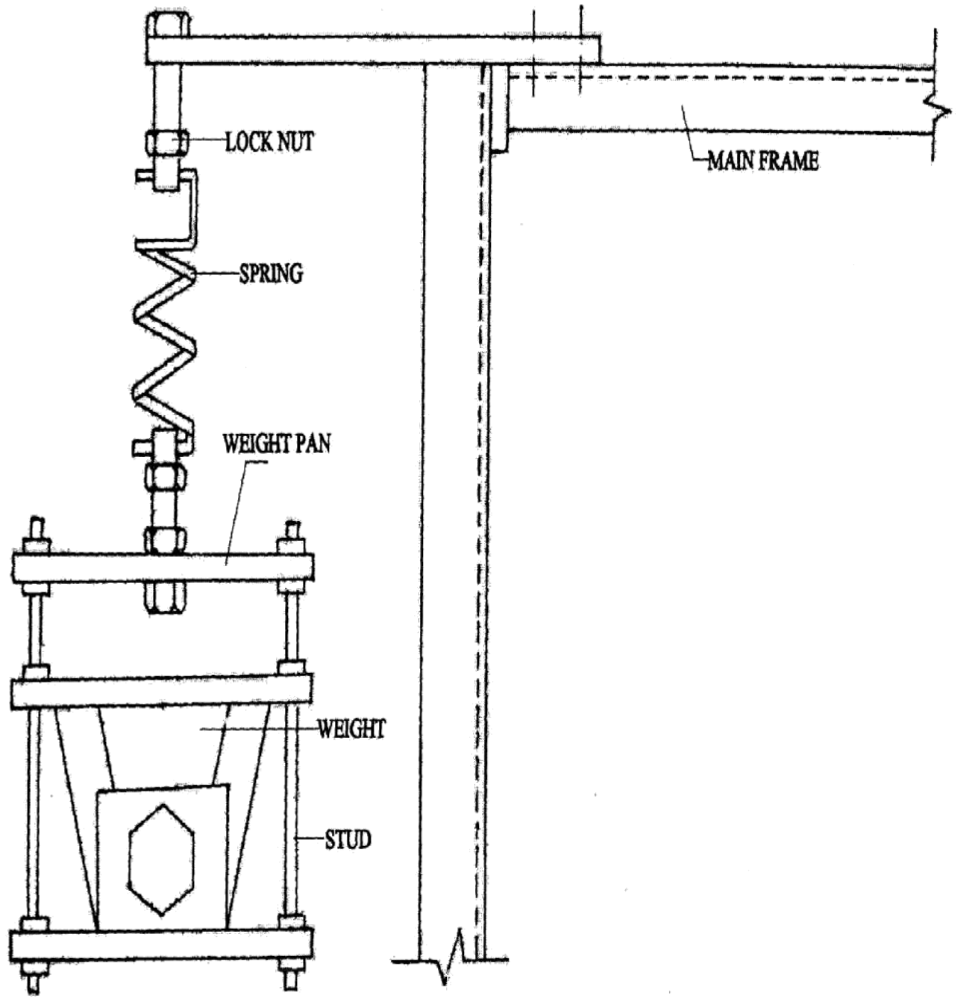


Fig. No. 4

Experiment No 5.

AIM: Equivalent spring mass system

DESCRIPTION OF SET UP:

Fig .shows the general arrangement of experiment setup. It's consist of fixed support of which there is hole where spring can be attached through the hook.

THEORY:

Spring in Series:

Let K_e =Equivalent stiffness of system

K_1,K_2 =Deflection of spring.

The total definition of the system is equal to the sum of deflection of individual springs.

~~X =X1 + X2 +X3 +~~-----

$1 = 1_1 + 1_2 + 1_3 +$ -----------

Thus the springs are connected in series the reciprocal of equivalent spring stiffness is equal to the sum of reciprocal of individual spring stuffiness.

PROCEDURE:

1. first the tension spring is attached is attached to the support with load no attached to it and it's length is measure (pitch).
2. Then dead wt is attached to that spring with the help of hook and again length is measured.
3. Same procedure is applied for the spring 2 of different stiffness.
4. Then spring i.e spring 1 and spring 2 connected in series and length is measured then dead wt. is attached to spring and length is measured.

Observations:

For Spring 1:

Initial pitch = 8mm

Final pitch (with load) = 11mm   Load = 1.5kg

Deflection = 3mm

For Spring 2:

Initial pitch = 7mm

Final pitch (with load) = 8.5mm   Load = 4.872kg

Deflection = 1.5mm

For Springs in series:

Initial length = 24cm

Final length(with load) = 27.8cm   Load = 1.5kg

Deflection = 3.8cm

CALCULATIONS:

For Spring 1:

$\mathbf{K_1 = Load*9.81/def^n}$

$K_1 = 1.5*9.81/0.003$

$\mathbf{K_1 = 4905\ N/m}$

For Spring 2:

$\mathbf{K_2 = Load*9.81/def^n}$

$K_2 = 4.872*9.81/0.0015$

$\mathbf{K_2 = 31862.88\ N/m}$

For Springs in series:

$Kexpt = Load*9.81/def^n$, $\omega_{nexpt} = \sqrt{Kexpt/m}$

$Kexpt = 1.5*9.81/0.038$, $\omega_{nexpt} = \sqrt{3872.4/1.5}$

Kexpt =3872.4 N/m, $\mathbf{\omega_{nexpt} = 50.8\ rad/sec.}$

$1/Ktheo = 1/k1 + 1/k2$, $\omega_{nexpt} = \sqrt{Kexpt/m}$

Ktheo = 4250.65N /m, $\mathbf{\omega_{nexpt} = 53.28\ rad/sec.}$

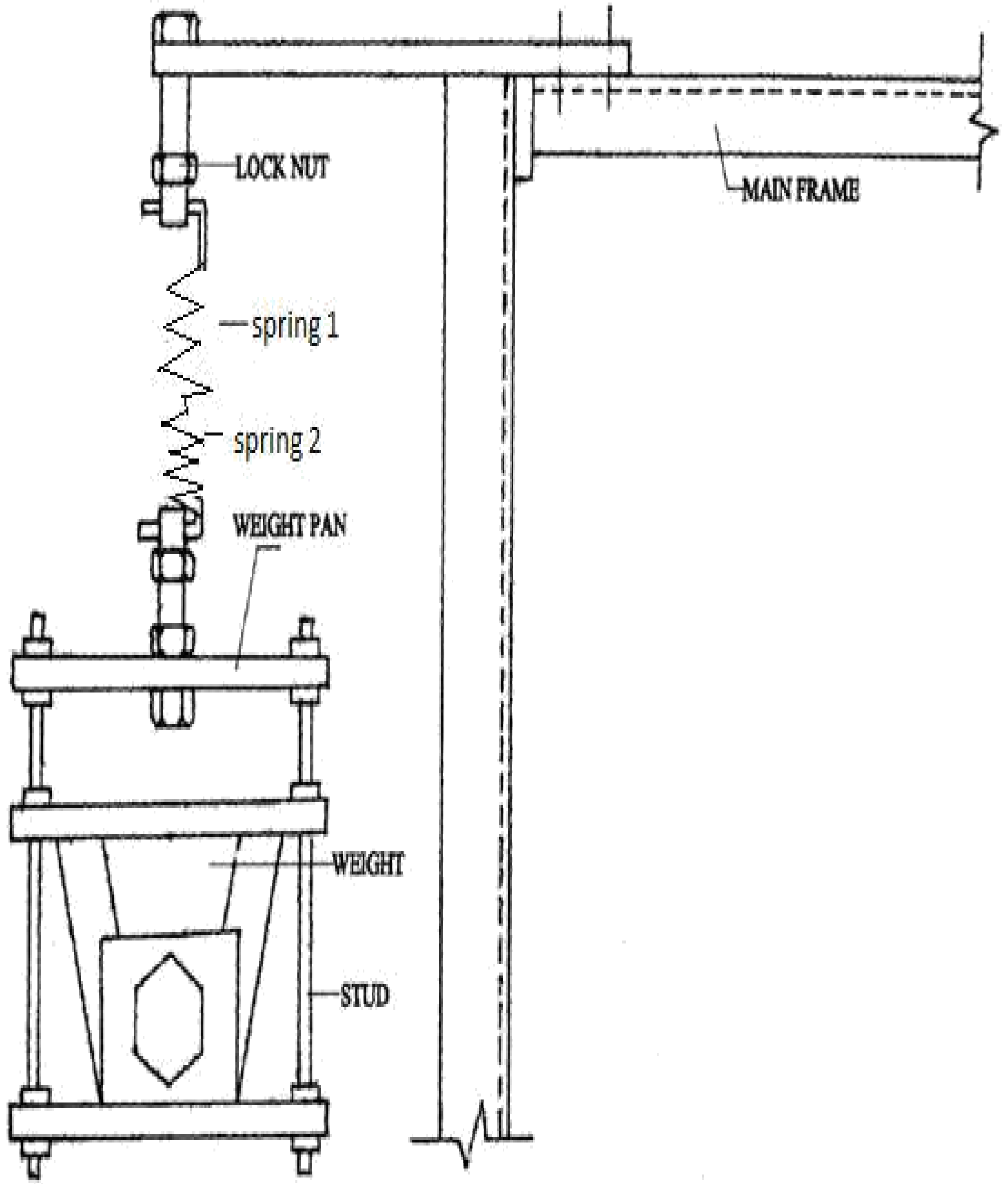
RESULT:

Kexp =3872.4 N/m , Wexp = 50.81 rad/sec

K th = 4250.66 N/m, W th = 53.28 rad/sec

CONCLUSION:

The theoretical and experimental value of equivalent stiffness were found to almost equal.


LOCK NUT
MAIN FRAME
spring 1
spring 2
WEIGHT PAN
WEIGHT
STUD

Experiment No 6.

AIM:To determine natural frequency of free torsional vibrations of single rotor system.

A.Horizontal rotor

B.Vertical rotor

Horizontal rotor

DISCRIPTION OF SET UP:

The arrangement is an shown in fig one end of shift is gripped in dule and a flywheel free to rotate in ball bearing in fixed to other end of shaft.

The bracket with fixed end shaft can be conveniently damped at any position along beam. Thus length of shaft can be varied during experiment, especially designed b chucks are used for clamping end of shaft. The ball bearing support to flywheel provides negligible acting support during experiment. The bearing housing is fixed to side member of main frame.

PROCEDURE:

1] Fix bracket at convenient position along lever beam.

2] Grip one end of shaft at bracket by means of chucks.

3] Fix rotor onto through end of shaft.

4] Twist the rotor through semi cycle and release.

5] Note down time required for 10 oscillations.

6] Repeat procedure for different length of shaft.

OBSERVATION TABLE:-

a) Shaft dia = 4 mm

b) Dia of disc = 225 mm

c) Wt.of the disc = 2.835 kg

d) Modulus of rigidity for shaft = $0.8 \cdot 10^6$ kg/cm²

Obs.No.	Length of shaft L cm.	No. of oscillation n	Time required for n oscillation secs.	Periodic Time T=(t/n) secs
1	52.5	20	7.14 7.69 7.3	.368
2	65	20	8.3 8.28 8.7	.4213

SPECIMEN CALCULATION:-

Sample calculation for Sr No. 1

(1) Determination of Torsional stiffness Kt.

$Kt = (G\, I_P) / L$ .... (1)

Where, L = length of shaft.

I_P = Polar M.I. of shaft.

$= (\pi d^4)/32$ .... (1a)

d = Shaft dia in cm

G = Modulus of rigidity of shaft = $0.8 \cdot 10^6$ kg/cm²

Putting d = 4 mm = .4 cm in equation we get I_P = 2.513 * 10 ^ -3 cm ^ 4

Putting I_P =2.513*0.001, G = 800000 Kg/cm^2 , L =52.5 cm

We get $Kt = 38.29$ kg – cm

(2) Determination of T_{theo}

$$T_{theo} = 2\pi\sqrt{(I / Kt)} \quad \ldots\ldots\ldots\ldots(2)$$

Where, I = M.I. of disc = $(W/g) \cdot (D^2/8)$ ………….. (2a)

Putting $W = 2.835$ kg, $g = 980$ cm/sec^2, $D = 22.5$ cm

We get $I = .1830$ (kg/cm/sec ^2) * (cm ^2)

Putting $I = .1830$ (kg/cm/sec ^2) * (cm ^2) and $Kt = 38.29$ kg – cm in equation (2)

We get $T = .434$ secs

(3) Determination of T_{expt}

= Time for n osc / No. of osc n = (7.376/20) = .368 seconds

RESULTS:-

Obs.No.	Length of shaft	Kt	T_{theo} secs	T_{expt} secs.	F_{theo} Hz	F_{expt} Hz.
1	52.5	38.29	.434	.368	2.304	2.717
2	65	30.929	.483	.4213	2.07	2.374

CONCLUSIONS:-

Difference in time period is due to

1. Human error
2. Damping in the system

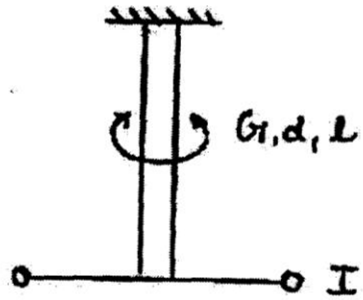
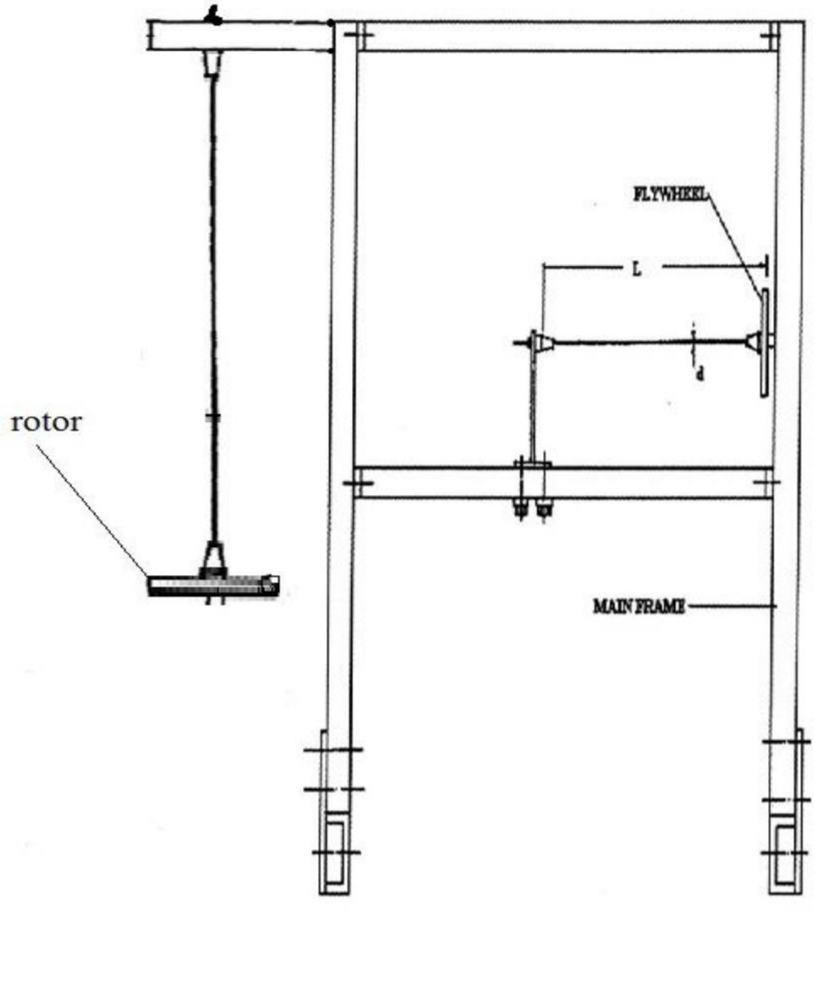
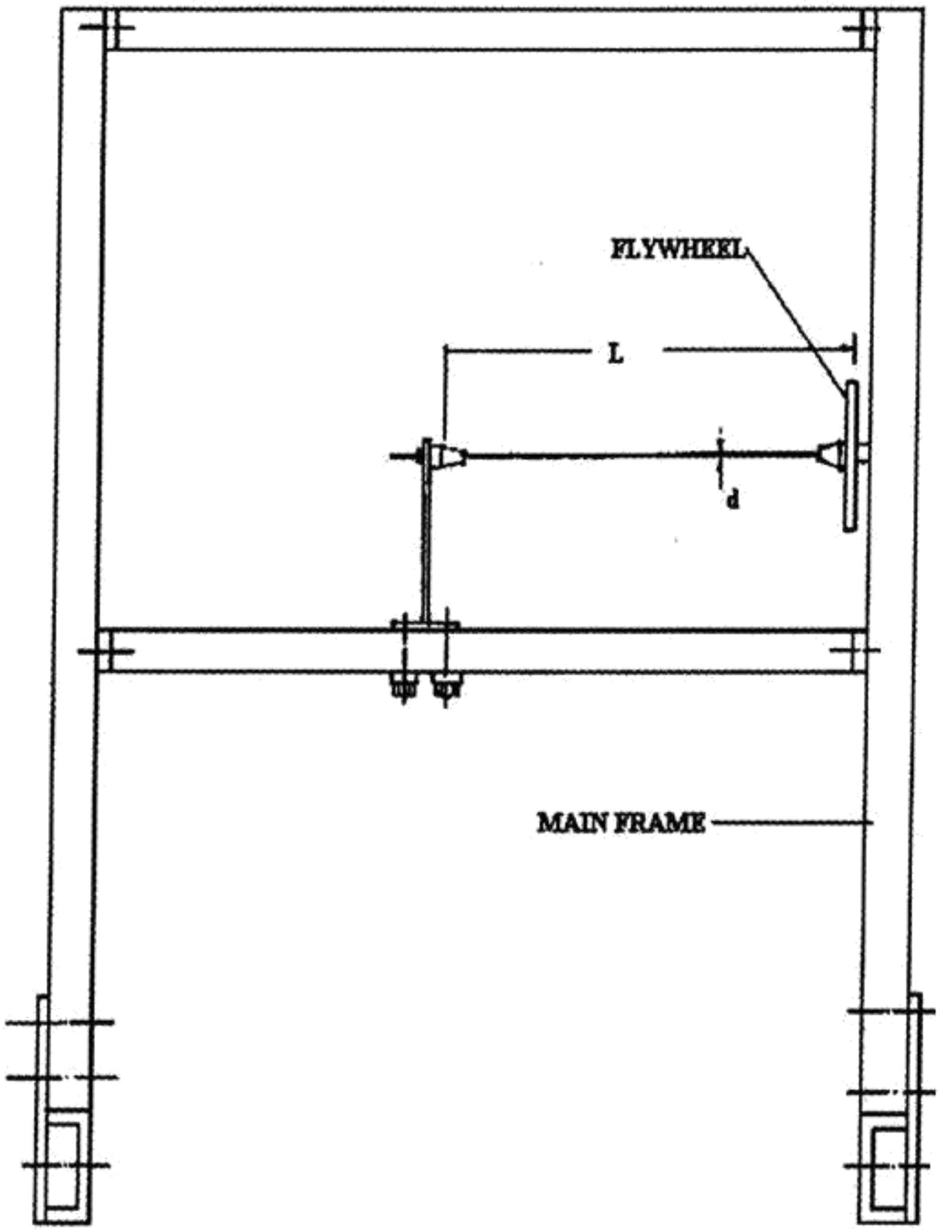


Figure 2 (h)



Horizontal rotor



Vertical rotor

Experiment No 07.

DUNKERLEY'S RULE

AIM:

To verify Dunkerley's $\frac{1}{\ } += \frac{1}{\ } + \frac{1}{\ }$

Where F = Natural frequency of beam with central load w.

FL=Natural frequency of given beam with central load to be calculated as:

48

Fb = 4 ^2 ^3

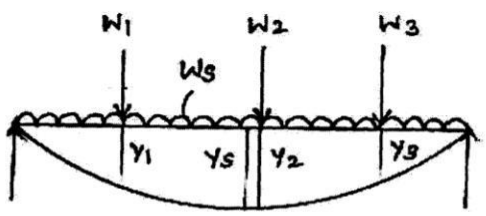
L = Length of beam

W = Central Load.

Fb =Natural Frequency

DISCRIPTION OF SET UP:

The fig shown general arrangement for carrying experiment a rectangular beam supported on a trunion at each end ,each trunion is pivoted on ball burning carried in housing & is fixed to vertical frame member. The beam carries at its center a weight platform



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PROCEDURE:

1] Arrange the setup as shown with some weight W clamped to weight platform.

2] Pull the plat form and release it to set the system into natural vibration.

3] Find the periodic time T and frequency of vibration by measuring time for some oscillation.

4] Repeat expt by additional mass on weight platform.

OBSERVATIONS:

1.Length of beam = 1035 mm

2.Sectional area of beam = (25*6) mm^2

3.Weight of the beam =1.215 kg

4.wt per cm of beam weight = w/l = 1.1739 kg/m.

OBSERVATION TABLE:

SR. NO.	Wt. attached W in kg	No.of oscillations n	Time for n oscillations t in sec	T = tavg/n In sec.	$1/F^2$
1	1.5	5	0.9	0.18	0.0324
		5	0.92	0.184	0.0338
		5	0.96	0.192	0.0368

CALCULATIONS:

1. **Texpt = t/n = 0.9/5 =0.18 sec.**
2. **Fexpt. =1/Texpt = 1/ 0.18 = 5.55 Hz**
3. **Fb^2 =** $/2L^{2}$ * / ^2

   W = 1.173 kg/m

   I = bh^3 ~~/12 = 450~~*10^-12 m^4

   E = 2*10^10 Kg / m^2

   $\frac{1}{\quad} + \frac{1}{\quad}$, = 0.022 Hz

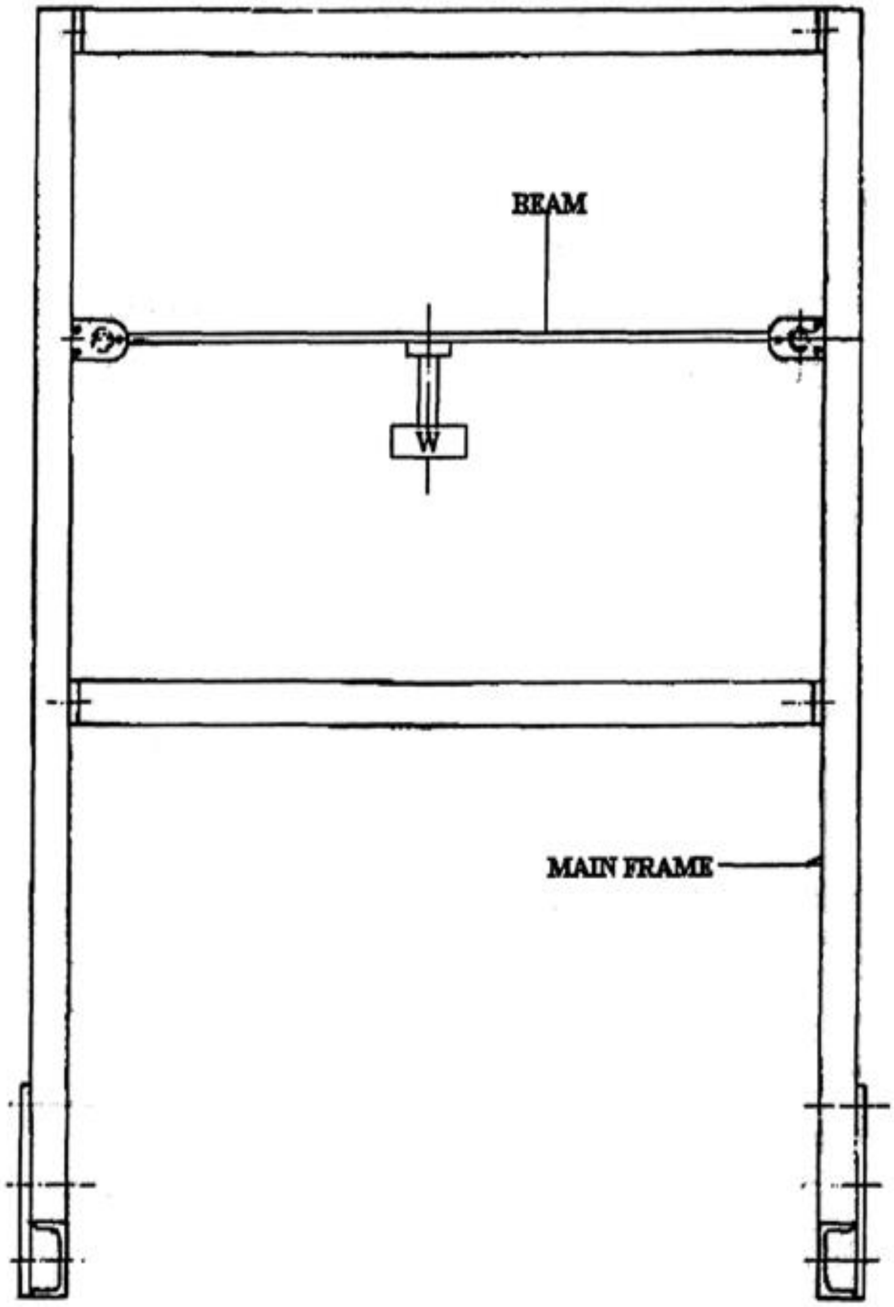
4. FL = 4 ^2 ^3 = 8.034 Hz
5. By Dunkerley's formulae 1^ +=

RESULT:

Sr No	Dead Wt attached	$1/F^2$ experimental	$1/F^2$ theorotical
1	1.5	0.0324	0.022

CONCLUSION:

Thus Dunkerley's rule is verified , since theoretical and experimental values are closer.


BEAM
W
MAIN FRAME

Experiment No 08.

AIM: Performing the experiment to find out damping co-efficient in case of free damped torsional vibration.

DESCRIPTION OF SET UP:

The fig shows general arrangement for experiment. It consists of long elastic shaft gripped at upper end by chuck in bracket. The bracket is clamped to upper beam of main frame. A heavy flywheel Clamped to lower end of shaft suspended from bracket, this drum is immersed in oil which provides damping. Rotor can be taken up and down for varying depth of immersion of damping drum, depth of immersion can be read on scale.

PROCEDURE:

1] With no container allow flywheel to oscillate and measure time for 10 Oscillations.

2] Put thin mineral oil in drum and note depth of immersion.

3] Allow flywheel to vibrate.

4] Put sketching pen in bucket.

5] Allow pen to descend see that pen always makes contact with paper and record oscillations.

6] Measure time for some oscillations by means of stop watch.

7] Determine amplitudes of any positions.

OBSERVATION TABLE:

Sr. no.	Damping medium	X_n	X_{n+1}
1	Air	1.4	1.3
2	Water	1.15	0.6
3	Oil	1	0.6

CALCULATIONS:-

Determining Damping ratio:

Determining logarithmic decrement

$$\delta = \log_e [Xn / X_{n+1}]$$

Where,

Xn = Amplitude of Vibration of the n^{th} cycle

X_{n+1} = Amplitude of Vibration of the $(n+1)^{th}$ cycle

$$\delta = \log_e [1.4 / 1.3]$$

$$\delta = 0.0741$$

We have

$$\delta = 2\pi\xi / \sqrt{(1 - \xi^2)}$$

$$(1 - \xi^2)\ \delta^2 = 4\pi^2 \xi^2$$

$$\delta^2 = (4\pi^2 + \delta^2)\ \xi^2$$

$$\xi = (\ \delta / \sqrt{(4\pi^2 + \delta^2)})$$

putting $\delta = 0.0741$

we get $\xi = .018$

RESULT:

Response curves: 1. For Air

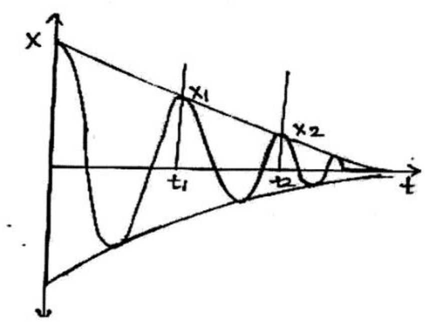
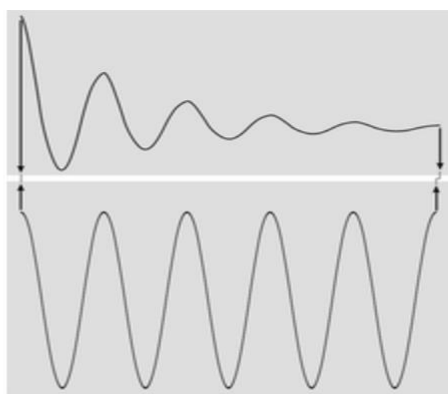


Figure (k)

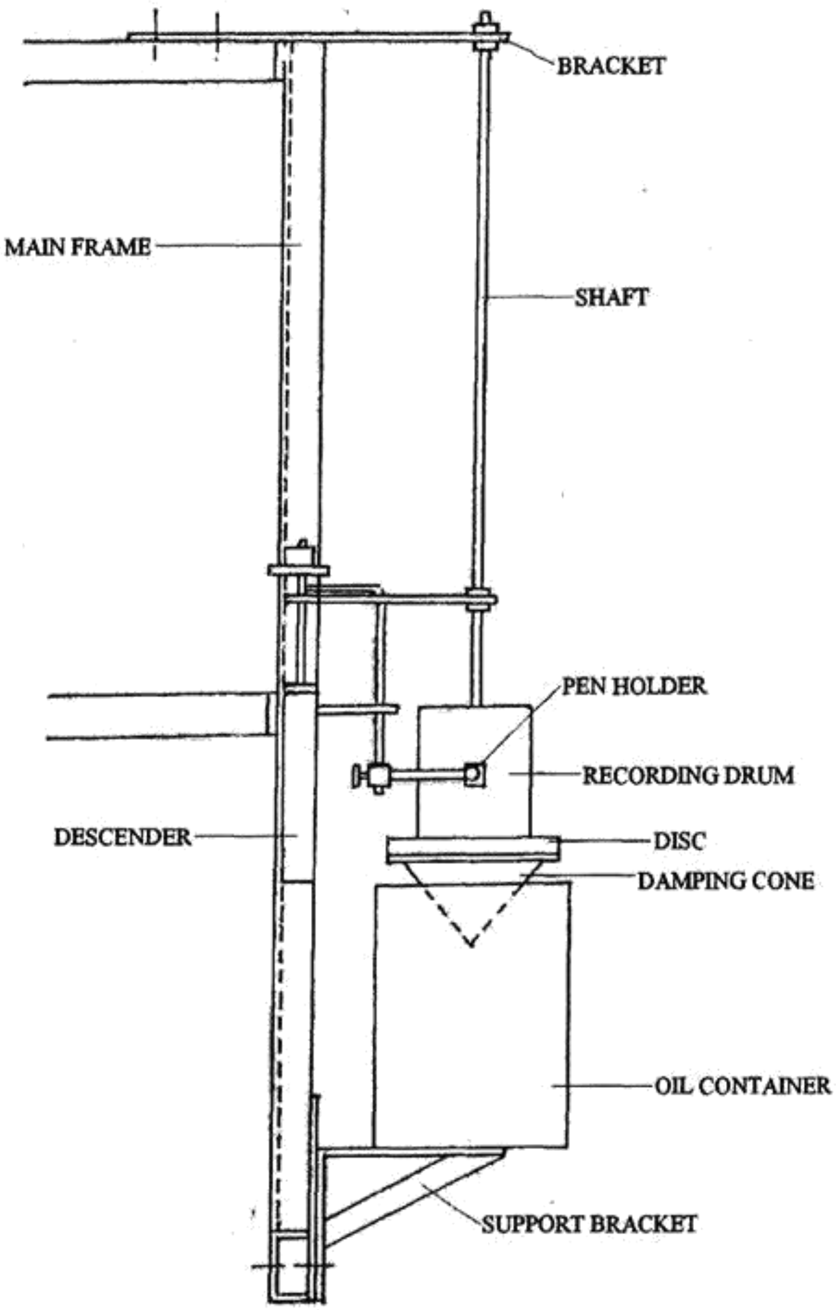


CONCLUSION: Value of damping coefficient (ξ)

For air = 0.18

For water = 0.6

For oil = 0.6



Experimental set up

Experiment no 09.

AIM: To conduct experiment of trifler suspension.

APPARATUS REQUIRED: Main frame, Trifilar suspension, Weights, Stopwatch,Thread.

INTRODUCTION:

Trifilar Suspension (Torsional Pendulum) :- It is also used to find the moment of inertia of a body experimentally. The body (say a disc or flywheel) whose moment of inertia is to be determined is suspended by three long flexible wires A, B and C, as shown in fig.-b. When the body is twisted about its axis through a small angle θ and then released, it will oscillate with simple harmonic motion Trifilar suspension is a disc of mass m (weight w) suspended by three verticalcords, each of length l, from a fixed support. Each cord is symmetrically attached to the disc at the same distance r from the mass of the disc.

THEORY:

The disc is now turned through a small angle its vertical axis, the cords becomes inclined. One being released the disc will perform oscillations about the vertical axis. At any instant

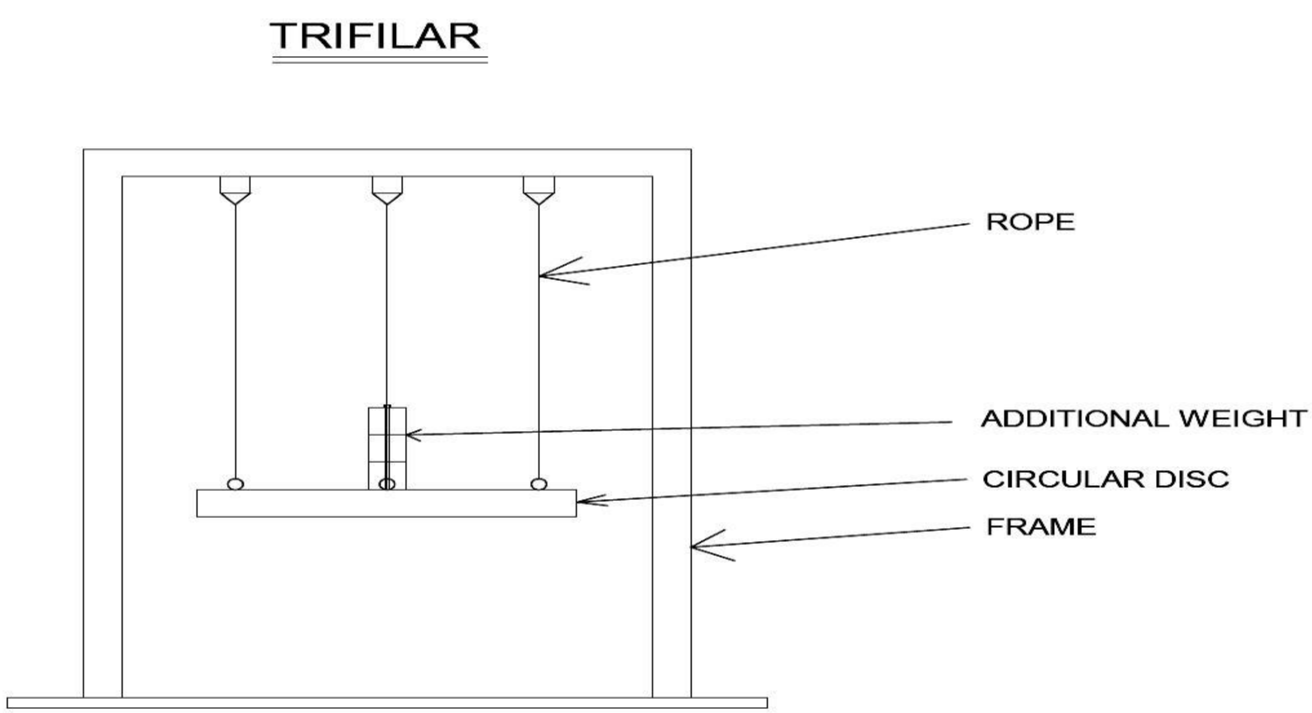
Let: ɵ = angular displacement of the disc

F = tension in each cord =w/3

Inertia torque = i × ɵ

Restoring torque = 3 × horizontal component forces of each string × r

Inertia torque = restoring torque



<u>FORMULA USED</u>:

Time period T= t/n, sec
Natural Frequency fn = 1/T Hz
Mass of the body (m) = --------kg.
Distance of each wire from the axis of the disc (r) = ------- metres.

=

= ²in kg- ²

<u>PROCEDURE</u>:

1. Hang the plate from chucks with 3 strings of equal lengths at equal angular intervals (1200 each)
2. Give the plate a small twist about its polar axis
3. Measure the time taken, for 5 or 10 oscillations.
4. Repeat the experiment by changing the lengths of strings and adding weights.

<u>OBSERVATION:</u>

S.No.	Added,mass, m, kg	Time for N oscillations, t, sec	Time period T, sec	Natural frequency f_n, Hz
1				
2				
4				

<u>PRECAUTIONS</u>:

1. Tight the drill chucks properly.
2. Length of each cord should be equal.

<u>RESULT</u> :

Experiment No 10.

AIM: - Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.

To study the forced vibration of equivalent spring mass system.

DESCRIPTION OF SET UP :-

The arrangement is shown in Fig. The exciter unit is coupled to D.C. variable speed motor.

Speed of the motor can be varied with the dimmerstat provided on the control panel. Speed of rotation can be known from the speed indication on the control panel. It is necessary to connect the damper unit to the exciter. Amplitude record of vibration is to be obtained on the strip-chart recorder.

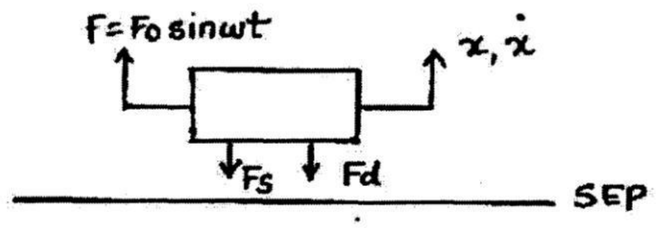


Figure 2 (f)

PROCEDURE:

1. Arrange the set-up as described for expt.no.8.

2. Start the motor & allow the system to vibrate.

3. Wait for 1 to 2 minutes for the amplitude to build the particular forcing frequency.

4. Adjust the position of strip-chart recorder. Take the record of amplitude vs. time on strip- chart by starting recording motor. Press the recorder platform on the pen gently. Pen should be wet with ink. Avoid excessive pressure to get good record.

5. Take record by changing forcing frequency.

6. Repeat the experiment for different damping. Damping can be changed by adjusting the holes on the piston of the damper.

OBSERVATION TABLE:-

1 Without damping

Speed = 200 rpm

Forcing Frequency cp.s.	Amplitude mm.
3.07	6

2 With damping N = 200 rpm.

Forcing Frequency cp.s.	Amplitude mm.
4.46	3

CALCULATIONS

To find ξ of the damping oil for damped forced vibration at N = 200 rpm

We have

$$(A/(m_o/m)) = (r^2)/((1-r2)^2+(2\xi r)^2)$$

Here $w = (2\Pi N)/60$

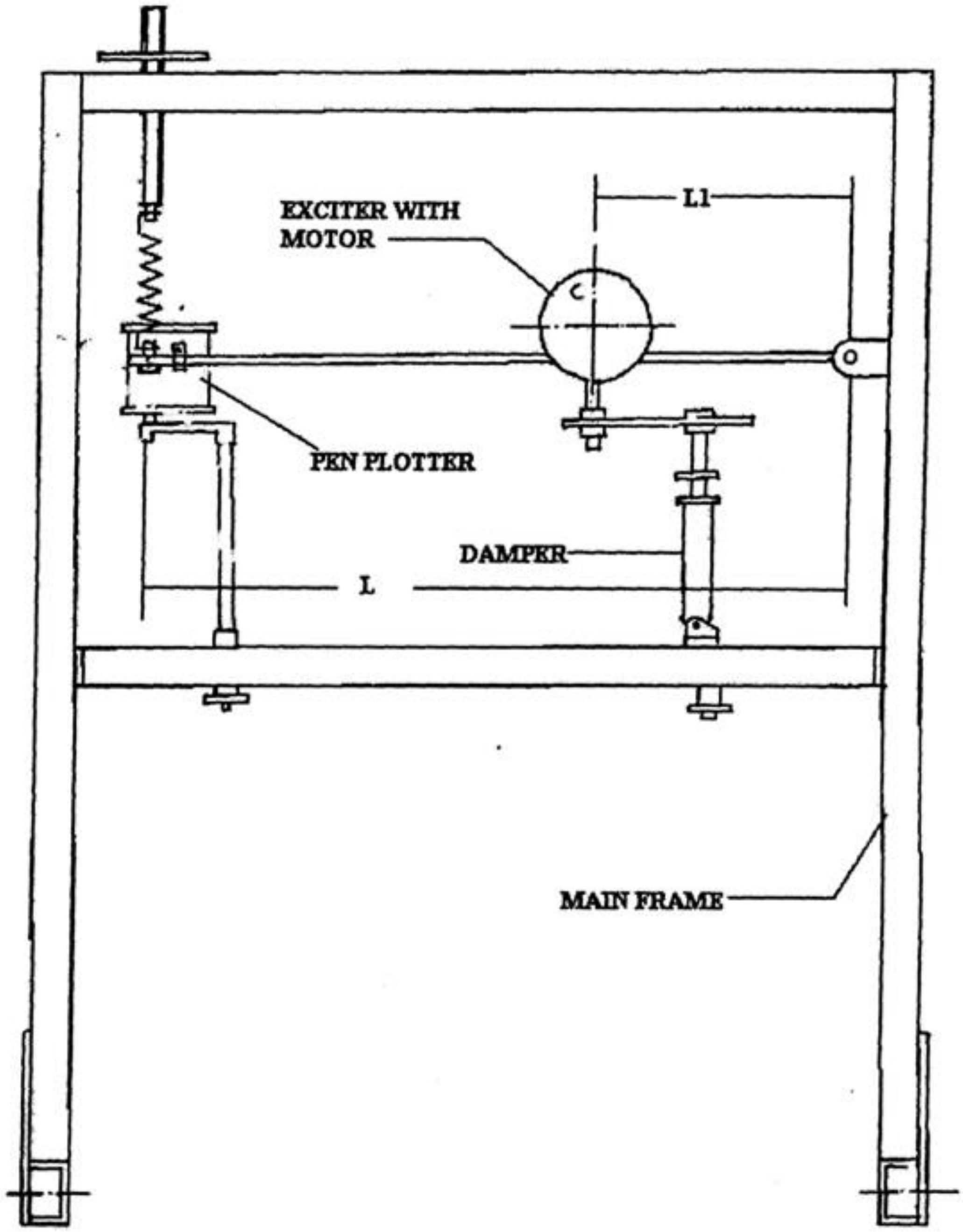
N=200rpm
w = 20.94 rad. /sec
w_n = 19.03 rad. /sec
$r = w / w_n$ = 1.099
A = amplitude = 3 mm
m_o = Eccentric mass = .2 kg
r = 1.099
m = 17.815 kg
solving we get

$$\xi = .135$$

RESULT

Sr No.	condition	Speed rpm	Frequency (Hz)	Amplitude mm	Damping Ratio ξ
1	undamped	200	3.07	6	
2	damped	200	4.46	3	.135

CONCLUSION: Forced vibrations of equivalent spring mass system was studied.



Experimental Set up