INDIRA GANDHI INSTITUTE OF TECHNOLOGY,
DEPARTMENT OF MECHANICAL & AUTOMATION ENGG.
Kashmere Gate, Delhi-110006.

INSTRUCTION MANUAL

FOR

STUDY OF DIFFERENT TYPES OF CAM-FOLLOWER SYSTEMS

AIM

To study different types of cam- follower systems.

INTRODUCTION OF CAM

A cam may be defined as a mechanical member used to impart desired motion to another member termed as follower by direct contact. The cam may be rotating or reciprocating whereas the follower may be rotating, reciprocating or oscillating. A cam and follower usually have line contact between them and constitute a higher pair. The cams are usually rotated at uniform speed by a shaft, but the follower motion is pre determined and will be according to the shape of the cam.

CLASSIFICATION OF CAM

Cams may be classified in the following ways:

1. Based on the shape of the cam.
2. Based on the follower movement.
3. Based on the manner of constraint of the follower.

<u>CLASSIFICATION BASED ON THE SHAPE OF THE CAM</u>

Wedge or flat cam

A wedge cam has a wedge, which, in general, has a translational motion. The follower can either translate or oscillate. A spring is usually used to maintain the contact between the cam and the follower. Instead of using a wedge, a flat plate with a groove can also be used. In the groove the follower is held.

Radial or disc cam

A cam in which the follower moves radially from the center of rotation of the cam is known as radial or a disc cam. In radial cams, the follower reciprocates or translates in a direction perpendicular to the cam axis. Radial cams are very popular due to their simplicity and compactness.

Cylindrical or Drum Cam

In a cylindrical cam, a cylinder which has a circumferential contour cut in the surface rotates about its axis. The follower motion can be of two types as follows:

In the first type, a groove is cut on the surface of the cam and a roller follower has a constrained motion. Another type is an end cam in which end of cylinder is the working surface. A spring loaded follower translates along or parallel to the axis of the rotating cylinder.

CLASSIFICATION BASED ON FOLLOWER MOTION

The motions of the followers are distinguished from each other by the dwells they have. A dwell is the zero displacement or the absence of motion of the follower during the motion of the cam.

Cams are classified according to the motions of the followers in the following ways:

Rise – Return – Rise (R-R-R)
In this, there is alternate rise and return of the follower with no periods of dwells. Its use is very limited in the industry. The follower has a linear or angular displacement.

Dwell – Rise – Return – Dwell (D-R-R-D)
In such a type of cam, there is rise and return of the follower after a dwell. This type is used more frequently than the R-R-R type of cam.

Dwell – Rise – Dwell – Return – Dwell (D-R-D-R-D)
It is the most widely used type of cam. The dwelling of the cam is followed by rise and dwell and subsequently by return and dwell. In case the return of the follower is by a fall, the motion may be known as Dwell-Rise-Dwell (D-R-D).

CLASSIFICATION BASED ON THE MANNER OF CONSTRAINT OF THE FOLLOWER

To reproduce exactly the motion transmitted by the cam to the follower, it is necessary that the two remain in touch at all speeds and at all times. The cams can be classified according to the manner in which this is achieved.

Pre-loaded Spring Cam
A pre loaded compression spring is used for the purpose of keeping the contact between the cam and the follower.

Positive Drive Cam
In this type, constant touch between the cam and the follower is maintained by a roller follower operating in the groove of a cam.

CLASSIFICATION OF FOLLOWER

Follower may be classified in the following ways:
1. Based on the surface in contact.
2. Based on its motion.
3. Based on its path of motion.

CLASSIFICATION ACCORDING TO THE SURFACE IN CONTACT

The followers, according to the surface in contact, are classified as follows:

Knife Edge Follower
When the contacting edge of the follower has a sharp knife-edge, it is called a knife edge follower. The sliding motion takes place between the contacting surfaces. It is seldom used in practice because of the small area of contacting surface results in excessive wear. In knife-edge followers, a considerable side thrust exists between the follower and the guide.

Roller Follower
When the contacting edge of the follower is a roller, it is called a roller follower. Since the rolling motion takes place between the contacting surfaces, therefore the rate of wear is greatly reduced. The roller followers are extensively used where more space is available.

Flat Faced or Mushroom Follower
When the contacting edge of the follower is a perfectly flat face, it is called a flat face follower. It may be noted that the side thrust between the follower and the guide is much reduce in case of flat face follower. The only side thrust is due to friction between the contact surfaces.

CLASSIFICATION ACCORDING TO THE SURFACE IN CONTACT

The followers, according to its motion, are of the following two types:

Reciprocating or Translating Follower
When the followers reciprocate in guides as the cam rotates uniformly, it is known reciprocating or translating follower.

Oscillating or Rotating Follower
When the uniform rotary motion of the cam is converted into predetermined oscillatory motion of the follower, it is called oscillating or rotating follower.

CLASSIFICATION ACCORDING TO THE SURFACE IN CONTACT

The followers, according to its path of motion, are of the following two types:

Radial Follower
When the motion of the follower is along an axis passing through the center of the cam, it is known as radial follower.

Offset Follower

When the motion of the follower is along an axis away from the axis of the cam center, it is known as offset follower.

APPLICATION OF CAMS

The cam and follower is one of the simplest as well as one of the most important mechanisms found in modern machinery today. The cams are widely used for
*Operating the inlet and exhaust valves of internal combustion engine.
*Automatic attachment of machineries.
*Paper cutting machines.
*Spinning and weaving textile machineries.
*Feed mechanism of automatic lathes.

OBSERVATONS

1. PLATE CAM WITH FLAT – FACED FOLLOWER

In this type of cam and follower mechanism, the cam rotates with respect to the frame along its axis while the follower reciprocates in guides. It consists of the following link:

LINK	MEMBER	MOTION
Link1	Frame	Fixed
Link2	Plate Cam	Rotating
Link3	Flat Faced Follower	Reciprocating

2. TRANSLATING CAM WITH RECIPROCATING KNIFE EDGE FOLLOWER

In this type of mechanism, the crank rotates about its axis while the cam reciprocates horizontally. The follower also imparts translator motion.

LINK	MEMBER	MOTION
Link1	Frame	Fixed
Link2	Crank	Rotating
Link3	Cam	Reciprocating
Link4	Knife Edge Follower	Reciprocating

3. CYLINDRICAL CAM WITH TRANSLATING FOLLOWER

Here, the follower reciprocates in groove provided on the surface of cylindrical cam. This mechanism also has three links.

LINK	MEMBER	MOTION
Link1	Frame	Fixed
Link2	Cylindrical Cam	Rotating
Link3	Reciprocating Follower	Reciprocating

4. TANGENT CAM WITH ROLLER OSCILLATING FOLLOWER

In this type of cam and follower mechanism, a roller attached to the follower rolls on the periphery of the rotating cam.

LINK	MEMBER	MOTION
Link1	Frame	Fixed
Link2	Cam	Rotating
Link3	Roller	Rolls w.r.t cam
Link4	Follower	Oscillating

5. END CAM- WITH TRANSLATING FOLLOWER

LINK	MEMBER	MOTION
Link1	Frame	Fixed
Link2	Crank and cam	Rotating
Link3	Roller	Rolls
Link4	Follower	Translating

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INSTRUCTION MANUAL

FOR

PLOTTING n-θ CURVE FOR GIVEN CAM FOLLOWER PAIR AND DRAWING CAM PROFILE

AIM : To plot follower n-ɵ (displacement vs. angle of cam rotation) curve for the given cam follower pair mounted on cam analysis machine and to draw the cam profile.

The exact profile of the cam can be obtained by plotting observations n Vs ɵ where n = displacement of the follower from rotation initial position and ɵ = angle of cam rotation with reference from axis of symmetry chosen.

DESCRIPTION OF A CAM ANALYSIS MACHINE:

The machine is a motorized unit consisting of a cam shaft driven by a D.C motor. The shaft runs in a double ball bearing. At the free end of the cam shaft a cam can be easily mounted. As the follower is properly guided in gun metal bushes and the type of he follower can be changed to suit the cam under test. A graduated circular protractor is fitted coaxial with the shaft and a dial gauge can be fitted to note the follower displacement for the angle of cam rotation. A spring is used to provide controlling force to the follower system. Weights on the follower rod can be adjusted as per the requirements. The arrangement of speed regulation is provided.

APPLICATION: The machine is particularly very useful for testing the cam performance for jump phenomenon during operation. This machine clearly shows the effect of change of inertia forces on jump action of cam follower during operation. It is used for testing various cam follower pairs i.e.

i)Circular arc cam with mushroom follower

ii)Tangent cam with roller follower

iii)An eccentric cam with knife edge follower

ASSEMBLY: The unit is provided with the push rod in the two bush bearings. The same push rod is to be used for the flat face and roller follower, should the unit be disassembled, for any reason while assembling the following precautions should be taken.

1)The horizontality of the upper and lower glands should be checked by a spirit level.

2)The supporting pillers should be properly tightened with the lock nuts provided.

3) SPECIFICATIONS:

A) The following types of cam are supplied along with the unit except tachometer

1.Circular Arc Cam   2. Eccentric Cam   3. Tangential Cam

B)Three types of followers are provided

1.Mushroom Follower   2.Roller Follower   3.Knife edge follower

C) COMPRESSION SPRINGS: Two springs are provided. The approximate stiffness are 4.5 kg/cm and 5.5 kg/cm for the bigger and smaller spring respectively.

D) WEIGHTS:

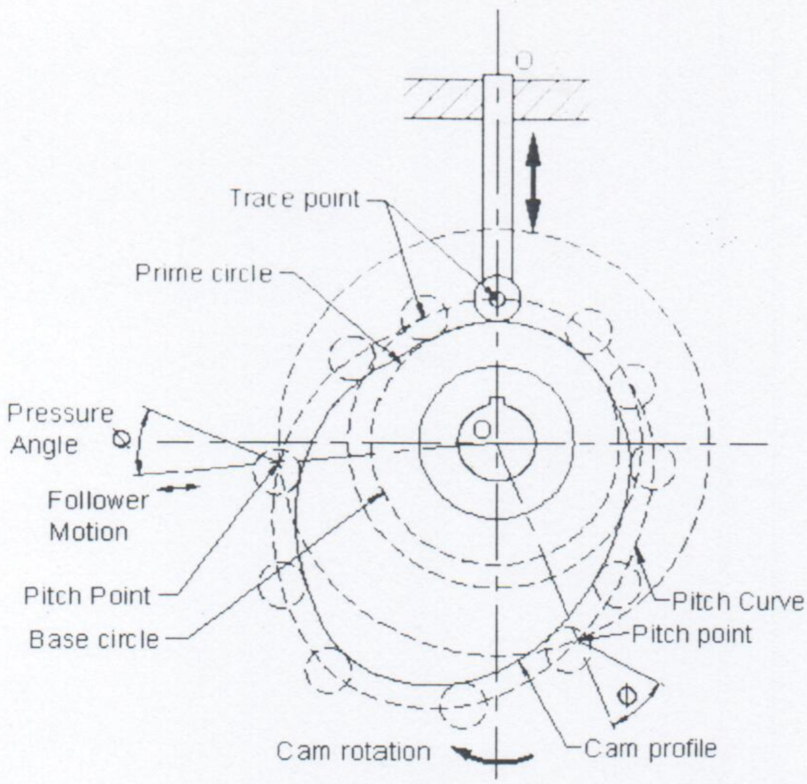
a) One set of three weights is provided. All the weights have a central hole so that they can be accommodated in the push rod. Total weight provided is 1600 gms.

b)The weights of the reciprocating parts are as follows:

1)Push rod with lock nut	150 gms.
2)Rest Plate and two lock nuts	105 gms.
3)Spring Seat and lock nut	75 gms.

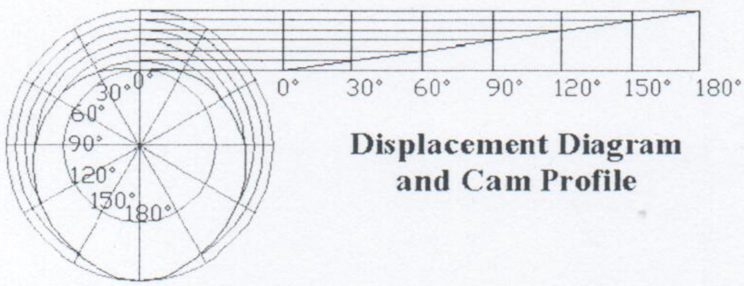
4)Wt. of spring (1/3 of the spring weight is to be taken as reciprocating weight)

5)Roller Follower	125 gms.
6)Knife Edge Follower	125 gms.
7)Mushroom Follower	130 gms.

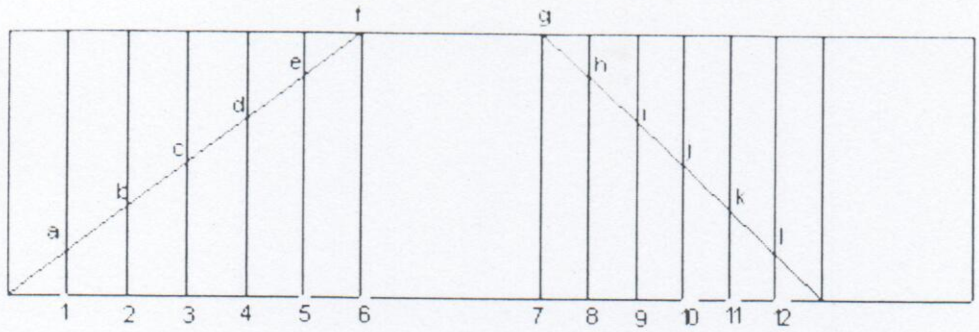


Depending upon types of follower motion:

1. **Uniform motion (constant velocity)**

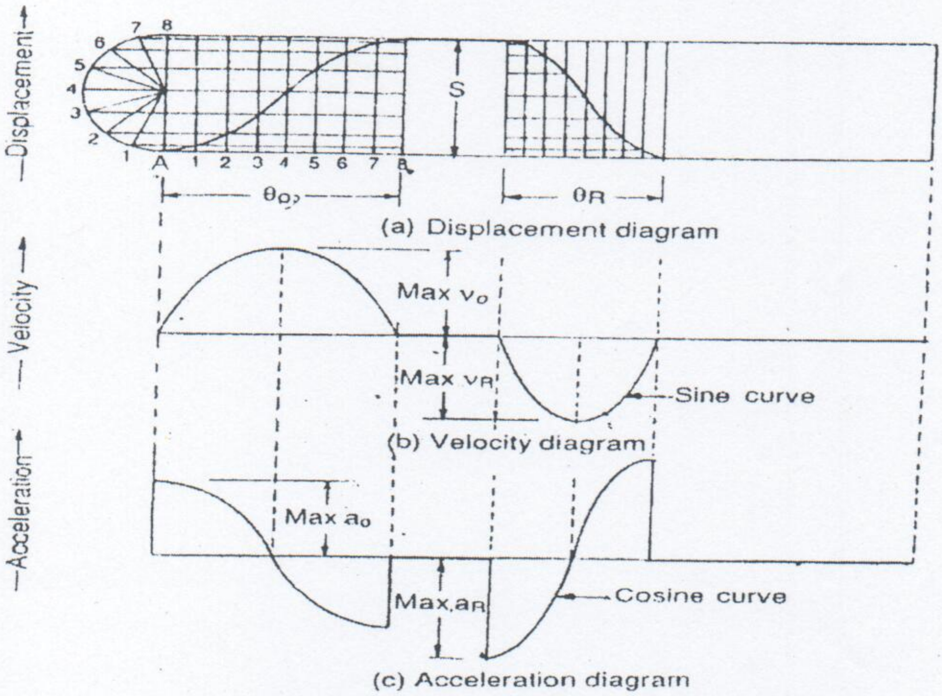


Displacement Diagram and Cam Profile



Since the follower moves with uniform velocity during its rise and fall, the slope of the displacement curve must be constant as shown in fig

2. **Simple Harmonic motion**



(a) Displacement diagram

(b) Velocity diagram

(c) Acceleration diagram

Since the follower moves with a simple harmonic motion, therefore velocity diagram consists of a sine curve and the acceleration diagram consists of a cosine curve.

OBSERVATION TABLE:

Angular Displacement Of Cam (In degrees)	Movement of Follower(in mm)

PROCEDURE :

1. Set the roller follower on the cam.
2. Give rotation to cam 10 degrees at a time.
3. Measure displacement of follower.
4. To draw displacements curve, take a horizontal line corresponding to 360 degrees.
5. On each degree mark corresponding displacements.
6. To draw cam profile, draw base circle.
7. Then draw a circle with radius = radius of base circle + ½(~~radius~~ (diameter) of roller of follower).
8. Divide the circle into different parts corresponding to rise, dwell and return and again dwell of follower.
9. Divide rise part of circle into even no. of parts as in displacement diagram.
10. Do same with return part of the circle.
11. Mark the offset corresponding to displacements on the line dividing the circle parts.
12. Draw circles on these points of radius of roller.
13. Draw profile of the cam passing through these circles(as tangent).

PRECAUTIONS:

1. Give equal angular displacement to cam at a time.
2. Measure displacement of follower during rise and fall period carefully.
3. To draw cam profile divide rise and fall in same no. of even equal parts as in displacement diagram.

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INSTRUCTION MANUAL

FOR

DETERMINING THE RADIUS OF GYRATION 'K' OF GIVEN COMPOUND PENDULUM

AIM To determine the radius of gyration 'k' of a given compound pendulum and to verify the relation

$$T = 2\Pi\sqrt{(k^2 + OG^2)/g(OG)}$$

Where T = Periodic time in sec

K = radius of gyration about C.G in cms

OG = Distance of the C.G of rod from support.

L = length of suspended pendulum in cms

DESCRIPTION OF THE SET UP :

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

THEORY:

A rigid body which can swing in a vertical plane about some axis passing through it is called
a compound or physical pendulum.

In Fig.1 a body of irregular shape is pivoted about a horizontal frictionless axis through P and is displaced from its equilibrium position by an angle θ. In the equilibrium position the center of gravity G of the body is vertically below P. The distance GP is a and the mass of the body is m.

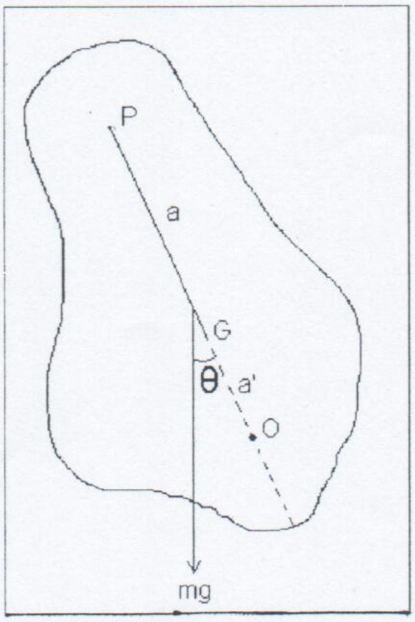

Fig 1

The restoring torque for an angular displacement θ is $\tau = - mg\ a$
$\sin\theta$ ...(1)

for small amplitudes,

$$I \frac{d^2\theta}{dt^2} = - mg\ a\theta \qquad ...(2)$$

where I is the moment of inertia of the body through the axis P. Expression (2) represents a simple harmonic motion and hence the time period of oscillation is given by

$T = 2\pi \sqrt{I/mga}$
...(3)

Now $I = IG + ma^2$, where IG is moments of inertia of the body about an axis parallel with axis
of oscillation and passing through the center of gravity G.

$IG = m\ k^2$
....(4)

where k is the radius of gyration about the axis passing through G. Thus

$T = 2\pi\sqrt{(mk^2 + ma^2)/mag} = 2\pi\sqrt{(k^2/a + a)/g}$
....(5)

Comparing expression (5) with an expression of time period ($T = 2\pi\sqrt{l/g}$) for a simple
pendulum suggests, $l = k^2/a + a$. This is the length of "equivalent simple pendulum". If all
the mass of the body were concentrated at point O, along PG produced such that
$OP = k^2/a + a$, we would have a simple pendulum with the same time period. The point O is
called the 'Centre of Oscillation'.

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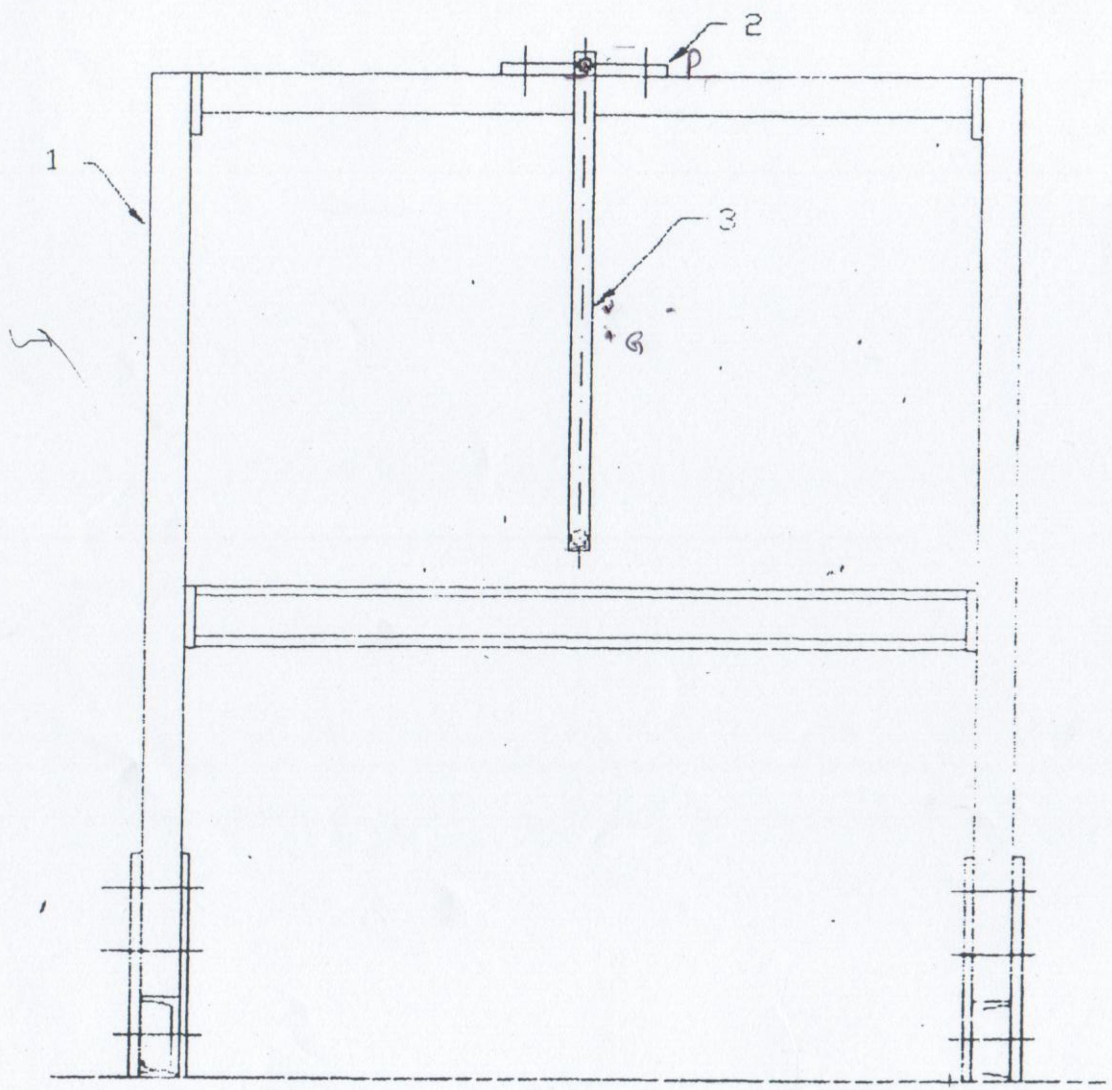

VIB LAB

EXPT. NO - 2

COMPOUND PENDULUM

1 MAIN FRAME

2 BRACKET

3 PENDULLM

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FIG. No. 2

PROCEDURE

1. Support the rod on knife edge.
2. Note the length of suspended pendulum and determine OG.
3. Allow the bar to oscillate and determine T by knowing the time for say 10 oscillations.
4. Repeat the experiment with second pendulum i.e readings for both smaller and larger pendulum.
5. Complete the observation table given below.

OBSERVATION TABLE

Sr. No.	L cms	OG	No. of Oscillations	Time for n osclillations in sec t	T in sec.(Expt) t/n	K Expt	k theortical

CALCULATIONS

i) Find 'k' experimental from the relation

$$T = 2\pi\sqrt{(k^2 + OG^2)/g(OG)}$$

Where T = Periodic time in sec
T = t/n
t = Time for n osc.
n = no. of osc.

Substituting for OG and T in the above formula.

Find K(exp) = K theoretical = $\frac{L}{2\sqrt{3}}$

Compare values of K obtained theoretical and experimental.

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INSTRUCTION MANUAL

FOR

STUDY OF RADIUS OF GYRATION OF GIVEN BAR BY USING BI-FILAR SUSPENSION

AIM

To determine the radius of gyration of given bar by using Bi – Filar suspension.

APPARATUS

Uniform rectangular section bar, Stop watch, Meter scale, Spirit Level.

DESCRIPTION OF SET UP

A uniform rectangular section bar is suspended from the pendulum support frame by two parallel cords. Top ends of the cords are attached to hooks fitted at the top. Other ends are secured in the Bi-filar bar. It is possible to change the length of the cord.
The suspension may also be used to determine the radius of gyration of any body. In this case the body under investigation is bolted to the centre. Radius of gyration of the combined bar and body is then determined.

THEORY

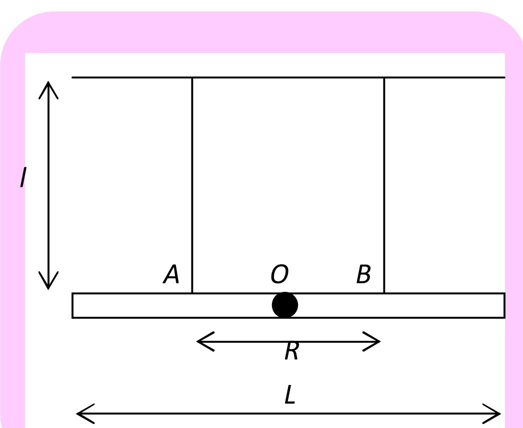
Consider the bifilar suspension pendulum shown schematically to the left. The name bifilar originates from the 2 (bi) filaments (filar) which support the rod. If this bar is suspended **symmetrically** in the horizontal plane by the two strings of equal length and set to swing about a vertical axis through its centre, the period of the swing **may** depend upon some, or all of the following quantities that define the system:

1. The difference in height between the bar and the support, l
2. The distance apart of the upper and lower ends of the strings, r
3. The mass of the suspended bar, m, and
4. The length of the suspended bar, L

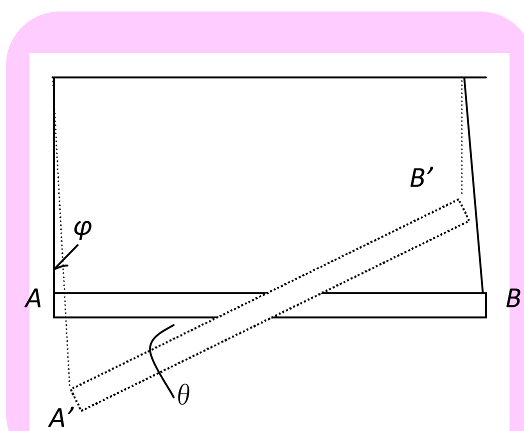
Bifilar pendulum

(Fig. a) shows a uniform bar of mass M and length L suspended horizontally by two vertical strings. The length of each string is l and they are attached symmetrically about the center O, a distance R apart. If the bat is now twisted horizontally, it will undergo SHM. We wish to analyze this motion, and in particular to find the period.

Let the bar rotate about O through a small angle θ. Then the points A and B move a distance x in opposite directions to A' and B' respectively (Fig. b), and



(Fig. a)



(Fig. b)

$$\boxed{x = \frac{1}{2} R\theta}$$

Because A and B have moved, the strings are no longer vertical. Rather, each string makes an angle φ with the vertical, given by

$$\boxed{\varphi \approx \frac{x}{l} = \frac{1}{2}\frac{R}{l}\theta}$$

if φ is sufficiently small. The tension T in each string must support half the weight, i.e.

$$T \cos\varphi = \frac{1}{2} Mg$$

$$T = \frac{1}{2} Mg$$

For small φ. T has a horizontal component

$$\mathrm{T} \sin\varphi = \frac{1}{2} Mg \sin\varphi \approx \frac{1}{2} Mg\varphi$$

$$= \frac{MgR}{4l}\theta$$

Since θ small, this force acts perpendicularly on the bar with a moment arm $\frac{R}{2}$, and so provides a restoring moment.

$$\boxed{\frac{MgR^2}{8l}\theta}$$

Since there are two such strings, the total moment is

$$\boxed{N = -\frac{MgR^2}{4l}\theta}$$

And the moment of inertia is $\frac{1}{12}ML^2$, so

$$-\frac{MgR^2}{4l}\theta = \frac{1}{12}ML^2\alpha$$

$$\alpha = -3\frac{gR^2}{lL^2}\theta$$

$$\omega_o^2 = 3\frac{g}{l}\left(\frac{R}{L}\right)^2$$

and the period of SHM is

$$\boxed{T = 2\pi\sqrt{\frac{l}{3g}}\,\frac{L}{R}}$$

The bifilar pendulum is interesting in that rather long periods can be achieved.

The formula for calculate the mass *(m)*:

$$\boxed{P = 2\pi\sqrt{\frac{4lI}{mgL^2}}}$$

Where $I = \frac{1}{12}m$

SOURCES OF ERROR

1. In this experiment if the angular displacement was large, that is over 10°, then the motion of the Bifilar Pendulum was no longer Simple Harmonic Motion. So if this occurred the Time Period, T (s), formula sown below would no longer be valid for the motion of the rod.
2. The lengths of the two strings may not have been the same, or they may not have been the same distance from the centre of mass of the rod, so the rod may have been slightly slanted. Therefore the position of the axis of rotation of the rod was not perpendicular through the centre of the rod, this means that its Moment of Inertia is not exactly by the given formula.
3. If the rod that was used was not a uniform rod (of uniform density) then its centre of mass may not have been at the axis of rotation, which was perpendicular through the centre of the rod. Therefore the Moment of Inertia may not exactly be given by the formula. This may have caused the slight error in the result of this experiment.
4. The error in this experiment may have been caused by the incorrect measurement of the length of the rod, the string separation, the string length or of the time for oscillations. A faulty stopwatch or human error may have caused this.

PROCEDURE

1. Suspend the bar from hook. The suspension length of each cord must be the same.
2. Allow the bar to oscillate about the vertical axis passing through the centre and measure the periodic time T by knowing the time for say 10 oscillations.
3. Repeat the experiment by varying the difference in height between the bar and the support, *l*
4. Complete the observation table given below.

Sr.No	*l in cms*	*R in cms*	*T in sec*

PRECAUTIONS

1. The suspended bar should be horizontal (use spirit level),
2. The suspension thread should be vertical (use set-square against vertical thread and the suspended bar),
3. The suspension threads measured from bar to support must be equal in length.

CALCULATIONS

For Bi – Filar suspension

$$T = 2\pi\sqrt{\frac{l}{3g}\,\frac{L}{R}}$$

Find, K experimental by using above formula.

K theoretical (for bar) = $L/2\sqrt{3}$

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INSTRUCTION MANUAL

FOR

VERIFYING THE RELATION OF TIME PERIOD OF A SIMPLE PENDULUM AND PLOTTING THE GRAPH OF T^2 Vs L

AIM To verify the time period of a simple pendulum and plotting the graph of T^2 and L.

FORMULA USED

$$T = 2\Pi\sqrt{L/g}$$

Where T = Periodic time in sec
L = Length of pendulum in cms.

DESCRIPTION OF SET UP:

For conducting the experiment, each ball is supported by nylon thread into the hook. 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 for large ball to illustrate that the period of oscillation is independent of the mass of the ball.

THEORY

A simple pendulum, is a concentration of mass on the end of a string or rod. When the string is set in motion, it will swing with a constant frequency. A pendulum swinging on either side of mean position does so under the action of gravity.When the pendulum swings through the midposition,its center of mass is at the lowest point and it possesses only kinetic energy.At each extremity of its swing,it has only potential energy.In the absence of any friction,the motion continues indefinitely.

The time taken for each oscillation, its period, is dependant upon the length of the string.
Time required to complete one vibration is called time period.
When the bob of the pendulum completes one vibration it travels 360° or 2π i.e $\theta = 2\pi$.

Using the relation $\theta = \omega T$

Or $T = \theta/\omega$

$T = 2\pi/\omega$ ------- (1)

Where ω = angular velocity of the bob
We know that
$a = -\omega^2 x$
Also $a = -\dfrac{g}{L}x$

Comparing above two

$$-\omega^2 x = -\frac{g}{L} x$$

$$\omega^2 = \frac{g}{L}$$

$$\omega = \sqrt{g/L}$$

$$T = 2\pi/\omega \quad \text{from (1)}$$

Putting the value of ω

$$T = 2\pi/\sqrt{g/L}$$
$$T = 2\pi\sqrt{L/g}$$

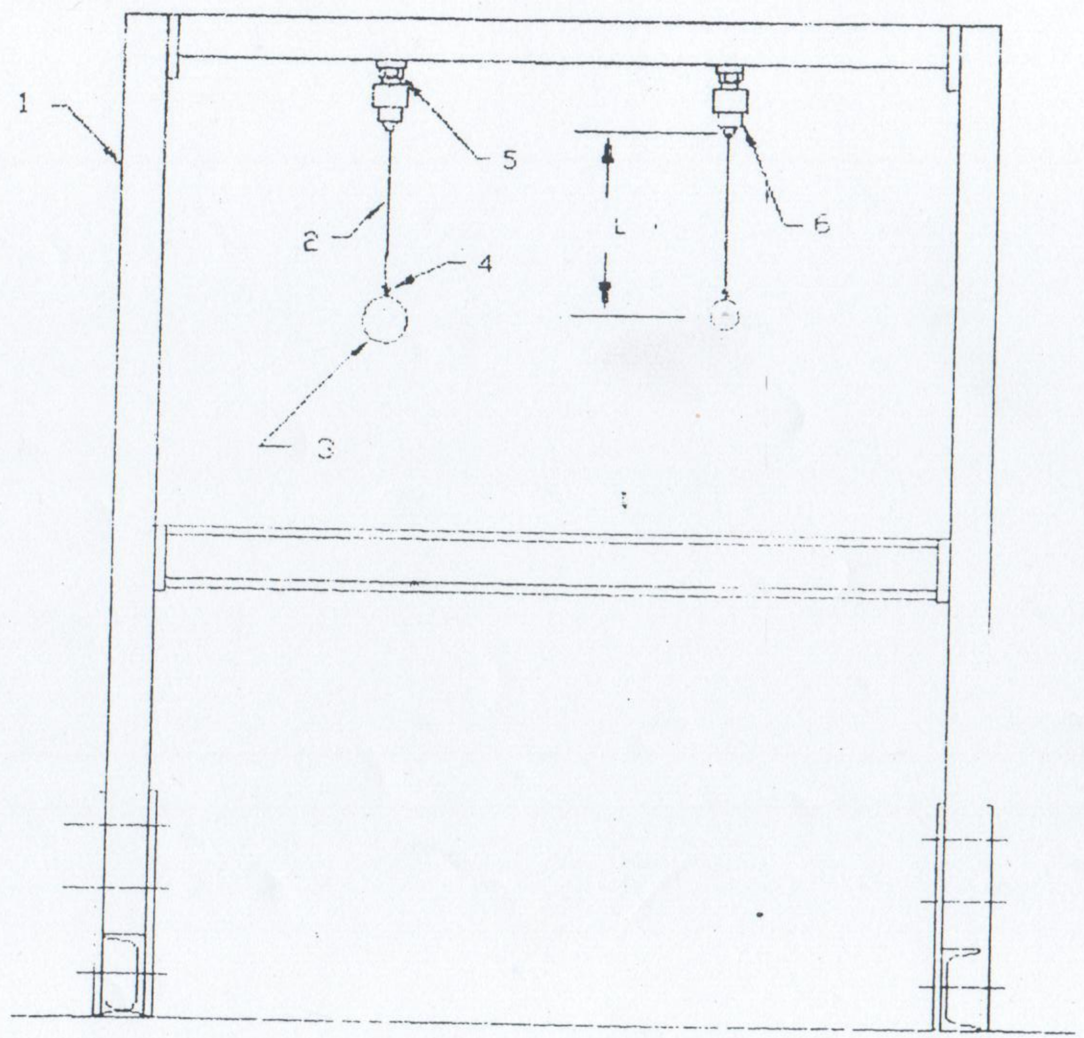
This expression indicates that the time period of simple pendulum is independent of its mass but it depends on the length of pendulum.

PROCEDURE:

1. Attach each ball to one end of thread.
2. Allow the ball to oscillate and determine the periodic time T by knowing the time for say 10 oscillations.
3. Repeat the experiment by changing the length.
4. Complete the observation table given below.

4

AMP 26/9/99 VIBLAB\FIG1



VIB LAB

EXPT. NO. 1

SIMPLE PENDULUM

1 MAIN FRAME
2 NYLONE ROPE
3 RUBBER BALL
4 HOOK
5 CHUCK HOLDER
6 DRILL CHUCK

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FIG. NO. 1

OBSERVATION TABLE

Sr. No.	Mass of the ball	L cms.	No. of Oscillations	Time for n osclillations in sec t	T in sec.(Expt) t/n	T theortical

Weight of the small ball : gms
Weight of the big ball : gms

CALCULATIONS :

Calculate T theoritical using the formula

$$T = 2\pi\sqrt{L/g}$$

Plot the graph of T^2 Vs L. It should yield a straight line.

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INSTRUCTION MANUAL

FOR

STUDY OF LOGITUDINAL VIBRATIONS OF HELICAL SPRING AND TO DETERMINED THE FREQUENCY OR PERIOD OF VIBRATION

AIM

To study the longitudinal vibrations of helical spring and to determine the frequency or period of vibration (Oscillation) theoretically and actually by experiment.

DESCRIPTION OF APPARATUS

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

PROCEDURE

1. Fix one end of the helical spring to the upper screw.
2. Determine free length.
3. Put some weight to platform and note down the deflection.
4. Stretch the spring through some distance and release.
5. Count the time required (in sec.) for some say 10, 20 oscillations.
6. Determine the actual period.
7. Repeat the procedure for different weights.

OBSERVATIONS

1. Length of spring :
2. Mean dia. Of spring :
3. Wire dia. :

OBSERVATION TABLE NO.1 (For finding Km)

Obs. No	Weight attached (w) in Kg.	Deflection of Spring in cm. (δ)	$K = w/\delta$	Km (Mean)

OBSERVATION TABLE NO.2

Obs. No	Weight attached (w) in Kg.	No. of oscillation (n)	Time required(t) for (n) oscillation	Periodic time & T expt.= t/n

CALCULATIONS

1. Find Km (mean stiffness) of the spring as follows-----------

   $$Km = \frac{K1+K2+K3}{n} \quad \text{Kg/cm.}$$

   Where,

   $$K1 = \frac{w1}{\delta 1} \qquad K2 = \frac{w2}{\delta 2} \qquad K3 = \frac{w3}{\delta 3} \qquad \text{etc.}$$

   n = number of readings.

2. Find T theoretical by using relation :

   $$T\ \text{theoretical} = 2\pi \sqrt{\frac{w}{Km\ x\ g}}$$

3. Check with experimental value T expt. = t/n

   Hence, f theoretical = 1/T (theo.) cps.

   And f experimental = 1/ T (expt.) cps.

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INSTRUCTION MANUAL

FOR

GENERATION OF INVOLUTE GEAR TOOTH PROFILE

AIM: To generate involute gear tooth profile using rack type cutter.

GENERATION OF INVOLUTE GEAR TOOTH PROFILE:

This board illustrates the process of cutting of involute Gear Teeth,by use of rack type cutter. It consists of 3 polystrene discs A,B,C, having pitch circle diameters 450 mm,300 mm & 200 mm respectively.A gear tooth profile with module 25 mm can be traced out on a piece of paper placed between disc and cutter.An effect of interference & undercutting on correct profile of gear tooth can be studied from the profiles traced.

PROCEDURE:

Fix any one disc by adjusting the screw provided at the centre of the disc,in the slot of the board so that the circumference of the disc just touches the depth line of the rack cutter which is marked. Fix paper on the circumference of the disc (analogous shaped paper) to draw the gear tooth profile generated by the relative motions of polystyrene disc & rack cutter.

Now take the cutter on the right hand side of the board with the help of knows.

Mark the initial position of rack portion by pencil on the paper attached to the circular disc.

Now gradually rotate the disc in a clockwise direction by one division on the circular scale and adopt the another position of rack cutter by advancing the cutter by one division of the left side of the board. At this position of the disc the cutter trace the profile by pencil. Repeat the same procedure till the cutter comes to extreme left hand position and the graph as shown in the figure will be observed. The same procedure can be adopted in case of other discs also. Hence,the involute tooth profile can be generated with the help of use of rack cutter.

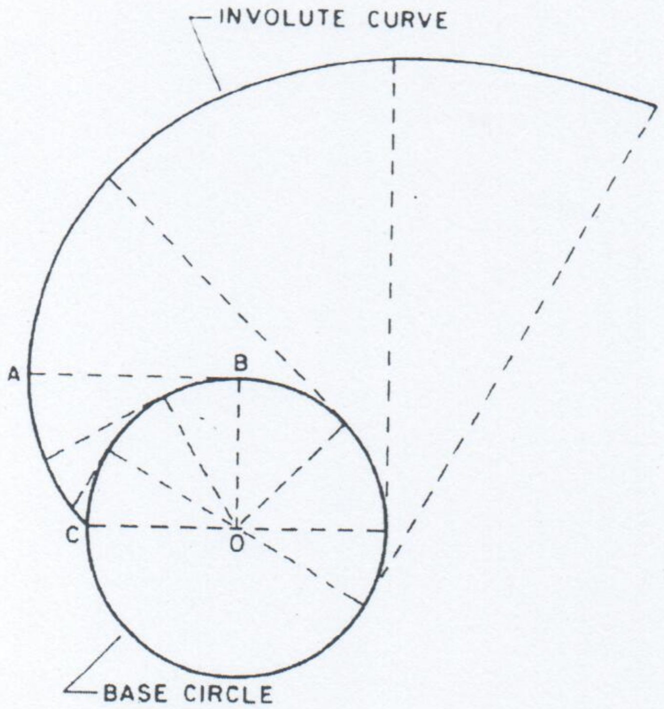

Illustration of the generation of the involute profile.

FORMS OF TEETH

Two curves of any shape that fulfil the law of gearing can be used as the profiles of teeth. In other words an arbitrary shape of one of the mating teeth can be taken and applying the law of gearing the shape of the other can be determined. Common forms of teeth that satisfy the law of gearing are:

1. Cycloidal profile teeth
2. Involute profile teeth

INVOLUTE PROFILE TEETH

An involute is defined as the locus of a point on a straight line which roles without slipping on the circumference of a circle also it is the path traced out by the end of a piece of taut cord being unbound from the circumference of a circle. The circle on which a straight line roles or from which the cord is unbound is known as the base circle. Figure 1 shows an involute generated by a line rolling over the circumference of a base circle with centre at O. At the start, the tracing point is at A. As the line rolls on the circumference of the circle, the path ABC traced out by the point A is the revolute.

CYCLOIDAL PROFILE TEETH

In this type the faces of the teeth are epicycloids and the flanks the hypocycloids. A cycloid is the locus of a point on the circumference of a circle that rolls without slipping on the circumference of a another circle. A hypocycloidal is the locus of a point on the circumference of a circle that rolls without slipping inside the circumference of another circle. The formation of a cycloidal tooth has been shown in the figure 2. A circle H rolls inside another circle APB(pitch circle). At the start, the point of contact of the two circles is at A. As the circle H rolls inside the pitch circle, the locus of the point A on the circle H traces the path ALP which is a hypocycloid. A small portion of this curve near the pitch circle is used for the flank of the tooth.

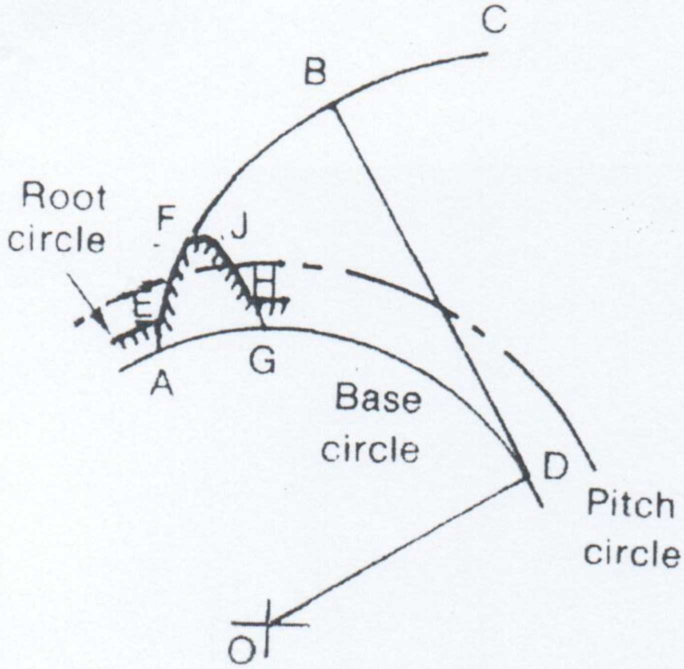

FIGURE 1

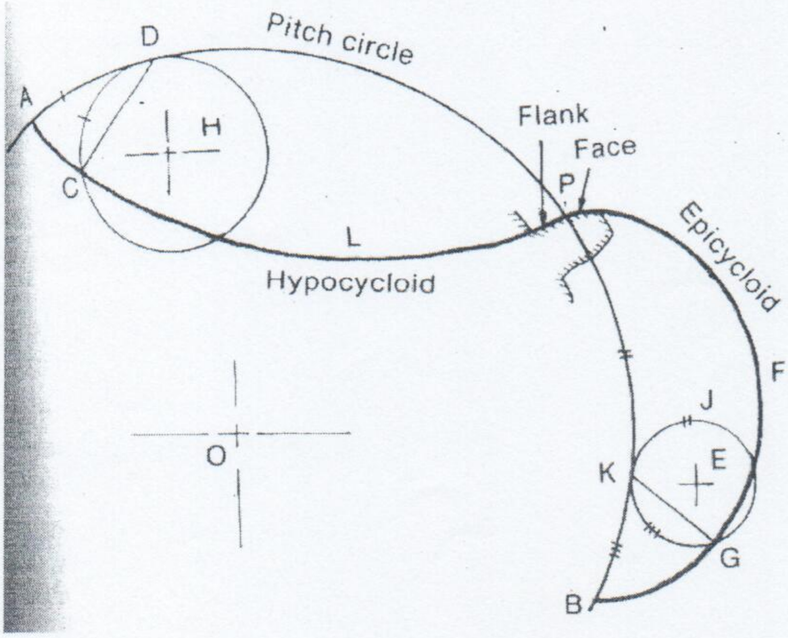

FIGURE 2