List of Practical

List of practical (as per BTEUP)

1. To study various equipment related to Engineering Mechanics.
2. To find the M.A., V.R., Efficiency and law of machine for differential Axel and Wheel.
3. To find the M.A., V.R., Efficiency and law of machine for Simple Screw Jack.
4. Derive Law of machine using Worm and worm wheel.
5. Determine resultant of concurrent force system applying law of Polygon of forces using force table.
6. Determine resultant of concurrent force system graphically.
7. Determine resultant of parallel force system graphically.
8. Verify Lami's theorem.
9. Study forces in various members of Jib crane.
10. Determine force reaction's for simply supported beam.
11. Determine Coefficient of friction for motion on horizontal and inclined plane.
12. Determine centroid of geometrical plane figures.

LAB MANUAL

ENGINEERING MECHANICS

LAL BAHADUR SHASTRI POYTECHNIC
MANDA, PRAYAGARAJ

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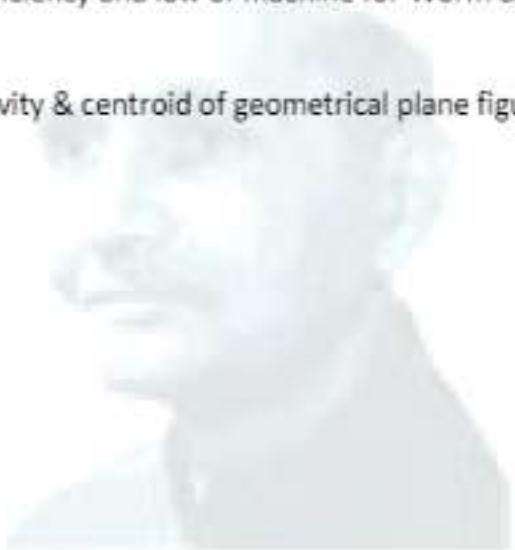
LIST OF EXPERIMENTS

1. To study various equipment related to Engineering Mechanics
2. Determine force reaction's for simply supported beam.
3. Study forces in various members of Jib crane
4. To find the M.A., V.R., Efficiency and law of machine for Simple Screw Jack.
5. To find the M.A.,V.R., Efficiency and law of machine for Worm and worm wheel
6. To find out center of gravity & centroid of geometrical plane figures.



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INDEX

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1	To study various equipment related to Engineering Mechanics			
2	Determine force reaction's for simply supported beam.			
3	Study forces in various members of Jib crane			
4	To find the M.A., V.R., Efficiency and law of machine for Simple Screw Jack.			
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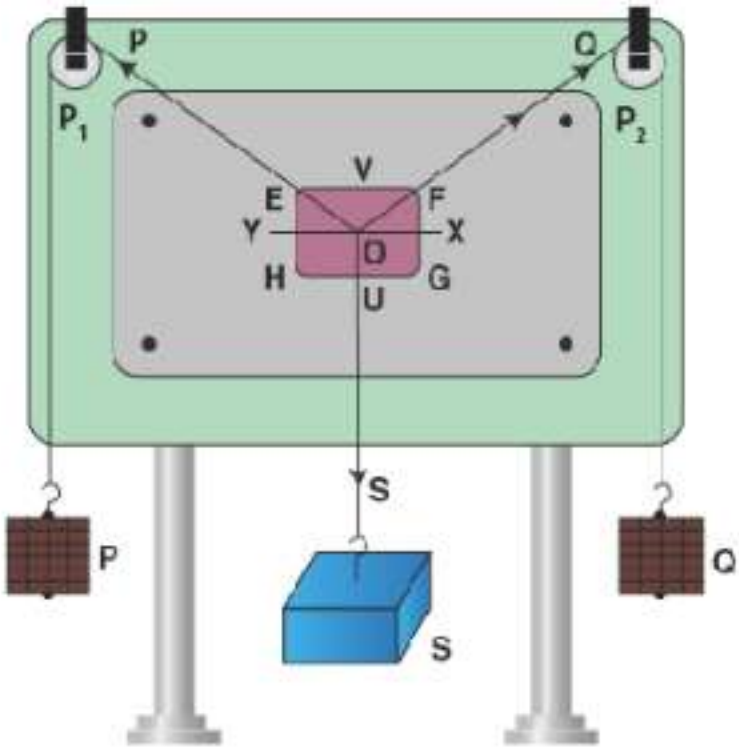
6	To find out center of gravity & centroid of geometrical plane figures.			

Experiment-01

Aim: To study various equipment related to Engineering Mechanics

1:Polygon law of forces



Gravesand's apparatus

Apparatus: - 1. Gravesand's Apparatus, 2. Paper Sheet, 3. Weight Box, 4. Thread, 5. Drawing pins & Pencil, 6. Mirror Strip Pans.

Theory: - "Polygon law of apparatus" states that if a number of forces acting on a particle are represented in magnitude & direction by sides of a polygon taken in same orde, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in the opposite direction.

Procedure: - 1. Set the board in a vertical plane & fix the paper sheet with drawing pins

2. Pass a thread over two pulleys

3. Take a second thread & tie the middle of this thread to the middle of first thread

4. Pass the ends of second thread over the other set of two pulleys

5. Take a third thread & tie its one end to the point of first two threads

6. Attach pans to the free ends of the threads

7. Place the weights in the pans in such a manner that the knot comes approximately in the centre of the paper.

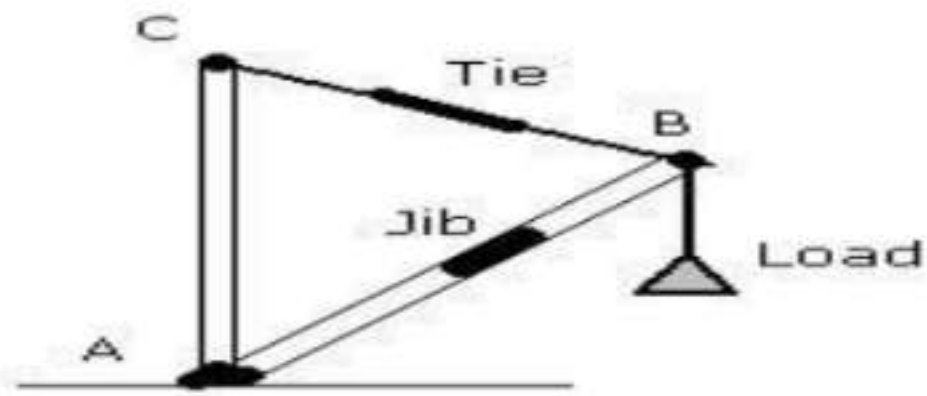
8. Mark the line of forces & write down the magnitude of forces

9. Remove the paper from the board & produce the line to meet at centre point O

10. Select a suitable scale & draw the vector diagram by moving in one direction. draw a b parallel to A B & cut it equal to force P; draw b c parallel to B C & cut it equal to Q; draw c d parallel to C D & cut it equal to force R; draw d e parallel to D E & cut it equal to force S. vector a e will be the resultant force T1 taken in the opposite direction & should be equal to force T which proves the law of polygon forces. If a e is not equal to T then percentage error is found .

Precautions: - 1. Pans/weights should not touch the board 2. There should be only one central knot on the thread which should be small 3. While calculating the total force in each case the weight of the pan should be added to the weight onto the pan 4. Make sure that all pans are at rest when the lines of action of force sare marked 5. All the pulleys should be free from friction

2: JIB CRANE



Apparatus: Jib Crane Apparatus Weights—

Procedure:

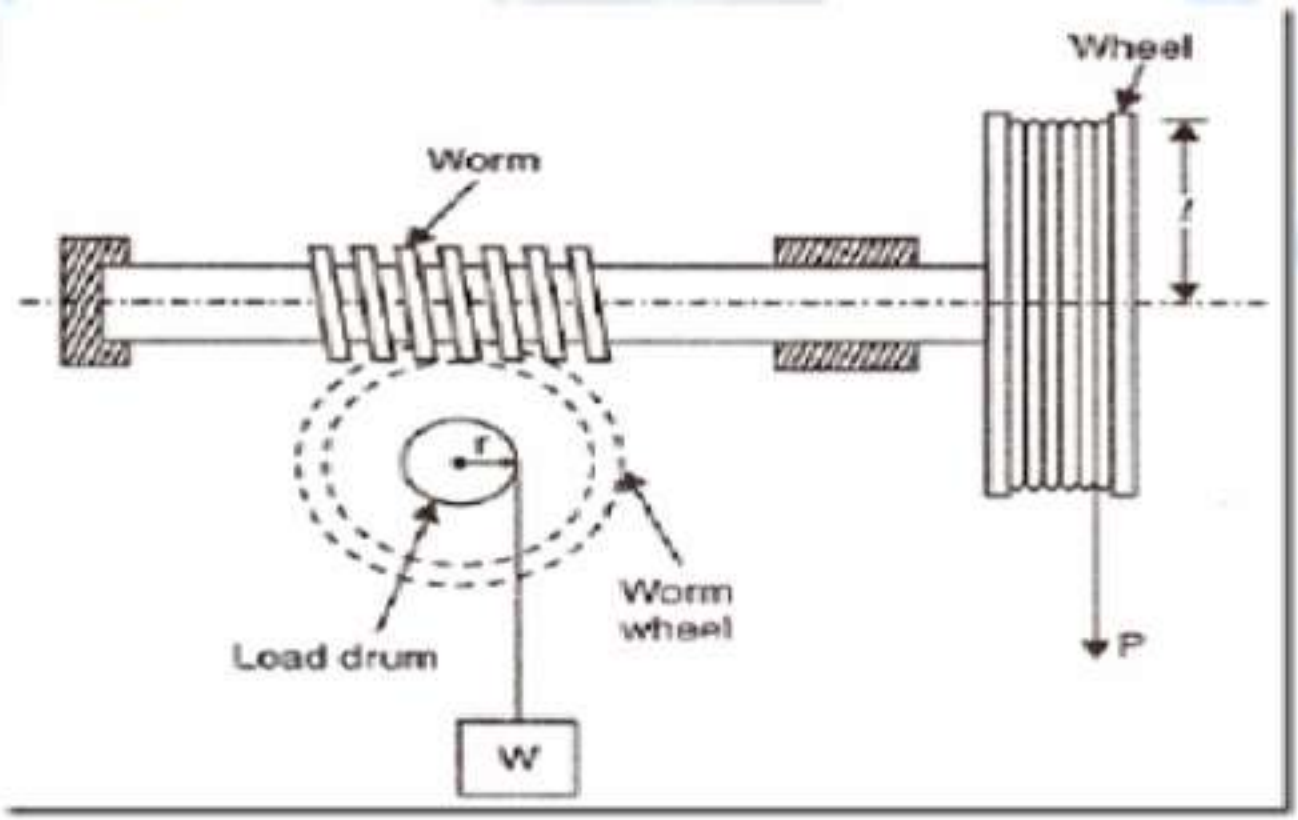
1. Note the zero error in the compression balance and the spring balance.

2. Suspend a wt (w) from the pt. A. Then measure AB, BC, AC, Draw the scale. Note. B is center of the compression balance and C s vertically above B. Fig. can serve as the vector or stress diagram also because it is a triangle (as any other triangle with sides parallel to it will be a similar triangle.

3. Let w be represented by CB. Then BA will be represent stress in the Arm AC (Tie). Thus these are the calculated values (Note, we can do without the scale diagram and simple measure AB, AC and BC)

4. Note the reading in the compression balance which will give the observed stress in the Arm AB, and tension in the spring balance given the observed force in the Arm AC. Find the %age error between the calculated and observed value.

3:Worm Wheel



WORKING:- As the pulley of the worm moves through n revolutions, n teeth of the wheel pass completely through the worm. If there are N teeth in the worm wheel, then N revolutions will have to be given to the pulley of the worm to rotate completely the worm wheel. So that if the effort applied at the pulley of the worm moves through N revolution the load is raised up by the a distance equal to the length of the circumference of the pulley of the worm wheel. So that velocity ratio is

$$\frac{N \times \text{circumference of pulley of worm}}{\text{Circumference of pulley of worm wheel}}$$

THEORY :- If the worm is single threaded (i.e for one revolution of the wheel, the worm pushes the worm wheel through one teeth) then for one revolution of the effort pulley the distance moved by effort load = 2πl

The load drum will move through 1/T revolution

Therefore, distance moved by the load on

load drum = 2πr/ T

And velocity ratio(V.R) = $\frac{\text{distance moved by P}}{\text{distance moved by W}}$

V.R = 2πl/2πr T = lT / r

Mechanical advantage = W/ P

Efficiency, η = M.A /V.R

PROCEDURE:- 1. Wrap the string round the pulley of the worm the free end of which is to be tied to the effort.

2. Wrap another string to carry the load round the pulley the worm wheel in such a manner that as the effort is applied the load is lifted up. 3. Suspend a small weight (w) through the free end of the second string and suspend another weight (p) through the free end of the first string which should just move the load upward.

4. Note w and P, so that mechanical advantage is given by W P

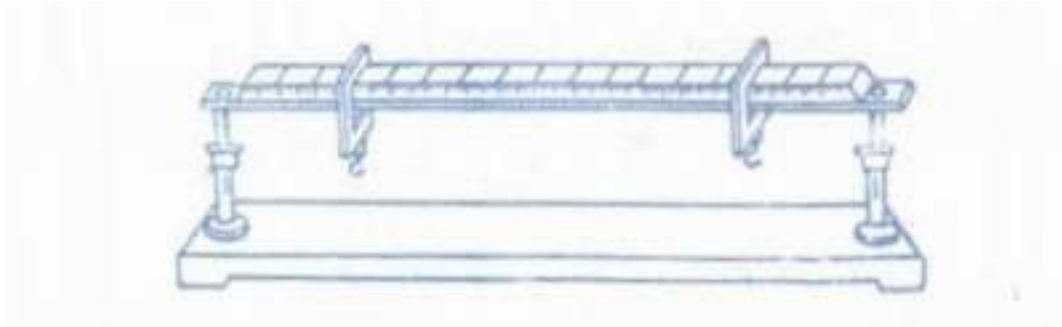
5. Increase the load (w) gradually and increase the effort (p) correspondingly and take in this way about seven readings.

6. Measure the circumference of the pulley of the worm and also that of the worm wheel.

7. The percentage efficiency is given by W x 100 /PV

8. Plot a graph between w and p and w and.

4: Parallel Force Apparatus



Apparatus Required: Parallel Forces Apparatus 10 Kg Dial Type, Conical Weights, and Aluminum hangers for hanging weights.

Procedure: The apparatus comprising of two dial type weight gauges of 10 kg, one straight wooden beams of 100cm, a wooden platform for the support of the dial gauges, Two weight hangers for hanging the weights on the wooden beams, Two weights weighing 2 kg aggregate. The beam is provided with angular slots on them in order to place the hanger in it, the distance between each groove is 5cms. The weight of each hanger will be neglected. The whole apparatus is well designed & painted. Theory: If a system of coplanar forces acting on a rigid body keeps it in equilibrium then the algebraic sum of their moments about any point in their plane is zero. Normally a beam is analysed to obtain the maximum stress and this is compared to the material strength to determine the design safety margin. It is also normally required to calculate the deflection on the beam under the maximum expected load. The determination of the maximum stress results from producing the shear and bending moment diagrams.

Experiment No.-02

AIM: To verify the reactions at the supports of a simply supported beam.

APPARATUS: A parallel forces apparatus consisting of a wooden beam, two compression balances, weights, threads, hooks etc.

THEORY: The experiment is based upon the fundamental principle of equilibrium which states that if a stationary body, subjected to coplanar forces, is in equilibrium, the algebraic sum of all the forces and their moments about any point lying in their plane, is zero.

1) The algebraic sum of vertical forces i.e. $\sum F = 0$
2) The algebraic sum of moments about a point must be zero i.e. $\sum M = 0$

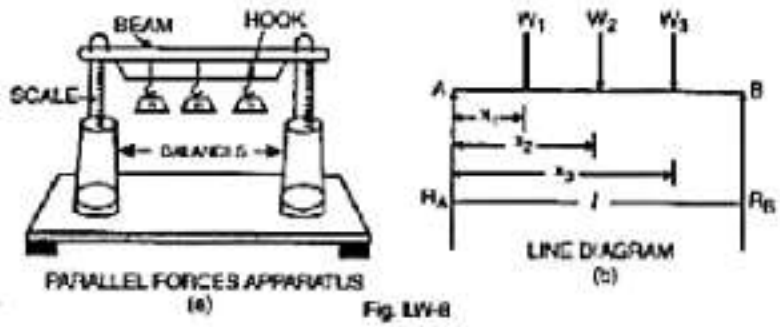


Fig. LW-8

PROCEDURE:

I) Place the graduated beam on the compression spring balances.
II) Either adjust the spring balances to zero reading with the help of adjusting screw or note the initial reading zero reading.
III) Place sliding hooks at different point on the beam and suspend different weights.
IV] Note down the final readings on the spring balance S_1 and S_2. These are called observed readings.
V) Note down the distance of each weight from any one support say from left.
VI] Take the moments about eh support to calculate the reaction. The second reaction may be found by subtraction first reaction from total vertical load. If there is difference in the observed and the calculated reactions and then calculate the percentage error.
VII) Repeat the experiment by taking different load at different places.

OBSERVATIONS AND CALCULATIONS:

Observed Reaction at		Weight Suspended			Distance of load from support A			Calculated reactions		% Error in reactions at the support	
R_A	R_B	W_1	W_2	W_3	X_1	X_2	X_3	R_A	R_B	$A = \frac{S_1 - R_A}{S_1} \times 100$	$B = \frac{S_2 - R_B}{S_2} \times 100$

By taking moments about A

$$W_1x_1 + W_2x_2 + W_3x_3 - R_Bl = 0$$

$$R_B \times l = W_1x_1 + W_2x_2 + W_3x_3$$

$$R_B = \frac{W_1x_1 + W_2x_2 + W_3x_3}{l}$$

$$R_A + R_B = W_1 + W_2 + W_3$$

$$R_A = (W_1 + W_2 + W_3) - R_B$$

% age error in the reaction at support A = $\frac{S_1 - R_A}{S_1} \times 100 =$ .....

% age error in the reaction at support B = $\frac{S_2 - R_B}{S_2} \times 100 =$ .....

PRECAUTIONS:

1. The apparatus should be placed perfectly horizontal.
2. The balances should be adjusted to zero after placing the beam on the compression spring balance.
3. The hooks should be place in the groves of the beam.
4. The weights are hung to the hooks gently.
5. The measurement of distances of weights should be done from one end.

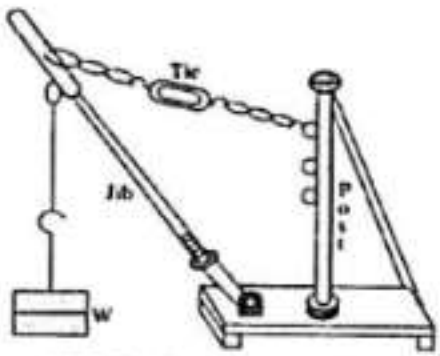
Experiment No.-03

AIM: TO VERIFY THE FORCES IN THE DIFFERENT MEMBERS OF A JIB CRANE.

APPARATUS: Jib Crane apparatus, weights, meter rod, set squares, paper sheet cello tape etc.

THEORY: This experiment is based on the triangle law of forces. According to this law if two forces acting on a body can be represented in magnitude and direction by the two side of a triangle taken in order, then their resultant can be given by the third side of the triangle, taken in the opposite direction.

Thus with the help of Jib Crane's apparatus the three forces i.e. known load, forces in the tie and that in the Jib are also calculated and the same are compared with the readings observed from the spring balances, there in.



JIB CRANE APPARATUS
Fig. LW-6

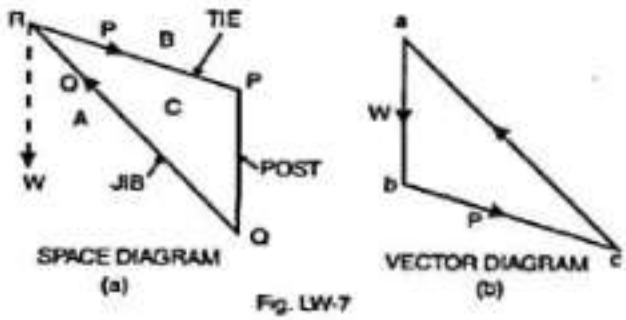


Fig. LW-7

PROCEDURE:

I) Note the zero error in the compression spring balance and the tension spring balance separately.
II) Attach a known weight W with the hook of the hanging chain.
III) Note the final reading of the spring balances separately.

IV) Subtract the initial reading from the final readings. The difference between the two readings of the spring balances will give the observed value of the forces in the tie and that of the compression spring.

V) Measure the height of vertical post from the junction of jib to the junction of tie and the length of jib and length of tie.

VI) From these measurements, to a suitable scale, draw the space diagram as shown in this fig LW-7(a) and name the members by Bow's Notation.

VII) Draw ab parallel and equal to W to some convenient scale to draw vector diagram direction.

VIII) Draw ca parallel to P and bc parallel to Q meeting at c moving in anticlockwise respectively.

IX) Compare the calculated values of the forces to that of the observed values and determine the percentage error if any.

X) Repeat the experiment twice by changing the load.

OBSERVATIONS:

Height of Post =
Length of tie =
Length of Jib =
Scale .....

PRECAUTIONS:

I) The weight should be hung to the hook gently. The initial readings of balances should be taken into account.

II) The Jib and the tie spring balances must be properly oiled for free movement.

III) The measurement of length should be done accurately.

IV) The space and force diagram should be carefully and accurately.

Experiment No.-04

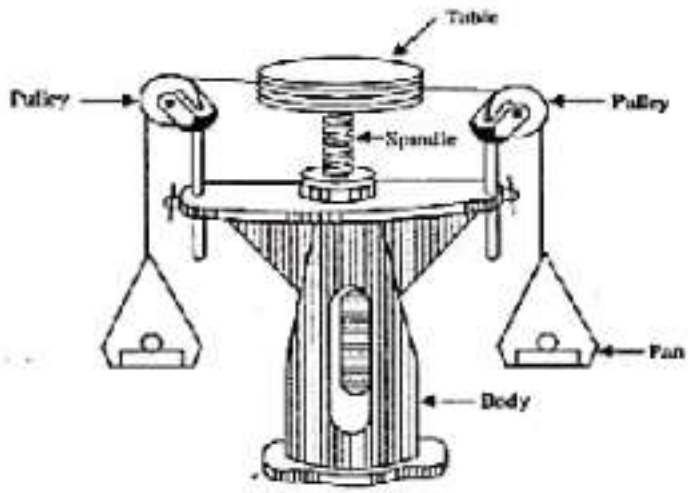
AIM: TO FIND THE MECHANICAL ADVANTAGE, VELOCITY RATIO AND EFFICIENCY OF SIMPLE SCREW JACK.

APPARATUS: Screw jack apparatus, pans, weights, string, vernier calipers, meter rod etc.

Theory: The screw jack is a simple machine by means of which heavy loads can be raised with the application of small effort. It works on the principle of screw and nut. The screw is rotated with the help of a tommy bar at the end of which an effort is applied. By doing so, the screw passing through the nut is raised and so is the load placed on its head.

The screw jack show in Figure is only experimental. It consist of a square threaded screw which is provide with double flanged circular table at its top to carry load to be lifted. The heavy body is providing with the two pulleys to hang the loads which act as an effort.

Let the pitch of the screw be p and D the diameter of the flanged table on which the load W is to be placed and lifted.



SCREW JACK APPARATUS
Fig. LW-11

Let the table turns through one revolution.
Then, the distance through which load rises in one revolution = p
Effort moved in one revolution = πD

$$\therefore V.R = \frac{\pi D}{p}$$

Weight on the table = W kg

P = Total effort in the two pans including the weights of pans.

$$\therefore M.A = \frac{W}{P} \text{ and } \% \eta = \frac{M.A}{V.R} \times 100$$

PROCEDURE:

I. Measure the circumference of the flanged table with the help of an inextensible thread or measure the diameter of table with an outside calipers.

II. Measure the pitch of thread with the help of vernier calipers.

III. Wrap the string round the circumference of the flanged table and pass it over one pulley. Similarly warp another string over the circumference of flanged table and pass it over the second pulley. The free ends of both the strings be tied to two pans in which the weights are to be placed.

IV. Note down the weight of each pan.

V. Place the load W on the top of the table and start adding weight in to the pans so that the load W is just lifted, the effort P is equal to the sum of weights placed on both the pans.

VI. Calculate the M.A., V.R. and & η in each case.

VII. Repeat the experiment twice more by varying the load on the top of the table and in the pans.

OBSERVATIONS:

Sr. No.	Circumference of the Table = π *Discuss*	Pitch of Screw P cm	Velocity Ratio = $\frac{\pi D}{p}$	Weight on Table = W N	Total Effort P = P1 + P2 + wt. of pans	M.A = W/ P	$\% \eta = \frac{M.A}{V.R} \times 100$
1							
2							
3							

PRECAUTIONS:

1. The circumference of the disc and the pitch of the screw should be measure precisely.
2. Use both the pulleys to find the total thrust.
3. Lubricate the screw adequately to decrease friction.
4. Make use of both the pulley to find the total effort applied.
5. Put the weights in the pans gently.
6. The string should not overlap on the disc.

Experiment No-05

AIM: TO FIND THE MECHANICAL ADVANTAGE, VELOCITY RATIO, AND EFFICIENCY OF A WORM AND WORM WHEEL.

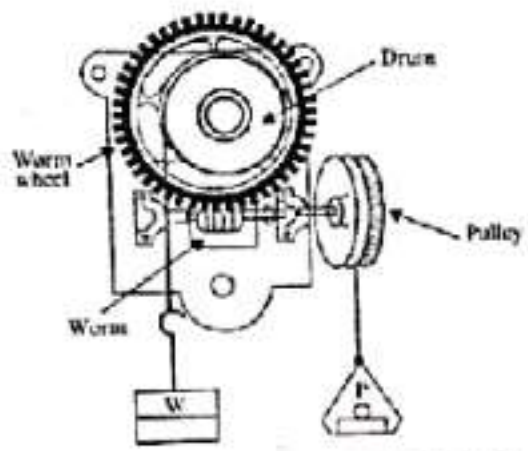
APPARATUS: Worm and worm wheel apparatus, weights string, meter rod, outside calipers, pan etc.

THEORY: The apparatus consist of a horizontal spindle having worm provided on it. It is supported between two bearings. On the overhanging portion of the spindle a pulley is provided to which is attached a string, carrying pan to its free end where effort is applied. The worm is engaged to the teeth of the worm wheel which has a projecting drum. Another string is provided on be drum to which weight to be hanged is hooked. Let,

D= diameter of pulley attached to worm

D = diameter of drum fixed on the wheel

T = number of teeth on worm wheel.



WORM AND WORM WHEEL APPARATUS
Fig. LW-12

Assuming the worm thread having single start, when one revolution is given to the pulley only one thread of the worm wheel moves.

Displacement of effort P = πD

Displacement of load W = $\frac{\pi d}{T}$

Velocity Ratio V.R = $\frac{\pi D}{\pi d} \times \frac{T}{1} = \frac{D}{d} \times T$

Mechanical Advantage = $\frac{W}{P}$

$$\eta = \frac{M.A}{V.R} = \frac{W}{P} \times \frac{d}{DT}$$

$$\% \text{ age } \eta = \frac{W}{P} \times \frac{d}{DT} \times 100$$

PROCEDURE:

1. Measure the circumference of both the pulleys and the drum with the help of a string and meter rod.
2. Wrap the string round the pulley of the worm for effort and also wrap another string round the drum to carry the load.
3. Suspend a known weight W with the string from the drum and add weights in the pan, till the load just starts moving upwards.
4. Note down the weight in the effort pan.
5. Calculate the M.A., V.R. and % η
6. Repeat the experiment at least twice more by varying the load.

OBSERVATIONS:

Wt. of scale pan =
Diameter of pulley =
Diameter of load drum =
Number of teeth on the worm wheel =

Sr. NO.	Load W in kg	Total effort, P in kg = wt. of pan + Wt. in pan	M.A = W/P	V.R = $\frac{D}{d} \times T$	% η = $\frac{M.A}{V.R} x\ 100$
1.					
2.					
3.					

Mean Value.....

PRECAUTIONS:

i) The bearings of the worm, spindle and teeth of worm-wheel should be well lubricated to decrease friction.
ii) Weights on the effort pan should be put gently.
iii) The string should not overlap on the pulley or on the drum.
iv) The load and effort should not touch the walls.
v) The load and effort should move slowly.

Experiment No.-06

AIM: TO FIND OUT CENTER OF GRAVITY OF REGULAR LAMINA.

APPARATUS: Regular lamina, A stand, Inextensible string, meter rod, pencil etc.

THEORY: The center of gravity of a body is that point at which the whole weight of the body may be assumed to be acting.

When the body is considered to be composed of infinite number of small weights each of which is acting vertically downward, then the point where the resultant of all of these small weights acts, gives the position of the center of gravity of the body.

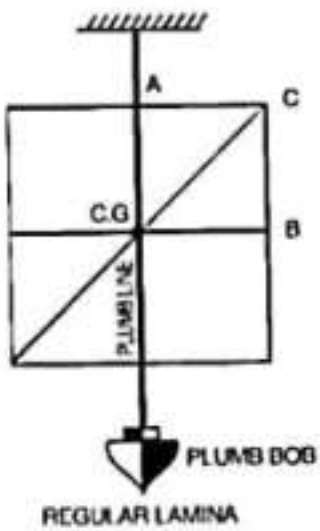


Fig. LW—15

The center of gravity of a plane figure or lamina referred to as the centroid or center of area. A very thin sheet of any cross section is known as lamina.

The center of gravity of irregular bodies is determined by the principle of free suspension of bodies, which is as stated below:

If a body is suspended vertically with the help of a string, the forces which come into play are:-

I) The weight of the body acting vertically downward through its C.G.
II) The tension in the string.

PROCEDURE:

I) Take a lamina of any regular shape of some suitable material.
II) Tie the string at point A as shown in figure.
III) Suspend the lamina vertically by fixing the other end of the string to the stand and drawing line along the plumb line.
IV) Now suspend the lamina at some other suitable point so that the lamina is suspended vertically and again draws the line along the plumb line.
V) The center of gravity of the lamina will be the point where these two plumb lines intersect.
VI) Suspended the lamina at another point C and draw the plumb line, which should pass through the C.G center of gravity already located.

PRECAUTIONS:

I) The lamina should be of perfectly uniform mass.
II) The point of suspension should be quite small.
III) Draw the plumb line when lamina and string come to rest.
IV) The thickness of the lamina should be uniform.