LABORATORY MANUAL

KINEMATICS OF MACHINE

ME-212-F

LIST OF EXPERIMENTS

Note: 1. At least Ten experiments are to be performed in the Semester.

2. At least eight experiments should be performed from the above list. However these experiments should include experiments at Sr. No. 12, 13 and 14. Remaining two experiments may either be performed from the above list or as designed & set by the concerned institution as per the scope of the syllabus

EXPERIMENT No. : -1

AIM: - To study various types of kinematics links, pairs, chains & Mechanisms.

APPARATUS USED: - Kinematics links, pairs, chains & Mechanisms.

THEORY: -

1. Definitions of kinematics links, pairs, chains & Mechanisms.
2. Classifications of kinematics links, pairs, chains & Mechanisms.
3. Diagrams of kinematics links, pairs, chains & Mechanisms
4 Advantages & Disadvantages of kinematics links, Pairs, chains & Mechanisms.
5. Applications of kinematics link, Pairs, chains & Mechanism
6. Examples of kinematics link, Pairs, chains & Mechanisms.

KINEMATIC LINK: - A mechanism is made of a number of resistant bodies out of which some may have motions relative to the others. A resistant body or a group of resistant bodies with rigid connections preventing their relative movement is known as a link. A link also known as kinematic link or element.

Examples :- A slider-crank mechanism consists of four links: frame and guides, crank connecting rod and slider, the crank link may have crankshaft and flywheel also, forming one link having no relative motion of these.

CLASSIFICATIONS OF LINKS:-

1. Binary link
2. Ternary link
3. Quarternary link

KINEMATIC PAIR: - A kinematic pair or simply a pair is a joint of two links having relative motion between them.

CLASSIFICATIONS OF PAIRS:

1-Kinematics pairs according to nature of contact:-

(i) Lower pair (links having surface or area contact)

Examples- Nut turning on a screw, shaft rotating in a bearing, universal joint etc.

(ii) Higher pair (Point or line contact between the links)

Examples:- when rolling on a surface, cam and follower pair, tooth gears, ball and roller bearings etc.

2- Kinematics pairs according to nature of Mechanical Constraint:-

(a) Closed pair (when the elements of a pair are held together mechanically)
Examples :- all the lower pairs and some of the higher pair

(b) Unclosed pair (when two links of a pair are in contact either due to force of gravity or some spring action), Example :- cam and follower pair.

3-Kinematics pairs according to nature of relative motion:-

(i) Sliding pair
(ii) Turning pair
(iii) Rolling Pair
(iv) Screw pair (Helical pair)
(v) Spherical pair

KINEMATIC CHAIN :- A kinematic chain is an assembly of links in which the relative motions of the links is possible and the motion of each relative to the others is definite. If indefinite motions of other links , it is a non-kinematic chain.

Types of kinematics chains :-

(i) Four bar chain or quadric cycle chain
(ii) Single slider crank chain
(iii) Double slider crank chain

MECHANISM :- A linkage is obtained if one of the links of a kinematics chain is fixed to the ground. If motion of each link results in definite motions of the others, the linkage is known as a mechanism. If one of the links of a redundant chain is fixed, it is known as a structure. The degree of freedom of a structure is zero or less. A structure with negative degree of freedom is known as a superstructure.

OBSERVATION & CONCLUSION:- 1. Comparison between kinematics links, Pairs, chains & Mechanisms.

2. Type of Motion to be named.

VIVA-QUESTIONS :-

a) Define machine & structure.
b) Concept of kinematics links, pairs, chains & mechanism.
c) Classification & examples of all the kinematics links, pairs, chains & mechanism.
d) Grasshof's criterion.
e) Types & examples of constrained motion.

EXPERIMENT No. :- 2

AIM : - To study inversions of 4 Bar Mechanisms, Single & double slider crank mechanisms.

APPARATUS USED : - Models of 4 Bar Mechanisms, Single & double slider Crank mechanisms

THEORY: -

1. Definitions of 4 Bar Mechanisms, Single & Double slider crank mechanisms.
2. Classifications of 4 Bar Mechanisms, Single & Double slider crank mechanisms
3. Diagrams of 4 Bar Mechanisms, Single & Double slider crank mechanisms
4. Working & Construction of 4 Bar Mechanisms, Single & Double slider crank mechanisms.
5. Applications of of 4 Bar Mechanisms, Single & Double slider crank mechanisms

FOUR BAR MECHANISM :- A four bar link mechanism or linkage is the most fundamental of the plane kinematics linkages. It is a much preferred mechanical device for the mechanization and control of motion due to its simplicity and versatility. Basically it consists of four rigid links which are connected in the form of a quadrilateral by four pin joints. A link that makes complete revolutions is the crank, the link opposite to the fixed link is the coupler and the fourth link a lever or rocker if oscillates or an another crank, if rotate. By fixing the link :-

- Shortest Link Fixed
- Link opposite to Shortest Link fixed

INVERSIONS OF SINGLE SLIDER–CRANK CHAIN :-

Different mechanisms obtained by fixing different links of a kinematics chain are known as its inversions. A slider –crank chain has the following inversions :-

1. **First inversion (**i.e; Reciprocating engine and compressor) – this inversion is obtained when link 1 is fixed and links2 and 4 are made the crank and the slider respectively.
2. **Second inversion** (i.e., Whitworth quick return mechanism and Rotary engine) – fixing of link 2 of a slider – crank chain.
3. **Third inversion** (i.e., Oscillating cylinder engine and crank & slotted – lever mechanism)- By fixing link 3 of the slider crank mechanism.
4. **Fourth inversion** (Hand pump) – if link 4 of the slider crank mechanism is fixed, the fourth inversion is obtained.

DOUBLE-SLIDER CRANK-CHAIN:

A four-bar chain having two turning and two sliding pairs such that two pairs of the same kind are adjacent is known as a double-slider-crank chain. The following are its inversions:

1. **First inversion** (i.e., Elliptical trammel)

2. **Second inversion** (i.e., Scotch yoke)
3. **Third inversion** (i.e., Actual Oldham's coupling)

OBSERVATION & CONCLUSION: -

(a) Comparison between 4 Bar, Single & Double slider cranks mechanisms.
(b) Type of Motion to be named.

APPLICATIONS :-

- In reciprocating engine.
- In reciprocating compressor.
- In Whitworth quick – return mechanism and Rotary engine.
- In Oscillating cylinder engine and crank & slotted-lever mechanism.
- In hand pump.
- In scotch yoke.

VIVA-QUESTIONS :-

1. What are the of inversions of four bar mechanism & give their applications also ?
2. What are the of Inversions of single slider crank mechanism & give their applications also ?
3. What are the of Inversions of Double slider crank mechanism & give their applications also ?
4. Define degree of freedom & give examples ?
5. Define Kutzbach & grubler's criterian.

EXPERIMENT No. :- 3

AIM :- To find coefficient of friction between belt and pulley.

APPARATUS USED:- Belt & Pulley System.

THEORY:-

1. Definition of belt and pulley.
2. Diagram of belt and pulley system.
3. To prove the relation of belt tension for flat belt i.e.

$$T_1 / T_2 = e^{\mu \theta}$$

BELT :-

Power is transmitted from one to another by means of belts.

- Belts are used where the distance between the shafts is large.
- Belts are flexible type of connectors.
- The flexibility of belts and ropes is due to the property of their materials.
- Belts transmit power due to friction between them and the pulleys. If the power transmitted exceeds the force of friction, the belt slips over the pulley.
- Belts are strained during motion as tensions are developed in them.
- Owing to slipping and straining action, belts are not positive type of drives.

Types of belts :-

1. Flat belt
2. V-belt

Material for belts :- Usual materials are leather, canvas, cotton and rubber.

PULLEY :- Pulley are mounted on the two shafts. The speed of the driven shaft can be varied by varying the diameters of the pulleys.

Types of pulleys :-

1. Idler pulleys
2. Intermediate pulleys
3. Loose and fast pulleys
4. Guide pulleys

FORMULAE USED:-

$$T_1 / T_2 = e^{\mu \theta}$$

; Where T_1 = Tension at the tight side of the belt (N/m^2)

T_2 = Tension at the slack side of the belt (N/m^2)

μ = Co-efficient of Friction between belt and pulley

θ = Arc of contact (rad)

OBSERVATION TABLE :-

Sl. No.	**T_1** **(N/m^2)**	**T_2** **(N/m^2)**	**θ**		**$\mu = (1/\theta)\log (T_1/ T_2)$**
			(in degree)	**(in rad.)**	

CALCULATION :- $\mu = (1/\theta)\log (T_1/ T_2)$

PROCEDURE:-

1. Note the angle of arc of contact.
2. Hang some weight on one side of the belt & put some Weight on other side of the belt, till the belt just slide
3. Note down the values of T_1 & T_2
4. Vary T_1 & correspondingly determine the value of T_2 .
5. Now calculate the value of μ

PRECAUTION:-

1. Tapping of pulley should be done after increasing the weight.
2. Weight should be increased in small step.
3. Add weights slowly without jerks.

RESULT:- μ (Co-efficient of Friction between belt and pulley) =

VIVA-QUESTIONS :-

a. Define Belt, Classification of belt, advantage & disadvantage, Applications.
b. What do you meant by slip & creep in belt drive ?
c. What do you meant by crowning of pulley ?
d. What do you meant by initial tension & centrifugal tension ?
e. What is the formulae for the ratio of belt tensions in case of flat & V-belt drive ?

EXPERIMENT No :- 4

AIM: - To plot slider displacement, velocity & acceleration against crank rotation for Single slider crank Mechanisms.

APPARATUS USED:- Single slider crank mechanism.

THEORY:-

1. Definition of Single slider cranks mechanism.
2. Working of Single slider crank mechanism.

A slider crank mechanism converts the reciprocating motion of a slider into a roatary motion of crank or vice-versa.

Velocity :- Fig. shows a slider–crank mechanism in which OA is the crank moving with uniform angular velocity in the clockwise direction. At point B, a slider moves on the fixed guide G. AB is the coupler joining A and B. it is required to find the velocity of the slider at B.

Velocity vector equation :

Velocity of B rel. to O = Vel. of B rel. to A + Vel. of A rel. to O

Vbo = Vba + Vao

Vbg = Vao + Vba

gb = oa + ab

Accelration :- Acc. Of B rel. to O = Acc. Of B rel. to A + Acc. Of A rel. to O

$\mathbf{g_1b_1 = o_1a_1 + a_1b_a + b_ab_1}$

PROCEDURE:-

a) Bring the wheel & the slider to the respective reference marks.
b) For a given angle of rotation of the crank, note down the displacement of the slides.
c) Plot a graph between slider displacement & the crank rotation.
d) Assume that the crank is rotating with a uniform angular speed of one rad/sec.
e) Convert the crank rotation angle into time & plot the slider displacement versus time.
f) By graphical differentiation, determine the velocity time graph .
g) By graphical differentiation twice, determine the acceleration time graph.
h) Calculate the values of velocity & acceleration.

OBSERVATION TABLE :-

Crank Radius, r =

Length of Connecting rod, l =

Sl. No.	Crank Rotation (θ)		Time (Sec.)	Slider Displacement (m)	Slider Velocity (m/ Sec.)	Slider Acceleration (m/ Sec^2.)
	(in deg.)	(rad)				

PRECAUTIONS:- 1 Displacement of slider should be measured at equal intervals of crank angle rotation.

2 Smooth curves should be drawn while plotting.

VIVA-QUESTIONS :-

- What do you mean by I.C.R. ?
- What is the formulae for calculating I.C.R for all mechanisms ?
- How will you find I.C.R. of velocity for 4 bar chain mechanisms and single slider crank mechanism?
- How will you find graphically & analytically the methods of velocity & acc. Analysis of 4-bar chain mechanism and single slider crank mechanism. ?

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EXPERIMENT NO. - 5

AIM: - To study various types of cam and follower arrangements.

APPARATUS USED: - Cam and follower arrangements.

THEORY: -

1. Definition of Cam & Follower.
2. Classification of Cam & Follower.
3. Diagrams of Cam & Follower.
4. Working & Construction of Cam & Follower.
5. Advantages & Disadvantages of Cam & Follower.
6. Applications of Cam & Follower.
7. Examples of Cam & Follower.

CAM & FOLLOWER :- A cam is a mechanical member used to impart desired motion to a follower by direct contact. The cam may be rotating or reciprocating whereas the follower may be rotating, reciprocating or oscillating. A cam and the follower combination belongs to the category of higher pairs.

- A driver member known as the cam.
- A driven member called the follower

Types of Cams :

A. According to shape

(i) wedge and flat Cams :- A wedge cam has a wedge W which, in general, has a translational motion. The follower. The follower F can either translate or oscilate.

(ii) Radial or Disc Cams :- A cam in which the follower moves radially from the centre of rotation of the cam is known as a radial or a disc cam.

(iii) Spiral cams :- A spiral cam is a face cam in which a groove is cut in the form of a spiral as shown in fig. the spiral spiral groove consists of teeth which mesh with a pin gear follower.

(iv) Cylindrical cams :- In a cylindrical cam, a cylinder which has a circumferential contour cut in the surface, rotate about its axis.

(v) Conjugate cams :- A conjugate cam is a double – disc cam, the two discs being keyed together and are in constant touch with the two rollers of a follower. It is used for low noise, high speed and dynamic loads.

(vi) Globoidal cams :- A globoidal cam can have two types of surfaces, convex or concave. A circumferential contour is cut on the surface of rotation of the cam to impart motion to the follower which has an oscillatory motion.

(vii) Spherical cams :- In a spherical cam, the follower oscillates about an axis perpendicular to the axis of rotation of the cam.

B. According to Follower Movement

(i) 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 an angular displacement.

(ii) 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

(iii) Dwell-Rise-Dwell-Return (D-R-D-R) :- It is most widely used type of cam. The dwelling of the cam is followed by rise and dwell and subsequently by return and dwell as shown in fig.

C. According to Manner of Constraint of the Follower

(i) Pre-loaded Spring Cam

(ii) Positive-Drive Cam

(iii) Gravity Cam

Types of Followers :-

A. According to shape

(i) Knife-edge Follower

(ii) Roller Follower

(iii) Mushroom Follower

B. According to Movement

(i) Reciprocating Follower

(ii) Oscillating Follower

C. According to Locating of Line of Movement

(i) Radial Follower

(ii) Offset Foolower

OBSERVATION & CONCLUSION: -

1. Comparison between Cam & Follower.
2. Type of Motion to be named.

APPLICATIONS :-

(i) Cams are used in Automatic machines

(ii) In internal combustion engine

(iii) In machine tools

(iv) Printing Control mechanisms

VIVA-QUESTIONS :-

(i) Define about cam & follower, Classification of cam & follower, advantage & disadvantage, Applications.

(ii) Define Disc cam nomenclature.

(iii) Define the cut off-set position of follower motion.

EXPERIMENT NO.- 6

AIM :- To study various types of gear- Helical, cross helical, worm, bevel gear.

APPARATU USED :- Arrangement of gear system.

THEORY :-

1. Definition of gear
2. Classification of gear
3. Diagram of different type of gear
4. Working and construction of different type of gear
5. Advantage & disadvantage of gear
6. Application of gear
7. Example of gear

GEAR :- Gear are used to transmit motion from one shaft to another shaft or between a shaft or slide. This is accomplished by successively engaging teeth.

CLASSIFICATION OF GEAR :- Gears can be classified according to the relative position of their shaft axis are follows:

A: PARALLEL SHAFT

(i) Spur gear
(ii) Spur rack and pinion
(iii) Helical gears or Helical spur gear
(iv) Double- helical and Herringbone gear

B: INTER SECTING SHAFT

(i) Straight bevel gear
(ii) Spiral bevel gear
(iii) Zerol bevel gear

C: SKEW SHAFT

(i) Crossed- helical gear
(ii) Worm gears(Non-throated, Single throated, Double throated)

Spur gear:- They have straight teeth parallel to the axes and thus are not subjected to axial thrust due to teeth load.

Helical gears:- In helical gears, the teeth are curved, each being helical in shape. Two mating gears have the same helix angle, but have teeth of opposite hands. At the beginning of engagement, contact occurs only at the point of leading edge of the curved teeth. As the gears rotate, the contact extends along a diagonal line across the teeth. Thus the load application is gradual which result in now impact stresses and reduction in noise. Therefore, the helical gears can be used at higher velocities then the spur gears and have greater load – carrying capacity.

DOUBLE HELICAL AND HERRING BONE GEARS :- A- double- helical gear is equivalent to a pair of helical gears secured together, one having a right – hand helix and the other a left hand helix. The tooth of two raw is separated by a grooved used for too run out.
If the left and the right inclinations of a double – helical gear meet at a common apex and there is no groove in between, the gear is known as herring bone gear.

CROSSED – HELICAL GEAR :- The used of crossed helical gear or spiral gears is limited to light loads. By a suitable choice of helix angle for the mating gears, the two shaft can be set at any angle.

WORM GEAR :- Worm gear is a special case of spiral gear in which the larger wheel, usually, has a hollow or concave shape such that a portion of the pitch diameter is the other gear is enveloped on it. The smaller of two wheels is called the worm which also has larger spiral angle.

BEVEL GEAR :- Kinematically, the motion between two intersecting shafts is equivalent to the rolling of two cones, assuming no slipping. The gears, in general, are known as bevel gear. When teeth formed on the cones are straight, the gear are known as straight bevel and when inclined, they are known as spiral or helical bevel.

CONCLUSION :-

APPLICATION :-

1. Bevel gears are used for the drive to the differential of automobiles.
2. Spur rack and pinion are used in a lathe.
3. Helical gears are used for greater load at higher velocities.
4. Gears are used in different machinery.

VIVA QUESTIONS:-

1. Define gears with classification, advantage and disadvantage. Application.
2. Gear terminology.
3. Law of gearing.
4. Write down the formulae for length of path of contact, length of arc of contact, contact ratio.
5. Formation of teeth profile.
6. About interference and under cutting.
7. Write down the formulae for minimum number of teeth required for wheel to avoid interference.
8. Write down the formulae for minimum number of teeth required for pinion to avoid interference.
9. Write down the formulae for minimum number of teeth required for rack and pinion to avoid interference.

EXPERIMENT No. : -7

AIM: - To study various types of gear trains- simple, compound, reverted, epicyclic and differential.

APPARATUS USED: -. Arrangement of Gear train system.

THEORY: -

1. Definition of. Geart rain
2. Classification of Geartrain
3. Diagrams of different types of Gear train.
4. Working & Construction of different types of Gear train.
5. Advantages & Disadvantages of Gear train
6. Applications of Gear train .
7. Examples of Gear train

GEAR TRAIN :- A gear train is a combination of gears used to transmit motion from one shaft to another. It becomes necessary when it is required to obtain large speed reduction within a small space. The following are the main types of gear trains:

(i) Simple gear train
(ii) Compound gear train
(iii) Reverted gear train
(iv) Planetary gear train

SIMPLE GEAR TRAIN :- A series of gears, capable of receiving and transmitting motion from one gear to another is called a simple gear train. In it, all the gear axes remain fixed relative to the frame and each gear is on a separate shaft.

Train Value = Number of teeth on driving gear / Number of teeth on driven gear

COMPOUND GEAR TRAIN :- When a series of gears are connected in such a way that two or more gears rotate about an axis with the same angular velocity, it is known as compound gear train. In this type, some of the intermediate shafts.

Train Value = Product of Number of teeth on driving gear / Product of Number of teeth on driven gear

REVERTED GEAR TRAIN :- If the axes of the first and last wheels of a compound gear coincide; it is called a reverted gear train. Such an arrangement is used in clocks and in simple lathes where ‘back gear’ is used to give a slow speed to the chuck.

Train Value = Product of Number of teeth on driving gear / Product of Number of teeth on driven gear

PLANETARY OR EPICYCLIC GEAR TRAIN :- When there exists a relative motion of axis in gear train, it is called a planetary or an epicyclic gear train (or simply epicyclic gear or train). Thus in an epicyclic train, the axis of at least one of the gears also moves relative to the frame.

Consider two gear wheels S and P, the axis of which are connected by an arm a. if the arm 'a' is fixed, the wheels S and P constitute a simple train. However, if the wheel s is fixed so that the arm can rotate about the axis of S, the wheel P would also move around S. therefore, it is an epicyclic train.

DIFFERENTIAL GEAR :- When a vehicle takes a turn, the outer wheels must travel farther than the inner wheels. In automobiles, the front wheels can rotate freely on their axis and thus can adapt themselves to the conditions. Both rear wheels are driven by the engine through gearing. Therefore, some sirt of automatic device is necessary so that the two rear wheels are driven at slightly different speeds. This is accomplished by fitting a differential gear on the rear axle.

OBSERVATION & CONCLUSION: -

1. Comparison between simple, compound reverted, epicyclic and differential. Gear train.
2. To calculate the train value.
3. To calculate the speed of any gear.

APPLICATIONS :-

(i) Gear trains are used in automobiles.
(ii) Reverted gear train are used in clock and simple lathe
(iii) Epicyclic gear are used in transmission, computing devices.
(iv) Gears are used in different machinery.

VIVA-QUESTIONS :-

a. Define about gear trains with classification, advantages & disadvantages and applications.
b. Define train value.
c. Define differential gear train with applications.

EXPERIMENT No.:- 8

AIM: - To study various types of steering mechanisms.

APPARATUS USED: -. Steering Mechanism Apparatus.

THEORY: -

1. Definition of. Steering mechanisms
2. Classification of steering mechanisms
3. Diagrams of different types of steering mechanisms
4. Working & Construction of different types of steering mechanisms.
5. Advantages & Disadvantages of steering mechanisms
6. Applications of steering mechanisms.
7. Examples of steering mechanisms

STEERING GEAR :- When an automobile takes turn on a road all the wheels should make concentric circle to ensure that they roll on the road smoothly and there is line contact between the tyres and the surface of the path, preventing the excess wear of the tyres.this is achieved by mounting the two front wheels on two short axles, known as stub axles. The stub axles are pin-jointed with the main front axle which is rigidly attached to the rear axle. Thus the steering is affected by the use of front wheels only.

TYPES OF STERING GEARS :-

There are two main types of steering gears :

1. The Davis steering Gear
2. The Ackermann steering gear

DAVIS STEERING GEAR :- A Davis steering gear has sliding pairs which means more friction and easy wearing. The gear fulfils the fundamental equation of gearing in all the positions. However, due to easy wearing it becomes inaccurate after some time. A davis steering shown in fig. consists of two arms PK and QL fixed to the stub axles PC and QD to form two similar bell crank levers CPK and DQL pivoted at P and Q respectively. A cross link AB, constrained to slide parallel to PQ, is pin-jointed at its ends to two sliders. The sliders S1 and S2 are free to slide on the links PK and QL respectively. During the straight

motion of the vehicle, the gear is in the mid-position with equal inclination of the arms PK and QL with PQ.

As the vehicle turns right, the cross-arm AB also moves right through a distance x from the mod-position as shown in fig. the bell crank levers assume the positions C′ P K′ and D′QL′.

tanα = w/2l (l = wheel base, w = distance between the pivots of front axle)

usual value of w/l is between 0.4 to 0.5 and that of α from 11 to 14 degrees.

ACKERMANN STEERING GEAR :- An Ackermann steering gear has only turning pairs and thus is preferred. Its drawback is that it fulfils the fundamental equation of correct gearing at the middle and the two extreme position and not in all positions. This steering gear consists of a four link mechanism PABQ having four-turning pairs.

Three positions of the correct gearing are-

1. when the vehicle moves straight.
2. when the vehicle moves at a correct angle to the right, and
3. when the vehicle moves at a correct angle to the left.

OBSERVATION & CONCLUSION:- 1. Type of Motion to be named.

VIVA-QUESTIONS :-

i. what do you mean by steering?
ii. What is the difference between the Davis & Ackermann steering gear mechanism?
iii. What is correct fundamental equation of steering gear mechanism?
iv. What do you mean by stub ?

EXPERIMENT NO.:- 9

AIM:- To study the simple and compound screw jack and to find out Mechanical Advantage, V.R. and Efficiency.

APPARATUS USED:- Simple and compound screw jack

THEORY :-

Screw Jack :- It is a device employed for lifting heavy loads with help of a small effort applied at its handle. The loads are usually centrally loaded upon it. Screw jacks of three types :

1. Simple screw jack
2. Compound Screw jack
3. Differential Screw jack

A simple screw jack consists of a nut, a screw square threaded and a handle fitted to the head of the screw. The nut also forms the body of the jack. The load to be lifted is placed on the head of the screw. Here the axial distance between corresponding points on two consecutive threads is known as pitch. If 'p' be the pitch of the screw and 't' is the thickness of thread, then p = 2t.

V.R. = Distance moved by the effort/Distance moved by the load

$= 2\pi l / p$

Now M.A. = W / P

PROCEDURE :-

When we are moving the handle horizontal direction the screw is also moved it attached with screw and load is lifted by pitch of the screw, in one revolution of the handle.

OBSERVATION :-

For single Screw Jack :

S.No.	Load (W) in Nt.	Effort (P) in Nt.	Length of lever	Pitch of screw	V.R.	M.A.	Efficiency

C-+OMPOUND SCREW JACK :-

It is a further improved from of differential screw jack, in which the velocity ratio is further intensified with the help of a geared screw jack, in which the screw is lifted with the help of worm and worm wheel, instead of effort at the end of a lever. Now consider a worm geared screw jack.

Let,

l = Radius of the effort wheel

p = pitch of the screw,

P = effort applied to lift the load,

W = Load lifted and

T = No. of teeth on the worm wheel.

We know that distance moved by effort in one revolution of wheel = $2\pi l$

If the worm is single threaded then the worm wheel move through 1/T revolution. Therefore distance moved by the load = p/T

V.R. = $2\pi l$/ p/T

M.A. = W/P

Efficiency = M.A. / V.R.

For Compound screw jack :

S.No.	**Load (W) in Nt.**	**Effort (P) in Nt.**	**Distance moved by effort**	**Distance moved by load**	**V.R.**	**M.A.**	**Efficiency**

CALCULATION :-

M.A. = W/P

V.R. = Distance moved by effort/Distance moved by load

Efficiency = M.A. / V.R.

PRECAUTIONS :-

1. Rope should not be overlap.
2. Carefully measure pitch of screw.
3. Effort handle move smoothly do not applied suddenly or jerking.
4. Oiling & greasing should be properly.
5. Effort arm measure very carefully.

RESULT :-

CONCLUSION :-

VIVA-QUESTIONS :-

- What is maximum efficiency of screw jack ?
- What is efficiency for non-reversible m/c ?
- If a m/c having an efficiency greater than 50% is known as m/c. reversible or non-reversible m/c.
- Who is m/c self locking m/c ?
- What is the max. M.A. of a lifting m/c ?

EXPERIMENT No.-10

AIM :- Create various type of linkage mechanism in CAD and simulate for motion output and study the relevant effect.

THEORY :- A link can be represented by a vector. These vector are resolved along X and Y-axis. The displacement equation can be obtained by writing equation about X-Y-axis. The vector representing links from closed loop in mech. It is similar to the case of equal forces and a closed polygon of forces.

COMPUTER AIDED ANALISES OF SLIDER CRANK MECHANISM :-

This rep. a general case when axis of motion of slider is offset with respect to the centre of the rotation of the crank. The angle of connecting rod φ is in the negative same as shown in fig.

COMPUTER PROGRAMME FOR A SLIDER CRANK MECHANISM IN C^{++} :-

Computer Programme to find velocity and acceleration for slider crank mechanism.

```
# include<iostream . h>
# include<math . h>
void    main ( )
{
float   q = .36 , s = 1.2 , t = .075 , velq = 20 , accq = 10 , theta = 0.0 , pi ;
pi = 4 * atan (1.0) ;
for     (int     i = 0 ; i < = 12 ; i ++)
{
float   phi = asin ((t-q * sin (theta)) / s) ;
float   al = -2 * q * cos (theta)
float   a2 = q*q+t * t – s*s – 2*t*q*sin (theta) ;
float   a12 = al * al – 4 * a2 ;
float   a21 = sqrt (a12) ;
float   disp = (-al + a21) / 2 ;
```

```
float     velp = (q*velq*sin (phi – theta)) / cos (phi) ;
float     vels = - (velq*q*cos (theta)) / (s*cos (phi)) ;
float     accp = (q*accq*sin (phi – theta) – q*velq*velq*cos (phi-theta) – s*vels*vels) / cos
(phi) ;
float     accs = (s*sin (phi)*vels*vels –
q*cos (theta) * accq + q*sin (theta) *vels*velq) / (s*cos (phi)) ;
cout << ``theta = ``<< (theta * 180 / pi) << ``phi = `` << (phi * 180 / pi) <<``, disp =
``<<disp<<``
velp = ``<< velp<<``, vels = ``<< vels <<``, accp = ``<< accp << ``, accs =
``<<accs<<endl<<endl ;
theta = theta+pi / 6 ;
}
}
```