

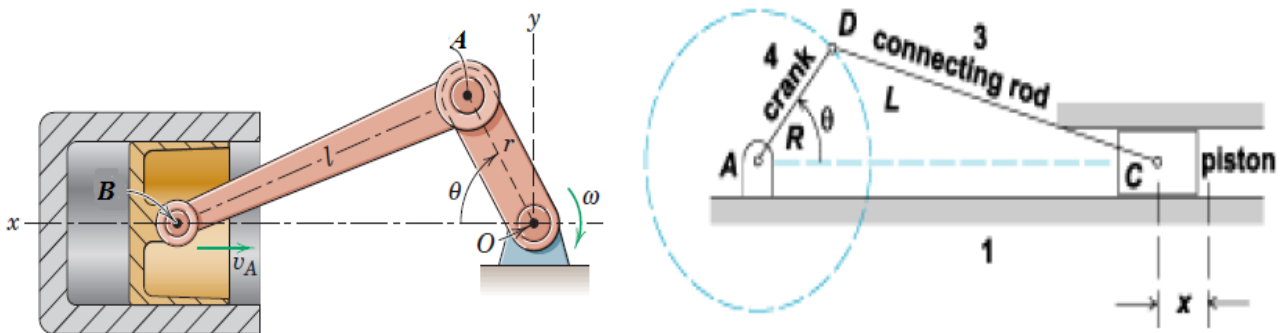
Exp. No. 1 : Analysis of mechanism

Objective

1. To find the equation of motion for a mechanism.
2. Plot a graph of the experimental piston rod displacement versus crank angle
3. Plot on the same graph of the theoretical piston rod displacement versus crank angle.
4. Plot a graph of the theoretical piston rod velocity and acceleration versus crank angle.

1-1 Slider crank Mechanism

A Mechanism is a device which transforms some input motion to some desirable pattern of output motion. The slider-crank mechanism is a simple four bar mechanism in which the rocker is replaced by a slider. Thus the four links in the slider-crank mechanism are: Crank, Coupler/Connecting Rod, Slider and the Ground link. A simple slider-crank mechanism is shown below. A slider crank mechanism converts circular motion of the crank into linear motion of the slider. In order for the crank to rotate fully the condition $L > r$ must be satisfied where r is the crank length is the length of the link connecting crank and slider. A crank is an arm attached at right angles to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. The Slider-Crank mechanism can be used whenever there is a need of converting rotational motion to translational motion. The common applications of slider-crank mechanism are the internal combustion engines, Bull Gear, locomotives, etc.



Apparatus



Procedures

- 1- Set the crank angle at zero degrees with the help of the angular scale available on the crank and record the piston displacement.
- 2- Move the crank angle by 30° and record the displacement.
- 3- Repeat steps 1&2 for one complete revolution of the crank angle.
- 4- Tabulate your results in the table given.
- 5- Calculate the theoretical piston rod displacement, velocity and acceleration in the table.

: Equation of motion

$$X_B = (r + L) - (r \cos \theta + L \cos \phi) \dots\dots\dots 1$$

Where: $r = OA = 25\text{mm}$

$L = AB = 150\text{mm}$

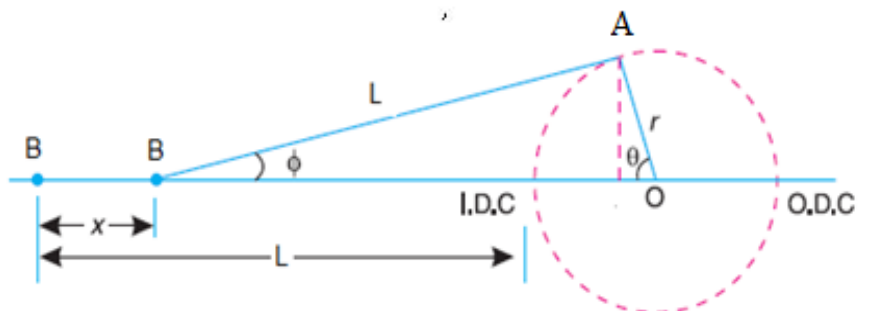
$$r \sin \theta = L \sin \phi \dots\dots\dots 2$$

Let $n = L/r$

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$$X_B = r \left(1 - \cos \theta + \frac{\sin^2 \theta}{2n} \right)$$



$$v_B = w r \left(\sin \theta + \frac{\sin 2\theta}{2n} \right)$$

$$a_B = w^2 r \left(\cos \theta + \frac{\cos 2\theta}{n} \right)$$

Table: Experimental results

Crank Angle (Degrees)	Slider Position (mm) With C.W	Slider Position (mm) With C.C.W
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		
330		
360		

Table: Theoretical results

Crank Angle (Degrees)	Slider Position (mm)	Velocity mm/s	Acceleration mm/s ²
0			
30			
60			
90			
120			
150			
180			
210			
240			

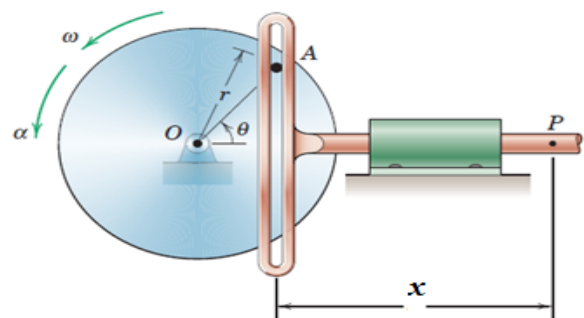
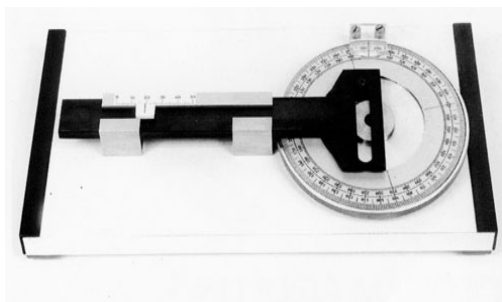
270			
300			
330			
360			

Graph:

5. Plot a graph of the experimental piston rod displacement versus crank angle.
6. Plot on a same graph of the theoretical piston rod displacement versus crank angle.
7. Plot a graph of the theoretical piston rod velocity and acceleration versus crank angle.

1-2 Scotch yoke Mechanism

The Scotch Yoke Mechanism is an example of slider-crank mechanism. It is a mechanism for converting the linear motion of a slider into rotational motion or vice versa. To studies the variation in velocity and acceleration of the slider when the crank is rotated with a constant angular velocity in a slotted link slider-crank mechanism. It is a simple variation of the normal slider-crank with the connecting rod replaced by a slotted link is shown blow.



Procedures

- 1- Set the crank angle at zero degrees, with the help of the angular scale available on the crank, and record the piston displacement.
- 2- Move the crank angle by 30° and record the displacement.
- 3- Repeat steps 1&2 for one complete revolution of the crank angle.
- 4- Tabulate your results in the table given.

: Equation of motion

$$x_B = r - r \cos \theta$$

Let

$$r = OA = 25 \text{ mm}$$

.

$$v_B = r \omega \sin \theta$$

.

$$a_B = r \omega^2 \cos \theta$$

Table: Experimental results

Crank Angle (Degrees)	Slider Position (mm) With C.W	Slider Position (mm) With C.C.W
0		
30		
60		
90		
120		

150		
180		
210		
240		
270		
300		
330		
360		

Table: Theoretical results

Crank Angle (Degrees)	Slider Position (mm)	Velocity mm/s	Acceleration mm/s²
0			
30			
60			
90			
120			
150			
180			
210			
240			
270			
300			
330			
360			

Graph:

- 1- Plot a graph of the experimental piston rod displacement versus crank angle.
- 2- Plot on a same graph of the theoretical piston rod displacement versus crank angle.

- 3- Plot a graph of the theoretical piston rod velocity and acceleration versus crank angle.

1-3 Four bar Mechanism

Mechanisms can be treated kinematic ally (without regard to the forces) if they are lightly loaded or are run at very low speeds. A four-bar linkage, also called a four-bar, is the simplest movable closed chain linkage. It consists of four bodies, called bars or links, connected in a loop by four joints. Generally, the joints are configured so the links move in parallel planes, and the assembly is called a planar four-bar linkage. If the linkage has four hinged joints with axes angled to intersect in a single point, then the links move on concentric spheres and the assembly is called a spherical four-bar linkage. Bennett's linkage is a spatial four-bar linkage with hinged joints that have their axes angled in a particular way that makes the system movable.



Procedures

- 1- Set the crank angle (θ) at zero degrees and record the angular displacement for another angle (α).
- 2- Move the crank angle by 30° and record the angular displacement.
- 3- Repeat steps 1&2 for one complete revolution of the crank.
- 4- Tabulate your results in the table given.

: Equation of motion

$$L^2 = (R \sin \alpha - r \sin \theta)^2 + (G - R \cos \alpha - r \cos \theta)^2$$

Let:

$$L = 160 \text{ mm}$$

$$r = 40 \text{ mm} \quad , \quad R = 100 \text{ mm}$$

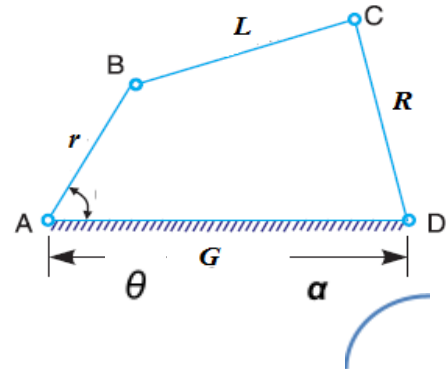


Table: Experimental results

Sr. No.	crank angle (degree) (θ)	Angler displacement (degree) (α)
1	0	
2	30	
3	60	
4	90	
5	120	
6	150	
7	180	
8	210	
9	240	
10	270	
11	300	
12	330	
13	360	

Graph

Plot a graph of the experimental angular displacement (θ) versus crank angle (α) only.

Discussion

- 1. Compare the experimental and theoretical piston rod displacement, velocity and acceleration.*
- 2. How well do your experimental results agree with theory.*
- 3. Where do maximum displacement, velocity and acceleration on the slide occur? Explain your answer.*
- 4. Where dose maximum forces on the drive pin occur? Explain your answer.*
- 5- Tabulate the application of all the mechanism above.*