Government Women College of Engineering, Ajmer

Mechanical Engineering Department

Mid Term Paper

Semester:-IV **22/02/2018**

Subject: - Kinematics of Machines **[Marks-20]**

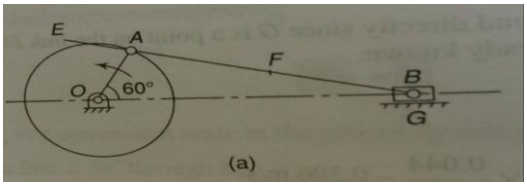
Q1 Define Kinematic Pair. How are the kinematic pair classified? Explain with examples. [1+4]

Q2 With neat sketch, describe various inversion of a four bar mechanism **or** the inversion of double-slider crank. [3]

Q3 Explain with neat sketch: Beam Engine **or** Watt Indicator Mechanism [5]

Q4 In a Slider – crank mechanism, the crank is 480 mm long and rotates at 20 rad/s in the counter clock wise direction. The length of the connecting rod is 1.6m. When the crank turn 60° from the inner dead centre, explain the construction of velocity diagram and determine: [7]

1. Velocity of slider.
2. Velocity of point E located at distance 450mm on the connecting rod extended.
3. Angular velocity of the connecting rod.



Solutions

Ans.1

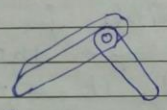
1.3 Kinematic Pair :-

Any connection b/w two links is a joint or a pair, but this pair will also be kinematic pair if the relative motion b/w the link is a constrained motion

Classification of Kinematic Pair

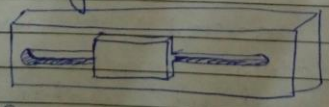
1) According to the type of relative motion

→ Turning Pair :- [Pin joint]



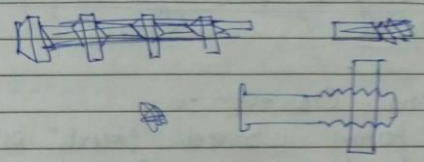
- It is also known as "Revolute Pair"
- Pure Turning
- Dof = 1

→ Sliding Pair

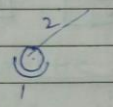


- Pure Translation motion
- Dof = 1

→ Helical Joint



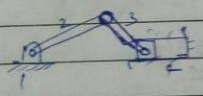
→ Spherical Pair



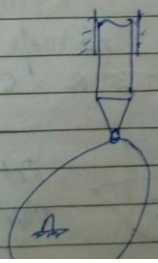
Ball in Socket

b] According to the type of Contact

→ Lower Pair: Describe joints with surface contact.

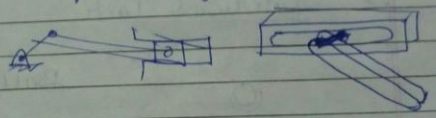


→ Higher Pair - H.P describes joint with point or line contact.

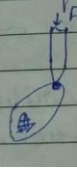


c] According to the type of physical closure

→ Form - Closed :-
A form closed joint is kept together or closed by its geometry.
Ex:-



→ Force - Closed :-
Forceful Contact of links.

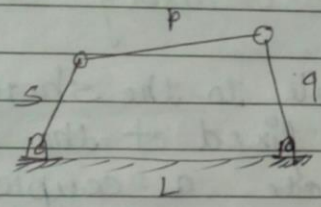


Ans 2.

Kinematic Inversion

The process of fixing different links of a kinematic chain one at a time to produce distinct mechanism is called kinematic inversion. Here the relative motions of the links of the mechanisms remain unchanged.

Inversion of 4-Bar Chain



(i) Crank-Rocker Mechanism

If any of the adjacent links of link s [smallest link] is fixed, s will have a full revolution [crank] & the link opposite to it will oscillates (rocks).

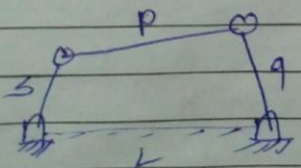


Fig: (a)

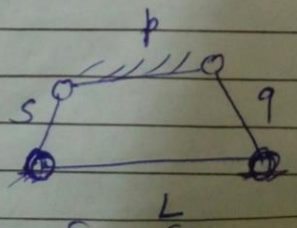


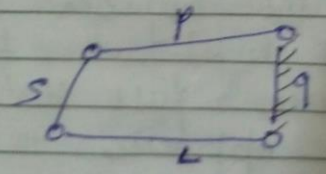
Fig: (b)

In above fig a,
L is fixed
S is Crank
q oscillates

In above fig b
p is fixed
S is Crank
q revolution

(ii) Double-lever Mechanism
[Oscillating- Oscillating Converter

If the link opposite to the shortest li
i.e link q is fixed + the shortes
link S is made a coupler,
the other two link p & L will
oscillate as can be seen in
below fig.



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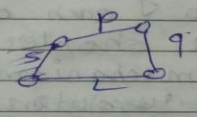
Double Crank / Crank Mechanism
Crank - Crank Mechanism

If the shortest link "S" is fixed, then
both the links p + L rotate through
full circles, the link q also
makes one complete revolution
relative to the fixed link "S".

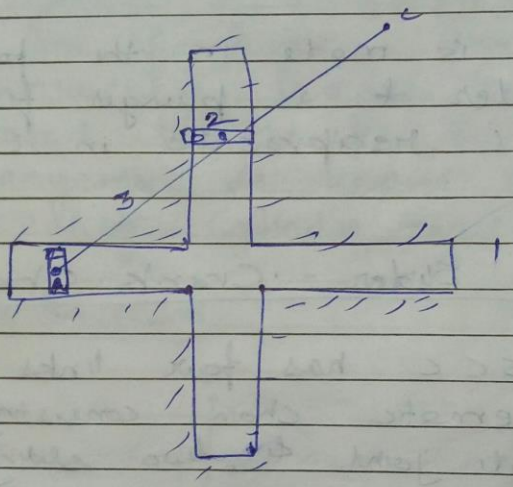


Or

(6) 1st Inversion

This inversion is obtained when the link 1 is fixed & the two adjacent pairs 2,3 & 3,4 are turning pair and the other two pair 1,2 & 4,1 sliding pair.

Appl^{n} :- Elliptical trammel



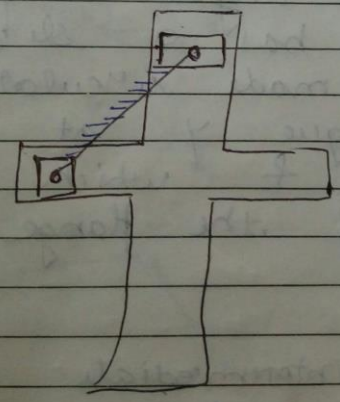
Above fig. shows an elliptical trammel in which the fixed link 1 is in the form of guides for sliders 2 & 4.
With the movement of the sliders, any point C on the link 3, except the midpoint of AB will trace an ellipse on a fixed plate.

(ii) Second Inversion

If any of the slide-blocks of the 1st inversion is fixed, the second inversion of the double-slider crank chain is obtained.
When the link 4 is fixed, the end of B of the crank 3 rotates about A & the link 1 reciprocates in the horizontal dirn

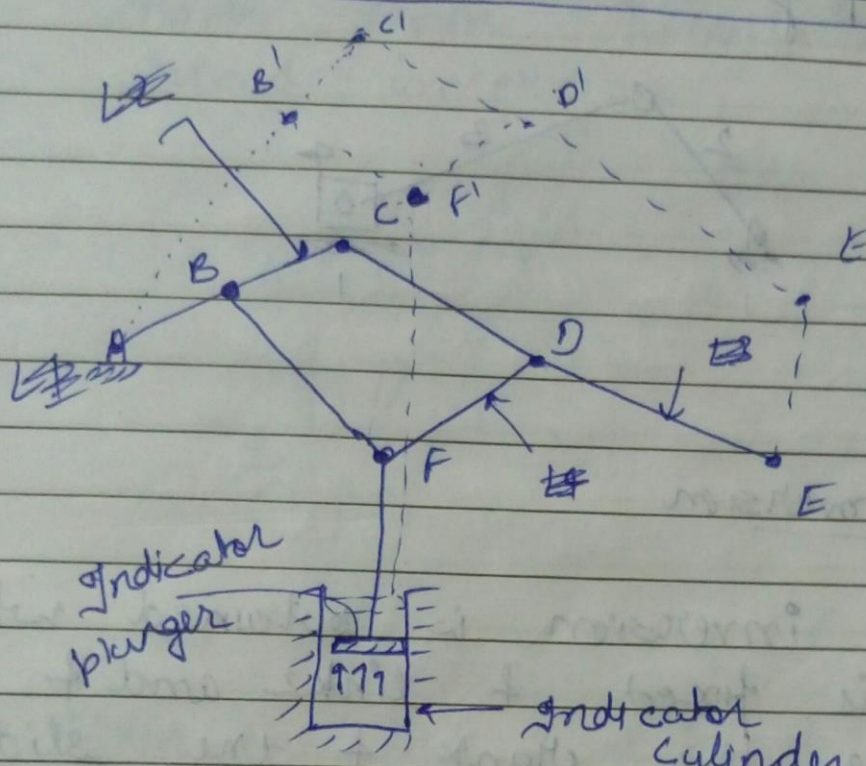
(iii) Third Inversion

The inversion is obtained when the link 3 of the 1st inversion is fixed & the link 1 is free to move.



Ans 3.

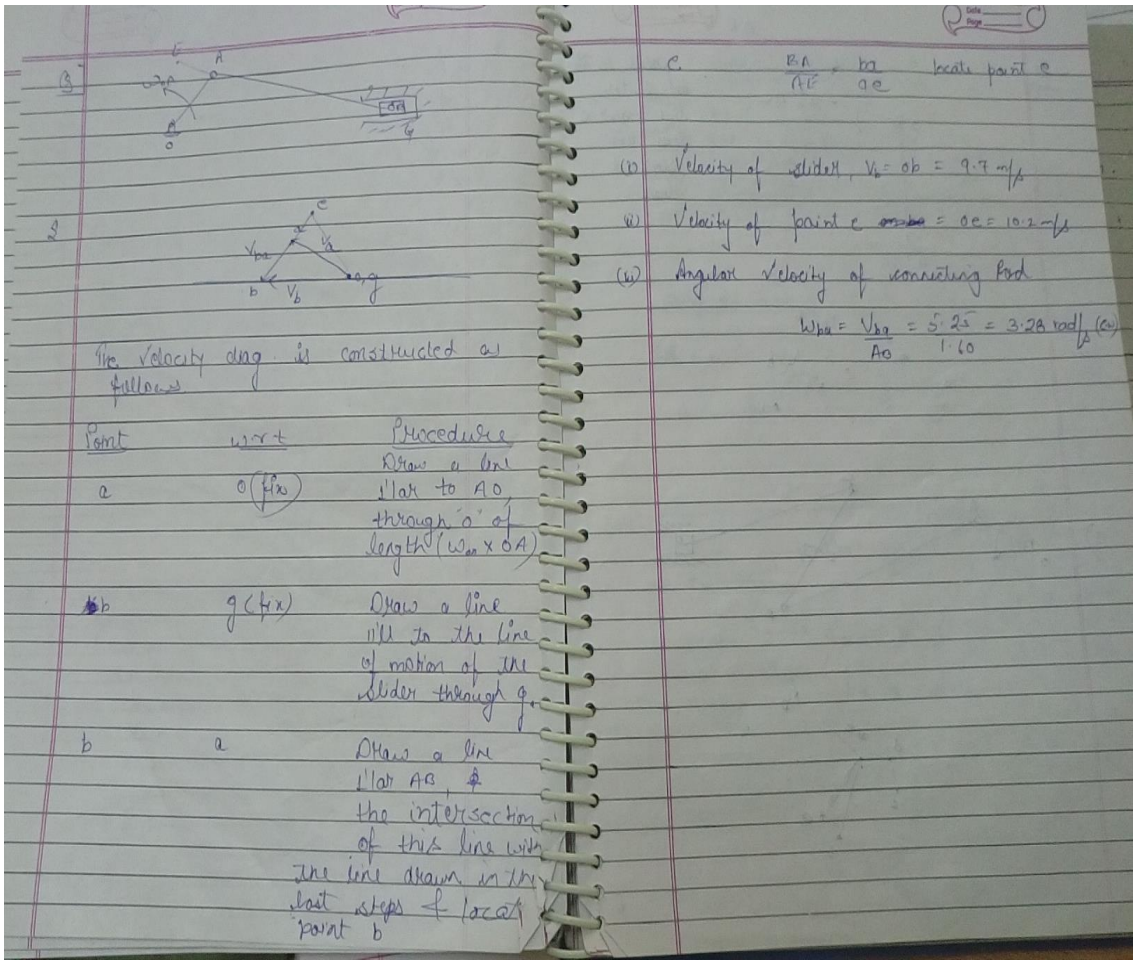
Case IV :- Watt Indicator Mechanism



Watt's linkage is a type of mechanical linkage in which the point E is constrained to travel an approximation: to a straight line.

The initial position of the mechanism is shown in above fig by full lines whereas the dotted lines shows the position of the mechanism when the gas or steam pressure acts on the indicator plunger

Ans 4.



3.

2.

The velocity diag is constructed as follows

Point	w.r.t	Procedure
c	o (fix)	Draw a line ⊥lar to AO through 'o' of length ($\omega_{ao} \times OA$)
b	g (fix)	Draw a line ||l to the line of motion of the slider through g.
b	a	Draw a line ⊥lar AB, the intersection of this line with the line drawn in the last steps & locate point b

c. $\frac{BA}{AE} = \frac{ba}{ae}$ locate point e

(i) Velocity of slider, $V_b = ob = 9.7$ m/s

(ii) Velocity of point e = oe = 10.2 m/s

(iii) Angular velocity of connecting rod

$\omega_{ba} = \frac{V_{ba}}{AO} = \frac{5.25}{1.60} = 3.28$ rad/s (cw)