1. **Velocities in Slider Crank Mechanism**

The slider *A,* in Fig. 1(*a*) *,*is attached to the connecting rod *AB*. *v*B is known in magnitude and direction. The slider reciprocates along the line of stroke *AO*.

 The velocity of the slider *A* (*i*.*e*. *v*A) may be determined by follow:

 

**Fig. 1**

1. From any point *o*, draw vector *ob* parallel to the direction of *v*B (or perpendicular to *OB*) such that *ob* = *v*B = ω.*r*, to some suitable scale, as shown in Fig. 1(*b*).
2. Draw vector *ba* perpendicular to *AB* to represent the velocity of *A* with respect to *B i*.*e*. *v*AB.
3. From point *o*, draw vector *oa* parallel to the path of motion of the slider *A* (which is along *AO* only). The vectors *ba* and *oa* intersect at *a*. Now *oa* represents the velocity of the slider *A i*.*e*. *v*A, to the scale.
4. To find velocity of point *E* $\frac{be}{BE}$ = $\frac{ba}{BA}$ and then find point e in Fig. 1(*b*) and then *v*E.

ωAB = $\frac{v\_{BA}}{AB}$ = $\frac{ab}{AB}$ (Anticlockwise about *A*)

The angular velocity of the sliding member is zero.

1. **Rubbing Velocity at a Pin Joint**

Consider two links *OA* and *OB* connected by a pin joint at *O* as shown in Fig. 2.

 Let ω1 = Angular velocity of the link *OA* or the angular velocity of thepoint  *A* with respect to *O*.

 ω2 = Angular velocity of the link *OB*,

 *r* = Radius of the pin.



Rubbing velocity at the pin joint *O*

 = (ω1 – ω2) *r* , if the links move in the same direction

 = (ω1 + ω2) *r* , if the links move in the opposite direction

**Example: 1**

In a four bar chain *ABCD*, *AD* is fixed and is 150 mm long. The crank *AB* is 40 mm long and rotates at 120 r.p.m. clockwise, while the link *CD* = 80 mm oscillates about *D*. *BC* and *AD* are of equal length. Find the angular velocity of link *CD* when angle *BAD* = 60°.

**Solution**



1. Draw the mechanism as shown in Fig. (*a*) by take suitable scale, let 20mm = 1 cm in paper
2. Find  *v*BA *= v*B = ωBA × *AB*

 *N*BA = 120 r.p.m. , ωBA = 2π × 120/60 = 12.568 rad/s

 *v*B = 12.568 × 40 = 503 mm/s

1. Draw the velocity diagram as shown in Fig. (*b*) by take suitable scale, let 503 mm/s = 4 cm in paper
2. From point *a,d* draw line *ab* = 4 cm ⊥ link *AB* (vector *ab* = *v*B), Fig. (*b*).
3. From point *b* draw line *bc* ⊥ link *BC*.
4. From point *a,d* draw line *dc* ⊥ link *DC* intersecting the line *bc* at *c*.
5. Measure *dc* from Fig. (*b*)

*dc* = 3 cm in paper, *v*CD = *v*C = vector *dc*

*v*C = 3 × $\frac{503}{4}$ = 378 mm/s

 We know that *CD* = 80 mm

 $ ∴$ Angular velocity of link *CD*, ωCD = $\frac{v\_{CD}}{DC}$ = $\frac{378}{80}$ = 4.72 rad/s

 (clockwise about *D*) **Ans.**

**Example: 2**

The mechanism, as shown in Figure below, has the dimensions of various links as follows :

*AB* = *DE* = 150 mm ; *BC* = *CD* = 450 mm ; *EF* = 375 mm.

 The crank *AB* makes an angle of 45° with the horizontal and rotates about *A* in the clockwise direction at a uniform speed of 120 r.p.m. The lever *DC* oscillates about the fixed point *D*, which is connected to *AB* by the coupler *BC*. The block *F* moves in the horizontal guides, being driven by the link *EF*. Determine:

1. velocity of the block *F*,
2. angular velocity of *DC*, and
3. rubbing speed at the pin *C* which is 50 mm in diameter.

**Solution**:



1. Draw the mechanism, to some suitable scale, as shown in Fig.(*a*). let 100 mm = 1 cm in paper
2. Find  *v*BA *= v*B = ωBA × *AB*

 *N*BA = 120 r.p.m. , ωBA = 2π × 120/60 = 12.568 rad/s

 *v*BA = *v*B = 12.568 × 150 = 1.885 m/s

1. Draw the velocity diagram, as shown in Fig. (*b*), since the points *A* and *D* are fixed. Now from point *a*, draw vector *ab* ⊥ *AB*, to some suitable scale.

let 1.885 m/s = 3 cm in paper

vector *ab = v*B

1. From point *b* draw vector *bc* ⊥ *BC* to represent *v*CB, and from point *d*, draw vector *dc* ⊥ *DC* to represent *v*CD = *v*C. The vectors *bc* and *dc* intersect at *c*.
2. Since the point *E* lies on *DC*,

$\frac{dc}{DC}$ = $\frac{de}{DE}$

From Fig. (*b*) measure *dc* = 3.6 cm in paper

*de* = 3.6 × $\frac{150}{450}$ = 1.2 cm

1. From point *e*, draw vector *ef* ⊥ *EF* to represent *v*FE, and from point *d* draw vector *df* // to the path of motion of *F*, which is horizontal, to represent *v*F. The vectors *ef* and *df* intersect at *f*.

From Fig. (*b*) measure *df* = 1.1 cm in paper

 *v*F = vector *df* = 1.1 × $\frac{1.885}{3}$ = 0.7 m/s **Ans.**

1. *v*CD = vector *dc* = 3.6 × $\frac{1.885}{3}$ = 2.26 m/s

 ωDC = $\frac{v\_{CD}}{DC}$ = $\frac{2.26}{0.45}$ = 5 rad/s ….. (Anticlockwise about *D*) **Ans.**

1. From velocity diagram, we find that *v*CB ,

 By measurement *bc* = 3.6 cm in paper

*v*CB = vector *bc* = 3.6 × $\frac{1.885}{3}$ = 2.26 m/s

 ωCB = $\frac{v\_{CB}}{BC}$ = $\frac{2.26}{0.45}$ = 5 rad/s ….. (Anticlockwise about *B*)

 We know that rubbing speed at the pin *C*

 = (ωCB – ωCD) *r*C = (5 – 5) 0.025 = 0  **Ans.**

Home work

In a mechanism shown in Figure below, the crank *OA* is 100 mm long and rotates clockwise about *O* at 120 r.p.m. The connecting rod *AB* is 400mm long.

 At a point *C* on *AB*, 150 mm from A, the rod *CE* 350 mm long is attached. This rod *CE* slides in a slot in a trunnion at *D*. The end *E* is connected by a link *EF*, 300 mm long to the horizontally moving slider *F*.

 For the mechanism in the position shown, find **1.** velocity of F, **2.** velocity of sliding of *CE* in the trunnion, and  **3.** angular velocity of *CE*.



Answers

1. *v*f = 0.53 m/s.
2. Velocity of sliding of *CE* in the trunnion = *v*D = 1.08 m/s.
3. ωCE = 1.26 rad/s.