UNIT - 2.

1) In a four bar link mechanism - AB = 50mm, BC = 66mm, CD = 56mm, AD = 100mm. at an instant when ∠DAB = 60°. AB has angular velocity of 10.5 r/s in Aclockwise. find.

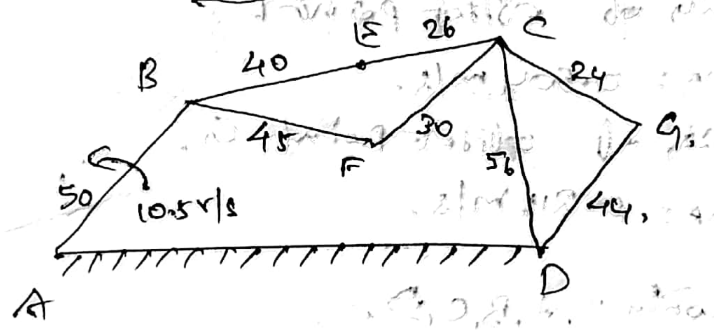
1) velocity @ C
2) velocity of point E on link BC when BE = 40mm.
3) angular velocity of link BC & CD.
4) velocity of an offset point F on the link BC if BF = 45mm, CF = 30mm. & BCF is read clockwise.

[AU; M/J - 2013].

Given:- AB = 50mm, BC = 66mm, CD = 56mm, AD = 100mm
∠DAB = 60°, ω_{BA} = 10.5 r/s.

Sol.

step - 1. Configuration diagram.



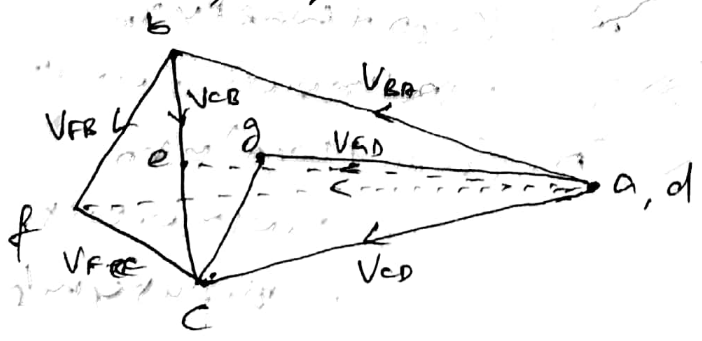
Step 2

velocity of input link ω_{BA} = 10.5 r/s.

AB V_{BA} = $\omega_{BA} \times AB$ = 10.5 × 0.05 = 0.525 m/s

Step 3

velocity diagram. 1cm = 0.1 m/s.



Scanned by CamScanner

$$\frac{V_{BE}}{V_{BC}} = \frac{BE}{BC}$$

$$V_{BE} = V_{BC} \times \frac{BE}{BC} = 0.84 \times \frac{40}{66} = 0.206 m/s.$$

Step-4 velocity of point C.

1) V_{CA} = vector ca = 0.393 m/s

2) velocity @ E

V_{EB} = 0.206 m/s.

3) Angular velocity of link BC & CD.

V_{BC} = bc = 0.341 m/s

V_{CD} = 0.393 m/s.

$$\omega_{BC} = \frac{V_{BC}}{BC} = \frac{0.341}{0.066} = 5.17 r/s.$$

$$\omega_{CD} = \frac{V_{CD}}{CD} = \frac{0.393}{0.056} = 7.01 r/s$$

Step 4) velocity of offset point F.

V_{FA} = 0.504 m/s.

5) velocity of offset point G.

V_{GA} = 0.315 m/s.

Rubbing velocity · A, B, C, D.

velocity of Rubbing at pin B = $(\omega_{AB} + \omega_{B}) r_B$

$= (0.5 + 5.17) \times 0.040$

$= 0.2268 m/s.$

pin C = $(\omega_{CD} + \omega_{BC}) \times r_C$

$= (7.01 + 5.17) \times 0.025 = 0.3045 m/s.$

A = $(\omega_{AD} + \omega_{AB}) \times r_A$

$= 10.5 \times 0.03 = 0.315$

D = $(\omega_{AD} + \omega_{CD}) \times r_D$

$= 7.01 \times 0.035$

$= 0.2454 m/s$

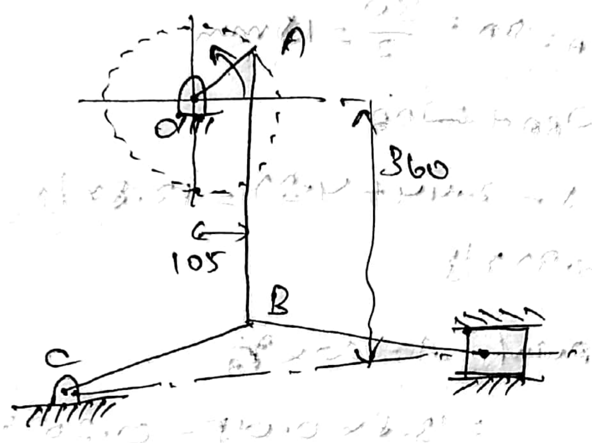
9). In a toggle mechanism as shown in fig. The slider D is constrained to move on a horizontal path. The crank OA is rotating in the ACD. at 180rpm.

Dimensions. OA = 180, CB = 240, AB = 360, BD = 540,

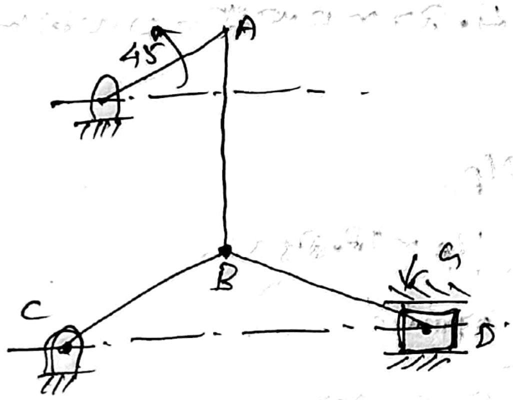
1) velocity D, 2) Angular velocity AB, CB, BD,

3) rubbing on pins of dia 30mm A & D.

(AU. Oct/Nov 2002, ND - 2004)



Sol. Configuration diagram



Step 2

$N_{OA} = 180$

$\omega_{OA} = \frac{2\pi N_{OA}}{60}$

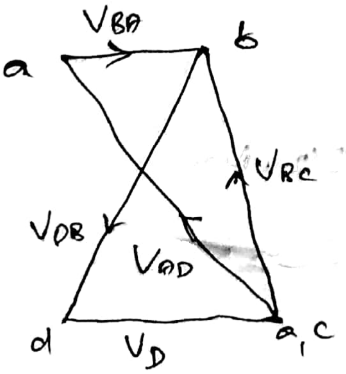
$= \frac{2\pi \times 180}{60}$

$= 18.85 \text{ r/s}$

$V_{OA} = \omega_{OA} \times OA$

$= 18.85 \times 0.18 = 3.4 \text{ m/s}$

Step-3. 1cm = 1 m/s



Step-4

1) velocity of slider D

$V_D = V_{CD} = cd = 2 \text{ m/s}$

2) ω_{AB}, CB, BD

$V_{BA} = 0.88 \text{ m/s}$

$V_{BC} = 2.88 \text{ m/s}$

$V_{BD} = 2.36 \text{ m/s}$

$\omega_{AB} = \frac{V_{BA}}{AB} = \frac{0.88}{0.36} = 2.44$ r/s

$\omega_{CB} = \frac{V_{BC}}{BC} = \frac{2.85}{0.24} = 11.875$ r/s

$\omega_{BD} = \frac{V_{DB}}{BD} = \frac{2.36}{0.54} = 4.37$ r/s

velocity at rubbing points.

$d_D = 30$mm.

radii A & D $\quad r_A = r_D = \frac{30}{2} = 15$ mm.

$= \omega_{BC} - \omega_{BA} + \omega_{DB}$

$= 11.875 - 2.44 + 4.37 = 13.8$ r/s

$\omega_{DB} = 4.37$ r/s

velocity @ rubbing point A $= \omega \times r_A$

$= 13.8 \times 0.015 = 0.207$ m/s.

$D = \omega_{DB} \times r_D$

$= 4.37 \times 0.015 = 0.065$ m/s.

4) Torque applied.

P I/P = P O/P.

$A = T_A \times \omega_{OA} = T_A \times 18.85$ Nm

T_A = Torque applied

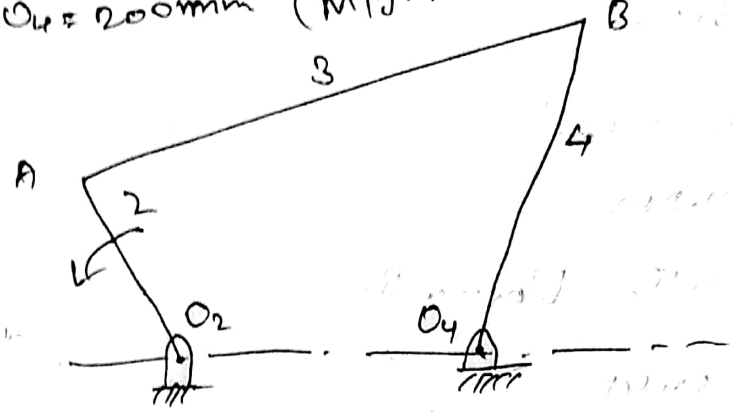
$D = F_D \times V_D = 2000 \times 2 = 4000$ Nm.

P I/P = P O/P

$18.85\, T_A = 4000$

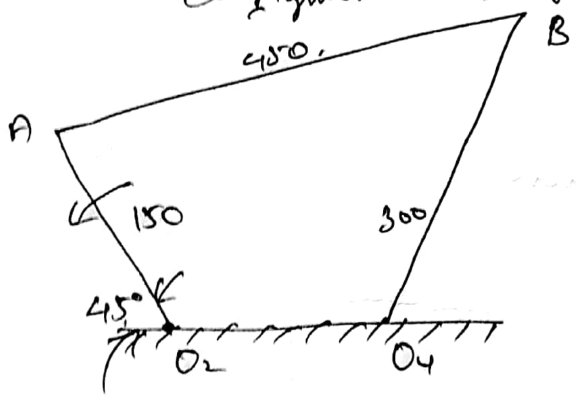
$T_A = \frac{4000}{18.85} = 212$. Nm

3). For Fourbar linkage shown in fig
1) acceleration of A & B,
2) angular acceleration of links 3 & 4.
Crank 2 has a constant velocity, $\omega_2 = 200$ r/s.
ACW. linkage $AO_2 = 150$ mm, BA = 450 mm, $BO_4 = 300$ mm
$O_2O_4 = 200$ mm (M/J. 2006, N/D. 2006, A/M. 2012.)



Procedure

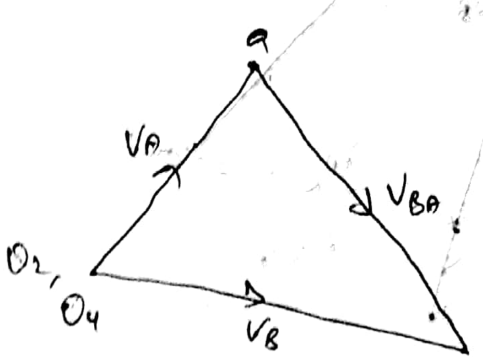
Configuration diagram. (1 cm = 100 mm)



velocity of input link AO_2.

AO_2. $\omega_{AO_2} = 200$ r/s

$= \omega_{AO_2} \times AO_2 = 200 \times 0.15 = 30$ m/s



velocity diagram.

step 3 velocity diagram. 1 cm = 75 r/s.

step 4 velocity of various links.

V_{BA} = vector ab = 3.9 m/s.

V_{BO_4} = ob = 3.9 m/s

step 5 in table.

link O_2O_4 fixed.

l = 0.2 m,

O_2A l = 0.15, V_{O_2A} = 3.

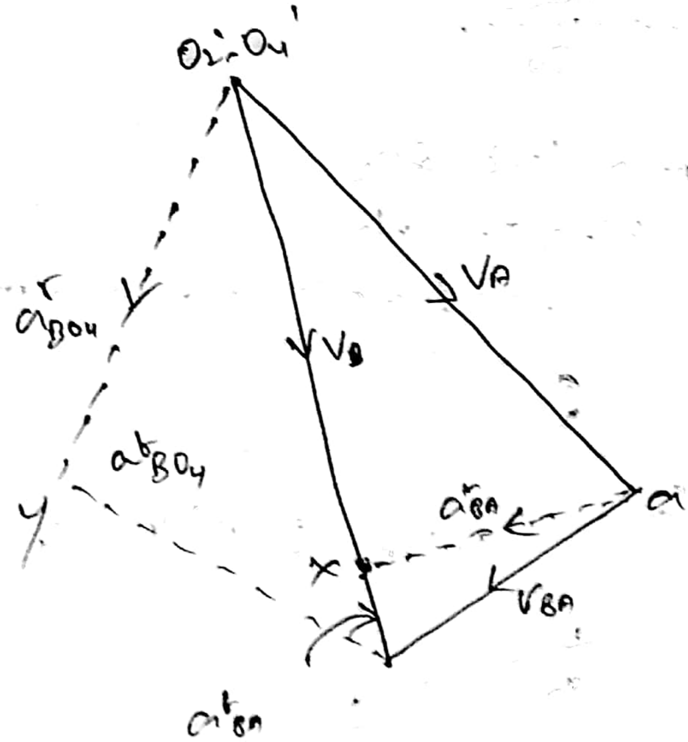
AB = l = 0.45

V_{BA} = 3.9

BO_4 = l = 0.3

V_{O_4B} = 3.9

acceleration diagram



4)

In the mechanism, as shown in fig. crank OA, rotates at 20rpm anticlockwise & gives motion to sliding blocks B & D. The dimensions of various links are OA = 300mm, AB = 1200mm, BC = 480mm, CD = 450mm

determine 1) velocity B & D. 2) Angular velocity CD. 3) linear acceleration of D. 4) angular acceleration CD.

(A/M. 2005, M/J. 2006.)

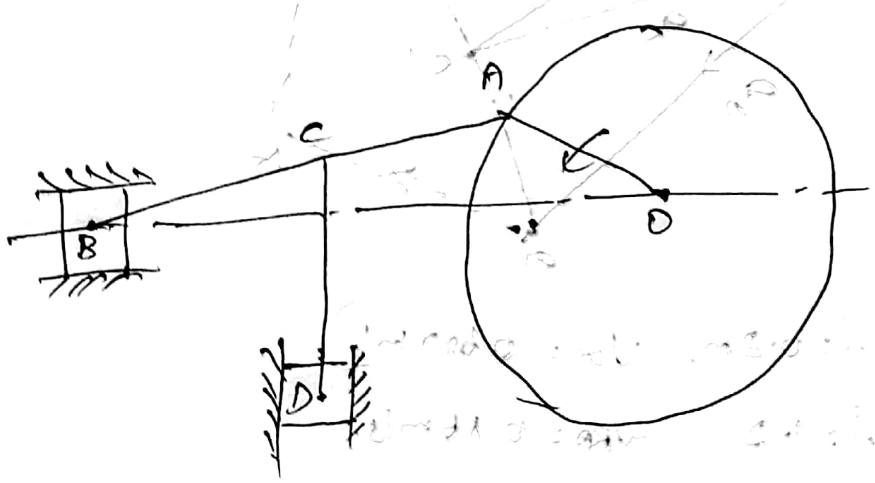
Given.

N_{OA} = 20 rpm, ACW, OA = 300 mm, AB = 1200

BC = 450mm, CD = 480 mm.

Sol.

step 1 Configuration Diagram. (1 cm = 200mm)



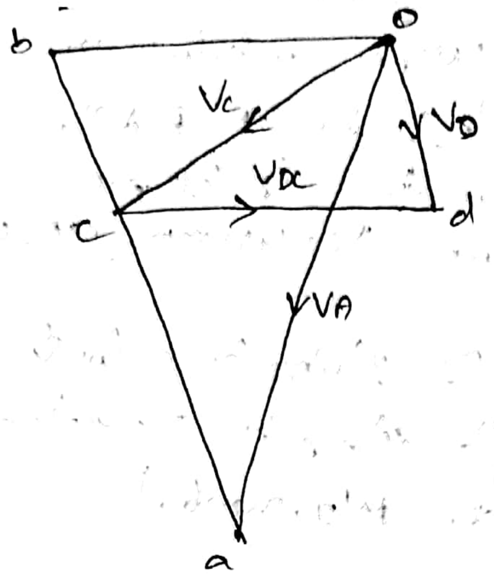
step. 2.

$$\omega_{OA} = \frac{2\pi N_{OA}}{60} = \frac{2\pi \times 20}{60} = 2.09 \, r/s.$$

velocity = $V_{OA} = \omega_{OA} \times OA$

$= 2.09 \times 0.3 = 0.627$ m/s

step 3 velocity diagram scale (1cm = 0.2 m/s) step 4



Velocity of slider

V_B = Vector Ob = 0.42 m/s

V_D = 0.27 m/s.

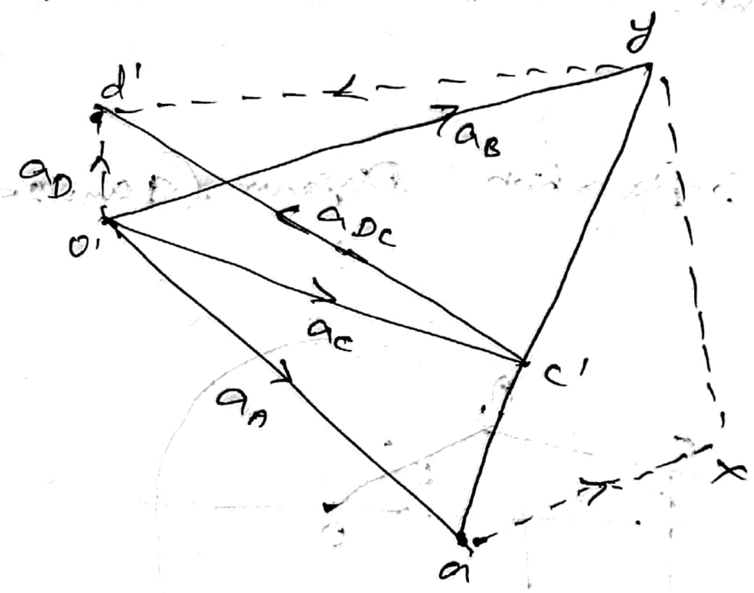
V_{DC} = 0.37 m/s

V_{BA} = 0.56 m/s.

$\omega_{CD} = \frac{V_{DC}}{CD} = \frac{0.37}{0.45} = 0.82$ r/s

Step - 5.

Acceleration



link OA	l = 0.8 m,	V_{OA} = 0.627 m/s.
AB	l = 1.2	V_{BA} = 0.56 m/s.
CD	l = 0.45	V_{DC} = 0.37 m/s.
Slider B	l = ?	V_B = 0.42 m/s
" D	l = ?	V_D = 0.27 m/s

5) In a reciprocating engine mechanism. the lengths of the crank & connecting rod are 150mm & 600mm respectively. The crank position is 60° from inner dead centre. The crank shaft speed is 450 rpm. clockwise. using analytical method.

1) velocity of piston. 2) acceleration

3) Crank angle for max velocity.

[Nov/Dec-2012, 2017]

Given:

$r = 150\,mm = 0.15\,m$, $l = 600\,mm = 0.6\,m$, $N = 450\,rpm$

$\theta = 60°$,

Sol.

$$\omega = \frac{2\pi N}{60} = \frac{2\pi\, 450}{60} = 47.12\,r/s.$$

oblique ratio $n = l/r = \frac{0.6}{0.15} = 4$

1) velocity of piston. (V_p)

$$V_p = r\omega\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$$

$$= 0.15 \times 47.12\left[\sin 60 + \frac{\sin(2\times 60)}{2\times 4}\right] = 6.8\,m/s$$

2) Accelerat of piston (a_p)

$$a_p = \omega^2 r\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$$

$$= 47.12^2 \times 0.15\left[\cos 60° + \frac{\cos(2\times 60)}{4}\right] = 124.89\,m/s^2$$

3) Crank angle for max velocity of piston.

$$V_p = \omega r\left[\sin\theta + \frac{\sin 2\theta}{n}\right]$$

$$\frac{dv_p}{d\theta} = 0 \quad (or) \quad d/d\theta\left[\omega r\left(\sin\theta + \frac{\sin 2\theta}{n}\right)\right] = 0$$

(or) $\omega r\left[\cos\theta + \frac{2\cos 2\theta}{2n}\right] = 0$

$n\cos\theta + 2\cos^2\theta - 1 = 0$

$2\cos^2\theta + 4\cos\theta - 1 = 0$

$\cos\theta = \frac{-4 \pm \sqrt{4^2 - 4(2)(-1)}}{2\times 2} = 0.225$

$\theta = \cos^{-1}(0.225) = 77°$

Sub θ value

$v_{p(max)} = 47.12 \times 0.15\left(\sin 77° + \sin\left(\frac{2\times 77}{2\times 4}\right)\right)$

$= 7.227\,m/s.$