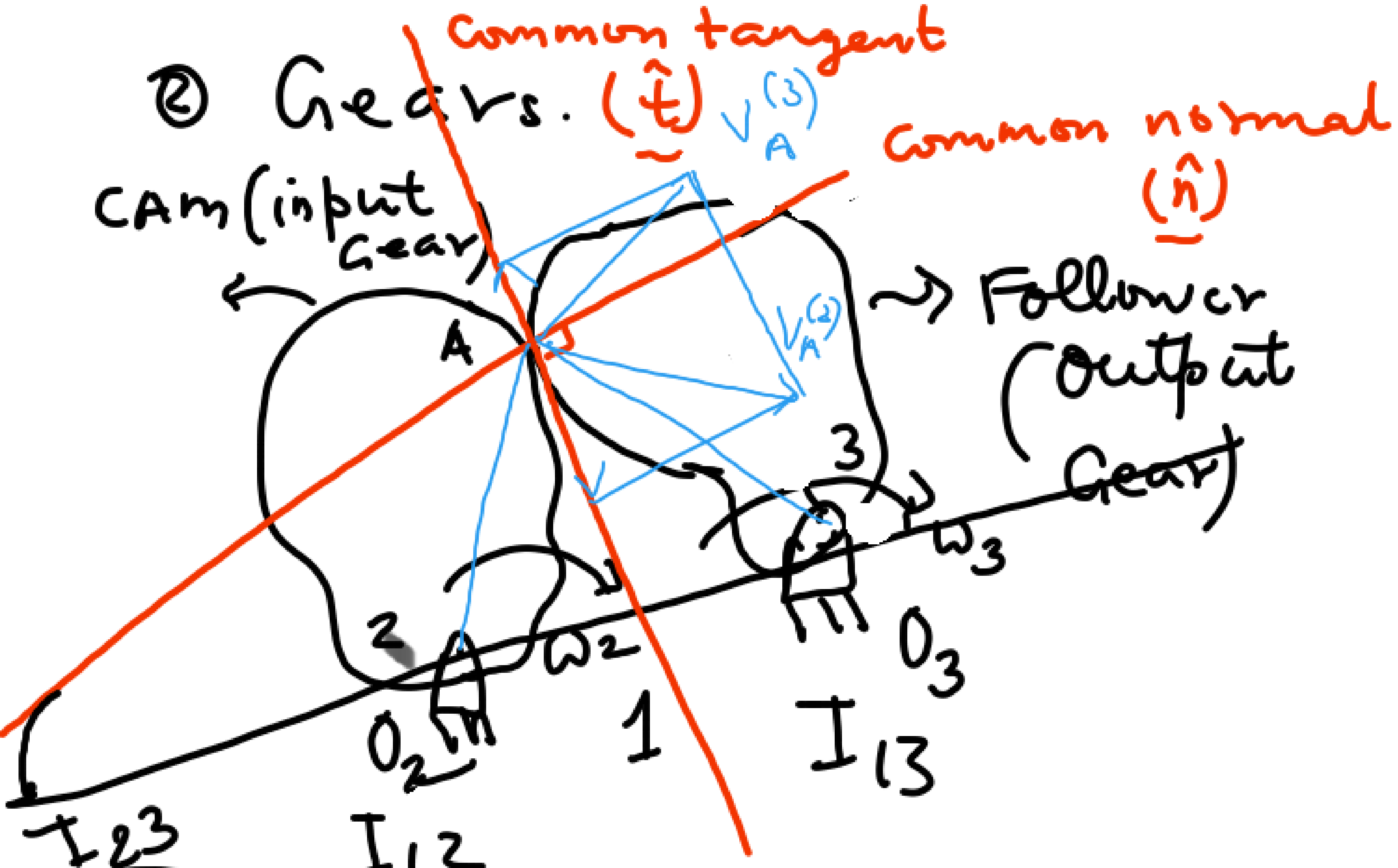
Mechanisms with higher pairs

① CAM and follower

② Gears.



Intersection

A } Point contact

Degree of freedom

$$F = 3(n-1) - 2j - h$$

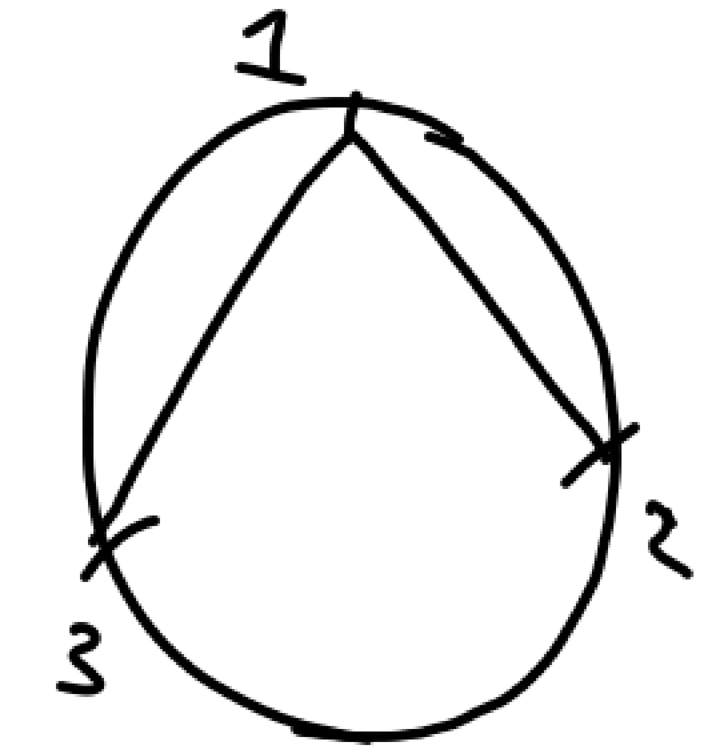
$$= 3(3-1) - 2\times 2 - 1$$

$$= 6 - 4 - 1$$

$$\boxed{F = 1}$$

At point A, sliding occurs between bodies 2 and 3.

Calculation of instantaneous Centre of velocities (ICV's)



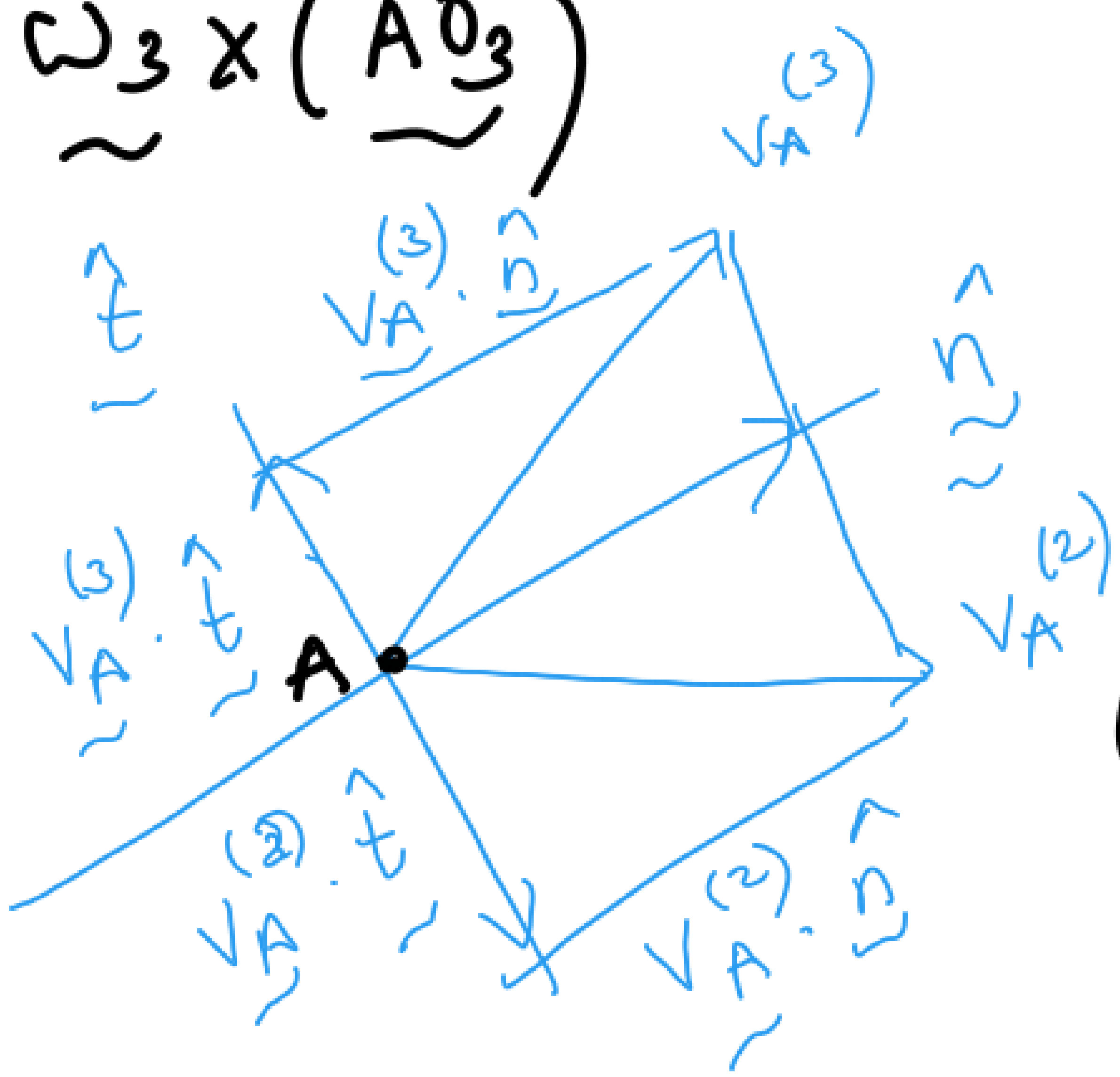
As per Aronhold Kennedy theorem, I_{23} has to lie on line joining O_2 and O_3.

Velocity of pt. A :

$$\underset{\sim}{V_A^{(2)}} = \underset{\sim}{\omega_2} \times \left(\underset{\sim}{AO_2}\right)$$

(Velocity w.r.t Body 2)

$$\underset{\sim}{V_A^{(3)}} = \underset{\sim}{\omega_3} \times \left(\underset{\sim}{AO_3}\right)$$



$$\underset{\sim}{V_A^{(2)}} \cdot \underset{\sim}{\hat{n}} = \underset{\sim}{V_A^{(3)}} \cdot \underset{\sim}{\hat{n}} \quad (*)$$

Necessary to maintain contact and avoid

(a) gap

(b) overlap

between bodies ② and ③.

(*) can be used to deduce relationship between ω_2 and ω_3

$$\underset{\sim}{V_A^{(2)}} - \underset{\sim}{V_A^{(3)}} = \left[\left(\underset{\sim}{V_A^{(2)}} - \underset{\sim}{V_A^{(3)}}\right) \cdot \underset{\sim}{\hat{t}}\right] \underset{\sim}{\hat{t}}$$

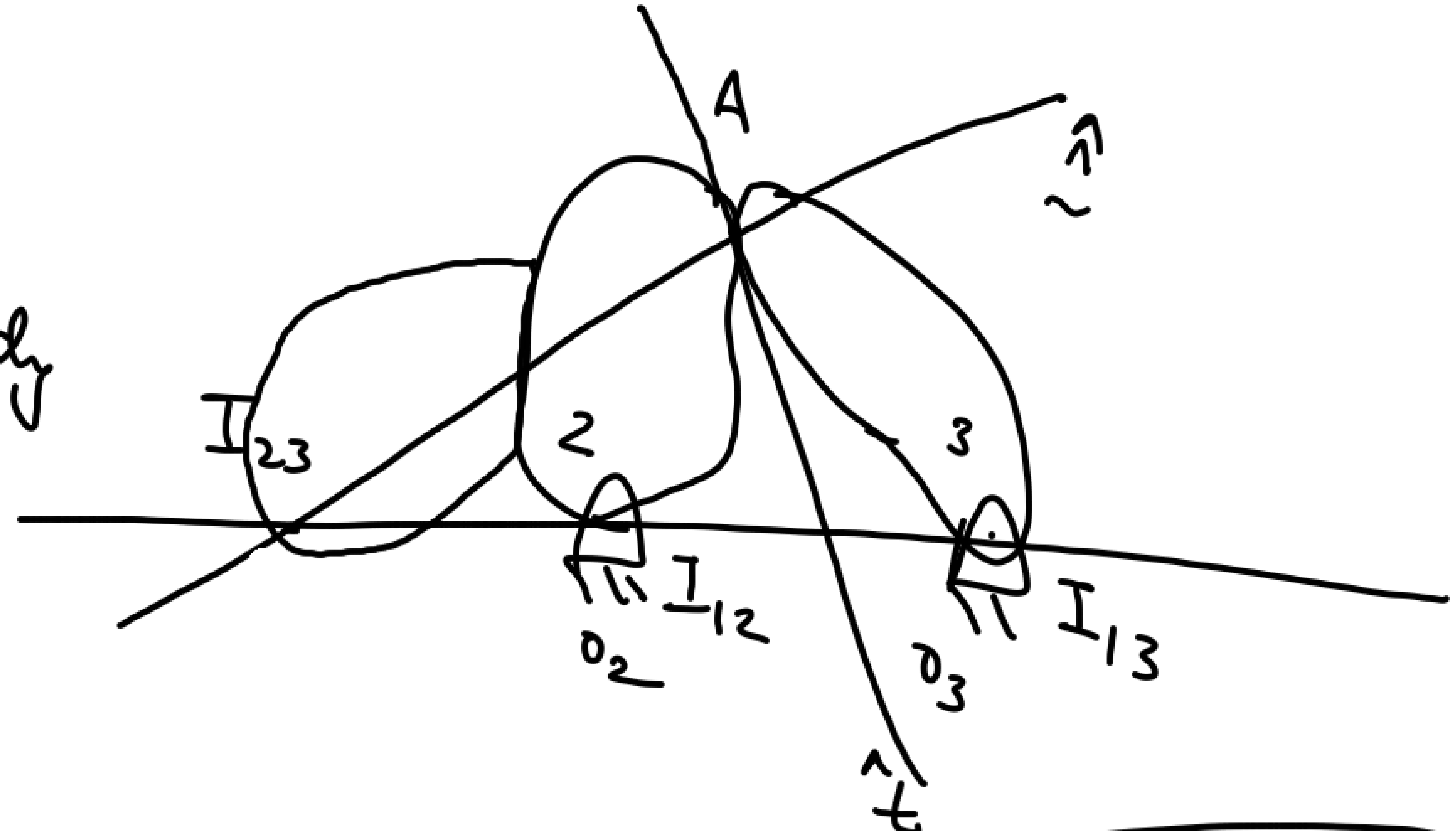
So the relative velocity between bodies 2 and 3 at point A is along the common tangent.

W.r.t I_{23}, point A as part of ?,

will rotate.

So relative velocity should be perpendicular to $(I_{23}A)$

So this implies that $I_{23}A$ should coincide with the common normal.



Velocity ratio ; $\boxed{\dfrac{\omega_3}{\omega_2} = \dfrac{(I_{23}O_2)}{(I_{23}O_3)}}$

$$V_{I_{23}}^{(2)} = \omega_2 (I_{23}O_2)$$

$$V_{I_{23}}^{(3)} = \omega_3 (I_{23}O_3)$$

For CAMS, location of I_{23} and consequently, the velocity ratio will keep on changing.

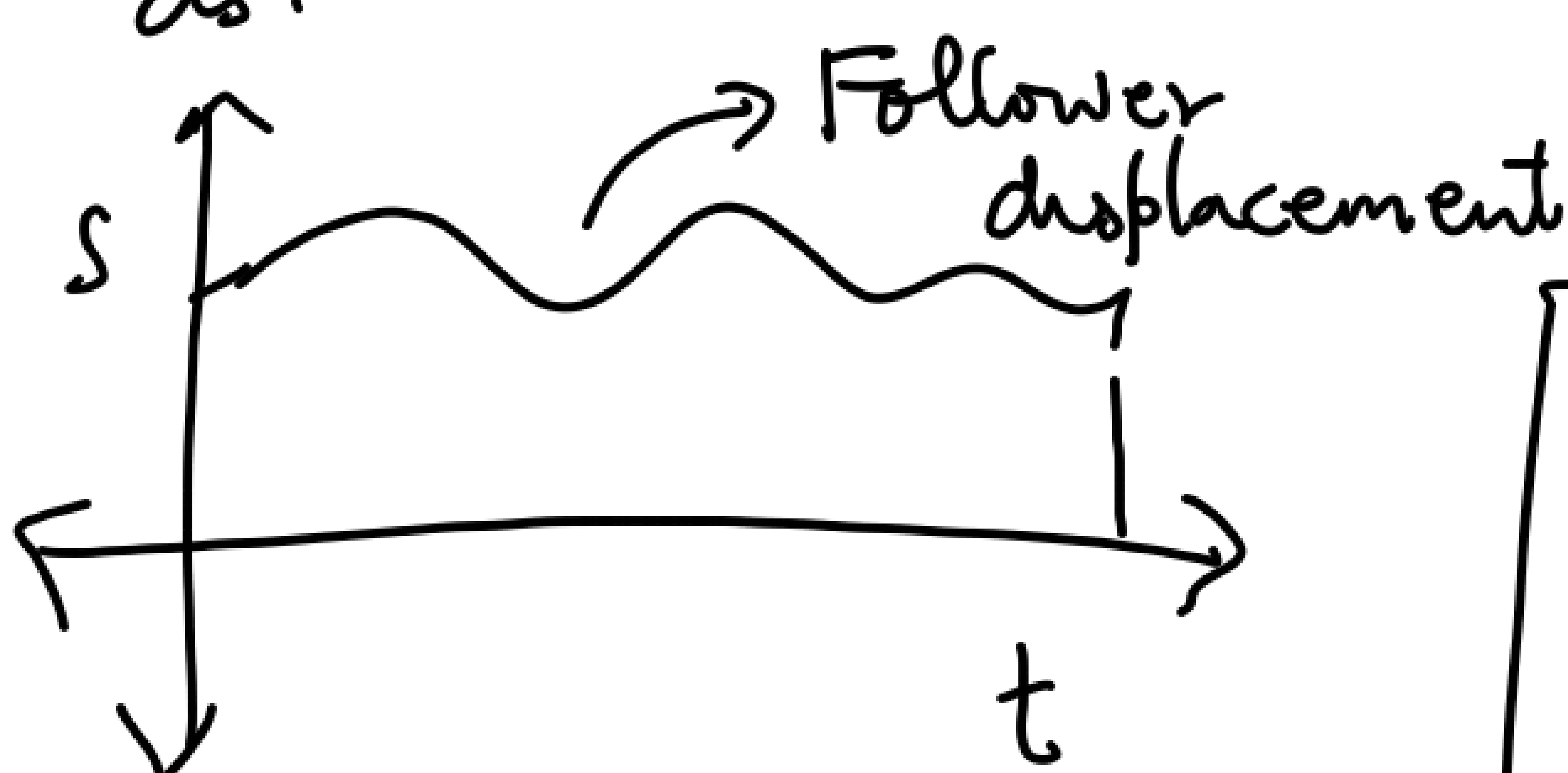
For gears, the surface profile is chosen such that I_{23} is also fixed.

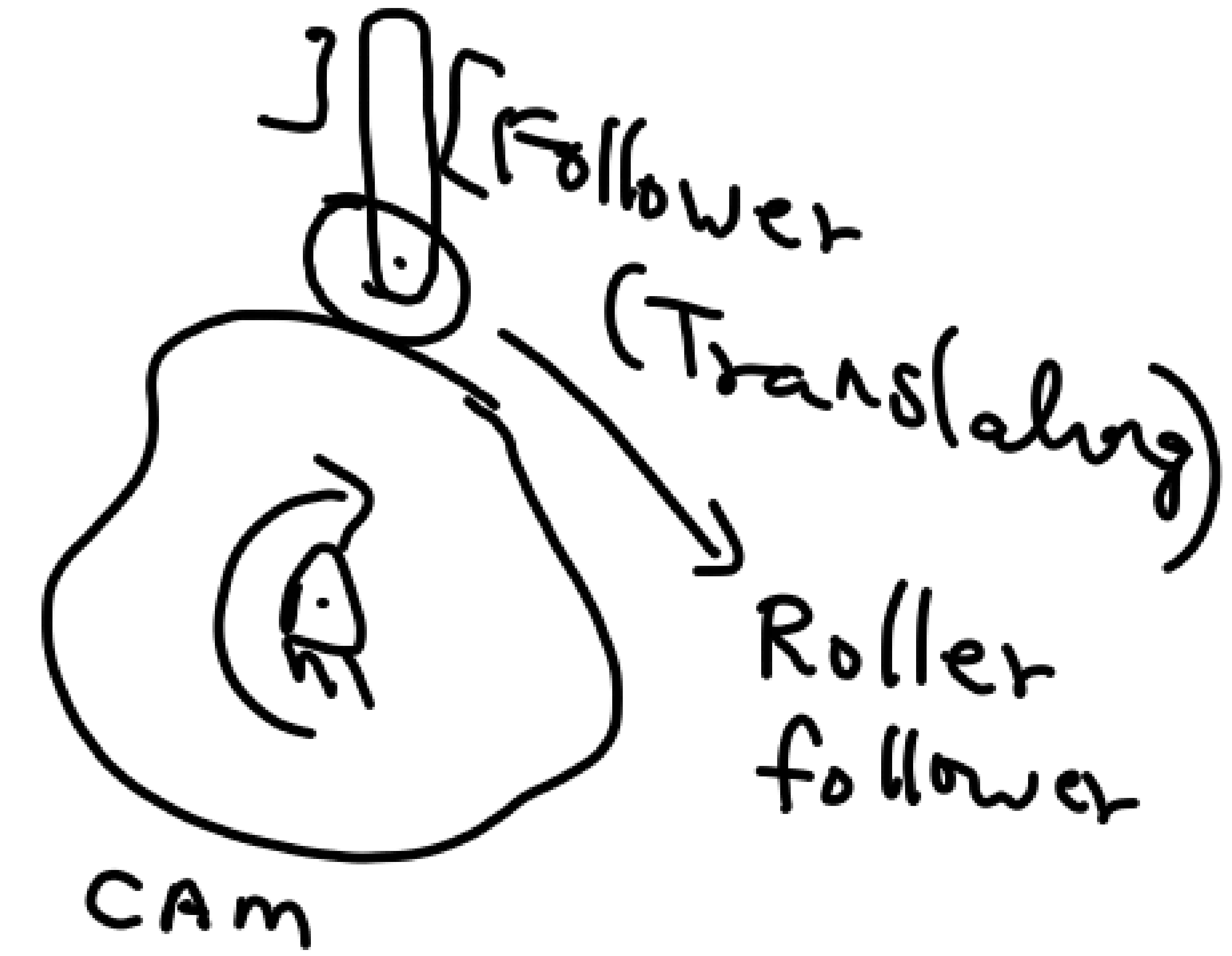
So we are able to achieve constant speed ratio.

CAM and follower

CAM is the input link, rotating at constant speed.

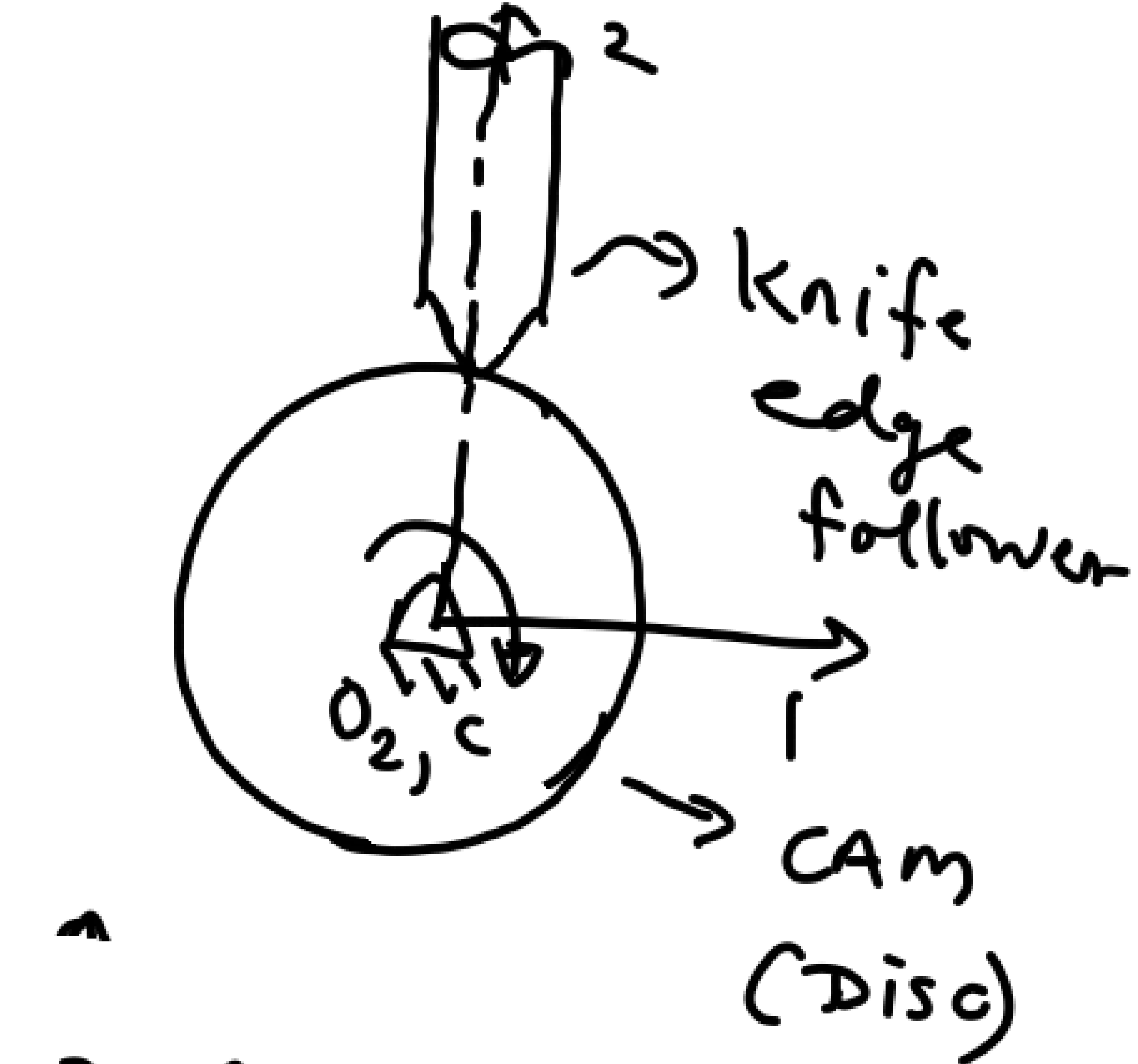
Follower usually follows the displacement as:

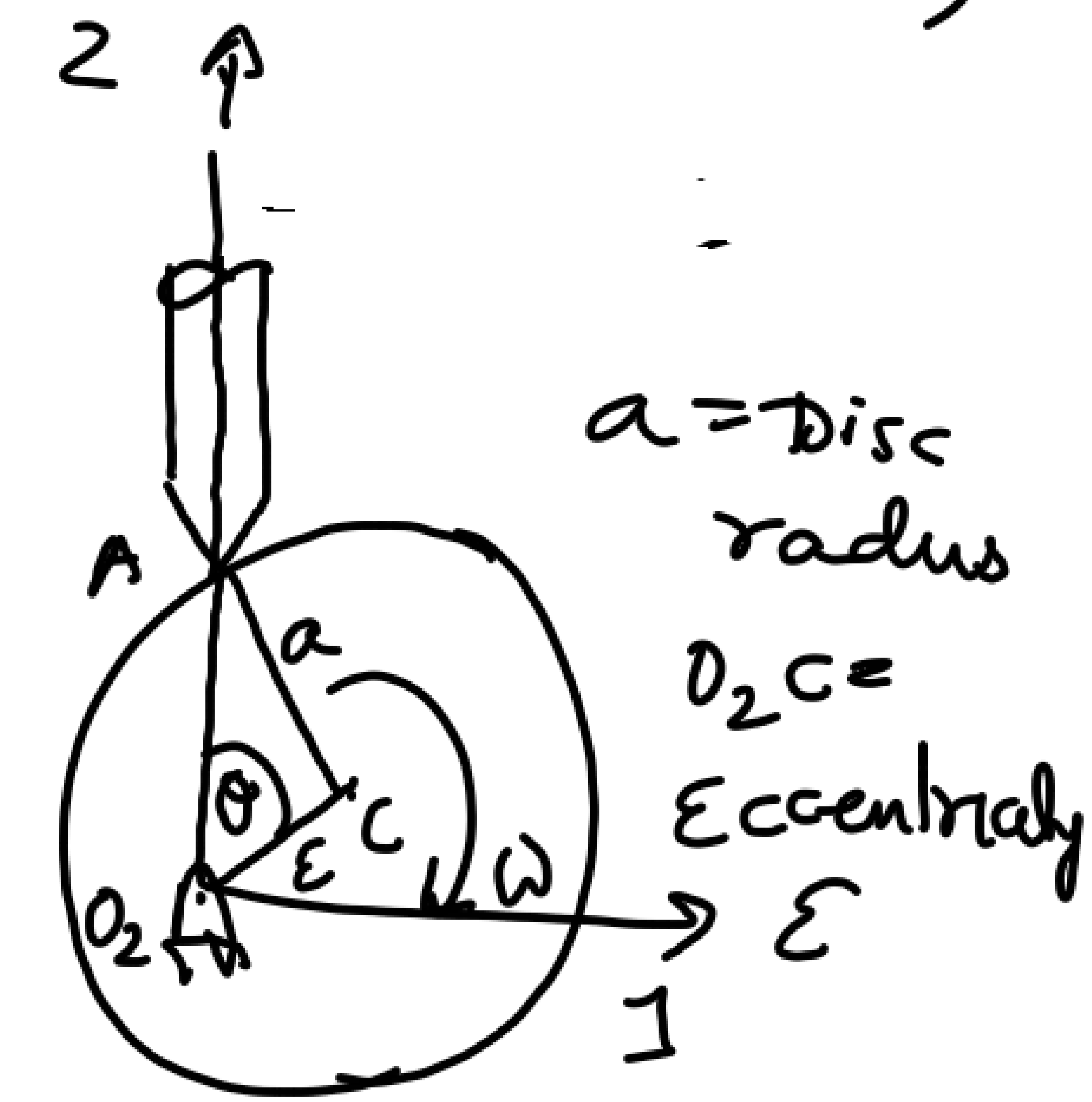




Follower is attached with a spring such that contact is not lost.

Circular disk and a knife edge follower:





Disc is rotating at constant speed ω

Follower displacement $\in [a-\varepsilon, a+\varepsilon]$

$$\cos\theta = \frac{(O_2A)^2+\varepsilon^2-a^2}{2(O_2A)\varepsilon}$$

$O_2A = x_2$

$$\therefore \quad x_2^2 - 2(x_2\varepsilon)\cos\theta + \varepsilon^2 - a^2 = 0$$

$$x_2 = \frac{2\varepsilon\cos\theta \pm \sqrt{4\varepsilon^2\cos^2\theta - 4(\varepsilon^2-a^2)}}{2}$$

$$x_2 = \varepsilon\cos\theta \pm \sqrt{a^2-\varepsilon^2\sin^2\theta}$$

For point C to lie above O_2 at the start, we choose "+" root

$$x_2 = \varepsilon\left[\cos\theta + \sqrt{\left(\frac{a}{\varepsilon}\right)^2 - \sin^2\theta}\right]$$

For $\theta = 0$: $x_2 = (\varepsilon + a)$