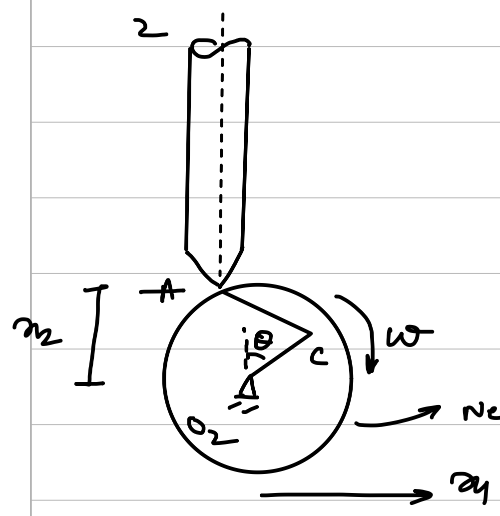
WEEK 6.2

13th Feb.

CIRCULAR DISC & KNIFE EDGE




$AC = a$

$O_2C = e$

$$\cos\theta = \frac{x_2^2 + e^2 - a^2}{2x_2 e}$$

→ Need not be perfect circle

$$x_2^2 - (2e\cos\theta)x_2 + (e^2 - a^2) = 0$$

$$x_2 = e\cos\theta \pm \sqrt{e^2 c^2\theta - (e^2 - a^2)}$$

$$x_2 = e\cos\theta \pm \sqrt{a^2 - e^2 s^2\theta}$$

+ve root such that, $\theta = 0°$, $x_2 = a + e$

$$V = \frac{dx_2}{dt} \qquad a = \frac{d^2x_2}{dt^2}$$

$$v = \omega \cdot \frac{dx_2}{d\theta}$$

$$= \omega \cdot \left[ -e\sin\theta - \frac{e^2\, 2\sin\theta\cos\theta}{2\sqrt{a^2 - e^2\sin^2\theta}} \right]$$

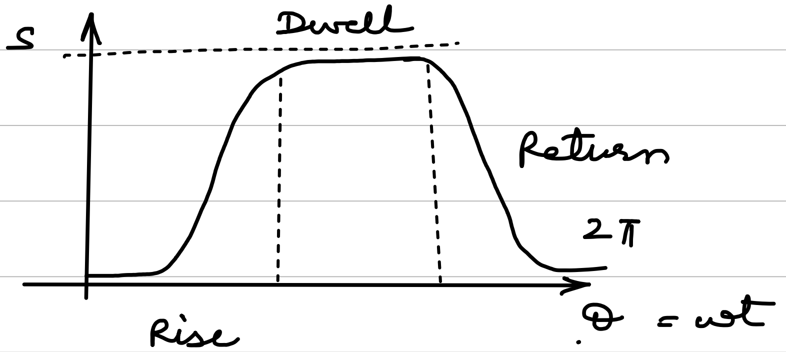
$$= -\omega e\sin\theta$$

$$= \left[ 1 + \frac{e\cos\theta}{\sqrt{a^2 - e^2\sin^2\theta}} \right]$$

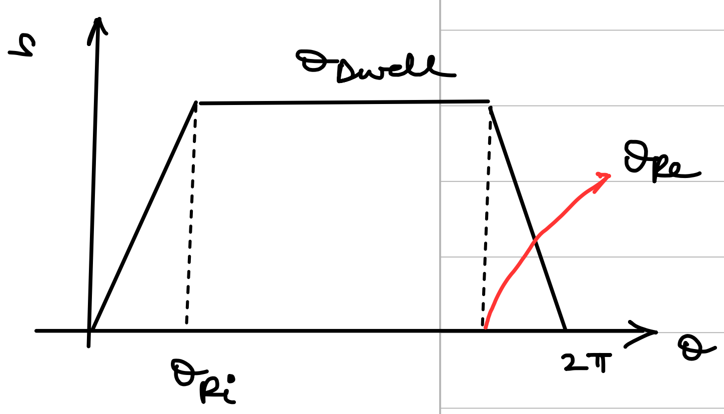
Similarly, $a =$

No control on the resulting velocities and acceleration. High values of $v$ and $a$ can lead to noise and vibration.

In the content of translating follower, usually the displacement $(S)$, can be expressed as,



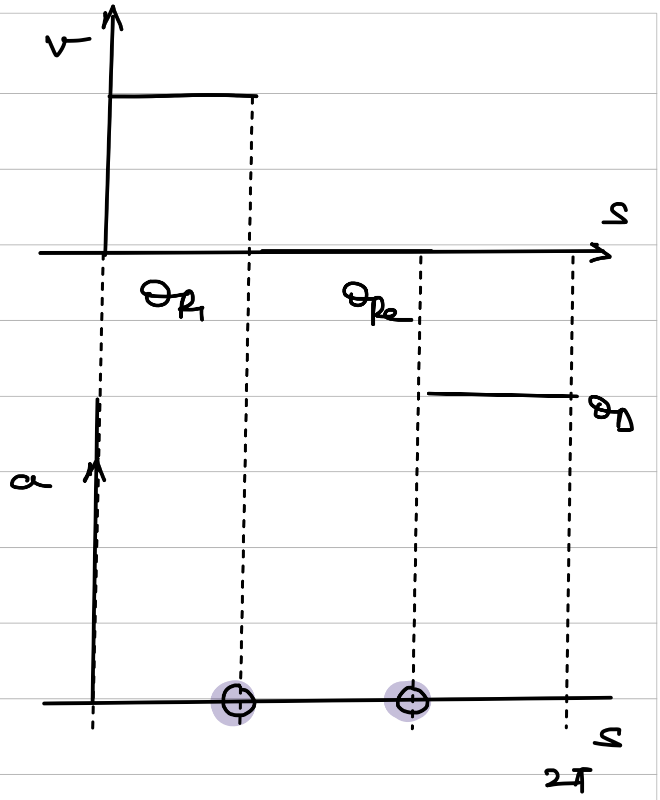

To model it, I can




$$
\begin{cases}
\left(\dfrac{\theta}{\theta_{Ri}}\right) A & Ri \\
A & Ri \rightarrow Re \\
\alpha\theta + \beta & Re \rightarrow 2\pi
\end{cases}
$$

ASS1 ✓ QUIZ1 ✓

$$V_{Ri} = \frac{\omega A}{\theta_{Ri}}$$




Higher order Polynomials or Trig.

$$s = A\left[\frac{\theta}{\theta_{Ri}} - \frac{1}{2\pi}\left[\sin\left(\frac{2\pi\theta}{\theta_{Ri}}\right)\right]\right]$$

$$s(0) = 0 \quad ; \quad s(\theta_{Ri}) = A$$

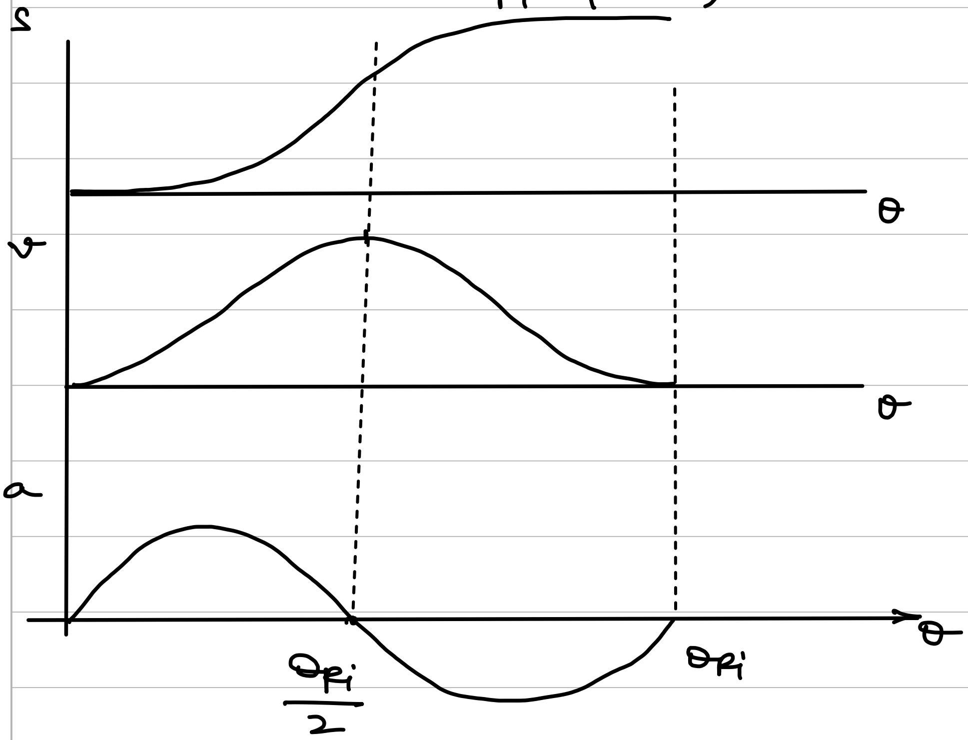
$$v = \frac{ds}{dt} = \frac{ds}{d\theta}\cdot\frac{d\theta}{dt} = \omega\cdot\frac{d\theta}{ds}$$

$$= A\left[\frac{1}{\theta_{Ri}} - \frac{1}{2\pi}\left(\frac{2\pi}{\theta_{Ri}}\right)\times\cos\left(\frac{2\pi\theta}{\theta_{Ri}}\right)\right]\omega$$

$$= \frac{A\omega}{\theta_{Ri}}\left[1 - \cos\left(\frac{2\pi\theta}{\theta_{Ri}}\right)\right]$$

Acceleration will lead to Inertial Forces.

$$a = \frac{dv}{dt} = \frac{\omega^2 A}{\theta_{Ri}}\left(\frac{2\pi}{\theta_{Ri}}\right)\sin\left(\frac{2\pi\theta}{\theta_{Ri}}\right)$$



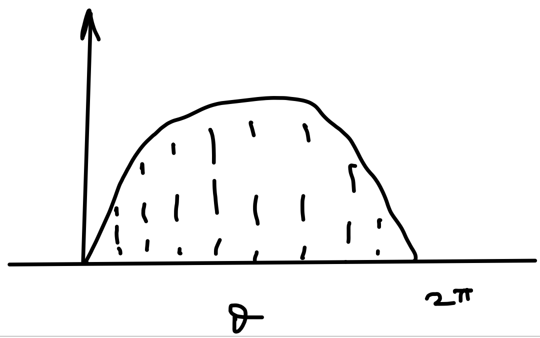

Cycloidal curve ensures zero velocity and zero acceleration at the Rise's rise

Given displacement profile, design the cam.

CAM - SYNTH.

KNIF-EDGE translating follower
→ some displacement function.
$s(\theta)$

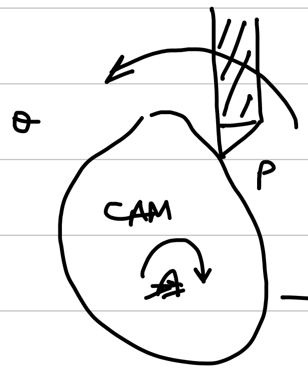
$\theta \in [0, 2\pi]$
$s(\theta) \in [s(\theta_i), .. s(2\pi)]$




θ → Angle of CAM

GRAPHICAL APPROACH.

No offset here.

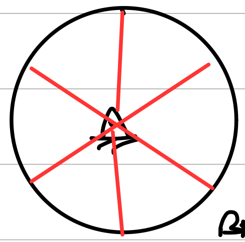



→ FIX IT.

KINEMATIC INVERSION
↓
Relative Motion b/w bodies remain same

WRT CAM → Anti clockwise ground.

Follow certain no. of points.



BASE CIRCLE

Part of CAM.

CAM synthesis :

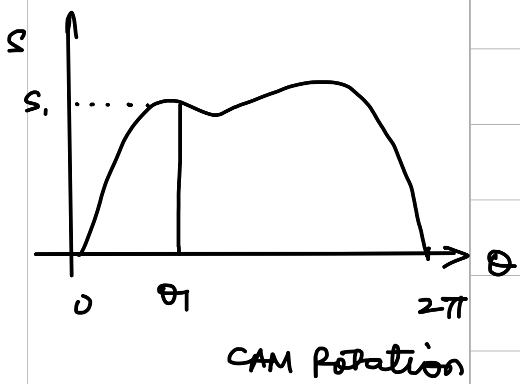
Principle of Inversion.

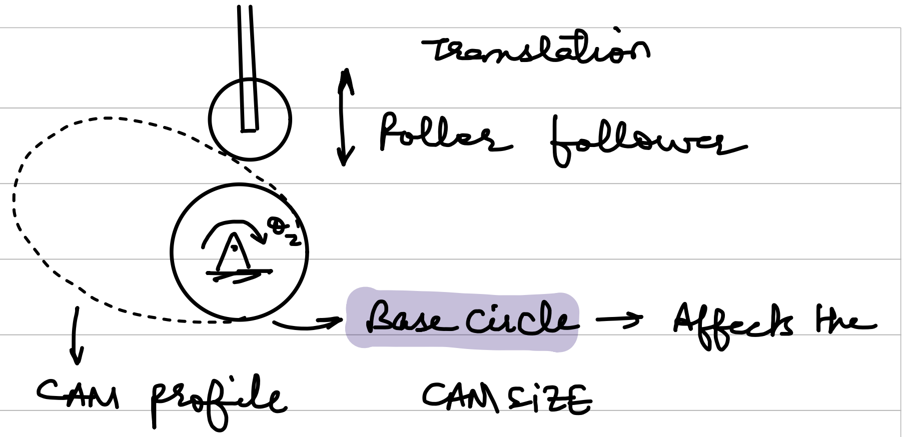
1. Translating Knife edge follower [No offset]
2. Roller follower [No-offset] translating

$$S = A\left[\frac{\theta}{\theta_R} - \frac{1}{2\pi}\sin\left(\frac{2\pi\theta}{\theta_R}\right)\right]$$

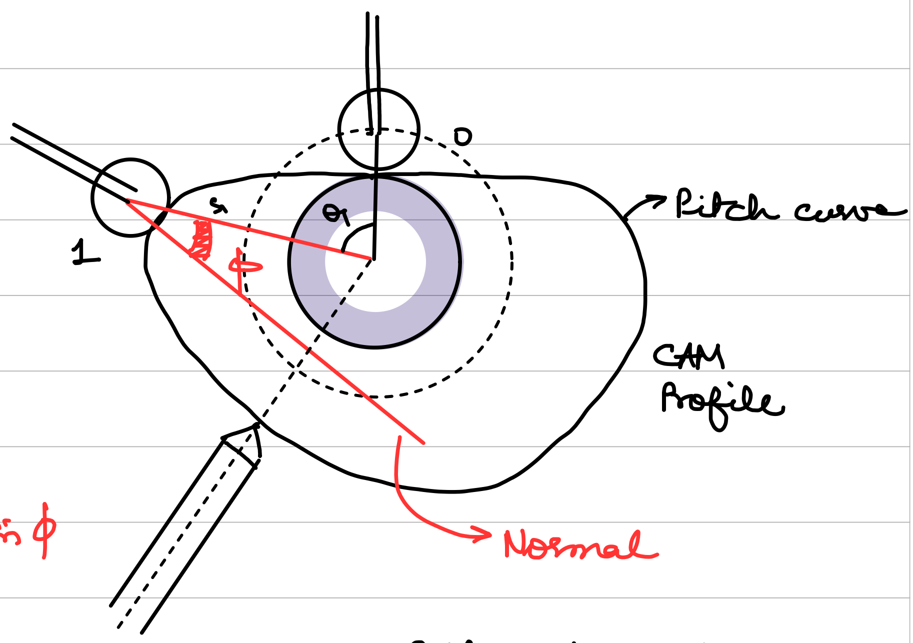
↓
CAM Rotation

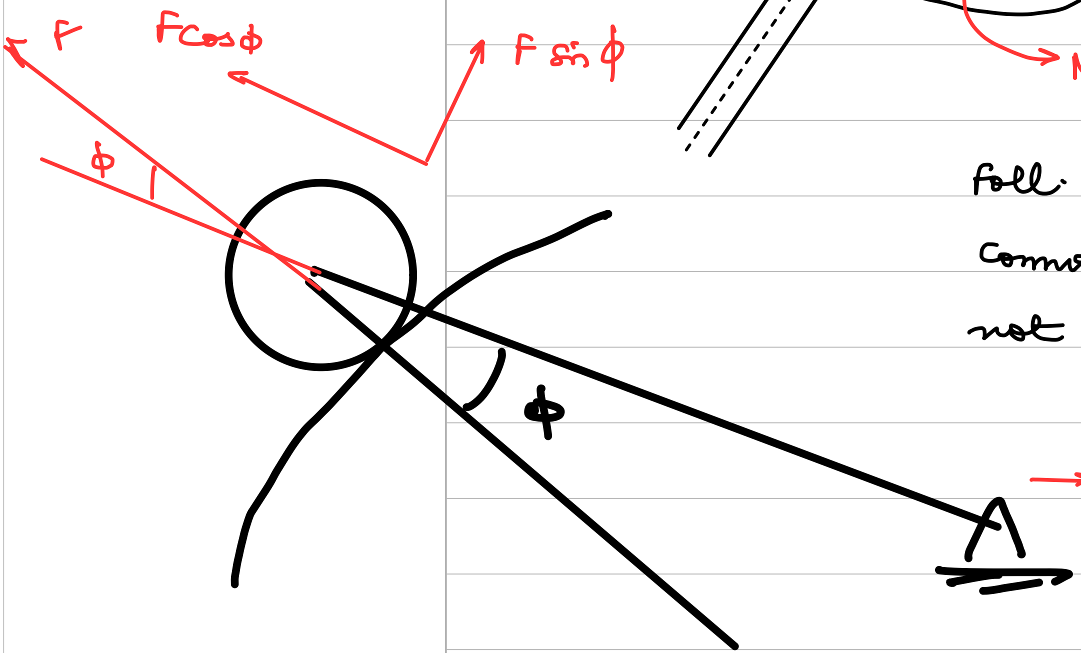
How do you imply convexity?




$\phi$ = Pressure Angle




Foll. axis and common normal are not coincident.

→ should sustain tangential forces ~~too~~.

→ $20 < \phi < 30'$ for optimal working.

greater the value of $r_p$, smaller the $\phi$.

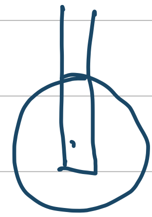
This was Pratham Srivastava

Woo hoo! — by Pratham Srivastava (with disappointment in Tanmay)

## Follower #2:

### Roller follower

Translating and Radial

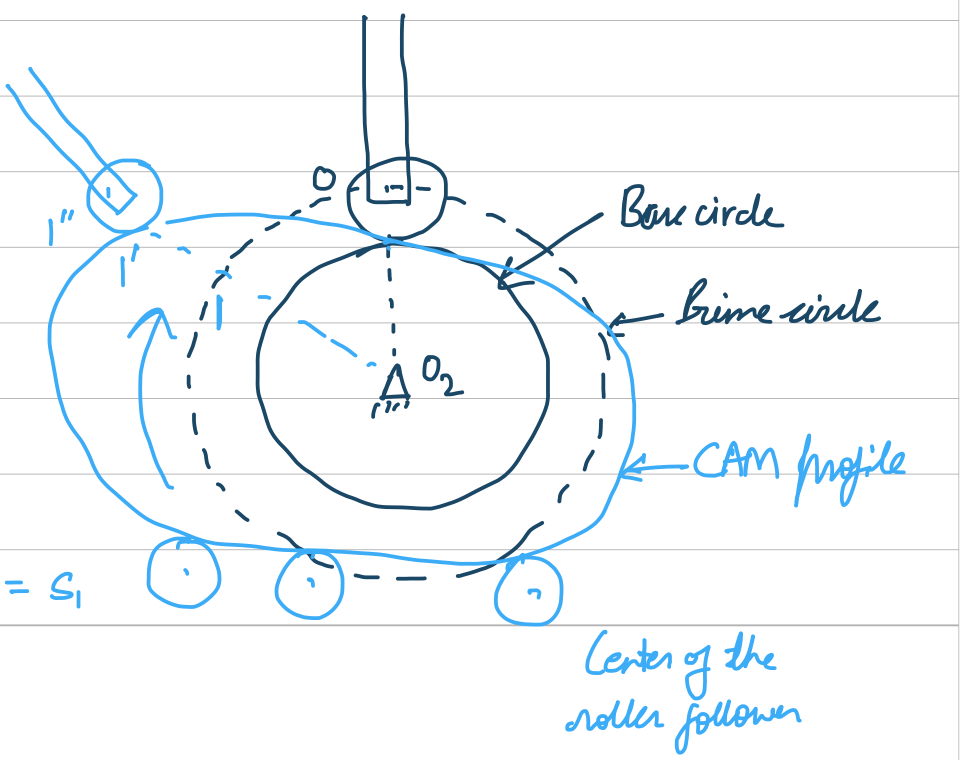


Given: Displacement profile of roller follower

To find: CAM surface

We have to assume values for radius of roller and base circle.

Assume clockwise motion

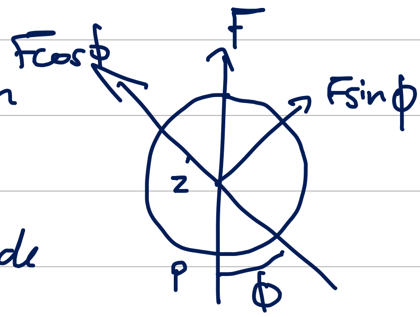


CAM profile is tangent to all the circles (roller follower) identified through process of inversion.

## Theory of envelopes

We want to find a curve which envelopes a family of given circles.

FBD at 2



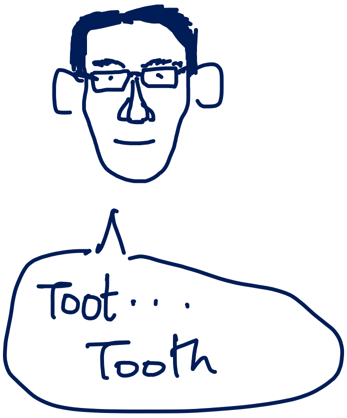


In general, the common normal at the point of contact, need not coincide with the follower axis.
The corresponding angle is called pressure angle.

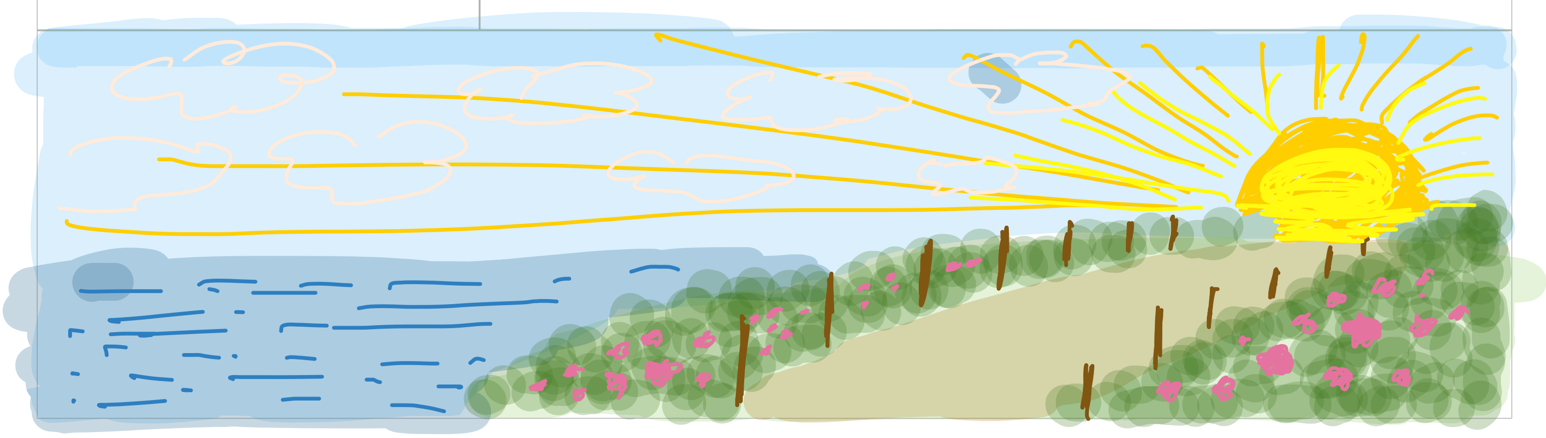
Wine

Recommended angle $\boxed{\phi < 20^\circ \text{ to } 30^\circ}$

Increasing the base circle radius, will bring down the pressure angle.



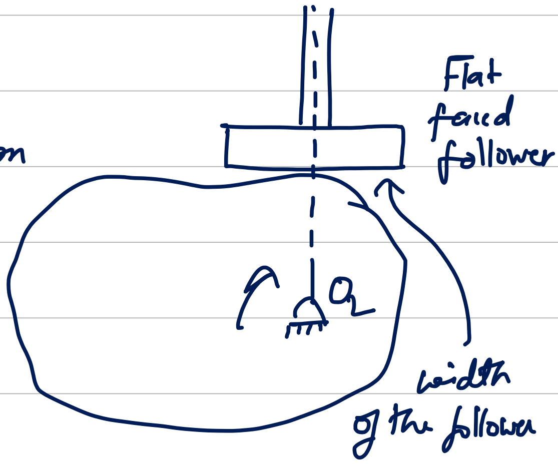




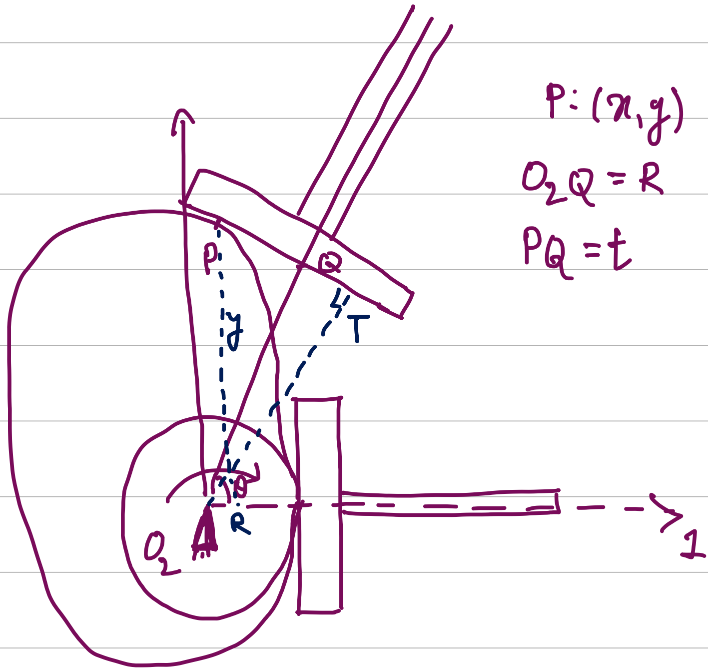
## Analytical Approach :.

Translating flat-faced follower.

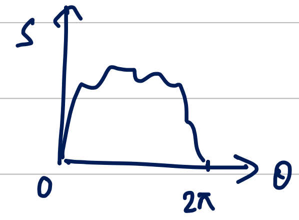
The flat line of the follower is the common tangent at the point of contacts.




The contact point P changes with the angle through which CAM rotates.



Displacement function $s = f(\theta)$




From fixed point $O_2$, the radial distance of follower is

$$R(\theta) = r_b + f(\theta)$$

Base circle radius

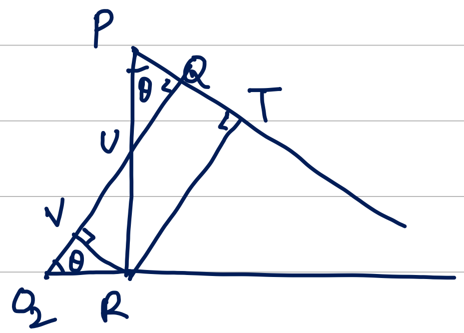
$PR = y$

$O_2 R = x$

$O_2 Q = R(\theta)$

In $\Delta PRT$,

$RT = PR \sin\theta$




$$O_2 Q = O_2 V + VQ$$
$$= O_2 V + RT$$

$$PQ = PT - QT$$
$$= PT - VR = PR \cos\theta - O_2 R \sin\theta$$

$t = y\cos\theta - x\sin\theta$

Tangent to the CAM at $(x, y)$ :

$\left(\frac{dy}{dx}\right) \tan\theta$