KDOM Project

PART A

PART A

Given information:

(insert all values given in the qn here)

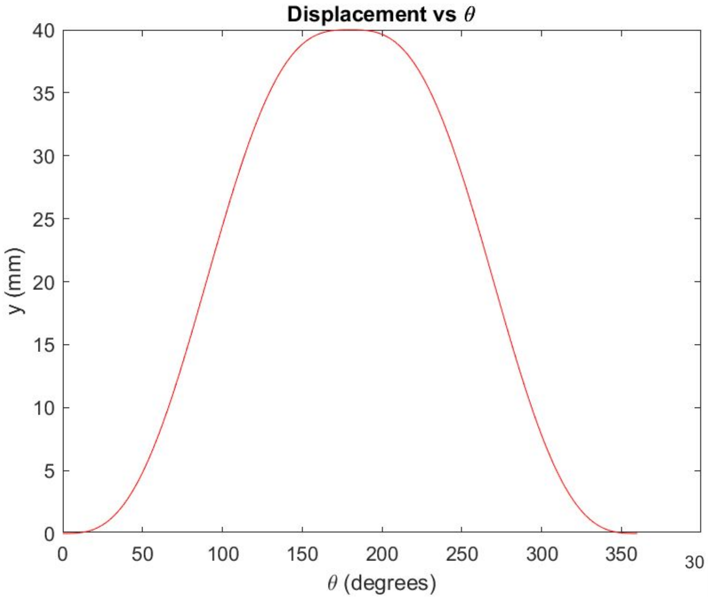
Formula for lift:

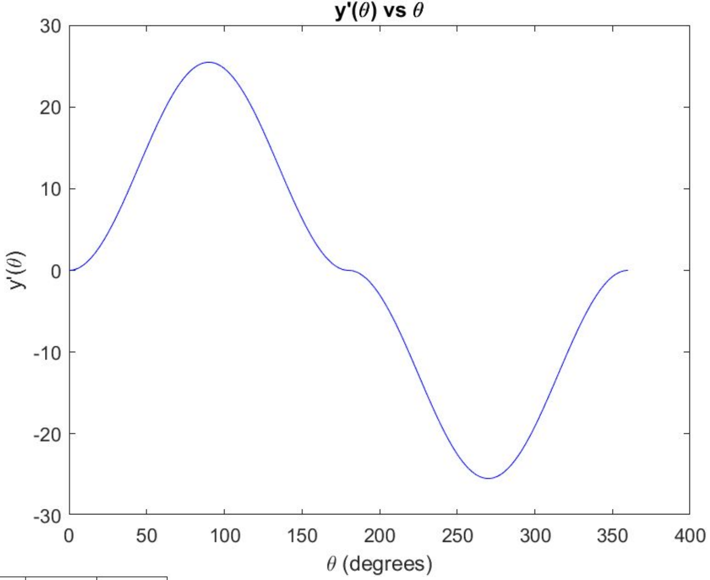
- Since the motion is cycloidal, we have the lift as a function of theta given below:

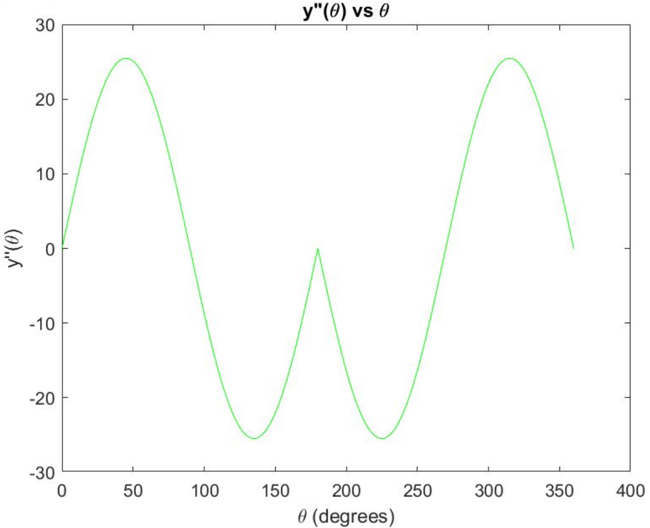
$$y(\theta) = \begin{cases} L\left(\frac{\theta}{\theta_i} - \frac{sin(2\pi\frac{\theta}{\theta_i})}{2\pi}\right. & \text{for} \quad 0^\circ \leq \theta \leq 180^\circ \\ L\left(1 - \frac{\theta-\beta}{\theta_r} + \left(\frac{sin(2\pi\frac{\theta-\beta}{\theta_r})}{2\pi}\right)\right. & \text{for} \quad 180^\circ < \theta \leq 360^\circ \end{cases}$$

here ,

$$\beta = 180^\circ, L = 40mm, \theta_r = 180^\circ$$


Displacement vs θ
y (mm)
θ (degrees)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350

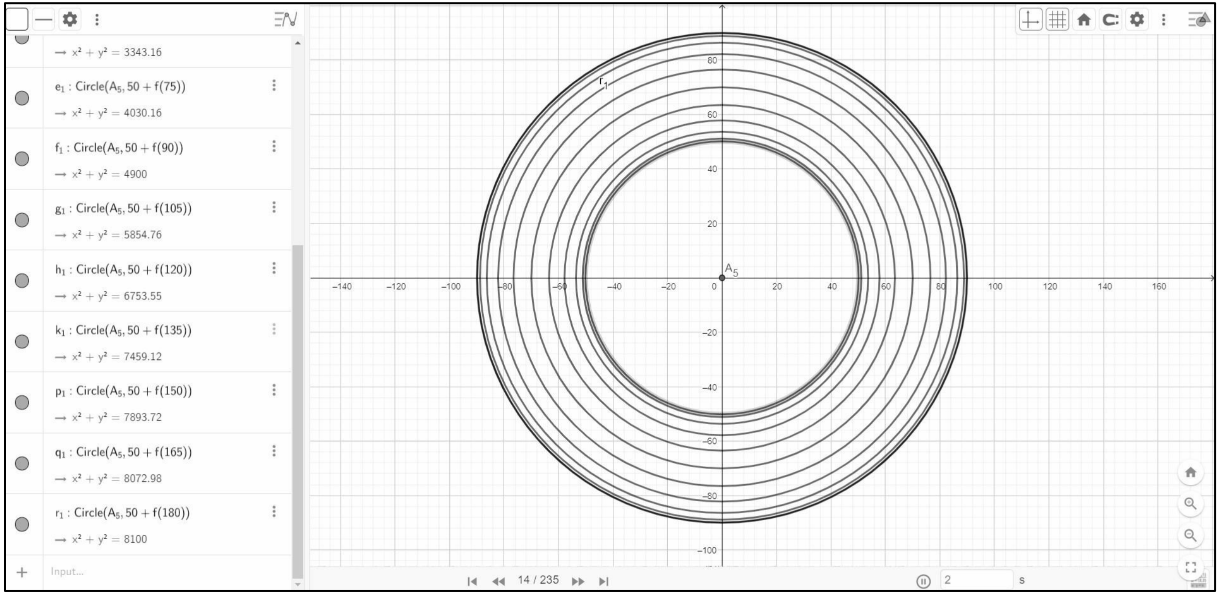

y'(θ) vs θ
y'(θ)
θ (degrees)
-30
-20
-10
0
10
20
30
0
50
100
150
200
250
300
350
400


y"(θ) vs θ
y"(θ)
θ (degrees)
-30
-20
-10
0
10
20
30
0
50
100
150
200
250
300
350
400

Graphical Approach

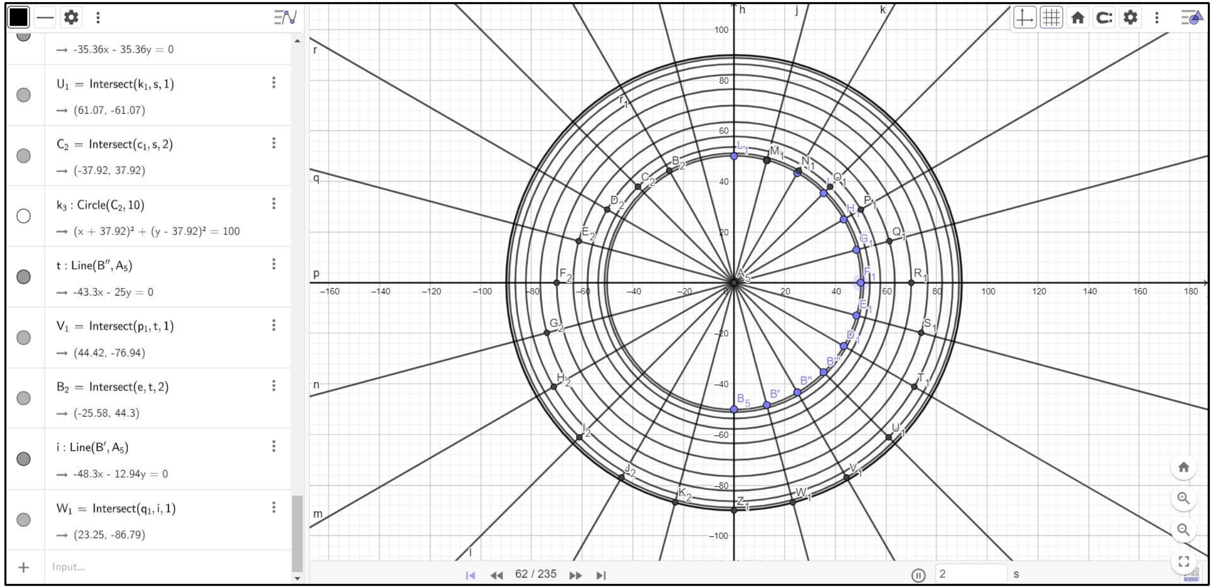
Step 1

Using the expression for lift as mentioned earlier, we plot circles with centre at origin and radii of base circle + value of lift expression at intervals of 15°, starting from 15° (15° to 180 ° i.e.).



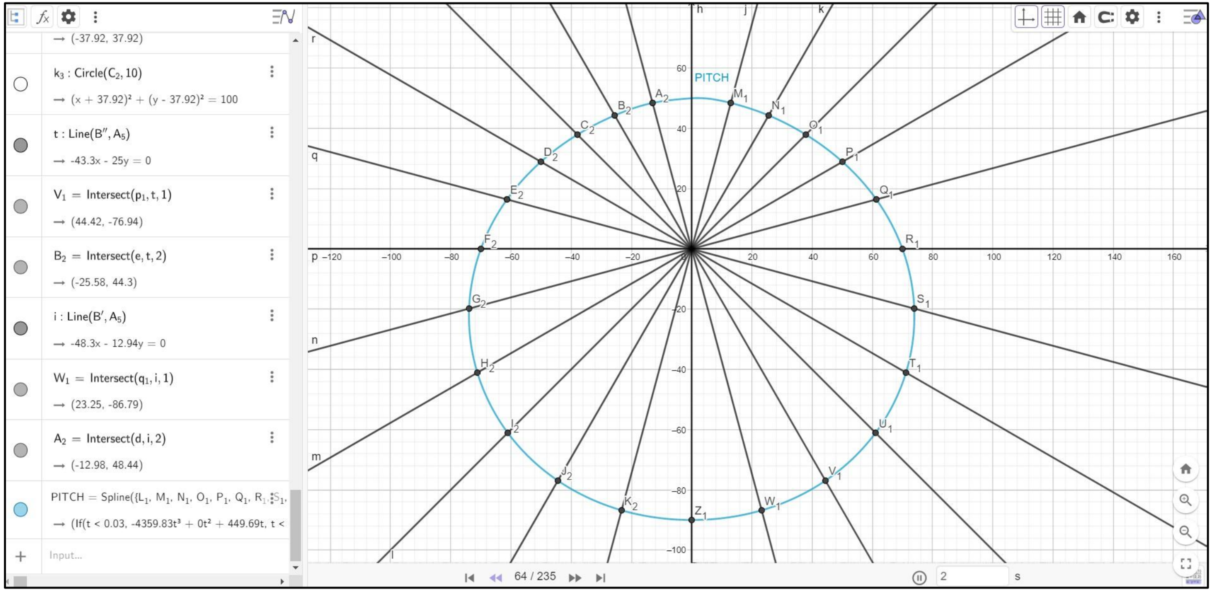
Step 2

Next, we take points 15° apart (from 0 °) and draw lines through them from origin, which intersect the corresponding circle with the value of lift expression at that angle (e.g. for 15°, we intersect the circle of radius 50 + f(15°)) and we mark these points.



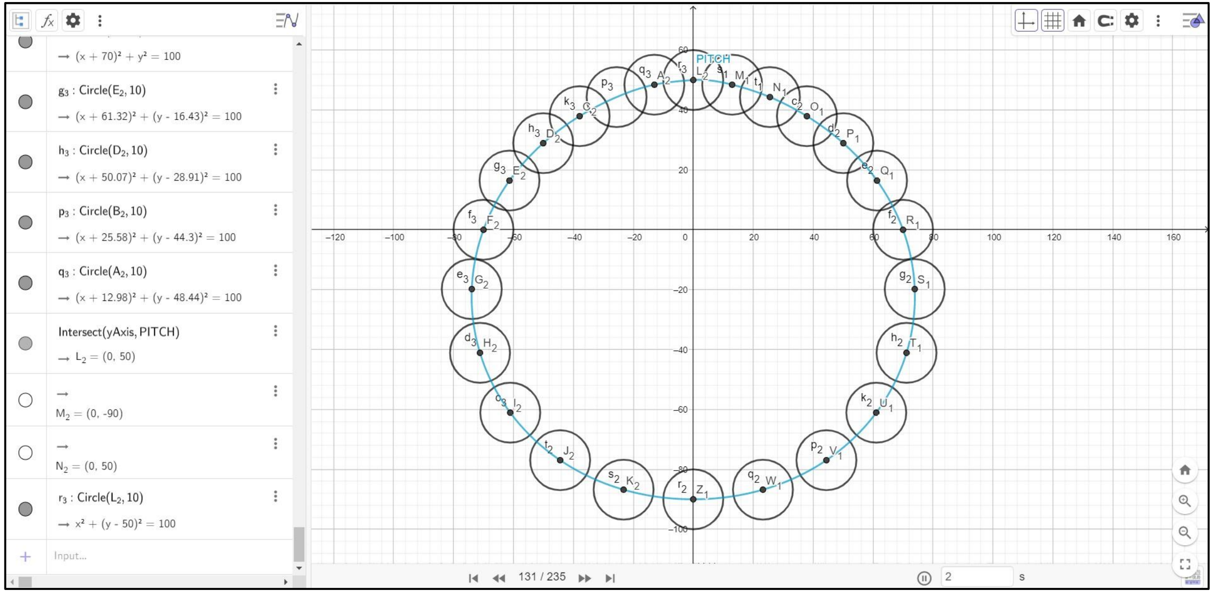
Step 3

We then use the spline function to draw a curve through all the points marked in the previous step, which forms the pitch curve (we are doing this first for convenience).



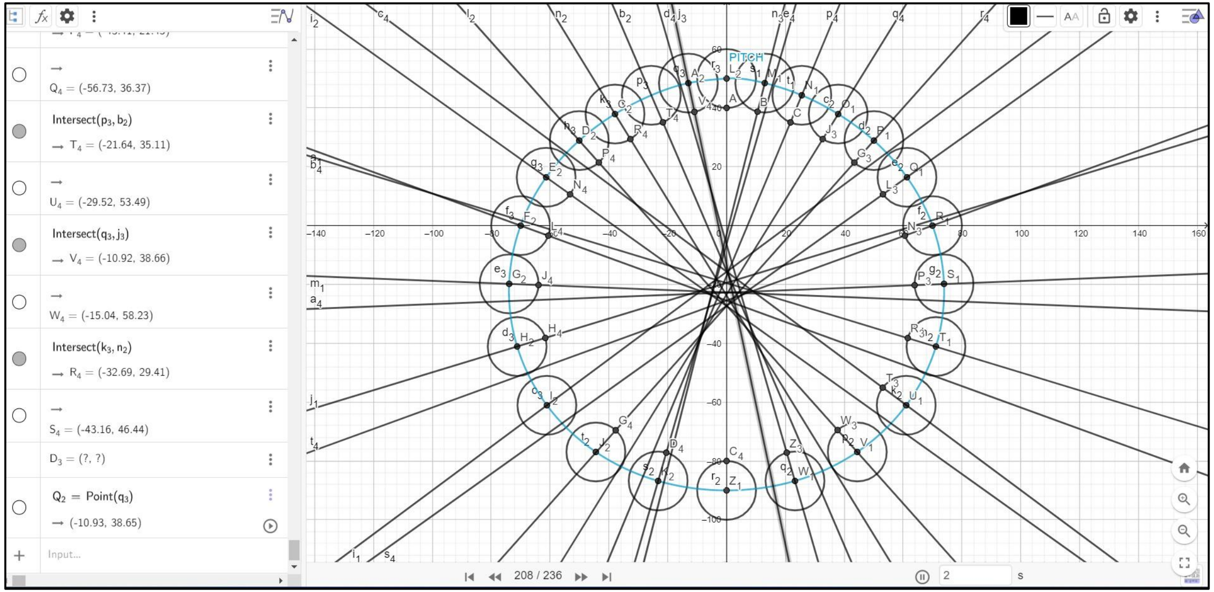
Step 4

After this, we draw circles of roller radius (5 mm) with centres at the points marked in step 2.



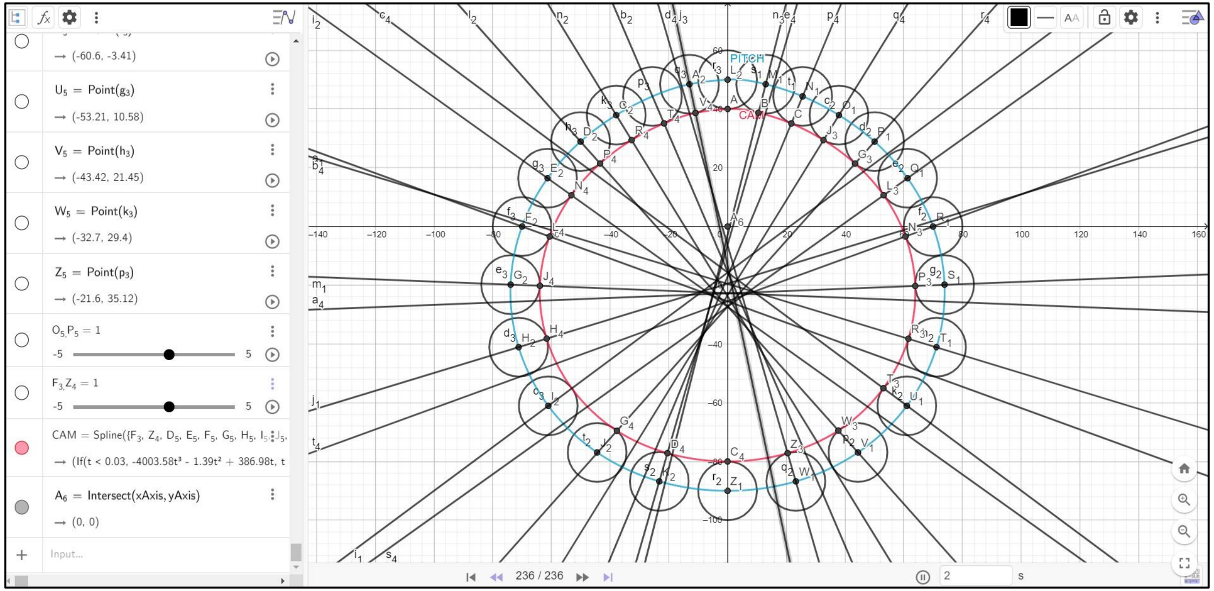
Step 5

We then draw normals to the pitch curve through the centre of each circle (using tangents drawn to pitch curve at those points), and the points where these intersect the respective circle are marked (inner side).

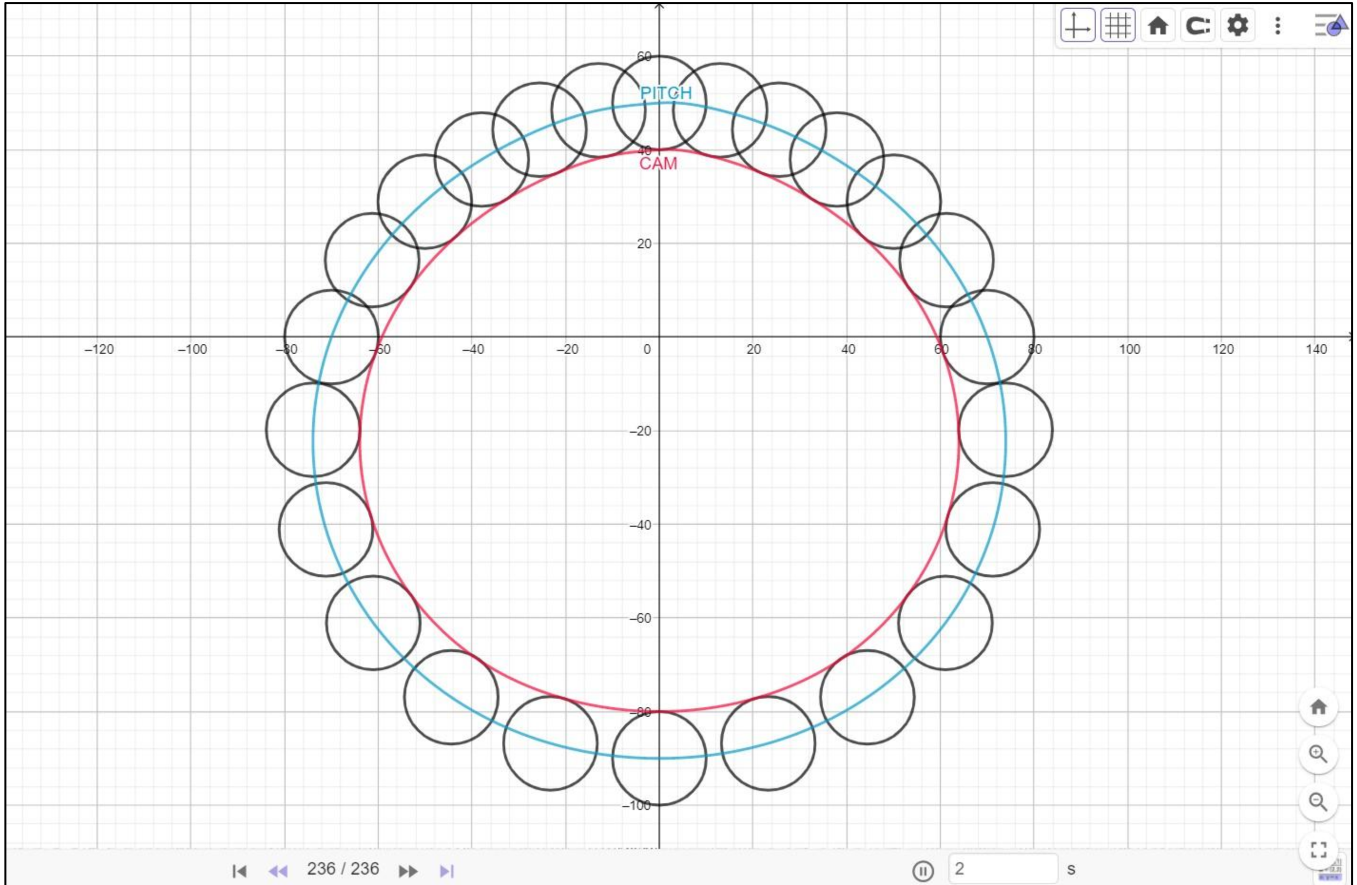


Step 6

We then use the spline function again to plot an *approximate* cam profile for the given specifications, thus completing the construction.



Final profile



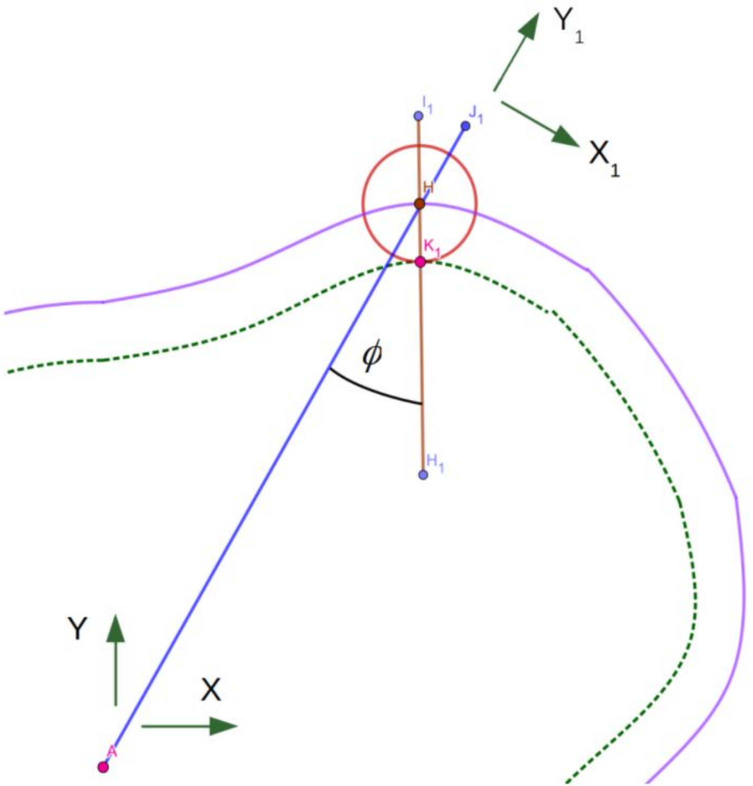
Analytical Approach

Analytical approach:

- Analytically ,we can synthesise the cam profile by formulating parametric equations Xc and Yc in terms of theta
- First, we can find the coordinates of Pitch curve by simply taking component of lift in the X and Y axes

$$X_p = (R_p + y(\theta))sin(\theta)$$
$$Y_p = (R_p + y(\theta))cos(\theta)$$

- A is the origin, we require the coordinates of the vector AK1
- We have coordinates of AH
- $(0, R_p + y(\theta))$
- So we need to subtract AH- HK1
- HK1 is given by
- $(R_r sin(\phi), -R_r cos(\phi))$
- AK1 is given by
- $(R_r sin(\phi), R_p + y(\theta) - R_r cos(\phi))$



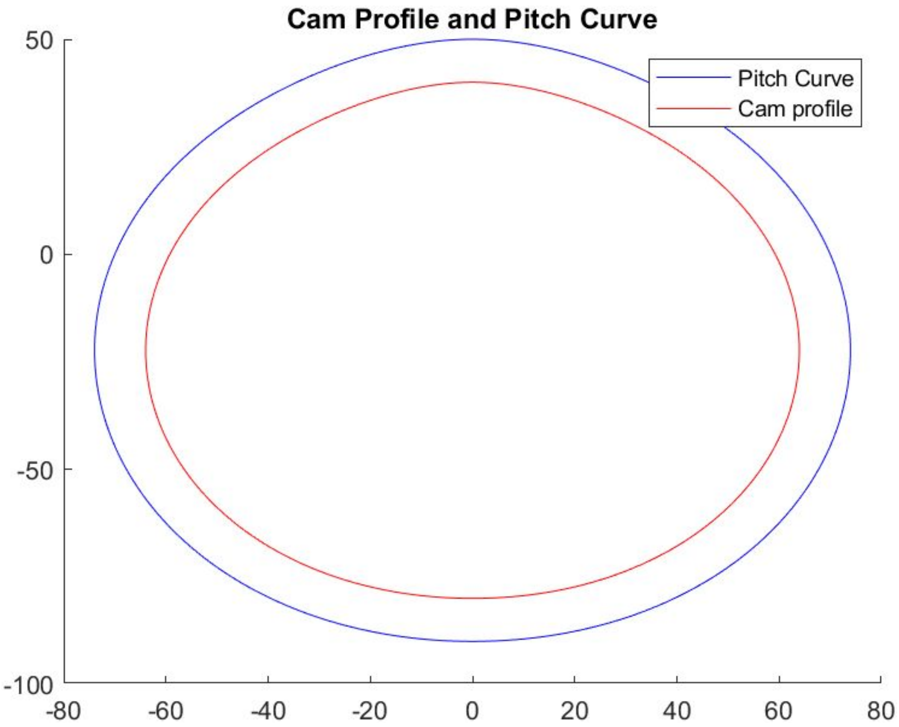
- Now we transform to XY coordinate system:

$$X_c = (R_r sin(\phi))cos(\theta) + (R_p + y(\theta) - R_r cos(\phi))sin(\theta)$$
$$Y_c = -(R_r sin(\phi))sin(\theta) + (R_p + y(\theta) - R_r cos(\phi))cos(\theta)$$

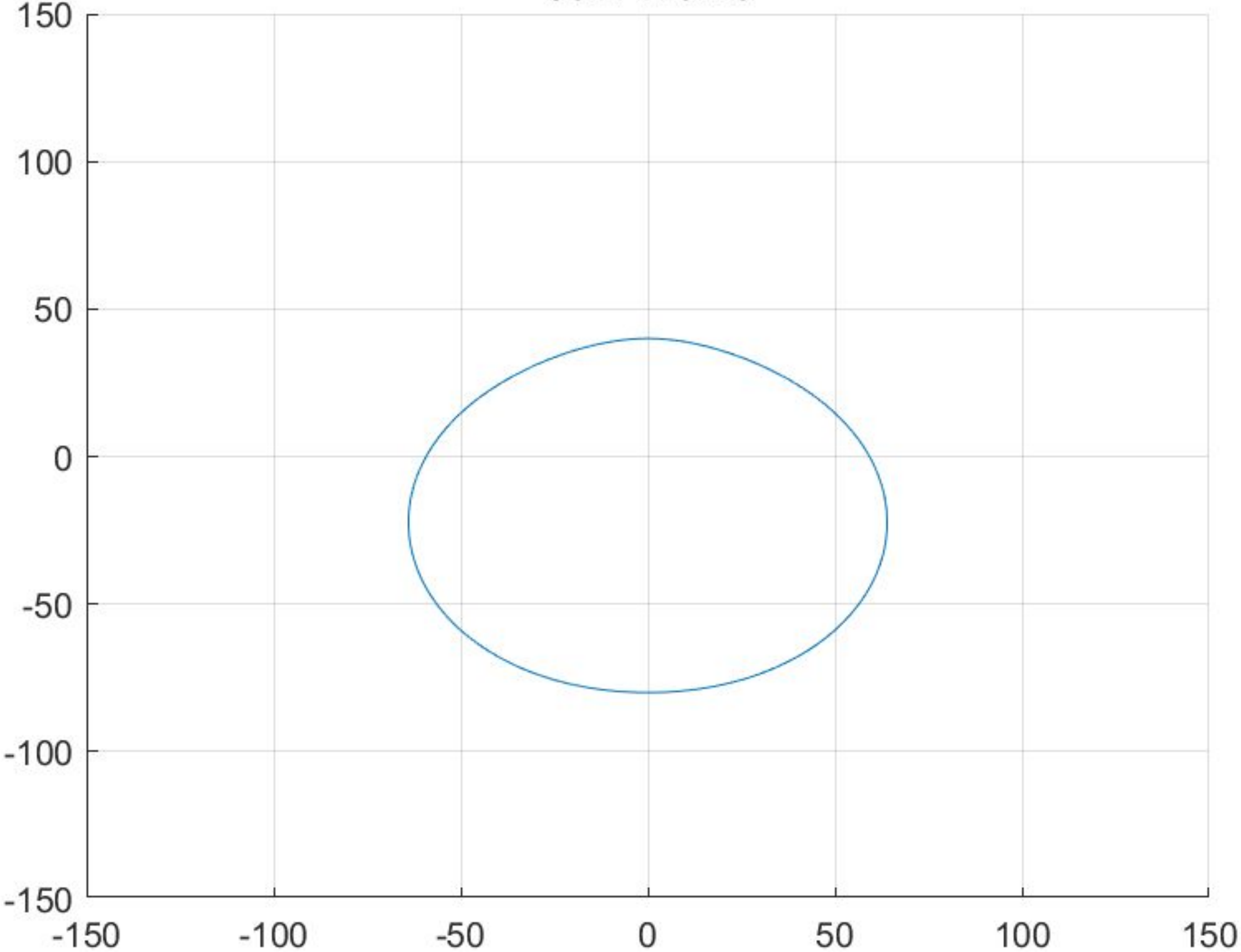
- For return, the sign of phi is negative, so the coordinates are given by:

$$X_c = (-R_r sin(\phi))cos(\theta) + (R_p + y(\theta) - R_r cos(\phi))sin(\theta)$$
$$Y_c = (R_r sin(\phi))sin(\theta) + (R_p + y(\theta) - R_r cos(\phi))cos(\theta)$$

- On running the matlab code, we get the pitch curve and the cam profile as follows:



Cam Profile



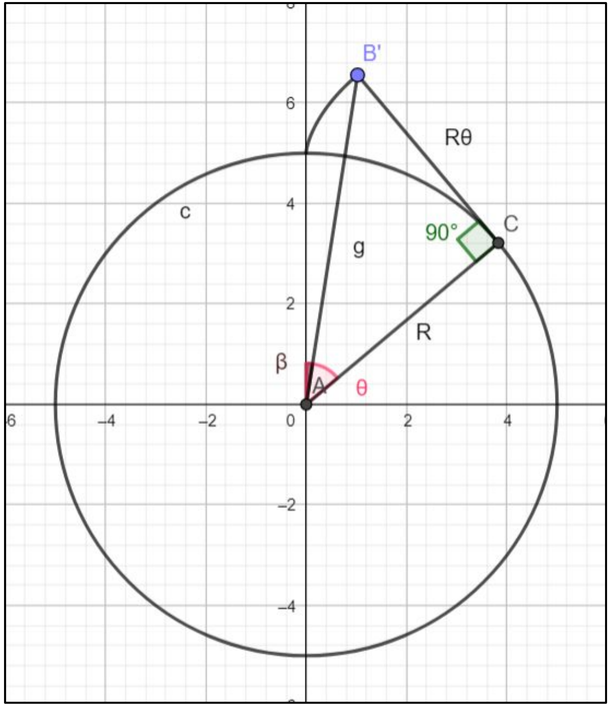
PART B

Equation of Involute

$$r = R\sqrt{1 + \theta^2}$$

$$y = R\sqrt{1 + \theta^2} cos(\theta - tan^{-1}(\theta))$$

$$x = R\sqrt{1 + \theta^2} sin(\theta - tan^{-1}(\theta))$$



Geogebra Link for the involute profile :

https://www.geogebra.org/classic/yuqgbq6v

Nomenclature

$$\theta$$

- Real Angle (Angle on the circle)

$$\beta = \theta - tan^{-1}(theta)$$

- Apparent angle

When Radius of dedendum circle is greater than Radius of base circle :

- Calculate the angular distances where the distance of a point on the involute from the center becomes:
  - Rd=$$\alpha$$
  - Rp=$$\beta$$
  - Ra=$$\gamma$$

Between alpha and beta, draw a circular arc of radius Rd, then between beta and gamma, draw part of involute curve that begins from Rb at an angular distance of 0

The return path of the tooth should have an involute of circle with radius Rb starting from angular distance of phi(say)

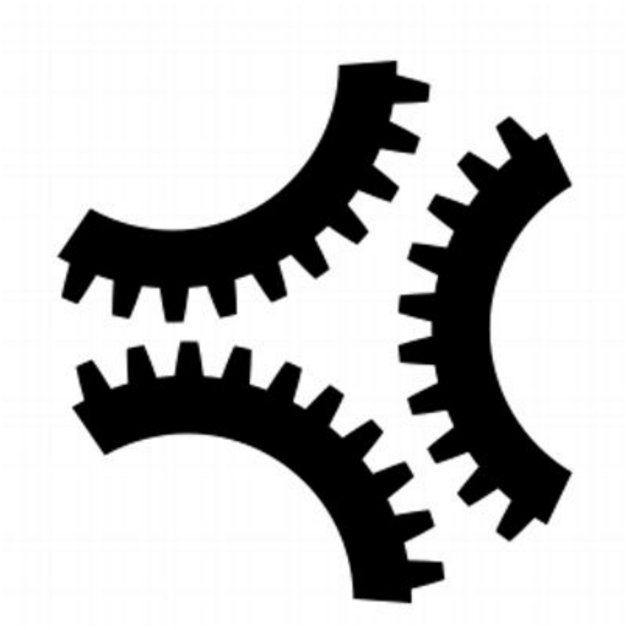
Phi will be angle subtended by the circular thickness + 2 x beta

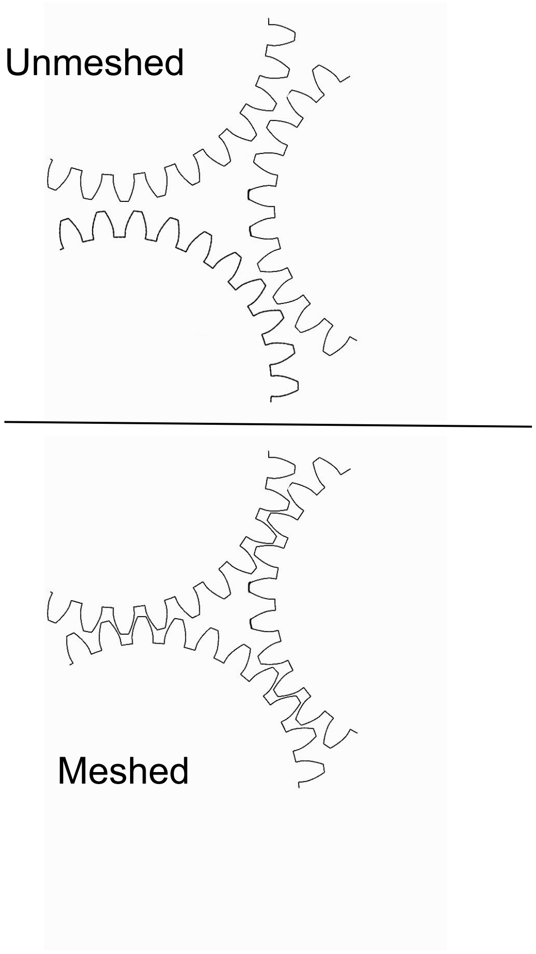
Using this information, we can repeat the same process for the return part also.

When Radius of dedendum circle is lesser than Radius of base circle :

- In this case, we need to draw an involute of base circle from angular distance of 0 to gamma.
- In addition to this we have to radially extend the starting point of the involute to the base circle.

Correcting the Mechanica logo :





(using gear generated by Matlab code, 30 teeth)