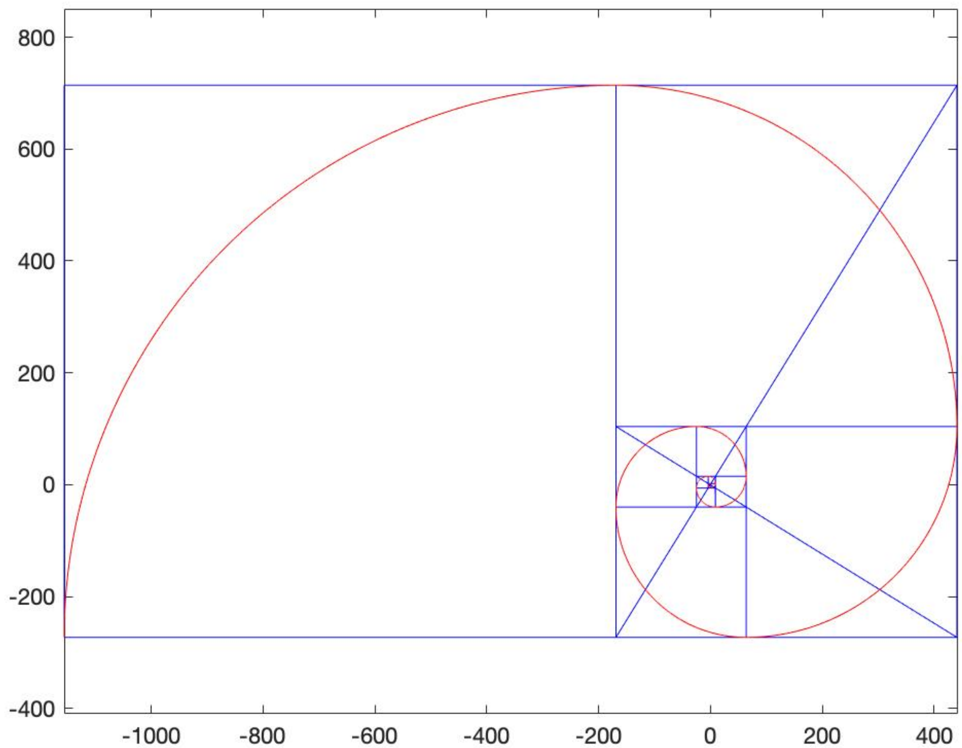
CAD Mid A53323531 Minghao LI

Problem1

MatLab code is in Matlab file as CADmidP1.m.



Problem 2

(1) $$x(t) = r\cos\theta = b(1+wt)\cos(wt)$$

$$y(t) = r\sin\theta = b(1+wt)\sin(wt)$$

(2) $$x'(t) = bw\cos(wt) - bw(1+wt)\sin(wt) = V_x$$

$$y'(t) = bw\sin(wt) + bw(1+wt)\cos(wt) = V_y.$$

$$S = \sqrt{V_x^2+V_y^2} = \Big(b^2w^2\cancel{\cos^2}(wt) + b^2w^2\cancel{(1+wt)^2\sin^2}(wt)$$

$$\cancel{- 2b^2w^2(1+wt)\cos(wt)\sin(wt)}$$

$$+ b^2w^2\cancel{\sin^2}(wt) + b^2w^2\cancel{(1+wt)^2\cos^2}(wt)$$

$$\cancel{+ 2b^2w^2(1+wt)\sin(wt)\cos(wt)}\Big)^{\frac{1}{2}}$$

$$= \sqrt{b^2w^2 + b^2w^2(1+wt)^2}$$

(3) $$r = b(1+wt) \qquad \Rightarrow \begin{cases} r_d = b(1+wt)+d \\ \theta_d = wt \end{cases}$$

$$\theta = wt$$

The vector with the offset d.

$$r_{new} = b[1+w(t+2\pi/w)] = b[1+wt+2\pi]$$

$$r_d = r_{new} \Rightarrow d = 2\pi b.$$ d is a constant.

$$\theta_{new} = w(t+2\pi/w) = wt+2\pi = \theta_d$$ Angle is same.

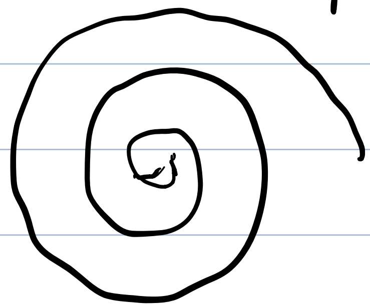
By virtue of this property, the channel space and channel width can be equal easily.

(14) diameter 2cm chanel width 0.5 mm

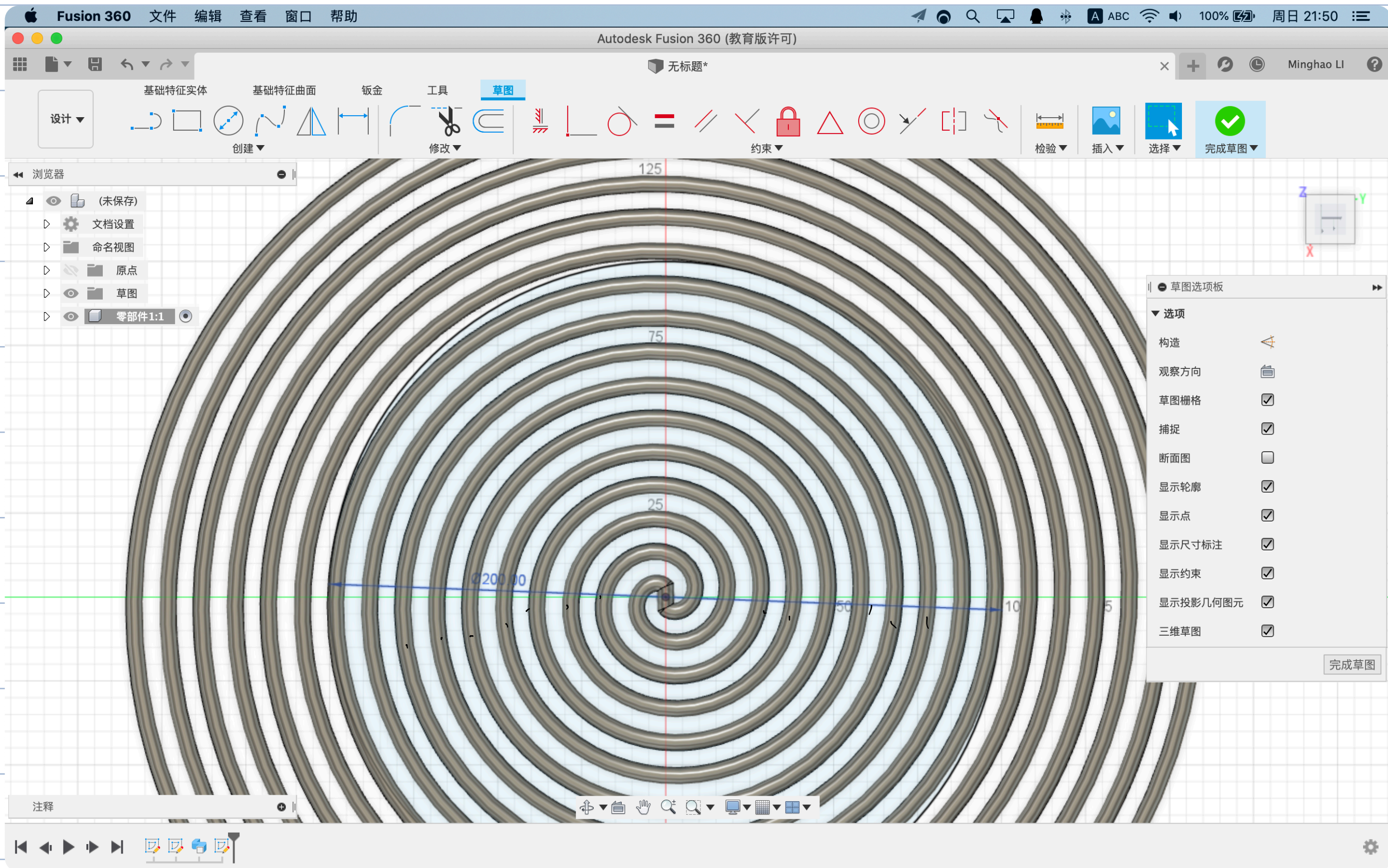
Channel space 0.5

$\boxed{d=2\pi b} = 2$

$b = \frac{d}{2\pi} = \frac{1}{\pi}$



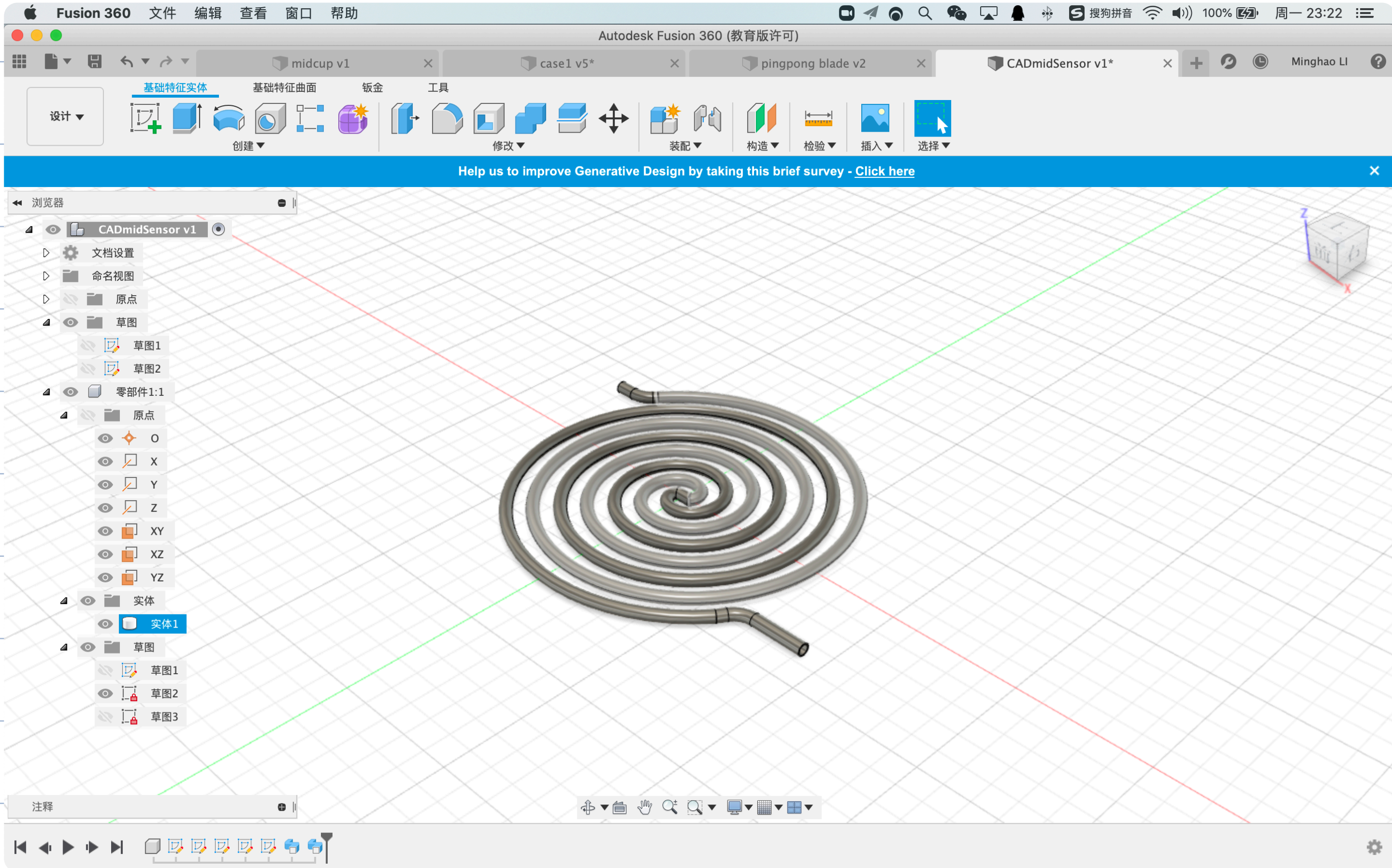
$$\begin{cases} r = b(1+\theta). \\ \theta = \theta. \end{cases}$$



From the picture above, it's about 7 or 8 rings depending on the direction you count the amount

Matlab file: CADmidP2.m

(5)



The parameter is same as (4), $b = \frac{1}{\pi}$ $d = 0.5$

The matlab code will be attached MATLAB file : CADmidP3.m

And the CAD link is :

https://a360.co/35xojwx

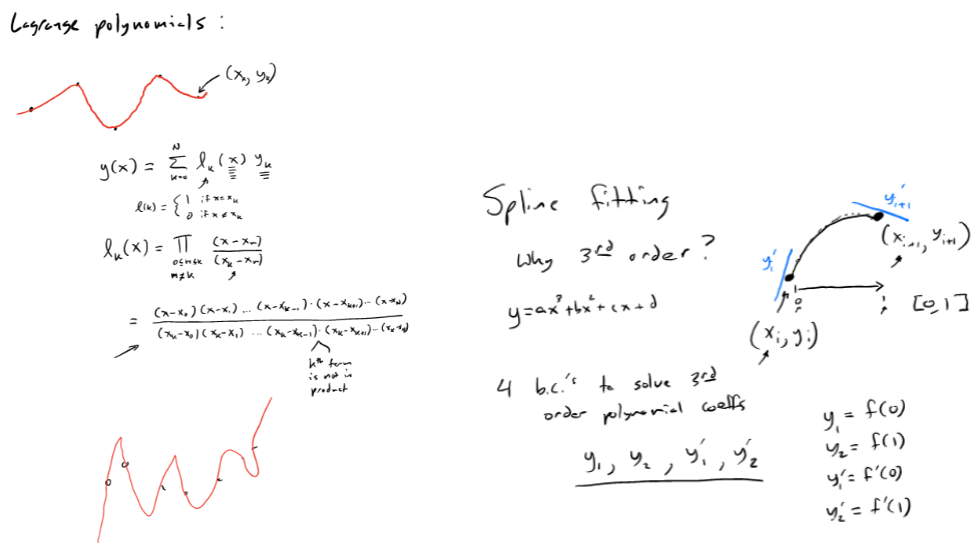
Problem 3

All Matlab code of this problem are in CADmidP3

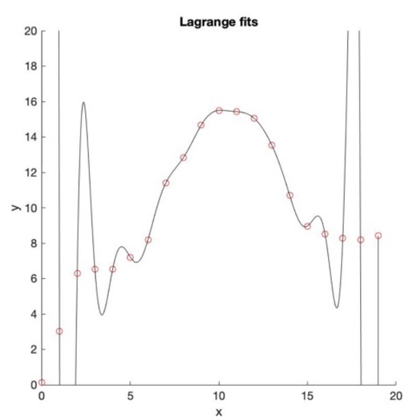
1.

Answer :Lagrange fitting formed by n orders equation of x, and calculating the n+1 unknows with n+1 constrains.

Spline fitting adopt 3rd order and thus will be more gentle than Lagrange fitting.



2. All Matlab code of this problem are in CADmidP3&&2



3. All Matlab code of this problem are in CADmidP3&&3

Overshot =2.543947688454147e+07

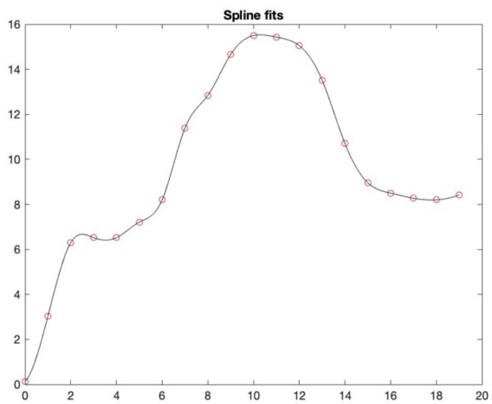
Code:

```
yline = [];
for realx = 0:0.01:19
    newy = (y(ceil(realx)+1)-y(floor(realx)+1))*(realx-
```

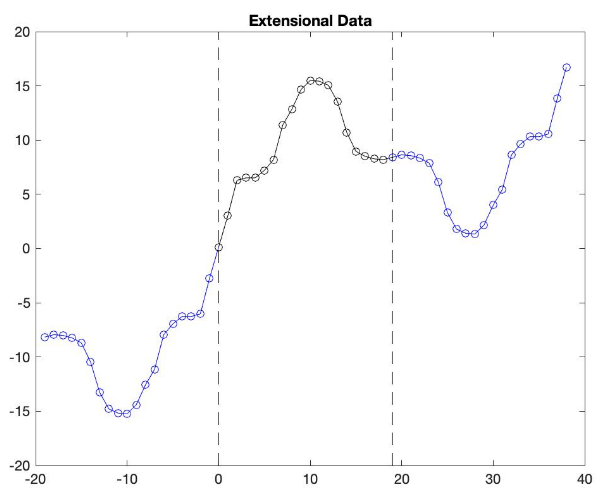
```
floor(realx))/1+y(floor(realx)+1);
    yline = [yline, newy];
end
%overshot for langrange
overshot_ysquare = (yline-lagrange_y).^2;
overshot_sum =sum(overshot_ysquare);
```

4. All Matlab code of this problem are in CADmidP3&&4

Overshot_spline = 27.442942466182550



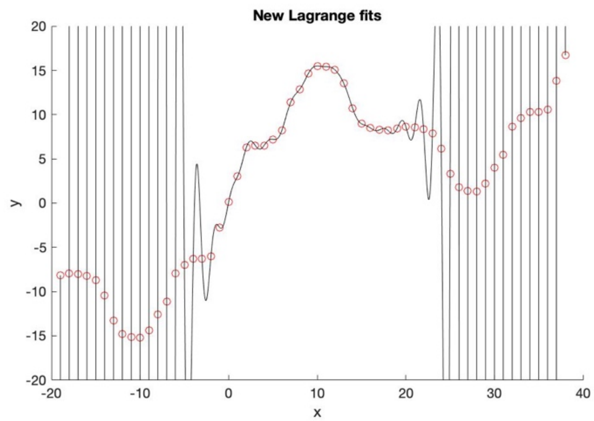
5. All Matlab code of this problem are in CADmidP3&&5



6. All Matlab code of this problem are in CADmidP3&&6

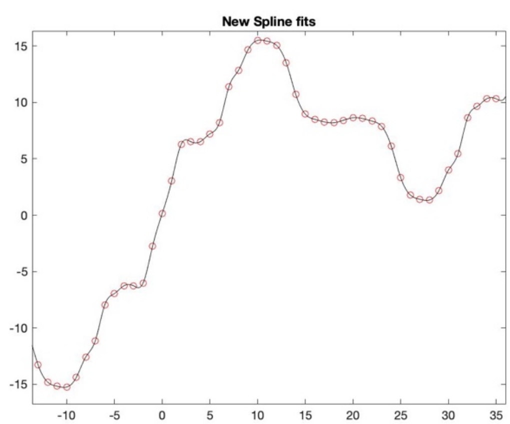
A: New Lagrange fits

New overshot of Lagrange = 77.733178764393070



B:New spline fits

New overshot of spline = 19.633775314668526



Answer: This overshot is the deviation between fitting line and original line. And we can compare the outcomes in Problem3-3 Problem3-4 with the outcome in Problem 3-6A and Problem 3-6B. Both the overshot of spline fit and Lagrange fit are decreased remarkably, which means the deviation between the fitting lines and original lines are smaller. Thus the reflection improve the quality of either fit.

Problem 4.

(1) $L(\theta) = R - A[1-\cos(b\theta)] = R - A + A\cos(b\theta)$

$v = L'(\theta) = -Ab\sin(b\theta) \quad a = v' = -Ab^2\cos(b\theta)$

when $b\theta = k\pi$, $a = \pm Ab^2$ are the maximum accerleration

$v = 0$, have the smallest velocity.

when $b\theta = k\pi + \frac{\pi}{2}$ $a = 0$, have the smallest accerleration

$v = \pm Ab$ have maximum velocity

(2) when $a=0$ (at neutral position), $\Rightarrow b\theta = k\pi + \frac{\pi}{2}$ $(\cos b\theta = 0)$

$L = R - A + A\cdot 0 = 2R \Rightarrow A = -R$

$\therefore L(\theta) = 2R - R\cos(b\theta) \quad \because b=1$

$\therefore L(\theta) = 2R - R\cos(\theta)$

$a=0$

$v = L'(\theta) = R\sin(\theta)$

follower $x = L(\theta)\cos\theta = 2R\cos\theta - R\cos^2\theta = 2R\cos\theta - R\frac{\cos 2\theta + 1}{2}$

$y = L(\theta)\sin\theta = 2R\sin\theta - R\sin\theta\cos\theta = 2R\sin\theta - \frac{\sin 2\theta}{2}R$

$V_x = x' = -2R\sin\theta + R\sin 2\theta \quad V_s = \text{speed} = \sqrt{x'^2 + y'^2} = \sqrt{5R^2 - 4R^2\cos\theta}$

$V_y = y' = 2R\cos\theta - \cos 2\theta R$

$4R^2\sin^2\theta + R^2\sin^2 2\theta - 4R^2\sin\theta\sin 2\theta$

$+ 4R^2\cos^2\theta + R^2\cos^2 2\theta - 4R^2\cos\theta\cos 2\theta$

drafe.

$= 4R^2 + R^2 - 4R^2(\sin\theta\sin 2\theta + \cos\theta\cos 2\theta)$

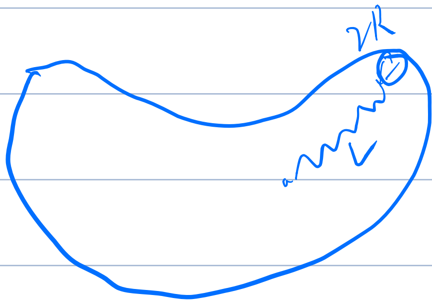
$= 5R^2 - 4R^2[\cos(2\theta - \theta)] = 5R^2 - 4R^2\cos\theta$

Cam surface:

$2R\cos\theta - \cos 2\theta R$

$$X_{cam} = X + R_F\frac{V_y}{V} = 2R\cos\theta - R\frac{\cos 2\theta + 1}{2} + R_F\frac{\cdots}{\sqrt{5R^2 - 4R^2\cos\theta}}$$

$$y_{cam} = y - R_F\frac{V_x}{V} = 2R\sin\theta - \frac{\sin 2\theta}{2}R - R_F\frac{-2R\sin\theta + R\sin 2\theta}{\sqrt{5R^2 - 4R^2\cos\theta}}$$



Curve Rate

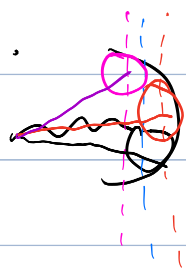
$$K = \frac{\left| x'_{cam} y''_{cam} - y'_{cam} x''_{cam} \right|}{\left| (x'^2_{cam} + y'^2_{cam}) \right|^{\frac{3}{2}}} \quad > R$$

Curve Radius

$$\Rightarrow \rho = \frac{1}{K} = \frac{\left| (x'^2_{cam} + y'^2_{cam}) \right|^{\frac{3}{2}}}{\left| x'_{cam} y''_{cam} - x''_{cam} y'_{cam} \right|}$$

$\rho' = 0 \Rightarrow$ the extrem value of ρ, θ_0

when $\rho'(\theta_0 - \delta) < 0$ $\rho'(\theta_0 + \delta) > 0$ or L has maximum value at that point. Because.



$L > L$ and L

Thus we can obtain ρ_{min}

$R_{F_{max}} \leq \rho_{min}$

ρ_{min} is the maximum value of $R_{F\,max}$

(3) Same as (2) just change $b=1$ with $b \geq 2$.

$L(\theta) = 2R - 2R\cos b\theta$

$V(\theta) = 2Rb\sin b\theta$ $\quad a = 2Rb^2\cos(b\theta)$

$x = L(\theta)\cos\theta$ $\quad y(\theta) = L(\theta)\sin\theta$ $\quad$ pictch curve.

$V_x = x' = L'(\theta)\cos\theta - L(\theta)\sin\theta$ $\quad V = \sqrt{V_x^2 + V_y^2}$

$V_y = y' = L'(\theta)\sin\theta + L(\theta)\cos\theta$

Thus cam surface

$$X_{cam} = X + R_F \frac{V_y}{\sqrt{V_x^2+V_y^2}}$$

$$Y_{cam} = Y - R_F \frac{V_x}{\sqrt{V_x^2+V_y^2}}$$

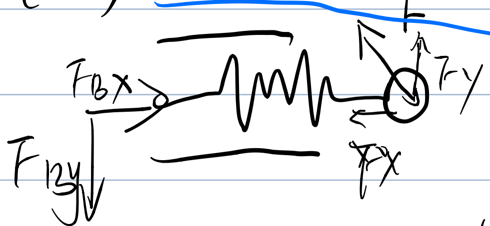
Curve rate $\quad K = \dfrac{|X'_{cam}Y''_{cam} - Y'_{cam}X''_{cam}|}{|X'^2_{cam} + Y'^2_{cam}|^{\frac{3}{2}}}$

$$\rho = \frac{1}{K}$$

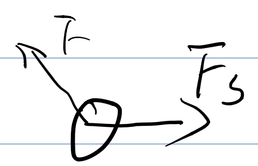
$$\rho = \nu \Rightarrow \rho_{min} \qquad R_{F\max} \leq \rho_{min}$$

The caculation process is too sophisticate T^T
So I show the main equation without caculation
same as below

(4)



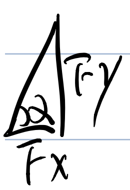
As for the whole spring, the bear offer the Fy, vertical component force of F



As for the follower

According to Newton second law of motion

$$ma = F_s - F_X$$



thus $\Rightarrow F_X = F_s - ma$

$$F_y = \frac{F_X}{\cos\alpha} \cdot \sin\alpha = F_X \cdot \frac{\sin\alpha}{\cos\alpha} = F_X \cdot \tan\alpha$$

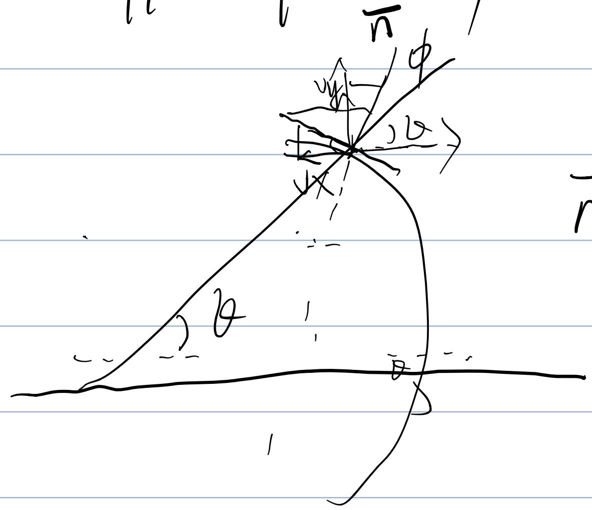
α is pressure angle $\Rightarrow \sin\alpha = \dfrac{V_y}{\sqrt{V_x^2+V_y^2}} \Rightarrow \tan\alpha = \dfrac{V_y}{V_x}$

$$\cos\alpha = \frac{V_x}{\ }$$

$\sqrt{v_x^2+v_y^2}$

$\therefore F_y = (F_s - ma) \cdot \frac{v_y}{v_x}$

According to Newton third law, the bearing offer force F_{By} that equal to F_y.



ϕ is the angle between $\bar{n}$ and $\overline{L(\theta)}$ $(\cos\theta, \sin\theta)$

$$\bar{n} = \left(-\frac{v_x}{v}, \frac{v_y}{v}\right)$$

$$= \frac{1}{\sqrt{L'^2+L^2}}\left[-L'\sin\theta - L\cos\theta, L'\cos\theta - L\sin\theta\right]$$

$$\frac{\bar{n}\cdot\overline{L(\theta)}}{|L|} = \frac{-L}{\sqrt{L'^2+L^2}}$$

$L = 2R - R\cos b\theta$

$L' = Rb\sin\theta$

$$= \frac{-2R + R\cos b\theta}{\sqrt{R^2b^2\sin^2 b\theta + 4R^2 + R^2\cos^2 b\theta - 4R^2\cos b\theta}}$$

Problem 5: Free-form CAD (20 points)

1. For the following three objects describe using words what steps you would perform to design 3D models of them in Fusion 360, turn these descriptions in on your pdf solutions.

2. In Fusion 360 construct 3D models of each of these objects. Use dimensions of your choice, they are not expected to be exact. Turn in a link to your objects in your solution pdf. Note, we will not penalize at all for dimensions, but all objects need to be topologically correct and should accurately represent the final objects (if your coffee cup has a hole in the bottom of it you will lose points). Color and material choice is not important, and objects should be modeled as a single solid body.

(a) A cup

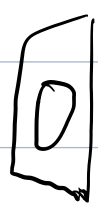
(b) A phone case

(c) A ping-pong paddle

(a) A cup. ①

extrude the body of the cup with a certain angle.

②

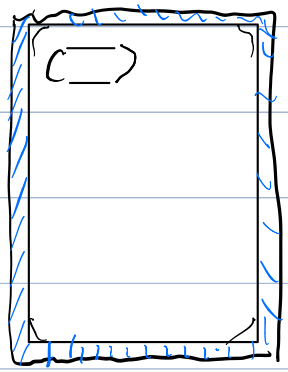


create the handle.

③ assemble the body and handle.

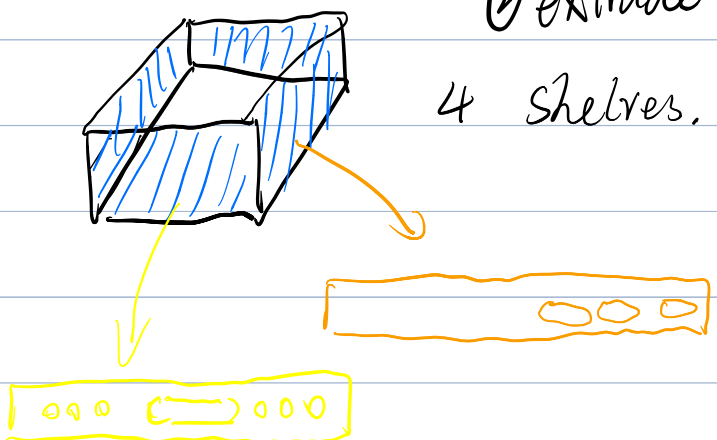
④ ~~curve~~ chamfer to make a smooth surface.

(b)



① creater the bottom of the case.

② extrude blue area in ① to create the 4 shelves.

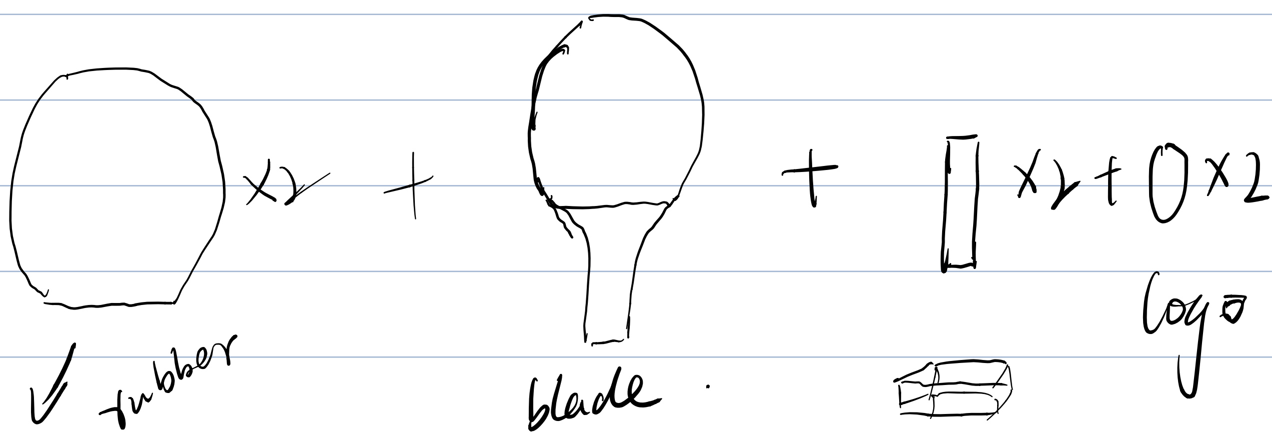


create volume-control button

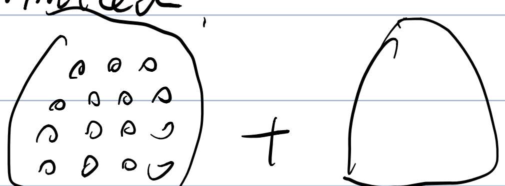
create microphone and charging ports

③ create chamfers to make a smooth surface.

(c)



or maybe can be divided in to sponge and rubber if time is permitted.



A:cup

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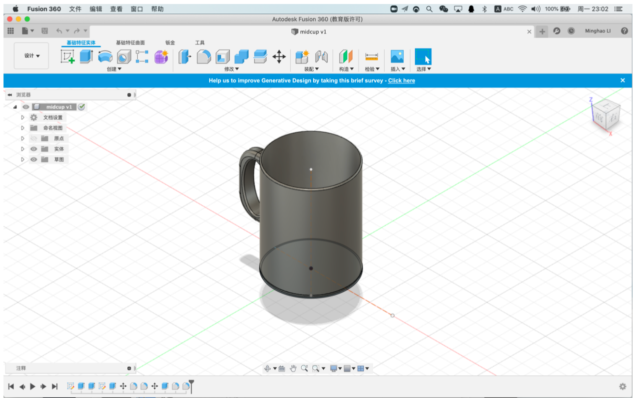
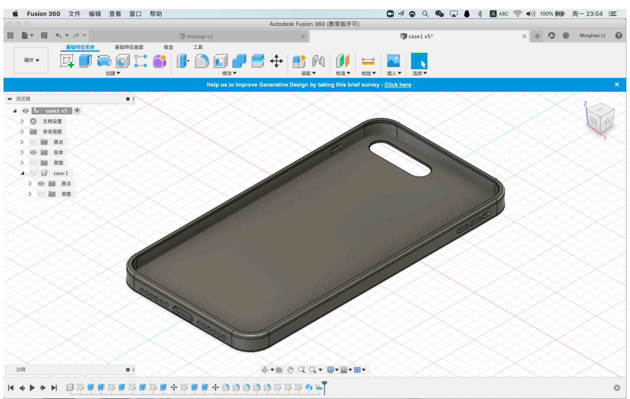


B: phone case

https://a360.co/3b2c7VW



C: pingpong blade

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