

ME224 – ASSIGNMENT 2

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Roll No. – 230103105

Sec. – B

Q1.

Q1) Analysis - Given:-

Translating flat face follower

a) $0^\circ \rightarrow 80^\circ \Rightarrow$ Dwell (Clockwise Rotation)

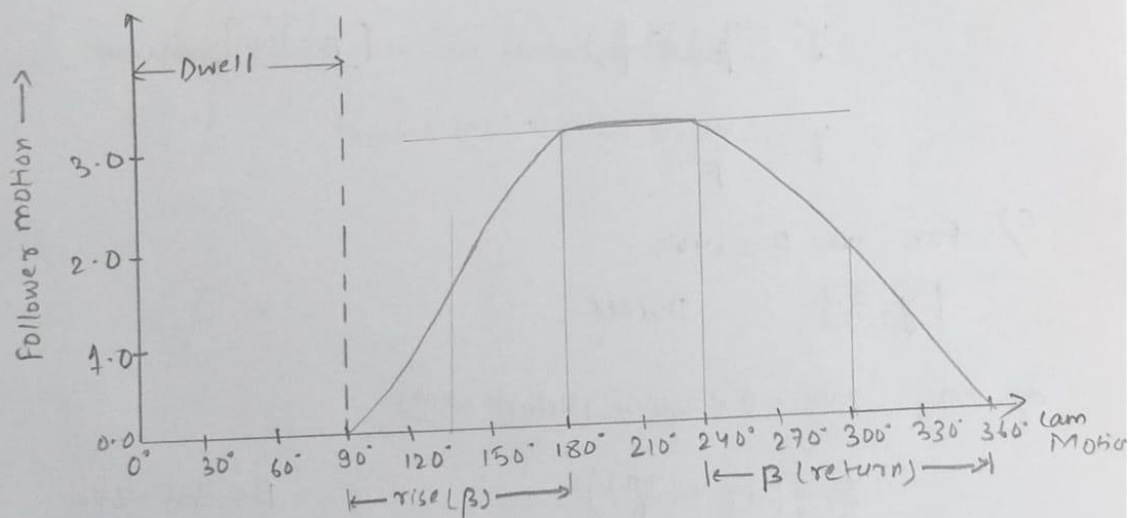
b) $80^\circ \rightarrow 180^\circ \Rightarrow$ rise (parabolic)

c) $180^\circ \rightarrow 240^\circ \Rightarrow$ Dwell

d) $240^\circ \rightarrow 360^\circ \Rightarrow$ Return (SHM)

amplitude $\Rightarrow 3 \text{ cm (h)}$

base circle radius (r_{bmin}) = ?



a) For $0^\circ \leq \theta \leq 80^\circ$;

$y = 0$ Dwell

$y' = 0$; $y'' = 0$

b) For $80^\circ \leq \theta \leq 180^\circ$ (Parabolic rise)

i) First part of rise; ($80^\circ \leq \theta \leq 130^\circ$)

$$y = 2L \left(\frac{\theta}{\beta} \right)^2$$

$$\beta = 180^\circ - 80^\circ$$

$$\Rightarrow y' = \frac{4L}{\beta} \left(\frac{\theta}{\beta} \right)$$

$$\boxed{\beta = 100^\circ}$$

$$\Rightarrow y'' = \frac{4L}{\beta^2}$$

ii) For the second part of rise; ($130^\circ \leq \theta \leq 180^\circ$)

$$y = L \left(1 - 2 \left(1 - \frac{\theta}{\beta} \right)^2 \right)$$

$$y' = \frac{4L}{\beta} \left(1 - \frac{\theta}{\beta} \right)$$

$$\boxed{\beta = 100^\circ}$$

$$y'' = -\frac{4L}{\beta^2}$$

c) For, $180^\circ \leq \theta \leq 240^\circ$;

$$\boxed{y = 3}$$

Drum

d) For, $240^\circ \leq \theta \leq 360^\circ$ - (Return stroke)

$$y = \frac{L}{2} \left(1 + \cos \left(\frac{\pi \theta}{\beta} \right) \right)$$

$$\beta = 360^\circ - 240^\circ$$

$$\Rightarrow y' = \frac{\pi}{2\beta} L \sin \left(\frac{\pi \theta}{\beta} \right)$$

$$\boxed{\beta = 120^\circ}$$

$$\Rightarrow y'' = -\frac{L}{2} \left(\frac{\pi}{\beta} \right)^2 \cos \left(\frac{\pi \theta}{\beta} \right)$$

c) For $180^\circ \leq \theta < 240^\circ$

$$\boxed{y = 4 \text{ cm}} \quad \text{Dwell}$$

d) For, $240^\circ \leq \theta < 360^\circ$; (SHM Descent)

$$\Rightarrow y = \frac{L}{2} \left(1 + \cos \frac{\pi \theta}{\beta} \right)$$

$$\beta = 360^\circ - 240^\circ$$

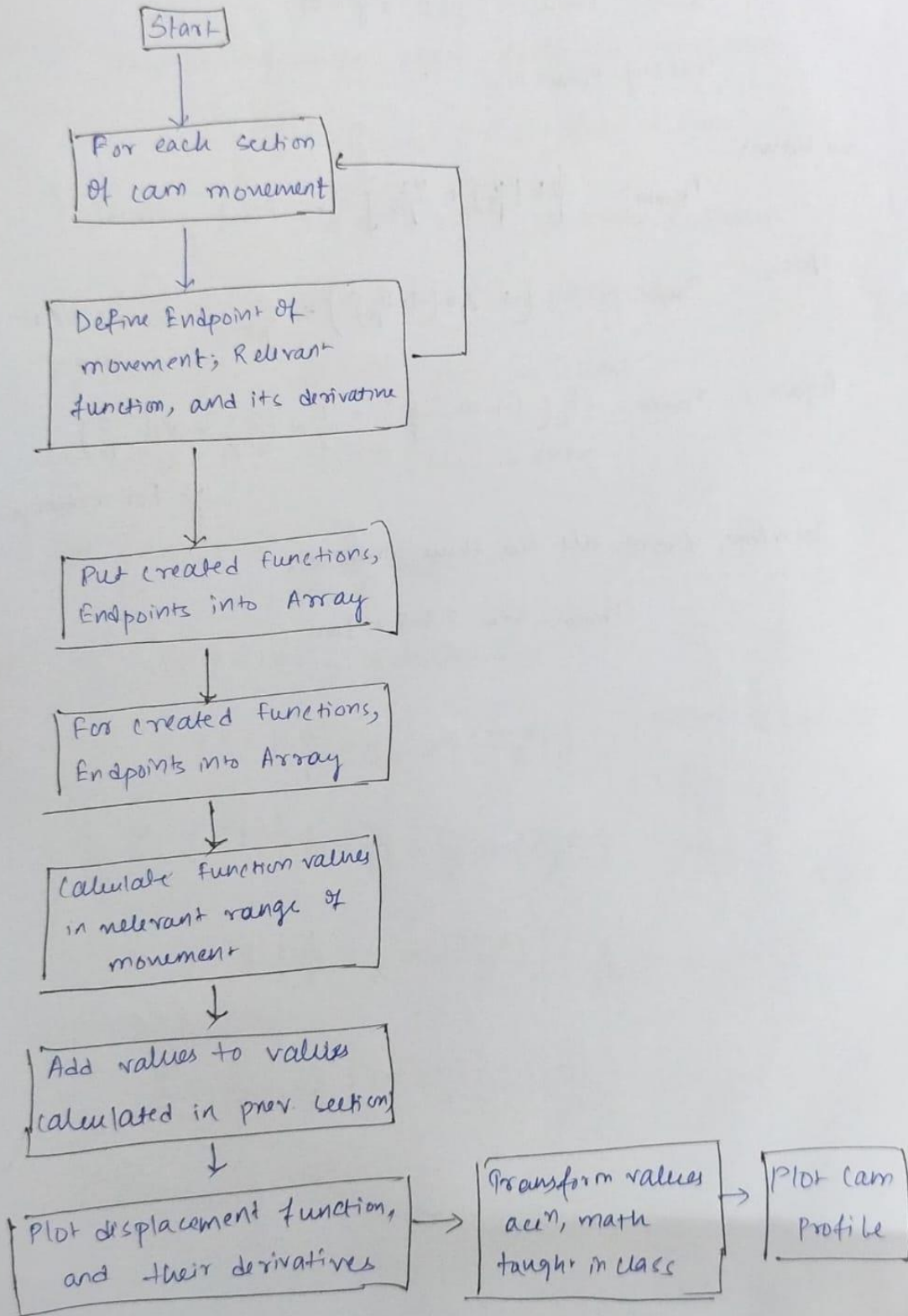
$$\boxed{\beta = 120^\circ}$$

$$\Rightarrow y' = \frac{L\pi}{2\beta} \left(-\sin \frac{\pi \theta}{\beta} \right) = -\frac{\pi L}{2\beta} \sin \left(\frac{\pi \theta}{\beta} \right)$$

$$\boxed{\theta \rightarrow \theta - 240^\circ}$$

$$\Rightarrow y'' = -\frac{\pi^2 L}{2\beta^2} \cos \left(\frac{\pi \theta}{\beta} \right)$$

2) Flowchart (Pseudocode) of Computations:-

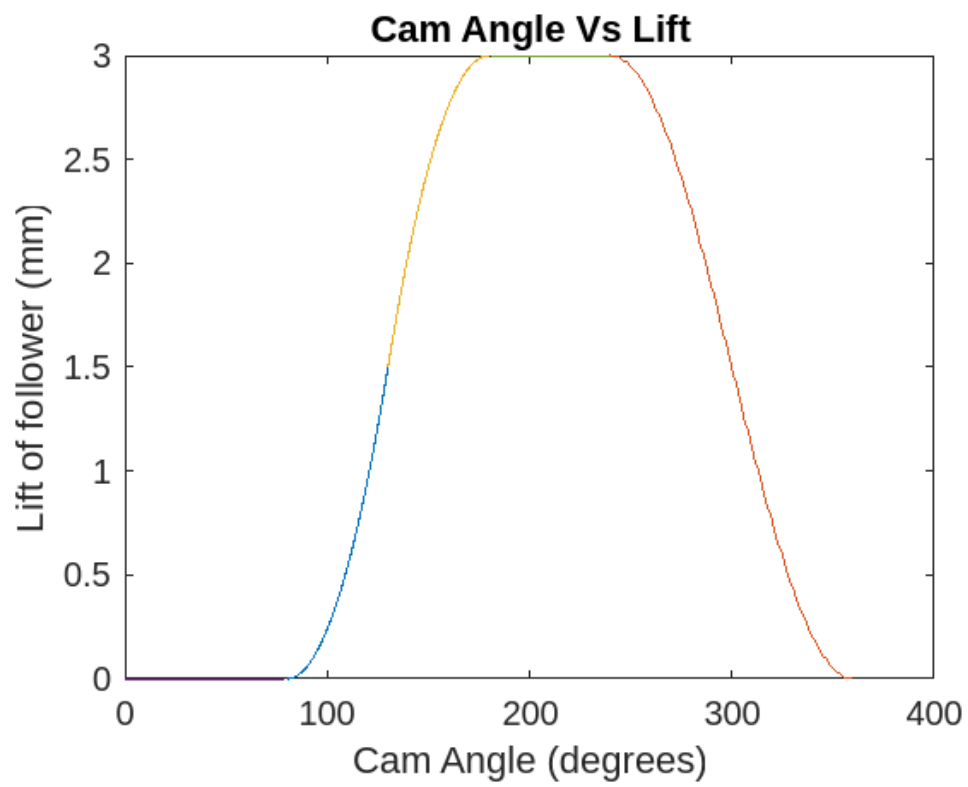


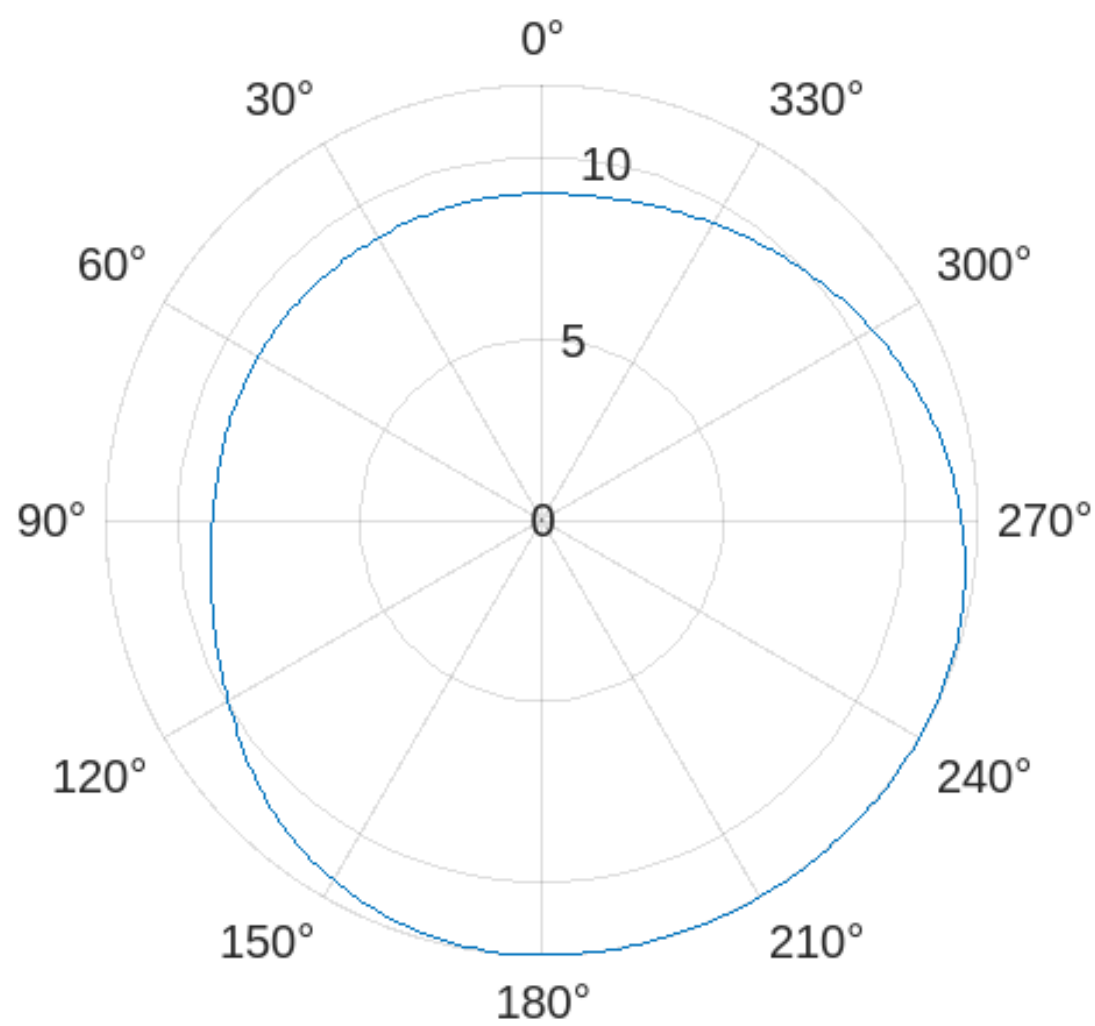
MATLAB CODE

```
clc
clear all
h=3;
r=9;
%Ascent and Descent Angles
dwell_1 = 80;
ascent = 100;
dwell_2 = 60;
descent = 360 -(ascent + dwell_1 + dwell_2);
%Additional Angles
after_dwell_1 = dwell_1 + ascent/2;
after_half_ascent = after_dwell_1 + ascent/2;
after_dwell_2 = after_half_ascent + dwell_2;
final = after_dwell_2 + descent;
%Cam Angle
theta = linspace(0,360,361);
%Ascent Motion Conditions
h_half_ascent = (2*h).*((theta(theta<=ascent/2))/ascent).^2);
h_Ahalf_ascent = h.*(1-2*(1-(theta(theta>=ascent/2 &
theta<=100)/ascent)).^2);
%Descent Motion Conditions
h_descent = h-((0.5*h).*(1 - cosd((180/descent).*theta(theta<=descent))));
%Lift during Dwell
h_dwell1 = zeros(1,dwell_1);
h_dwell2 = ones(1,dwell_2).*h;
%Plotting Cam Angle Vs Lift
plot(theta(theta>=dwell_1 & theta<=after_dwell_1),h_half_ascent,
theta(theta>=after_dwell_2 & theta<=final),h_descent);
hold on
plot(theta(theta>=after_dwell_1 & theta<=after_half_ascent),
h_Ahalf_ascent);
hold on
plot(theta(theta<dwell_1), h_dwell1 , theta(theta>after_half_ascent &
theta<=after_dwell_2),h_dwell2);
title('Cam Angle Vs Lift')
xlabel('Cam Angle (degrees)');
ylabel('Lift of follower (mm)');
%Defining radii during different phases of Cam
r1 = r + h_dwell1;
r2 = r + h_half_ascent(h_half_ascent<1.5);
r3 = r + h_Ahalf_ascent(h_Ahalf_ascent<3);
r4 = r + h_dwell2;
r5 = r + h_descent;
%Joining all radii
r = [r1 r2 r3 r4 r5];
%Convert theta to radians
theta_radians = deg2rad(theta);
%Plotting Cam Profile
figure
polarplot(theta_radians,r);
set(gca,'ThetaZeroLocation','top')
%Converting Polar to Cartesian Coordinate System
[x,y] = pol2cart(theta_radians,r);
x_cord = transpose(x);
y_cord = transpose(y);
```

```
z_cord = zeros(361,1);  
cam_profile = [x_cord y_cord z_cord];
```

%end of code





Q2.

Q2) Analysis:- We have:-

Given:-

Translating knife edged follower translation,

$$h = 4 \text{ cm}; r_{\text{bmin}} = 5 \text{ cm}; \text{offset} = 0.5 \text{ cm}$$

a) Dwell $\Rightarrow 0 \leq \theta < 80^\circ$ - clockwise rotation

b) Rise $\Rightarrow 80^\circ \leq \theta < 180^\circ$ - cycloidal

c) Dwell $\Rightarrow 180^\circ \leq \theta < 240^\circ$ - Dwell

d) Descent $\Rightarrow 240^\circ \leq \theta < 360^\circ \rightarrow \text{SHM}$

a) For $0 \leq \theta < 80^\circ$ $y = 0$ Dwell

b) For $80^\circ \leq \theta < 180^\circ$; cycloidal rise

$$y = L \left(\frac{\theta}{\beta} - \frac{1}{2\pi} \sin \left(\frac{2\pi\theta}{\beta} \right) \right)$$

$$\text{where, } \beta = 180^\circ - 80^\circ$$

$$\boxed{\beta = 100^\circ}$$

$$\Rightarrow y' = L \left(\frac{1}{\beta} - \frac{1}{2\pi} \times \frac{2\pi}{\beta} \cos \left(\frac{2\pi\theta}{\beta} \right) \right)$$

$$\text{Also, } \boxed{\theta \rightarrow 0^\circ - 80^\circ}$$

$$\Rightarrow y' = L \left(\frac{1}{\beta} - \frac{1}{\beta} \cos \left(\frac{2\pi\theta}{\beta} \right) \right) = \frac{L}{\beta} (1 - \cos \frac{2\pi\theta}{\beta})$$

$$\text{Also, } y'' = \frac{L}{\beta} \times \frac{2\pi}{\beta} \left(\sin \frac{2\pi\theta}{\beta} \right) = \frac{2\pi L}{\beta^2} \sin \left(\frac{2\pi\theta}{\beta} \right)$$

Also, we know that:

$$\tau_{bmin} = P_{min} - (y(0) + y''(0))$$

$$\text{Taking } P_{min} = 0;$$

we have:-

$$\tau_{bmin} = -\left\{ L\left(\frac{\theta}{\beta}\right)^2 + \frac{4L}{\beta^2} \right\} \Rightarrow \text{first part rise}$$

Also,

$$\tau_{bmin} = -L\left(1 - 2 \times \left(1 - \frac{\theta}{\beta}\right)^2\right) + \frac{4L}{\beta^2} \Rightarrow \text{second part rise}$$

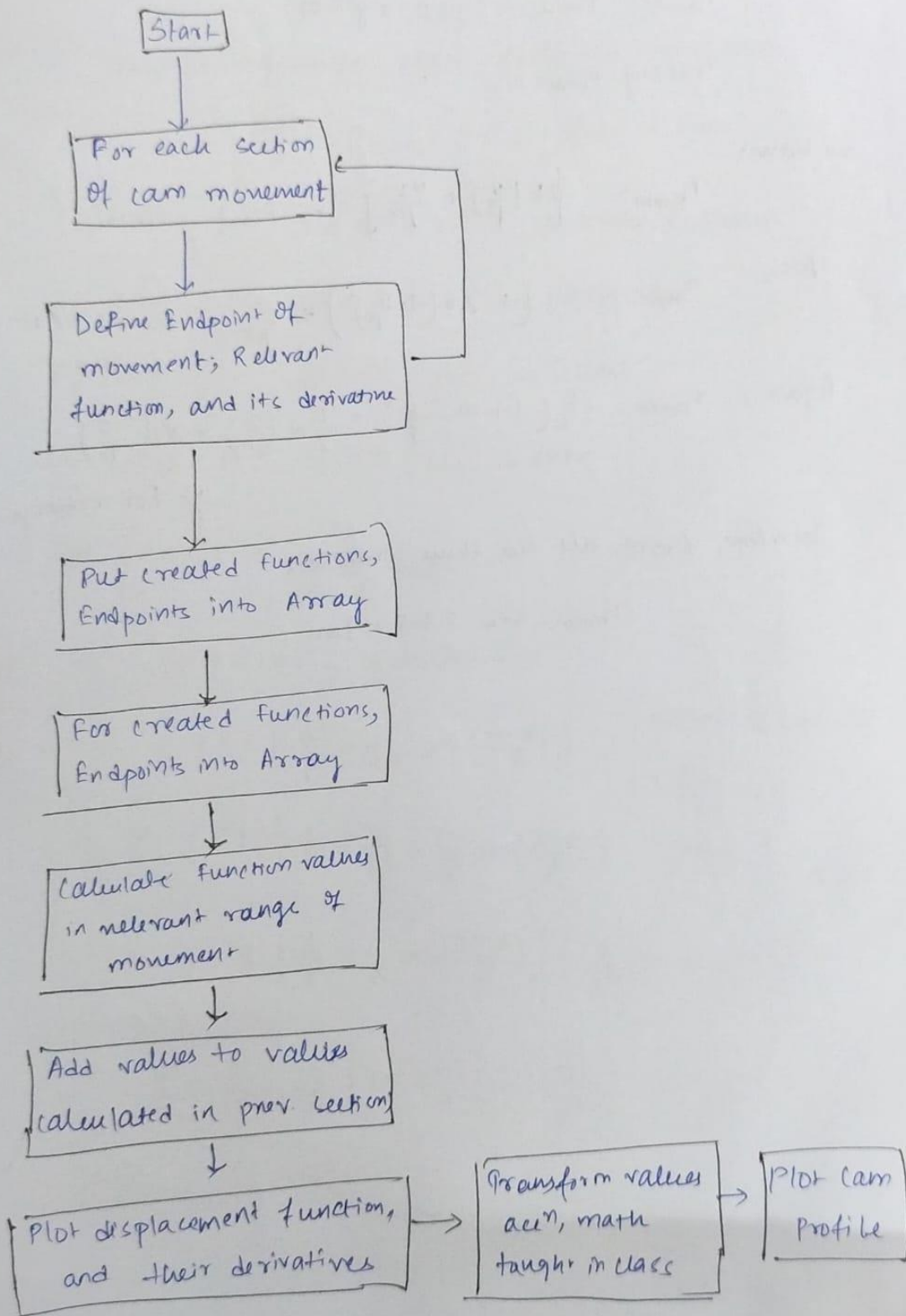
$$\text{Again, } \tau_{bmin} = -\frac{L}{2}\left(1 + \cos\left(\frac{\pi\theta}{\beta}\right)\right) + \frac{L}{2} \times \left(\frac{\pi}{2}\right)^2 \times \cos\left(\frac{\pi\theta}{\beta}\right)$$

\Rightarrow for return.

Therefore, from all the three conditions,

$$\tau_{bmin} = 3 \times L = 3 \times 3 = 9 \text{ cm}$$

2) Flowchart (Pseudocode) of Computations:-

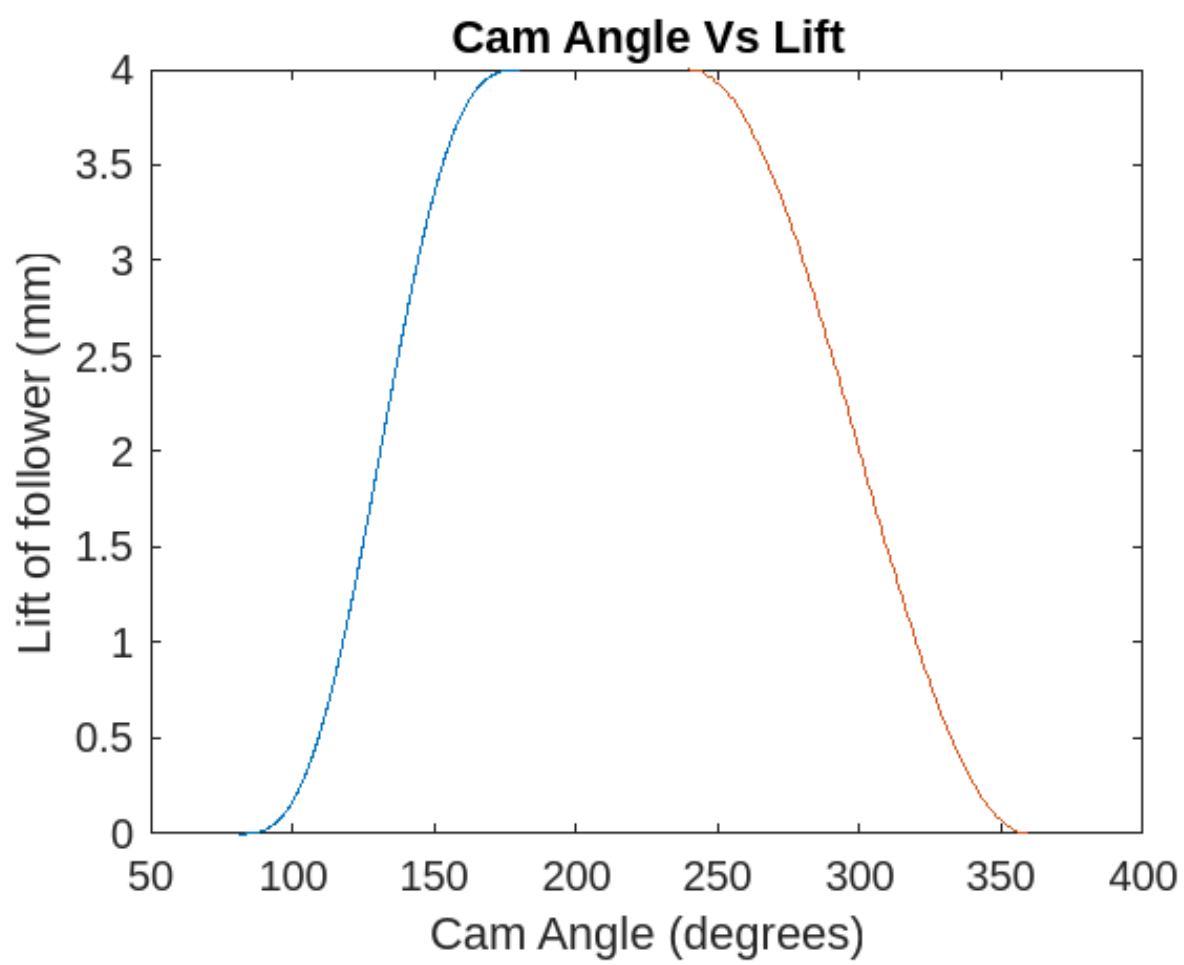


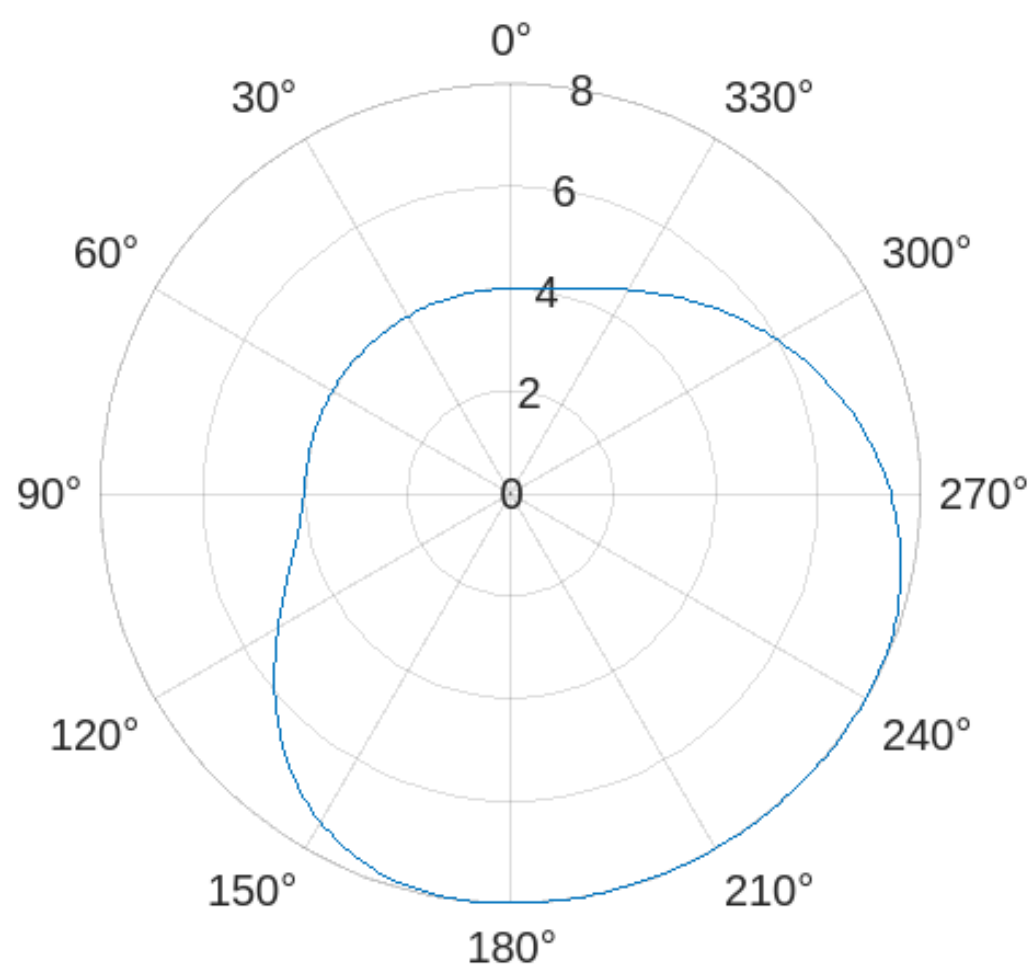
```

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clear all
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r=4;
%Ascent and Descent Angles
dwell_1 = 80;
ascent = 100;
dwell_2 = 60;
descent = 360 -(ascent + dwell_1 + dwell_2);
%Additional Angles
after_dwell_1 = dwell_1 + ascent;
after_dwell_2 = after_dwell_1 + dwell_2;
%Cam Angle
theta = linspace(0,360,361);
%Ascent Motion Conditions
h_ascent = (h/pi)*(((pi/ascent).*theta(theta<ascent)) -
0.5*sind((2*180/ascent).*theta(theta<ascent)));
%Descent Motion Conditions
h_descent = h-((0.5*h).*(1 - cosd((180/descent).*theta(theta<=descent))));
%Lift during Dwell
h_dwell1 = zeros(1,dwell_1);
h_dwell2 = ones(1,dwell_2).*h;
%Plotting Cam Angle Vs Lift
plot(theta(theta>dwell_1 & theta<=after_dwell_1),h_ascent,
theta(theta>=after_dwell_2 & theta<=360),h_descent);
title('Cam Angle Vs Lift')
xlabel('Cam Angle (degrees)');
ylabel('Lift of follower (mm)');
%Defining radii during different phases of Cam
r1 = r + h_dwell1;
r2 = r + h_ascent;
r3 = r + h_dwell2;
r4 = r + h_descent;
%Joining all radii
r = [r1 r2 r3 r4];
%Convert theta to radians
theta_radians = deg2rad(theta);
%Plotting Cam Profile
figure
polarplot(theta_radians,r);
set(gca,'ThetaZeroLocation','top')
%Converting Polar to Cartesian Coordinate System
[x,y] = pol2cart(theta_radians,r);
x_cord = transpose(x);
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z_cord = zeros(361,1);
cam_profile = [x_cord y_cord z_cord];

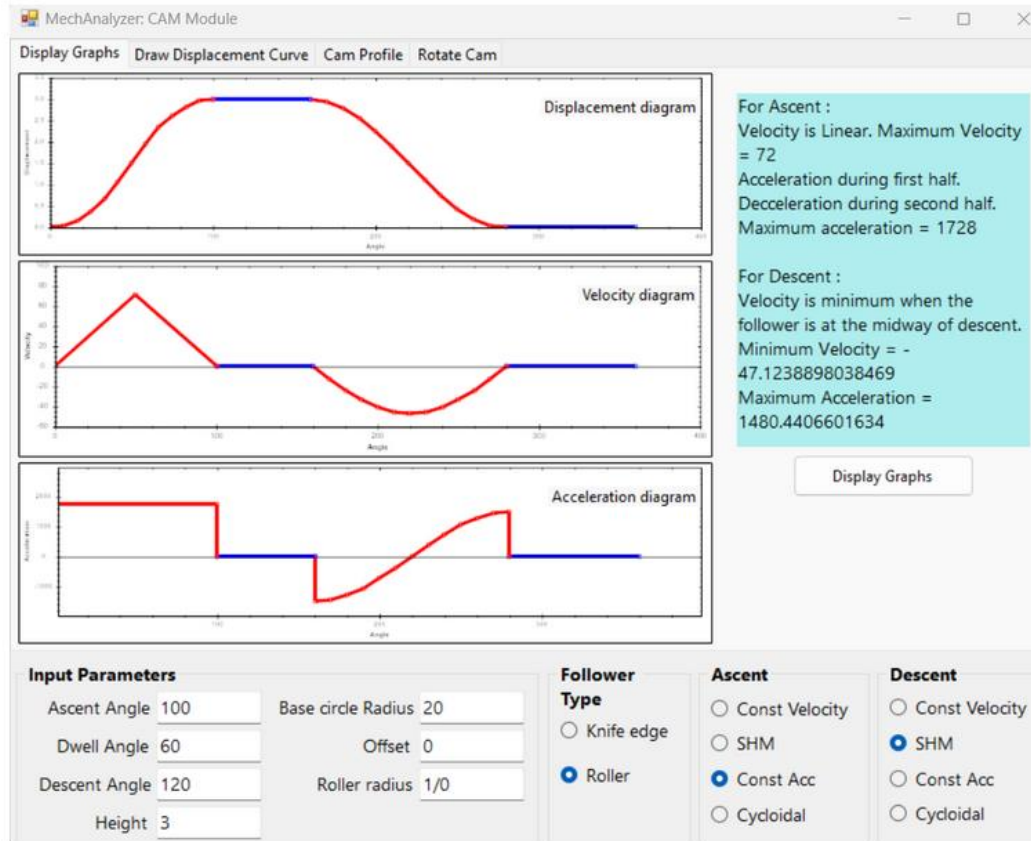
%END OF CODE

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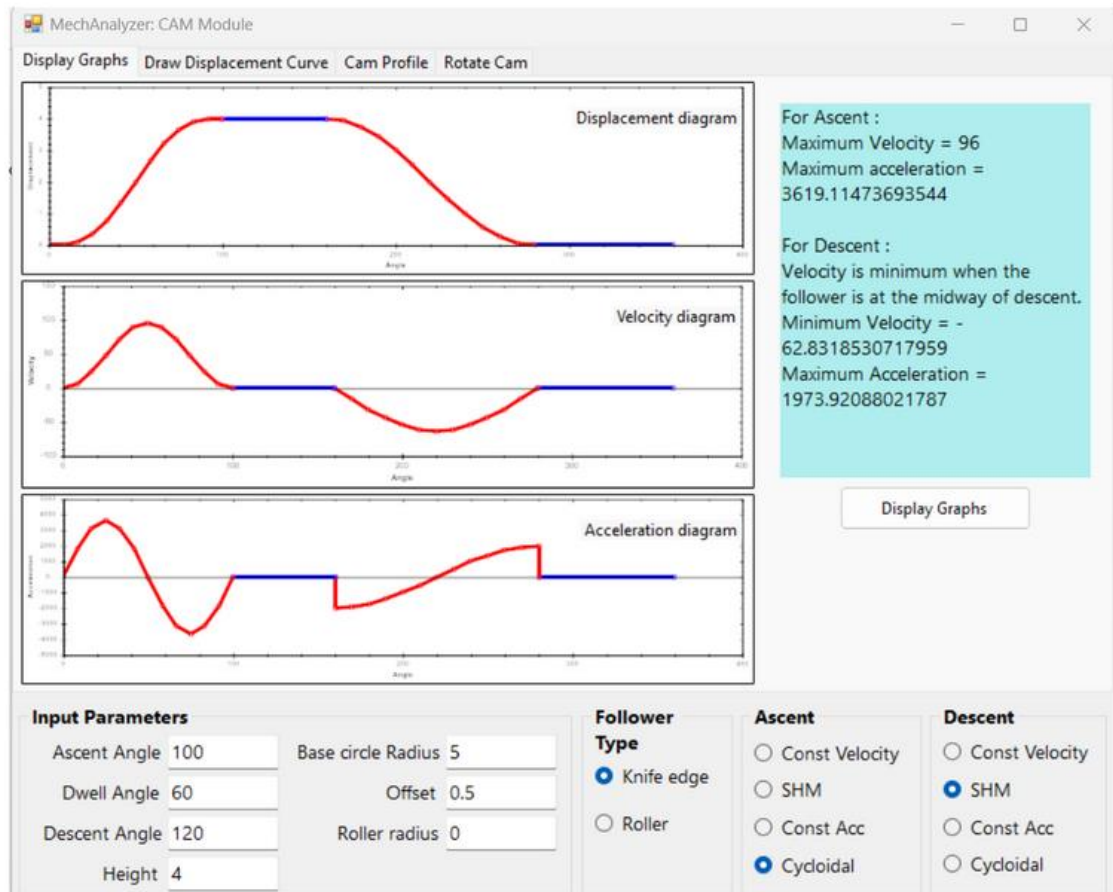


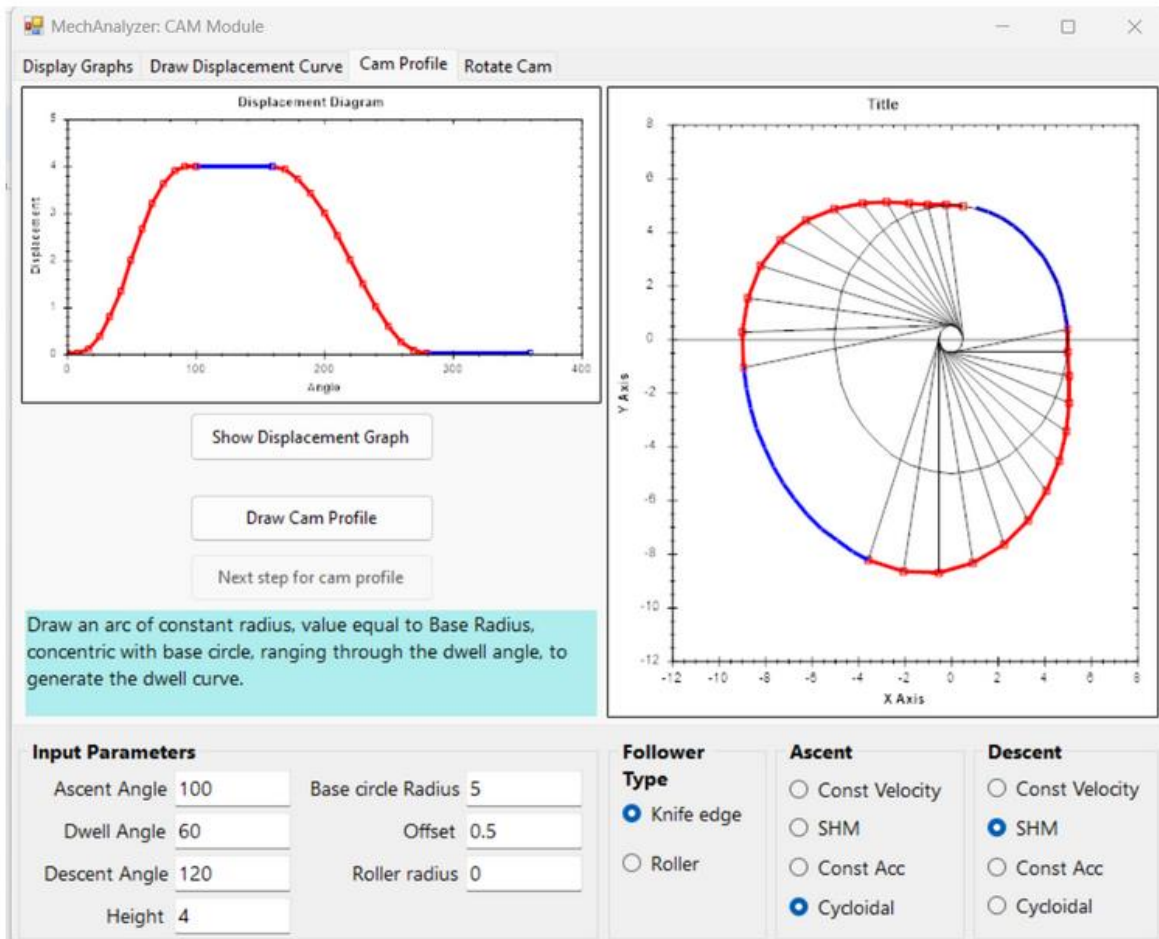


ADDITIONAL PLOT1



Additional PLOT2





THANK YOU!