Kinematics Of Machinary

Assignment -2

Name- Nidhi Singh

Roll NO-210103127

Branch-Mechanical Engineering

Section- B

= Quest =

Name: Nidhi Singh
Roll no: 210103127
Section: ME(B)

= Analysis: We have:

Given:

Translating flat face follower

(a) $0° \to 80°$ = Dwell (clockwise rotation)

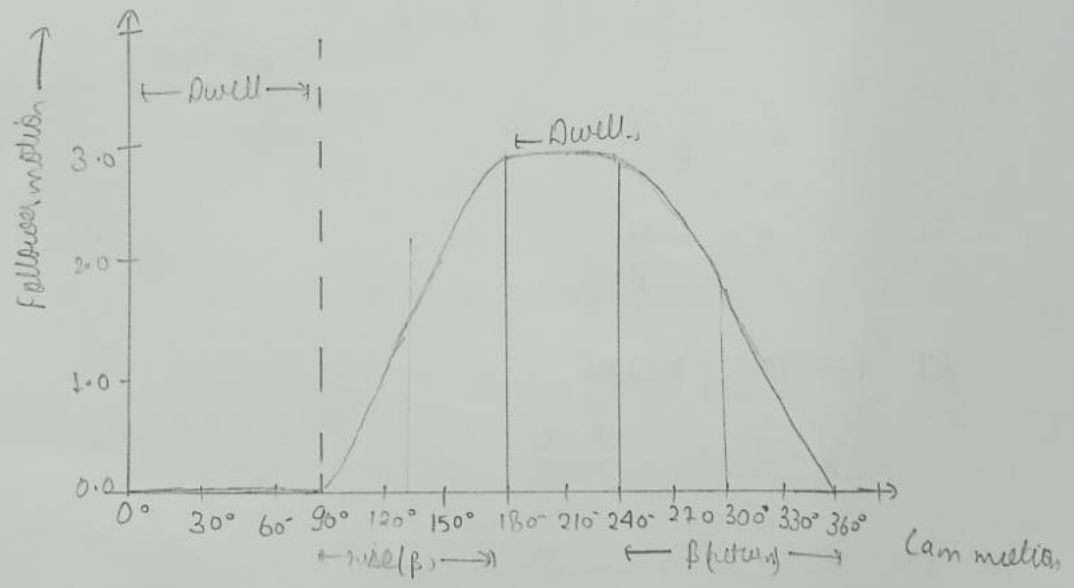
(b) $80° \to 180°$ = rise (parabolic)

(c) $180° \to 240°$ = Dwell

(d) $240° \to 360°$ = return (SHM)

amplitude = 3 cm (h)

base circle radius ($r_{b\,min}$) = ?



(a) For $0° \le \theta \le 80°$;

$\boxed{y = 0}$ Dwell

$\boxed{y' = 0}$; $\boxed{y'' = 0}$

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

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

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

$\beta = 180° - 80°$

$\beta = 100°$

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

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

(ii) For the second part of rise;

$(130° \leq \theta \leq 180°)$

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

$\beta = 100°$

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

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

(c) For $180° \leq \theta \leq 240°$;

$y = 3$ Dwell

(d) For $240° \leq \theta \leq 360°$ — (Return SHM)

$\beta = 360° - 240°$

$\beta = 120°$

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

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

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

Also we know that:

$$r_{b\,min} = f_{min} - [y(0) + y''(0)]$$

Taking $f_{min} = 0$;

We have:

$$r_{b\,min} = -\left\{2L\left(\frac{\theta}{\beta}\right)^2 + \frac{4L}{\beta^2}\right\} \Rightarrow \text{First part rise}$$

Also,

$$r_{b\,min} = -L\left[1-2\times\left(1-\frac{\theta}{\beta}\right)^2\right] + \frac{4L}{\beta^2} \Rightarrow \text{second part rise}$$

Again

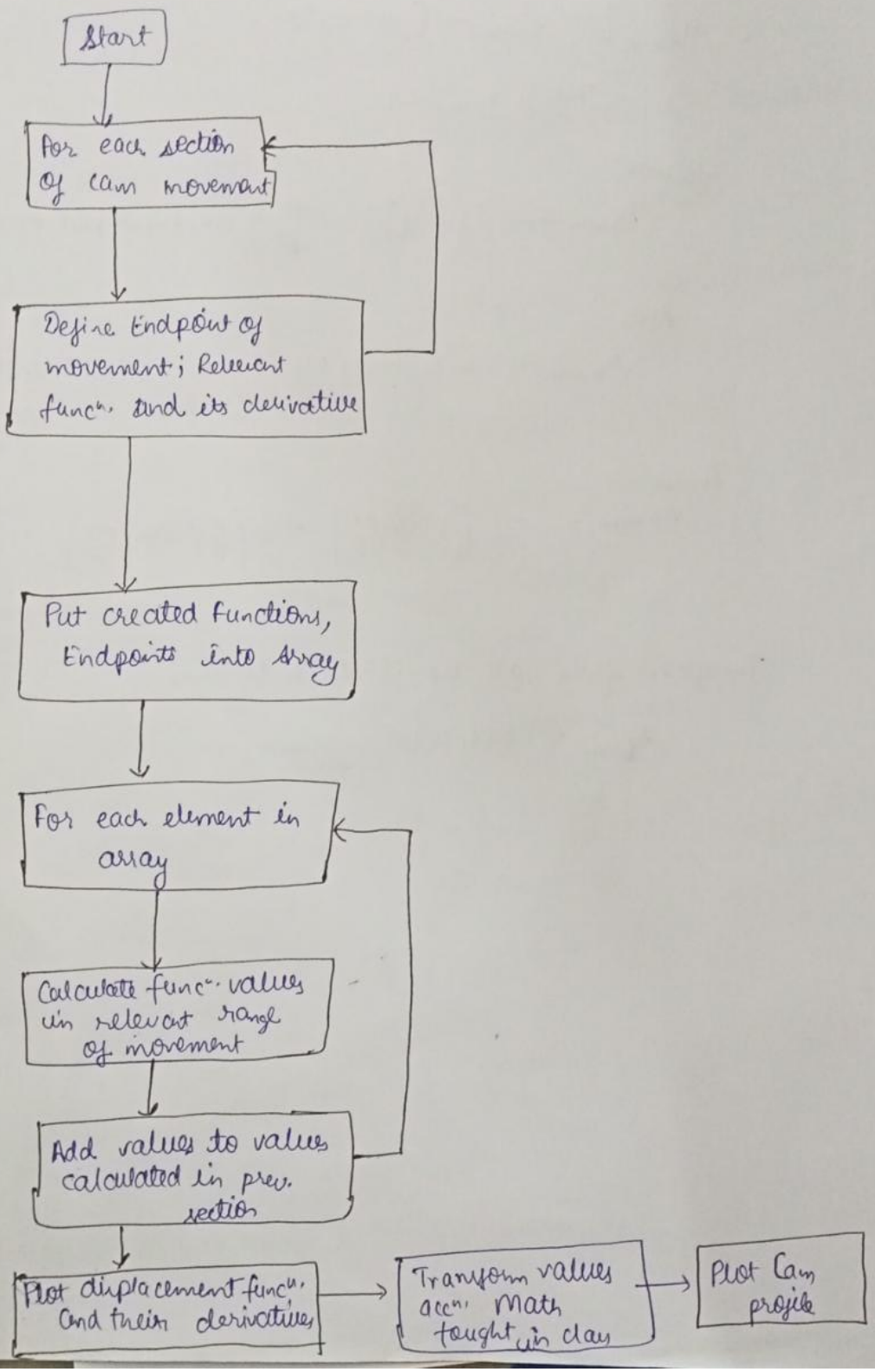
$$r_{b\,min} = \frac{-L}{2}\left(1+\cos\frac{\pi\theta}{\beta}\right) + \frac{L}{2}\left(\frac{\pi}{\beta}\right)^2\cos\left(\frac{\pi\theta}{\beta}\right)$$

$\Rightarrow$ For return.

Therefore, from all the three conditions;

$$r_{f\,min} = 3\times L = 3\times 3 = \underline{\underline{9\ cm}}$$

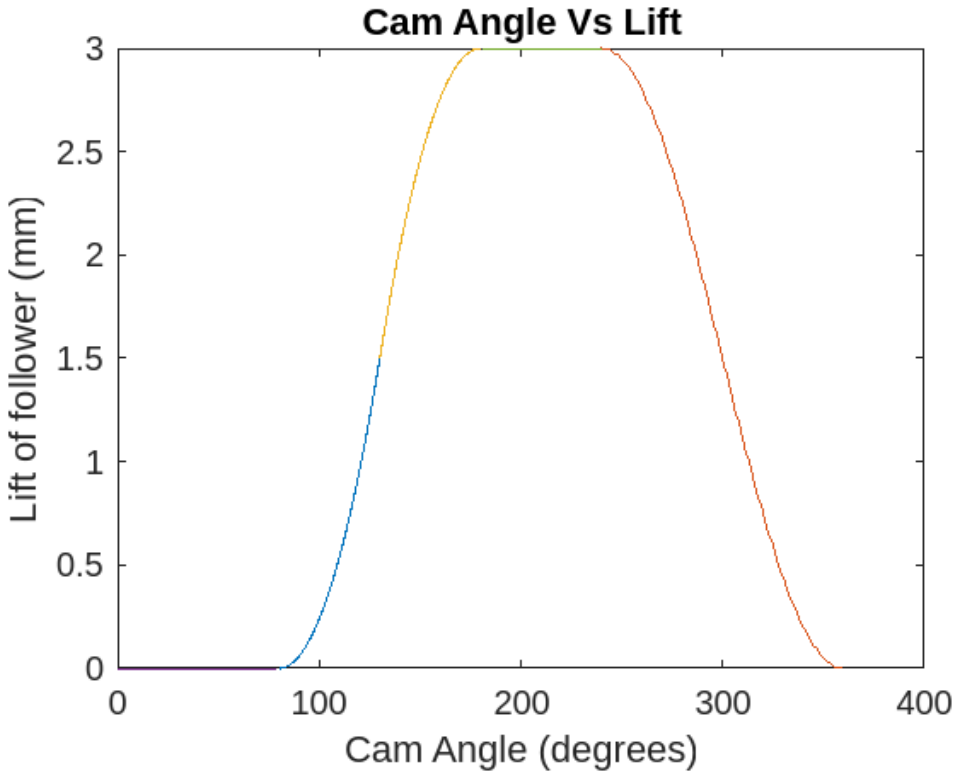
(2) Flowchart (Pseudocode) of computations :-

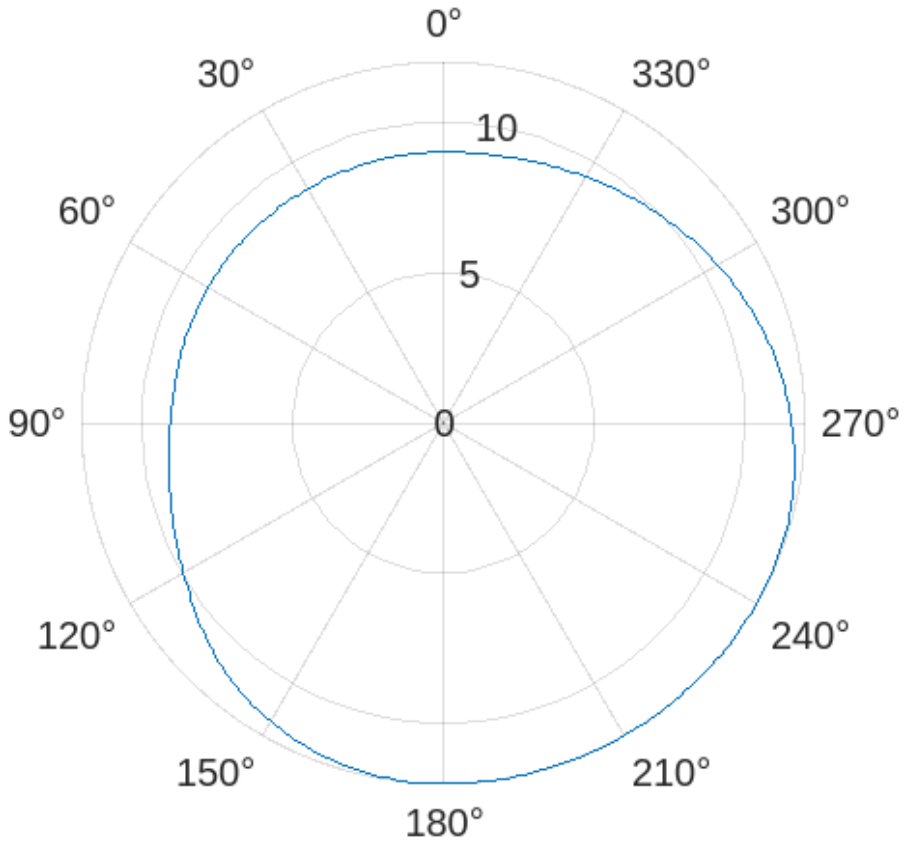


MATLAB CODE :

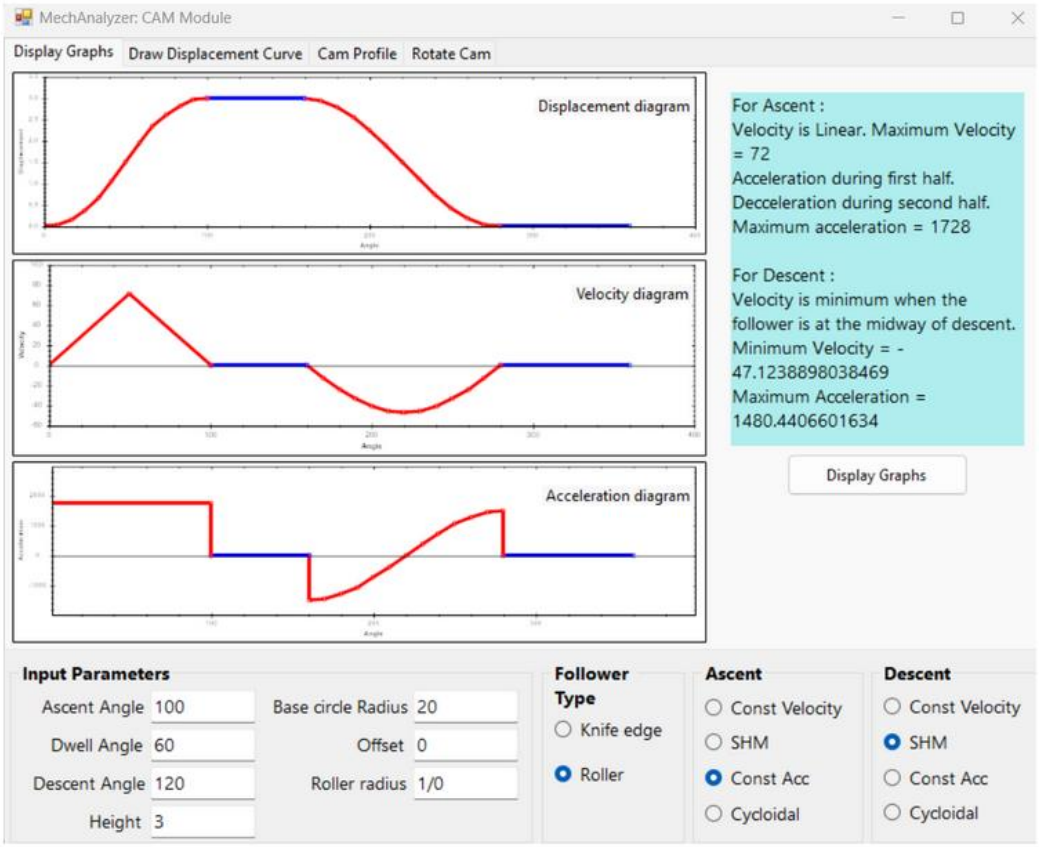
```
%Question1 : Cam profile generation in MATLAB (Translating flat follower)

clc
clear all

height=3;
radius_base=9;

%Ascent and Descent Angles
dwell1 = 80;
ascent  = 100;
dwell2 = 60;
descent = 360 -(ascent + dwell1 + dwell2);

%Additional Angles
afterdwell1 = dwell1 + ascent/2;
afterhalf_ascent = afterdwell1 + ascent/2;
afterdwell2 = afterhalf_ascent + dwell2;
final = afterdwell2 + descent;

%Cam Angle
theta = linspace(0,360,361);

%Ascent Motion Conditions
 hhalfascent = (2*height).*(((theta(theta<=ascent/2))/ascent).^2);
 hAhalfascent = height.*(1-2*(1-(theta(theta>=ascent/2 & theta<=100)/ascent)).^2);
%Descent Motion Conditions
 h_descent = height-((0.5*height).*(1 -
cosd((180/descent).*theta(theta<=descent))));

%Lift during Dwell
hdwell1 = zeros(1,dwell1);
hdwell2 = ones(1,dwell2).*height;

%Plotting Cam Angle Vs Lift
plot(theta(theta>=dwell1 & theta<=afterdwell1),hhalfascent,
theta(theta>=afterdwell2 & theta<=final),h_descent);
hold on
plot(theta(theta>=afterdwell1 & theta<=afterhalf_ascent), hAhalfascent);
hold on
plot(theta(theta<dwell1), hdwell1 , theta(theta>afterhalf_ascent &
theta<=afterdwell2),hdwell2);

title('Cam Angle Vs Lift')
xlabel('Cam Angle (degrees)');
ylabel('Lift of follower (mm)');


%Defining radii during different phases of Cam
r1 = radius_base + hdwell1;
r2 = radius_base + hhalfascent(hhalfascent<1.5);
r3 = radius_base + hAhalfascent(hAhalfascent<3);
r4 = radius_base + hdwell2;
r5 = radius_base + h_descent;

%Joining all radii
```

```
radius_base = [r1 r2 r3 r4 r5];

%Convert theta to radians
theta_radians = deg2rad(theta);

%Plotting Cam Profile
figure
polarplot(theta_radians,radius_base);
set(gca,'ThetaZeroLocation','top')

%Converting Polar to Cartesian Coordinate System
[x,y] = pol2cart(theta_radians,radius_base);
x_cord = transpose(x);
y_cord = transpose(y);
z_cord = zeros(361,1);

cam_profile = [x_cord y_cord z_cord];
% Code ends here--Thankyou--
```


Cam Angle Vs Lift
Lift of follower (mm)
Cam Angle (degrees)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400


0°
30°
330°
10
60°
300°
5
90°
0
270°
120°
240°
150°
210°
180°

Additional Plots



(Dwell 1 taken in last segment)

Ques2

⇒ Ques2 ⇐

⇒ Analysis:- We have:

Given:

Translating knife edged follower translation,

$h = 4cm$;

$r_{bmin} = 5\ cm$; Offset $= 0.5cm$.

(a) Dwell ⇒ $0 < \theta \leq 80°$ – clockwise rotation

(b) Rise ⇒ $80° \leq \theta < 180°$ – Cycloidal

(c) Dwell ⇒ $180° \leq \theta < 240°$ – Dwell

(d) Descent ⇒ $240° \leq \theta \leq 360°$ → SHM.

(a) For $0 < \theta < 80°$

$\boxed{y = 0}$, Dwell

(b) For $80° \leq \theta \leq 180°$, cycloidal rise

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

where $\beta = 180° - 180°$

$\Rightarrow \boxed{\beta = 100°}$

Also; $\boxed{\theta \to \theta - 80°}$

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

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

Also;

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

(c) For $180° \le \theta < 240°$

$\Rightarrow \boxed{y = 4cm}$ Dwell.

(d) For $240° \le \theta < 360°$; (SHM descent)

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

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

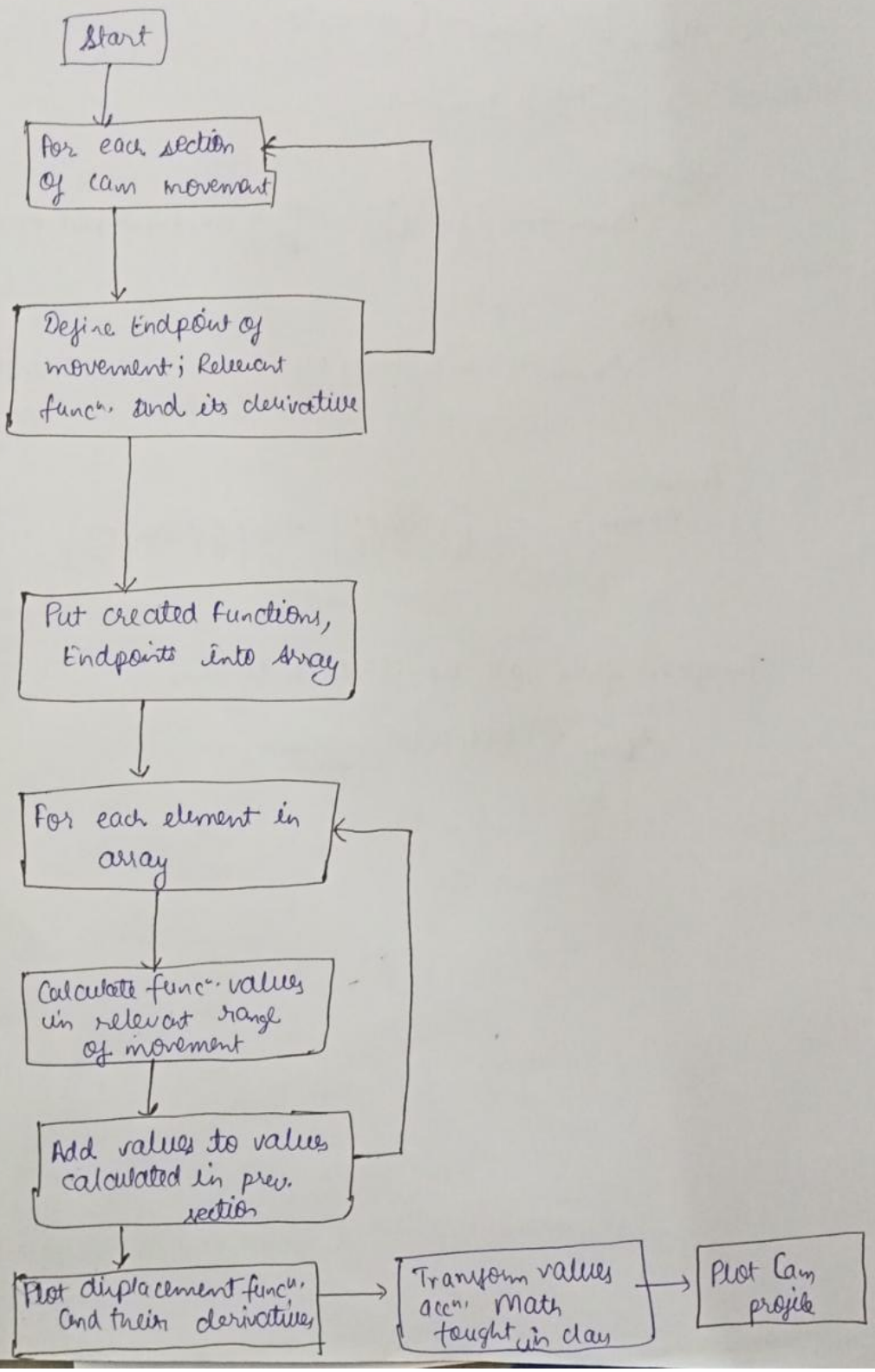
$$\Rightarrow y'' = -\frac{\pi^2 L}{2\beta^2}\cos\frac{\pi\theta}{\beta}.$$

$\beta = 360° - 240°$

$\Rightarrow \boxed{\beta = 120°}$

$\boxed{\theta \to \theta - 240°}$

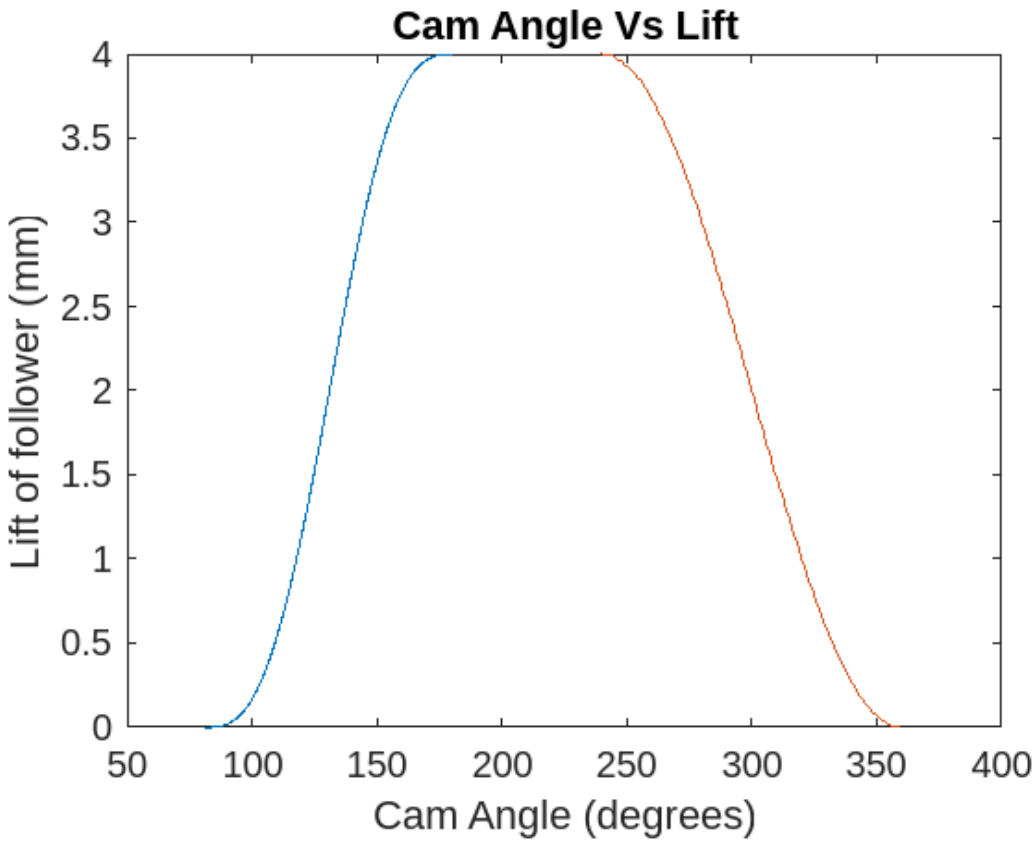
(2) Flowchart (Pseudocode) of computations :-

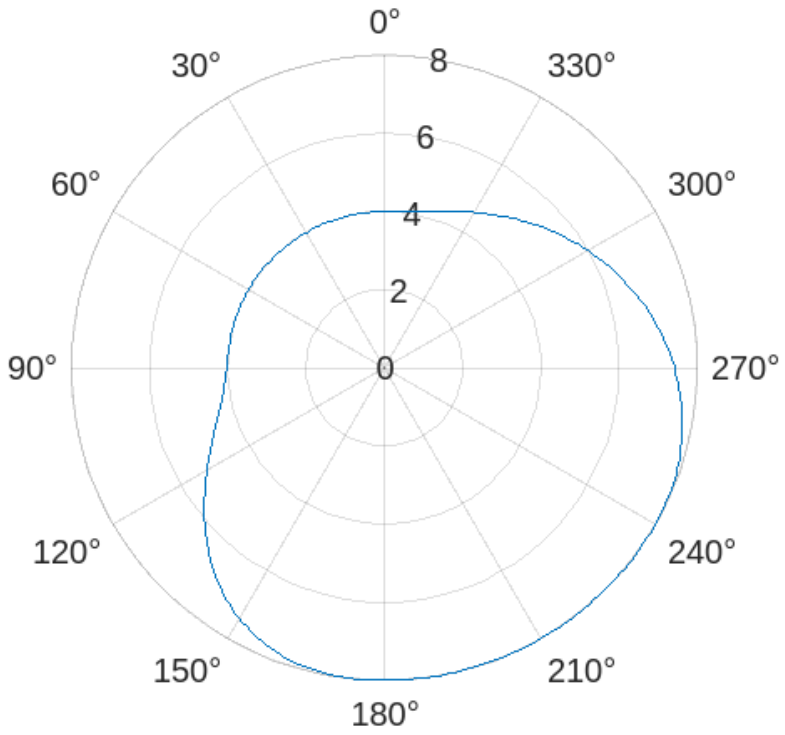


MATLAB CODE(Ques2)

```
%Ques2 : Cam profile generation in MATLAB(Knife edge follower)

clc
clear all

h=4;
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')
```

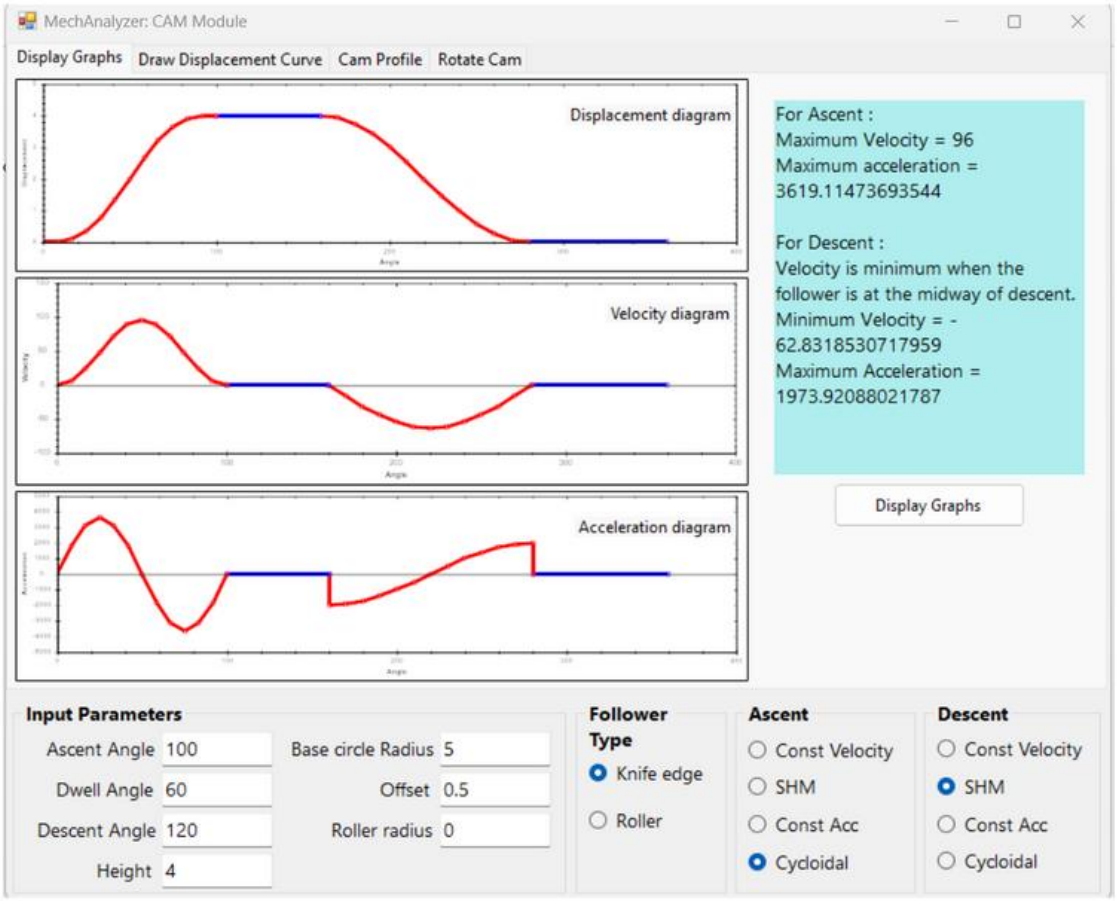
```
%Converting Polar to Cartesian Coordinate System
[x,y] = pol2cart(theta_radians,r);
x_cord = transpose(x);
y_cord = transpose(y);
z_cord = zeros(361,1);

cam_profile = [x_cord y_cord z_cord];
```

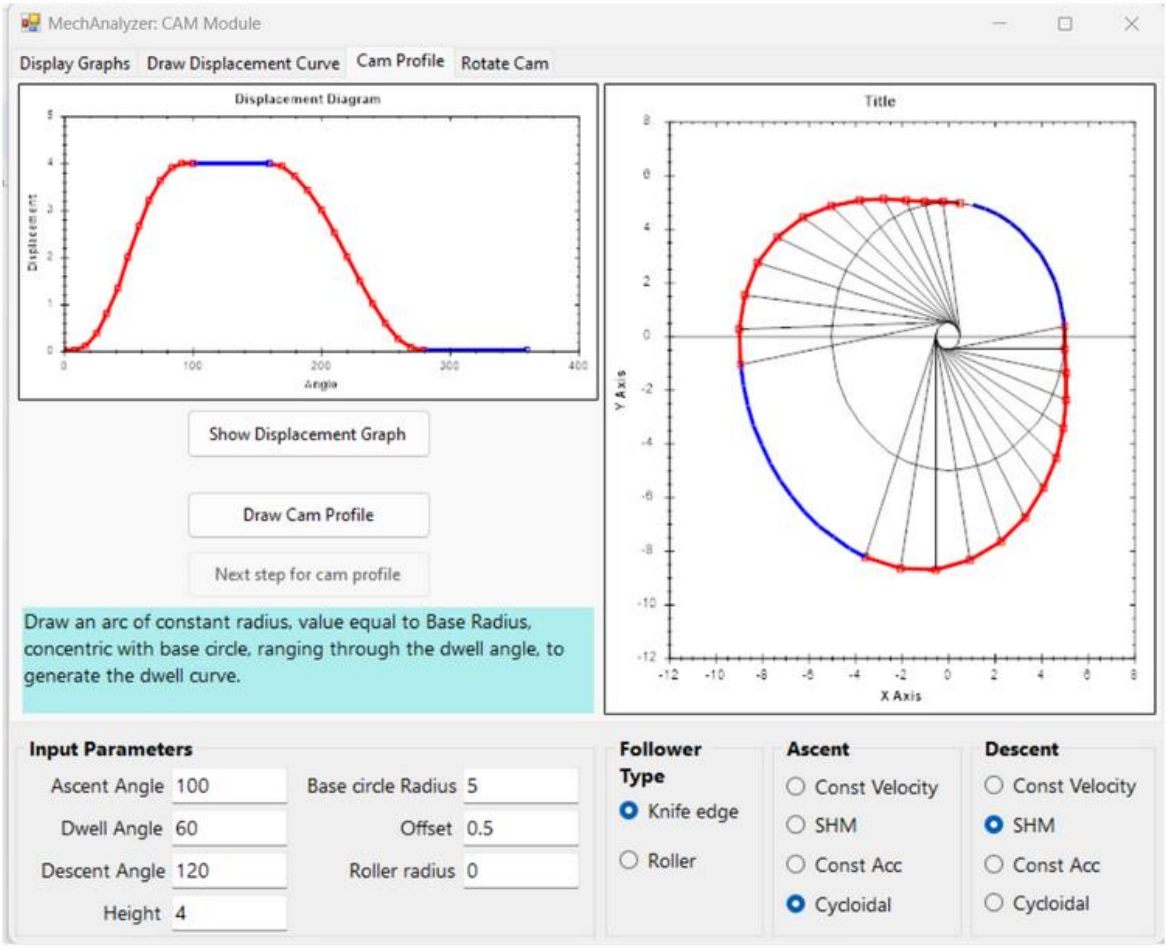

Cam Angle Vs Lift
Lift of follower (mm)
Cam Angle (degrees)
0
0.5
1
1.5
2
2.5
3
3.5
4
50
100
150
200
250
300
350
400



CAM PROFILE FOR QUES2

Additional Plots


MechAnalyzer: CAM Module
Display Graphs
Draw Displacement Curve
Cam Profile
Rotate Cam
Displacement diagram
Velocity diagram
Acceleration diagram
For Ascent :
Maximum Velocity = 96
Maximum acceleration =
3619.11473693544
For Descent :
Velocity is minimum when the
follower is at the midway of descent.
Minimum Velocity = -
62.8318530717959
Maximum Acceleration =
1973.92088021787
Display Graphs
Input Parameters
Ascent Angle 100
Dwell Angle 60
Descent Angle 120
Height 4
Base circle Radius 5
Offset 0.5
Roller radius 0
Follower Type
Knife edge
Roller
Ascent
Const Velocity
SHM
Const Acc
Cycloidal
Descent
Const Velocity
SHM
Const Acc
Cycloidal


MechAnalyzer: CAM Module
Display Graphs
Draw Displacement Curve
Cam Profile
Rotate Cam
Displacement Diagram
Displacement
Angle
Show Displacement Graph
Draw Cam Profile
Next step for cam profile
Draw an arc of constant radius, value equal to Base Radius, concentric with base circle, ranging through the dwell angle, to generate the dwell curve.
Title
Y Axis
X Axis
Input Parameters
Ascent Angle 100
Dwell Angle 60
Descent Angle 120
Height 4
Base circle Radius 5
Offset 0.5
Roller radius 0
Follower Type
Knife edge
Roller
Ascent
Const Velocity
SHM
Const Acc
Cycloidal
Descent
Const Velocity
SHM
Const Acc
Cycloidal

THANKYOU