PROBLEM 8-7 DESIGN A DOUBLE-DWELL CAM TO MOVE A FOLLOWER FROM 0 TO 2.5in IN 60°, DWELL FOR 120°, FALL 2.5in IN 30°, AND DWELL FOR THE REMAINDER. THE TOTAL CYCLE MUST TAKE 4 SEC. CHOOSE SUITABLE FUNCTIONS FOR RISE AND FALL TO MINIMIZE ACCELERATION. PLOT THE s, v, a, & j DIAGRAMS

GIVEN:

1. THE SEGMENT REQUIREMENTS FOR THIS PROBLEM ARE AS FOLLOWS

SEGMENT	INTERVAL LENGTH	DESCRIPTION
1	$\beta_1 = 60° = \frac{\pi}{3}$ rad	RISE TO 2.5in
2	$\beta_2 = 120° = \frac{2}{3}\pi$ rad	DWELL AT 2.5in
3	$\beta_3 = 30° = \pi/6$ rad	FALL TO 0in
4	$\beta_4 = 150° = 5/6\,\pi$ rad	DWELL AT 0in

2. TOTAL CYCLE TIME OF 4 SEC.

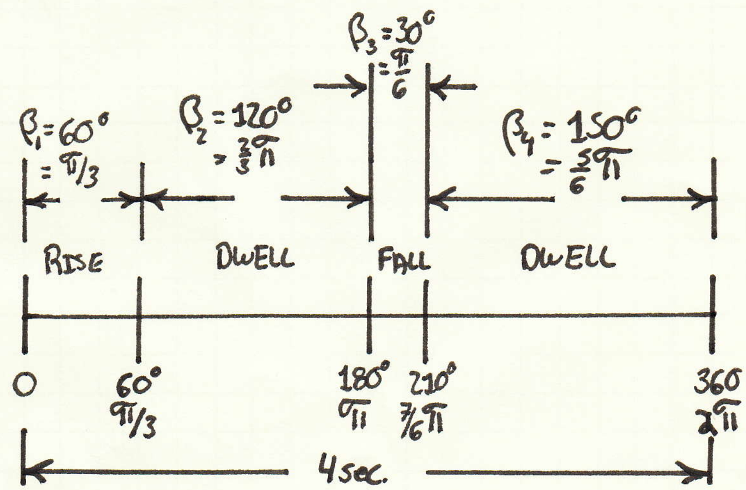
ASSUMPTIONS:

1. THE CAM FUNCTION MUST BE CONTINUOUS THROUGH THE FIRST AND SECOND DERIVATIVES OF THE DISPLACEMENT FUNCTIONS.
2. THERE IS THIRD ORDER CONTINUITY AT ALL BOUNDARIES

FIND:

1. DESCRIBE THE FUNCTIONS THAT WILL ACHIEVE THE SEGMENT REQUIREMENTS AND MINIMIZE ACCELERATION
2. DRAW THE POSITION (s) - VELOCITY (v) - ACCELERATION (a) - JERK (j) DIAGRAMS FOR THE ENTIRE CAM.

FIGURE:



	0	60°	180°	210°	360
s [in] =	0	2.5	2.5	0	0
v [in/rad] =	0	0	0	0	0
a [in/rad²] =	0	0	0	0	0
j [in/rad³] =	0	0	0	0	0

SOLUTION:

GIVEN THAT THE TOTAL CYCLE TIME IS 4 SEC. AND A COMPLETE CYCLE IS ONE REVOLUTION OF THE CAM (OR 2π RADIANS), THE CONSTANT ANGULAR VELOCITY OF THE CAM IS CALCULATED AS

$$\omega = \frac{2\pi}{4}\ \frac{rad}{s} = \frac{\pi}{2}\ \frac{rad}{s} \qquad (1)$$

IN THIS PROBLEM THERE ARE FOUR SEGMENTS OF THE CAM THAT NEED TO BE DESIGNED. EACH SEGMENT MUST BE INDIVIDUALLY DESIGNED TO SATISFY THE INITIAL BOUNDARY CONDITIONS, FINAL BOUNDARY CONDITIONS, AND THE DESIRED MOVEMENT OF THE FOLLOWER.

SEGMENT 1 : RISE, $\beta_1 = 60° = \frac{\pi}{3}$ rad, $0 \le \theta \le 60°$, $0 \le \theta_1 \le 60°$

FOR THIS SEGMENT A CYCLOID FUNCTION WILL BE USED THAT INSURES CONTINUITY OF THE FUNCTION COMING OUT OF A DWELL INITIALLY AND THEN RISING INTO A SECOND DWELL. BECAUSE THESE BOUNDARY CONDITIONS WILL REQUIRE THE VELOCITY AND ACCELERATION TO BE ZERO AT THE START AND END OF THE SEGMENT, THE FOLLOWING FORM OF THE ACCELERATION WILL BE REQUIRED

$$a_1 = \underline{\underline{C_1 \cdot \sin\left(\frac{2\pi}{\beta_1}\cdot\theta_1\right)}} = C_1 \cdot \sin\left(\frac{2\pi}{\pi/3}\cdot\theta_1\right) = \underline{\underline{C_1 \cdot \sin(6\cdot\theta_1)}} \qquad (2)$$

THE ACCELERATION BOUNDARY CONDITIONS FOR THIS SEGMENT ARE $a_1(0) = 0\ ^{in}/_{rad^2}$ AND $a_1(\pi/3) = 0\ ^{in}/_{rad^2}$. SUBSTITUTING THESE INTO (2)

$$a_1(0) = 0\ ^{in}/_{rad^2} = C_1 \cdot \sin(6\cdot 0) = 0\ \checkmark$$

$$a_1\left(\frac{\pi}{3}\right) = 0\ ^{in}/_{rad^2} = C_1 \cdot \sin\left(6\cdot\frac{\pi}{3}\right) = C_1 \cdot \sin(2\pi) = 0\ \checkmark$$

(2) SATISFIES THE BOUNDARY CONDITIONS IN THIS SEGMENT; HOWEVER, THE VALUE OF C_1 IS STILL UNKNOWN.

THE NEXT SET OF BOUNDARY CONDITIONS THAT NEED TO BE CONSIDERED ARE ~~TH~~ IN TERMS OF VELOCITY. AN EXPRESSION FOR THE VELOCITY IN SEGMENT 1 IS DEVELOPED BY INTEGRATING (2) WITH RESPECT TO θ_1.

$$a_1 = \frac{dv_1}{d\theta_1} \Rightarrow v_1 = \int a_1 \cdot d\theta_1 = \int C_1 \cdot \sin\left(\frac{2\pi}{\beta_1}\cdot\theta_1\right) d\theta_1$$

$$v_1 = -C_1 \cdot \frac{\beta_1}{2\pi} \cdot \cos\left(\frac{2\pi}{\beta_1}\cdot\theta_1\right) + C_2 = C_2 - C_1 \cdot \frac{\beta_1}{2\pi} \cdot \cos\left(\frac{2\pi}{\beta_1}\cdot\theta_1\right) \qquad (3)$$

THE VELOCITY BOUNDARY CONDITIONS FOR THIS SEGMENT CAN BE WRITTEN AS $v_1(0) = 0\ ^{in}/_{rad}$ AND $v_1(\pi/3) = 0\ ^{in}/_{rad}$. SUBSTITUTING THESE INTO (3)

$$v_1(0) = 0\,\text{in/rad} = C_2 - C_1 \cdot \frac{\beta_1}{2\pi} \cdot \cos\left(\frac{2\pi}{\beta_1} \cdot 0\right) = C_2 - C_1 \cdot \frac{\beta_1}{2\pi}$$

$$\Rightarrow C_2 = C_1 \cdot \frac{\beta_1}{2\pi}$$

$$v_1 = C_1 \cdot \frac{\beta_1}{2\pi} - C_1 \cdot \frac{\beta_1}{2\pi} \cdot \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right) = \underline{\underline{C_1 \cdot \frac{\beta_1}{2\pi}\left[1 - \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]}} \quad (4)$$

$$v_1(\beta_1) = v_1\left(\frac{\pi}{3}\right) = 0\,\text{in/rad} = C_1 \cdot \frac{\beta_1}{2\pi}\left[1 - \cos\left(\frac{2\pi}{\beta_1} \cdot \beta_1\right)\right]$$

$$= C_1 \cdot \frac{\beta_1}{2\pi}\left[1 - \cos(2\pi)\right] = 0 \checkmark$$

ALTHOUGH THE FORM OF (4) SATISFY'S THE BOUNDARY CONDITION, IT DOES NOT SOLVE FOR THE CONSTANT C_1. ADDITIONAL BOUNDARY CONDITIONS NEED TO BE CONSIDERED.

THE NEXT SET OF BOUNDARY CONDITIONS THAT NEED TO BE CONSIDERED ARE IN TERMS OF DISPLACEMENT. AN EXPRESSION FOR THE DISPLACEMENT IN SEGMENT 1 IS DEVELOPED BY INTEGRATING (4) WITH RESPECT TO θ_1.

$$v_1 = \frac{ds_1}{d\theta_1} \Rightarrow s_1 = \int v_1 \cdot d\theta_1 = \int\left\{C_1 \cdot \frac{\beta_1}{2\pi}\left[1 - \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]\right\} d\theta_1$$

$$s_1 = C_1 \cdot \frac{\beta_1}{2\pi}\left[\theta_1 - \frac{\beta_1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right] + C_3 \quad (5)$$

THE DISPLACEMENT BOUNDARY CONDITIONS FOR THIS SEGMENT ARE WRITTEN $s_1(0) = 0\,\text{in}$ AND $s_1(\beta_1) = s_1(\pi/3) = 2.5\,\text{in}$. SUBSTITUTING THESE INTO (5)

$$s_1(0) = 0\,\text{in} = C_1 \cdot \frac{\beta_1}{2\pi}\left[0 - \frac{\beta_1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot 0\right)\right] + C_3$$

$$= C_1 \frac{\beta_1}{2\pi}\left[0 - \frac{\beta_1}{2\pi}(0)\right] + C_3 \Rightarrow \underline{\underline{C_3 = 0}}$$

$$s_1(\beta_1) = s_1(\pi/3) = 2.5\,\text{in} = h = C_1 \cdot \frac{\beta_1}{2\pi}\left[\beta_1 - \frac{\beta_1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \beta_1\right)\right]$$

$$= C_1 \cdot \frac{\beta_1}{2\pi}\left[\beta_1 - \frac{\beta_1}{2\pi} \cdot \underbrace{\sin(2\pi)}_{0}\right] = C_1 \cdot \frac{\beta_1^2}{2\pi}$$

$$\Rightarrow \underline{\underline{C_1 = \frac{2 \cdot \pi \cdot h}{\beta_1^2}}} \quad (6)$$

$$\Rightarrow s_1 = \frac{\cancel{2\pi} \cdot h}{\beta_1^{\cancel{2}}} \cdot \frac{\cancel{\beta_1}}{\cancel{2\pi}}\left[\theta_1 - \frac{\beta_1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]$$

$$= \frac{h}{\beta_1}\left[\theta_1 - \frac{\beta_1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right] = \underline{\underline{h\left[\frac{\theta_1}{\beta_1} - \frac{1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]}} \quad (7)$$

ALL BOUNDARY CONDITIONS HAVE BEEN SATISFIED. (6) CAN NOW BE SUBSTITUTED INTO (2) SO THAT THE DERIVATIVE OF (2) WITH RESPECT TO θ_2 CAN BE TAKEN TO DETERMINE AN EXPRESSION FOR THE JERK IN THIS REGION OF THE CAM

$$\underline{a_1 = \frac{2\pi \cdot h}{\beta_1^2} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)} \qquad (8)$$

$$j = \frac{da_1}{d\theta_1} = \frac{d}{d\theta_1}\left[\frac{2\pi \cdot h}{\beta_1^2} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right] = \frac{2\pi \cdot h}{\beta_1^2} \cdot \frac{2\pi}{\beta_1} \cdot \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)$$

$$= \underline{\frac{4\pi^2}{\beta_1^3} \cdot h \cdot \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)} \qquad (9)$$

SUMMARIZING THE FUNCTIONS FOR THE FOLLOWER IN REGION 1

$$\underline{S_1 = h\left[\frac{\theta_1}{\beta_1} - \frac{1}{2\pi} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]}$$

$$= 2.5\,\text{in}\left[\frac{\theta_1}{\pi/3} - \frac{1}{2\pi} \cdot \sin\left(\frac{2\pi}{\pi/3} \cdot \theta_1\right)\right] = \underline{2.5\,\text{in}\left[\frac{3 \cdot \theta_1}{\pi} - \frac{1}{2\pi} \cdot \sin(6 \cdot \theta_1)\right]}$$

$$v_1 = \frac{\cancel{2\pi} \cdot h}{\beta_1^{\cancel{2}}} \cdot \frac{\cancel{\beta_1}}{\cancel{2\pi}}\left[1 - \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right] = \underline{\frac{h}{\beta_1}\left[1 - \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)\right]}$$

$$= \frac{2.5\,\text{in}}{\pi/3\ \text{rad}}\left[1 - \cos\left(\frac{\cancel{2\pi}}{\cancel{\pi}/3} \cdot \theta_1\right)\right] = \underline{\frac{7.5}{\pi}\frac{\text{in}}{\text{rad}}\left[1 - \cos(6 \cdot \theta_1)\right]}$$

$$\underline{a_1 = \frac{2\pi \cdot h}{\beta_1^2} \cdot \sin\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)}$$

$$= \frac{2\pi \cdot 2.5\,\text{in}}{\pi^2/9\ \text{rad}^2} \cdot \sin\left(\frac{2\pi}{\pi/3} \cdot \theta_1\right) = \underline{\frac{45}{\pi}\frac{\text{in}}{\text{rad}^2} \cdot \sin(6 \cdot \theta_1)}$$

$$\underline{j_1 = \frac{4\pi^2}{\beta_1^3} \cdot h \cdot \cos\left(\frac{2\pi}{\beta_1} \cdot \theta_1\right)}$$

$$= \frac{4 \cdot \pi^2}{\pi^3/27} \cdot 2.5\,\frac{\text{in}}{\text{rad}^3} \cdot \cos\left(\frac{2\pi}{\pi/3} \cdot \theta_1\right) = \underline{\frac{270}{\pi} \cdot \frac{\text{in}}{\text{rad}^3} \cdot \cos(6 \cdot \theta_1)}$$

NOW THESE FUNCTIONS WILL BE CHECKED TO MAKE SURE THE BOUNDARY CONDITIONS ARE SATISFIED.

$$S_1(0) = 2.5\text{in}\left[\frac{3\cdot 0}{\pi} - \frac{1}{2\pi}\cdot\sin(6\cdot 0)\right] = 2.5\text{in}[0-0] = 0\text{ in} \checkmark$$

$$S_1(\pi/3) = 2.5\text{in}\left[\frac{3}{\pi}\cdot\frac{\pi}{3} - \frac{1}{2\pi}\cdot\sin(6\cdot\frac{\pi}{3}\right) = 2.5\text{in}[1-0] = 2.5\text{in} \checkmark$$

$$v_1(0) = \frac{7.5}{\pi}\frac{\text{in}}{\text{rad}}[1-\cos(6\cdot 0)] = \frac{7.5}{\pi}\frac{\text{in}}{\text{rad}}[1-1] = 0\frac{\text{in}}{\text{rad}} \checkmark$$

$$v_1(\tfrac{\pi}{3}) = \frac{7.5}{\pi}\frac{\text{in}}{\text{rad}}[1-\cos(6\cdot\tfrac{\pi}{3})] = \frac{7.5}{\pi}\frac{\text{in}}{\text{rad}}[1-1] = 0\frac{\text{in}}{\text{rad}} \checkmark$$

$$a_1(0) = \frac{45}{\pi}\frac{\text{in}}{\text{rad}^2}\cdot\sin(6\cdot 0) = \frac{45}{\pi}\frac{\text{in}}{\text{rad}^2}\cdot(0) = 0\frac{\text{in}}{\text{rad}^2} \checkmark$$

$$a_1(\tfrac{\pi}{3}) = \frac{45}{\pi}\frac{\text{in}}{\text{rad}^2}\cdot\sin(6\cdot\tfrac{\pi}{3}) = \frac{45}{\pi}\frac{\text{in}}{\text{rad}^2}(0) = 0\frac{\text{in}}{\text{rad}^2} \checkmark$$

$$j_1(0) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}\cdot\cos(6\cdot 0) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}(1) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}$$

$$j_1(\tfrac{\pi}{3}) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}\cdot\cos(6\cdot\tfrac{\pi}{3}) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}(1) = \frac{270}{\pi}\frac{\text{in}}{\text{rad}^3}$$

SEGMENT 2: DWELL, $\beta_2 = \frac{2}{3}\pi$, $60° \leq \theta \leq 180°$, $0 \leq \theta_2 \leq 120°$

$$S_2 = 2.5\text{in} \quad (8)$$

$$v_2 = 0\text{ in/rad} \quad (9)$$

$$a_2 = 0\text{ in/rad}^2 \quad (10)$$

$$j_2 = 0\text{ in/rad}^3 \quad (11)$$

SEGMENT 3: FALL, $\beta_2 = \pi/6 = 30°$, $180° \leq \theta \leq 210°$, $0 \leq \theta_3 \leq 30°$

IN THIS SEGMENT THE FOLLOWER NEEDS TO FALL FROM THE DWELL POSITION OF 2.5in TO A SECOND DWELL POSITION OF 0in. THE DISPLACEMENT FUNCTION FOR THIS SEGMENT MUST RESULT IN A VELOCITY AND ACCELERATION FUNCTION THAT ~~IS~~ ARE ZERO ~~AT~~ AT THE START AND END OF THE SEGMENT. A SLIGHT MODIFICATION OF THE DISPLACEMENT IN SEGMENT 1 WILL BE USED

$$\underline{S_3 = h\left[1 - \frac{\theta_3}{\beta_3} + \frac{1}{2\pi}\cdot\sin\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)\right]}$$

$$= 2.5\text{in}\left[1 - \frac{\theta_3}{\pi/6} + \frac{1}{2\pi}\cdot\sin\left(\frac{2\pi}{\pi/6}\cdot\theta_3\right)\right] = \underline{2.5\text{in}\left[1 - \frac{6}{\pi}\cdot\theta_3 + \frac{1}{2\pi}\sin(12\cdot\theta_3)\right]} \quad (12)$$

CHECKING THE BOUNDARY CONDITIONS

$$S_3(0) = 2.5\text{in}\left[1 - \frac{6}{\pi}\cdot 0 + \frac{1}{2\pi}\cdot\sin(12\cdot 0)\right] = 2.5\text{in}[1-0+0] = 2.5\text{in} \checkmark$$

$$S_3\left(\frac{\pi}{6}\right) = 2.5\text{in}\left[1 - \frac{6}{\pi}\cdot\frac{\pi}{6} + \frac{1}{2\pi}\sin\left(12\cdot\frac{\pi}{6}\right)\right] = 2.5\text{in}[1-1+0] = 0\text{ in} \checkmark$$

TAKING THE DERIVATIVE OF S_3 WITH RESPECT TO θ_3 TO DETERMINE THE EXPRESSION FOR THE VELOCITY v_3

$$v_3 = \frac{ds_3}{d\theta_3} = \frac{d}{d\theta_3}\left\{h\left[1 - \frac{\theta_3}{\beta_3} + \frac{1}{2\pi}\cdot\sin\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)\right]\right\}$$

$$= h\left[-\frac{1}{\beta_3} + \frac{1}{2\pi}\cdot\frac{2\pi}{\beta_3}\cdot\cos\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)\right] = \underline{\underline{\frac{h}{\beta_3}\left[\cos\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right) - 1\right]}}$$

$$= \frac{2.5}{\pi/6}\frac{\text{in}}{\text{rad}}\left[\cos\left(\frac{2\pi}{\pi/6}\cdot\theta_3\right) - 1\right] = \underline{\underline{\frac{15}{\pi}\frac{\text{in}}{\text{rad}}\left[\cos(12\cdot\theta_3) - 1\right]}} \quad (13)$$

CHECKING THE BOUNDARY CONDITIONS

$$v_3(0) = \frac{15}{\pi}\frac{\text{in}}{\text{rad}}\left[\cos(12\cdot 0) - 1\right] = \frac{15}{\pi}\frac{\text{in}}{\text{rad}}[1-1] = 0\frac{\text{in}}{\text{rad}} \checkmark$$

$$v_3\left(\frac{\pi}{6}\right) = \frac{15}{\pi}\frac{\text{in}}{\text{rad}}\left[\cos\left(12\cdot\frac{\pi}{6}\right) - 1\right] = \frac{15}{\pi}\frac{\text{in}}{\text{rad}}[1-1] = 0\frac{\text{in}}{\text{rad}} \checkmark$$

TAKING THE DERIVATIVE OF v_3 WITH RESPECT TO θ_3 TO DETERMINE THE EXPRESSION FOR THE ACCELERATION a_3

$$a_3 = \frac{dv_3}{d\theta_3} = \frac{d}{d\theta_3}\left\{\frac{h}{\beta_3}\left[\cos\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right) - 1\right]\right\}$$

$$= -\frac{h}{\beta_3}\cdot\frac{2\cdot\pi}{\beta_3}\cdot\sin\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right) = \underline{\underline{-\frac{2\pi}{\beta_3^2}\cdot h\cdot\sin\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)}}$$

$$= -\frac{2\pi}{\pi^2/36}\cdot 2.5\frac{\text{in}}{\text{rad}^2}\cdot\sin\left(\frac{2\pi}{\pi/6}\cdot\theta_3\right) = \underline{\underline{-\frac{180}{\pi^2}\frac{\text{in}}{\text{rad}^2}\cdot\sin(12\theta_3)}} \quad (14)$$

CHECKING THE BOUNDARY CONDITIONS

$$a_3(0) = -\frac{180}{\pi^2}\frac{\text{in}}{\text{rad}^2}\cdot\sin(12\cdot 0) = 0\frac{\text{in}}{\text{rad}^2} \checkmark$$

$$a_3\left(\frac{\pi}{6}\right) = -\frac{180}{\pi^2}\frac{\text{in}}{\text{rad}^2}\cdot\sin\left(12\cdot\frac{\pi}{6}\right) = 0\frac{\text{in}}{\text{rad}^2} \checkmark$$

TAKING THE DERIVATIVE OF a_3 WITH RESPECT TO θ_3 TO DETERMINE THE EXPRESSION FOR THE JERK j_3

$$j_3 = \frac{da_3}{d\theta_3} = \frac{d}{d\theta_3}\left\{-\frac{2\pi}{\beta_3^2}\cdot h\cdot \sin\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)\right\}$$

$$= -\frac{2\pi}{\beta_3^2}\cdot h\cdot\frac{2\pi}{\beta_3}\cdot\cos\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right) = \underline{\underline{-\frac{4\cdot\pi^2}{\beta_3^3}\cdot h\cdot\cos\left(\frac{2\pi}{\beta_3}\cdot\theta_3\right)}}$$

$$= -\frac{4\cdot\pi^2}{\pi^3/216}\cdot 2.5\ \frac{in}{rad^3}\cdot\cos\left(\frac{2\pi}{\pi/6}\cdot\theta_3\right) = \underline{\underline{\frac{-2160}{\pi}\ \frac{in}{rad^3}\cdot\cos(12\cdot\theta_3)}} \quad (15)$$

CHECKING THE BOUNDARY CONDITIONS

$$j_3(0) = \frac{-2160}{\pi}\ \frac{in}{rad^3}\cdot\cos(12\cdot 0) = -\frac{2160}{\pi}\ \frac{in}{rad^3}$$

$$j_3\left(\frac{\pi}{6}\right) = -\frac{2160}{\pi}\ \frac{in}{rad^3}\cdot\cos\left(12\cdot\frac{\pi}{6}\right) = -\frac{2160}{\pi}\ \frac{in}{rad^3}$$

<u>SEGMENT 4: DWELL, $\beta_4 = \frac{5}{6}\pi = 150°$, $210° \le \theta \le 360°$, $0 \le \theta_4 \le 150°$</u>

$$s_4 = 0\ in$$

$$v_4 = 0\ in/rad$$

$$a_4 = 0\ in/rad^2$$

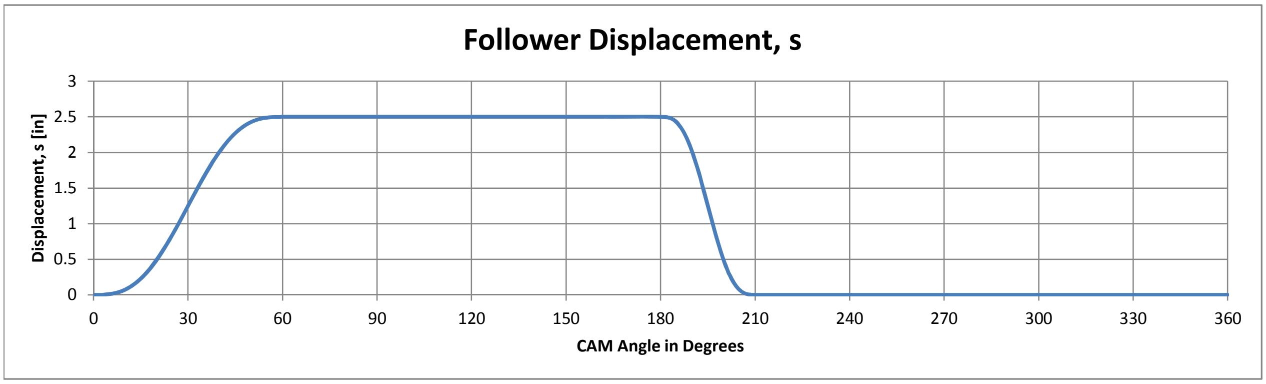
$$j_4 = 0\ in/rad^3$$

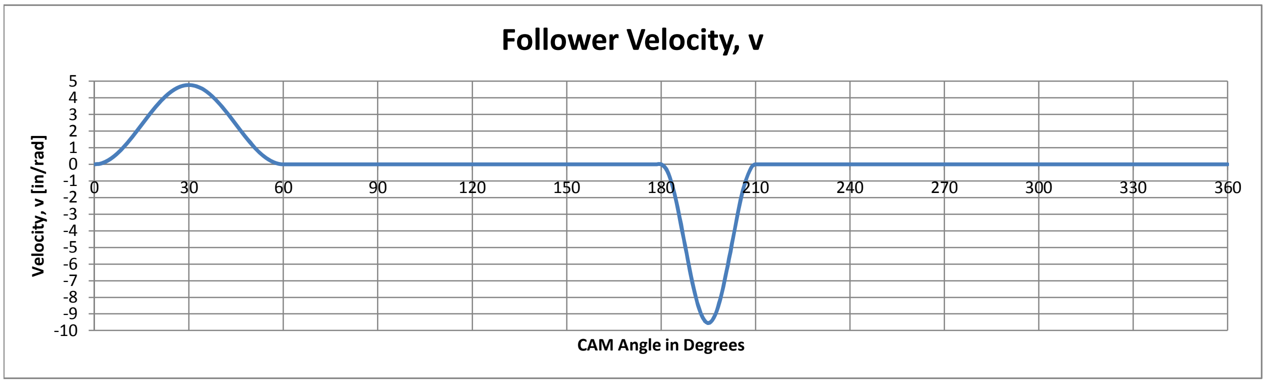
S-V-A-J DIAGRAMS ON THE NEXT PAGE

<u>SUMMARY</u>

THE CYCLOID FUNCTION WAS CHOSEN FOR THE SOLUTION TO THE CAM FOLLOWER TO INSURE THAT GOING INTO AND COMING OUT OF DWELLS THE VELOCITY AND ACCELERATION ARE ZERO.

A SLIGHT MODIFICATION TO THE CYCLOID FUNCTION IN SECTION 1 WAS MADE AND USED IN SECTION 3. THE MODIFICATION TURNED THE FUNCTION INTO A FALL FUNCTION.


Follower Displacement, s
Displacement, s [in]
3
2.5
2
1.5
1
0.5
0
0 30 60 90 120 150 180 210 240 270 300 330 360
CAM Angle in Degrees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Velocity, v [in/rad]
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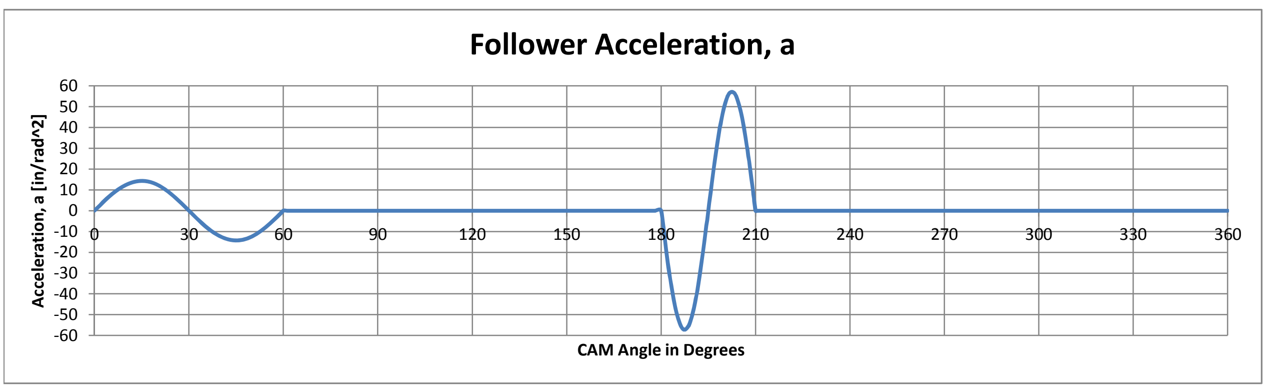
0 30 60 90 120 150 180 210 240 270 300 330 360
CAM Angle in Degrees


Follower Acceleration, a
Acceleration, a [in/rad^2]
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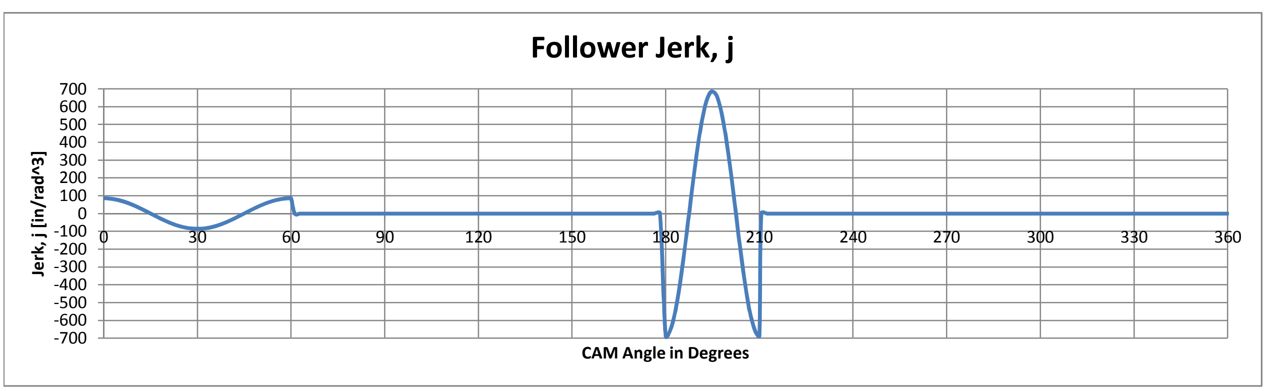
0 30 60 90 120 150 180 210 240 270 300 330 360
CAM Angle in Degrees


Follower Jerk, j
Jerk, j [in/rad^3]
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0 30 60 90 120 150 180 210 240 270 300 330 360
CAM Angle in Degrees