Slider-crank Analysis

Crank and coupler dimensions:

$$a := 10 \cdot in \qquad b := 20 \cdot in$$

Vector loop approach:

$$\theta_3(\theta_2) := 180deg - asin\left(\frac{a}{b} \cdot sin(\theta_2)\right)$$

$$d(\theta_2) := a \cdot cos(\theta_2) - b \cdot cos(\theta_3(\theta_2))$$

Law of cosines approach:

$$d_{lc}(\theta_2) := a \cdot \left[cos(\theta_2) + \sqrt{\left(\frac{b}{a}\right)^2 - sin(\theta_2)^2} \right]$$

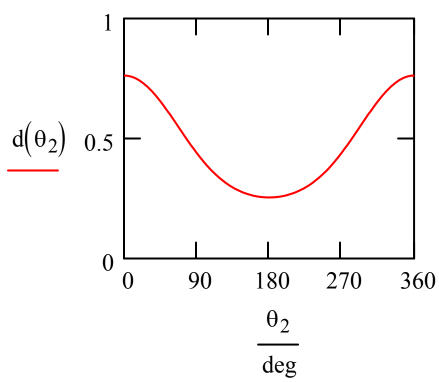
Approximation:

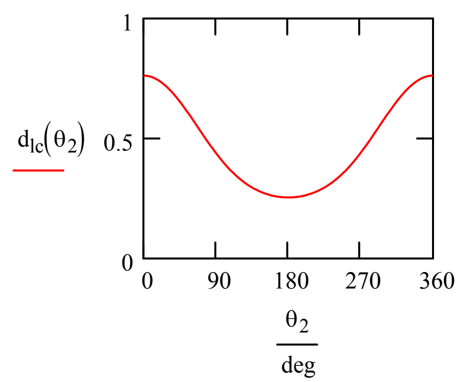
$$d_{app}(\theta_2) := a \cdot cos(\theta_2) + b - \frac{a^2}{4 \cdot b} \cdot (1 - cos(2 \cdot \theta_2))$$

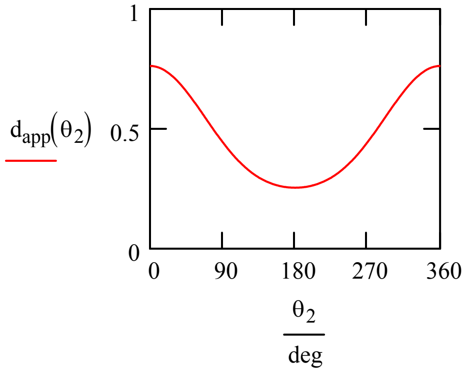
Error in approximation:

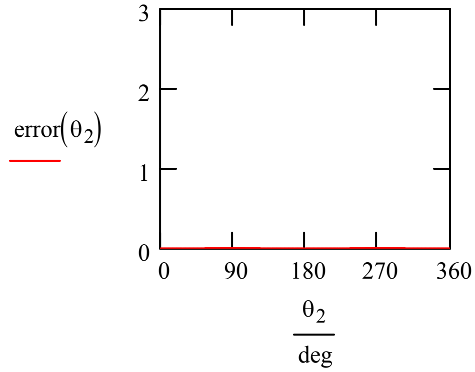
$$error(\theta_2) := d_{app}(\theta_2) - d_{lc}(\theta_2)$$

$$\theta_2 := 0 \cdot deg, 1 \cdot deg .. 360 \cdot deg$$









Velocity Analysis:

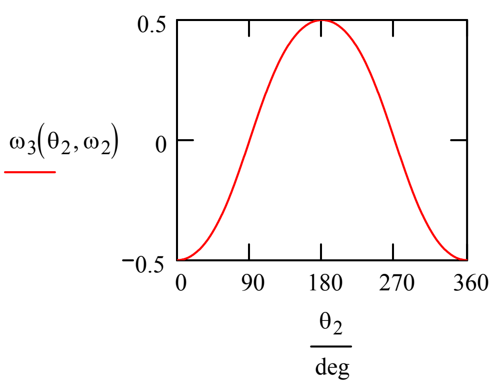
$$\omega_3(\theta_2,\omega_2) := \frac{a}{b}\cdot\frac{\cos(\theta_2)}{\cos(\theta_3(\theta_2))}\cdot\omega_2$$

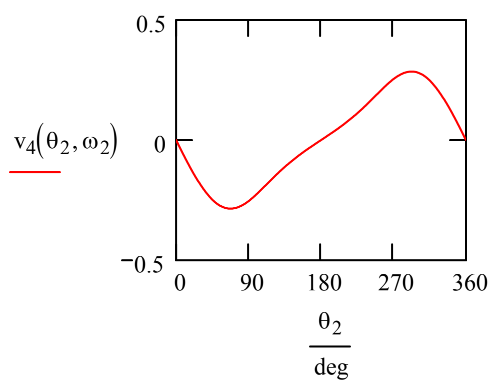
$$v_4(\theta_2,\omega_2) := -a\cdot\omega_2\cdot\sin(\theta_2) + b\cdot\omega_3(\theta_2,\omega_2)\cdot\sin(\theta_3(\theta_2))$$

$\theta_2 := 45\cdot deg$ $\quad\omega_2 := 1\cdot\frac{rad}{sec}$ $\quad\theta_3(\theta_2) = 159.295\ deg$

$\omega_3(\theta_2,\omega_2) = -0.378\,\frac{rad}{sec}$ $\quad v_4(\theta_2,\omega_2) = -9.744\,\frac{in}{sec}$

$\theta_2 := 0\cdot deg, 1\cdot deg\,..\,360\cdot deg$

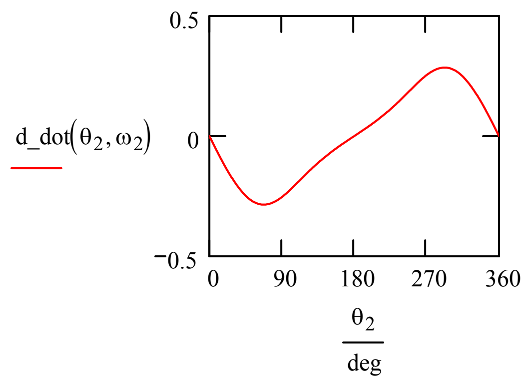




Geometric Solution Result:

$$v_{4\_geo}(\theta_2,\omega_2) := \sqrt{\left[(a\cdot\omega_2)^2 + (b\cdot\omega_3(\theta_2,\omega_2))^2\right] - 2\cdot a\cdot b\cdot\omega_2\cdot\omega_3(\theta_2,\omega_2)\cdot\cos(\theta_3(\theta_2) - \theta_2)}$$

$$d\_dot(\theta_2,\omega_2) := if(\theta_2 > 180\cdot deg, v_{4\_geo}(\theta_2,\omega_2), -v_{4\_geo}(\theta_2,\omega_2))$$



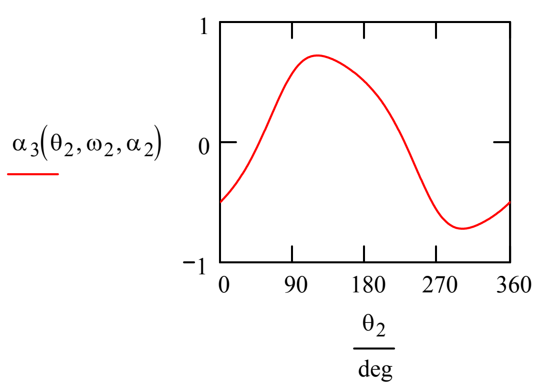
Acceleration Analysis:

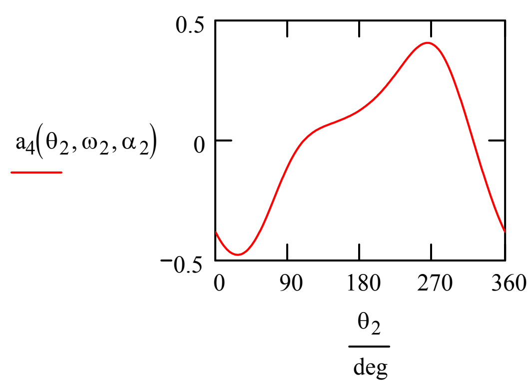
$\omega_2 := 1\cdot\frac{rad}{sec}$ $\alpha_2 := 1\cdot\frac{rad}{sec^2}$

$$\alpha_3(\theta_2,\omega_2,\alpha_2) := \frac{1}{b\cdot\cos(\theta_3(\theta_2))}\cdot\left(a\cdot\alpha_2\cdot\cos(\theta_2) - a\cdot\omega_2^{\,2}\cdot\sin(\theta_2) + b\cdot\omega_3(\theta_2,\omega_2)^2\cdot\sin(\theta_3(\theta_2))\right)$$

$$a_4(\theta_2,\omega_2,\alpha_2) := -a\cdot\left(\cos(\theta_2)\cdot\omega_2^{\,2} + \sin(\theta_2)\cdot\alpha_2\right) + b\cdot\left(\cos(\theta_3(\theta_2))\cdot\omega_3(\theta_2,\omega_2)^2 + \sin(\theta_3(\theta_2))\cdot\alpha_3(\theta_2,\omega_2\right.$$

$\theta_2 := 0\cdot deg, 1\cdot deg .. 360\cdot deg$





Slider Block Kinematics Summary:

$\alpha_2 := 1\cdot\frac{rad}{sec^2}$ $\omega_2(t) := \alpha_2\cdot t$ $\theta_2(t) := \frac{1}{2}\cdot\alpha_2\cdot t^2$

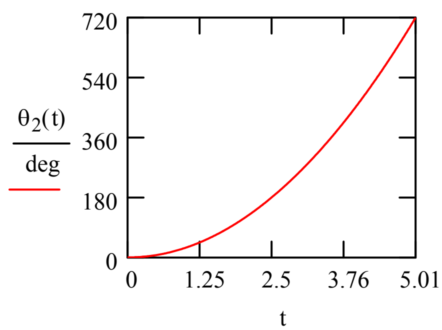
$$\theta_3(t) := 180deg - asin\left(\frac{a}{b}\cdot\sin(\theta_2(t))\right) \qquad d(t) := a\cdot\cos(\theta_2(t)) - b\cdot\cos(\theta_3(t))$$

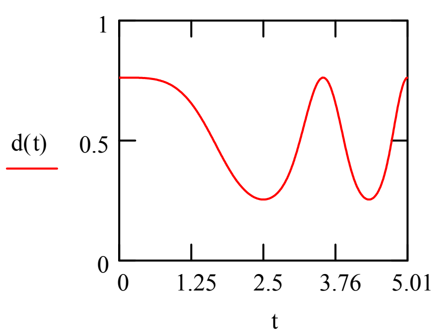
$$\omega_3(t) := \frac{a}{b}\cdot\frac{\cos(\theta_2(t))}{\cos(\theta_3(t))}\cdot\omega_2(t) \qquad v_4(t) := -a\cdot\omega_2(t)\cdot\sin(\theta_2(t)) + b\cdot\omega_3(t)\cdot\sin(\theta_3(t))$$

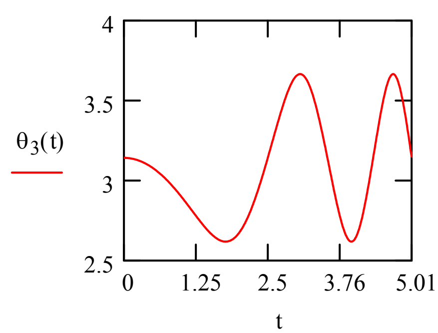
$$\alpha_3(t) := \frac{1}{b\cdot\cos(\theta_3(t))}\cdot\left(a\cdot\alpha_2\cdot\cos(\theta_2(t)) - a\cdot\omega_2(t)^2\cdot\sin(\theta_2(t)) + b\cdot\omega_3(t)^2\cdot\sin(\theta_3(t))\right)$$

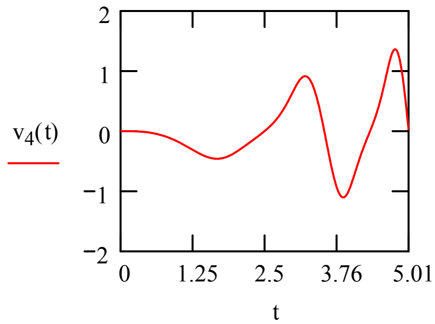
$$a_4(t) := -a\cdot\left(\cos(\theta_2(t))\cdot\omega_2(t)^2 + \sin(\theta_2(t))\cdot\alpha_2\right) + b\cdot\left(\cos(\theta_3(t))\cdot\omega_3(t)^2 + \sin(\theta_3(t))\cdot\alpha_3(t)\right)$$

$$\Delta\theta := 2\cdot(2\cdot\pi) \qquad T := \sqrt{\frac{2\cdot(\Delta\theta)}{\alpha_2}} \qquad t := 0\cdot sec, 0.01\cdot sec .. T$$

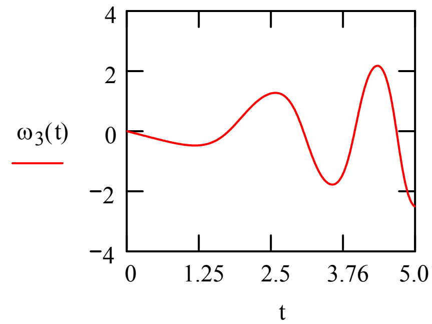




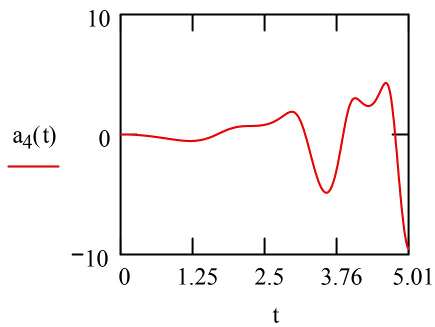




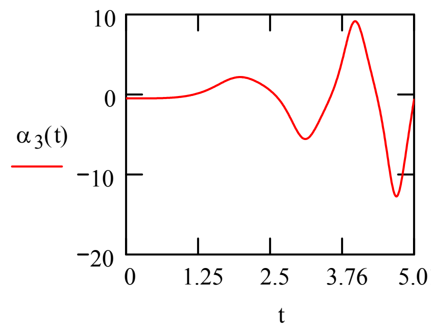
2
1
0
−1
−2
v4(t)
0
1.25
2.5
3.76
5.01
t



4
2
0
−2
−4
ω3(t)
0
1.25
2.5
3.76
5.01
t



10
0
−10
a4(t)
0
1.25
2.5
3.76
5.01
t



10
0
−10
−20
α3(t)
0
1.25
2.5
3.76
5.01
t