Flyball governor differential equation solution

Constants:

$a := 1$ $\quad k := 500$ $\quad m := 0.5$ $\quad g := 32.2$ $\quad \omega := 10$

Equation of motion:

$$a\cdot\frac{d^2}{dt^2}\theta(t) + a\cdot\omega^2\cdot\sin(\theta(t))\cdot\cos(\theta(t)) - \frac{2\cdot a\cdot k}{m}\cdot(1-\sin(\theta(t)))\cdot\cos(\theta(t)) + g\cdot\cos(\theta(t)) = 0$$

Equilibrium condition:

$$\theta_e := \operatorname{asin}\left(\frac{2\cdot a\cdot k - m\cdot g}{m\cdot a\cdot\omega^2 + 2\cdot a\cdot k}\right) \qquad \theta_e = 69.562\ \text{deg}$$

Initial conditions:

$\theta_o := 75\cdot\text{deg}$ $\qquad d\theta dt_o := 0$

Solution of the equation of motion:

$\Delta T := 9$

Given

$$a\cdot\frac{d^2}{dt^2}\theta(t) + a\cdot\omega^2\cdot\sin(\theta(t))\cdot\cos(\theta(t)) - \frac{2\cdot a\cdot k}{m}\cdot(1-\sin(\theta(t)))\cdot\cos(\theta(t)) + g\cdot\cos(\theta(t)) = 0$$

$\theta(0) = \theta_o$

$\theta'(0) = d\theta dt_o$

$\theta := \text{Odesolve}(t, \Delta T)$ $\qquad \theta(\Delta T) = 69.523\ \text{deg}$