$Y_B := 40\ mm$ $\quad J := 10\ kg \cdot m^2$

$i := 1$

$s_B := 40\ mm$ $\quad p := 6\ mm$ $\quad \eta := 0.9$ $\quad I_{lim} := 1\ A$

$Y_A := 255\ mm$ $\quad I_{bl} := 11\ A$ $\quad M_{bl} := 2450\ N \cdot mm$

$M_R := 0\ N \cdot m$

$s_A := 45\ mm$ $\quad I_{leer} := 0.27\ A$ $\quad n_{leer} := 352.57\ min^{-1}$

$\mathbf{clear_{sym}}\left(Y_B, J, Y_A, s_B, s_A, I_{bl}, M_{bl}, I_{leer}, n_{leer}, p, \eta\right)$

$$K := \sqrt{\left(Y_B \cdot \cos(0) - s_B \cdot \sin(0) + Y_A\right)^2 + \left(Y_B \cdot \sin(0) + s_B \cdot \cos(0) - s_A\right)^2} = 295.042\ mm$$

$\mathbf{clear_{sym}}(K)$

$$M_{lim} := \frac{\left(I_{lim} - I_{leer}\right) \cdot M_{bl}}{I_{bl} - I_{leer}} = 166.682\ N \cdot mm$$

$$n_{lim} := -\frac{n_{leer}}{M_{bl}} \cdot \left(M_{lim} - M_{bl}\right) = 5.476\ \frac{1}{s}$$

$$x(t, \varphi) := K - \sqrt{\left(Y_B \cdot \cos(\varphi(t)) - s_B \cdot \sin(\varphi(t)) + Y_A\right)^2 + \left(Y_B \cdot \sin(\varphi(t)) + s_B \cdot \cos(\varphi(t)) - s_A\right)^2}$$

$$n(t, \varphi_0, \varphi_1) := \frac{\frac{d}{dt} x(t, \varphi)}{p} \xrightarrow[\text{substitute}, \frac{d}{dt}\varphi(t) = \varphi_1]{\text{substitute}, \varphi(t) = \varphi_0} \frac{s_A \cdot Y_B \cdot \varphi_1 \cdot \cos(\varphi_0) + s_B \cdot Y_A \cdot \varphi_1 \cdot \cos(\varphi_0)}{p \cdot \sqrt{s_A^2 - 2 \cdot \cos(\varphi_0) \cdot s_A \cdot s_B - 2 \cdot \sin(\varphi_0) \cdot s_A \cdot Y_B + s_B}}$$

$$h(t) := \frac{\left(Y_B \cdot \cos(\varphi(t)) - s_B \cdot \sin(\varphi(t)) + Y_A\right) \cdot s_A - \left(Y_B \cdot \sin(\varphi(t)) + s_B \cdot \cos(\varphi(t)) - s_A\right) \cdot \left(-Y_A\right)}{\sqrt{\left(Y_B \cdot \cos(\varphi(t)) - s_B \cdot \sin(\varphi(t)) + Y_A\right)^2 + \left(Y_B \cdot \sin(\varphi(t)) + s_B \cdot \cos(\varphi(t)) - s_A\right)^2}}$$

$$h(t, \varphi_0) := h(t) \xrightarrow{\text{substitute}, \varphi(t) = \varphi_0} \frac{s_A \cdot Y_B \cdot \cos(\varphi_0) + s_B \cdot Y_A \cdot \cos(\varphi_0) - s_A \cdot s_B \cdot \sin(\varphi_0) + Y_A \cdot Y_B \cdot \sin(\varphi}{\sqrt{\left(Y_A + Y_B \cdot \cos(\varphi_0) - s_B \cdot \sin(\varphi_0)\right)^2 + \left(s_B \cdot \cos(\varphi_0) - s_A + Y_B \cdot \sin(\varphi_0\right.}}$$

$M_{test}(n$

$$M\left(t,\varphi_0,\varphi_1\right):=\left\| \begin{array}{l} \text{if } 0\ A<I_{lim}<I_{bl} \\ \quad \left\| \begin{array}{l} \text{if } 0\le n\left(t,\varphi_0,\varphi_1\right)\le n_{lim} \\ \quad \left\| M_{lim} \right. \\ \text{else} \\ \quad \left\| -\dfrac{M_{bl}}{n_{leer}}\cdot n\left(t,\varphi_0,\varphi_1\right)+M_{bl} \right. \end{array}\right. \\ \text{else} \\ \quad \left\| -\dfrac{M_{bl}}{n_{leer}}\cdot n\left(t,\varphi_0,\varphi_1\right)+M_{bl} \right. \end{array}\right.$$

$n_{test}:=0$

$$F_A\left(t,\varphi_0,\varphi_1,i\right):=\frac{2\cdot\pi\cdot\eta}{p}\cdot M\left(t,\varphi_0,\varphi_1\right)\cdot i$$

$t:=0\ s,0.01\ s..10\ s$

$t_{end}:=4\ s$

$$I\left(t,\varphi_0,\varphi_1\right):=\frac{M\left(t,\varphi_0,\varphi_1\right)}{M_{bl}}\cdot\left(I_{bl}-I_{leer}\right)+I_{leer}$$

$\mathbf{TOL}:=10^{-7}$

Gleichungslöser Nebenbedingungen Schätzwerte

$J\cdot\varphi''(t)=F_A\left(t,\varphi(t),\varphi'(t),i\right)\cdot h\left(t,\varphi(t)\right)-M_R$

$\varphi(0\ s)=0\ °$

$\varphi'(0\ s)=0\ \dfrac{°}{s}$

$\varphi(i):=\mathbf{odesolve}\left(\varphi(t),t_{end}\right)$

$$f(i,t):=\left\| \begin{array}{l} f_{tmp}\leftarrow\varphi(i) \\ f_{tmp}(t) \end{array}\right.$$

Gleichungslöser Nebenbedingungen Schätzwerte

$t:=3\ s$

$f(i,t)=90\ deg$

$t_{90deg}(i):=\mathbf{find}(t)$

check:

$t_{90deg}(1)=2.851\ s$

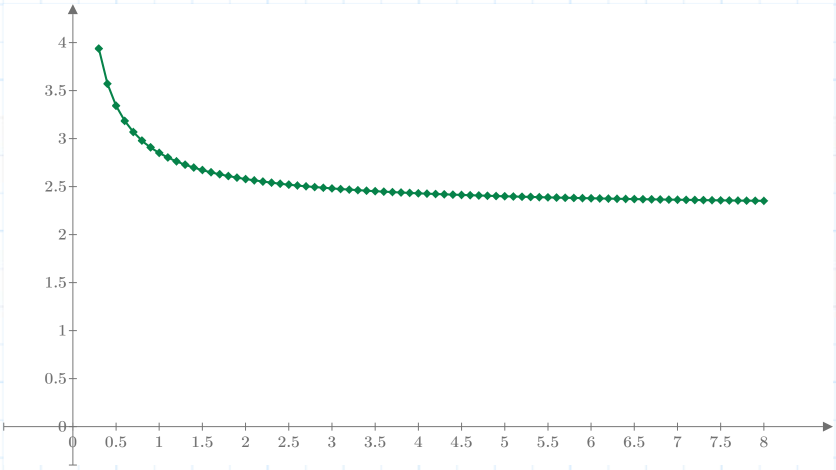
$i := 0.3, 0.4 .. 8$ *No solution is found for values of i lower than 0.29 and higher than ca. 85*

$\boxed{t_{90deg}(0.28)} = ?$

$t_{90deg}(0.29) = 3.987\ s$

$t_{90deg}(85) = 2.277\ s$

$t_{90deg}(i)\ (s)$



i

$ii := 0.5$ Guess value

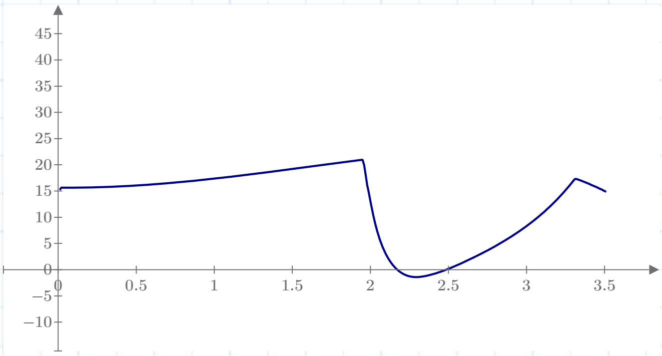
$i_{3.5} := \mathbf{root}\left(t_{90deg}(ii) - 3.5\ s, ii\right) = 0.427$

$\varphi := \varphi\left(i_{3.5}\right)$ $\varphi(3.5\ s) = 90\ °$ $\varphi'(3.5\ s) = 44.633\ \frac{°}{s}$

$t_{kp} :=$

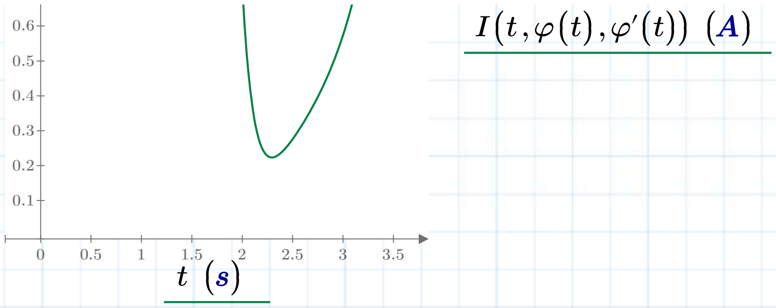
$\varphi\left(t_{kp}\right.$

$\varphi'\left(t_{k}\right.$



$\varphi''(t)\ \left(\frac{deg}{s^2}\right)$

$t\ (s)$



$t_{90deg} := t_{90deg}\left(i_{3.5}\right) \qquad t_{90deg} = 3.5\ s$

$$\int_0^{t_{90deg}} 12\ V \cdot I(t, \varphi(t), \varphi'(t))\, \mathrm{d}t = 33.28\ J$$