```
> restart:
> xB:=xA-L0*cos(psi(t));
```
$$xB := xA - L0 \cos(\psi(t)) \tag{1}$$

```
> xA:=v0*t;
```
$$xA := v0\, t \tag{2}$$

```
> yB:=yA-L0*sin(psi(t));
```
$$yB := yA - L0 \sin(\psi(t)) \tag{3}$$

```
> rce1:= S(t)*cos(psi(t))-k*sqrt(diff(xB,t)^2+diff(yB,t)^2)*diff
  (xB,t)-mB*diff(xB,t,t);
```
$$rce1 := S(t) \cos(\psi(t))$$

$$-k \sqrt{\left(v0 + L0\left(\frac{d}{dt}\psi(t)\right)\sin(\psi(t))\right)^2 + L0^2\left(\frac{d}{dt}\psi(t)\right)^2 \cos(\psi(t))^2}\ \left(v0\right.$$

$$\left. + L0\left(\frac{d}{dt}\psi(t)\right)\sin(\psi(t))\right) - mB\left(L0\left(\frac{d^2}{dt^2}\psi(t)\right)\sin(\psi(t)) + L0\left(\frac{d}{dt}\right.\right.$$

$$\left.\left.\psi(t)\right)^2 \cos(\psi(t))\right) \tag{4}$$

```
> rce2:=-mB*g+S(t)*sin(psi(t))-k*sqrt(diff(xB,t)^2+diff(yB,t)^2)*
  diff(yB,t)-mB*diff(yB,t,t);
```
$$rce2 := -mB\, g + S(t) \sin(\psi(t))$$

$$+k \sqrt{\left(v0 + L0\left(\frac{d}{dt}\psi(t)\right)\sin(\psi(t))\right)^2 + L0^2\left(\frac{d}{dt}\psi(t)\right)^2 \cos(\psi(t))^2}\ L0\left(\frac{d}{dt}\right.$$

$$\left.\psi(t)\right)\cos(\psi(t)) - mB\left(-L0\left(\frac{d^2}{dt^2}\psi(t)\right)\cos(\psi(t)) + L0\left(\frac{d}{dt}\psi(t)\right)^2 \sin(\psi(t))\right) \tag{5}$$

```
> g:=9.81; mB:=90+60; mA:=25e3; v0:=200/3.6; L0:=150;
```
$$g := 9.81$$
$$mB := 150$$
$$mA := 25000.$$
$$v0 := 55.55555556$$
$$L0 := 150 \tag{6}$$

Vyjdeme-li z kvadratického odporu: R=1/2*c_D*S*rho_o*v^2, uvažujme prez lovka kolmo ke smru hlava-nohy 0,2m2 a souinitel odporu c_D cca 0,5 (nco mezi skreným a ležícím)

```
> k:=1/2*0.5*0.5*1.27;
```
$$k := 0.1587500000 \tag{7}$$

```
> rce1
```
$$S(t) \cos(\psi(t)) \tag{8}$$

$$-0.1587500000$$

$$\sqrt{\left(55.55555556 + 150\left(\frac{d}{dt}\psi(t)\right)\sin(\psi(t))\right)^2 + 22500\left(\frac{d}{dt}\psi(t)\right)^2 \cos(\psi(t))^2}$$

$$\left(55.55555556 + 150 \left(\frac{d}{dt}\,\psi(t)\right)\sin\big(\psi(t)\big)\right) - 22500 \left(\frac{d^2}{dt^2}\,\psi(t)\right)\sin\big(\psi(t)\big)$$

$$- 22500 \left(\frac{d}{dt}\,\psi(t)\right)^2 \cos\big(\psi(t)\big)$$

```
> rce2
```

$$-1471.50 + S(t)\sin\big(\psi(t)\big) \tag{9}$$

$$+ 23.81250000$$

$$\sqrt{\left(55.55555556 + 150\left(\frac{d}{dt}\,\psi(t)\right)\sin\big(\psi(t)\big)\right)^2 + 22500\left(\frac{d}{dt}\,\psi(t)\right)^2\cos\big(\psi(t)\big)^2}$$

$$\left(\frac{d}{dt}\,\psi(t)\right)\cos\big(\psi(t)\big) + 22500\left(\frac{d^2}{dt^2}\,\psi(t)\right)\cos\big(\psi(t)\big) - 22500\left(\frac{d}{dt}\right.$$

$$\left.\psi(t)\right)^2\sin\big(\psi(t)\big)$$

```
> icsol:=solve(eval(eval({rce1,rce2},{diff(psi(t),t)=Dpsi0}),{psi
  (t)=Pi/2,S(t)=S0}),[Dpsi0,S0]);
```

$$icsol := [[Dpsi0 = -0.3703703704, S0 = 4557.919754]] \tag{10}$$

```
> assign(icsol);
```

```
> sol:=dsolve({rce1,rce2,psi(0)=Pi/2, D(psi)(0)=Dpsi0,S(0)=S0},
  numeric);
```

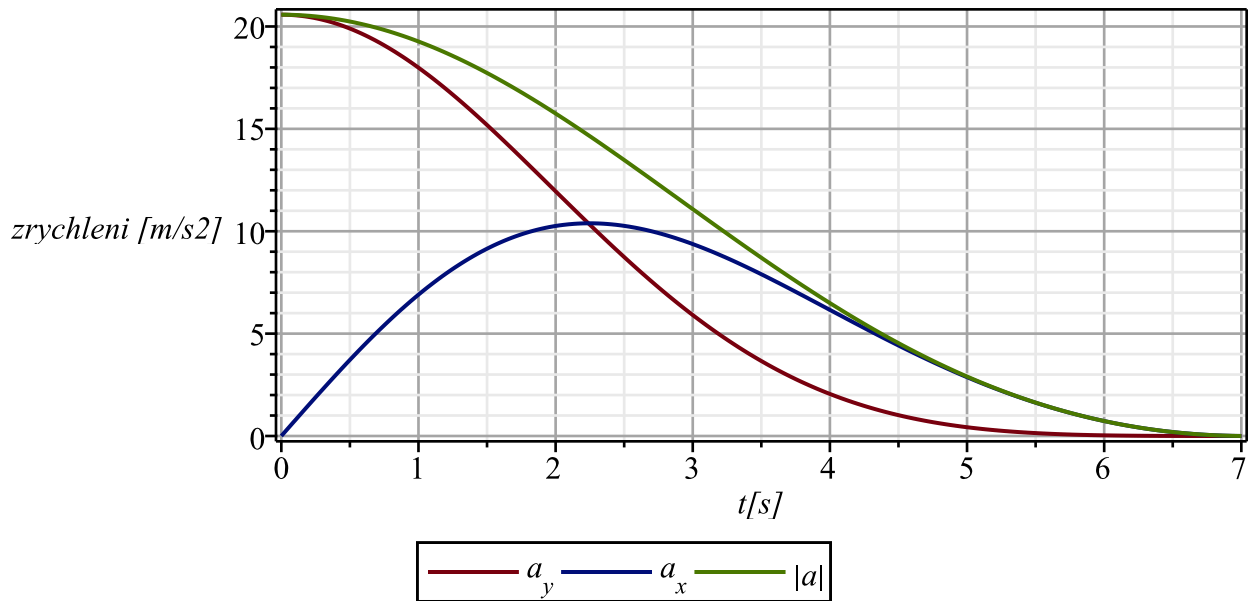$$sol := \mathbf{proc}(x\_rkf45\_dae)\ ...\ \mathbf{end\ proc} \tag{11}$$

```
> yA:=L0;
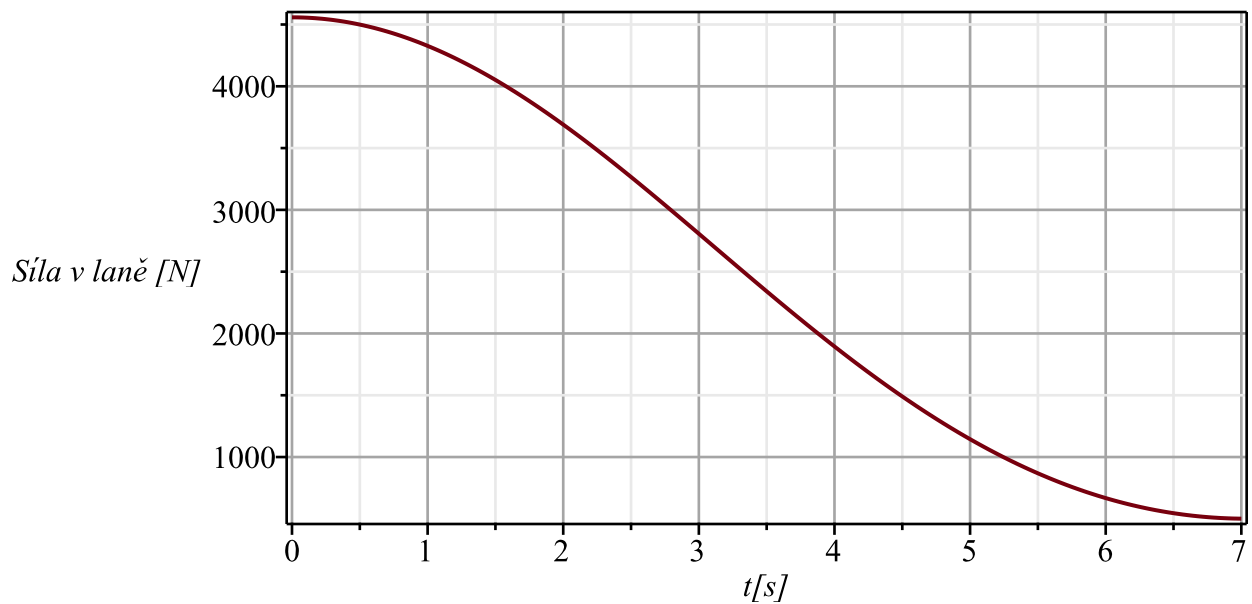```

$$yA := 150 \tag{12}$$

```
> plots:-setoptions(labelfont= [TIMES,18], axesfont= [TIMES,18],
  titlefont= [TIMES,18], captionfont= [TIMES,18]):
```

```
> plots[odeplot](sol, [[t,diff(yB,t,t)],[t,diff(xB,t,t)],[t,sqrt
  (diff(xB,t,t)^2+diff(yB,t,t)^2)]], 0 .. 7, numpoints = 1000,
  labels=[`t[s]`,`zrychleni [m/s2]`],gridlines,axes=boxed,legend=
  ['a[y]','a[x]','abs(a)'],legendstyle=[font=[TIMES,18]])
```

Plot: zrychleni [m/s2] vs t[s], with curves labeled a_y (červená), a_x (modrá), $|a|$ (zelená)

```
> plots[odeplot](sol, [t,S(t)], 0 .. 7, numpoints = 1000,labels=[`t
   [s]`,`Síla v lan [N]`],gridlines,axes=boxed)
```


Plot: Síla v laně [N] vs t[s]

```
> plots[odeplot](sol, [xB,yB], 0 .. 7, numpoints = 1000,labels=[`x
   [m]`,`y [m]`],title=[`trajektorie bodu B`],gridlines,axes=boxed);
```

trajektorie bodu B