```
syms x(t) y(t) a(t) phi1(t) phi2(t) OC e Ic I0 m mw ...
    len hgt kx ky bx by...
     g x_dot a_dot y_dot phi1_dot phi2_dot xc1 ...
        xc2 yc1 yc2 xc1_dot xc2_dot yc1_dot ...
        yc2_dot %hgt - od srodka do dolnej ...
        krawedzi(w osi y) len - od srodka do osi ...
        sprezyny(w osi x)

x_dot = diff(x, t)
```

x_dot(t) =

$$\frac{\partial}{\partial t}\, x(t)$$

```
y_dot = diff(y, t)
```

y_dot(t) =

$$\frac{\partial}{\partial t}\, y(t)$$

```
a_dot = diff(a, t)
```

a_dot(t) =

$$\frac{\partial}{\partial t}\, a(t)$$

```
phi1_dot = diff(phi1, t)
```

phi1_dot(t) =

$$\frac{\partial}{\partial t}\, \varphi_1(t)$$

```
phi2_dot = diff(phi2, t)
```

phi2_dot(t) =

$$\frac{\partial}{\partial t}\, \varphi_2(t)$$

```
xc1 = -OC*cos((pi/3)-a)-e*cos(phi1)+x
```

xc1(t) =

$$x(t) - e\,\cos(\varphi_1(t)) - \mathrm{OC}\,\cos\left(\frac{\pi}{3} - a(t)\right)$$

```
yc1 = OC*sin((pi/3)-a)+e*sin(phi1)+y
```

yc1(t) =

$$y(t) + e\ \sin(\varphi_1(t)) + \mathrm{OC}\ \sin\left(\frac{\pi}{3} - a(t)\right)$$

```
xc1_dot = diff(xc1, t)
```

xc1_dot(t) =

$$\frac{\partial}{\partial t}\, x(t) - \mathrm{OC}\ \sin\left(\frac{\pi}{3} - a(t)\right)\ \frac{\partial}{\partial t}\, a(t) + e\ \sin(\varphi_1(t))\ \frac{\partial}{\partial t}\, \varphi_1(t)$$

```
yc1_dot = diff(yc1, t)
```

yc1_dot(t) =

$$\frac{\partial}{\partial t}\, y(t) - \mathrm{OC}\ \cos\left(\frac{\pi}{3} - a(t)\right)\ \frac{\partial}{\partial t}\, a(t) + e\ \cos(\varphi_1(t))\ \frac{\partial}{\partial t}\, \varphi_1(t)$$

```
xc2 = OC*cos((pi/3)-a)+e*cos(phi2)+x
```

xc2(t) =

$$x(t) + e\ \cos(\varphi_2(t)) + \mathrm{OC}\ \cos\left(\frac{\pi}{3} - a(t)\right)$$

```
yc2 = OC*sin((pi/3)-a)+e*sin(phi2)+y
```

yc2(t) =

$$y(t) + e\ \sin(\varphi_2(t)) + \mathrm{OC}\ \sin\left(\frac{\pi}{3} - a(t)\right)$$

```
xc2_dot = diff(xc2, t)
```

xc2_dot(t) =

$$\frac{\partial}{\partial t}\, x(t) + \mathrm{OC}\ \sin\left(\frac{\pi}{3} - a(t)\right)\ \frac{\partial}{\partial t}\, a(t) - e\ \sin(\varphi_2(t))\ \frac{\partial}{\partial t}\, \varphi_2(t)$$

```
yc2_dot = diff(yc2, t)
```

yc2_dot(t) =

$$\frac{\partial}{\partial t}\, y(t) - \mathrm{OC}\ \cos\left(\frac{\pi}{3} - a(t)\right)\ \frac{\partial}{\partial t}\, a(t) + e\ \cos(\varphi_2(t))\ \frac{\partial}{\partial t}\, \varphi_2(t)$$

```
T = 0.5*m*(x_dot^2+y_dot^2) + ...
    0.5*Ic*a_dot^2 + 0.5*mw*xc1_dot^2 + ...
    0.5*mw*yc1_dot^2 + 0.5*I0*phi1_dot^2+...
     0.5*mw*xc2_dot^2 + 0.5*mw*yc2_dot^2 + ...
        0.5*I0*phi2_dot^2
```

T(t) =

$$\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_1(t))\ \frac{\partial}{\partial t}\ \varphi_1(t)\right)^2}{2}+\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_2(t))\ \frac{\partial}{\partial t}\ \varphi_2(t)\right)^2}{2}+\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ x(t)-\sigma_1+e\ \sin(\varphi_1(t))\ \frac{\partial}{\partial t}\right.}{2}$$

where

$$\sigma_1 = \mathrm{OC}\ \sin(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_2 = \mathrm{OC}\ \cos(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_3 = \frac{\pi}{3} - a(t)$$

```
V = m*g*y + mw*g*yc1 + mw*g*yc2 + ...
    0.5*kx*(-x*hgt*a*x)^2 + 0.5*ky*(y+len*a)^2
```

V(t) =

$$\frac{\mathrm{ky}\,(y(t)+\mathrm{len}\,a(t))^2}{2} + g\,\mathrm{mw}\,(y\,(t) + e\ \sin(\varphi_1\,(t)) + \sigma_1) + g\,\mathrm{mw}\,(y\,(t) + e\ \sin(\varphi_2\,(t)) + \sigma_1) + g\,m\,y\,(t) + \frac{\mathrm{hg}}{}$$

where

$$\sigma_1 = \mathrm{OC}\ \sin\left(\frac{\pi}{3} - a(t)\right)$$

```
L = T-V
```

L(t) =

$$\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_1(t))\ \frac{\partial}{\partial t}\ \varphi_1(t)\right)^2}{2}-\frac{\mathrm{ky}\,(y(t)+\mathrm{len}\,a(t))^2}{2}+\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_2(t))\ \frac{\partial}{\partial t}\ \varphi_2(t)\right)^2}{2}+\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ x(t\right.}{}$$

where

$$\sigma_1 = \mathrm{OC}\ \sin(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_2 = \mathrm{OC}\ \cos(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_3 = \frac{\pi}{3} - a(t)$$

```
N = ...
    0.5*bx*(-x_dot-hgt*a_dot)^2+0.5*by*(y_dot+len*a_dot)^2
```

N(t) =

$$\frac{\mathrm{bx}\left(\mathrm{hgt}\ \frac{\partial}{\partial t}\ a\,(t) + \frac{\partial}{\partial t}\ x\,(t)\right)^2}{2} + \frac{\mathrm{by}\left(\mathrm{len}\ \frac{\partial}{\partial t}\ a\,(t) + \frac{\partial}{\partial t}\ y\,(t)\right)^2}{2}$$

```
dldx = functionalDerivative(L, x)
```

dldx(t) =

$$e\,\mathrm{mw}\,\cos\left(\varphi_2(t)\right)\,\left(\frac{\partial}{\partial t}\,\varphi_2(t)\right)^2 - 2\,\mathrm{mw}\,\sigma_1 - 2\,\mathrm{hgt}^2\,\mathrm{kx}\,a(t)^2\,x(t)^3 - e\,\mathrm{mw}\,\cos\left(\varphi_1(t)\right)\,\left(\frac{\partial}{\partial t}\,\varphi_1(t)\right)^2 - m\,\sigma$$

where

$$\sigma_1 = \frac{\partial^2}{\partial t^2}\,x(t)$$

```
dldy = functionalDerivative(L, y)
```

dldy(t) =

$$e\,\mathrm{mw}\,\sin\left(\varphi_1(t)\right)\,\left(\frac{\partial}{\partial t}\,\varphi_1(t)\right)^2 - 2\,\mathrm{mw}\,\sigma_2 - g\,m - 2\,g\,\mathrm{mw} - \mathrm{ky}\,y(t) - \mathrm{ky}\,\mathrm{len}\,a(t) - m\,\sigma_2 + e\,\mathrm{mw}\,\sin(\varphi_2$$

where

$$\sigma_1 = \frac{\pi}{3} - a(t)$$

$$\sigma_2 = \frac{\partial^2}{\partial t^2}\,y(t)$$

```
dlda = functionalDerivative(L, a)
```

dlda(t) =

$$2\,\mathrm{OC}\,g\,\mathrm{mw}\,\cos(\sigma_4) - \mathrm{ky}\,\mathrm{len}\,y(t) - \mathrm{ky}\,\mathrm{len}^2\,a(t) - \mathrm{Ic}\,\sigma_1 - 2\,\mathrm{OC}^2\,\mathrm{mw}\cos(\sigma_4)^2\,\sigma_1 - \mathrm{hgt}^2\,\mathrm{kx}\,a(t)\,x(t)^4 -$$

where

$$\sigma_1 = \frac{\partial^2}{\partial t^2}\,a(t)$$

$$\sigma_2 = \left(\frac{\partial}{\partial t}\,\varphi_2(t)\right)^2$$

$$\sigma_3 = \left(\frac{\partial}{\partial t}\,\varphi_1(t)\right)^2$$

$$\sigma_4 = \frac{\pi}{3} - a(t)$$

$$\sigma_5 = \frac{\partial^2}{\partial t^2}\,\varphi_2(t)$$

$$\sigma_6 = \frac{\partial^2}{\partial t^2}\,\varphi_1(t)$$

```
dldphi1 = functionalDerivative(L, phi1)
```

dldphi1(t) =

$\mathrm{OC}\, e\, \mathrm{mw}\, \cos(\varphi_1(t))\, \sin(\sigma_2)\, \sigma_3 - e^2\, \mathrm{mw} \cos(\varphi_1(t))^2\, \sigma_1 - e^2\, \mathrm{mw} \sin(\varphi_1(t))^2\, \sigma_1 - e\, \mathrm{mw}\, \cos(\varphi_1(t))\, \frac{\partial}{\partial t}$

where

$\sigma_1 = \frac{\partial^2}{\partial t^2}\, \varphi_1(t)$

$\sigma_2 = \frac{\pi}{3} - a(t)$

$\sigma_3 = \left(\frac{\partial}{\partial t}\, a(t)\right)^2$

$\sigma_4 = \frac{\partial^2}{\partial t^2}\, a(t)$

```
dldphi2 = functionalDerivative(L, phi2)
```

```
dldphi2(t) =
```

$e\, \mathrm{mw}\, \sin(\varphi_2(t))\, \frac{\partial^2}{\partial t^2}\, x(t) - e^2\, \mathrm{mw} \cos(\varphi_2(t))^2\, \sigma_1 - e^2\, \mathrm{mw} \sin(\varphi_2(t))^2\, \sigma_1 - e\, \mathrm{mw}\, \cos(\varphi_2(t))\, \frac{\partial^2}{\partial t^2}\, y(t)$

where

$\sigma_1 = \frac{\partial^2}{\partial t^2}\, \varphi_2(t)$

$\sigma_2 = \frac{\pi}{3} - a(t)$

$\sigma_3 = \left(\frac{\partial}{\partial t}\, a(t)\right)^2$

$\sigma_4 = \frac{\partial^2}{\partial t^2}\, a(t)$

Tutaj zaczyna sie kombinowanie - matlab nie umie rozniczkowac po np. xprim - zamieniamy wszystkie funkcje symboliczne na zmienne

```
syms xvar yvar avar phi1var phi2var
syms x_dotvar y_dotvar a_dotvar phi1_dotvar ...
    phi2_dotvar
Lvar = subs(L, x, xvar)
```

```
Lvar(t) =
```

$$\frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_1(t))\ \frac{\partial}{\partial t}\ \varphi_1(t)\right)^2}{2} - \frac{\mathrm{ky}\,(y(t)+\mathrm{len}\,a(t))^2}{2} + \frac{\mathrm{mw}\left(\frac{\partial}{\partial t}\ y(t)-\sigma_2+e\ \cos(\varphi_2(t))\ \frac{\partial}{\partial t}\ \varphi_2(t)\right)^2}{2} + \frac{\mathrm{mw}\left(\sigma_1-e\ \mathrm{s}\right.}{}$$

where

$$\sigma_1 = \mathrm{OC}\ \sin(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_2 = \mathrm{OC}\ \cos(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_3 = \frac{\pi}{3} - a(t)$$

```
Lvar = subs(Lvar, y, yvar)
```

Lvar(t) =

$$\frac{\mathrm{mw}\left(\sigma_2-e\ \cos(\varphi_1(t))\ \frac{\partial}{\partial t}\ \varphi_1(t)\right)^2}{2} + \frac{\mathrm{mw}\left(\sigma_2-e\ \cos(\varphi_2(t))\ \frac{\partial}{\partial t}\ \varphi_2(t)\right)^2}{2} + \frac{\mathrm{mw}\left(\sigma_1-e\ \sin(\varphi_1(t))\ \frac{\partial}{\partial t}\ \varphi_1(t)\right)^2}{2} + \frac{\mathrm{mw}\left(\sigma_1-e\ \sin(\varphi\right.}{}$$

where

$$\sigma_1 = \mathrm{OC}\ \sin(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_2 = \mathrm{OC}\ \cos(\sigma_3)\ \frac{\partial}{\partial t}\ a(t)$$

$$\sigma_3 = \frac{\pi}{3} - a(t)$$

```
Lvar = subs(Lvar, a, avar)
```

Lvar(t) =

$$\frac{I_0\,\sigma_2}{2} - \frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} + \frac{I_0\,\sigma_1}{2} - g\,m\,\mathrm{yvar} - g\,\mathrm{mw}\,(\mathrm{yvar}+e\ \sin(\varphi_1(t))-\sigma_3) - g\,\mathrm{mw}\,(\mathrm{yvar}+e\ \sin(\varphi_2$$

where

$$\sigma_1 = \left(\frac{\partial}{\partial t}\ \varphi_2(t)\right)^2$$

$$\sigma_2 = \left(\frac{\partial}{\partial t}\ \varphi_1(t)\right)^2$$

$$\sigma_3 = \mathrm{OC}\ \sin\left(\mathrm{avar}-\frac{\pi}{3}\right)$$

```
Lvar = subs(Lvar, phi1, phi1var)
```

Lvar(t) =

$\frac{I_0\,\sigma_1}{2} - \frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\,(\mathrm{yvar} - \sigma_2 + e\,\sin(\mathrm{phi1var})) - g\,m\,\mathrm{yvar} - g\,\mathrm{mw}\,(\mathrm{yvar} + e\,\sin(\varphi_2(t))$

where

$\sigma_1 = \left(\frac{\partial}{\partial t}\,\varphi_2(t)\right)^2$

$\sigma_2 = \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right)$

```
Lvar = subs(Lvar, phi2, phi2var)
```

Lvar(t) =

$-\frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right) + e\,\sin(\mathrm{phi1var})\right) - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\right.$

```
Lvar = subs(Lvar, x_dot, x_dotvar)
```

Lvar(t) =

$-\frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right) + e\,\sin(\mathrm{phi1var})\right) - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\right.$

```
Lvar = subs(Lvar, y_dot, y_dotvar)
```

Lvar(t) =

$-\frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right) + e\,\sin(\mathrm{phi1var})\right) - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\right.$

```
Lvar = subs(Lvar, phi1_dot, phi1_dotvar)
```

Lvar(t) =

$-\frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right) + e\,\sin(\mathrm{phi1var})\right) - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\right.$

```
Lvar = subs(Lvar, phi2_dot, phi2_dotvar)
```

Lvar(t) =

$-\frac{\mathrm{ky}\,(\mathrm{yvar}+\mathrm{avar}\,\mathrm{len})^2}{2} - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\left(\mathrm{avar} - \frac{\pi}{3}\right) + e\,\sin(\mathrm{phi1var})\right) - g\,\mathrm{mw}\left(\mathrm{yvar} - \mathrm{OC}\,\sin\right.$

```
Nvar = subs(N, x, xvar)
```

Nvar(t) =

$\frac{\mathrm{by}\left(\mathrm{len}\,\frac{\partial}{\partial t}\,a(t) + \frac{\partial}{\partial t}\,y(t)\right)^2}{2} + \frac{\mathrm{bx}\,\mathrm{hgt}^2\left(\frac{\partial}{\partial t}\,a(t)\right)^2}{2}$

```
Nvar = subs(Nvar, y, yvar)
```

Nvar(t) =

$$\frac{\mathrm{bx}\,\mathrm{hgt}^2\left(\frac{\partial}{\partial t}\,a(t)\right)^2}{2}+\frac{\mathrm{by}\,\mathrm{len}^2\left(\frac{\partial}{\partial t}\,a(t)\right)^2}{2}$$

```
Nvar = subs(Nvar, a, avar)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, phi1, phi1var)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, phi2, phi2var)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, x_dot, x_dotvar)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, y_dot, y_dotvar)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, phi1_dot, phi1_dotvar)
```

Nvar(t) =

0

```
Nvar = subs(Nvar, phi2_dot, phi2_dotvar)
```

Nvar(t) =

0

```
%
dldx_dotvar = diff(Lvar, x_dotvar)
```

```
dldx_dotvar(t) =
    0
```

```
dldy_dotvar = diff(Lvar, y_dotvar)
```

```
dldy_dotvar(t) =
    0
```

```
dlda_dotvar = diff(Lvar, a_dotvar)
```

```
dlda_dotvar(t) =
    0
```

```
dldphi1_dotvar = diff(Lvar, phi1_dotvar)
```

```
dldphi1_dotvar(t) =
    0
```

```
dldphi2_dotvar = diff(Lvar, phi2_dotvar)
```

```
dldphi2_dotvar(t) =
    0
```

```
dndx_dotvar = diff(Nvar, x_dotvar)
```

```
dndx_dotvar(t) =
    0
```

```
dndy_dotvar = diff(Nvar, y_dotvar)
```

```
dndy_dotvar(t) =
    0
```

```
dnda_dotvar = diff(Nvar, a_dotvar)
```

```
dnda_dotvar(t) =
    0
```

```
dndphi1_dotvar = diff(Nvar, phi1_dotvar)
```

```
dndphi1_dotvar(t) =
    0
```

```
dndphi2_dotvar = diff(Nvar, phi2_dotvar)
```

```
dndphi2_dotvar(t) =
    0
```

i zamieniamy ze zmiennych spowrotem na funkcje

najpierw pochodne lagrangianu

```
%zmian dldx_dotvar na dldx_dot
dldx_dot = subs(dldx_dotvar, xvar, x)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, yvar, y)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, avar, a)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, phi1var, phi1)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, phi2var, phi2)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, x_dotvar, x_dot)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, y_dotvar, y_dot)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, phi1_dotvar, phi1_dot)
```

```
dldx_dot(t) =
    0
```

```
dldx_dot = subs(dldx_dot, phi2_dotvar, phi2_dot)
```

```
dldx_dot(t) =
    0
```

```

%zmiana dldy_dotvar na dldy_dot
dldy_dot = subs(dldy_dotvar, xvar, x)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, yvar, y)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, avar, a)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, phi1var, phi1)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, phi2var, phi2)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, x_dotvar, x_dot)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, y_dotvar, y_dot)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, phi1_dotvar, phi1_dot)
```

```
dldy_dot(t) =
    0
```

```
dldy_dot = subs(dldy_dot, phi2_dotvar, phi2_dot)
```

```
dldy_dot(t) =
    0
```

```

%zmiana dlda_dotvar na dlda_dot
dlda_dot = subs(dlda_dotvar, xvar, x)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, yvar, y)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, avar, a)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, phi1var, phi1)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, phi2var, phi2)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, x_dotvar, x_dot)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, y_dotvar, y_dot)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, phi1_dotvar, phi1_dot)
```

```
dlda_dot(t) =
    0
```

```
dlda_dot = subs(dlda_dot, phi2_dotvar, phi2_dot)
```

```
dlda_dot(t) =
    0
```

```

%zmiana dldphi1_dotvar na dldphi1_dot
dldphi1_dot = subs(dldphi1_dotvar, xvar, x)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, yvar, y)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, avar, a)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, phi1var, phi1)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, phi2var, phi2)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, x_dotvar, x_dot)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, y_dotvar, y_dot)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, phi1_dotvar, ...
    phi1_dot)
```

```
dldphi1_dot(t) =
    0
```

```
dldphi1_dot = subs(dldphi1_dot, phi2_dotvar, ...
    phi2_dot)
```

```
dldphi1_dot(t) =
    0
```

```



%zmiana dldphi2_dotvar na dldphi2_dot
dldphi2_dot = subs(dldphi2_dotvar, xvar, x)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, yvar, y)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, avar, a)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, phi1var, phi1)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, phi2var, phi2)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, x_dotvar, x_dot)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, y_dotvar, y_dot)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, phi1_dotvar, ...
    phi1_dot)
```

```
dldphi2_dot(t) =
    0
```

```
dldphi2_dot = subs(dldphi2_dot, phi2_dotvar, ...
    phi2_dot)
```

```
dldphi2_dot(t) =
    0
```

i pochodne dysypacji

```
%zmian dndx_dotvar na dndx_dot
dndx_dot = subs(dndx_dotvar, xvar, x)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, yvar, y)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, avar, a)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, phi1var, phi1)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, phi2var, phi2)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, x_dotvar, x_dot)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, y_dotvar, y_dot)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, phi1_dotvar, phi1_dot)
```

```
dndx_dot(t) =
    0
```

```
dndx_dot = subs(dndx_dot, phi2_dotvar, phi2_dot)
```

```
dndx_dot(t) =
    0
```

```

%zmiana dndy_dotvar na dndy_dot
dndy_dot = subs(dndy_dotvar, xvar, x)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, yvar, y)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, avar, a)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, phi1var, phi1)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, phi2var, phi2)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, x_dotvar, x_dot)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, y_dotvar, y_dot)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, phi1_dotvar, phi1_dot)
```

```
dndy_dot(t) =
    0
```

```
dndy_dot = subs(dndy_dot, phi2_dotvar, phi2_dot)
```

```
dndy_dot(t) =
    0
```

```

%zmiana dnda_dotvar na dnda_dot
dnda_dot = subs(dnda_dotvar, xvar, x)
```

```
dnda_dot(t) =
    0
```

```
dnda_dot = subs(dnda_dot, yvar, y)
```

```
dnda_dot(t) =
    0
```

```
dnda_dot = subs(dnda_dot, avar, a)
```

```
dnda_dot(t) =
    0
```

```
dnda_dot = subs(dnda_dot, phi1var, phi1)
```

dnda_dot(t) =
0

```
dnda_dot = subs(dnda_dot, phi2var, phi2)
```

dnda_dot(t) =
0

```
dnda_dot = subs(dnda_dot, x_dotvar, x_dot)
```

dnda_dot(t) =
0

```
dnda_dot = subs(dnda_dot, y_dotvar, y_dot)
```

dnda_dot(t) =
0

```
dnda_dot = subs(dnda_dot, phi1_dotvar, phi1_dot)
```

dnda_dot(t) =
0

```
dnda_dot = subs(dnda_dot, phi2_dotvar, phi2_dot)
```

dnda_dot(t) =
0

```

%zmiana dndphi1_dotvar na dndphi1_dot
dndphi1_dot = subs(dndphi1_dotvar, xvar, x)
```

dndphi1_dot(t) =
0

```
dndphi1_dot = subs(dndphi1_dot, yvar, y)
```

dndphi1_dot(t) =
0

```
dndphi1_dot = subs(dndphi1_dot, avar, a)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, phi1var, phi1)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, phi2var, phi2)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, x_dotvar, x_dot)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, y_dotvar, y_dot)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, phi1_dotvar, ...
    phi1_dot)
```

```
dndphi1_dot(t) =
    0
```

```
dndphi1_dot = subs(dndphi1_dot, phi2_dotvar, ...
    phi2_dot)
```

```
dndphi1_dot(t) =
    0
```

```



%zmiana dndphi2_dotvar na dndphi2_dot
dndphi2_dot = subs(dndphi2_dotvar, xvar, x)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, yvar, y)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, avar, a)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, phi1var, phi1)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, phi2var, phi2)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, x_dotvar, x_dot)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, y_dotvar, y_dot)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, phi1_dotvar, ...
    phi1_dot)
```

```
dndphi2_dot(t) =
    0
```

```
dndphi2_dot = subs(dndphi2_dot, phi2_dotvar, ...
    phi2_dot)
```

```
dndphi2_dot(t) =
    0
```

I budujemy rownania

```
ddt_dlddqi = [diff(dldx_dot, t); diff(dldy_dot, ...
    t); diff(dlda_dot, t); diff(dldphi1_dot, t); ...
    diff(dldphi2_dot, t)]
```

```
ddt_dlddqi(t) =
```

$$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

```
dldqi = [dldx; dldy; dlda; dldphi1; dldphi2]
```

```
dldqi(t) =
```

$$\left(\begin{array}{r} 2\,\mathrm{OC}\,g\,\mathrm{mw}\,\cos(\sigma_9) - \mathrm{ky}\,\mathrm{len}\,y(t) - \mathrm{ky}\,\mathrm{len}^2\,a(t) - \mathrm{Ic}\,\sigma_1 - 2\,\mathrm{OC}^2\,\mathrm{mw}\cos(\sigma_9)^2\,\sigma_1 - \mathrm{hgt}^2\,\mathrm{kx}\,a(t)\ x(t) \\ \mathrm{OC}\,e\,\mathrm{mw}\,\cos(\varphi \\ e\,\mathrm{mw}\,\sin(\varphi_2(t \end{array} \right.$$

where

$$\sigma_1 = \frac{\partial^2}{\partial t^2}\,a(t)$$

$$\sigma_2 = \left(\frac{\partial}{\partial t}\,a(t)\right)^2$$

$$\sigma_3 = \frac{\partial^2}{\partial t^2}\,\varphi_2(t)$$

$$\sigma_4 = \frac{\partial^2}{\partial t^2}\,\varphi_1(t)$$

$$\sigma_5 = \frac{\partial^2}{\partial t^2}\,y(t)$$

$$\sigma_6 = \frac{\partial^2}{\partial t^2}\,x(t)$$

$$\sigma_7 = \left(\frac{\partial}{\partial t}\,\varphi_2(t)\right)^2$$

$$\sigma_8 = \left(\frac{\partial}{\partial t}\,\varphi_1(t)\right)^2$$

$$\sigma_9 = \frac{\pi}{3} - a(t)$$

```
dnddqi = [diff(dndx_dot, t); diff(dndy_dot, t); ...
    diff(dnda_dot, t); diff(dndphi1_dot, t); ...
    diff(dndphi2_dot, t)]
```

```
dnddqi(t) =
```

$$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

```
m_eqns = -ddt_dlddqi + dldqi - dnddqi
```

```
m_eqns(t) =
```

$$\left(\begin{array}{r} 2\,\mathrm{OC}\,g\,\mathrm{mw}\,\cos\left(\sigma_9\right) - \mathrm{ky}\,\mathrm{len}\,y\left(t\right) - \mathrm{ky}\,\mathrm{len}^2\,a\left(t\right) - \mathrm{Ic}\,\sigma_1 - 2\,\mathrm{OC}^2\,\mathrm{mw}\cos\left(\sigma_9\right)^2\,\sigma_1 - \mathrm{hgt}^2\,\mathrm{kx}\,a\left(t\right)\,x\left(t\right) \\ \mathrm{OC}\,e\,\mathrm{mw}\,\cos\left(\varphi \right. \\ e\,\mathrm{mw}\,\sin\left(\varphi_2\left(t\right.\right. \end{array} \right.$$

where

$$\sigma_1 = \frac{\partial^2}{\partial t^2}\,a\left(t\right)$$

$$\sigma_2 = \left(\frac{\partial}{\partial t}\,a\left(t\right)\right)^2$$

$$\sigma_3 = \frac{\partial^2}{\partial t^2}\,\varphi_2\left(t\right)$$

$$\sigma_4 = \frac{\partial^2}{\partial t^2}\,\varphi_1\left(t\right)$$

$$\sigma_5 = \frac{\partial^2}{\partial t^2}\,y\left(t\right)$$

$$\sigma_6 = \frac{\partial^2}{\partial t^2}\,x\left(t\right)$$

$$\sigma_7 = \left(\frac{\partial}{\partial t}\,\varphi_2\left(t\right)\right)^2$$

$$\sigma_8 = \left(\frac{\partial}{\partial t}\,\varphi_1\left(t\right)\right)^2$$

$$\sigma_9 = \frac{\pi}{3} - a\left(t\right)$$

```
dsolve(m_eqns == 0)
```

```
Warning: Unable to find explicit solution.

ans =

[ empty sym ]
```