```
clear variables
```

In rotating co-ordinate system aligned with pole:

```
syms t r(t) v(t) a(t) rho(t) theta(t) urho(t) utheta(t)

r = rho(t) * urho
```

r(t) = $\rho(t)\,\mathrm{urho}(t)$

```
v = subs(diff(r, t), ...
    {diff(urho(t), t), diff(utheta(t), t)}, ...
    {utheta(t) * diff(theta(t), t), -diff(theta(t), t) * urho(t)} ...
)
```

v(t) =

$$\mathrm{urho}(t)\,\frac{\partial}{\partial t}\,\rho(t)+\rho(t)\,\mathrm{utheta}(t)\,\frac{\partial}{\partial t}\,\theta(t)$$

```
a = subs(diff(v, t), ...
    {diff(urho(t), t), diff(utheta(t), t)}, ...
    {utheta(t) * diff(theta(t), t), -diff(theta(t), t) * urho(t)} ...
)
```

a(t) =

$$\mathrm{urho}(t)\,\frac{\partial^2}{\partial t^2}\,\rho(t)-\rho(t)\,\mathrm{urho}(t)\,\left(\frac{\partial}{\partial t}\,\theta(t)\right)^2+\rho(t)\,\mathrm{utheta}(t)\,\frac{\partial^2}{\partial t^2}\,\theta(t)+2\,\mathrm{utheta}(t)\,\frac{\partial}{\partial t}\,\theta(t)\,\frac{\partial}{\partial t}\,\rho(t)$$

In stationary co-ordinate x-y system:

```
syms ux uy

urho_xy = rho(t) * cos(theta(t)) * ux + rho(t) * sin(theta(t)) * uy
```

urho_xy = $\mathrm{ux}\cos(\theta(t))\,\rho(t)+\mathrm{uy}\sin(\theta(t))\,\rho(t)$

```
r_xy = rho(t) * urho_xy
```

r_xy = $\rho(t)\,\left(\mathrm{ux}\cos(\theta(t))\,\rho(t)+\mathrm{uy}\sin(\theta(t))\,\rho(t)\right)$

```
v_xy = simplify(diff(r_xy, t))
```

v_xy =

$$\rho(t)\,\left(2\,\mathrm{ux}\cos(\theta(t))\,\frac{\partial}{\partial t}\,\rho(t)+2\,\mathrm{uy}\sin(\theta(t))\,\frac{\partial}{\partial t}\,\rho(t)+\mathrm{uy}\cos(\theta(t))\,\rho(t)\,\frac{\partial}{\partial t}\,\theta(t)-\mathrm{ux}\sin(\theta(t))\,\rho(t)\,\frac{\partial}{\partial t}\,\theta(t)\right.$$

```
a_xy = simplify(diff(v_xy, t))
```

a_xy =

$$2\,\mathrm{ux}\cos(\theta(t))\,\sigma_2 + 2\,\mathrm{uy}\sin(\theta(t))\,\sigma_2 + 2\,\mathrm{ux}\cos(\theta(t))\,\rho(t)\,\sigma_4 + 2\,\mathrm{uy}\sin(\theta(t))\,\rho(t)\,\sigma_4 - \mathrm{ux}\cos(\theta(t))\,\rho(t)^2\,\sigma_1$$

where

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

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

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

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