```
In [6]: run franke_oo.py
x =
```

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix}$$

```
 xdot =
```

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ \dot{x}_5 \end{bmatrix}$$

```
0 = F(x,xdot) =
```

$$\begin{bmatrix} -x_3 x_4 + \dot{x}_1 \\ -x_4 + \dot{x}_2 \\ -x_5 + \dot{x}_3 \end{bmatrix}$$

```
i = 0 ################################################################################

P10 [3 x 5] =
```

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{bmatrix}$$

```
P00 [3 x 5] =
```

$$\begin{bmatrix}0 & 0 & -x_4 & -x_3 & 0\\0 & 0 & 0 & -1 & 0\\0 & 0 & 0 & 0 & -1\end{bmatrix}$$

P10_roc [5 x 2] =

$$\begin{bmatrix}0 & 0\\0 & 0\\0 & 0\\1 & 0\\0 & 1\end{bmatrix}$$

P10_rpinv [5 x 3] =

$$\begin{bmatrix}1 & 0 & 0\\0 & 1 & 0\\0 & 0 & 1\\0 & 0 & 0\\0 & 0 & 0\end{bmatrix}$$

P10_dot [3 x 5] =

$$\begin{bmatrix}0 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 0 & 0\end{bmatrix}$$

A0 [3 x 3] =

$$\begin{bmatrix}0 & 0 & -x_4\\0 & 0 & 0\\0 & 0 & 0\end{bmatrix}$$

B0 [3 x 2] =

$$\begin{bmatrix}-x_3 & 0\\-1 & 0\\0 & -1\end{bmatrix}$$

B0_loc [1 x 3] =

$$\begin{bmatrix}-1 & x_3 & 0\end{bmatrix}$$

```
B0_lpinv [2 x 3] =
```

$$\begin{bmatrix}0 & -1 & 0 \\ 0 & 0 & -1\end{bmatrix}$$

```
i = 1 ################################################################################
```

```
P11 [1 x 3] =
```

$$\begin{bmatrix}-1 & x_3 & 0\end{bmatrix}$$

```
P01 [1 x 3] =
```

$$\begin{bmatrix}0 & 0 & x_4\end{bmatrix}$$

```
P11_roc [3 x 2] =
```

$$\begin{bmatrix}x_3 & 0 \\ 1 & 0 \\ 0 & 1\end{bmatrix}$$

```
P11_rpinv [3 x 1] =
```

$$\begin{bmatrix}-1 \\ 0 \\ 0\end{bmatrix}$$

```
P11_dot [1 x 3] =
```

$$\begin{bmatrix}0 & \dot{x}_3 & 0\end{bmatrix}$$

```
A1 [1 x 1] =
```

$$\begin{bmatrix}0\end{bmatrix}$$

```
B1 [1 x 2] =
```

$$\begin{bmatrix}-\dot{x}_3 & x_4\end{bmatrix}$$

```
--- Sonderfall 4.7 -------------------------------------------------------------------
```

B1_tilde [1 x 1] =

$$\left[\begin{matrix}1\end{matrix}\right]$$

B1_tilde_lpinv [1 x 1] =

$$\left[\begin{matrix}1\end{matrix}\right]$$

P11_tilde_roc [3 x 1] =

$$\left[\begin{matrix}- \frac{x_{3}}{\dot{x}_{3}}\\- \frac{1}{\dot{x}_{3}}\\0\end{matrix}\right]$$

Z1 [3 x 1] =

$$\left[\begin{matrix}\frac{x_{3} x_{4}}{\dot{x}_{3}}\\\frac{x_{4}}{\dot{x}_{3}}\\1\end{matrix}\right]$$

Z1_lpinv [1 x 3] =

$$\left[\begin{matrix}0 & 0 & 1\end{matrix}\right]$$

##

Algorithmus am Ende

Q-matrix =

$$\left[\begin{matrix}-1 & x_{3} & 0 & 0 & 0\\0 & 0 & 1 & 0 & 0\end{matrix}\right]$$

G-matrix =

$$\left[\begin{matrix}\frac{1}{\dot{x}_{3}} \left(x_{3} s - \dot{x}_{3}\right) & \frac{x_{3} x_{4}}{\dot{x}_{3}}\\\frac{s}{\dot{x}_{3}} & \frac{x_{4}}{\dot{x}_{3}}\\0 & 1\\\frac{s^{2}}{\dot{x}_{3}} & \frac{x_{4} s}{\dot{x}_{3}}\\0 & s\end{matrix}\right]$$

```
w1 = (-1) dx1+(x3) dx2

w2 = (1) dx3

######################################################################################


w[0].d^w[1]=0
<-> Integrabilitätsbedingung für w[0] erfüllt.


w[1].d = 0
<-> Integrabilitätsbedingung für w[1] erfüllt.
    Der Flache Ausgang wurde berechnet:
y2 =
```

x_3

```
######################################################################################
```

```
In [7]: sp.simplify(Q*G)
Out[7]:
```

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

```
In [8]: sp.simplify(P*G)
Out[8]:
```

$$\begin{bmatrix} -s & -x_4 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

```
In [9]:
```