Lösungen mit Exkursen

1

a

1

```
Remove[a]
```

```
A = {{0,a,-1},{0,2,2},{3,1,2}};A//MatrixForm
```

$$\begin{pmatrix} 0 & a & -1 \\ 0 & 2 & 2 \\ 3 & 1 & 2 \end{pmatrix}$$

```
A//TeXForm;
```

```
Det[A]
```

$$6 + 6\,a$$

```
B = {{1,0,1},{1,1,0},{0,1,1}};B//MatrixForm
```

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

```
B//TeXForm;
```

```
Det[B]
```

$$2$$

```
M = {{3,2,2},{1,1,2},{4,3,4}};M//MatrixForm
```

$$\begin{pmatrix} 3 & 2 & 2 \\ 1 & 1 & 2 \\ 4 & 3 & 4 \end{pmatrix}$$

```
M//TeXForm;
```

```
Det[M]
```

$$0$$

2

Det[X] = 0

3

Det[A]

$6 + 6\,a$

Det[A]/.a->-1

0

b

A.X.B == M

```
{{0, a, -1}, {0, 2, 2}, {3, 1, 2}}.X.{{1, 0, 1}, {1, 1, 0}, {0, 1, 1}} ==
 {{3, 2, 2}, {1, 1, 2}, {4, 3, 4}}
```

X = Inverse[A].M.Inverse[B]//Simplify//MatrixForm

$$\begin{pmatrix} \frac{7+3\,a}{6+6\,a} & \frac{2+a}{2+2\,a} & \frac{3+a}{6+6\,a} \\ \frac{2}{1+a} & \frac{3}{2+2\,a} & \frac{1}{1+a} \\ \frac{-3+a}{2\,(1+a)} & -\frac{3}{2+2\,a} & \frac{-1+a}{2\,(1+a)} \end{pmatrix}$$

X = (Inverse[A].M.Inverse[B]/.a->0)//Simplify//MatrixForm

$$\begin{pmatrix} \frac{7}{6} & 1 & \frac{1}{2} \\ 2 & \frac{3}{2} & 1 \\ -\frac{3}{2} & -\frac{3}{2} & -\frac{1}{2} \end{pmatrix}$$

X = (Inverse[A].M.Inverse[B]/.a->3)//Simplify//MatrixForm

$$\begin{pmatrix} \frac{2}{3} & \frac{5}{8} & \frac{1}{4} \\ \frac{1}{2} & \frac{3}{8} & \frac{1}{4} \\ 0 & -\frac{3}{8} & \frac{1}{4} \end{pmatrix}$$

%//N

```
{{0.666667, 0.625, 0.25}, {0.5, 0.375, 0.25}, {0., -0.375, 0.25}}
```

c

A = A/.a->-1; A//MatrixForm

$$\begin{pmatrix} 0 & -1 & -1 \\ 0 & 2 & 2 \\ 3 & 1 & 2 \end{pmatrix}$$

X = {{x11,x12,x13},{x21,x22,x23},{x31,x32,x33}}; X//MatrixForm

$$\begin{pmatrix} x11 & x12 & x13 \\ x21 & x22 & x23 \\ x31 & x32 & x33 \end{pmatrix}$$

A.X//MatrixForm

$$\begin{pmatrix} -x21 - x31 & -x22 - x32 & -x23 - x33 \\ 2\,x21 + 2\,x31 & 2\,x22 + 2\,x32 & 2\,x23 + 2\,x33 \\ 3\,x11 + x21 + 2\,x31 & 3\,x12 + x22 + 2\,x32 & 3\,x13 + x23 + 2\,x33 \end{pmatrix}$$

M.Inverse[B]//MatrixForm

$$\begin{pmatrix} \frac{3}{2} & \frac{3}{2} & \frac{1}{2} \\ 1 & 0 & 1 \\ \frac{5}{2} & \frac{3}{2} & \frac{3}{2} \end{pmatrix}$$

(A.X//MatrixForm) == (M.Inverse[B]//MatrixForm)

$$\begin{pmatrix} -x21 - x31 & -x22 - x32 & -x23 - x33 \\ 2\,x21 + 2\,x31 & 2\,x22 + 2\,x32 & 2\,x23 + 2\,x33 \\ 3\,x11 + x21 + 2\,x31 & 3\,x12 + x22 + 2\,x32 & 3\,x13 + x23 + 2\,x33 \end{pmatrix} == \begin{pmatrix} \frac{3}{2} & \frac{3}{2} & \frac{1}{2} \\ 1 & 0 & 1 \\ \frac{5}{2} & \frac{3}{2} & \frac{3}{2} \end{pmatrix}$$

Anhang

Transpose[X][[1]]

{x11, x21, x31}

RowReduce[A.X]//MatrixForm

$$\begin{pmatrix} 1 & 0 & \frac{-3\,x13\,x22+3\,x12\,x23-3\,x13\,x32+x23\,x32+3\,x12\,x33-x22\,x33}{3\,x12\,x21-3\,x11\,x22+3\,x12\,x31-x22\,x31-3\,x11\,x32+x21\,x32} \\ 0 & 1 & \frac{3\,x13\,x21-3\,x11\,x23+3\,x13\,x31-x23\,x31-3\,x11\,x33+x21\,x33}{3\,x12\,x21-3\,x11\,x22+3\,x12\,x31-x22\,x31-3\,x11\,x32+x21\,x32} \\ 0 & 0 & 0 \end{pmatrix}$$

RowReduce[M.Inverse[B]]//MatrixForm

$$\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & -\frac{2}{3} \\ 0 & 0 & 0 \end{pmatrix}$$

LinearSolve[{{1,0,0},{0,1,0},{0,0,1}},{1,2,3}]

{1, 2, 3}

LinearSolve[{{1,0,0},{0,1,0},{0,0,0}},{1,2,3}]

LinearSolve::nosol : Linear equation encountered which has no solution. Mehr…

LinearSolve[{{1, 0, 0}, {0, 1, 0}, {0, 0, 0}}, {1, 2, 3}]

LinearSolve[A,Transpose[M.Inverse[B]][[1]]]

LinearSolve::nosol : Linear equation encountered which has no solution. Mehr…

$$\text{LinearSolve}\left[\{\{0, -1, -1\}, \{0, 2, 2\}, \{3, 1, 2\}\}, \left\{\frac{3}{2}, 1, \frac{5}{2}\right\}\right]$$

LinearSolve[A,Transpose[M.Inverse[B]][[2]]]

LinearSolve::nosol : Linear equation encountered which has no solution. Mehr…

$$\text{LinearSolve}\left[\{\{0, -1, -1\}, \{0, 2, 2\}, \{3, 1, 2\}\}, \left\{\frac{3}{2}, 0, \frac{3}{2}\right\}\right]$$

LinearSolve[A,Transpose[M.Inverse[B]][[3]]]

LinearSolve::nosol : Linear equation encountered which has no solution. Mehr…

$$\text{LinearSolve}\left[\{\{0, -1, -1\}, \{0, 2, 2\}, \{3, 1, 2\}\}, \left\{\frac{1}{2}, 1, \frac{3}{2}\right\}\right]$$

2

Remove["Global`*"]

a Gleichmässig verteilte Streckenlast plus Gegenkraft am Balkenende, allgemeineGleichung

m[x_]:= -q1 (zL-x)^2 + F1 (zL-x); m[x]

$$F1\ (-x + zL) - q1\ (-x + zL)^2$$

s[x_] := DSolve[y''[x] == -m[x] / zE / zI, y[x], x] // Flatten; s[x]

$$\left\{y[x] \to \frac{\frac{q1\,x^4}{2} + x^3\ (F1 - 2\,q1\,zL) - 3\,x^2\,zL\ (F1 - q1\,zL)}{6\,zE\,zI} + C[1] + x\,C[2]\right\}$$

s[z]

$$\left\{y[z] \to \frac{\frac{q1\,z^4}{2} + z^3\ (F1 - 2\,q1\,zL) - 3\,z^2\,zL\ (F1 - q1\,zL)}{6\,zE\,zI} + C[1] + z\,C[2]\right\}$$

s[z][[1]][[2]] //FullForm

```
Plus[Times[Rational[1, 6], Power[zE, -1],
  Power[zI, -1], Plus[Times[Rational[1, 2], q1, Power[z, 4]],
   Times[Power[z, 3], Plus[F1, Times[-2, q1, zL]]],
   Times[-3, Power[z, 2], zL, Plus[F1, Times[-1, q1, zL]]]]], C[1], Times[z, C[2]]]
```

s[z][[1]][[2]] /. {C[1]->C1, C[2]->C2}

$$C1 + C2\,z + \frac{\frac{q1\,z^4}{2} + z^3\ (F1 - 2\,q1\,zL) - 3\,z^2\,zL\ (F1 - q1\,zL)}{6\,zE\,zI}$$

h[z_]:=s[z][[1]][[2]] /. {C[1]->C1, C[2]->C2} ; h[z]

$$C1 + C2\,z + \frac{\frac{q1\,z^4}{2} + z^3\ (F1 - 2\,q1\,zL) - 3\,z^2\,zL\ (F1 - q1\,zL)}{6\,zE\,zI}$$

h[3]

DSolve::dsvar : 3 cannot be used as a variable. Mehr…

DSolve::dsvar : 3 cannot be used as a variable. Mehr…

$$\frac{-F1\ (-3 + zL) + q1\ (-3 + zL)^2}{zE\,zI}$$

h[z]/.z->3

$$C1 + 3\,C2 + \frac{\frac{81\,q1}{2} + 27\ (F1 - 2\,q1\,zL) - 27\,zL\ (F1 - q1\,zL)}{6\,zE\,zI}$$

```
h1[u_]:=h[z]/.z->u;  h1[3]
```

$$C1 + 3\,C2 + \frac{\frac{81\,q1}{2} + 27\,(F1 - 2\,q1\,zL) - 27\,zL\,(F1 - q1\,zL)}{6\,zE\,zI}$$

```
solv1=Solve[{h1[0]==0,Evaluate[h1'[u]==0]/.u->0},{C1,C2}]//Simplify//Flatten
```

$$\{C1 \to 0,\ C2 \to 0\}$$

```
h2[u_]:=(h1[u]/.solv1)//Simplify;  h2[t]
```

$$\frac{t^2\,(2\,F1\,(t - 3\,zL) + q1\,(t^2 - 4\,t\,zL + 6\,zL^2))}{12\,zE\,zI}$$

```
Collect[h2[t],{t,t^2,t^3,t^4}]
```

$$\frac{q1\,t^4}{12\,zE\,zI} + \frac{t^3\,(2\,F1 - 4\,q1\,zL)}{12\,zE\,zI} + \frac{t^2\,(-6\,F1\,zL + 6\,q1\,zL^2)}{12\,zE\,zI}$$

```
Collect[h2[t],{t,t^2,t^3,t^4}]//Together
```

$$\frac{2\,F1\,t^3 + q1\,t^4 - 6\,F1\,t^2\,zL - 4\,q1\,t^3\,zL + 6\,q1\,t^2\,zL^2}{12\,zE\,zI}$$

```
(Collect[h2[t],{t,t^2,t^3,t^4}] /. q1-> q/2) //Together
```

$$\frac{4\,F1\,t^3 + q\,t^4 - 12\,F1\,t^2\,zL - 4\,q\,t^3\,zL + 6\,q\,t^2\,zL^2}{24\,zE\,zI}$$

Anhang

```
h2[u_]:=(h1[u]/.solv1)//Simplify;
h3[t_]=InputForm[h2[u]]/.u->t; {h2[w],h3[w]}
```

$$\left\{\frac{w^2\,(2\,F1\,(w - 3\,zL) + q1\,(w^2 - 4\,w\,zL + 6\,zL^2))}{12\,zE\,zI},\right.$$
$$\left.(w\text{^}2 * (2 * F1 * (w - 3 * zL) + q1 * (w\text{^}2 - 4 * w * zL + 6 * zL\text{^}2))) / (12 * zE * zI)\right\}$$

```
h3[t_]=h2[u]/.u->t; {h2[w],h3[w]}
```

$$\left\{\frac{w^2\,(2\,F1\,(w - 3\,zL) + q1\,(w^2 - 4\,w\,zL + 6\,zL^2))}{12\,zE\,zI},\ \frac{w^2\,(2\,F1\,(w - 3\,zL) + q1\,(w^2 - 4\,w\,zL + 6\,zL^2))}{12\,zE\,zI}\right\}$$

```
FullForm[h3[t]]
```

```
Times[Rational[1, 12], Power[t, 2], Power[zE, -1],
 Power[zI, -1], Plus[Times[2, F1, Plus[t, Times[-3, zL]]],
  Times[q1, Plus[Power[t, 2], Times[-4, t, zL], Times[6, Power[zL, 2]]]]]]
```

b

```
q1=q/2
```

$$\frac{q}{2}$$

Masse in Meter und kg

F1 = 500 9.81 Newton

$$4905.\ \text{Newton}$$

hoehe= 6 Zentimeter; A=hoehe^2; zI = A hoehe^2 /12

$$108\ \text{Zentimeter}^4$$

h3[u]

$$\frac{u^2\ (9810.\ \text{Newton}\ (u - 3\ zL) + \frac{1}{2}\ q\ (u^2 - 4\ u\ zL + 6\ zL^2))}{1296\ zE\ \text{Zentimeter}^4}$$

A

$$36\ \text{Zentimeter}^2$$

zE=210000 Newton /Mimimeter^2

$$\frac{210000\ \text{Newton}}{\text{Mimimeter}^2}$$

zL = 4 Meter

$$4\ \text{Meter}$$

q = 800 9.81 Newton /zL

$$\frac{1962.\ \text{Newton}}{\text{Meter}}$$

h3[t]/.{Zentimeter-> 0.01 Meter, Mimimeter-> 0.001 Meter}

$$\frac{1}{\text{Meter}^2\ \text{Newton}}\left(3.67431 \times 10^{-7}\ t^2\ \left(9810.\ \text{Newton}\ (-12\ \text{Meter} + t) + \frac{981.\ \text{Newton}\ (96\ \text{Meter}^2 - 16\ \text{Meter}\ t + t^2)}{\text{Meter}}\right)\right)$$

h3[zL]/.{Zentimeter-> 0.01 Meter, Mimimeter-> 0.001 Meter}

$$-0.18455\ \text{Meter}$$

h3[zL]/.{Meter-> 100 Zentimeter, Mimimeter-> 0.1 Zentimeter}

$$-18.455\ \text{Zentimeter}$$

Anhang

q zL^4/zE/zI (* Einheitenvergleich *)

$$\frac{0.022146\ \text{Meter}^3\ \text{Mimimeter}^2}{\text{Zentimeter}^4}$$

c

h3[t]//Expand//Simplify

$$(\text{Mimimeter}^2\ t^2\ (-0.0000865079\ \text{Meter}^2 - 0.000021627\ \text{Meter}\ t + 3.6045 \times 10^{-6}\ t^2)) /\ (\text{Meter}\ \text{Zentimeter}^4)$$

hh=h3[t]//Expand//Simplify

$$\left(\text{Mimimeter}^2\, t^2\, \left(-0.0000865079\, \text{Meter}^2 - 0.000021627\, \text{Meter}\, t + 3.6045 \times 10^{-6}\, t^2\right)\right) / \left(\text{Meter}\, \text{Zentimeter}^4\right)$$

h3[t]/.t->u

$$\left(\text{Mimimeter}^2\, u^2\, \left(9810.\ \text{Newton}\, \left(-12\, \text{Meter} + u\right) + \frac{981.\ \text{Newton}\, \left(96\, \text{Meter}^2 - 16\, \text{Meter}\, u + u^2\right)}{\text{Meter}}\right)\right) \Big/ \left(272160000\, \text{Newton}\, \text{Zentimeter}^4\right)$$

hh[[1]]/.t->u

$$\frac{1}{\text{Meter}}$$

h4[s_]:=hh[[1]]/.t->s ; h4[u]

$$\frac{1}{\text{Meter}}$$

h4[s_]=Evaluate[h3[t]]/.t->s

$$\left(\text{Mimimeter}^2\, s^2\, \left(9810.\ \text{Newton}\, \left(-12\, \text{Meter} + s\right) + \frac{981.\ \text{Newton}\, \left(96\, \text{Meter}^2 - 16\, \text{Meter}\, s + s^2\right)}{\text{Meter}}\right)\right) \Big/ \left(272160000\, \text{Newton}\, \text{Zentimeter}^4\right)$$

D[h4[v],v]

$$\frac{\text{Mimimeter}^2\, v^2\, \left(9810.\ \text{Newton} + \frac{981.\ \text{Newton}\, \left(-16\, \text{Meter} + 2\, v\right)}{\text{Meter}}\right)}{272160000\, \text{Newton}\, \text{Zentimeter}^4} + \left(\text{Mimimeter}^2\, v\, \left(9810.\ \text{Newton}\, \left(-12\, \text{Meter} + v\right) + \frac{981.\ \text{Newton}\, \left(96\, \text{Meter}^2 - 16\, \text{Meter}\, v + v^2\right)}{\text{Meter}}\right)\right) \Big/ \left(136080000\, \text{Newton}\, \text{Zentimeter}^4\right)$$

D[h4[v],v]/.{v->zL}

$$-\frac{0.000807407\, \text{Meter}^2\, \text{Mimimeter}^2}{\text{Zentimeter}^4}$$

%/. {Meter-> 100 Zentimeter, Mimimeter-> 0.1 Zentimeter}

$$-0.0807407$$

ArcTan[%]

$$-0.080566$$

ArcTan[%%]/(1. Degree)

$$-4.61609$$

Remove["Global`*"]

3 Eigenwerte

a

a1

```
v1 = {1,2,1}; v2={3,8,4}; v3={-4,0,3};
k1=1; k2=4; k3=-2;

Det[{v1,v2,v3}]
```

```
6
```

```
M = Transpose[{k1 v1, k2 v2, k3 v3}]. Inverse[Transpose[{v1,v2,v3}]]; M//MatrixForm
```

$$\begin{pmatrix} -8 & \frac{17}{2} & -8 \\ -24 & 29 & -32 \\ -12 & \frac{31}{2} & -18 \end{pmatrix}$$

```
M//InputForm
```

```
{{-8, 17/2, -8}, {-24, 29, -32}, {-12, 31/2, -18}}
```

a2

```
Eigensystem[M]
```

$$\left\{\{4, -2, 1\}, \left\{\left\{\frac{3}{4}, 2, 1\right\}, \left\{-\frac{4}{3}, 0, 1\right\}, \{1, 2, 1\}\right\}\right\}$$

b

b1

```
v1 = {1,2}; v2={3,8};
k1=1; k2=4;

M = Transpose[{k1 v1, k2 v2}]. Inverse[Transpose[{v1,v2}]]; M//MatrixForm
```

$$\begin{pmatrix} -8 & \frac{9}{2} \\ -24 & 13 \end{pmatrix}$$

```
M//TeXForm;

Eigensystem[M]
```

$$\left\{\{4, 1\}, \left\{\left\{\frac{3}{8}, 1\right\}, \left\{\frac{1}{2}, 1\right\}\right\}\right\}$$

```
M.{3/8, 1}
```

$$\left\{\frac{3}{2}, 4\right\}$$

```
M.{1/2, 1}
```

$$\left\{\frac{1}{2}, 1\right\}$$

b2

```
a[t_]:= +t v1;
a[t]
```

$$\{t, 2\,t\}$$

```
g[s_]:={6,3}+s {1,1};
M.g[s]//Simplify
```

$$\left\{\frac{1}{2}\,(-69-7\,s), -105-11\,s\right\}$$

```
Solve[g[s]==M.g[s],{t}]
```

$$\{\{\}\}$$

b3

```
(M.g[1]-g[1])/(-120)
```

$$\left\{\frac{3}{8}, 1\right\}$$

```
(M.g[0]-g[0])/(-108)
```

$$\left\{\frac{3}{8}, 1\right\}$$

```
Solve[a[t]==g[s],{t,s}]
```

$$\{\{t \to -3, s \to -9\}\}$$

```
Solve[a[t]==M.g[s],{t,s}]
```

$$\{\{t \to -3, s \to -9\}\}$$

```
a[-3]
```

$$\{-3, -6\}$$

```
(M.g[s]-g[s])/(9+s)/(-12)//Simplify
```

$$\left\{\frac{3}{8}, 1\right\}$$

4 Bewegungen von Punkten, Abstände

a Projiziere die Gerade: g (0), g(1)

```
u = {1,2,1}; a={3,8,4}; b={-4,0,3}; n={0,0,0};

g[s_]:={6,3,0}+s{1,1,1};

g10=g[0]
```

$\{6, 3, 0\}$

```
g20=g[1]
```

$\{7, 4, 1\}$

```
mP = Transpose[{a,b,n}].Inverse[ Transpose[{a,b,u}]]; mP//MatrixForm
```

$$\begin{pmatrix} -3 & \frac{25}{6} & -\frac{16}{3} \\ -8 & \frac{28}{3} & -\frac{32}{3} \\ -4 & \frac{25}{6} & -\frac{13}{3} \end{pmatrix}$$

```
g11=mP.g[0]
```

$\left\{-\frac{11}{2}, -20, -\frac{23}{2}\right\}$

```
%//N
```

$\{-5.5, -20., -11.5\}$

```
g21=mP.g[1]
```

$\left\{-\frac{29}{3}, -\frac{88}{3}, -\frac{47}{3}\right\}$

```
%//N
```

$\{-9.66667, -29.3333, -15.6667\}$

b Drehe die projizierte Gerade (Punkte) um 30 Grad um die z-Achse

```
Remove[d,x]

d[x_]:= {{Cos[x],-Sin[x],0},{Sin[x],Cos[x],0},{0,0,1}}

d[30 Degree]//MatrixForm
```

$$\begin{pmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & \frac{\sqrt{3}}{2} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

```
%//N
```

$\{\{0.866025, -0.5, 0.\}, \{0.5, 0.866025, 0.\}, \{0., 0., 1.\}\}$

g12=d[30 Degree].(mP.g[0])

$$\left\{10-\frac{11\sqrt{3}}{4},-\frac{11}{4}-10\sqrt{3},-\frac{23}{2}\right\}$$

%//N

{5.23686, −20.0705, −11.5}

g22=d[30 Degree].(mP.g[1])

$$\left\{\frac{44}{3}-\frac{29}{2\sqrt{3}},-\frac{29}{6}-\frac{44}{\sqrt{3}},-\frac{47}{3}\right\}$$

g22=d[30 Degree].mP.g[1]//Simplify

$$\left\{\frac{1}{6}\left(88-29\sqrt{3}\right),-\frac{29}{6}-\frac{44}{\sqrt{3}},-\frac{47}{3}\right\}$$

%//N

{6.29509, −30.2367, −15.6667}

c Berechne die minimalen Abstände der ursprünglichen Geraden und der bewegten Geraden von 0

abst[r_,s_]:=Norm[Cross[r,s]]/Norm[r-s]

abst[g10,g20]

$$3\sqrt{2}$$

%//N

4.24264

abst[g11,g21]

$$5\sqrt{\frac{534}{731}}$$

%//N

4.27348

abst[g12,g22]

$$\frac{\sqrt{1024+\left(\frac{25}{2}+12\sqrt{3}\right)^2+\left(-12+\frac{25\sqrt{3}}{2}\right)^2}}{\sqrt{\frac{625}{36}+\left(\frac{25}{12}+\frac{44}{\sqrt{3}}-10\sqrt{3}\right)^2+\left(-10+\frac{11\sqrt{3}}{4}+\frac{1}{6}\left(88-29\sqrt{3}\right)\right)^2}}$$

%//N

4.27348

d

```
M={g20-g10,g12-g10,g22-g10}; Det[M]/6
```

$$\frac{1}{6}\left(-\frac{85}{2}+\frac{89\sqrt{3}}{4}\right)$$

```
%//N
```

```
-0.660312
```

---

5 a

```
M=2 {{-8, 17/2, -8}, {-24, 29, -32}, {-12, 31/2, -18}}; M//MatrixForm
```

$$\begin{pmatrix} -16 & 17 & -16 \\ -48 & 58 & -64 \\ -24 & 31 & -36 \end{pmatrix}$$

```
M//TeXForm;
```

```
IdentityMatrix[3]//TeXForm;
```

```
Det[M- t IdentityMatrix[3]]
```

$$-64+24\,t+6\,t^2-t^3$$

```
-64 IdentityMatrix[3] + 24 M + 6 M.M - M.M.M
```

```
{{0, 0, 0}, {0, 0, 0}, {0, 0, 0}}
```

```
%//MatrixForm
```

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