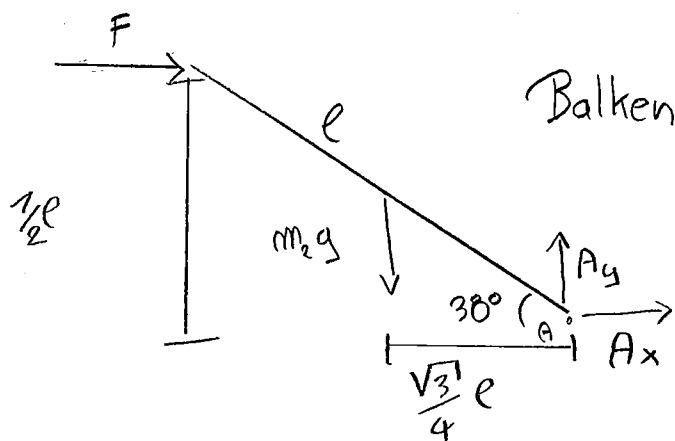
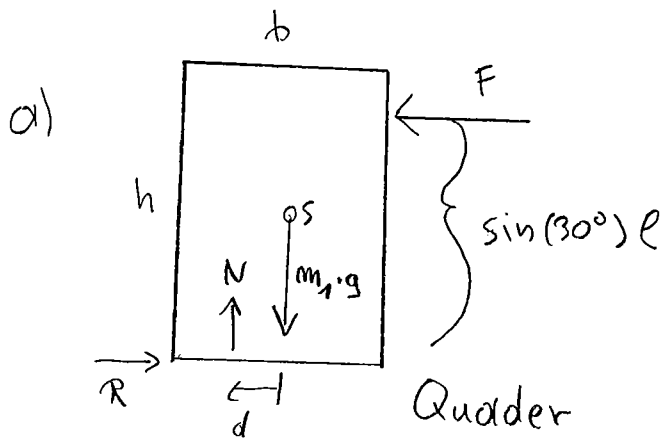


Aufgabe 1

$$\sin(30^\circ) = \frac{1}{2}$$

$$\cos(30^\circ) = \frac{\sqrt{3}}{2}$$



b) Balken GGL

$$\text{in } x: A_x + F = 0$$

$$\text{in } y: A_y = m_2 \cdot g$$

$$M_B(A): \frac{1}{2} \cdot F \cdot l = \frac{\sqrt{3}}{4} l \cdot m_2 g$$

$$\Rightarrow F = \frac{\sqrt{3}}{2} m_2 \cdot g$$

$$\left(\Rightarrow A_x = -\frac{\sqrt{3}}{2} m_2 \cdot g \right)$$

Aufgabe 1

b2) Quader

$$\text{in } x: F = R$$

$$\text{in } y: N = m_1 \cdot g$$

$$\text{MB}(S): -d \cdot N + h_2 \cdot R + (\sin(30^\circ) e - h_2) \cdot F = 0$$

$$\Rightarrow d \cdot N = h_2 \cdot \underbrace{\frac{\sqrt{3}}{2} m_2 \cdot g}_F + \left(\frac{1}{2} e - h_2\right) F$$

$$\Rightarrow d \cdot m_1 \cdot g = \frac{1}{2} e \cdot F$$

$$\Rightarrow d = \frac{1}{2} \frac{F}{m_1 \cdot g} \cdot e = \frac{\sqrt{3}}{4} \frac{m_2}{m_1} \cdot e$$

Rutschen

$$|R| \leq \mu_0 \cdot N$$

$$\Rightarrow \frac{\sqrt{3}}{2} m_2 \cdot g \leq \mu_0 \cdot m_1 \cdot g$$

$$\Rightarrow \mu_0 \geq \frac{\sqrt{3}}{2} \frac{m_2}{m_1}$$

Kippen

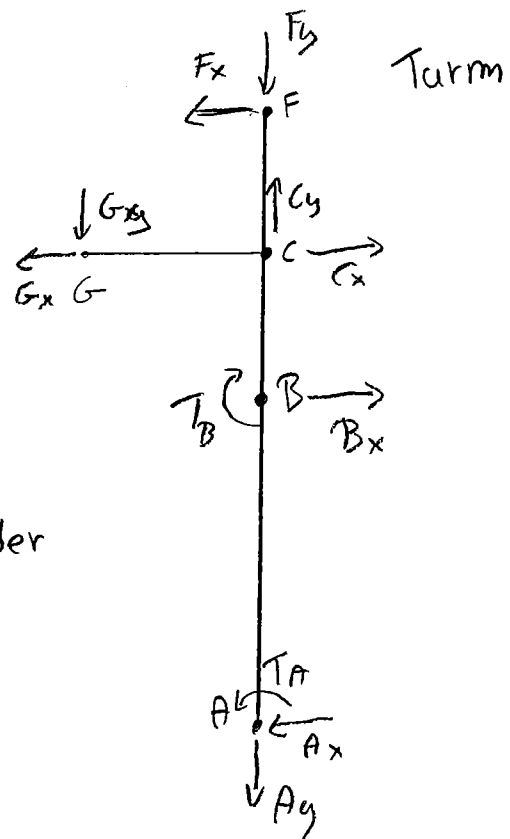
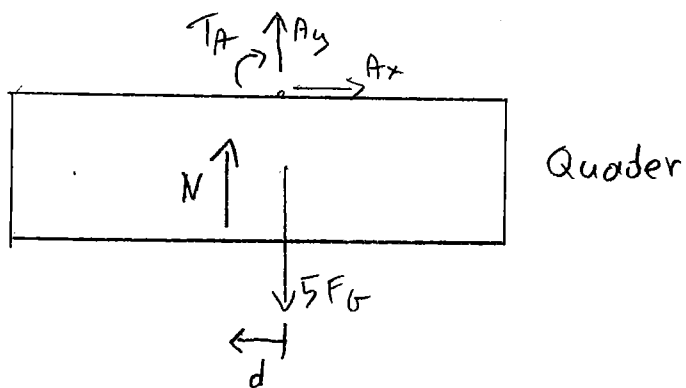
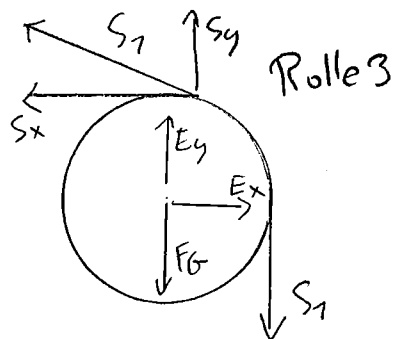
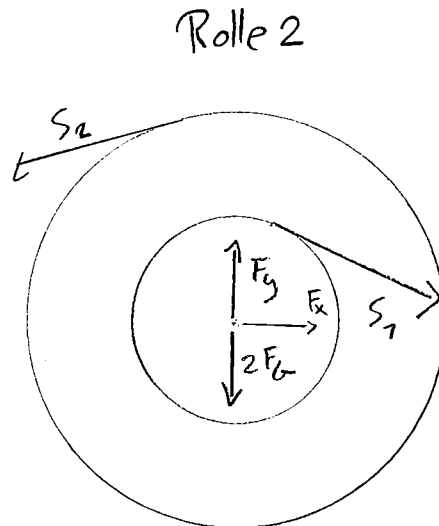
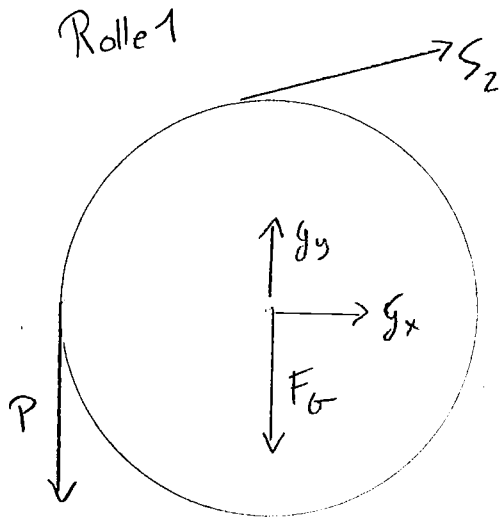
$$d = \frac{1}{2} \frac{F}{m_1 \cdot g} \cdot e \geq -\frac{\phi}{2} \quad \checkmark \quad \text{da } \frac{m_2}{m_1} \cdot e > 0$$

$$d = \frac{\sqrt{3}}{4} \frac{m_2}{m_1} \cdot e \leq \frac{\phi}{2} \Rightarrow \phi \geq \frac{\sqrt{3}}{2} \frac{m_2}{m_1} \cdot e$$

Aufgabe 2

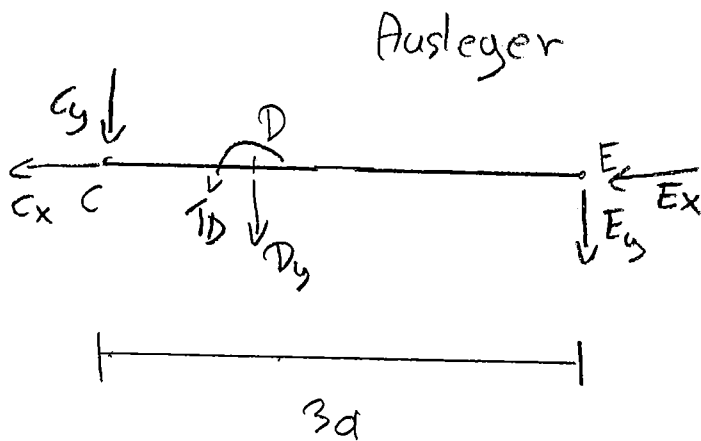
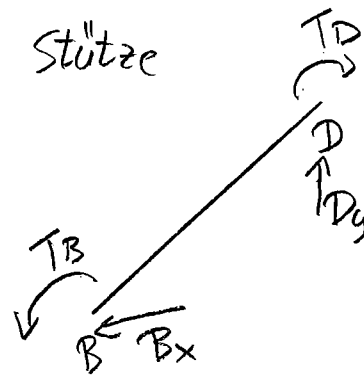
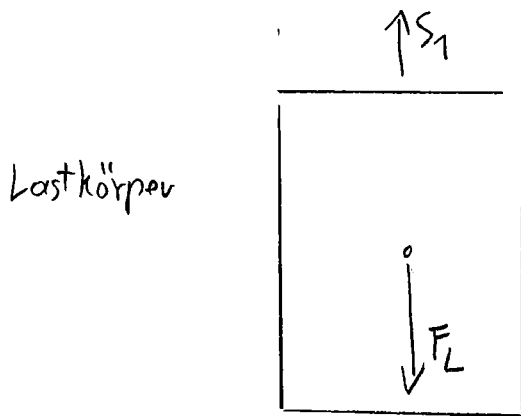
- a) kinematisch unbestimmt,
nicht statisch unbestimmt!

b)



Aufgabe 2

b2)



c) Stütze ggw

$$B_x = 0$$

$$D_y = 0$$

$$T_B = T_D$$

Rolle 3

$$E_x = S_x$$

$$E_y + S_y = F_G + S_1$$

$$S_1 = S_1 \text{ (schon in Skizze)} = F_L$$

Ausleger

$$C_y = -E_y$$

$$C_x = -E_x$$

$$T_D = 3a \cdot E_y$$

$$\frac{S_x}{S_y} = \frac{3}{1} \Rightarrow S_x = 3 S_y$$

$$\begin{aligned} S_x^2 + S_y^2 &= S^2 \\ \Rightarrow 9S_y^2 + S_y^2 &= S^2 \\ \Rightarrow 10S_y^2 &= S^2 \end{aligned} \quad \left| \Rightarrow \begin{aligned} S_y &= \frac{1}{\sqrt{10}} S \\ S_x &= \frac{3}{\sqrt{10}} S \end{aligned} \right.$$

Aufgabe 2

c2) $B_x = 0$

$D_y = 0$

$E_x = \frac{3}{\sqrt{10}} F_L$

$E_y = F_G + F_L - \frac{1}{\sqrt{10}} F_L$

$S_1 = F_L$

$T_D = 3a \cdot E_y = 3a \left(F_G + F_L - \frac{1}{\sqrt{10}} F_L \right) = T_B$

$C_y = -E_y = - \left(F_G + F_L - \frac{1}{\sqrt{10}} F_L \right)$

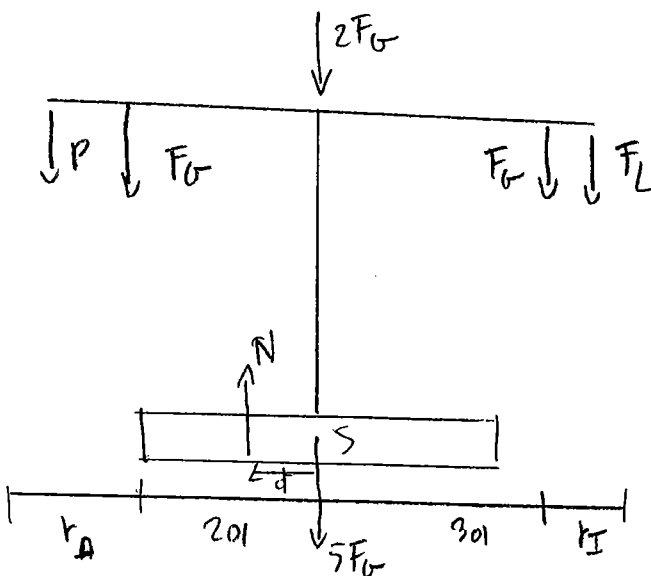
$C_x = - \frac{3}{\sqrt{10}} F_L$

d) ggw Rolle 2

$r_I \cdot F_L = P \cdot r_A$

$\Rightarrow P = \frac{r_I}{r_A} \cdot F_L = 0,5 F_L$

e)



MB(S):

$F_G \cdot 2a + P \cdot (2a + r_A)$

$= N \cdot d + F_G \cdot 3a + F_L (3a + r_I)$

$\Rightarrow 0,5 \cdot F_L (2a + \frac{1}{2} a)$

$= N d + F_G d + F_L (3a + \frac{1}{4} a)$

$\Rightarrow 0 = N d + F_G d + 2a F_L$

$N = 9 F_G + 3 \frac{1}{2} F_L$

$d = - \frac{(F_G + 2 F_L) a}{9 F_G + 3 \frac{1}{2} F_L}$

Aufgabe 3

$$d) A_y + J_y = F_H$$

$$A_x + F_E + F_F = 0$$

$$5a \cdot J_y - 5a \cdot F_H - 3a F_E - 4a F_F = 0$$

$$\Rightarrow J_y = \frac{1}{5} (5 F_H + 3 F_E + 4 F_F)$$

$$A_x = - F_E - F_F$$

$$A_y = F_H - \frac{1}{5} (5 F_H + 3 F_E + 4 F_F)$$

$$b) P_B = \frac{\sqrt{2}}{2} S \cdot \omega_2 \cdot 1,5a - 4a \cdot \omega_2 \cdot S \cdot \frac{\sqrt{2}}{2} = -2,5 \frac{\sqrt{2}}{2} S \omega_2 a$$

$$P_H = 0$$

$$P_E = 0,5 \cdot a \cdot F_E \omega_2$$

$$P_F = 1,5a \cdot F_F \omega_2$$

$$\sum P_i = 0 \Rightarrow \left(-2,5 \frac{\sqrt{2}}{2} S + 0,5 F_E + 1,5 F_F \right) \omega_2 a = 0$$

$$\Rightarrow -5 \frac{\sqrt{2}}{2} S + F_E + 3 F_F = 0$$

$$S = \frac{\sqrt{2}}{5} (F_E + 3 F_F) > 0 \text{ Zugstab}$$

Aufgabe 3

$$\begin{aligned} c) \quad \omega_1 &= 4 \cdot \omega_2 \quad \Rightarrow \quad \omega_2 = \frac{1}{4} \omega_1 \\ \omega_1 \cdot 6 &= 4 \omega_3 \quad \omega_3 = \frac{3}{2} \omega_1 \\ \omega_1 \cdot 2 &= 1 \cdot \omega_4 \quad \omega_4 = 2 \omega_1 \end{aligned}$$

$$P_D = -2\sqrt{2} \, a \cdot s \cdot \omega_1$$

$$P_H = 0$$

$$P_K = \left(4a \cdot \frac{\sqrt{2}}{2} s + 2a \frac{\sqrt{2}}{2} s \right) \omega_2 = \frac{3\sqrt{2}}{4} a \cdot s \cdot \omega_1$$

$$P_{FF} = \frac{2}{3} \cdot \omega_3 \cdot F_F \cdot a = \omega_1 \cdot a \cdot F_F$$

$$P_E = -\frac{1}{3} \omega_3 \cdot F_E \cdot a = -\frac{1}{2} \omega_1 F_E \cdot a$$

$$\Sigma P = -\frac{8}{4} \sqrt{2} \, a \, s \, \omega_1 + \frac{3}{4} \sqrt{2} \, a \, s \, \omega_1$$

$$+ F_F a \omega_1 - \frac{1}{2} F_E a \omega_1 = 0$$

$$= -\frac{5}{4} \sqrt{2} \, s \, \omega_1 a$$

$$+ F_F a \omega_1 - \frac{1}{2} F_E a \omega_1 = 0$$

$$\Rightarrow s \cdot \frac{5}{4} \sqrt{2} = F_F - \frac{1}{2} F_E$$

$$s = \frac{2\sqrt{2}}{5} (F_F - \frac{1}{2} F_E)$$

$$F_F - \frac{1}{2} F_E > 0 \text{ Zug}$$

$$F_F - \frac{1}{2} F_E < 0 \text{ Druck}$$

Name:

Vorname:

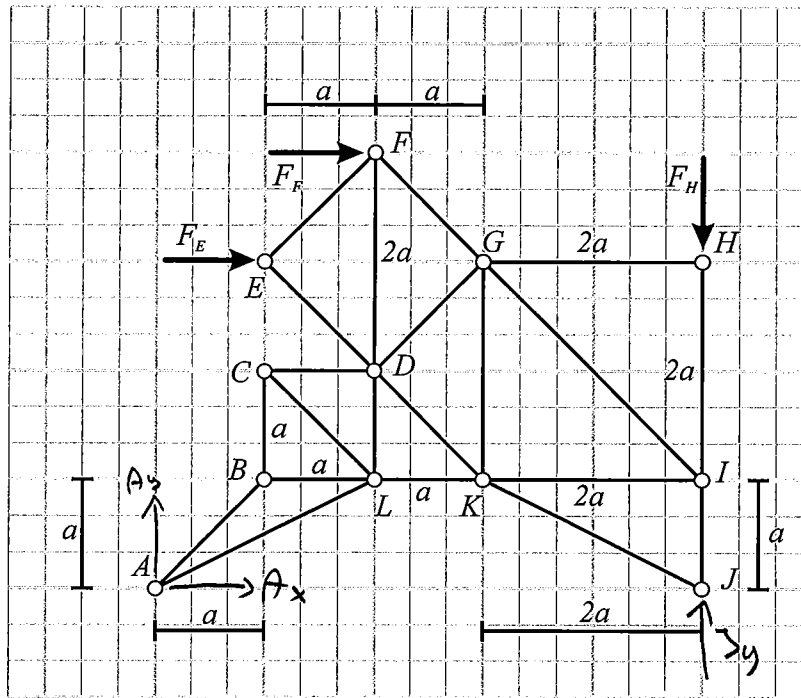
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Studiengang:

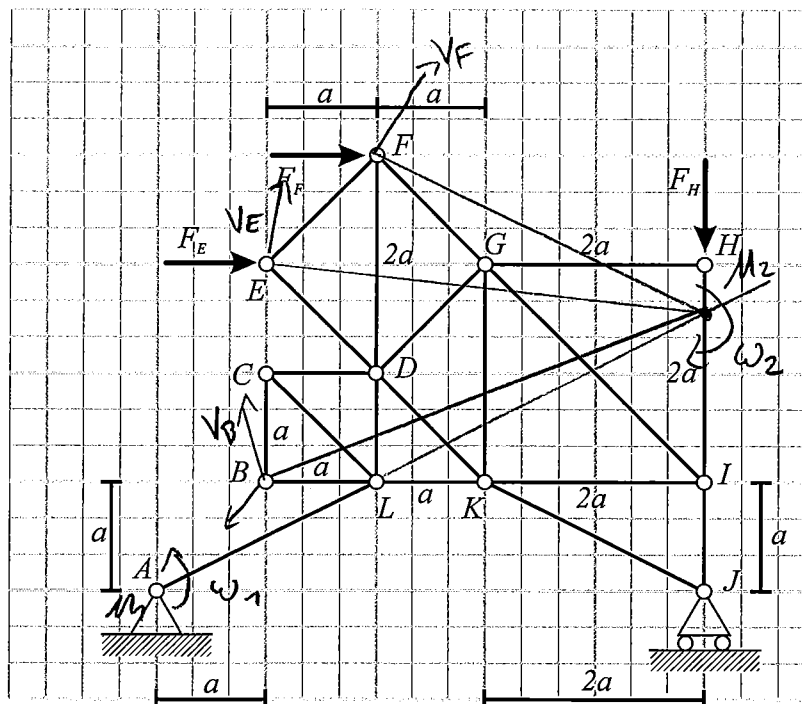
D -

Aufgabe 3 Reserveskizzen (ungültige Skizzen deutlich durchstreichen!)

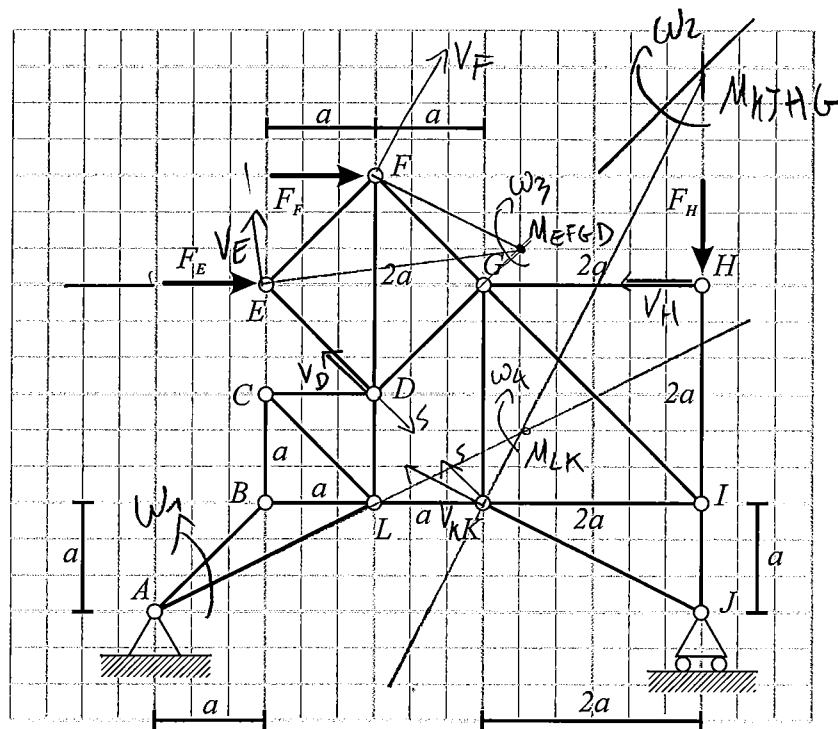
a)



b)



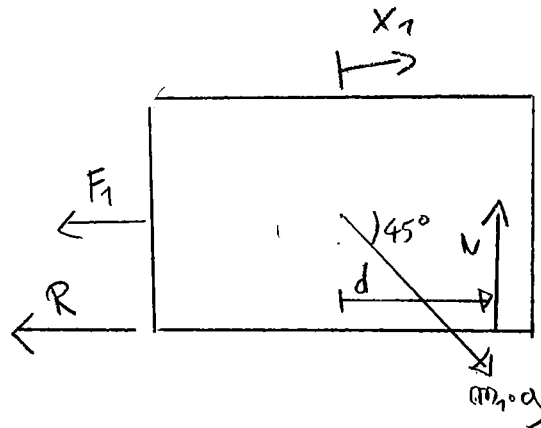
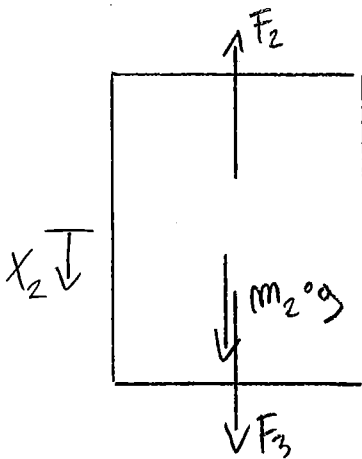
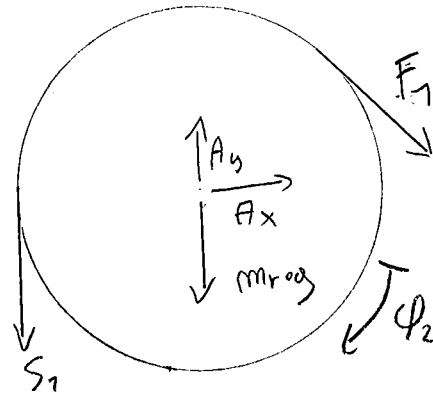
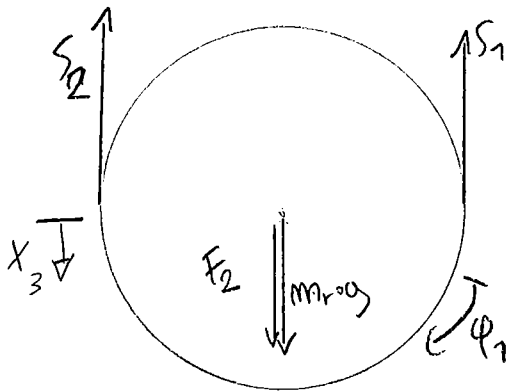
c)



Aufgabe 4

a) Der Freiheitsgrad des Systems ist 3.

b)



$$c) \ddot{x}_1 \cdot m_1 = \frac{\sqrt{2}}{2} \cdot m_1 g - F_1 - R$$

$$\ddot{x}_2 m_2 = m_2 g + F_3 - F_2$$

$$\ddot{x}_3 m_r = F_2 - S_1 + m_r g - S_2$$

$$\ddot{\phi}_1 \cdot I_c = S_2 \cdot r - S_1 \cdot r$$

$$\ddot{\phi}_2 I_c = F_1 \cdot r - S_1 \cdot r$$

Aufgabe 4

$$d) \quad F_1 = c \cdot (-\varphi_2 \cdot r + x_1)$$

$$F_2 = c \cdot (-x_3 + x_2)$$

$$F_3 = -x_2 \cdot c$$

$$R = \mu_1 \cdot N = \mu_1 \cdot \frac{\sqrt{2}}{2} m_1 g$$

$$N = \frac{\sqrt{2}}{2} m_1 \cdot g$$

$$e) \quad \varphi_1 \cdot r = x_3$$

$$\varphi_1 \cdot 2r = -r \cdot \varphi_2$$

$$\Rightarrow \varphi_2 = -2\varphi_1 = -\frac{2}{r} x_3$$

$$\varphi_1 = \frac{x_3}{r}$$

$$f) \quad \ddot{\varphi}_1 \cdot I_c = S_2 \cdot r - S_1 \cdot r$$

$$\ddot{\varphi}_2 I_c = F_1 \cdot r - S_1 \cdot r$$

$$\Rightarrow -\frac{2}{r} \cdot \ddot{x}_3 \cdot I_c = r c (-\varphi_2 \cdot r + x_1) - S_1 r$$

$$\Rightarrow S_1 = +\frac{2}{r^2} I_c \ddot{x}_3 + c (+2x_3 + x_1)$$

$$S_2 = \ddot{\varphi}_1 \frac{I_c}{r} + S_1$$

$$= \frac{\ddot{x}_3}{r^2} I_c + \frac{2}{r^2} I_c \ddot{x}_3 + c (2x_3 + x_1)$$

Aufgabe 4

$$f2) \ddot{x}_1 m_1 = \frac{\sqrt{2}}{2} m_1 g - c(2x_3 + x_1) - \mu_1 \frac{\sqrt{2}}{2} m_1 g$$

$$\ddot{x}_2 m_2 = m_2 g + (-x_2 c) - c(-x_3 + x_2)$$

$$\ddot{x}_3 m_r = c(-x_3 + x_2) - \frac{2}{r^2} I_c \ddot{x}_3 - c(2x_3 + x_1)$$

$$+ m_r g - 3 \frac{\ddot{x}_3}{r^2} I_c - c(2x_3 + x_1)$$

$$= m_r g - \frac{5}{r^2} \ddot{x}_3 I_c + c(-2x_1 + x_2 - 5x_3)$$
