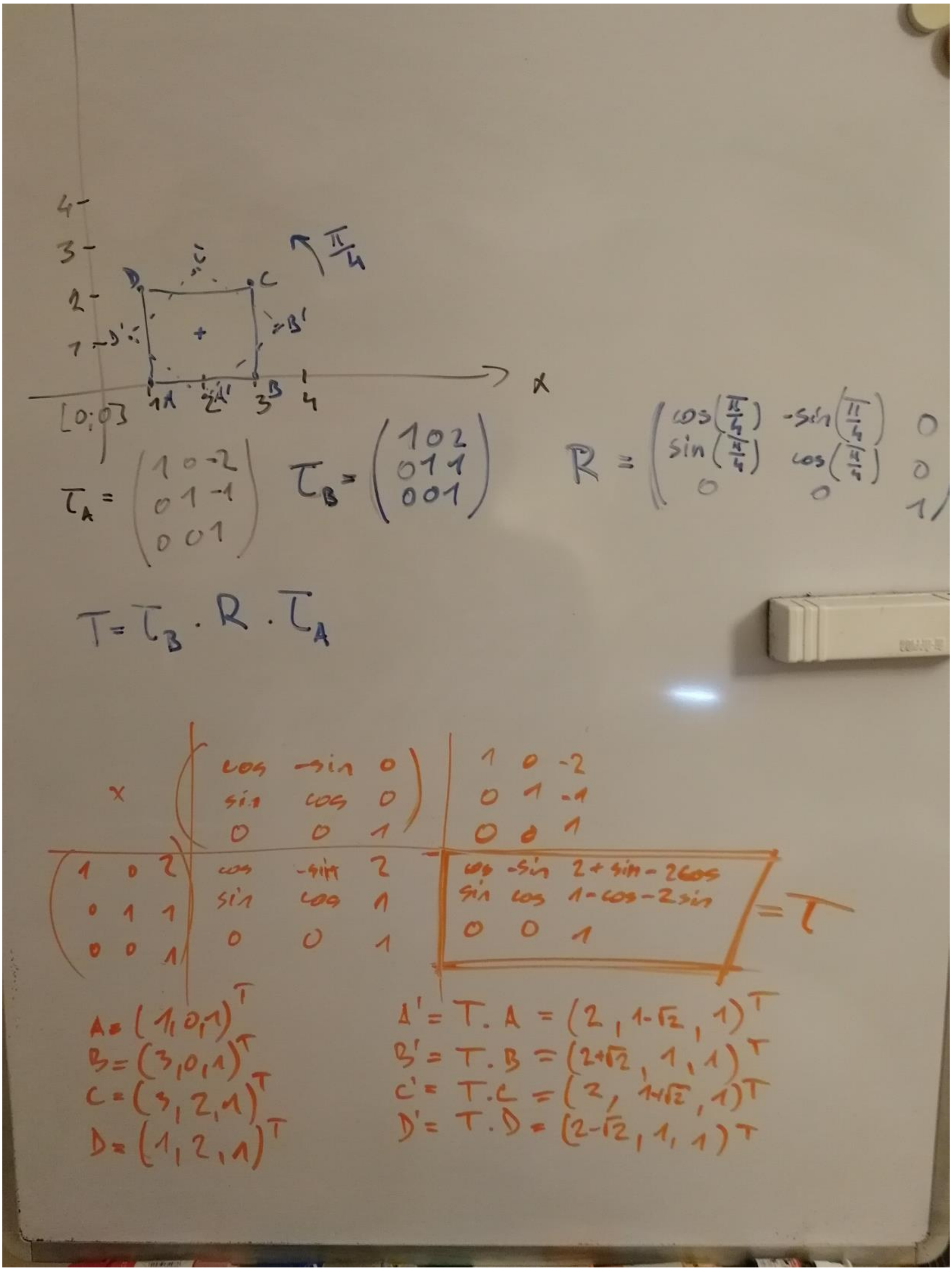
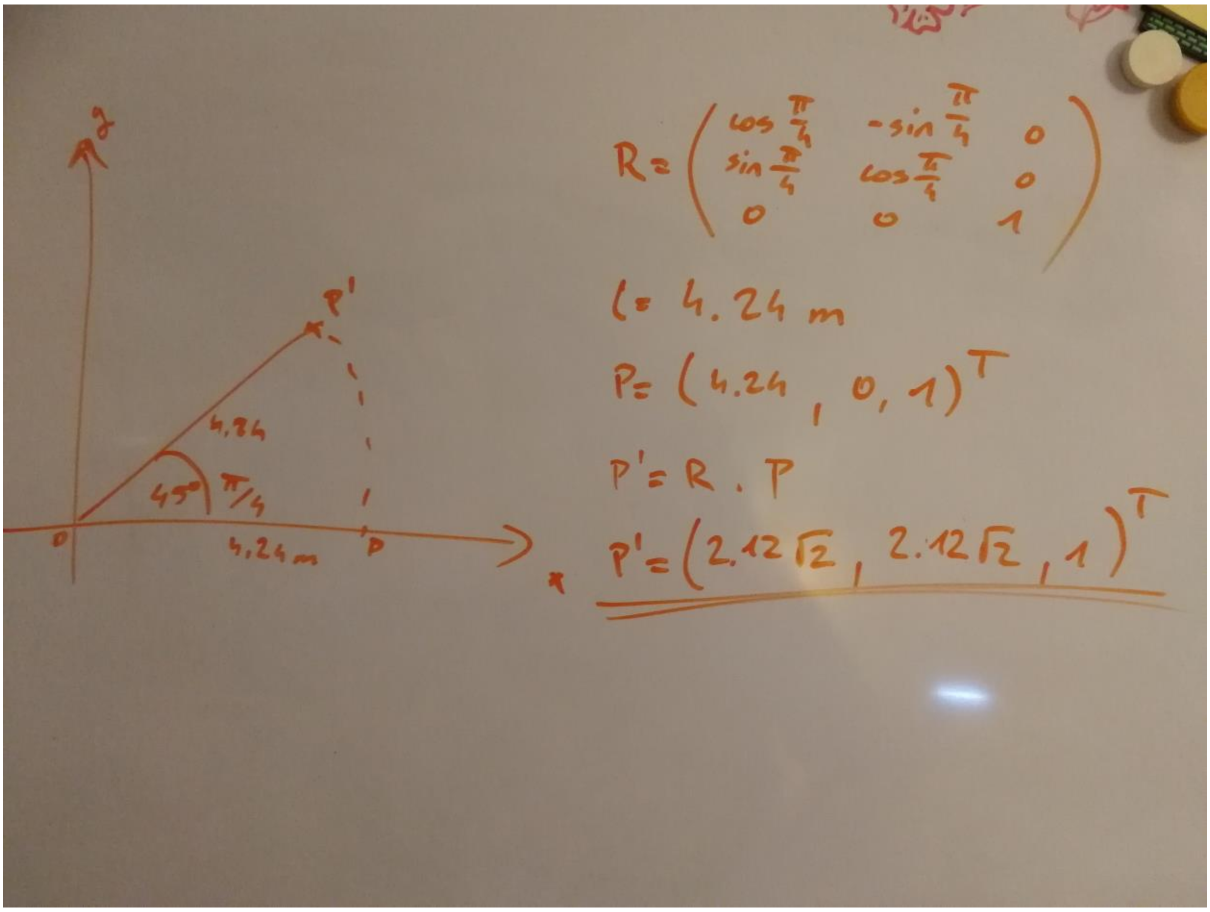
Exercise 1



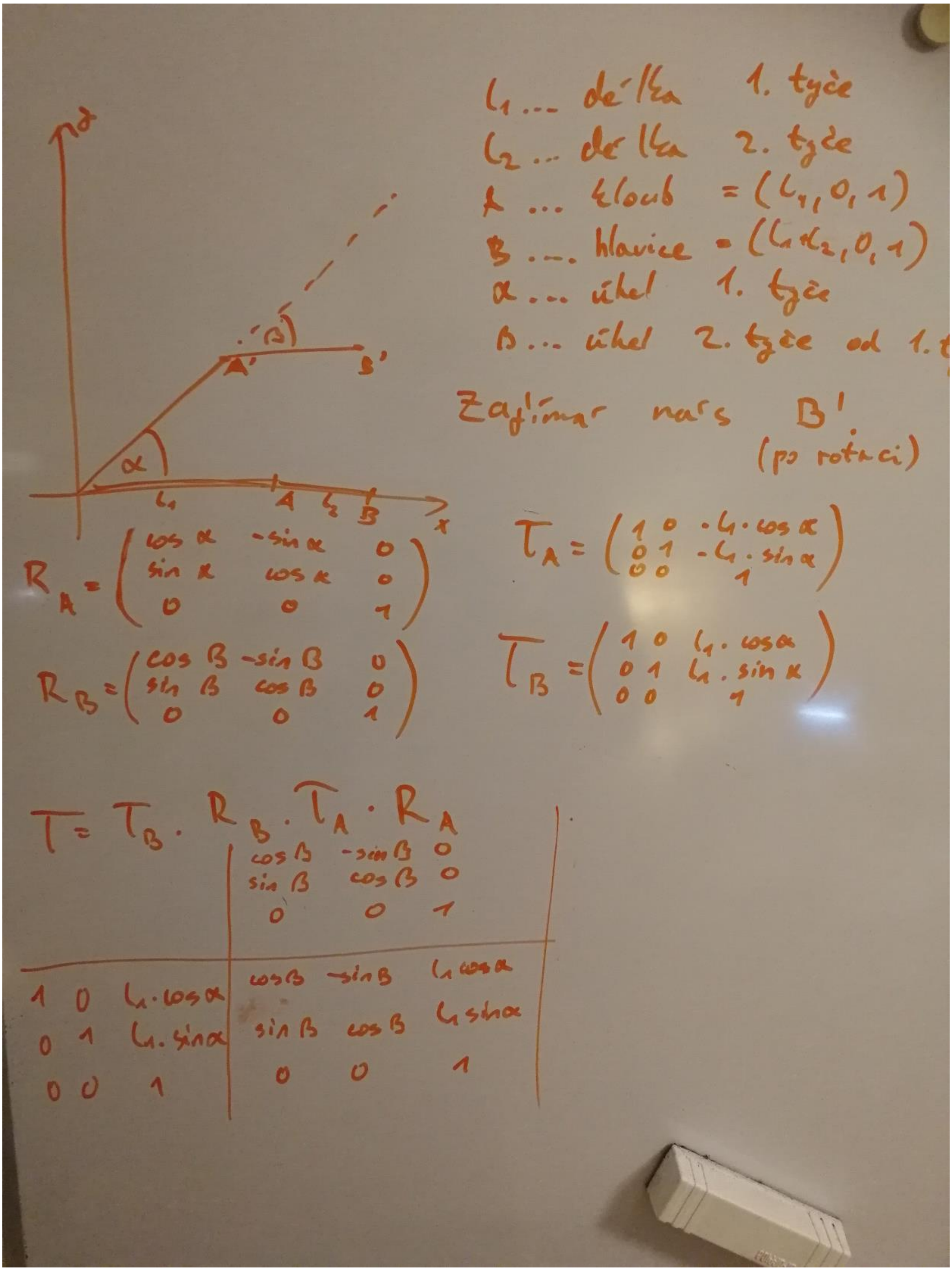
$\frac{\pi}{4}$
x
[0;0]
$T_A = \begin{pmatrix} 1 & 0 & -2 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{pmatrix}$
$T_B = \begin{pmatrix} 1 & 0 & 2 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{pmatrix}$
$R = \begin{pmatrix} \cos(\frac{\pi}{4}) & -\sin(\frac{\pi}{4}) & 0 \\ \sin(\frac{\pi}{4}) & \cos(\frac{\pi}{4}) & 0 \\ 0 & 0 & 1 \end{pmatrix}$
$T = T_B \cdot R \cdot T_A$
$\begin{pmatrix} \cos & -\sin & 2+\sin-2\cos \\ \sin & \cos & 1-\cos-2\sin \\ 0 & 0 & 1 \end{pmatrix} = T$
$A = (1,0,1)^T$
$B = (3,0,1)^T$
$C = (3,2,1)^T$
$D = (1,2,1)^T$
$A' = T.A = (2, 1-\sqrt{2}, 1)^T$
$B' = T.B = (2+\sqrt{2}, 1, 1)^T$
$C' = T.C = (2, 1+\sqrt{2}, 1)^T$
$D' = T.D = (2-\sqrt{2}, 1, 1)^T$

Exercise 2



y
x
0
P
P'
4.24
45°
π/4
4.24 m
R = (cos π/4 -sin π/4 0 ; sin π/4 cos π/4 0 ; 0 0 1)
l = 4.24 m
P = (4.24, 0, 1)^T
P' = R . P
P' = (2.12 √2, 2.12 √2, 1)^T

Exercise 3


l1 ... délka 1. tyče
l2 ... délka 2. tyče
A ... kloub = (l1, 0, 1)
B ... hlavice = (l1+l2, 0, 1)
α ... úhel 1. tyče
β ... úhel 2. tyče od 1.
Zajímá nás B'
(po rotaci)
x
y
A
B
A'
B'
α
(β)
l1
l2
R_A = (cos α -sin α 0 ; sin α cos α 0 ; 0 0 1)
R_B = (cos β -sin β 0 ; sin β cos β 0 ; 0 0 1)
T_A = (1 0 -l1·cos α ; 0 1 -l1·sin α ; 0 0 1)
T_B = (1 0 l1·cos α ; 0 1 l1·sin α ; 0 0 1)
T = T_B · R_B · T_A · R_A
cos β -sin β 0
sin β cos β 0
0 0 1
1 0 l1·cos α
0 1 l1·sin α
0 0 1
cos β -sin β l1 cos α
sin β cos β l1 sin α
0 0 1

sis

$$\begin{pmatrix} 1 & 0 & -l_1 \cdot \cos\alpha \\ 0 & 1 & -l_1 \cdot \sin\alpha \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} \cos\beta & -\sin\beta & l_1 \cdot \cos\alpha \\ \sin\beta & \cos\beta & l_1 \cdot \sin\alpha \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} \cos\beta & -\sin\beta & l_1 \cdot \cos\alpha(1-\cos\beta) + l_1 \cdot \sin\beta \sin\alpha \\ \sin\beta & \cos\beta & l_1 \cdot \sin\alpha(1-\cos\beta) - l_1 \sin\beta \cos\alpha \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$X = \cos\alpha \cos\beta$

$Y = \sin\alpha \sin\beta$

$C = \sin\alpha \cos\beta$

$D = \cos\alpha \sin\beta$

$$\begin{pmatrix} \cos\beta & -\sin\beta & l_1(Y + \cos\alpha(1-\cos\beta)) \\ \sin\beta & \cos\beta & l_1(-D + \sin\alpha(1-\cos\beta)) \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} X-Y & -C-D & l_1(Y+\cos\alpha(1-\cos\beta)) \\ D+C & X-Y & l_1(-D+\sin\alpha(1-\cos\beta)) \\ 0 & 0 & 1 \end{pmatrix}$$

$$T = \left(\begin{array}{c|c|c} \cos\alpha\cos\beta - \sin\alpha\sin\beta & -\sin\alpha\cos\beta - \cos\alpha\sin\beta & l_1(\sin\alpha\sin\beta + \cos\alpha(1-\cos\beta)) \\ \hline \cos\alpha\sin\beta + \sin\alpha\cos\beta & \cos\alpha\cos\beta - \sin\alpha\sin\beta & l_1(-\cos\alpha\sin\beta + \sin\alpha(1-\cos\beta)) \\ \hline 0 & 0 & 1 \end{array}\right)$$

Doufám, že potřebné informace jsou z těchto fotek dostatečně čitelné.

Výsledné transformační matice označuji písmenem T.

Své výsledky jsem ověřoval pomocí následného ekvivalentního matlab kódu:

```
alpha=pi/4.0
movA=[[1,0,-2];[0,1,-1];[0,0,1]]
rotation=[[cos(alpha),-sin(alpha),0];[sin(alpha),cos(alpha),0];[0,0,1]]
movB=[[1,0,2];[0,1,1];[0,0,1]]

centre=[2,1,1]'
A=[1,0,1]'
B=[3,0,1]'
C=[3,2,1]'
D=[1,2,1]'

combined=movB*rotation*movA
combined*A
combined*B
combined*C
combined*D


length=4.24
beta=pi/4.0
rotation2=[[cos(beta),-sin(beta),0];[sin(beta),cos(beta),0];[0,0,1]]
point=[length,0,1]'
rotation2*point



l1=2
l2=3
a1=pi/4
a2=pi/2 + pi/4
P=[l1+l2,0,1]'
rotationA=[[cos(a1),-sin(a1),0];[sin(a1),cos(a1),0];[0,0,1]]
P=rotationA*P
transformationA=[[1,0,-l1*cos(a1)];[0,1,-l1*sin(a1)];[0,0,1]]
P=transformationA*P
rotationB=[[cos(a2),-sin(a2),0];[sin(a2),cos(a2),0];[0,0,1]]
P=rotationB*P
transformationB=[[1,0,l1*cos(a1)];[0,1,l1*sin(a1)];[0,0,1]]
P=transformationB*P

allinone=transformationB*rotationB*transformationA*rotationA
P2=[l1+l2,0,1]'
allinone*P2
```