4. Определяне на основните размери на гърбичните механизми с плоско изпълнително звено (тарелка).

Условие за изпъкналост на профила

$$r_i = R_0 + S_i + S'' > 0$$

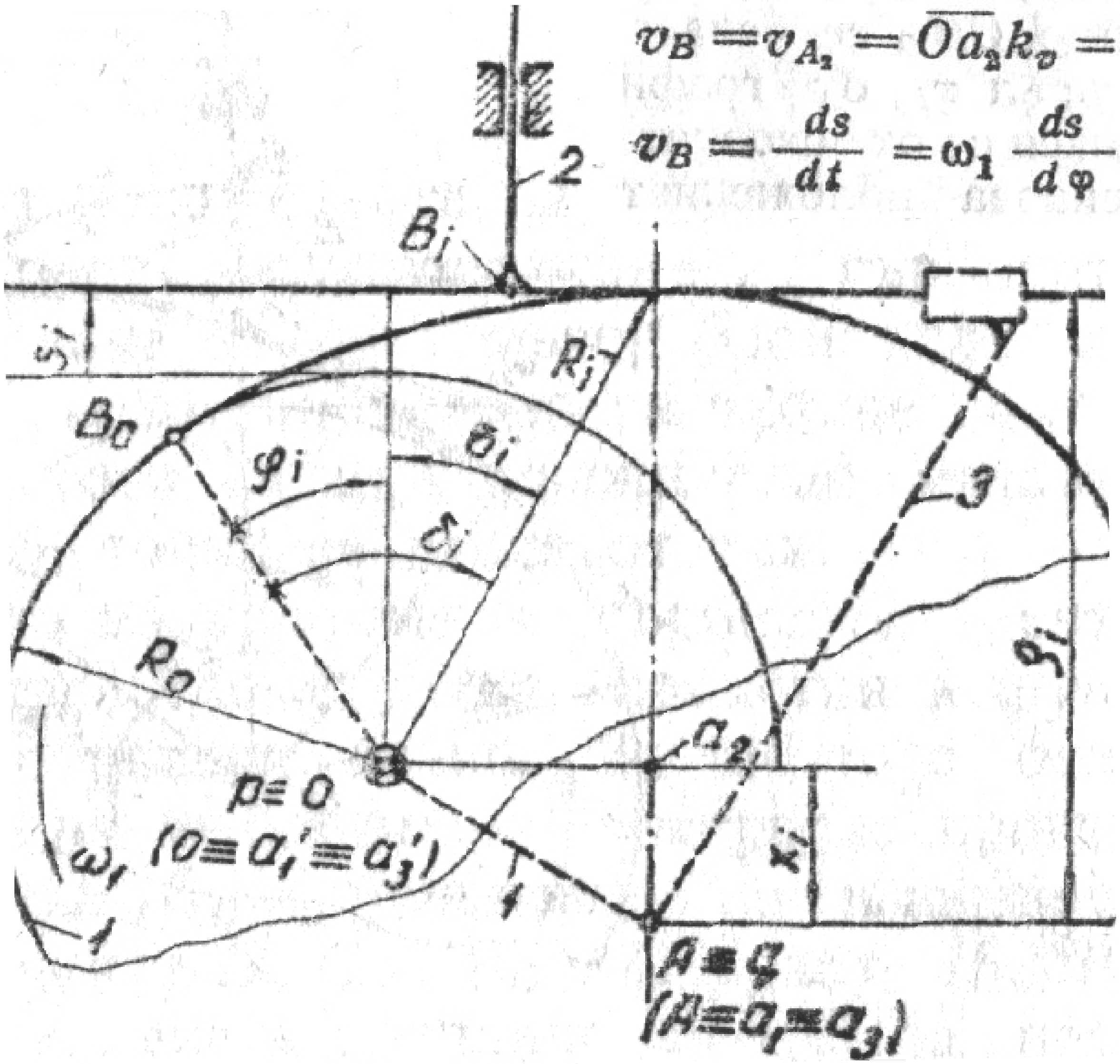
$$r_i = x_i + R_0 + S_i > 0$$

$$\vec{v}_{A_2} = \vec{v}_{A_3} + \vec{v}_{A_{23}};$$

$$v_{A_3} = v_{A_1} = l_{OA}\,\omega_1 = k_v \overline{OA}, k_v = \frac{l_{OA}\,\omega_1}{\overline{OA}} = k_l\,\omega_1;$$

$$v_B = v_{A_2} = \overline{Oa_2}\,k_v = \overline{Oa_2}\,k_l\,\omega_1 = l_{Oa_2}\,\omega_1;$$

$$v_B = \frac{ds}{dt} = \omega_1 \frac{ds}{d\varphi} = \omega_1 s'_i.$$



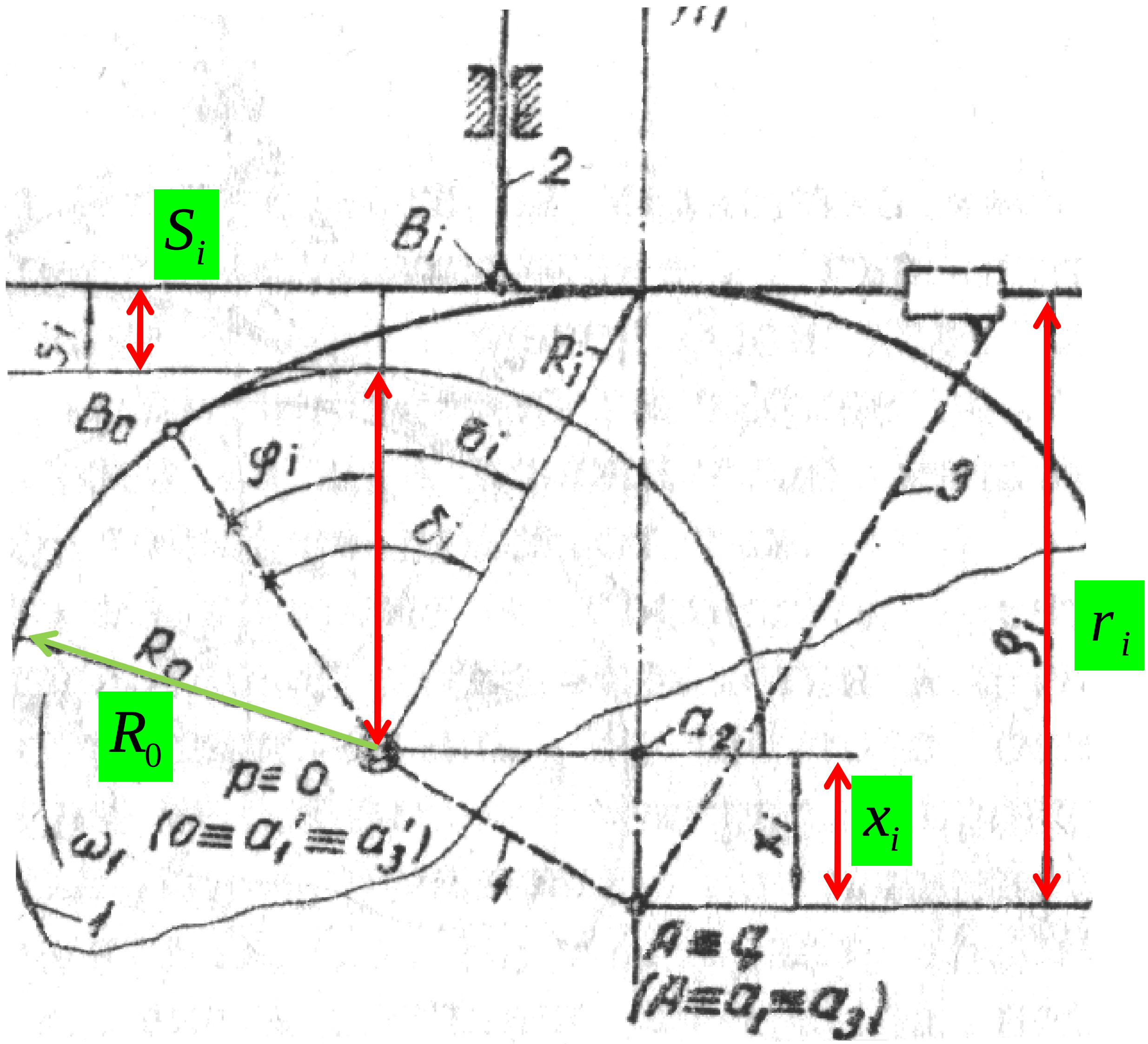
$$\vec{a}_{A2} = \vec{a}_{A3} + \vec{a}^{\,t}_{A23} + \vec{a}^{\,c}_{A23}$$

$$k_a = \frac{a_{A3}}{\overline{OA}} = \frac{l_{OA} w_1^2}{\overline{OA}} = w_1^2$$

$$\overline{qa_2} = \frac{a_{A2}}{k_A} = \frac{\dfrac{d^2S}{dt^2}}{w_1^2} = \frac{w_1^2\,\dfrac{d^2S}{dj^2}}{w_1^2} = S''$$

$$x_i = S''$$

$$r_i = x_i + R_0 + S_i > 0 \qquad l_{Oa_2} = \overline{Oa_2} = S_i' \qquad x_i = \overline{qa_2} = S''$$

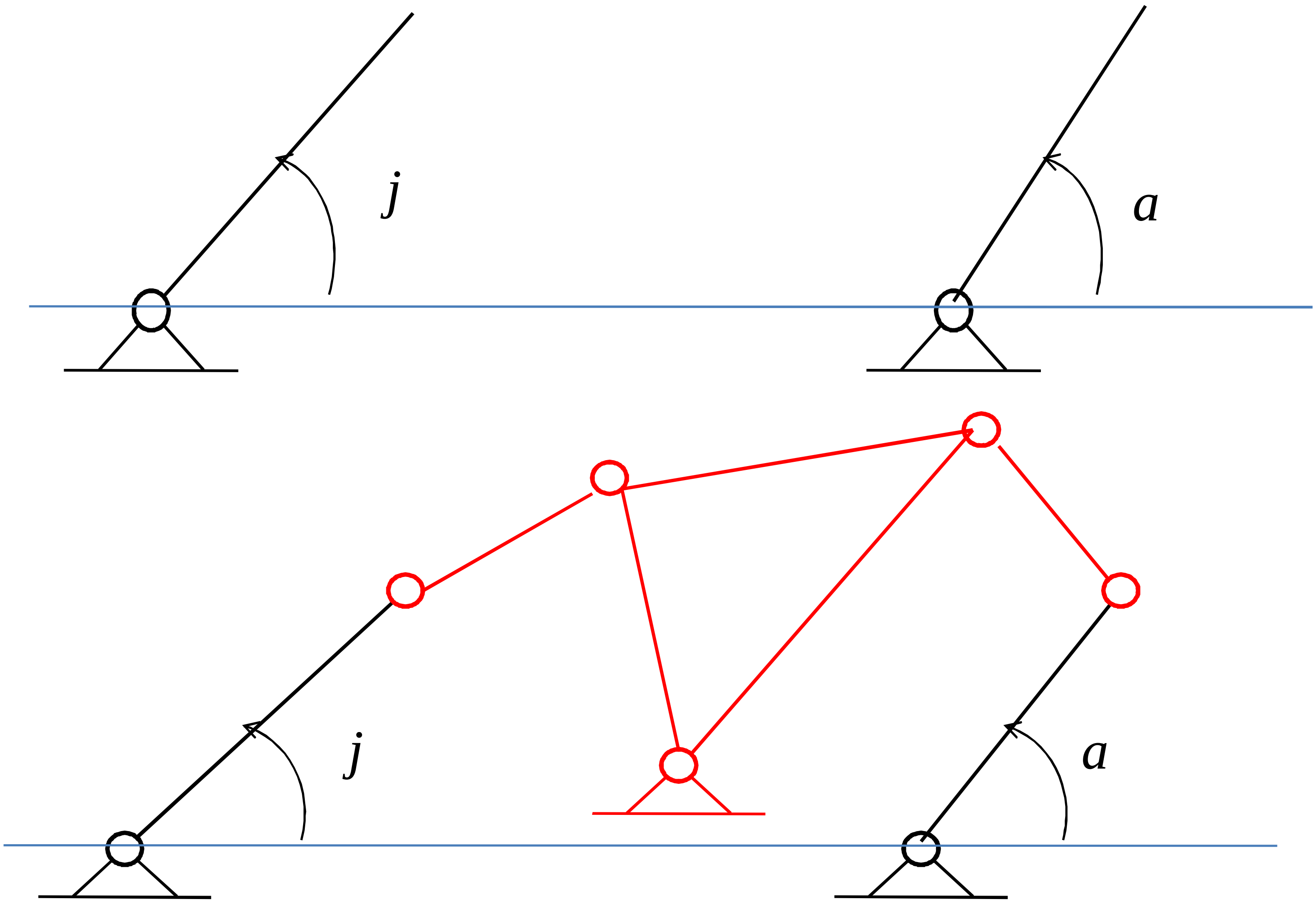


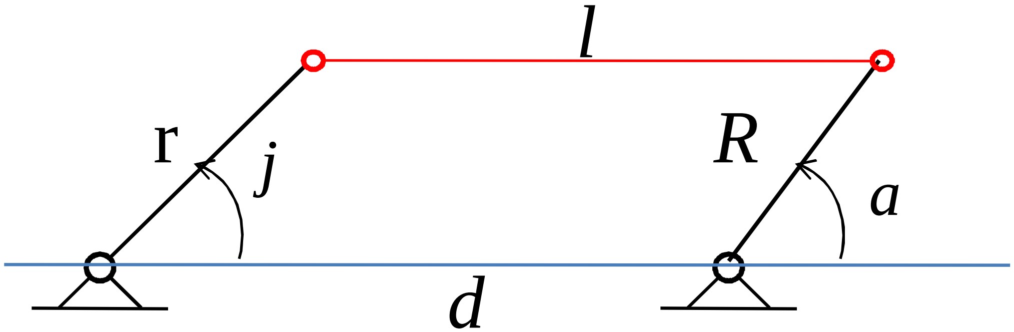
КИНЕМАТИЧЕН СИНТЕЗ И ТОЧНОСТ НА РАВНИННИТЕ ЛОСТОВИ МЕХАНИЗМИ

Задачи на синтеза:

- Осъществяване на зададен закон на движение.
- Осъществяване на зададена траектория на точка.
- Осъществяване на зададено движение на равнина.

Осъществяване на зададен закон на движение.





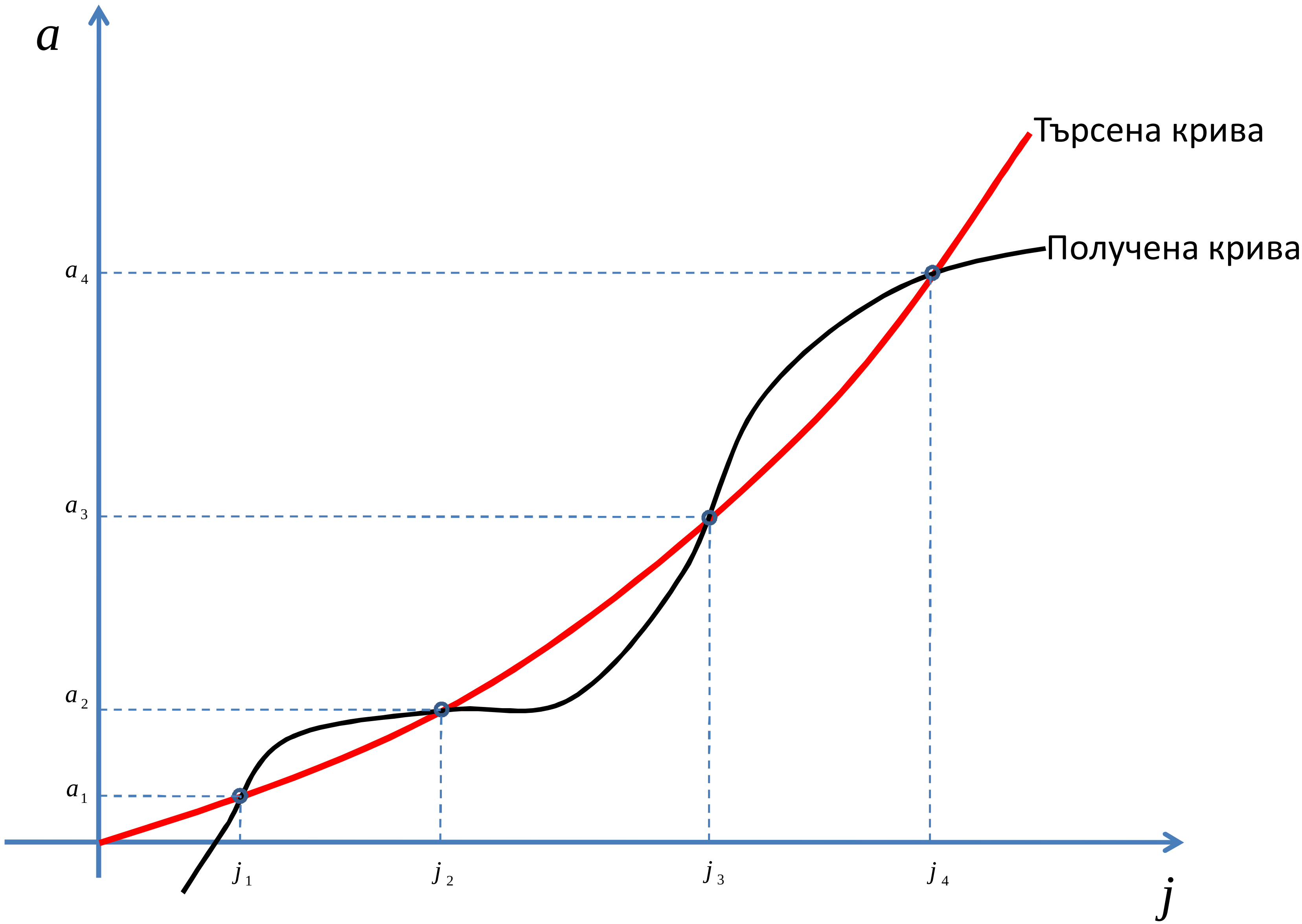
$$j = j(t), \qquad a = a(t)$$

$$\vec{r} + \vec{l} = \vec{d} + \vec{R}$$

$$\left| \begin{array}{l} r\cos(j) + l\cos(b) = d + R\cos(a) \\ r\sin(j) + l\sin(b) = R\sin(a) \end{array} \right.$$

$$r, l, d, R = ?$$

$$\left| \begin{array}{l} l^2 = \left[d + R\cos(a_1) - r\cos(j_1)\right]^2 + \left[R\sin(a_1) - r\sin(j_1)\right]^2 \\ l^2 = \left[d + R\cos(a_2) - r\cos(j_2)\right]^2 + \left[R\sin(a_2) - r\sin(j_2)\right]^2 \\ l^2 = \left[d + R\cos(a_3) - r\cos(j_3)\right]^2 + \left[R\sin(a_3) - r\sin(j_3)\right]^2 \\ l^2 = \left[d + R\cos(a_4) - r\cos(j_4)\right]^2 + \left[R\sin(a_4) - r\sin(j_4)\right]^2 \end{array} \right.$$



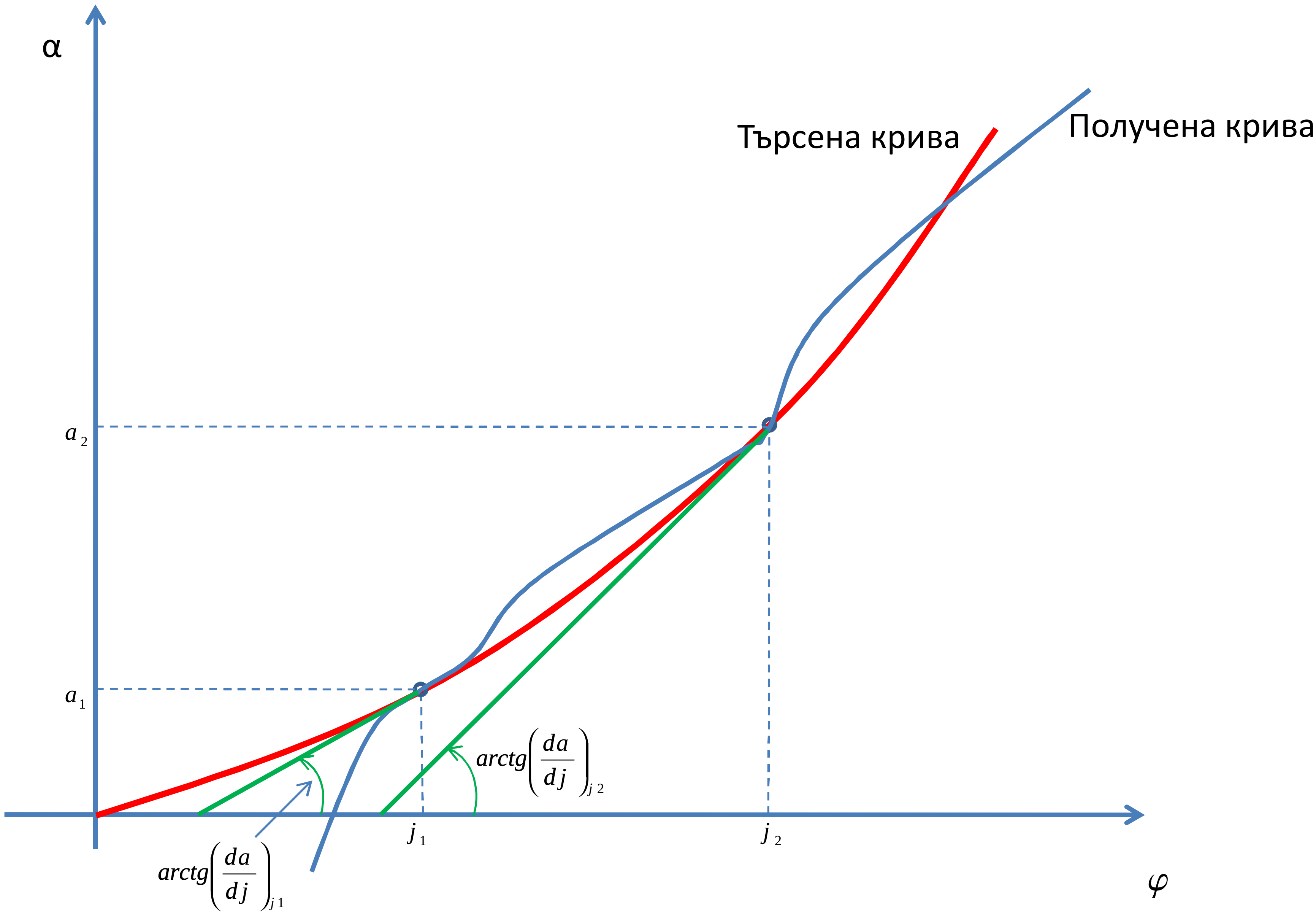
a
Търсена крива
Получена крива
a 4
a 3
a 2
a 1
j 1
j 2
j 3
j 4
j

Аналитичен синтез по зададени стойности на функцията на положението и на първата преводна функция.

$$\left|\begin{array}{l} r\cos(j)+l\cos(b)=d+R\cos(a) \\ r\sin(j)+l\sin(b)=R\sin(a) \end{array}\right.$$

$$\left|\begin{array}{l} -r\sin(j)-l\sin(b)\dfrac{db}{dj}=-R\sin(a)\dfrac{da}{dj} \\ r\cos(j)+l\cos(b)\dfrac{db}{dj}=R\cos(a)\dfrac{da}{dj} \end{array}\right.$$

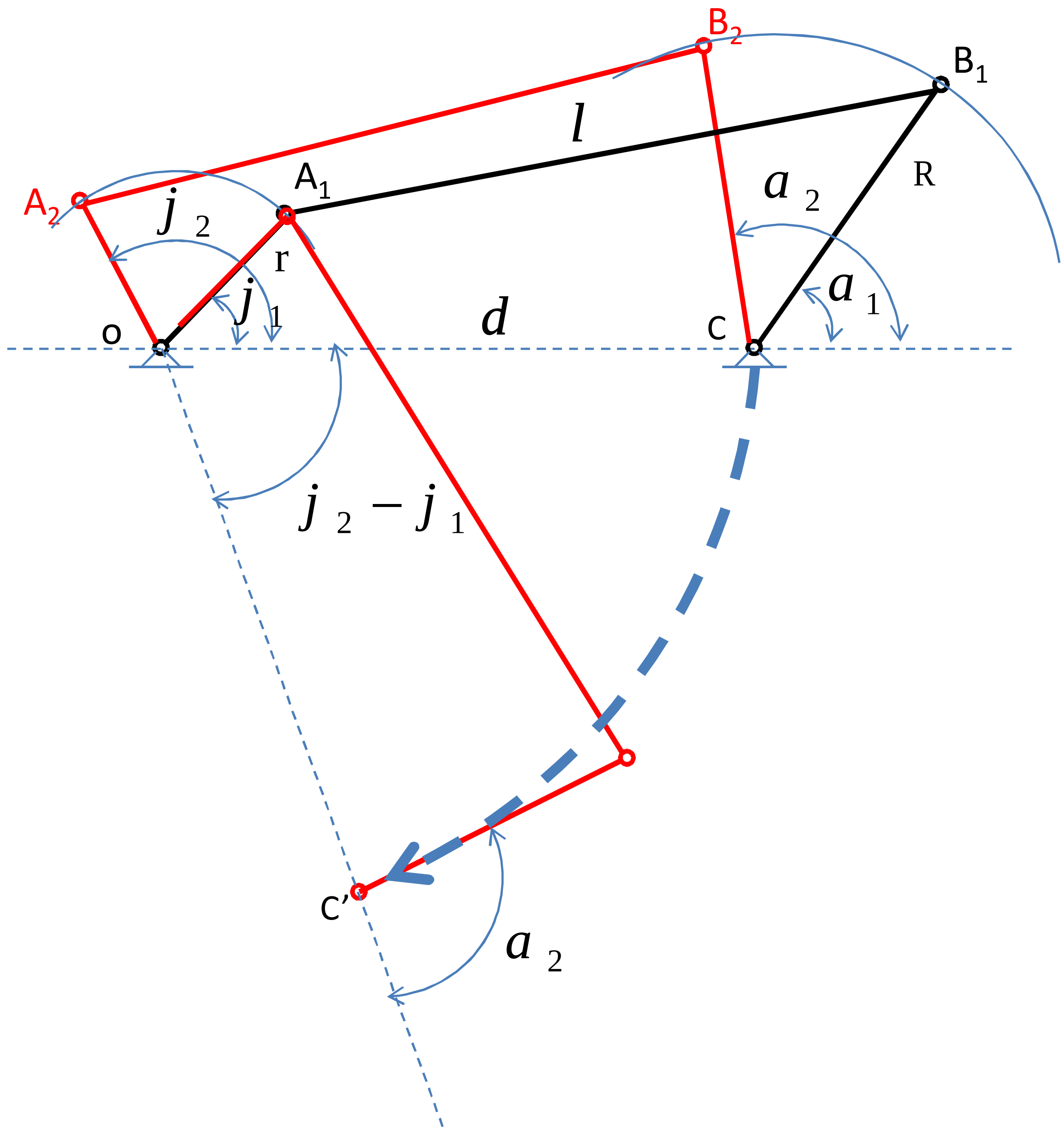
$$
\left|
\begin{array}{l}
r\cos(j_1)+l\cos(b_1)=d+R\cos(a_1) \\[2ex]
r\sin(j_1)+l\sin(b_1)=R\sin(a_1) \\[2ex]
r\cos(j_2)+l\cos(b_2)=d+R\cos(a_2) \\[2ex]
r\sin(j_2)+l\sin(b_2)=R\sin(a_2) \\[2ex]
-r\sin(j_1)-l\sin(b_1)\left(\dfrac{db}{dj}\right)_{j1}=-R\sin(a_1)\left(\dfrac{da}{dj}\right)_{j1} \\[2ex]
r\cos(j_2)+l\cos(b_2)\left(\dfrac{db}{dj}\right)_{j2}=R\cos(a_2)\left(\dfrac{da}{dj}\right)_{j2}
\end{array}
\right.
$$



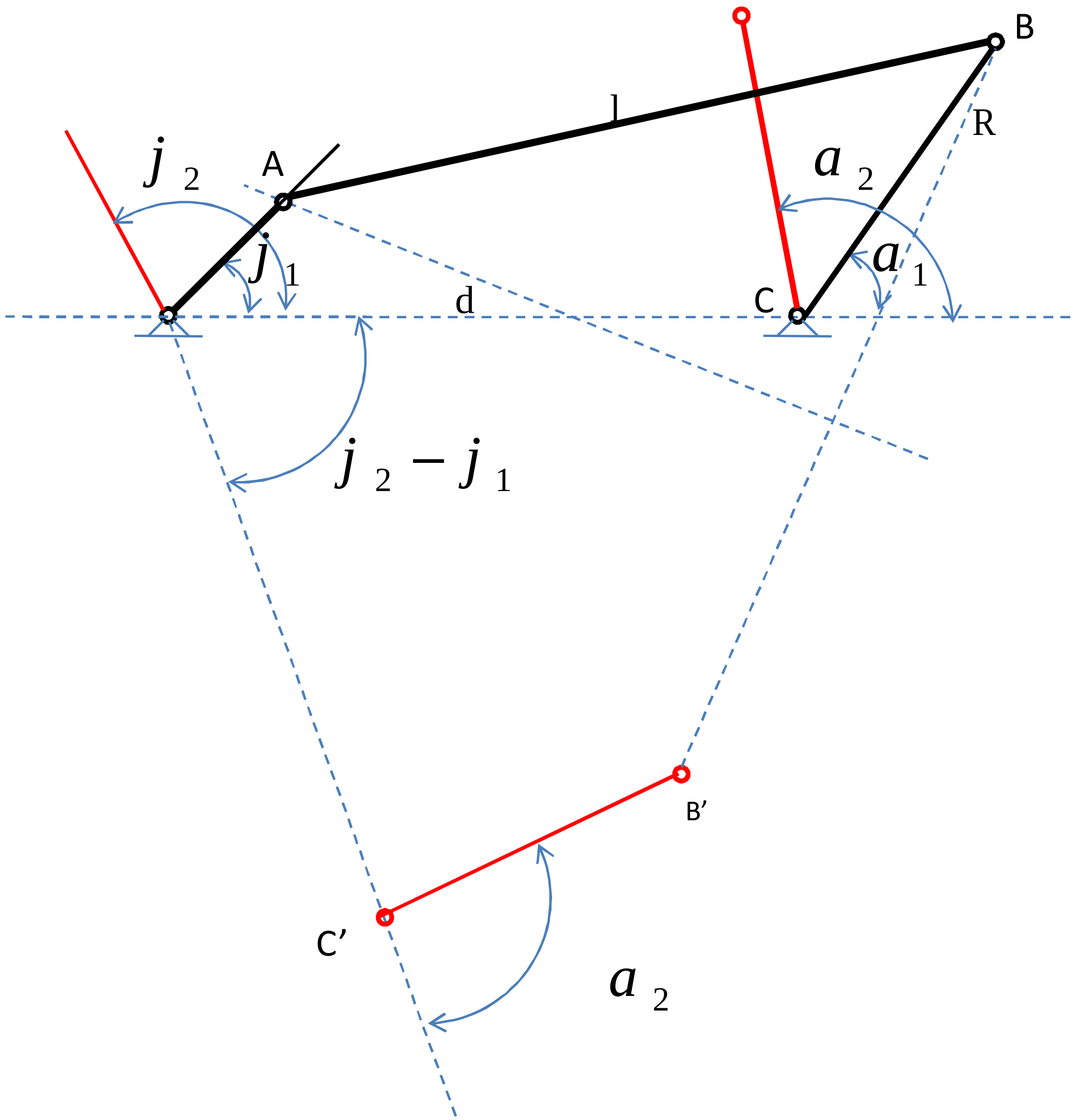
α
Търсена крива
Получена крива
a 2
a 1
j 1
j 2
φ
arctg(da/dj) j 2
arctg(da/dj) j 1

Графичен синтез на четиризвенни механизми по две зададени положения на водещото и изпълнителното звено

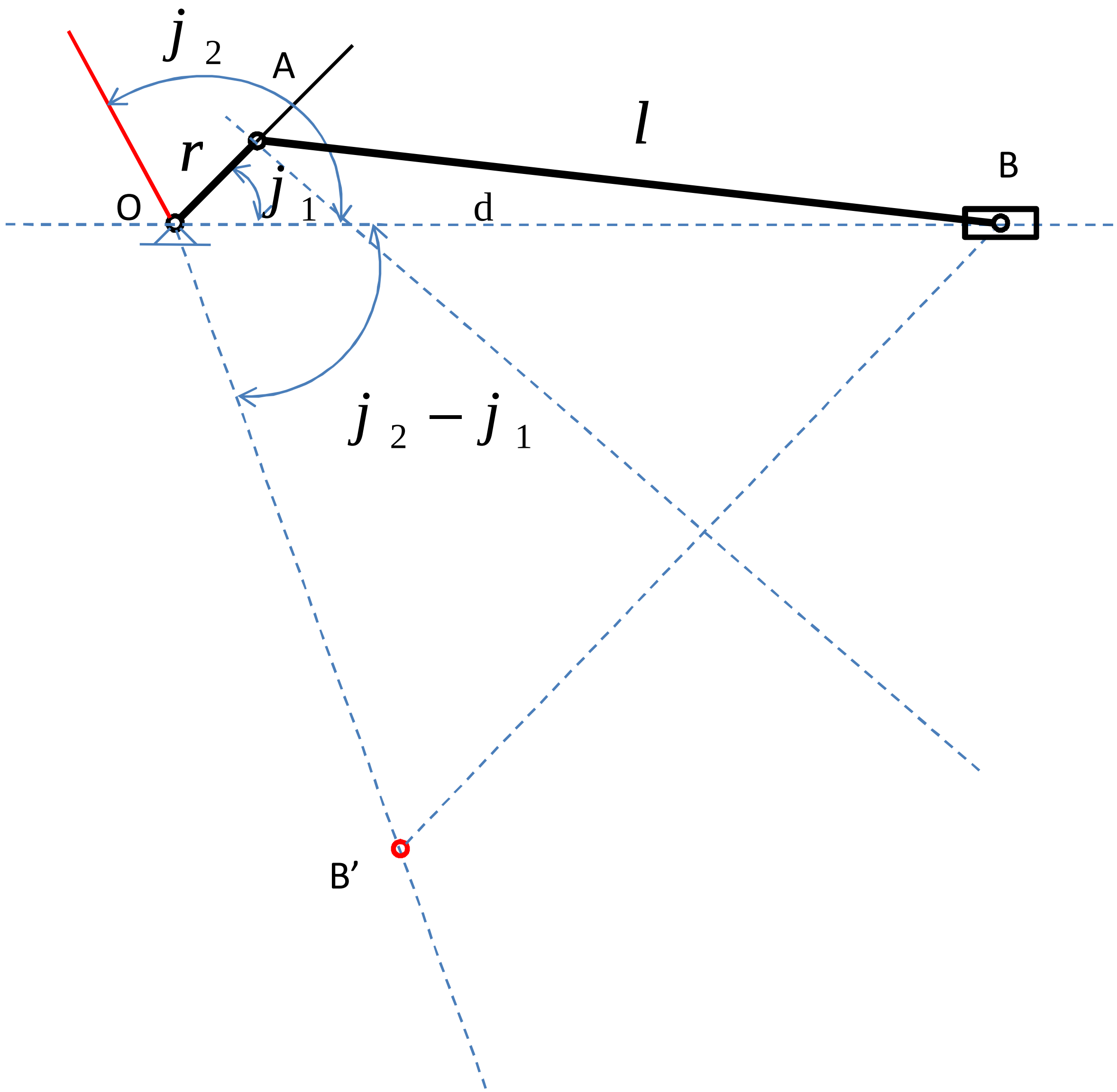
1. Шарнирен четиризвенник



B2
B1
l
A1
A2
R
a 2
j 2
r
j 1
a 1
o
d
C
j 2 − j 1
c'
a 2


B
l
R
A
j 2
a 2
j 1
a 1
d
C
j 2 − j 1
B'
C'
a 2

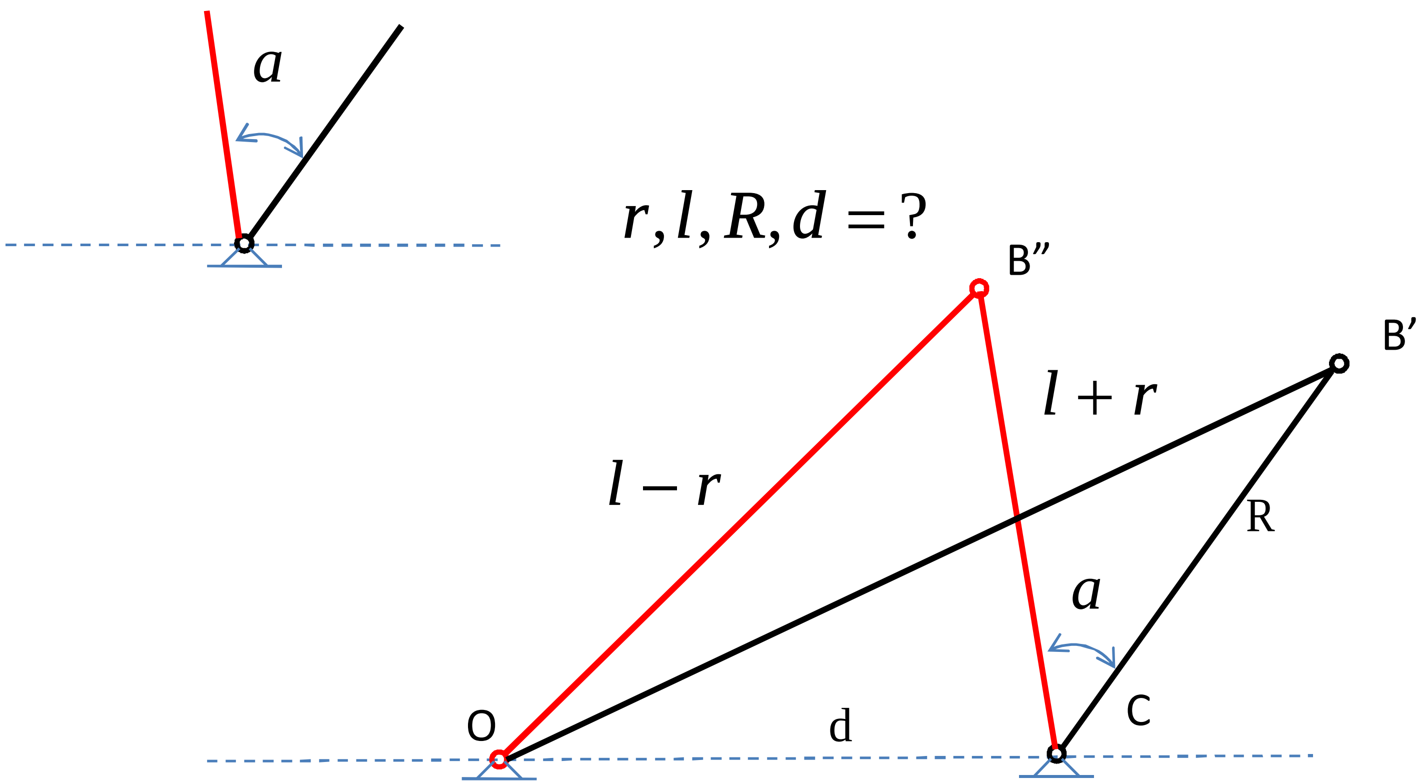
2.Коляно-мотовилков механизъм



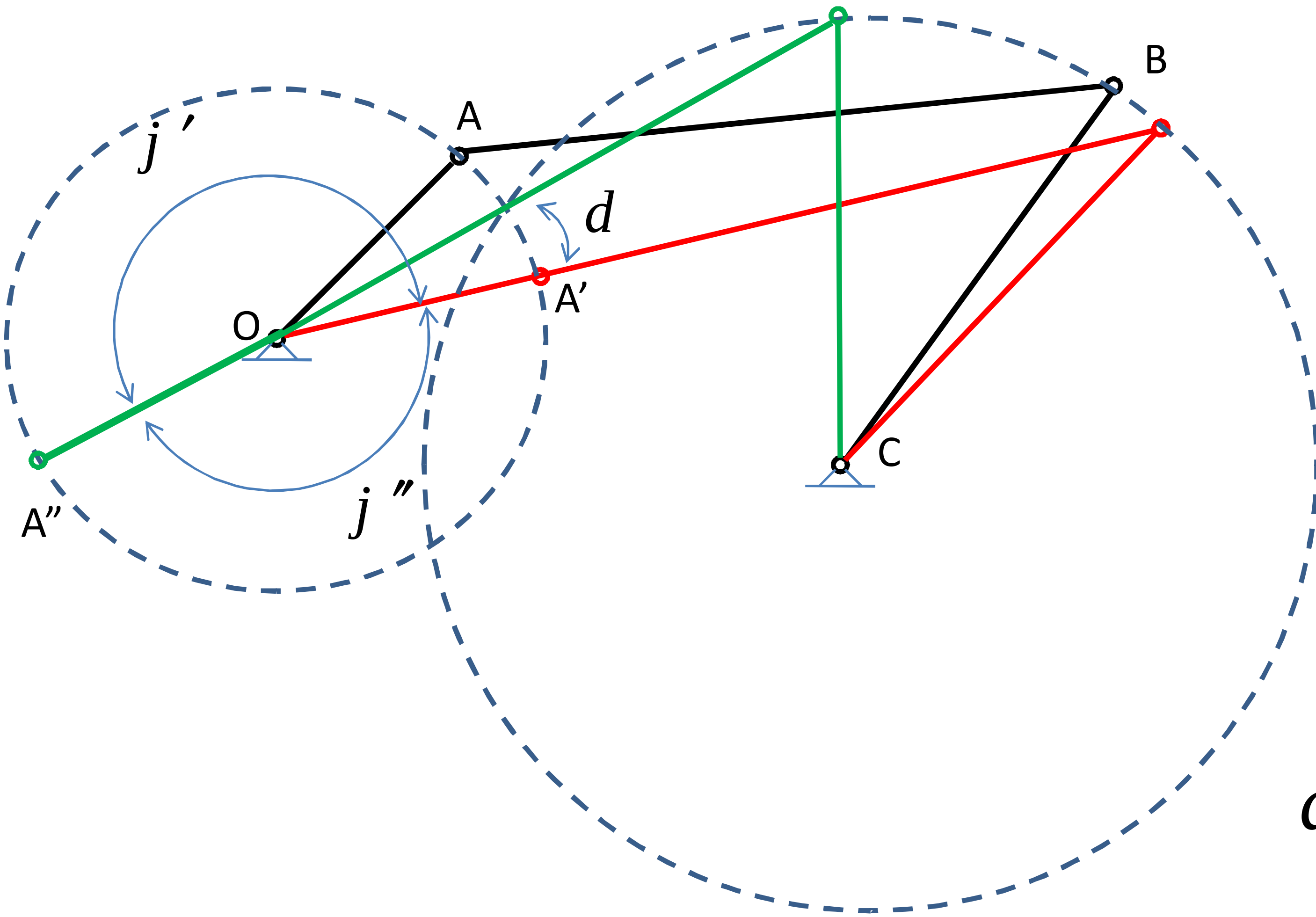
φ_2
A
l
r
B
O
φ_1
d
$\varphi_2 - \varphi_1$
B'

Графичен синтез на четиризвенни механизми по зададени крайни положения на изпълнителното звено:

$$r, l, R, d = ?$$



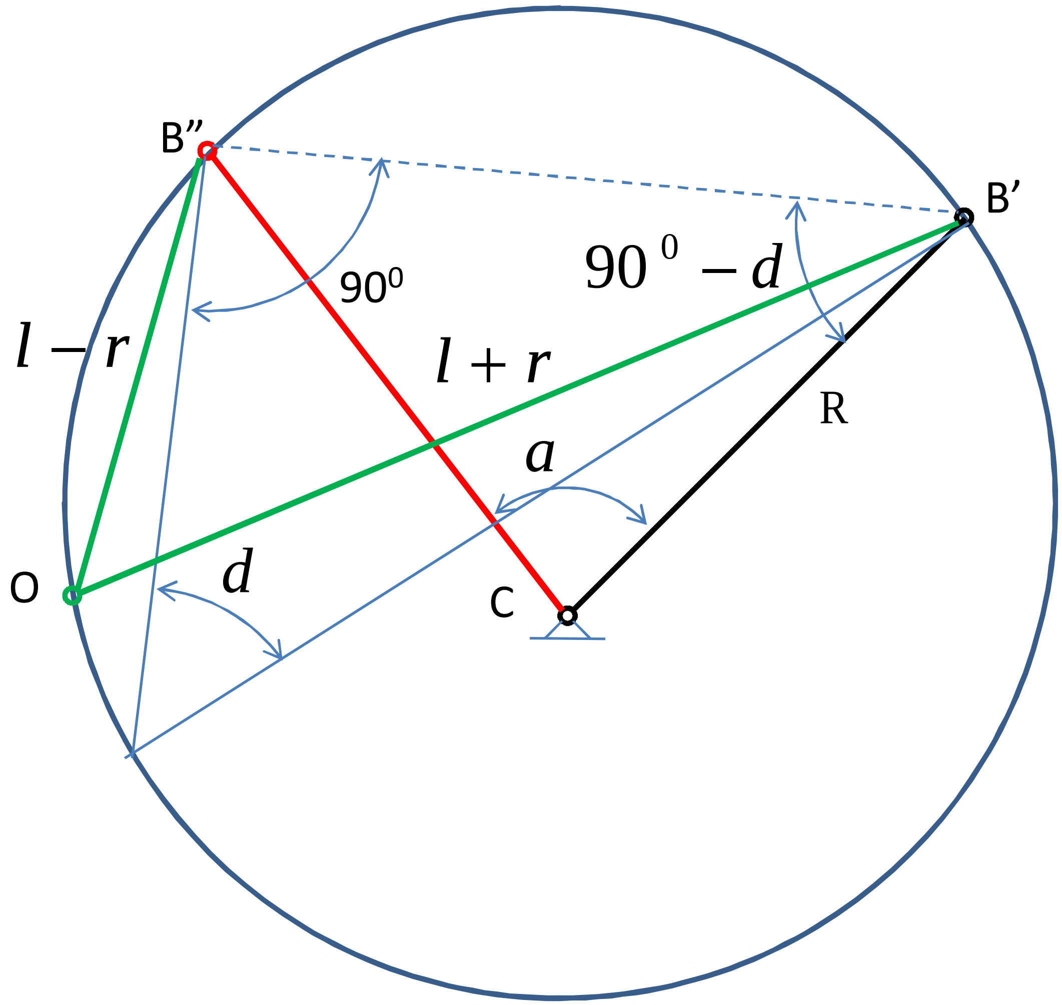
Графичен синтез на четиризвенни механизми по зададен коефициент на производителност:



$$\frac{j'}{j''} = k$$

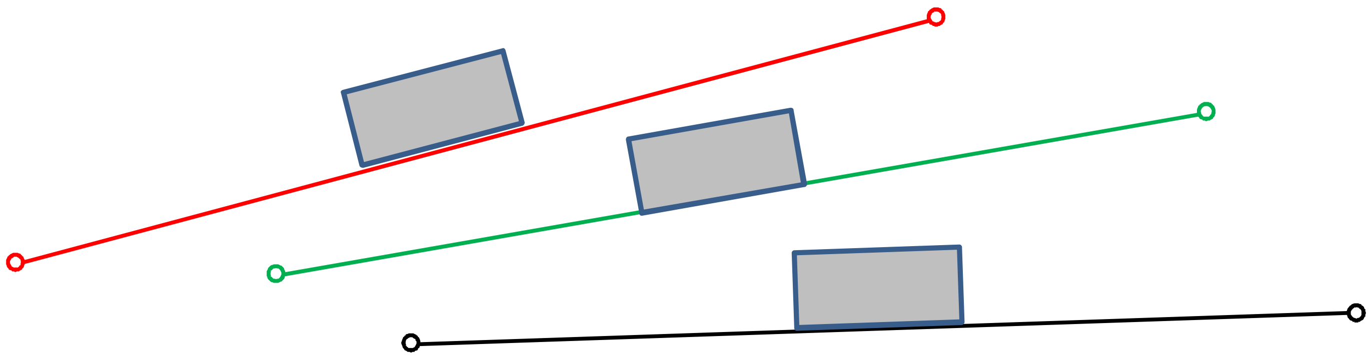
$$k = \frac{180^0 + d}{180^0 - d}$$

$$d = 180^0 \frac{k-1}{k+1}$$

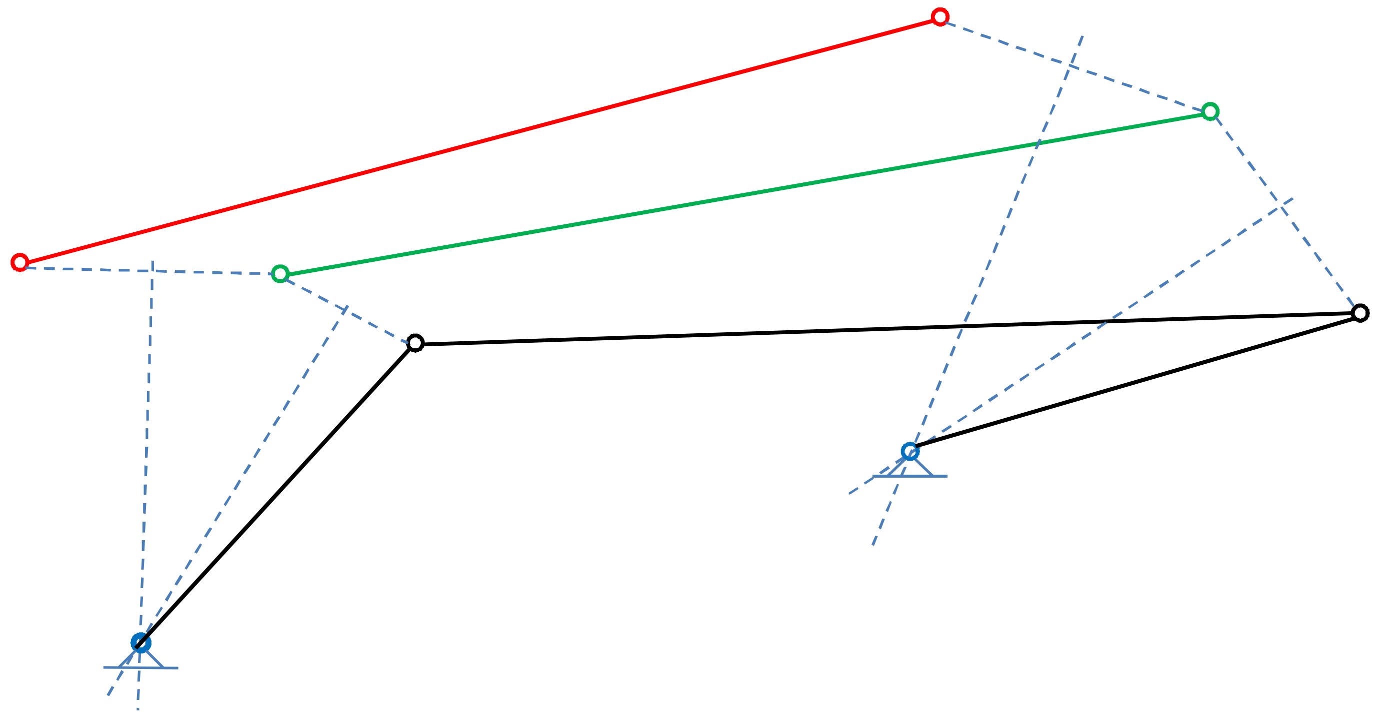


B''
B'
90^0
$90^0 - d$
$l - r$
$l + r$
R
a
O
d
C

3. Осъществяване на зададено движение на равнина.



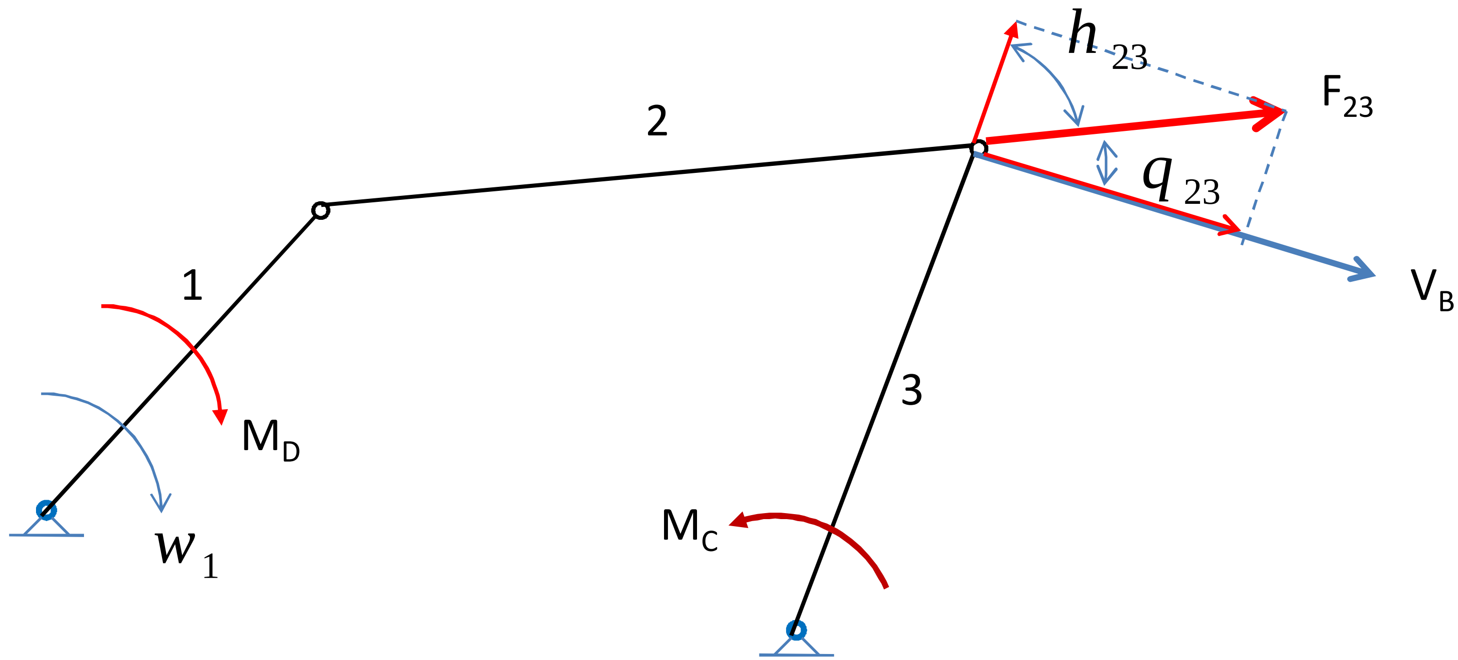
Графичен синтез на четиризвенни механизми по зададени три положения на мотовилката:



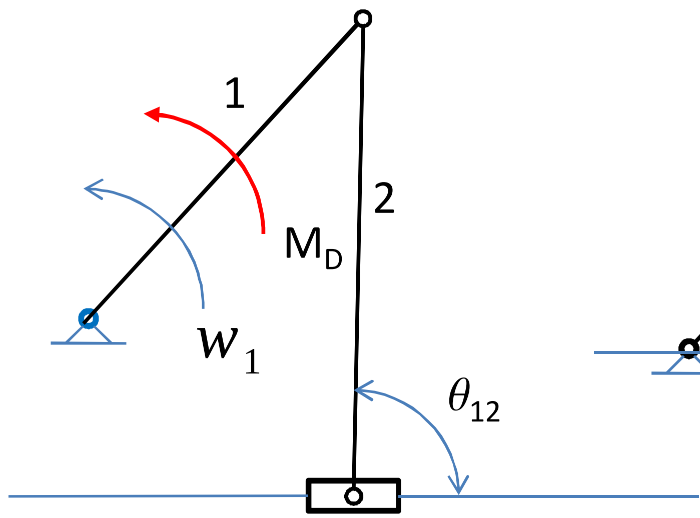
4. Допълнителни изисквания при синтеза

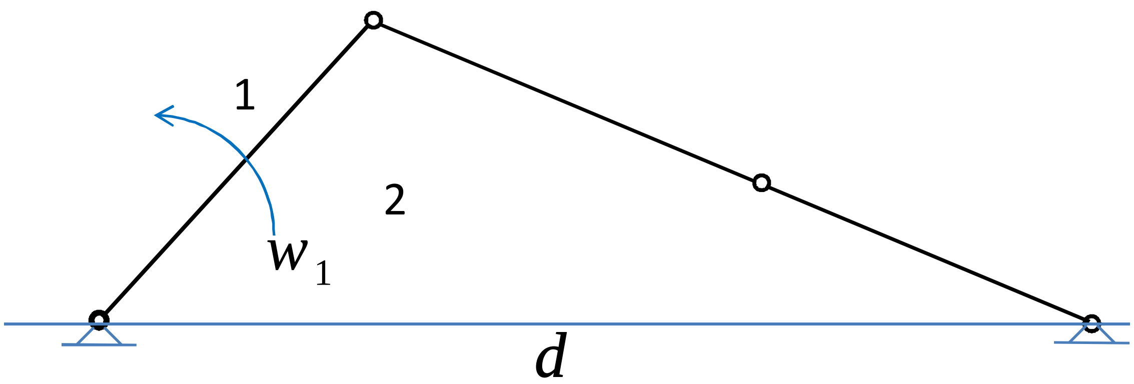
4.1 Условия за движение на звената на механизма.

Ъгъл на предаване на силата:



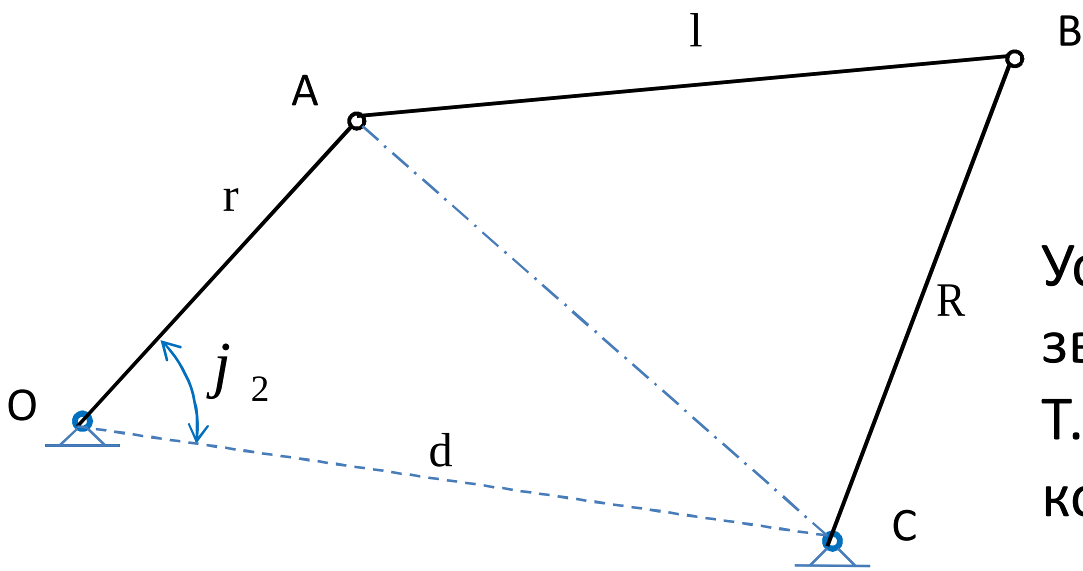
4.2 Условия за превъртане(геометрични условия) на механизма.





$$l \geq r + e$$

$$d \geq r + l + R$$



Условия за превъртане на звено 1.
Т.е. Съществуване на коляно.

$$\Delta OAC \Rightarrow \overline{AC}^2 = r^2 + d^2 - 2rd\cos j$$
$$\Delta ABC \Rightarrow \overline{AC} \le l + R,\ \ \overline{AC} \ge |l - R|$$
$$(l+R)^2 = r^2 + d^2 - 2rd\cos j$$
$$(l-R)^2 = r^2 + d^2 - 2rd\cos j$$
$$j \in [0, 360^o] \Rightarrow \cos j \in [1, -1]$$
$$(l+R)^2 \ge r^2 + d^2 + 2rd$$
$$(l-R)^2 \le r^2 + d^2 - 2rd$$

$$(l+R) \ge r + d$$
$$|l - R| \le |r - d|$$

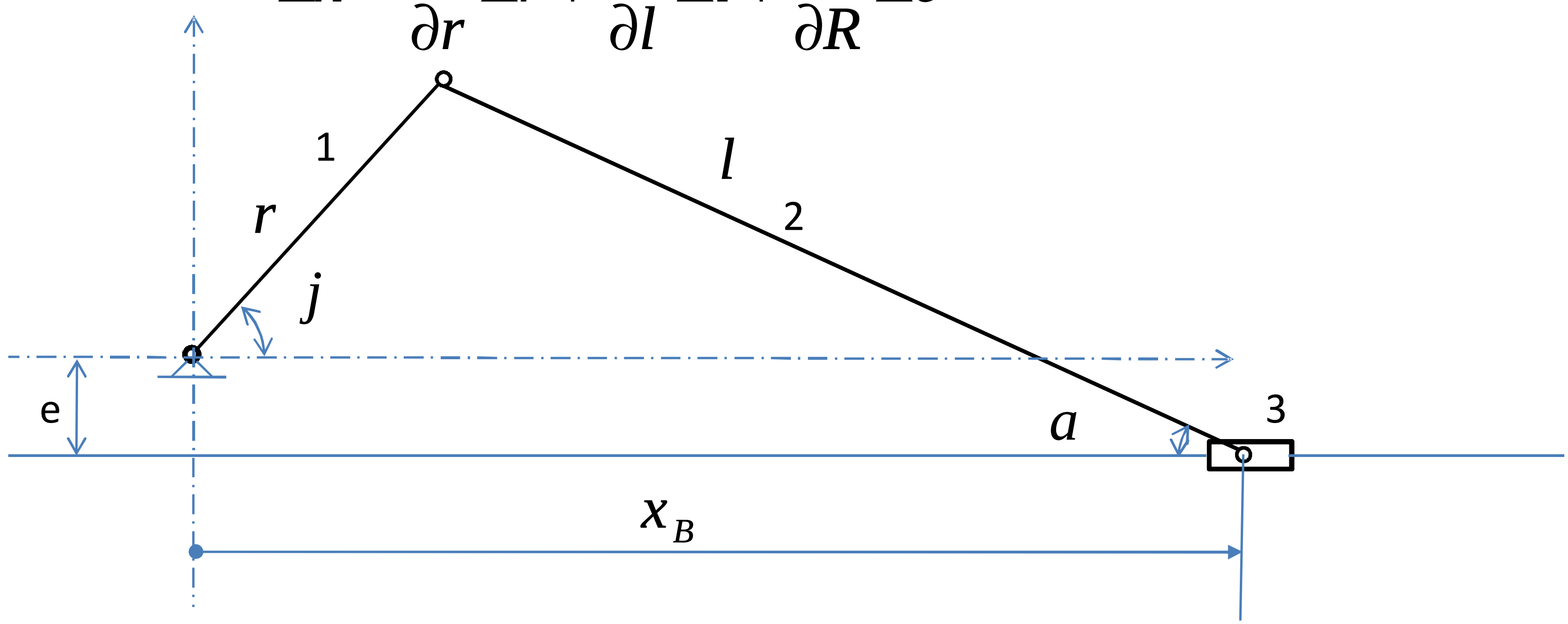
Точност на механизмите

$$x_B = x = f\left(j, r + \Delta r, l + \Delta l, e + \Delta e\right)$$

$$\Delta x = x - x_0$$

$$x = x_0 + \frac{\partial x}{\partial r}\Delta r + \frac{\partial x}{\partial l}\Delta l + \frac{\partial x}{\partial e}\Delta e$$

$$\Delta x = \frac{\partial x}{\partial r}\Delta r + \frac{\partial x}{\partial l}\Delta l + \frac{\partial x}{\partial R}\Delta e$$



$$\vec{e}+\vec{r}+\vec{l}=x_B$$

$$\begin{cases} r\cos j+l\cos a=x_B \\ e+r\sin j=l\sin a \end{cases}$$

$$x_B=r\cos j+\sqrt{l^2-\left(e+r\sin j\right)^2}$$

$$\Delta x=\frac{\partial x}{\partial r}\Delta r+\frac{\partial x}{\partial l}\Delta l+\frac{\partial x}{\partial e}\Delta e$$

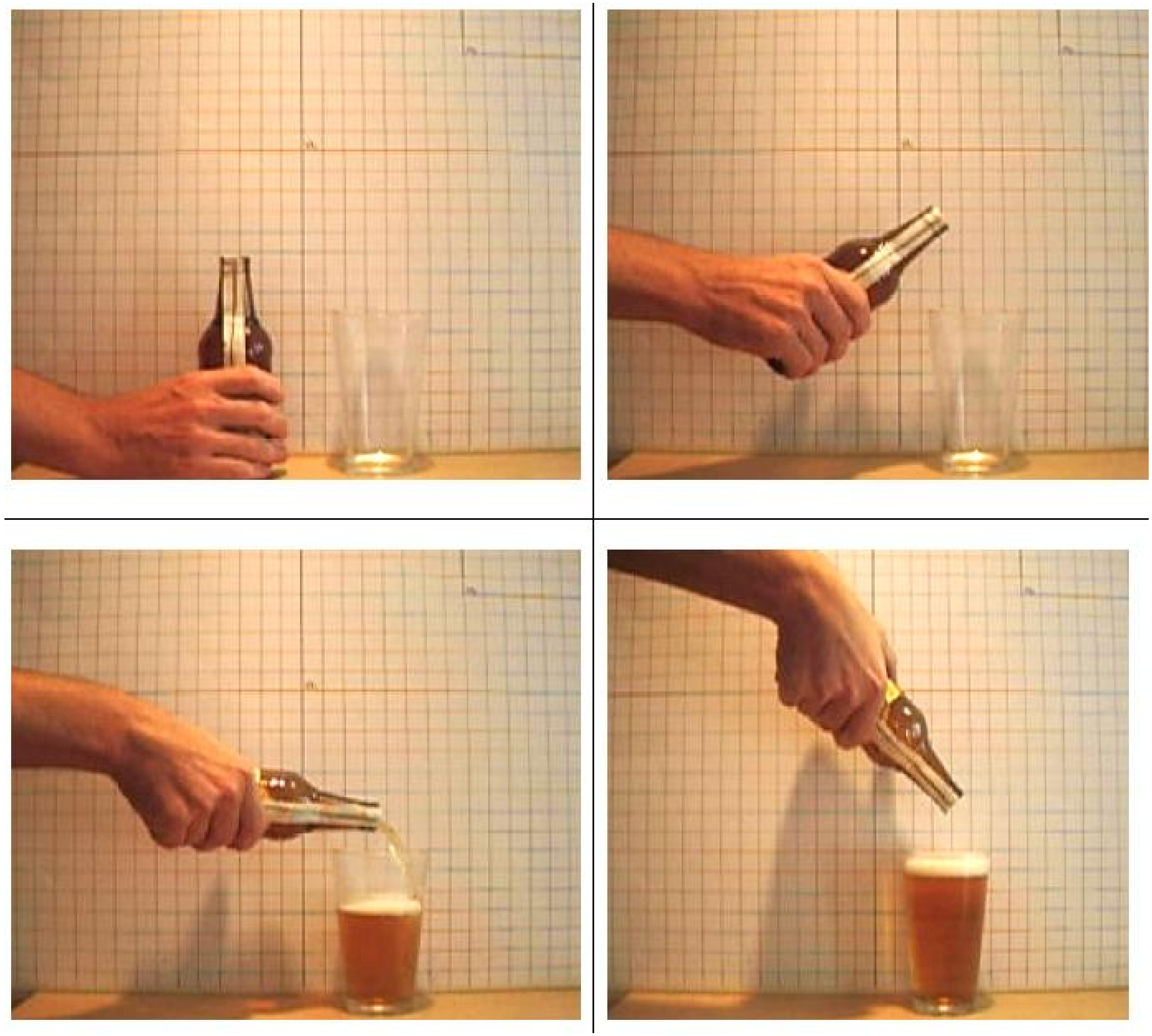
$$\frac{\partial x}{\partial r}=\frac{\cos\left(j+a\right)}{\cos a}$$

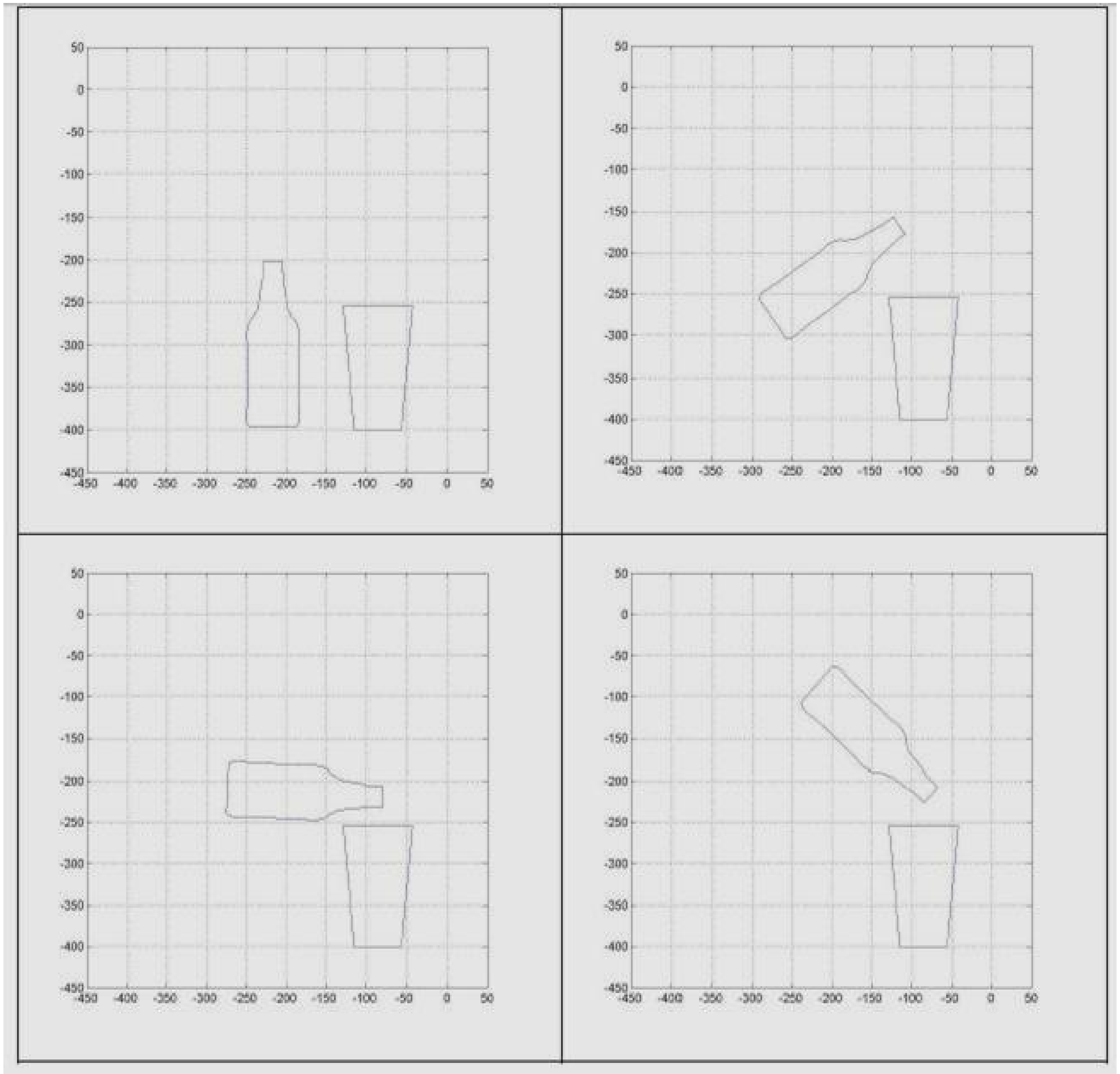
$$\frac{\partial x}{\partial l}=\frac{1}{\cos a}$$

$$\frac{\partial x}{\partial e}=-\tan a$$

$$\Delta x=\frac{\cos\left(j+a\right)}{\cos a}\Delta r+\frac{1}{\cos a}\Delta l-\tan a\,\Delta e$$

Пример за апроксимационен синтез на шестзвенен механизъм




50 0 -50 -100 -150 -200 -250 -300 -350 -400 -450
-450 -400 -350 -300 -250 -200 -150 -100 -50 0 50
50 0 -50 -100 -150 -200 -250 -300 -350 -400 -450
-450 -400 -350 -300 -250 -200 -150 -100 -50 0 50
50 0 -50 -100 -150 -200 -250 -300 -350 -400 -450
-450 -400 -350 -300 -250 -200 -150 -100 -50 0 50
50 0 -50 -100 -150 -200 -250 -300 -350 -400 -450
-450 -400 -350 -300 -250 -200 -150 -100 -50 0 50

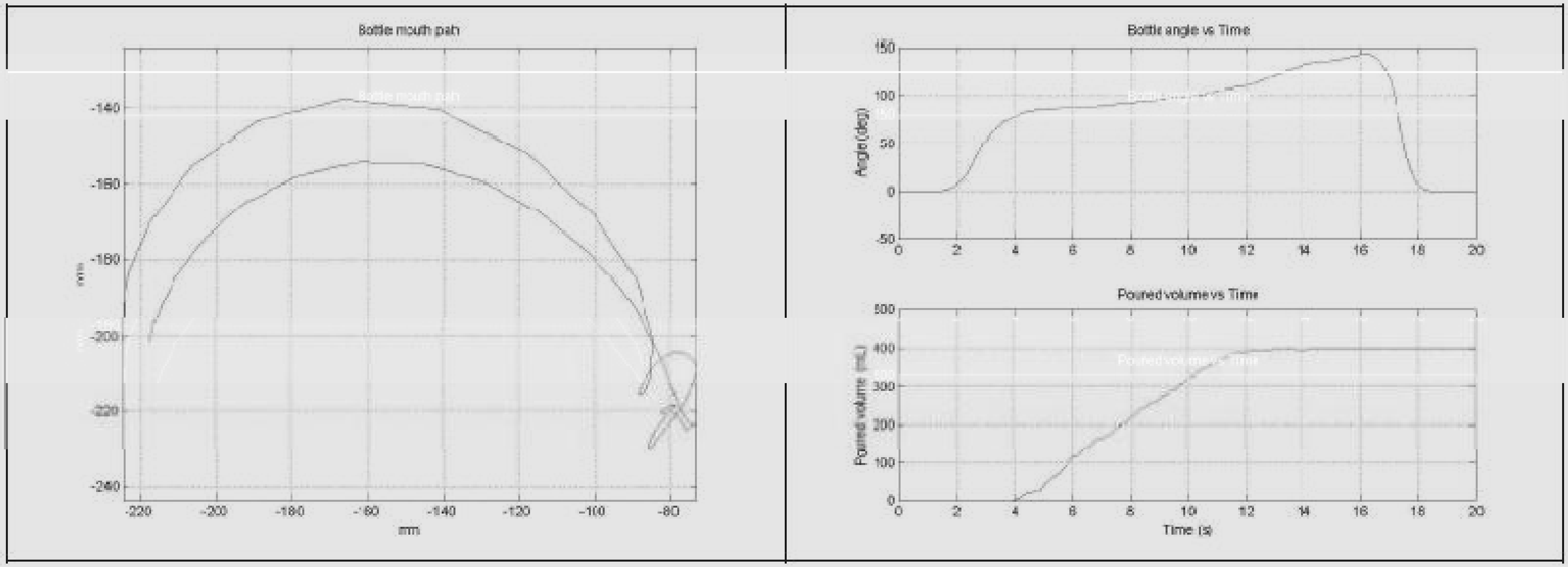
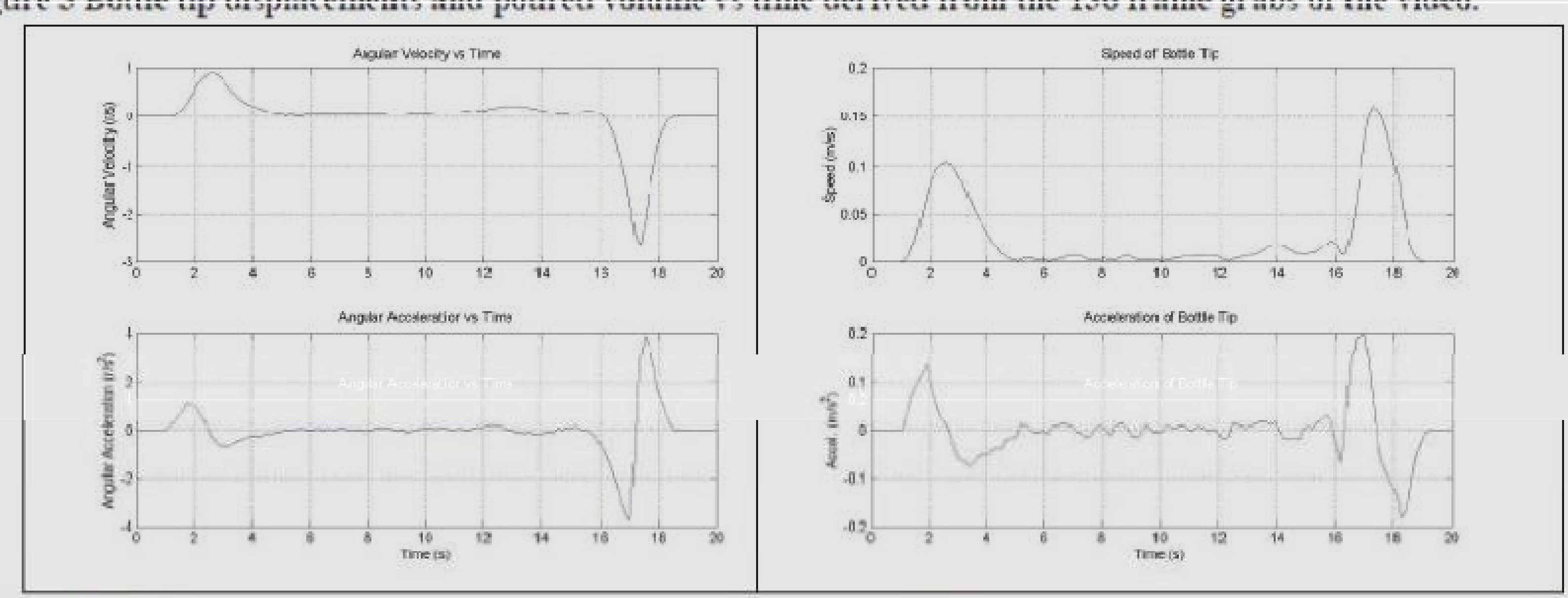
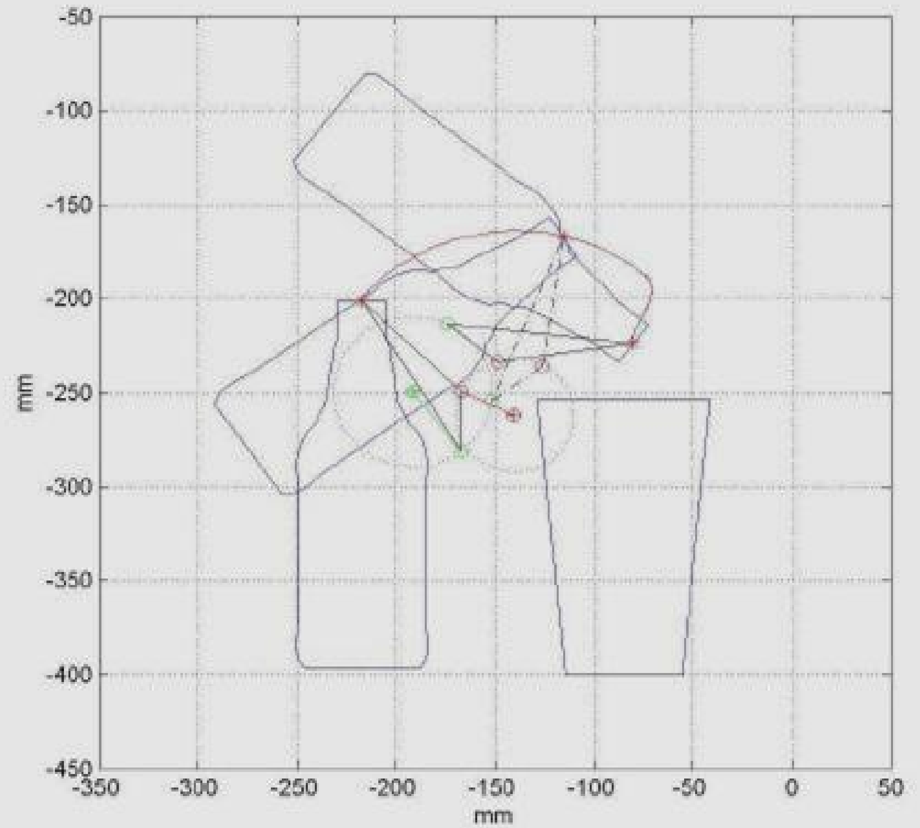


Figure 3 Bottle tip displacements and poured volume vs time derived from the 136 frame grabs of the video.





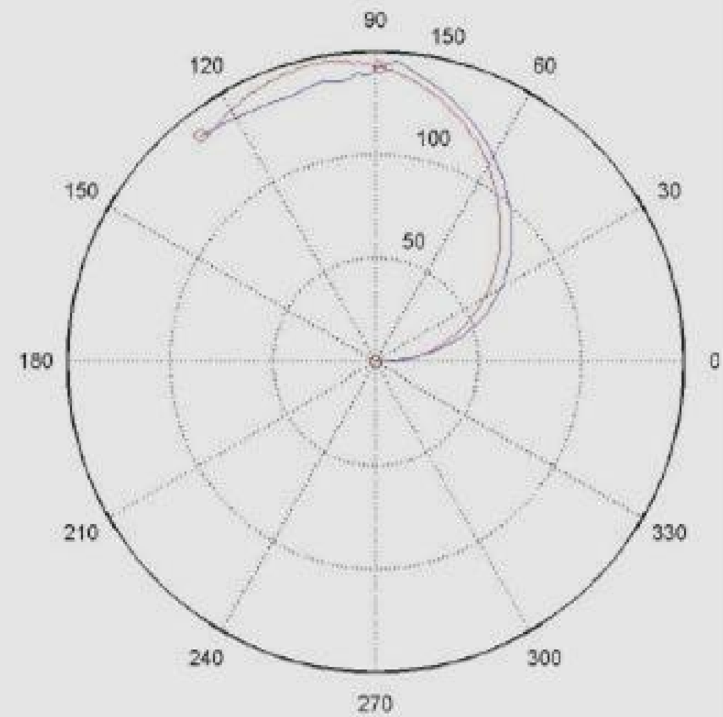
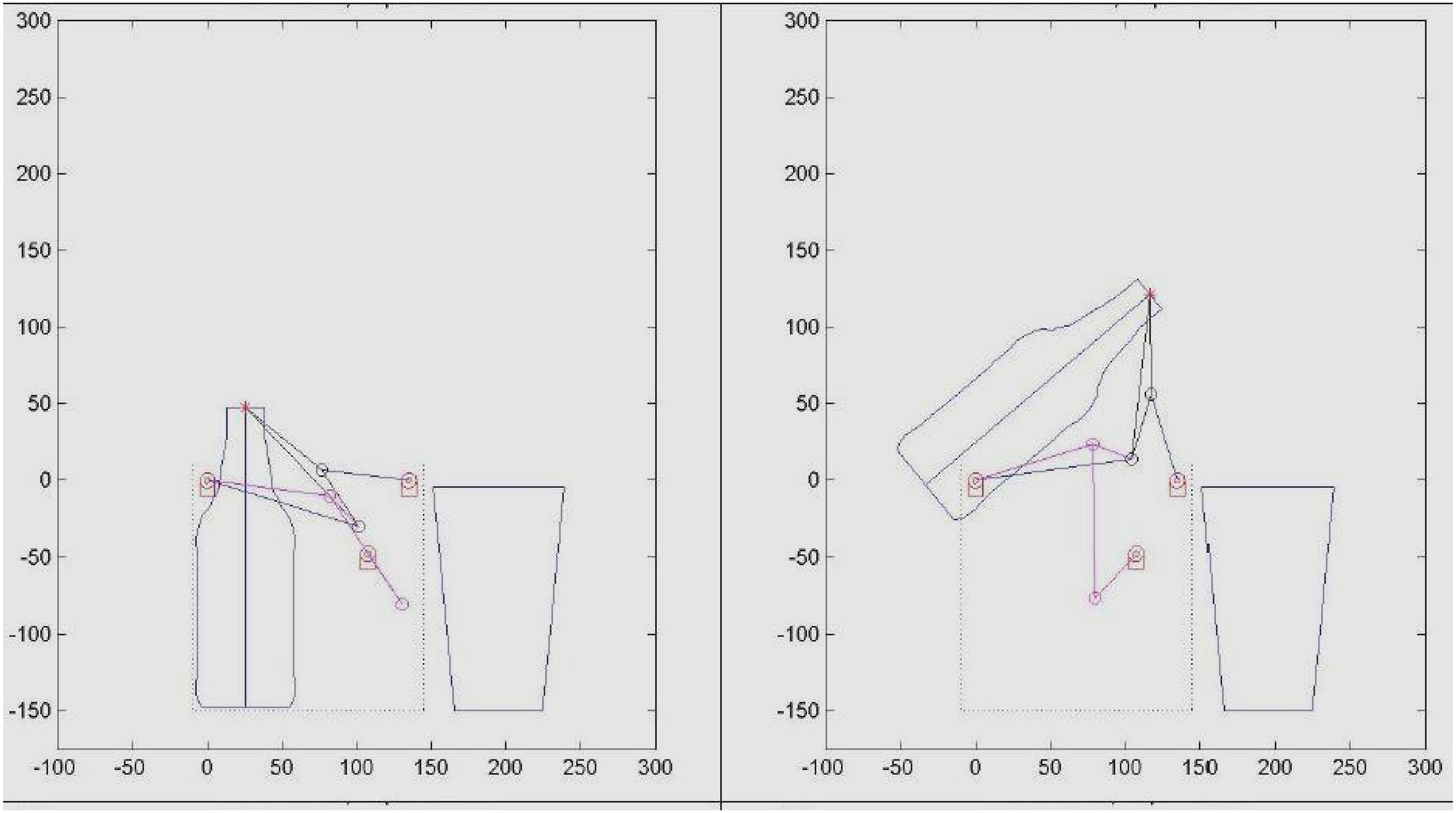
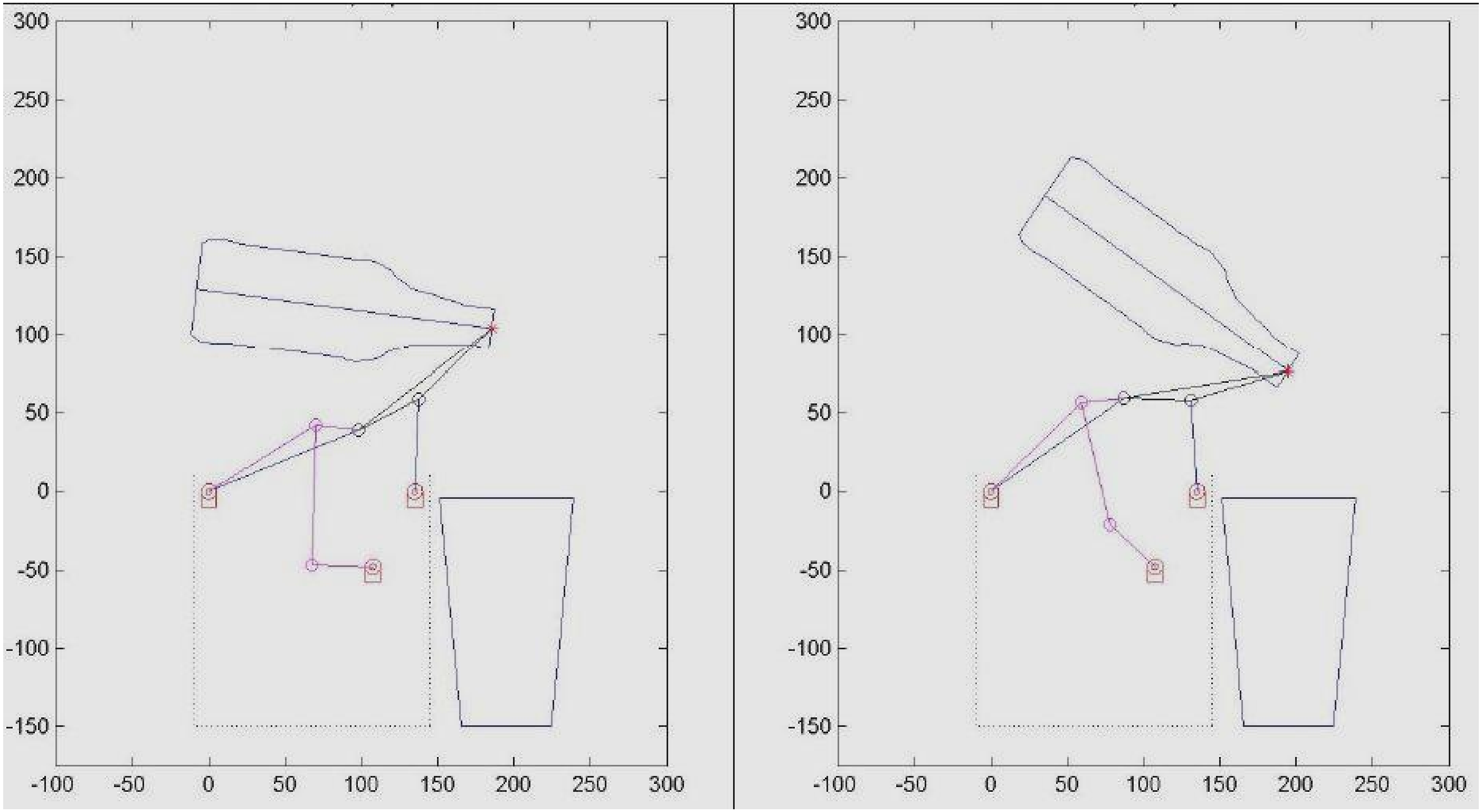


Figure 5 Three prescribed locations of the bottle are used to synthesise a four-bar mechanism which carries the bottle

Figure 6 Superposition of the actual (red) and desired (blue) paths of the bottle. Angle on the polar plot represents the orientation of the bottle relative to vertical. Radius on the plot represents the magnitude of the distance of the bottle tip from its start position.



300
250
200
150
100
50
0
-50
-100
-150
-100
-50
0
50
100
150
200
250
300


300
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