



# KINETOSTATIČKI PRITISCI

# ***KINETOSTATIČKI PRITISCI - definicija***

## **DEFINICIJA**

unutrašnje reakcije u vezama mehanizma

## **ZAŠTO ?**

Na osnovu njih se vrši dimenzionisanje članova i veza

## **METODE**

Grafoanalitička i analitička

# KINETOSTATIČKI PRITISCI

## – karakteristike grafoanalitičke metode

- Vršiti se **dekompozicija mehanizma** (na pojedinačne članove i dijade)
- Koriste se **jednačine “statičkih” uslova ravnoteže**
- Radi se sukcesivno – **od poslednjeg člana ka pogonskom**
- Koriste se osobine reakcije **karakteristične za određenu vrstu veze**

## JEDNAČINE

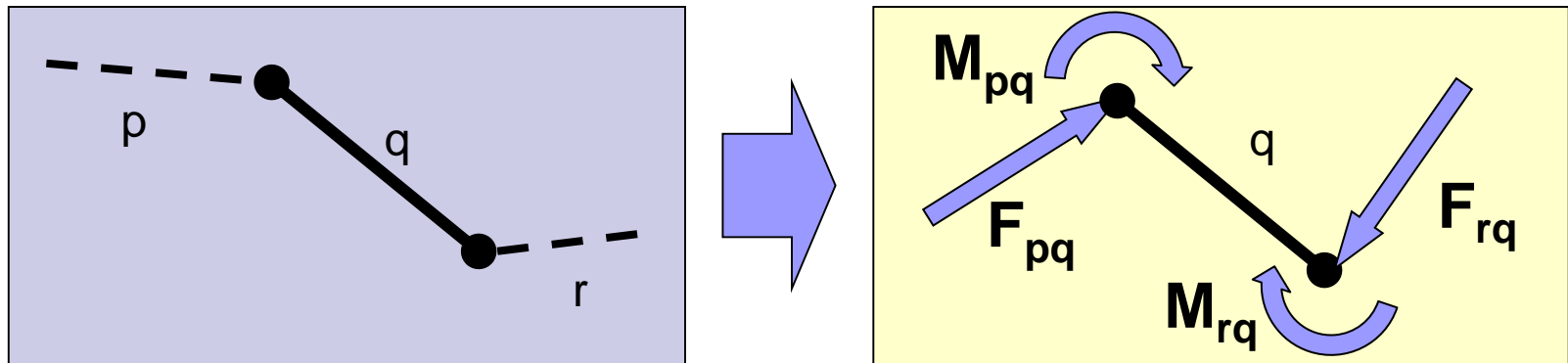
Suma **sila** je jednaka nuli

$$\sum \vec{F}_i = 0$$

Suma **momenata** svih sila za neku tačku je jednaka nuli

$$\sum M(F_i) = 0$$

# DEKOMPOZICIJA



## Označavanje

Dejstvo člana  $p$  na član  $q$   
se označava kao  $F_{pq}$

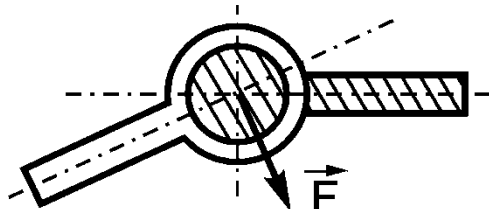
# KARAKTERISTIKE REAKCIJE

Kinetostatički pritisak zavisi od

- Opterećenja
- Vrste veze

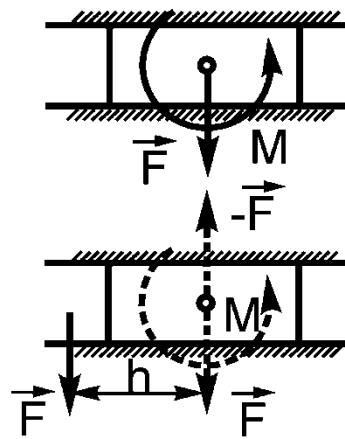
reakcija je sila  $F$  koja **prolazi kroz centar zgloba**. Intenzitet, pravac i smer sile su nepoznati.

zglobna



reakcija je sila  $F$  **normalna na pravac klizanja**, nepoznatog smera i intenziteta koja deluje **izvan centra veze** na nepoznatom rastojanju  $h$ .

klizna

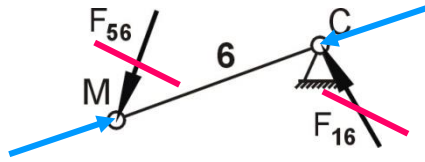


**Moment reakcije se zamenjuje spregom**

# KINETOSTATIČKI PRITISCI

## – grafoanalitički primer

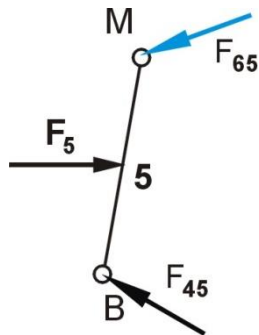
Član 6



$$\sum \vec{F}(6) = \vec{F}_{16} + \vec{F}_{56} = 0 \Rightarrow \vec{F}_{16} = -\vec{F}_{56}$$

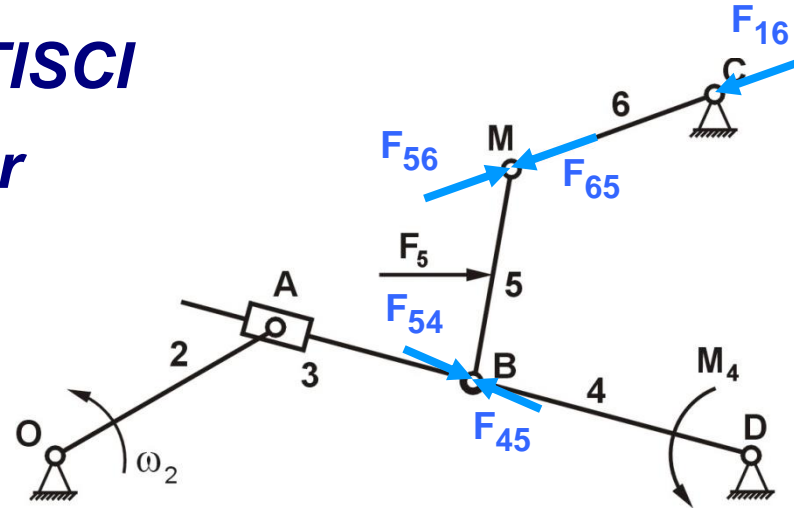
$$\sum M_M(6) = F_{16} \cdot h_{16M} = 0 \Rightarrow h_{16M} = 0$$

Član 5



$$\sum M_B(5) = F_{65} \cdot h_{65B} - F_5 \cdot h_{5B} = 0$$

$$F_{65} = \frac{F_5 \cdot h_{5B}}{h_{65B}} = \frac{100 \cdot 0,13}{0,225} = 57,8 \text{ N}$$

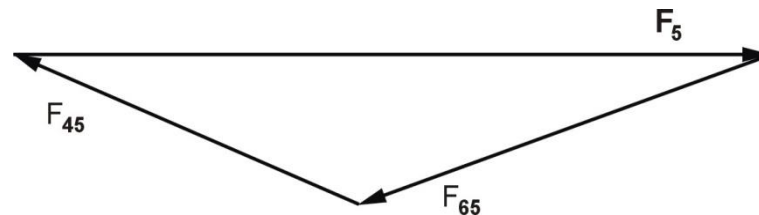


$$U_l = \frac{0,1 \text{ m}}{1 \text{ cm}}$$

$$F_5 = 100 \text{ N}$$

$$M_4 = 10 \text{ Nm}$$

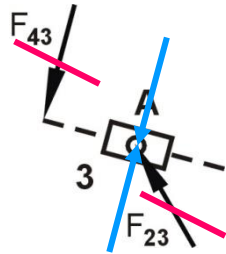
$$U_F = \frac{10 \text{ N}}{1 \text{ cm}}$$



$$\sum \vec{F}_i(5) = \vec{F}_5 + \vec{F}_{65} + \vec{F}_{45} = 0$$

$$F_{45} = 49,8 \text{ N}$$

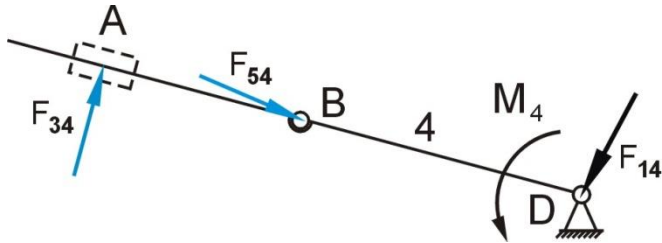
### Član 3



$$\sum \vec{F}(3) = \vec{F}_{23} + \vec{F}_{43} = 0 \Rightarrow \vec{F}_{23} = -\vec{F}_{43}$$

$$\sum M_A(3) = F_{43} \cdot h_{43A} = 0 \Rightarrow h_{43A} = 0$$

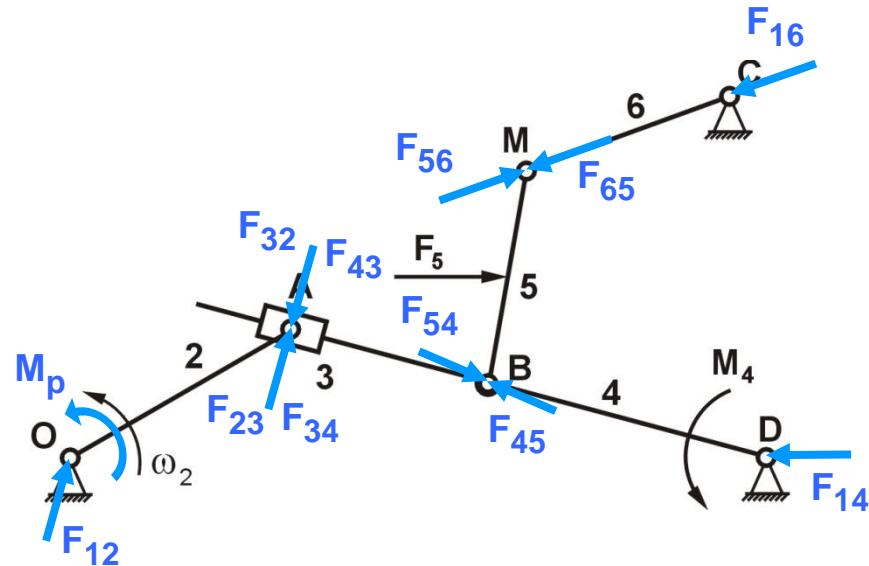
### Član 4



$$\sum M_D(4) = F_{54} \cdot h_{54D} - F_{34} \cdot h_{34D} + M_4 = 0$$

$$F_{34} = \frac{1}{h_{34D}} (M_4 + F_{54} \cdot h_{54D}) =$$

$$= \frac{1}{0,59} (10 + 49,8 \cdot 0,05) = 21,2 \text{ N}$$

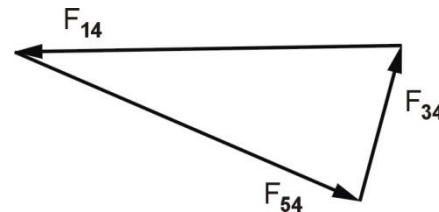


$$U_I = \frac{0,1 \text{ m}}{1 \text{ cm}}$$

$$F_5 = 100 \text{ N}$$

$$M_4 = 10 \text{ Nm}$$

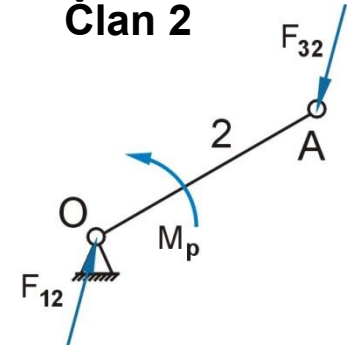
$$U_F = \frac{10 \text{ N}}{1 \text{ cm}}$$



$$\sum \vec{F}_i(4) = \vec{F}_{54} + \vec{F}_{34} + \vec{F}_{14} = 0$$

$$F_{14} = 51,3 \text{ N}$$

### Član 2



$$\sum M_O(2) = F_{32} \cdot h_{32O} - M_p = 0$$

$$M_p = F_{32} \cdot h_{32O} = 21,2 \cdot 0,215 = 4,56 \text{ Nm}$$

# ***KINETOSTATIČKI PRITISCI***

## ***– karakteristike analitičke metode***

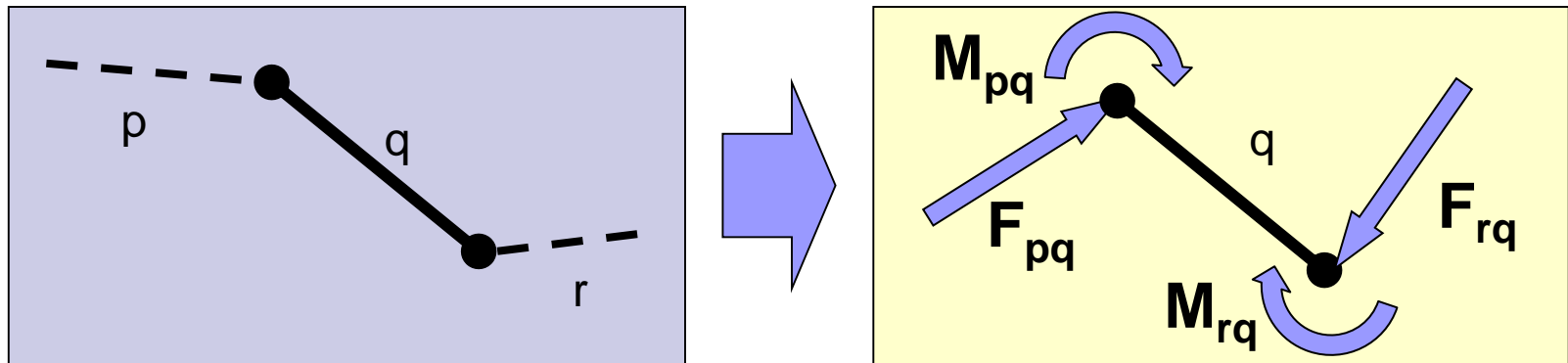
- Kinematičkom analizom se **odrede svi parametri položaja** (promenljive dužine i uglovi)
- Vršiti se **dekompozicija mehanizma** (na pojedinačne članove)
- Koriste se **jednačine “statičkih” uslova ravnoteže**
- Koriste se osobine reakcije **karakteristične za određenu vrstu veze**

**Može – ali ne mora – da se**

- Radi se sukcesivno – **od poslednjeg člana ka pogonskom**



# DEKOMPOZICIJA



## Označavanje

Dejstvo člana  $p$  na član  $q$   
se označava kao  $F_{pq}$

## JEDNAČINE

Suma **sila** koje deluju na član i mehanizma je jednaka nuli.

$$\sum \vec{F}_i = 0$$

Suma **momenata** svih sila koje deluju na član mehanizma, za neku tačku na tom članu, je jednaka nuli.

$$\sum \vec{M}(\vec{F}_i) = 0$$

Vektorska jednačina!!!!



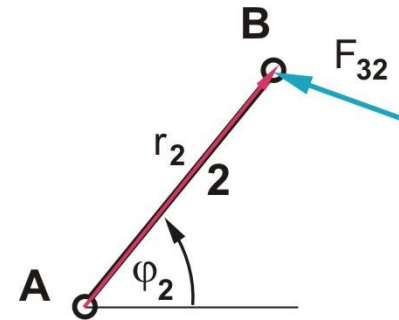
## Jednačine – moment sile za tačku

Momentna jednačina

$$\sum \vec{M}(A, 2) = \vec{r}_2 \times \vec{F}_{32} = \overrightarrow{AB} \times \vec{F}_{32}$$

$$\vec{r}_2 \times \vec{F}_{32} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ r_{2x} & r_{2y} & 0 \\ F_{32x} & F_{32y} & 0 \end{vmatrix} = \vec{k} \cdot (r_{2x} F_{32y} - r_{2y} F_{32x})$$

$$r_{2x} = AB \cos \varphi_2 \quad r_{2y} = AB \sin \varphi_2$$



# VEZE

Reakcija na mestu **zglobne veze**

$$\vec{F}_{32} = F_{32x} \cdot \vec{i} + F_{32y} \cdot \vec{j} \quad F_{32x} = ?$$

$$F_{32y} = ?$$

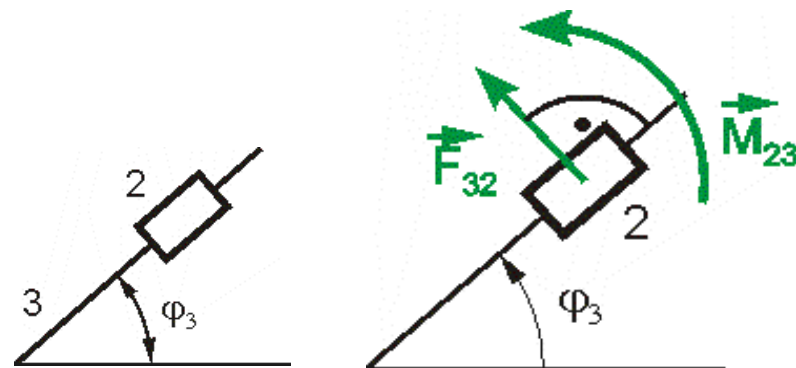
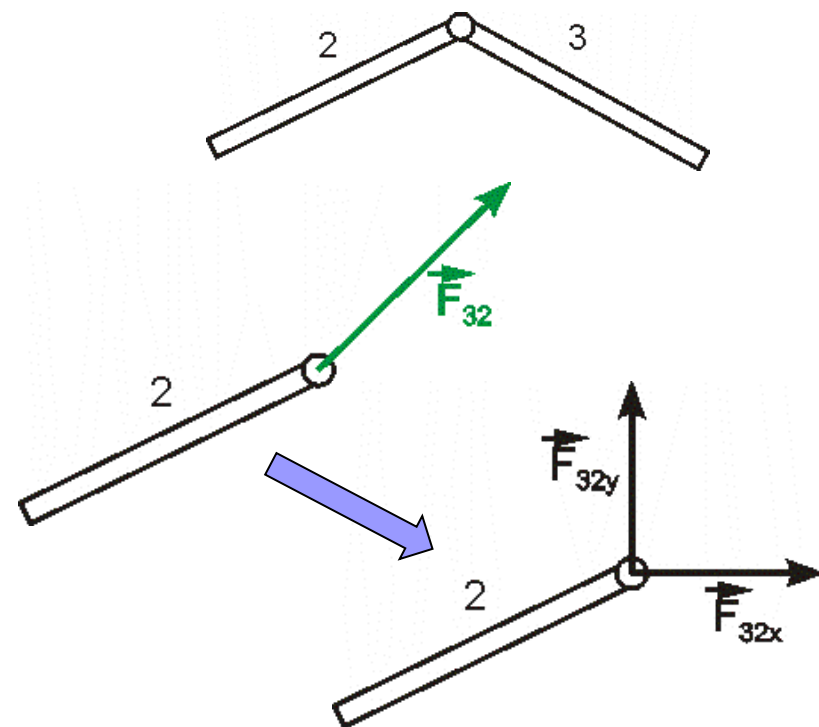
Reakcija na mestu **klizne veze**

$$\vec{M}_{32} = M_{32} \cdot \vec{k}$$

$$\vec{F}_{32} = F_{32x} \cdot \vec{i} + F_{32y} \cdot \vec{j} \quad F_{32} = ?$$

$$F_{32x} = F_{32} \cos(\phi_3 + 90^\circ) \quad M_{32} = ?$$

$$F_{32y} = F_{32} \sin(\phi_3 + 90^\circ)$$



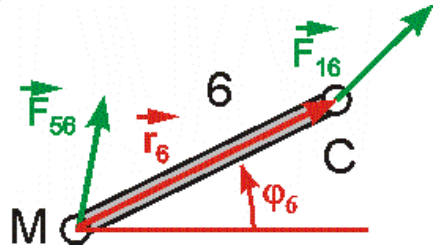
# KINETOSTATIČKI PRITISCI

## – analitički primer

### Član 6

$$\sum \vec{F}(6) = \vec{F}_{16} + \vec{F}_{56} = 0$$

$$\sum \vec{M}_M(6) = \vec{r}_6 \times \vec{F}_{16} = 0$$

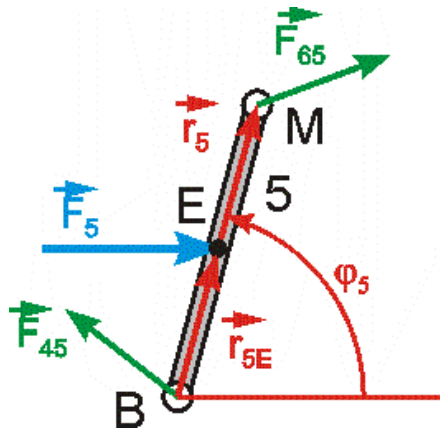


### Član 5

$$\sum \vec{F}_i(5) = \vec{F}_5 + \vec{F}_{65} + \vec{F}_{45} = 0$$

$$\sum \vec{M}_B(5) = \vec{r}_{5E} \times \vec{F}_5 + \vec{r}_5 \times \vec{F}_{65} = 0$$

$$\vec{F}_{65} = -\vec{F}_{56}$$

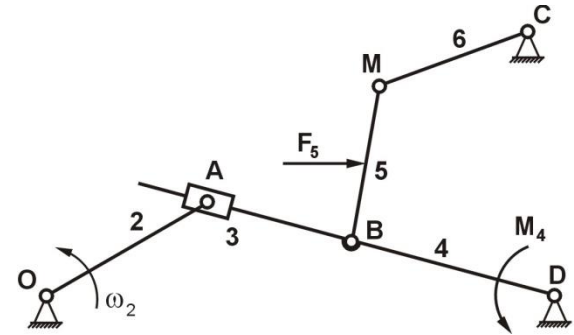


$$\sum \vec{F}(6) = \vec{F}_{16} + \vec{F}_{56} = 0$$

$$\sum \vec{M}_M(6) = \vec{r}_6 \times \vec{F}_{16} = 0$$

$$\sum \vec{F}_i(5) = \vec{F}_5 + (-\vec{F}_{56}) + \vec{F}_{45} = 0$$

$$\sum \vec{M}_B(5) = \vec{r}_{5E} \times \vec{F}_5 + \vec{r}_5 \times (-\vec{F}_{56}) = 0$$



$$\vec{F}_5 = 100 \cdot \vec{i}$$

$$\vec{M}_4 = 10 \cdot \vec{k}$$

$$\vec{F}_{16} = F_{16x} \cdot \vec{i} + F_{16y} \cdot \vec{j}$$

$$\vec{F}_{56} = F_{56x} \cdot \vec{i} + F_{56y} \cdot \vec{j}$$

$$\vec{F}_{45} = F_{45x} \cdot \vec{i} + F_{45y} \cdot \vec{j}$$

$$F_{16x} + F_{56x} = 0$$

$$F_{16y} + F_{56y} = 0$$

$$r_{6x} \cdot F_{16y} - r_{6y} \cdot F_{16x} = 0$$

$$100 - F_{56x} + F_{45x} = 0$$

$$-F_{56y} + F_{45y} = 0$$

$$r_{5x} \cdot 0 - r_{5y} \cdot 100 + r_{5Ex} \cdot (-F_{56y}) - r_{5Ey} \cdot (-F_{56x}) = 0$$

$$\vec{r}_6 = \overline{MC}$$

$$r_{6x} = \overline{MC} \cos \varphi_6$$

$$r_{6y} = \overline{MC} \sin \varphi_6$$

$$\vec{r}_5 = \overline{BM}$$

$$r_{5x} = \overline{BM} \cos \varphi_5$$

$$r_{5y} = \overline{BM} \sin \varphi_5$$

$$\vec{r}_{5E} = \overline{BE}$$

$$r_{5Ex} = \overline{BE} \cos \varphi_5$$

$$r_{5Ey} = \overline{BE} \sin \varphi_5$$

$$F_{16x} + F_{56x} = 0$$

$$F_{16y} + F_{56y} = 0$$

$$r_{6x} \cdot F_{16y} - r_{6y} \cdot F_{16x} = 0$$

$$100 - F_{56x} + F_{45x} = 0$$

$$-F_{56y} + F_{45y} = 0$$

$$-r_{5y} \cdot 100 + r_{5Ex} \cdot (-F_{56y}) - r_{5Ey} \cdot (-F_{56x}) = 0$$

$$F_{16x} + F_{56x} = 0$$

$$F_{16y} + F_{56y} = 0$$

$$\overline{MC} \cdot \cos \varphi_6 \cdot F_{16y} - \overline{MC} \cdot \sin \varphi_6 \cdot F_{16x} = 0$$

$$100 - F_{56x} + F_{45x} = 0$$

$$-F_{56y} + F_{45y} = 0$$

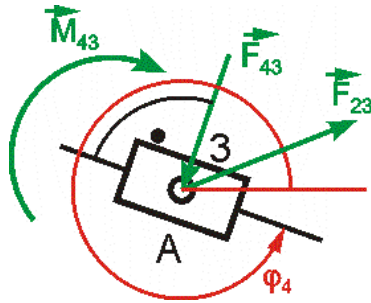
$$-\overline{BM} \cdot \sin \varphi_5 \cdot 100 + \overline{BE} \cdot \cos \varphi_5 \cdot (-F_{56y}) - \overline{BE} \cdot \sin \varphi_5 \cdot (-F_{56x}) = 0$$

$$F_{16x}, F_{16y}, F_{56x}, F_{56y}, F_{45x}, F_{45y}$$

### Član 3

$$\sum \vec{F}(3) = \vec{F}_{23} + \vec{F}_{43} = 0$$

$$\sum \vec{M}_A(3) = \vec{M}_{43} = 0$$



$$\vec{F}_{34} = F_{34} \cos(\varphi_4 + \pi/2) \cdot \vec{i} + F_{34} \sin(\varphi_4 + \pi/2) \cdot \vec{j}$$

$$\vec{M}_{34} = M_{34} \cdot \vec{k}$$

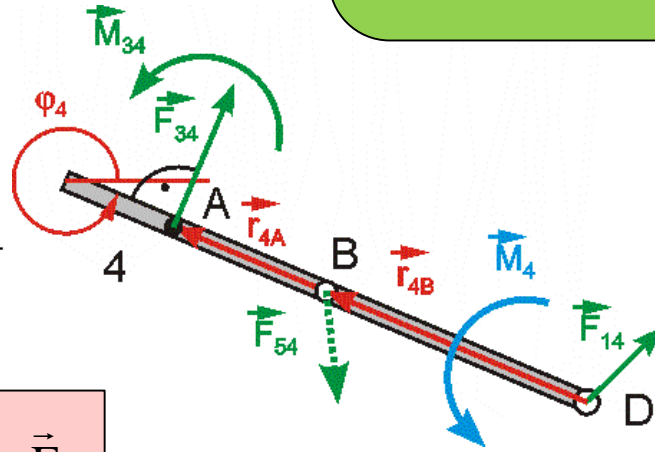
$$\vec{F}_{14} = F_{14x} \cdot \vec{i} + F_{14y} \cdot \vec{j}$$

$$\vec{F}_{23} = F_{23x} \cdot \vec{i} + F_{23y} \cdot \vec{j}$$

### Član 4

$$\sum \vec{F}_i(4) = \vec{F}_{54} + \vec{F}_{34} + \vec{F}_{14} = 0$$

$$\sum \vec{M}_D(4) = \vec{r}_{4B} \times \vec{F}_{54} + \vec{r}_{4A} \times \vec{F}_{34} + \vec{M}_{34} + \vec{M}_4 = 0$$



$$\vec{F}_{43} = -\vec{F}_{34} \quad \vec{M}_{43} = -\vec{M}_{34}$$

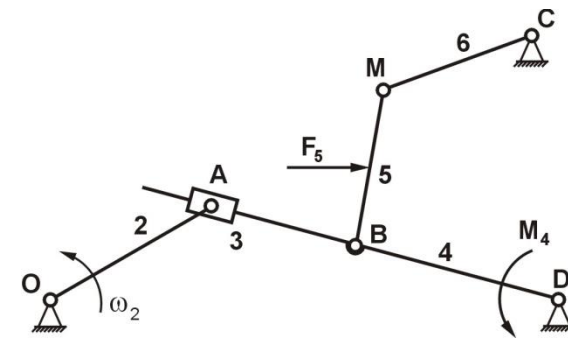
$$\vec{F}_{54} = -\vec{F}_{45}$$

$$\sum \vec{F}(3) = \vec{F}_{23} + (-\vec{F}_{34}) = 0$$

$$\sum \vec{M}_A(3) = (-\vec{M}_{34}) = 0$$

$$\sum \vec{F}_i(4) = (-\vec{F}_{45}) + \vec{F}_{34} + \vec{F}_{14} = 0$$

$$\sum \vec{M}_D(4) = \vec{r}_{4B} \times (-\vec{F}_{45}) + \vec{r}_{4A} \times \vec{F}_{34} + \vec{M}_{34} + \vec{M}_4 = 0$$



$$F_{23x} + (-F_{34} \cdot \cos(\varphi_4 + \pi/2)) = 0$$

$$F_{23y} + (-F_{34} \cdot \sin(\varphi_4 + \pi/2)) = 0$$

$$(-M_{34}) = 0$$

$$(-F_{45x}) + F_{34} \cdot \cos(\varphi_4 + \pi/2) + F_{14x} = 0$$

$$(-F_{45y}) + F_{34} \cdot \sin(\varphi_4 + \pi/2) + F_{14y} = 0$$

$$r_{4Bx} \cdot F_{54y} - r_{4By} \cdot F_{54x} + 10 + r_{4Ax} \cdot F_{34} \cdot \sin(\varphi_4 + \pi/2) - r_{4Ay} \cdot F_{34} \cdot \cos(\varphi_4 + \pi/2) + M_{34} = 0$$

$$\vec{r}_{4B} = \overline{DB}$$

$$\vec{r}_{4A} = \overline{DA}$$

$$r_{4Bx} = \overline{DB} \cos(\phi_4 - \pi) \quad r_{4Ax} = \overline{DA} \cos(\phi_4 - \pi)$$

$$r_{4By} = \overline{DB} \sin(\phi_4 - \pi) \quad r_{4Ay} = \overline{DA} \sin(\phi_4 - \pi)$$

$$F_{23x} + (-F_{34} \cdot \cos(\phi_4 + \pi/2)) = 0$$

$$F_{23y} + (-F_{34} \cdot \sin(\phi_4 + \pi/2)) = 0$$

$$(-M_{34}) = 0$$

$$F_{54x} + F_{34} \cdot \cos(\phi_4 + \pi/2) + F_{14x} = 0$$

$$F_{54x} + F_{34} \cdot \cos(\phi_4 + \pi/2) + F_{14x} = 0$$

$$F_{23x} + (-F_{34} \cdot \cos(\phi_4 + \pi/2)) = 0$$

$$F_{23y} + (-F_{34} \cdot \sin(\phi_4 + \pi/2)) = 0$$

$$(-M_{34}) = 0$$

$$F_{54x} + F_{34} \cdot \cos(\phi_4 + \pi/2) + F_{14x} = 0$$

$$F_{54y} + F_{34} \cdot \sin(\phi_4 + \pi/2) + F_{14y} = 0$$

$$\overline{DB} \cdot \cos(\phi_4 - \pi) \cdot F_{54y} - \overline{DB} \cdot \sin(\phi_4 - \pi) \cdot F_{54x} + 10 + \overline{DA} \cdot \cos(\phi_4 - \pi) \cdot F_{34} \cdot \sin(\phi_4 + \pi/2) -$$

$$- \overline{DA} \cdot \sin(\phi_4 - \pi) \cdot F_{34} \cdot \cos(\phi_4 + \pi/2) + M_{34} = 0$$

$$r_{4Bx} \cdot F_{54y} - r_{4By} \cdot F_{54x} + 10 + r_{4Ax} \cdot F_{34} \cdot \sin(\phi_4 + \pi/2) -$$

$$- r_{4Ay} \cdot F_{34} \cdot \cos(\phi_4 + \pi/2) + M_{34} = 0$$

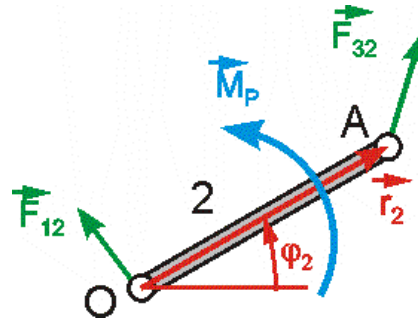
$$F_{14x}, F_{14y}, F_{34}, M_{34}, F_{23x}, F_{23y}$$



## Član 2

$$\sum \vec{F}(2) = \vec{F}_{12} + \vec{F}_{32} = 0$$

$$\sum \vec{M}_O(2) = \vec{r}_2 \times \vec{F}_{32} + \vec{M}_p = 0$$



$$\vec{F}_{32} = -\vec{F}_{23}$$

$$\sum \vec{F}(2) = \vec{F}_{12} + (-\vec{F}_{23}) = 0$$

$$\sum \vec{M}_O(2) = \vec{r}_2 \times (-\vec{F}_{23}) + \vec{M}_p = 0$$

$$\vec{F}_{12} = F_{12x} \cdot \vec{i} + F_{12y} \cdot \vec{j}$$

$$\vec{M}_p = M_p \cdot \vec{k}$$

$$F_{12x} + (-F_{23x}) = 0$$

$$F_{12y} + (-F_{23y}) = 0$$

$$r_{2x} \cdot (-F_{23y}) - r_{2y} \cdot (-F_{23x}) + M_p = 0$$

$$\overline{OA} \cdot \cos \varphi_2 \cdot (-F_{23y}) - \overline{OA} \cdot \sin \varphi_2 \cdot (-F_{23x}) + M_p = 0$$

$$F_{12x} + (-F_{23x}) = 0$$

$$F_{12y} + (-F_{23y}) = 0$$

$$F_{12x}, F_{12y}, M_p$$

$$\vec{r}_2 = \overline{OA} \vec{e}$$

$$r_{2x} = \overline{OA} \cos(\varphi_2)$$

$$r_{2y} = \overline{OA} \sin(\varphi_2)$$