Lezione #7

1/12/2022

Equilibrio di un corpo rigido:

$$\begin{cases} \vec{F} = M\vec{a}_{CDM} = \vec{0} & (\text{moto traslaz.}) \\ \vec{M}^{RIS} = \vec{0} & (\text{" rotazionale}) \end{cases}$$

LEVE

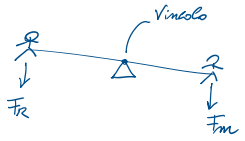
LEVA: macchina meccanica vincolata in grado di trasferire energia

$\vec{F}_m$ = forza motrice

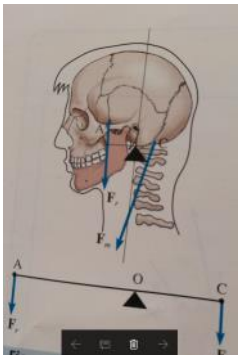
$\vec{F}_R$ = " resistiva

Fulcro = vincolo, pto fisso, asse di rotazione

Es.



LEVA DI PRIMO TIPO:



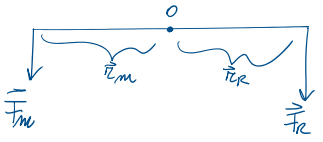
EQUILIBRIO:

$$\begin{cases} \vec{F}^{RIS} = \vec{0} \\ \vec{M}^{RIS} = \vec{0} \end{cases}$$

$$\vec{F}^{RIS} = \vec{F}_m + \vec{F}_R = 0$$

$\vec{F}_m$: forza peso del cranio

$\vec{F}_R$: forza muscoli spinali



$F_m = 80\ N$ (Peso cranio)

$F_R = ?$

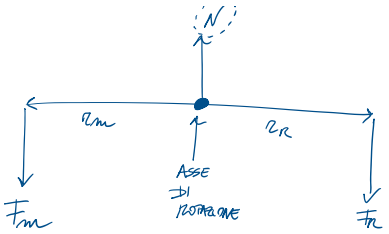
$r_R = 2\ cm$

$r_m = 8\ cm$

$r_R = 2\ cm$

$r_m = 8\ cm$

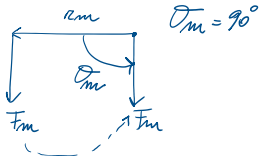
$\vec{F}^{RIS} = \vec{0}$?



$\vec{M}_m$: ?

$\vec{M}_m = \vec{r}_m \times \vec{F}_m$

$M_m = r_m F_m \sin\theta_m$

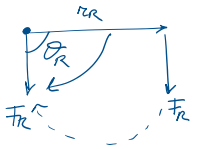


r_m e F_m in senso antiorario

$M_m > 0$

$M_m = r_m F_m$

$\vec{M}_R$:



$\vec{r}_R$ e $\vec{F}_R$ senso orario

$\Downarrow$

$M_R < 0$

$M_R = - r_R F_R$

$\vec{M}^{RIS} = \vec{M}_m + \vec{M}_R$ => lungo z:

$M^{RIS} = r_m F_m - r_R F_R = 0$

$\uparrow \uparrow \uparrow$ L?

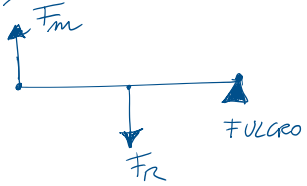
$F_R = \frac{r_m F_m}{r_R} = \frac{0{,}08}{0{,}02} F_m$

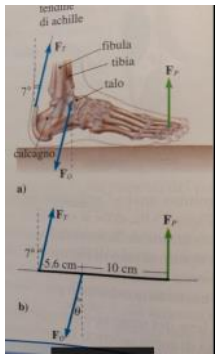
$F_R = 4 F_m$

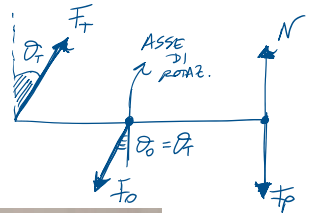
La forza esercitata dai muscoli glutei è 4 volte la forza peso del cranio!!!

$F_R = 4 \cdot 80 = 320\ N$

- LEVA II TIPO -







F_T : " Tendine Achille

F_0 : " osso del piede

$F_T = ?$

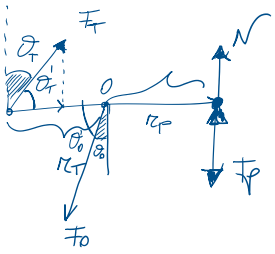
$\theta_T = \theta_0 = 7°$

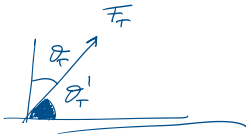
$F_0 = ?$

$F_P = 900\,N$

$r_P = 10\,cm$

$r_T = 5{,}6\,cm$

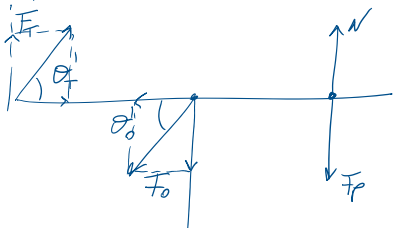




Gli angoli devono essere rispetto asse x !!!

$\theta_T' = 90° - \theta_T = 83°$

$\theta_0' = 90° - \theta_0 = 83°$



$$\begin{cases} F_x^{RIS} = F_T \cos\theta_T' - F_0 \cos\theta_0' = 0 \\ F_y^{RIS} = +F_T \sin\theta_T' - F_0 \sin\theta_0' - F_P + N = 0 \end{cases} \qquad (\vec{F}^{RIS} = \vec{0})$$

$\theta_0' = \theta_T'$ $\quad \cos\theta_0' = \cos\theta_T'$

$$\begin{cases} F_x^{RIS} = F_T \cos\theta_T' - F_0 \cos\theta_0' = 0 \\ \Rightarrow \boxed{F_T = F_0} \end{cases}$$

$$\Rightarrow \boxed{F_T = F_0}$$

$$F_y^{RIS} = F_T \sin\vartheta_T' - F_0 \sin\vartheta_0' - F_p + N = 0$$

$$= F_0 \sin\vartheta_T' - F_0 \sin\vartheta_0' - F_p + N = 0$$

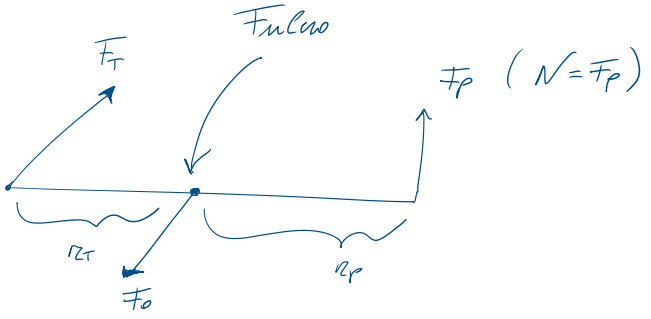
$\vartheta_T' = \vartheta_0'$

$$\Rightarrow -F_p + N = 0$$

$$\boxed{N = F_p}$$

$$\Rightarrow \begin{cases} F_0 = F_T \\ N = F_p \end{cases}$$

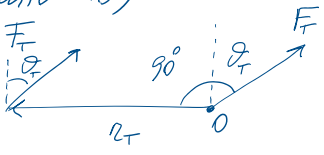
$\vec{M}^{RIS} = \vec{0}$:



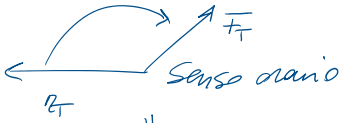
Con questa scelta non dobbiamo considerare in contributo di $\vec{M}_0$ (momento $\vec{F}_0$)

$\vec{M}_T$:

$$M_T = -r_T F_T \sin(90° + \vartheta_T)$$

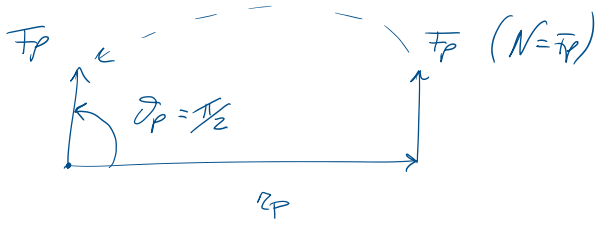


$$\boxed{M_T = -r_T F_T \sin(97°)}$$



$M_T < 0$

$\vec{M}_P$:



r_P ↺ F_P senso antiorario

$\Downarrow$

$M_P > 0$

$M_P = r_P F_P \sin\vartheta_P$

$\vartheta_P = \pi/2$

$\Downarrow$

$\sin\vartheta_P = 1$

$$\boxed{M_P = r_P F_P}$$

$\vec{M}^{RIS} = \vec{M}_T + \vec{M}_P = \vec{0}$

$\Rightarrow - r_T F_T \sin(97°) + r_P F_P = 0$

$r_P F_P = r_T F_T \sin(97°)$

$$F_T = \frac{r_P F_P}{r_T \sin(97°)} = \frac{0,1}{0,056 \cdot 0,99} F_P$$

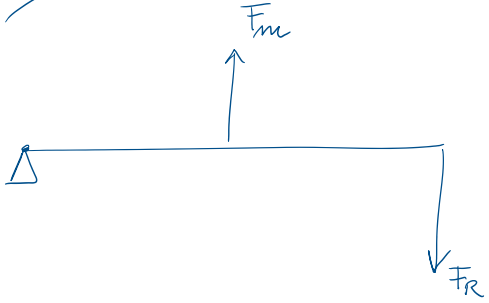
$$\boxed{F_T = 1,8\, F_P}$$

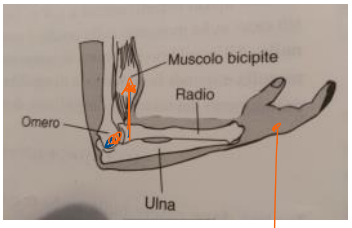
In ogni singolo passo sul Tendine di Achille si esercita una forza pari quasi al doppio della nostra forza peso!

$F_T = 1,8 \cdot 900 = 1636,36\ N \simeq 2000\ N$

$F_0 = F_T = 1636,36\ N = 2000\ N$

- LEVA III TIPO -





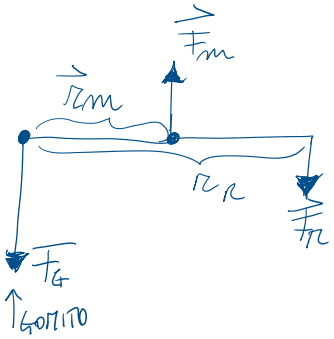
$F_{GOMITO} = ?$

$F_m = ?$

$r_m = 0{,}05\,m$

$r_R = 0{,}15\,m$

$F_R = 12\,N$

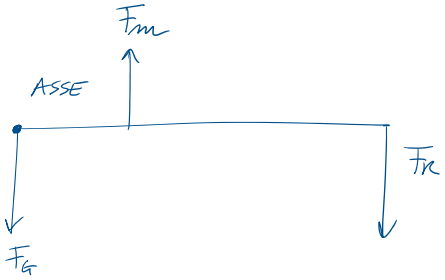


$$\begin{cases} \vec{F}^{RIS} = \vec{0} \Rightarrow 0 \Rightarrow F_G = ? \\ \vec{M}^{RIS} = \vec{0} \end{cases}$$

$$\begin{cases} F_x^{RIS} = 0 = 0 \\ F_y^{RIS} = -F_G + F_m - F_R = 0 \end{cases}$$

$$\boxed{F_G = F_m - F_R}$$

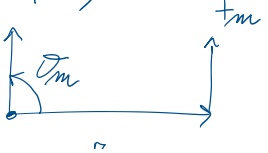
$\vec{M}^{RIS} = \vec{0}$



Con questa scelta dell'asse

$\vec{M}_G = \vec{0}$ $(\vec{r}_G = \vec{0})$

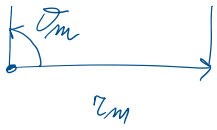
$\vec{M}_m$:



$\vartheta_m = 90°$

$r_m \cdot F_m$ senso

$\vec{M}_m$:

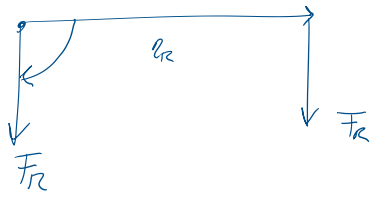


r_m – F_m senso antiorario

$M_m > 0$

$M_m = + r_m F_m$

$\vec{M}_R$:



Senso orario

$M_R < 0$

$M_R = - r_R F_R$

$M^{tot} = r_m F_m - r_R F_R = 0$

$r_m F_m = r_R F_R$

$$F_m = \frac{r_R}{r_m} F_R$$

$$F_m = \frac{0{,}15}{0{,}05} F_R \Rightarrow F_m = 3F_R$$

Sul braccio si esercita una forza pari al triplo del peso applicato

$F_G = F_m - F_R = 3F_R - F_R = 2F_R$

$$F_G = 2F_R$$

Sul tavolo si esercita una forza pari al doppio del peso

Esempio $\begin{cases} \vec{F}^{ris} = \vec{0} \\ \vec{M}^{ris} = \vec{0} \end{cases}$

Gatto

Riflesso Verticale

Da 6 mesi in poi il gatto sviluppa un "RIFLESSO VERTICALE" che gli consente di atterrare sempre sulle zampe

1) CDM → $\vec{F}_p$

ma se mi metto su CDM

↳ $\vec{M}^{ris} = \vec{0}$ ⇒ gatto non potrebbe ruotare

⇓

ma lui non lo sa e divide il suo corpo in due, conservando $\vec{M}^{ris} = \vec{0}$, ma prima ruota chiudendo le zampe anteriori e fa il contrario e ruota la parte posteriore

2) Sfrutta aumento delle sup. e del fattore di forma c per rallentare immediatamente prima del contatto col suolo.