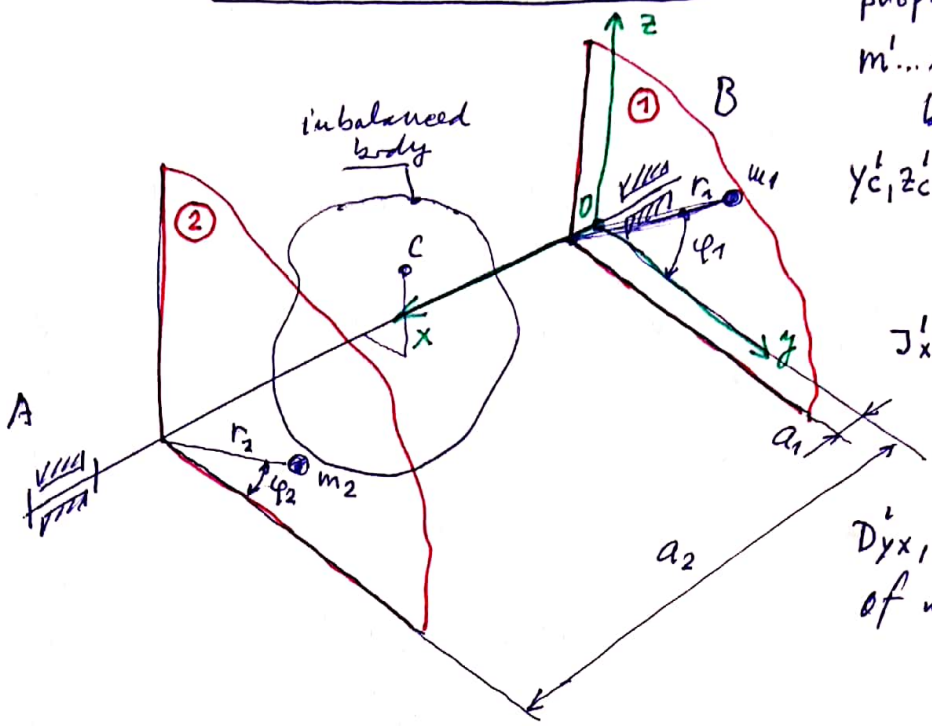
BALANCING OF ROTORS



properties of unbalanced body:

m'... mass of unbalanced body

y'_c, z'_c... coordinates of center of mass

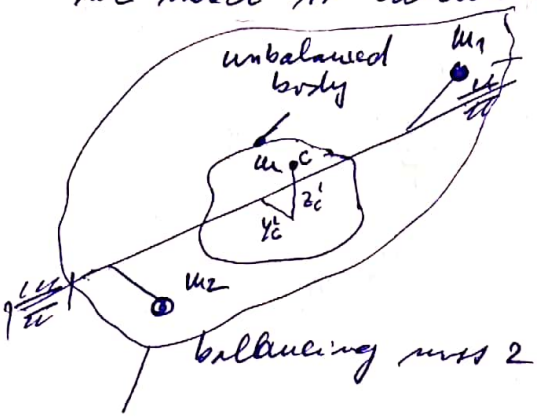
J'_x... moment of inertia with respect to x-axis

D'_{yx}, D'_{zx}... products of inertia

a_1... position of balancing plane 1

a_2 ... —"— —"— 2

we need to calculate $r_1, r_2, \varphi_1, \varphi_2, m_1, m_2$



balanced body

Parameters of balanced body:

mass: $m = m' + m_1 + m_2$

static moments:

$$S_{xy} = m' z'_c + r_1 m_1 \cdot \sin\varphi_1 + m_2 r_2 \sin\varphi_2$$

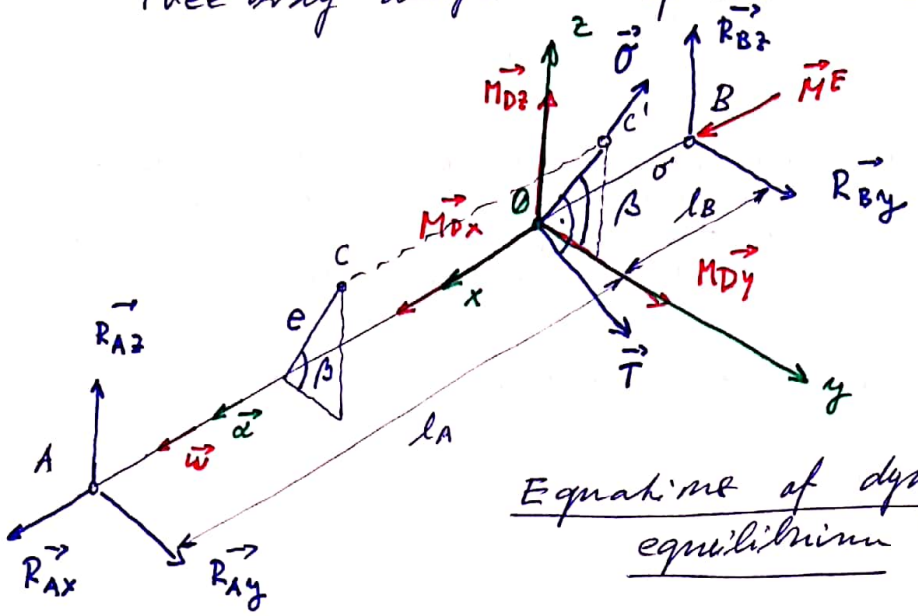
$$S_{zx} = m' y'_c + m_1 r_1 \cdot \cos\varphi_1 + m_2 r_2 \cos\varphi_2$$

products of inertia:

$$D_{xy} = D'_{xy} + m_1 a_1 r_1 \cdot \cos\varphi_1 + m_2 a_2 r_2 \cos\varphi_2$$

$$D_{zx} = D'_{zx} + m_1 a_1 r_1 \sin\varphi_1 + m_2 a_2 r_2 \sin\varphi_1$$

Free body diagram of balanced body



Equations of dynamic equilibrium

(1) x: $R_{Ax} = 0 \Rightarrow R_{Ax} = 0$

(2) y: $R_{Ay} + R_{AB} + \sigma \cdot \cos\beta + T \cdot \sin\beta = 0$

(3) z: $R_{Az} + R_{Bz} + \sigma \sin\beta - T \cos\beta = 0$

(4) $\vec{x}$: $M_E + M_{Dx} = 0$

(5) $\vec{y}$: $-R_{Az} \cdot l_A + R_{Bz} \cdot l_B + M_{Dy} = 0$

(6) $\vec{z}$: $R_{Ay} \cdot l_A - R_{By} \cdot l_B + M_{Dz} = 0$

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(2) $R_{Ay} + R_{By} = -\sigma \cos\beta - T \sin\beta$

(3) $R_{Az} + R_{Bz} = -\sigma \sin\beta + T \cos\beta$

(5) $-l_A R_{Az} + l_B R_{Bz} = -M_{Dy}$

(6) $l_A R_{Ay} + l_B R_{By} = -M_{Dz}$

$\sigma = m e \omega^2$

$T = m e \alpha$

if $\boxed{1}$ $\boxed{e = 0} \Rightarrow c \in \sigma$

Requirement for balanced case:

$M_{Dy} = \alpha D_{xy} - \omega^2 D_{xz} = 0$

$M_{Dz} = \alpha D_{xz} + \omega^2 D_{xy} = 0$

$\Big\} \boxed{2}$ $\boxed{D_{xy} = D_{xz} = 0}$

$\boxed{1}$ ... static condition for balancing

$\boxed{2}$ ... dynamic condition for balancing