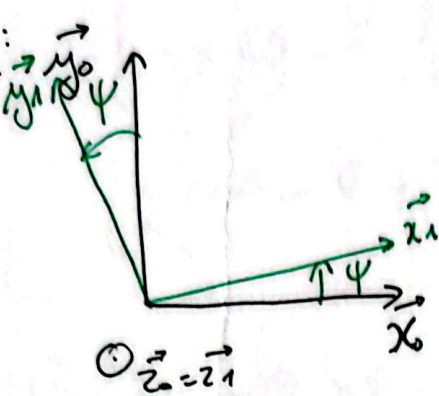
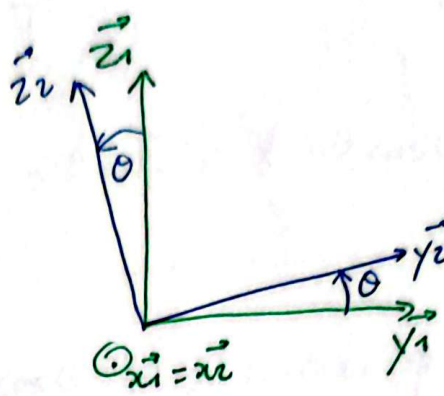


Centrifugeuse humaine LATÉCOÈRE

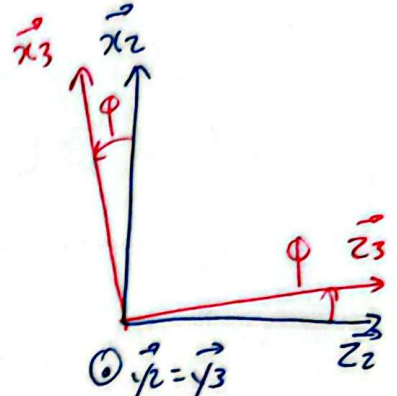
Q1:



$$\vec{\Omega}_{1/0} = \dot{\psi} \vec{z}_1$$



$$\vec{\Omega}_{2/1} = \dot{\theta} \vec{z}_2$$



$$\vec{\Omega}_{3/2} = \dot{\phi} \vec{y}_2$$

Q2: Composition des vitesses: $\vec{V}(I \in 3/0) = \vec{V}(I \in 3/2) + \vec{V}(I \in 2/1) + \vec{V}(I \in 1/0)$
 or I appartient aux axes des $\mathcal{I}$ point entre 3 et 2 et entre 2 et 1
 d'où $\vec{V}(I \in 3/2) = \vec{0}$ et $\vec{V}(I \in 2/1) = \vec{0}$

donc $\vec{V}(I \in 3/0) = \vec{V}(I \in 1/0) = \vec{V}(O \in 1/0) + \vec{IO} \wedge \vec{\Omega}_{1/0}$

donc: $\boxed{\vec{V}(I \in 3/0) = R \dot{\psi} \vec{x}_1}$

Q3: $\vec{I}'(I \in 3/0) = \left. \frac{d \vec{V}(I \in 3/0)}{dt} \right|_{R_0}$

donc $\boxed{\vec{I}'(I \in 3/0) = R \ddot{\psi} \vec{x}_1 + R \dot{\psi}^2 \vec{y}_1}$

$$\left(\frac{d \vec{x}_1}{dt} \right)_{R_0} = \left(\frac{d \vec{x}_1}{dt} \right)_{R_1} + \vec{\Omega}_{1/0} \wedge \vec{x}_1 = \dot{\psi} \vec{y}_1$$

Q4: $\vec{G} = \vec{g} - \vec{I}'(I \in 3/0)$

$$\vec{G} = g \vec{z}_0 - R \ddot{\psi} \vec{x}_1 - R \dot{\psi}^2 \vec{y}_1$$

$\vec{z}_0 = -\cos\theta \sin\phi \vec{x}_3 + \sin\theta \vec{y}_3 + \cos\theta \cos\phi \vec{z}_3$ $\vec{x}_1 = \cos\phi \vec{x}_3 + \sin\phi \vec{z}_3$

$\vec{y}_1 = \sin\theta \sin\phi \vec{x}_3 + \cos\theta \vec{y}_3 - \sin\theta \cos\phi \vec{z}_3$

$$\vec{G} = \left[-g \cos \theta \sin \varphi - R \ddot{\psi} \cos \varphi - R \dot{\psi}^2 \sin \theta \sin \varphi \right] \vec{x}_3 \\ + \left[g \sin \theta - R \dot{\psi}^2 \cos \theta \right] \vec{y}_3 \\ + \left[g \cos \theta \cos \varphi - R \ddot{\psi} \sin \varphi + R \dot{\psi}^2 \sin \theta \cos \varphi \right] \vec{z}_3$$

Q4:
$$\begin{cases} G_x = -g \cos \theta \sin \varphi - R \ddot{\psi} \cos \varphi - R \dot{\psi}^2 \sin \theta \sin \varphi \\ G_y = g \sin \theta - R \dot{\psi}^2 \cos \theta \\ G_z = g \cos \theta \cos \varphi - R \ddot{\psi} \sin \varphi + R \dot{\psi}^2 \sin \theta \cos \varphi \end{cases}$$

Q5: $G_y = g \sin \theta - R \dot{\psi}^2 \cos \theta$

$$G_y = 0 \Leftrightarrow g \sin \theta = R \dot{\psi}^2 \cos \theta$$

$$\Leftrightarrow \boxed{\tan \theta = \frac{R \dot{\psi}^2}{g}} \quad \left(\text{ou } \theta = \arctan \left(\frac{R \dot{\psi}^2}{g} \right) \right)$$

Q6: si $\dot{\psi} = \text{cte}$, alors $\ddot{\psi} = 0$

alors $G_x = -g \cos \theta \sin \varphi - R \dot{\psi}^2 \sin \theta \sin \varphi$

$$G_x = -\sin \varphi [g \cos \theta + R \dot{\psi}^2 \sin \theta]$$

$$G_x = 0 \text{ si } \sin \varphi = 0 \Rightarrow \boxed{\varphi = 0}$$

Si l'on prend $\varphi = 0$, à vitesse de rotation constante de la centrifugeuse, on aura toujours $G_x = 0$. Par contre pendant les phases d'accélération, si $\varphi = 0$, le pilote sera soumis à une accélération longitudinale.

Q7: Le troisième axe permet donc d'annuler l'accélération longitudinale dans toutes les situations.

$$G_x = -g \cos \theta \sin \varphi - R \ddot{\psi} \cos \varphi - R \dot{\psi}^2 \sin \theta \sin \varphi = 0$$

on divise par $\cos \theta \cos \varphi$:

$$-g \tan \varphi - \frac{R \ddot{\psi}}{\cos \theta} - R \dot{\psi}^2 \tan \theta \tan \varphi = 0$$

$$\text{d'où } \boxed{\tan \varphi = -\frac{R \ddot{\psi}}{\cos \theta [g + R \dot{\psi}^2 \tan \theta]}} \quad \left(\text{ou } \varphi = -\arctan \left(\frac{R \ddot{\psi}}{\cos \theta [g + R \dot{\psi}^2 \tan \theta]} \right) \right)$$

$$\text{si } G_y = 0 \text{ alors } \boxed{\tan \theta = \frac{R \dot{\psi}^2}{g}}$$

$$\text{et on a } \cos^2 \theta = \frac{1}{1 + \tan^2 \theta} = \frac{1}{1 + \frac{R^2 \dot{\psi}^4}{g^2}} = \frac{g^2}{g^2 + R^2 \dot{\psi}^4}$$

$$\text{d'où } \boxed{\cos \theta = \frac{g}{\sqrt{g^2 + R^2 \dot{\psi}^4}}}$$

$$\text{d'où } \tan \varphi = \frac{-R \ddot{\psi}}{\frac{g}{\sqrt{g^2 + R^2 \dot{\psi}^4}} \left[g + \frac{R^2 \dot{\psi}^4}{g} \right]}$$

$$\boxed{\tan \varphi = -\frac{R \ddot{\psi}}{\sqrt{g^2 + R^2 \dot{\psi}^4}}} \quad \left(\text{ou } \varphi = -\arctan \left(\frac{R \ddot{\psi}}{\sqrt{g^2 + R^2 \dot{\psi}^4}} \right) \right)$$

Q9: $G_z = g \cos \theta \cos \varphi - R \ddot{\psi} \sin \varphi + R \dot{\psi}^2 \sin \theta \cos \varphi$

$$\text{si } \varphi = 0 \text{ et } G_y = 0 \Rightarrow \tan \theta = \frac{R \dot{\psi}^2}{g} \text{ et } \cos \theta = \frac{g}{\sqrt{g^2 + R^2 \dot{\psi}^4}}$$

$$\text{alors } G_z = g \cos \theta + R \dot{\psi}^2 \sin \theta$$

on divise par $\cos \theta$:

$$\frac{Gz}{\cos \theta} = g + R \dot{\psi}^2 \tan \theta$$

$$\frac{Gz \sqrt{g^2 + R^2 \dot{\psi}^4}}{g} = g + R \dot{\psi}^2 \frac{R \dot{\psi}^2}{g}$$

$$\text{done } \dot{\psi}^4 = \frac{Gz \sqrt{g^2 + R^2 \dot{\psi}^4} - g^2}{R^2}$$

$$\dot{\psi} = \frac{\sqrt[4]{Gz \sqrt{g^2 + R^2 \dot{\psi}^4} - g^2}}{\sqrt{R}}$$

Q10: $\dot{\psi} = \text{cte}$ done $\ddot{\psi} = 0$

$$\text{done } \|\vec{I'}(IE3/o)\| = R \dot{\psi}^2$$

$$\text{done } \dot{\psi} = \sqrt{\frac{\|\vec{I'}(IE3/o)\|}{R}}$$

A.N: $\dot{\psi} = \sqrt{\frac{9 \times 9,81}{8}} = \underline{\underline{3,32 \text{ rad/s}}}$

$\dot{\psi} = \underline{\underline{0,53 \text{ tr/s}}}$

conforme zu cdcF
($< 0,7 \text{ tr/s}$)

Cette valeur 101.3

fy: $\frac{\text{Latexaire 1001}}{R=6m}$

$\dot{\psi} = \underline{\underline{3,84 \text{ rad/s} = 0,61 \text{ tr/s}}}$ OK cdcF