**Question 1** – $\overrightarrow{V(B \in S/R)} = \overrightarrow{V(A \in S/R)} + \overrightarrow{BA} \wedge \overrightarrow{\Omega_{S/R}} = \overrightarrow{V(A \in S/R)} + \overrightarrow{\Omega_{S/R}} \wedge \overrightarrow{AB}$

**Question 2** – $\vec{V}(A \in R_2/R) = \vec{V}(A \in R_2/R_1) + \vec{V}(A \in R_1/R)$ et $\vec{\Omega}(R_2/R) = \vec{\Omega}(R_2/R_1) + \vec{\Omega}(R_1/R)$

**Question 3** – $\overrightarrow{\Omega_{4/3}} = \dot{\beta}\,\overrightarrow{y_3} = \dot{\beta}\,\overrightarrow{y_4}$ *et* $\overrightarrow{\Omega_{3/4}} = -\overrightarrow{\Omega_{4/3}} = -\dot{\beta}\,\overrightarrow{y_3}$

**Question 4** – $\left[\frac{d\vec{U}}{dt}\right]_{R_i} = \left[\frac{d\vec{U}}{dt}\right]_{R_j} + \overrightarrow{\Omega_{R_j/R_i}} \wedge \vec{U}$ *avec* $\overrightarrow{\Omega_{R_j/R_i}} = \dot{\theta}_{ij}\,\vec{z_i}$

**Question 5** – ***a)***

$$\vec{y}_0 \cdot \vec{y}_2 = \cos(\theta_{21} + \theta_{10})$$

$$\vec{x}_0 \cdot \vec{y}_3 = \vec{x}_0 \cdot (\cos\theta_{31}\,\vec{y}_1 + \sin\theta_{31}\,\vec{z}_1) = -\cos\theta_{31}\sin\theta_{10}$$

***b)***

$$\vec{y}_0 \wedge \vec{y}_2 = \sin(\theta_{21} + \theta_{10})\,\vec{z}_0$$

$$\vec{x}_0 \wedge \vec{y}_3 = \vec{x}_0 \wedge (\cos\theta_{31}\,\vec{y}_1 + \sin\theta_{31}\,\vec{z}_1) = \cos\theta_{31}\cos\theta_{10}\,\vec{z}_0 - \sin\theta_{31}\,\vec{y}_0$$

***c)***

$$\left[\frac{d\vec{x}_1}{dt}\right]_{(\vec{x}_0,\vec{y}_0,\vec{z}_0)} = \left[\frac{d\vec{x}_1}{dt}\right]_{(\vec{x}_1,\vec{y}_1,\vec{z}_1)} + \vec{\Omega}(1/0) \wedge \vec{x}_1 = \vec{0} + \dot{\theta}_{10}\vec{z}_0 \wedge \vec{x}_1 = \dot{\theta}_{10}\vec{y}_1$$

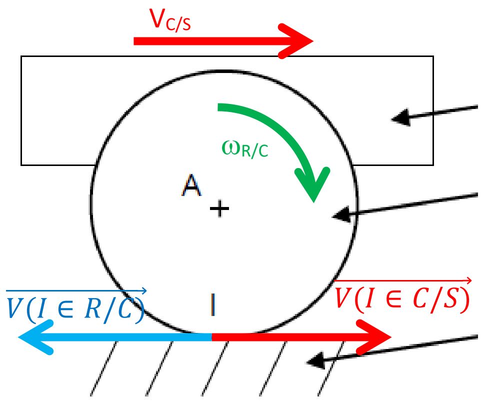
$$\left[\frac{d\vec{y}_3}{dt}\right]_{(\vec{x}_2,\vec{y}_2,\vec{z}_2)} = \left[\frac{d\vec{y}_3}{dt}\right]_{(\vec{x}_3,\vec{y}_3,\vec{z}_3)} + \vec{\Omega}(3/2) \wedge \vec{y}_3 = \left(\dot{\theta}_{31}\vec{x}_1 - \dot{\theta}_{21}\vec{z}_0\right) \wedge \vec{y}_3 = \dot{\theta}_{31}\vec{z}_3 + \dot{\theta}_{21}\cos\theta_{31}\,\vec{x}_1$$

$$\left[\frac{d\vec{x}_4}{dt}\right]_{(\vec{x}_0,\vec{y}_0,\vec{z}_0)} = \left[\frac{d\vec{x}_4}{dt}\right]_{(\vec{x}_4,\vec{y}_4,\vec{z}_4)} + \vec{\Omega}(4/0) \wedge \vec{x}_4 = \vec{0} + \dot{\alpha}\vec{z}_0 \wedge \vec{x}_4 = \dot{\alpha}\vec{y}_4$$

**Question 6** – $\overrightarrow{V(I \in R/S)} = \vec{0}$ d'où $\overrightarrow{V(I \in R/C)} = \overrightarrow{V(I \in S/C)} = -\overrightarrow{V(I \in C/S)}$

$\Rightarrow \overrightarrow{V(A \in R/C)} + \overrightarrow{IA} \wedge \overrightarrow{\Omega(R/C)} = -V_{C/S}\vec{x} \Rightarrow r\vec{y} \wedge \omega_{R/C}\vec{z} = -V_{C/S}\vec{x} \Rightarrow r\omega_{R/C} = -V_{C/S}$ (signes cohérents)

*modèle* "$\boldsymbol{V} = R\boldsymbol{\omega}$" avec




**Question 7** –

- liaison sphère-cylindre (linéaire annulaire) d'axe $(O, \vec{z})$ :

torseur cinématique en 3D $\left\{\begin{matrix} \omega_x & 0 \\ \omega_y & 0 \\ \omega_z & V_z \end{matrix}\right\}_{O\;\vec{x},\vec{y},\vec{z}}$ en 2D (plan (y,z)) $\left\{\begin{matrix} \omega_x & - \\ - & 0 \\ - & V_z \end{matrix}\right\}_{O\;\vec{x},\vec{y},\vec{z}}$

- liaison cylindre-plan (linéaire rectiligne) d'axe $(O, \vec{y})$ et de normale $\vec{x}$ :

torseur cinématique en 3D $\left\{\begin{matrix} \omega_x & 0 \\ \omega_y & V_y \\ 0 & V_z \end{matrix}\right\}_{O\;\vec{x},\vec{y},\vec{z}}$ en 2D (plan (y,z)) $\left\{\begin{matrix} \omega_x & - \\ - & V_y \\ - & V_z \end{matrix}\right\}_{O\;\vec{x},\vec{y},\vec{z}}$