Base Nationale des Sujets d'Examens de l'enseignement professionnel

Campagne 2009

CORRIGE

Ces éléments de correction n'ont qu'une valeur indicative. Ils ne peuvent en aucun cas engager la responsabilité des autorités académiques, chaque jury est souverain.

1er étape

SESSION 2009

I-1-1 M.R.U.V $V_1^2 - V_0^2 = 2\gamma_{01} x_{01}$

$\gamma_{01} = \dfrac{V_1^2 - V_0^2}{2x_{01}}$ $\left(V_1 = \dfrac{144}{3,6} = 40\ m/s\ ;\ V_0 = \dfrac{252}{3,6} = 70\ m/s\right)$

$x_{01} = 825\ m$

A.N.

$\gamma_{01} = \dfrac{40^2 - 70^2}{1650} = \boxed{-2\ m.s^{-2}}$

I-1-2 M.R.U.V $V_2^2 - V_1^2 = 2\gamma_{12} x_{12}$

$\gamma_{12} = \dfrac{V_2^2 - V_1^2}{2x_{12}}$ $(V_1 = 40\ m/s\ ;\ V_2 = 0\ ;\ x_{12} = 245\ m)$

A.N.

$\gamma_{12} = \dfrac{-40^2}{2 \times 245} = \boxed{3,2653\ m.s^{-2}}$

I-1-3 $\theta_{12} = \dfrac{x_{12}}{r_{roue}}$ $(x_{12} = 245\ m\ ;\ r_{roue} = 0,5\ m)$

$\boxed{\theta_{12} = 490\ radians}$ $\boxed{n = \dfrac{490}{2\pi} = 77,9859\ tours}$

I-2-1 on isole l'avion.

th de l'énergie cinétique:

$E_{c1} - E_{c0} = W_{01}\overrightarrow{R_{inv}} + W_{01}\overrightarrow{R_{air-avion}} + W_{01}\overrightarrow{R_{roue}}$

$E_c = \frac{1}{2} M V^2$ (mouvement de translation)

$E_{c1} - E_{c0} = \frac{1}{2} M (V_1^2 - V_0^2) = \frac{1}{2} 46800 (40^2 - 70^2)$

$= -77\ 220\ 000$ joules

I-2-1 (suite)

$W_{o1}\overrightarrow{R_{air-avion}}$ = 10% de la perte énergétique $(E_{c1} - E_{c0})$

$W_{o1}\overrightarrow{R_{air-avion}} = -7\,722\,000$ joules

$\overrightarrow{R_{roul}} = -0,02.\|\vec{P}\|.\vec{x}$ (2% du poids)

$= -0,02.46800.9,81\vec{x}$

$W_{o1}\overrightarrow{R_{roul}} = \overrightarrow{R_{roul}} \cdot X_{o1}\vec{x} = -0,02.46800.9,81.825$

$= -7\,575\,282$ joules

$W_{o1}\overrightarrow{R_{inv.}} = \overrightarrow{R_{inv}} \cdot X_{o1}\vec{x} = -\|\overrightarrow{R_{inv}}\|.X_{o1}$

$\|\overrightarrow{R_{inv}}\| = \dfrac{E_{c1} - E_{c0} - W_{o1}\overrightarrow{R_{air-avion}} - W_{o1}\overrightarrow{R_{roul}}.}{X_{o1}}$

$= \dfrac{-77\,220000 + 7722\,000 + 7\,575\,282}{825}$

$\|\overrightarrow{R_{inv.}}\| = 75\,057,84\ N$

I-2-2 l'énergie de freinage calculée à partir de C_f

$W_{\#2}\overrightarrow{C_f} = -C_f\,\theta_{\#2} = -500\,C_f$

$W_{12}\overrightarrow{R_{roul.}} = -0,02.46800.9,81.245$

$= -2\,246\,629,2$ joules

on isole l'avion :

$E_{c_2} - E_{c_1} = W_{\#2}\overrightarrow{C_f} + W_{12}\overrightarrow{R_{roul.}}$

$\Rightarrow W_{12}\overrightarrow{C_f} = E_{c_2} - E_{c_1} - W_{12}\overrightarrow{R_{roul.}}$

I-2-2 (suit)

A.N.

$W_{12}\vec{C_f} = -\frac{1}{2}.46800.40^2 + 2\,846\,689,2$ joules

$$\boxed{W_{12}\vec{C_f} = -35\,190\,320,8 \text{ joules}}$$

4 freins, $\theta_{12} = \frac{500}{490}$ rd

$$\Rightarrow C_f = \frac{35\,190\,320,8}{4.\frac{500}{490}} = \boxed{17\,954,28 \text{ N.m}}$$

I-3

$\|\vec{B}_{0\to1}\| = 0,85\|\vec{P}\| = 390\,241,8$ N

$\|\vec{A}_{0\to1}\| = 0,15\|\vec{P}\| = 68\,866,2$ N

- on isole l'avion
- Bilan des A.M. ext

$$\left\{\begin{matrix}\vec{B}_{0\to1}\\ \vec{0}\end{matrix}\right\}_B ; \left\{\begin{matrix}\vec{A}_{0\to1}\\ \vec{0}\end{matrix}\right\}_A ; \left\{\begin{matrix}\vec{P}\\ \vec{0}\end{matrix}\right\}_G$$

P.F.S. $\quad \sum \{\mathcal{C}_{ext\to avion}\} = \left\{\begin{matrix}\vec{0}\\ \vec{0}\end{matrix}\right\}$

réduction en G

$$\vec{M}_G(\vec{B}_{0\to1}) = \vec{M}_B(\vec{B}_{0\to1}) + \vec{GB}\wedge\vec{B}_{0\to1} = -b\vec{x}\wedge B_{0,1}\vec{y}$$

$\vec{M}_B(\vec{B}_{0\to1}) = \vec{0}$

$$= -b.B_{01}\vec{z}$$

$$\vec{M}_G(\vec{A}_{0\to1}) = \vec{M}_A(\vec{A}_{0\to1}) + \vec{GA}\wedge\vec{B}_{0\to1} = a\vec{x}\wedge A_{01}\vec{y}$$

$$= a.A_{01}\vec{z}$$

$$-b\,B_{01} + a\,A_{01} = 0 \Rightarrow \frac{a}{b} = \frac{B_{01}}{A_{01}} = \frac{85}{15}$$

$a = 15\%\,(a+b)$ $\qquad b = 85\%\,(a+b)$

$a = 1,83$ m $\qquad b = 10,37$ m

I - 4 - 1 on isole l'avion

$$\left\{\begin{matrix}\vec{A}_{0\to 1}\\ \vec{0}\end{matrix}\right\}_A ; \left\{\begin{matrix}\vec{B}_{0\to 1}\\ \vec{0}\end{matrix}\right\}_B ; \left\{\begin{matrix}\vec{P}\\ \vec{0}\end{matrix}\right\}_G ; \left\{\begin{matrix}M\vec{a}_G\\ \vec{0}\end{matrix}\right\}_G$$

réduction en G

$$\left\{\begin{matrix}0 & \emptyset\\ Y_{01} & \emptyset\\ \emptyset & 0\end{matrix}\right\}_A \Rightarrow \left\{\begin{matrix}0 & \emptyset\\ Y_{01} & \emptyset\\ \emptyset & aY_{01}\end{matrix}\right\}_G$$

$$\left\{\begin{matrix}T_{B01} & \emptyset\\ N_{B01} & \emptyset\\ \emptyset & 0\end{matrix}\right\}_B \Rightarrow \left\{\begin{matrix}T_{B01} & \emptyset\\ N_{B01} & \emptyset\\ \emptyset & -bN_{B01}-hT_{B01}\end{matrix}\right\}_G$$

P.F.D. $\Sigma \{\mathcal{C}_{ext\to avion}\}_G = \left\{\begin{matrix}M\vec{a}_G\\ \vec{0}\end{matrix}\right\}_G = \left\{\begin{matrix}M\gamma_{A2} & \emptyset\\ 0 & \emptyset\\ \emptyset & 0\end{matrix}\right\}_G$

$T_{B01} = M\gamma = -46\,800 \cdot 3{,}5 =$ **$-163\,800$ N**

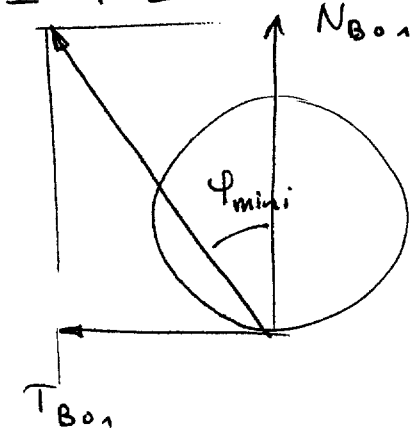
$N_{B01} + Y_{01} - 46\,800 \cdot 9{,}81 = 0$

$-bN_{B01} - hT_{B01} + aY_{01} = 0$

$\Rightarrow$

$N_{B01} = 343\,250$ N	→ 75 %
$Y_{01} = 115\,858$ N	→ 25 %

I - 4 - 2



$\tan \varphi_{mini} = \dfrac{T_{B01}}{N_{B01}} =$ **0,48**

II-1-1

$$k = \frac{G\, d^4}{8\, D^3\, n} = \frac{80\,000 \cdot 6^4}{8 \cdot 27^3 \cdot 5} = 131{,}69 \text{ N/mm}$$

$G = 80\,000$ MPa ; $n = 5$

$d = 6$ mm, $D = 27$ mm

II-1-2

$F = k\, f$

$f = l_{libre} - l_{comprimé} = l_0 - l_{comp.}$

$l_{comp} = 54 - 7 = 47$ mm

$l_0 = 58$

$\Big\} f = 11$ mm

$\boxed{F = 1448{,}56 \text{ N}}$

II-1-3

$$\tau = \frac{8 \cdot F \cdot D}{\pi\, d^3} = \frac{8 \cdot 1448{,}56 \cdot 27}{\pi\, 6^3} = \boxed{461{,}1 \text{ MPa}}$$

$$s = \frac{R_{eg}}{\tau} = \frac{800}{461{,}1} = 1{,}73$$

II-2 $\quad 110$ bar $= 11$ MPa

II-2-1 $\quad F = p \cdot S \qquad S = \frac{\pi}{4} \cdot 40^2$ (mm²)

$$F_{Pression} = 11 \cdot \frac{\pi}{4} \cdot 40^2 = 13\,823 \text{ N}$$

II-2-2

$\vec{F}_{Poussé} = \vec{F}_{Pression} + \vec{F}_{ressort}$

$F_{poussé} = 13\,823 - 1500 = 12\,323$ N

III -3-1 $n = 8$

III -3-2

$$C_f = \frac{2}{3} \cdot n \cdot f \cdot P \cdot \frac{R^3 - r^3}{R^2 - r^2}$$

$f = 0,7$ $\quad R = \frac{350}{2} = 175\ mm = 0,175\ m$

$P = 13000\ daN$ $\quad r = \frac{250}{2} = 125\ mm = 0,125\ m$

$$C_f = \frac{2}{3} \cdot 8 \cdot 0,7 \cdot 13000 \times 7 \cdot \frac{0,175^3 - 0,125^3}{0,175^2 - 0,125^2}$$

$$\boxed{C_f = 77147,8\ N.m}$$

III -3-3.

$$\boxed{C_f = 17954,28\ N.m}$$

conclusion le pilote n'agit pas au maximum sur les freins.