1

Correction DM de S1, ~~[illegible]~~, ~~[illegible]~~ — Voile solaire

Q1 300 d° en 10 h $\Rightarrow$ 7,5 d° en 15 min.

Q2 Trapèze de vitesse, angle = aire de la courbe. ($\Delta t \leftrightarrow \omega = cte$)

$7,5 = 0,18 \times (3 + \Delta t) \Rightarrow \Delta t = 38,7\ s \Rightarrow$ Durée $= 44,7\ s$.

Q3 Durée $= 44,7\ s$ | $\varphi_{max} = \Omega_{max} \left(\Delta t_{cte} + 3 \right) \Rightarrow \Delta t_{cte} = \frac{\varphi_{max}}{\Omega_{max}} - 3$

Q4 $V = \frac{3,651}{49} = 0,0745\ m/s \Rightarrow \omega = \frac{V}{R} = \frac{0,0745}{22,75} = 0,003275\ rad/s$.

$\omega = 0,1876\ d°/s > 0,18\ d°/s$. Pas OK $49\ s < 60\ s$ OK

Q5 Modèle multiphysique $\Rightarrow$ Brancher les 2 capteurs

Q6 Ecart $\varepsilon = 0,018\ m > 0,015\ m$ Pas OK

Q8 Schéma bloc transmission.

Q7 Rsg ; $V = \frac{D}{2} K_{red}\, \omega_{mot}$

Q13 $F_I + F_J = \left(\frac{m_v}{2} + m_{cc} \right) g$

Q14 $\vec{\Gamma}_c = -F_I . \delta\, \vec{y}$.   Q15 $\vec{\Gamma}_D = -F_J . \delta . \vec{y}$

Q15 $\vec{\Gamma}_{cc} = -(F_I + F_J)\, \delta . \vec{y} = -\left(\frac{m_v}{2} + m_{cc} \right) g\, \delta . \vec{y}$

Q16 $\vec{\Gamma}_{cl} = -\left(\frac{m_v}{2} + m_{cl} \right) g\, \delta\, \vec{y}$.

$\vec{\Gamma}_{glob} = -\left(m_v + m_{cc} + m_{cl} \right) g\, \delta\, \vec{y}$ $\|\vec{\Gamma}_{glob}\| = 7014\ Nm$

Q17 $E_c = \frac{1}{2} \left((m_v + m_{cc} + m_{cl}) V^2 + J_g\, \omega_r^2 + J_m\, \omega_m^2 \right)$

$E_c = \frac{1}{2} \left[(m_v + m_{cc} + m_{cl}) \left(\frac{D}{2} K_{red} \right)^2 + 2 J_g K_{red}^2 + 2 J_m \right] \omega_m^2$

$E_c = \frac{1}{2} . J_{eq} . \omega_m^2$ Rem : $V = \frac{D}{2} K_{red}\, \omega_m$ et $\omega_r = K_{red}\, \omega_m$

Q18 $P_{int} = F_{ext} . V + \Gamma_{glob}\, \omega_r = P_{ext}$ ($\Gamma_{glob} < 0$).

Q19 $P_{ext} = C_m\, \omega_m = P_{int}$

② **Q20** TEC $\Rightarrow J_{eq}\dot{\omega}_m \omega_m = C_m \omega_m + F_{ext}\underbrace{\frac{D}{2}K_{red}}_{=A}\omega_m + \underbrace{Mg_{lob}K_{red}}_{=B}\omega_m$

$\Rightarrow J_{eq}\dot{\omega}_m = C_m + F_{ext}\frac{D}{2}K_{red} + Mg_{lob}K_{red}.$

Q21 Schéma bloc perturbation.

Q22 Schéma bloc moteur + asservissement en vitesse

Q23 $K_a = K_{capt}$

Q24

$$\frac{\Omega_m}{C_{pert}} = \frac{R+Lp}{(R+Lp)Jp + k_c C K_h K_{capt} + k_c k_e} = \frac{\alpha(1+\tau p)}{\delta p^2 + \gamma p + 1}$$

$$\frac{\Omega_m}{C_{pert}} = \frac{R\left(1+\frac{L}{R}p\right)}{k_c(C K_h K_{capt} + k_e)\left[\frac{LJ}{k_c(\ )}p^2 + \frac{RJ}{k_c(\ )}p + 1\right]}$$

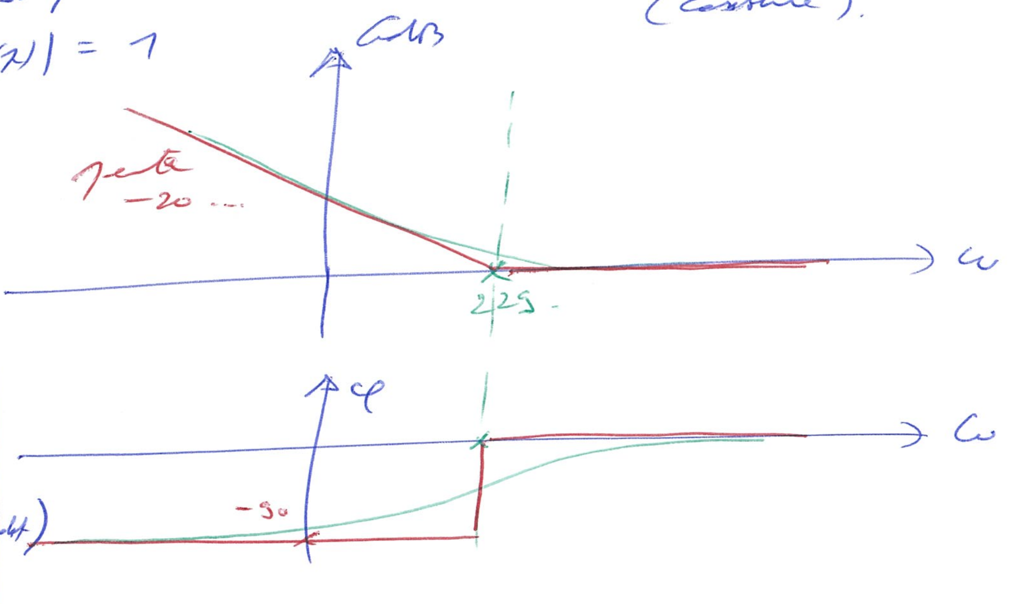
Q25 entrée $C_{pert}(p) = \frac{C_0}{p}$

$$\lim_{t\to\infty}\omega_m(t) = \lim_{p\to 0} p\,\Omega_m(p) = \lim_{p\to 0} p\,H_r(p)\frac{C_0}{p} = \lim_{p\to 0} H_r(p).C_0 = \alpha C_0 \neq$$

Q26 $C(p) = \frac{c(1+T_i p)}{T_i p}$ avec $c = 1$ et $\frac{1}{T_i} = \omega_0 = \sqrt{\frac{1}{1{,}5\,10^{-5}}} = 229$ rd/s.
(cassure).

$\omega \to 0 \Rightarrow |C(p)| = 1$

Bode :



Q27 Pb : Σ des ecarts

Q28 $M_{c2} = \dots$

Si $m_1 > m_2$ alors ω_{m2} sera augmenté

$M_{c2} = F_{con}(m_1 - 2m_2 + \omega_2 K_{cabt})$

Problème 2 : Voile solaire (Centrale MP 2020)

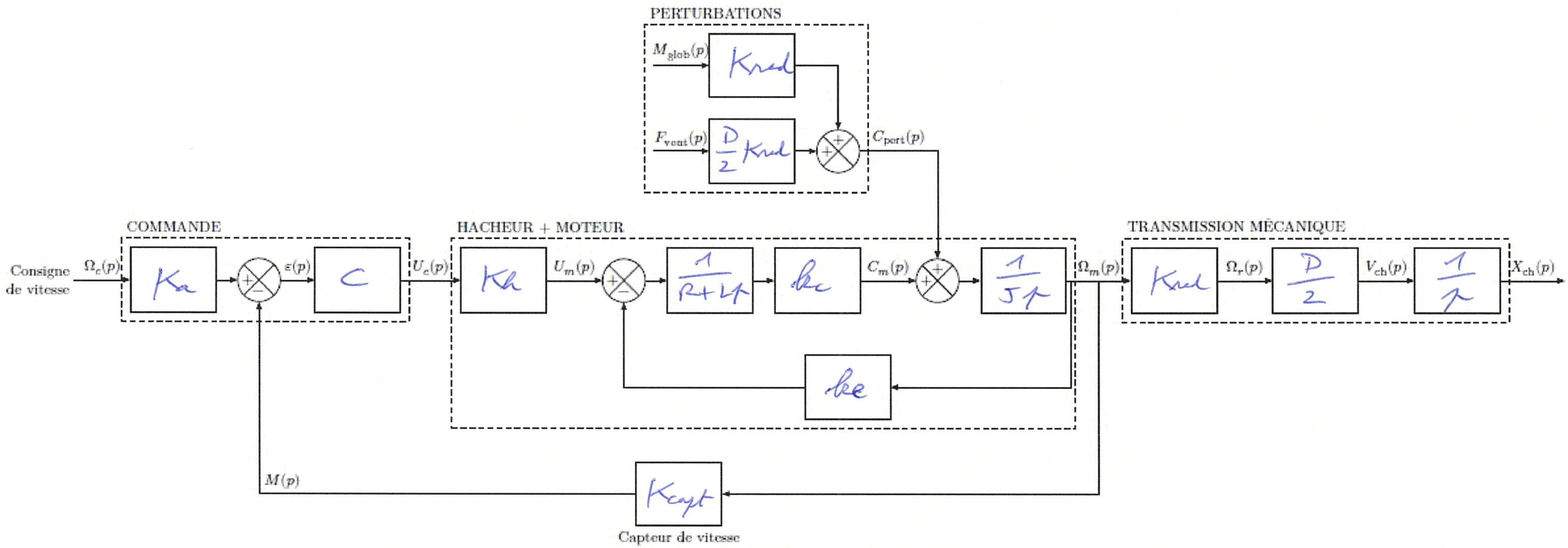


Figure B Schéma-bloc (questions 8, 21 et 22)

①

Corrigé DM MP Voile

I) Cinématique

Q1 Vitesse = tangente de la courbe

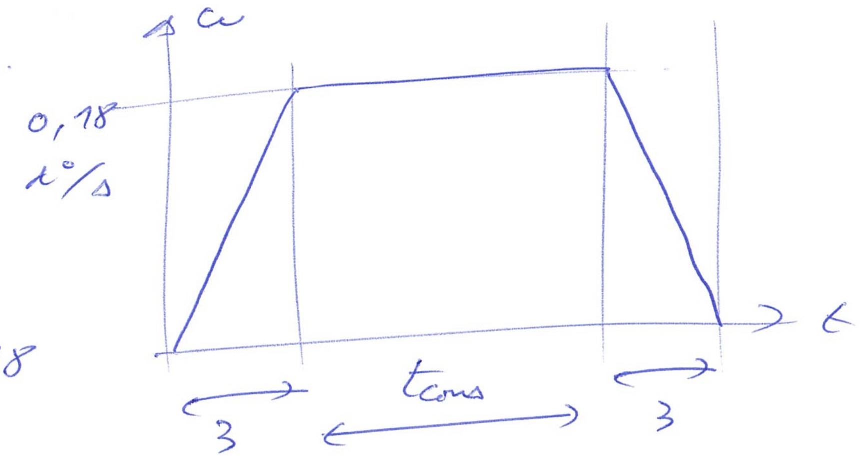
300 d° ⟶ 10 h = 600 min

x ⟶ 15 min

$$x = \frac{300 \times 15}{600} = \frac{45}{6} = \frac{15}{2} = 7{,}5°$$

Q2 Trapèze de vitesse

Angle = aire du trapèze



$7{,}5 = (t_{cons} + 3) \times 0{,}18$

$\Rightarrow t_{cons} = \dots = 38{,}7\,s$

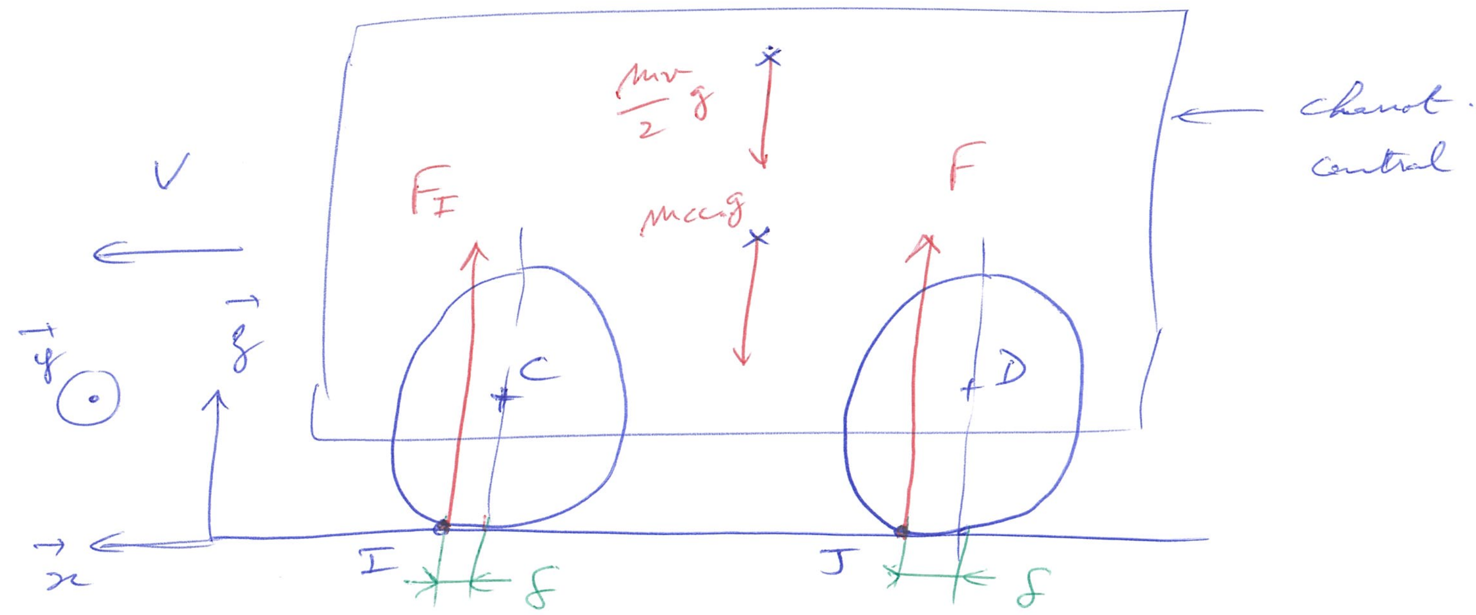
Q3 total = 44,7 s.

Q4 Courbe donnée : 3,651 m en 49 s < 60 s <u>OK</u>

$V = \frac{3{,}651}{49}$ m/s ; $V = R\omega \Rightarrow \omega = \frac{V}{R} = \frac{V}{22{,}5}$ m

$\omega = 0{,}0033$ rad/s $\Rightarrow \omega = 0{,}0033 \times \frac{180}{\pi} = 0{,}19$ d°/s > 18

② II Résistance au roulement (Q13 à Q15)



$$F_I + F_J = \left(\frac{m_v}{2} + m_{cc}\right) g$$

$$\Gamma_C = -F_I \cdot \delta \qquad \Gamma_D = -F_J \cdot \delta$$

$$\Gamma_{cc} = -\left(\frac{m_v}{2} + m_{cc}\right) g \cdot \delta$$

Idem (latéral) : $\Gamma_{cl} = -\left(\frac{m_v}{2} + m_{cl}\right) g \delta$

$$\Gamma_{glob} = -\left(m_v + m_{cc} + m_{cl}\right) g \, \delta$$

III E_c donné (Q17)

On utilise : $\omega_r = K_{red} \cdot \omega_m$

$$V = R \cdot \omega_r = \frac{D}{2} \omega_r$$

$$V = \frac{D}{2} K_{red} \cdot \omega_m$$

$$\Longrightarrow \quad E_c = \frac{1}{2} J_{eq} \cdot \omega_m^2$$

③ IV **TEC** . (Q18 à Q20)

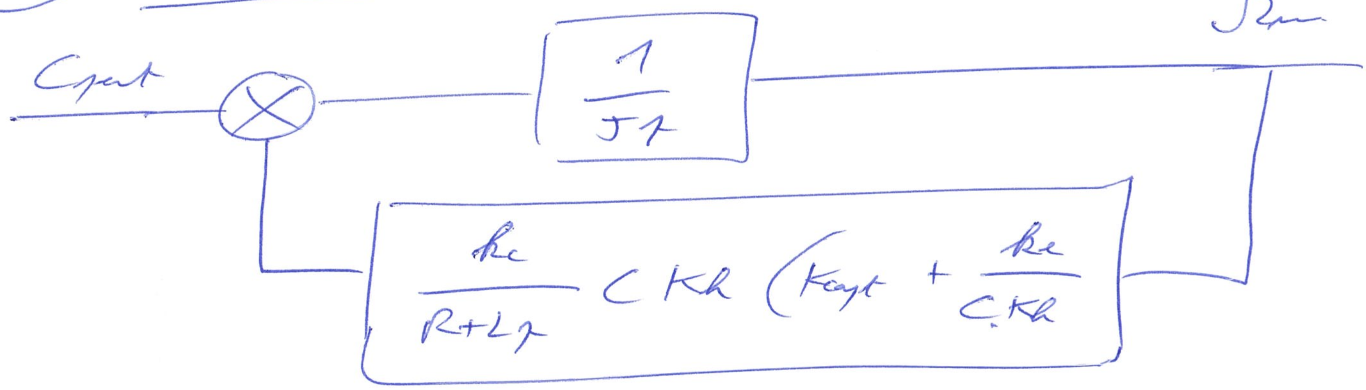
en

$$J_{eq}\,\omega_m\,\dot{\omega}_m = C_m\,\omega_m + F_{vent}\,V + Mgbb\,\omega_r .$$

$$J_{eq}\,\cancel{\omega_m}\,\dot{\omega}_m = C_m\,\cancel{\omega_m} + F_{vm}\,\frac{D}{2}K_{red}\,\cancel{\omega_m} + Mgbb.\,K_r\,\cancel{\omega_m}$$

⚠ Signes.

V **Precision en régulation.** (Q24 et Q25)



$$H_r = \frac{\Omega_m}{C_{pert}} = \frac{\frac{1}{Jp}}{1 + \frac{k_e}{R+Lp}\left(C\,K_h\,K_{capt} + k_e\right)\frac{1}{Jp}}$$

$$H_r = \frac{R+Lp}{(R+Lp)\,Jp + k_e\left(C\,K_h\,K_{capt} + k_e\right)} = \ldots$$

$$H_r = \frac{\alpha\,(1+\tau p)}{1+\gamma.p+\delta.p^2}$$

entrée $C_{pert} = \frac{C_0}{p}$ sortie $\Omega_m(p) = H_r \times C_{pert}$.

$$\lim_{t\to\infty} \omega_m(t) = \lim_{p\to 0} p\,\Omega_m(p) = C_0.\alpha \neq 0.$$

$$\Omega_m = \frac{1}{Jp}\left[C_{pert} + \frac{k_e}{R+Lp}\left(C K_h K_{capt}\, \Omega_m - k_e \Omega_m\right)\right]$$

$$\Omega_m\, Jp\,(R+Lp) = (R+Lp)\, C_{pert} + k_e\left(C K_h K_{capt} - k_e\right)\Omega_m$$

$$\Omega_m\left[Jp(R+Lp) + k_e\left(C K_h K_{capt} - k_e\right)\right] = (R+Lp)\, C_{pert}$$

$$\frac{\Omega_m}{C_{pert}} = \frac{R+Lp}{JLp^2 + JRp + k_e\left(C K_h K_{capt} - k_e\right)}$$

$$\frac{\Omega_m}{C_{pert}} = \underbrace{\frac{R}{k_e\left(C K_h K_{cap} - k_e\right)}}_{=\alpha}\ \frac{\left(1 + \overbrace{\frac{L}{R}}^{=\tau} p\right)}{\left[\underbrace{\frac{LJ}{k_e(\ )}}_{=\delta} p^2 + \underbrace{\frac{RJ}{k_e(\ )}}_{=\delta} p + 1\right]}$$