(1)

Correction DS de SI, MP, mars 26, Inverseur

Q20 $H_1 = \frac{1}{R+Lp}$ ; $K_2 = K_5 = K_m$ ; $H_3 = \frac{1}{Jp}$

Q21 $K_a = R_e$    Q22 $\Omega_m = 0$ et $a = 0$

$$U_{mes} = R_e \frac{1}{R+Lp} \cdot C(p) \cdot \varepsilon \Rightarrow \frac{U_{mes}}{\varepsilon} = \frac{R_e\, C(p)}{R+Lp} = \frac{R_e\, C(p)}{R\left(1+\frac{L}{R}p\right)}$$

Q23 Avec $\tau_i = \frac{L}{R}$ on a $\frac{U_{mes}}{\varepsilon} = \frac{R_e K_p}{R \tau_i p}$

Q24 $$\frac{I}{I_c} = \text{“}\frac{G}{1+GF}\text{”} = \frac{R_e K_p}{R\tau_i p + R_e K_p} = \frac{1}{1 + \frac{R\tau_i}{R_e K_p} p}$$

Q25 $$t_{5\%} = 3\tau = \frac{3R\tau_i}{R_e K_p} = \frac{3L}{R_e K_p} < 3.10^{-6}$$

$$\Rightarrow K_p > \frac{3L}{R_e\, 3.10^{-6}} = \frac{10^{-5}}{10^{-2}\, 10^{-6}} = 10$$

Q26 1er ordre, $\varepsilon(\infty) = 0$ ; gain $= 1$, $t_{5\%} = 0,3$ ms (Précision / Rapidité) OK

Q27 $$FTBO = \left(\frac{k}{p} + \ell\right)\frac{1}{Jp} = \frac{k + \ell p}{Jp^2}$$

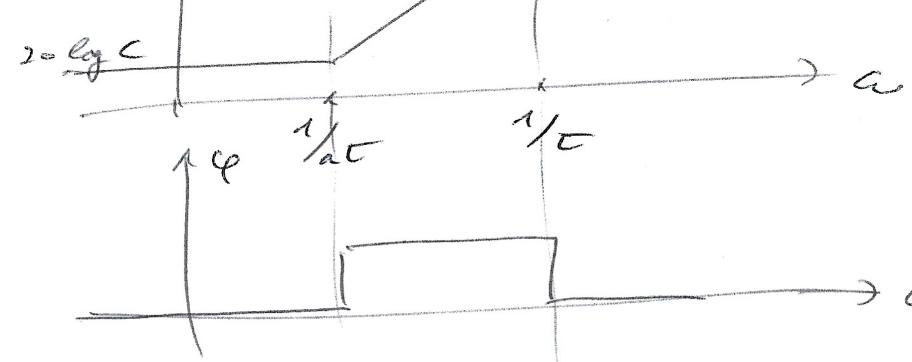
$$FTBF = \frac{k+\ell p}{Jp^2 + \ell p + k}$$

Q28 2 intégration dans la BO $\Rightarrow \varepsilon(\infty) = 0$ avec entrée rampe

Q29 FTBF est un 2e ordre généralisé avec $K_{BF} = 1$

$\Rightarrow$ stable et précis.

Q30




Pour $\omega = \frac{1}{\tau\sqrt{a}}$

$C(p) = C\sqrt{a}$

(2)

**Q31** Pour $\omega = \omega_{BP}$ on a $\varphi = -180$

Il faut donc $\phi_{max} = 50$

**Q32** $\sin 50 = 0{,}77 = \dfrac{a-1}{a+1} \Rightarrow \dots \Rightarrow a = 7{,}7$

$$\omega_{BP} = \frac{1}{\tau\sqrt{a}} \Rightarrow \tau = \frac{1}{2{,}77\,\omega_{BP}}$$

Pour $\omega = \omega_{BP}$ ; $G_{dB} = -38$

Il faut $20 \log(C\sqrt{a}) = 38 \Rightarrow C = \dfrac{10^{\frac{38}{20}}}{\sqrt{a}} = \dfrac{10^{1{,}9}}{2{,}77} = 28{,}7$

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**Q10** $\lambda \vec{x_0} + L_3 \vec{x_3} + L_4 \vec{y_4} = L \vec{x_0} + H \vec{y_0}$

$\vec{x_3} = \cos\theta_l \, \vec{x_0} + \sin\theta_l \, \vec{y_0}$ $\quad (\times L_3)$

$\vec{y_4} = -\sin\theta_{40} \, \vec{x_0} + \cos\theta_{40} \, \vec{y_0}$ $\quad (\times L_4)$

$$\begin{cases} \lambda + L_3 \cos\theta_l - L_4 \sin\theta_{40} = L \\ \cancel{L_3 \sin\theta_{40}}\; L_3 \sin\theta_l + L_4 \cos\theta_{40} = H \end{cases} \qquad \begin{cases} L_4 \sin\theta_{40} = \lambda - L + L_3 \cos\theta_l \\ L_4 \cos\theta_{40} = H - L_3 \sin\theta_l \end{cases}$$

$$L_4^2 = (\lambda - L + L_3 \cos\theta_l)^2 + (H - L_3 \sin\theta_l)^2$$

$$\lambda = L - L_3 \theta_l + \sqrt{L_4^2 - (H - L_3 \sin\theta_l)^2}$$

**Q11** Courbe $\Rightarrow \Delta\lambda = 800 - 250 = 550$ mm $> 500$ mm

~~Q12~~ **Q13** $V \rightarrow \boxed{K_{oc}} \rightarrow \omega_l$ $\qquad K_{oc} = \dfrac{\Delta\theta}{\Delta\lambda} = \dfrac{50}{300} = \dfrac{1}{6}$ °/mm

**Q14** $N = 2000$ tr/min $= 2000 \times 8$ mm/min

$$V = \frac{2000 \times 8}{60} \text{ mm/s} = \frac{800}{3} \text{ mm/s}$$

$$\omega_l = \frac{1}{6} \times \frac{800}{3} \text{ °/s} = \frac{400}{9} \text{ °/s}$$

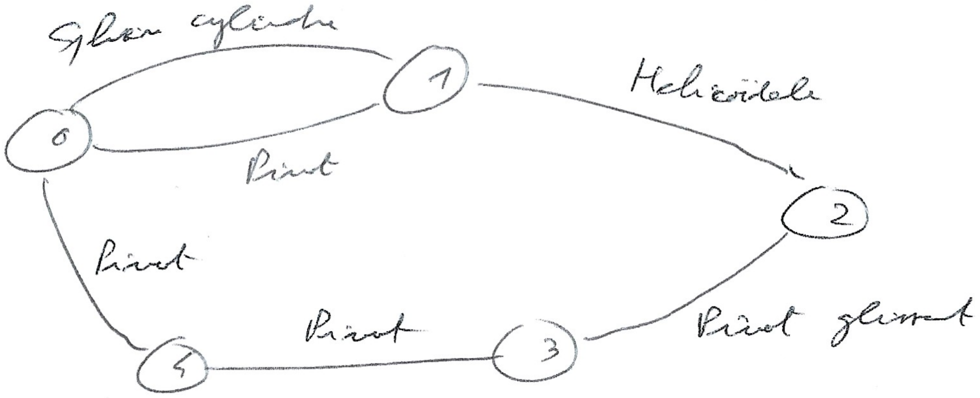
$$\omega_l = \frac{\Delta\theta}{\Delta t} \Rightarrow \Delta t = \frac{\Delta\theta}{\omega_l} = 80 \times \frac{9}{400} = \frac{72}{40} = 1{,}8 \text{ s} < 3 \text{ s}$$

**Q15** $\{\tau_{air \to 3}\} = \left\{ \begin{matrix} \vec{F}_{air} \\ \vec{M}(O_2) \end{matrix} \right\}$

$$\vec{F} = -p_s L_3 b \, \vec{y_3}$$

$$\vec{M}(O_2) = -p_s L_3 b \times \frac{L_3}{2} \vec{z_3} = -p_s \frac{L_3^2}{2} b \, \vec{z_3}$$

**Q16**




**Q17** Vis (1) $\Rightarrow$ solide de révolution d'axe $(O, \vec{x_0})$

Volet (3) $\Rightarrow$ 3 plans de sym

**Q18** $Ec_1 = \frac{1}{2} A_1 \dot{\theta}_f^2$

$$Ec_2 = \frac{1}{2} M_2 V^2 \qquad V = \frac{p}{2\pi}\dot{\theta}_f \implies Ec_2 = \frac{1}{2} \cdot M_2 \frac{p^2}{4\pi^2} \dot{\theta}_f^2$$

$$Ec_3 = \frac{1}{2}\left[ M_3 \vec{V}^2(G \in 3/0) + C_3 \dot{\theta}_e^2 \right]$$

$$\vec{V}(G \in 3/0) = \vec{V}(O_2 \in 3/0) + \vec{\Omega}_{3/0} \wedge \vec{O_2G} = V \vec{x_0} + \dot{\theta}_e \vec{z_3} \wedge \frac{L_3}{2}\vec{x_3}$$

$$= V\vec{x_0} + \dot{\theta}_e \frac{L_3}{2} \vec{y_3}$$

$$\vec{V}^2(G \in 3/0) = V^2 - 2V\dot{\theta}_e \frac{L_3}{2} \sin\theta_e + \left(\dot{\theta}_e \frac{L_3}{2}\right)^2$$

$$V = \frac{p}{2\pi}\dot{\theta}_f \qquad \dot{\theta}_e = K_c V = K_c \frac{p}{2\pi}\dot{\theta}_f$$

$$Ec_3 = \frac{1}{2}\left[ M_3 \frac{p^2}{4\pi^2} - M_3 \frac{p^2 K_c L_3}{4\pi^2 \cancel{2}} \sin\theta_e + M_3 K_c^2 \frac{p^2}{4\pi^2}\frac{L_3^2}{4} \right] \dot{\theta}_f^2$$

$$Ec_T = \frac{1}{2}\left[ A_1 + (M_2 + M_3)\frac{p^2}{4\pi^2} + \frac{K_c^2 p^2}{4\pi^2}\left(C_3 + M_3 \frac{L_3^2}{4}\right) - M_3 L_3 \frac{K_c p^2}{4\pi^2} \sin\theta_e \right] \dot{\theta}_f^2$$

4

$$J_{eq} = A_{eq} + B_{eq} \sin\theta_b$$

$$A_{eq} = A_1 + (m_2 + m_3)\frac{p^2}{4\pi^2} + \frac{K_{cc}^2 p^2}{4\pi^2}\left(C_3 + m_3 \frac{L_3^2}{4}\right)$$

$$B_{eq} = -m_3 L_3 \frac{K_{cc} p^2}{4\pi^2}$$

Q19 $P_{pes} = -m_3 g \vec{y_0} \cdot \left(V\vec{x_0} + \dot\theta_b \frac{L_3}{2}\vec{y_3}\right)$

$$P_{pes} = -m_3 g \dot\theta_b \frac{L_3}{2}\cos\theta_b = -m_3 g K_{cc}\frac{p}{2\pi}\dot\theta_f \frac{L_3}{2}\cos\theta_b$$

$$P_{flex} = C_f \dot\theta_f \quad ; \quad P_{air} = \begin{Bmatrix} F_{air}\vec{y_3} \\ \frac{L_3}{2} F_{air}\vec{z_3} \end{Bmatrix} \otimes \begin{Bmatrix} \dot\theta_b \vec{z_0} \\ V\vec{x_0} \end{Bmatrix}$$

$$P_{air} = -F_{air} V \sin\theta_b + \frac{L_3}{2} F_{air}\dot\theta_b =$$

$$P_{air} = +F_{air}\frac{p}{2\pi}\dot\theta_f \sin\theta_b - \frac{L_3}{2}F_{air}K_{cc}\frac{p}{2\pi}\dot\theta_f$$

$$P_{air} = \dot\theta_f F_{air}\frac{p}{2\pi}\left(\sin\theta_b - \frac{L_3}{2}K_{cc}\right)$$