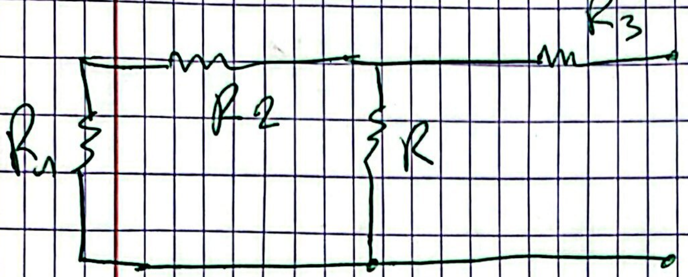
Ex 1 : (5 pts)

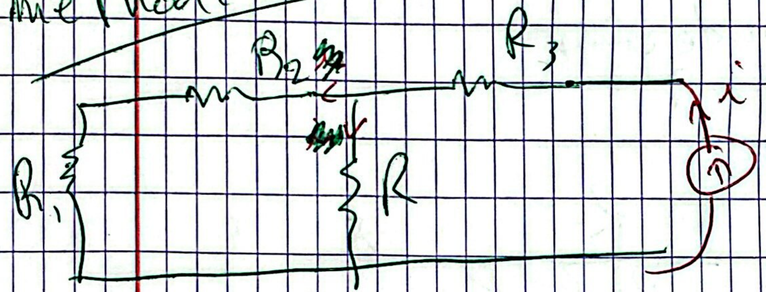
1) $R_{th} = ?$ (éteindre E et I)



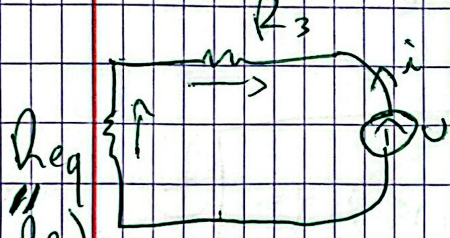
méthode 1 : $\boxed{R_{th}} = \left[(R_1 + R_2) // R\right] + R_3$

$$\boxed{= \frac{(R_1+R_2)R}{R_1+R_2+R} + R_3}$$ (1)

méthode 2



$R_{th} = \frac{U}{i}$

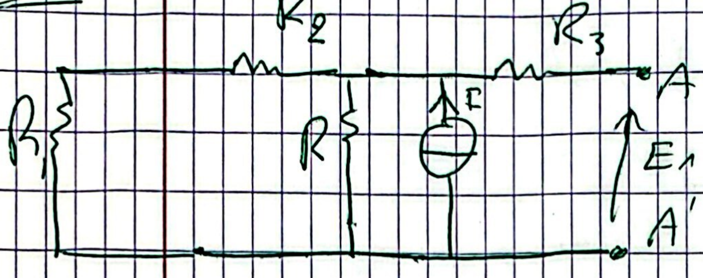


$Req = (R_1+R_2)//R$.

$i = \frac{U}{Req + R_3} \Rightarrow R_{th} = \frac{\cancel{U}}{\frac{\cancel{U}}{Req+R_3}} = Req + R_3$

$E_{Th} = E_1 + E_2$

$E_1 = ?$



pas de courant

$E_1 = R_{eq}\, I = (R_1+R_2)//R \cdot I$

$(R_1+R_2)//R$

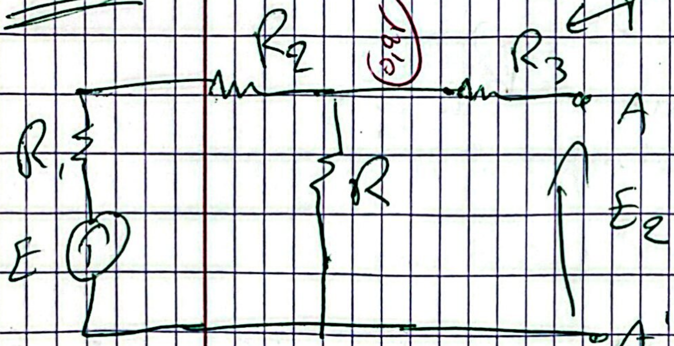
0,25

$$E_1 = \frac{(R_1+R_2)R}{R_1+R_2+R} \cdot I$$

$E_2 = ?$

pas de courant

0,25



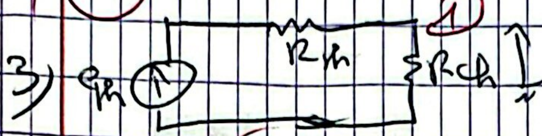
$$E_2 = \frac{R}{R+R_1+R_2} E$$

$$\Rightarrow \boxed{E_{Th} = \frac{R}{R+R_1+R_2} E + \frac{R(R_1+R_2)}{R+R_1+R_2} I}$$

$R_N = R_{th}$ (1) $= R_3 + \frac{R(R_1+R_2)}{R+R_1+R_2}$

$I_N = \frac{E_{th}}{R_{th}} = \left(R_3 E + R(R_1+R_2) I\right) \times \frac{1}{R_3(R+R_1+R_2)+R(R_1+R_2)}$

(1)

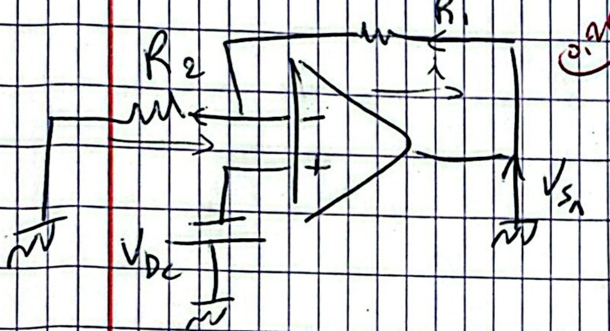
3)  (1)

$V_s = \frac{R_{ch}}{R_{ch}+R_{th}} e_{th}$ (1)

Ex 3 : (6pts)

$V_s = V_{s1} + V_{s2}$

$V_{s1} = ?$ (on éteint V_{in} ∿ $\Rightarrow C \equiv$ — —)
on garde V_{DC}

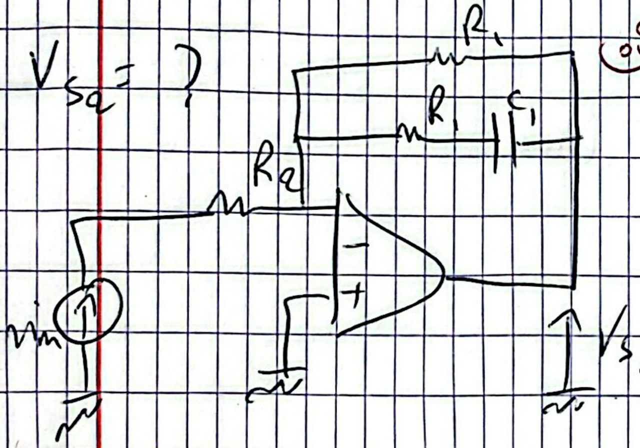


0,25

$V^+ = V^- = R_2 i = V_{DC} \Rightarrow i = \frac{V_{DC}}{R_2}$

$V_{s1} = (R_1+R_2) i = \frac{(R_1+R_2)}{R_2} V_{DC}$

$V_{s2} = ?$



0,25

$V_{s2} = -\frac{Z_1}{R_2} V_{in}$

avec $Z_1 = R_1 // (R_1 + Z_{C_1})$

$= \frac{R_1 \times (R_1 + Z_{C_1})}{R_1 + R_1 + Z_{C_1}}$

$= \frac{R_1 \times \left(R_1 + \frac{1}{jC_1\omega}\right)}{2R_1 + \frac{1}{jC_1\omega}}$

$Z_1 = \frac{\frac{(jR_1C_1\omega + 1)R_1}{jC_1\omega}}{\frac{j2R_1C_1\omega + 1}{jC_1\omega}} = R_1\left(\frac{1+jR_1C_1\omega}{1+2jR_1C_1\omega}\right)$

$$\rightarrow V_{s2} = -\frac{R_1}{R_2} \times \frac{(1+jR_1C_1\omega)}{(1+j2R_1C_1\omega)} V_{in}$$

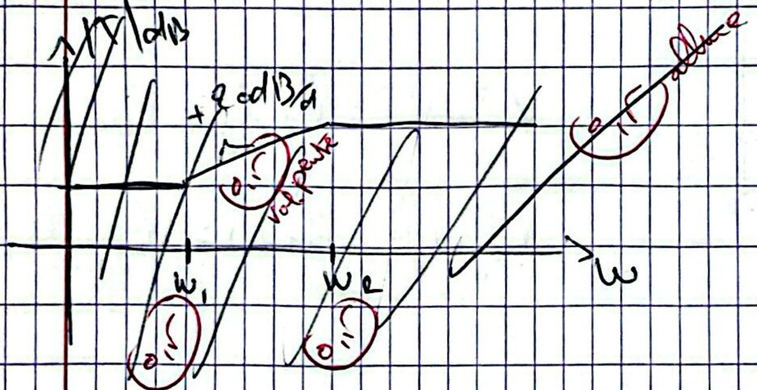
2

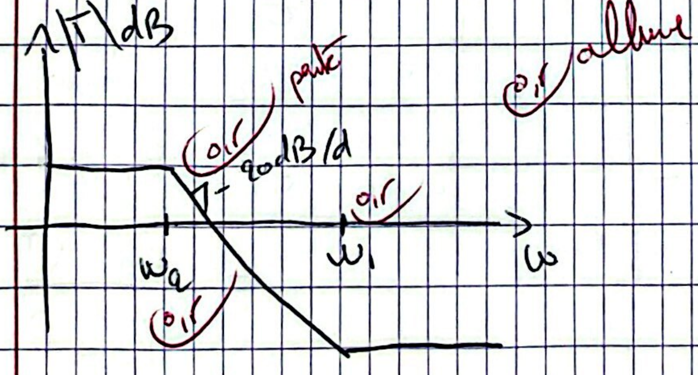
$$\longrightarrow V_s = V_{s1} + V_{s2} = \left(\frac{R_1+R_2}{R_2}\right) V_{DC} - \frac{R_2}{R_2} \frac{(1+jR_1C_1\omega)}{(1+j2R_1C_1\omega)} V_{in}$$

2) $R_2 = \frac{R_1}{2}$ / $T(j\omega) = \frac{V_s}{V_{in}} = -\frac{R_1}{R_2}\left(\quad \right)$

$$T(j\omega) = -2\left(\frac{1+jR_1C_1\omega}{1+j2R_1C_1\omega}\right)$$

$\omega_1 = \frac{1}{R_1C_1}$ et $\omega_2 = \frac{1}{2R_1C_1}$ $\qquad 2R_1C_1 > R_1C_1$





Ex 4 :

$G \times BP = 3\,M\,Hz$

on veut gain total $= 900 \pm 5\%$ et $BP_{totale} = 300\,kHz$

étage 1 : $G_1 = \dfrac{3.10^6}{300.10^3} = 10$

$BP_1 = 300\,kHz$ (on impose)

étage 2 : $G_2 = \dfrac{\text{Gain total}}{G_1} = \dfrac{900}{10} = 90$

$BP_2 = \dfrac{3.10^6}{90} = 33{,}3\,kHz << 300\,kHz$!!

↳ non !

↳ on fera donc 3 étages :

1		1		1
$G_1 = 10$ $BP_1 = 300\,kHz$	→	$G_2 = 10$ $BP_1 = 300\,kHz$	→	$G_3 = 9$ $BP_3 = 333\,kHz$

$BP_3 = \dfrac{3.10^6}{9} = 333\,kHz$

ampli 1 et 2 : $1 + \dfrac{R_2}{R_1} = 10 \Rightarrow \dfrac{R_2}{R_1} = 9$ 0,5

ampli 3 : $1 + \dfrac{R_2}{R_1} = 9 \longrightarrow \dfrac{R_2}{R_1} = 8$ 0,5

2) $V^+ = V_E$ et $V^- = R_1 i_1$

$V^+ = V^- \Rightarrow V_E = R_1 i_1 \Rightarrow i_1 = \frac{V_E}{R_1}$

pour que i^- soit négligeable devant i_1, il faut que

$i^- \ll i_1 \Leftrightarrow i^- \ll \frac{V_E}{R_1} \Leftrightarrow i^- \ll \frac{V_{Emin}}{R_1} \Leftrightarrow R_1 \ll \frac{V_{Emin}}{i^-}$ 0,5

$\Leftrightarrow R_1 \ll \frac{150 \cdot 10^{-6}}{3 \cdot 10^{-9}} \Leftrightarrow \boxed{R_1 \ll 50\,k\Omega}$ 0,5

Condition 2 :

$(R_1 + R_2)\, i_{smax} = V_{smax}$ or $V_{smax} = gain \times V_{inmax}$ 0,5

~~AoP 1,2 ⇒ R1+R2~~

il faut que $i_s < i_{smax} \Leftrightarrow \frac{V_s}{R_1+R_2} < 10\,mA \Leftrightarrow R_1 + R_2 > \frac{V_s}{10\,mA}$ 0,5

$\Leftrightarrow R_1 + R_2 > \frac{V_{smax}}{10\,mA}$ 0,5

or $\begin{cases} AoP_{1,2} : V_{smax} = 10 \times 2 \cdot 10^{-3} = 20\,mV \\ AoP_3 : V_{smax} = 9 \times 2 \cdot 10^{-3} = 18\,mV \end{cases}$

$\Leftrightarrow \begin{cases} AoP_{1,2} : R_1 + R_2 > \frac{20\,mV}{10\,mA} (= 2\,\Omega) \\ AoP_3 : R_1 + R_2 > \frac{18\,mV}{10\,mA} (= 1,8\,\Omega) \end{cases}$ 1

Conclusion

$AoP_{1,2}$: on choisit $R_1 = 1\,k\Omega \rightarrow R_2 = 9\,k\Omega$ 1

AoP_3 : $R_1 = 1\,k\Omega \rightarrow R_2 = 8\,k\Omega$

Ex 2

$E_{th} = e - V - V_1 = e - 2V = e - 2Ri$; (1)

et $E_{th} = R_3 i_3 = R_3\left(gV + \frac{V}{R}\right) = R_3 V\left(g + \frac{1}{R}\right)$ (2)

(1) $\Rightarrow$ ~~$V = $~~ $V = (e - E_{th})/2$

dans (2) $\Rightarrow E_{th} = R_3 \frac{(e - E_{th})}{2}\left(g + \frac{1}{R}\right)$

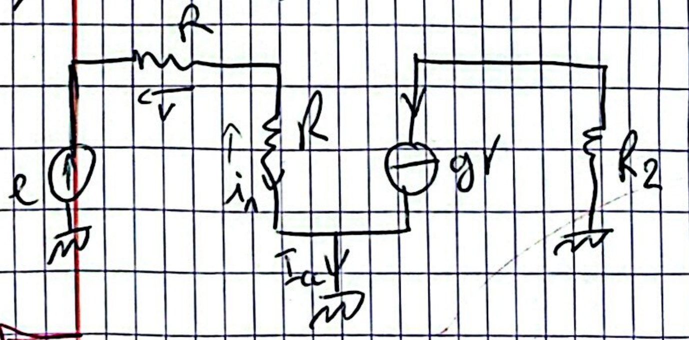
$\longrightarrow E_{th} = \underbrace{\frac{R_3}{2}\left(g + \frac{1}{R}\right)}_{\alpha}(e - E_{th}) = \alpha e - \alpha E_{th}$

$\longleftrightarrow E_{th}(1 + \alpha) = \alpha e \longrightarrow E_{th} = \frac{\alpha e}{1 + \alpha}$

$\longrightarrow E_{th} = e \dfrac{\frac{R_3}{2}\left(g + \frac{1}{R}\right)}{1 + \frac{R_3}{2}\left(g + \frac{1}{R}\right)} = \dfrac{\frac{R_3}{\cancel{2}}\left(g + \frac{1}{R}\right) \times 2R}{\left(1 + \frac{R_3}{2}\left(g + \frac{1}{R}\right)\right) \times 2R} \times e$

$$\boxed{E_{th} = \frac{R_3 R g + R_3}{2R + R_3 R g + R_3} \times e}$$ 1

2) R_{th} : (on CC la sortie) $\Rightarrow R_3$ en C.C



1

$$\boxed{I_{cc} = gV + i_1 = gV + \frac{V}{R} = V\left(g + \frac{1}{R}\right) = \frac{e}{2}\left(g + \frac{1}{R}\right) = \left(\frac{gR + 1}{2R}\right)e}$$

$e = Ri_1 + Ri_1 = V + V = 2V \longrightarrow V = \frac{e}{2}$

$$\Rightarrow R_{th} = \frac{E_{th}}{I_{cc}} = \frac{(R_3 R g + R_3)\, e}{(R_3 R g + R_3 + 2R)} \times \frac{2R}{e(1 + Rg)}$$

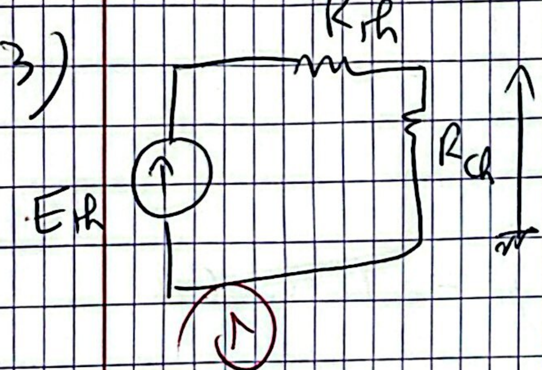
$$= \frac{\cancel{R_3}\,(\cancel{Rg+1}).2R}{\cancel{R_3}\left(Rg + 1 + \frac{2R}{R_3}\right)(\cancel{1+Rg})}$$

$$= \frac{2\cancel{R}}{\cancel{R}\left(g + \frac{1}{R} + \frac{2}{R_3}\right)}$$

$$= \frac{2}{\frac{RR_3 g + R_3 + 2R}{RR_3}}$$

$$\boxed{R_{th} = \frac{2RR_3}{RR_3 g + R_3 + 2R}}$$ 1

3)



$$\boxed{V_s = \frac{R_{ch}}{(R_{ch} + R_{th})} E_{th}}$$ 1