1) $R_i = 1,1\ cm \quad \pm 5\%$, tolleranze $\quad N = \text{spire} = 20$

$R_e = 1,8\ cm \quad \pm 5\%$

$\rho = 1,3\ cm \quad \pm 5\%$

$\mu_r = 800 \quad \pm 10\%$

$R = 50\ \Omega \quad \pm 1\%$

$$\boxed{L = M \cdot N}$$

$$f_c = \frac{R}{2\pi L}$$

$$L = \frac{N^2 \mu_0 \mu_r \Sigma}{2\pi \hat{R}} = \frac{N^2 \mu_0 \mu_r \rho (\cancel{R_e - R_i})}{2\pi \frac{\cancel{R_e - R_i}}{\ln\left(\frac{R_e}{R_i}\right)}} = \frac{N^2 \mu_0 \mu_r \rho}{2\pi} \ln\left(\frac{R_e}{R_i}\right)$$

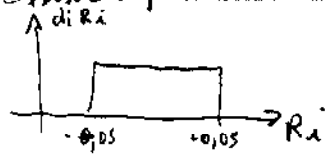
$$f_c = \frac{R}{\cancel{2\pi} \frac{N^2 \mu_0 \mu_r \rho \ln(R_e/R_i)}{\cancel{2\pi}}} = \frac{R}{N^2 \mu_0 \mu_r \rho \ln\left(\frac{R_e}{R_i}\right)}$$

$$\sigma_{f_c} = \sqrt{\left(\frac{\partial f_c}{\partial R_i} \sigma_{R_i}\right)^2 + \left(\frac{\partial f_c}{\partial R_e} \sigma_{R_e}\right)^2 + \left(\frac{\partial f_c}{\partial \rho} \sigma_\rho\right)^2 + \left(\frac{\partial f_c}{\partial \mu_r} \sigma_{\mu_r}\right)^2 + \left(\frac{\partial f_c}{\partial R} \sigma_R\right)^2}$$

scarto tipo

$$\boxed{\sigma_{f_c} \cdot t = 1,64\, \sigma_{f_c}}$$ (prendere grafico)

29/01/2004



Lo scarto tipo si ottiene facendo $\frac{5\%}{\sqrt{3}} = \frac{0,05}{\sqrt{3}}$

$$\boxed{R_i \Rightarrow \frac{\sigma_{R_i}}{R_i} = \frac{0,05}{\sqrt{3}}}$$ Scarto tipo espressi sotto scarti relativi

$$\frac{\sigma_{f_c}}{f_c} = \sqrt{\left(\frac{\sigma_{R_i}}{R_i} \frac{1}{\ln(R_e/R_i)}\right)^2 + \left(\frac{\sigma_{R_e}}{R_e} \frac{1}{\ln(R_e/R_i)}\right)^2 + \left(\frac{\sigma_\rho}{\rho}\right)^2 + \left(\frac{\sigma_{\mu_r}}{\mu_r}\right)^2 + \left(\frac{\sigma_R}{R}\right)^2} =$$

Incertezza su moltiplicazioni e divisioni le incertezze si sommano scorrelata o ordinaria degli scarti relativi

$$f_c = \frac{K}{\ln\left(\frac{R_e}{R_i}\right)} \Rightarrow \frac{\partial f_c}{\partial R_i} = K \cdot \frac{\frac{1}{R_i}}{\ln^2\left(\frac{R_e}{R_i}\right)} \Rightarrow f_c \frac{1}{R_i \ln\left(\frac{R_e}{R_i}\right)}$$

$$\frac{\partial \ln\left(\frac{R_e}{R_i}\right)}{\partial R_i} = \frac{1}{\frac{R_e}{R_i}} \left(R_e \left(-\frac{1}{R_i^2}\right)\right) = -\frac{1}{R_i}$$

$\ln \frac{R_e}{R_i} = 0,49$

$$\frac{\partial f_c}{\partial R_i} \cdot \frac{1}{f_c} \sigma R_i = \frac{f_c}{R_i \ln\left(\frac{R_e}{R_i}\right)} \frac{1}{f_c} \sigma R_i = \frac{\sigma R_i}{R_i \ln\left(\frac{R_e}{R_i}\right)} = \frac{\sigma R_e}{R_i} \frac{1}{\ln(R_e/R_i)}$$

$$\frac{\sigma_{f_c}}{f_c} = \sqrt{\left(\frac{5}{100} \frac{1}{\sqrt{3}} \cdot 0,49\right)^2 + \left(\frac{5}{100} \frac{1}{\sqrt{3}} \cdot 0,49\right)^2 + \left(\frac{5}{100} \frac{1}{\sqrt{3}}\right)^2 + \left(\frac{10}{100} \frac{1}{\sqrt{3}}\right)^2 + \left(\frac{1}{100} \cdot \frac{1}{\sqrt{3}}\right)^2} = \frac{10,52}{100}$$

$$L = \frac{(20)^2\, 4\pi \cdot 10^{-7} \cdot 1,3 \cdot 10^{-2} \cdot 800}{2,2} \ln\left(\frac{1,8}{1,1}\right) = 407,68\ \mu H$$

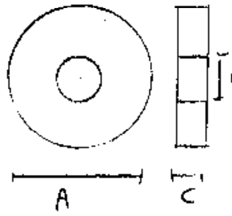
$$f_c = \frac{50}{2\pi \cdot 31,52 \cdot 10^{-3}} = 19,5\ kHz$$

$$\sigma_{f_c} = \frac{10,52}{100} \cdot 19,5 \cdot 10^3\ Hz = 2,05\ kHz$$

$$\sigma_{f_c} \cdot t = 2,05 \cdot 10^3 \cdot 1,64 = 3,36\ kHz$$

$$f_c = 20\ kHz \pm 3\ kHz$$

1)



$N = 20$ spire $\quad A = 1{,}8\,cm \quad B = 1{,}1\,cm \quad C = 1{,}3\,cm \quad \mu_r = 800 \quad$ livello fiducia 90%

sonda chiusa su $R = 50\,\Omega \quad f_c = ? \quad A, B, C \pm 5\% \quad \mu_r \pm 10\% \quad R \pm 1\%$

$$f_c = \frac{R}{2\pi L} \qquad L = M \cdot N = \frac{N^2 \mu_0 \mu_r \Sigma}{2\pi \hat{r}} = \frac{N^2 \mu_0 \mu_r C (A-B)}{2\pi \frac{(A-B)}{\ln(A/B)}} = \frac{N^2 \mu_0 \mu_r C}{2\pi} \ln(A/B)$$

$$f_c = \frac{R}{2\pi L} = \frac{R}{2\pi \frac{N^2 \mu_0 \mu_r C \ln(A/B)}{2\pi}} = \frac{R}{N^2 \mu_0 \mu_r C \ln(A/B)}$$

scarto tipo

$$\sigma_{f_c} = \sqrt{\left(\frac{\partial f_c}{\partial B}\sigma B\right)^2 + \left(\frac{\partial f_c}{\partial A}\sigma A\right)^2 + \left(\frac{\partial f_c}{\partial \rho}\sigma_\rho\right)^2 + \left(\frac{\partial f_c}{\partial \mu_r}\sigma_{\mu_r}\right)^2 + \left(\frac{\partial f_c}{\partial R}\sigma R\right)^2}$$

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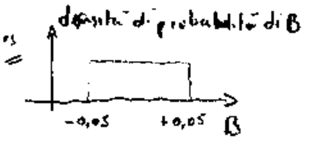
$\sigma_{f_c} \cdot t = 1{,}64\, \sigma_{f_c}$ "visto sul grafico" al 90%

es =



Lo scarto tipo si ha facendo $\dfrac{\text{tolleranza}\%}{\sqrt{3}} \Rightarrow \dfrac{5\%}{\sqrt{3}} = \dfrac{0{,}05}{\sqrt{3}}$

$B \Rightarrow \dfrac{\sigma B}{B} = \dfrac{0{,}05}{\sqrt{3}}$ scarto relativo espresso in scarto relativo

$$\frac{\sigma f_c}{f_c} = \sqrt{\left(\frac{\sigma B}{B}\right)^2 + \left(\frac{\sigma A}{A}\right)^2 + \left(\frac{\sigma_c}{c}\right)^2 + \left(\frac{\sigma_{\mu_r}}{\mu_r}\right)^2 + \left(\frac{\sigma R}{R}\right)^2}$$

Bisogna calcolare le derivate parziali $\Rightarrow$

Ricordarsi che l'incertezza su moltiplicazioni e divisioni si sommano (scorrelata o ordinaria (quadratura) degli scarti relativi)

$$\frac{\sigma f_c}{f_c} = \sqrt{\left(\frac{\sigma_B}{B}\frac{1}{\ln(A/B)}\right)^2 + \left(\frac{\sigma_A}{A}\frac{1}{\ln(A/B)}\right)^2 + \left(\frac{\sigma_c}{c}\right)^2 + \left(\frac{\sigma_{\mu_r}}{\mu_r}\right)^2 + \left(\frac{\sigma R}{R}\right)^2}$$

es = $f_c = KC \Rightarrow \dfrac{\partial f_c}{\partial C} = K \qquad \dfrac{\partial f_c}{\partial c} \cdot \dfrac{\sigma_c}{f_c} = \cancel{K}\dfrac{\sigma_c}{\cancel{K}C} = \dfrac{\sigma_c}{C}$

es = $f_c = K \ln(A/B) \Rightarrow \dfrac{\partial f_c}{\partial B} = K \,\partial(\ln A/B) = K\left(\dfrac{-\frac{A}{B^2}}{\frac{A}{B}}\right) = K\left(-\dfrac{A}{B^2}\dfrac{B}{A}\right) = K\left(-\dfrac{1}{B}\right)$

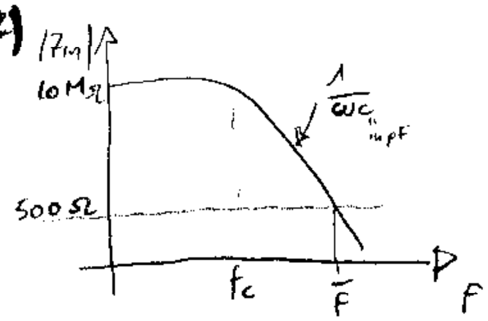
$$\frac{\partial f_c}{\partial B}\frac{\sigma B}{f_c} = -\frac{\cancel{K}}{B} \cdot \frac{\sigma B}{\cancel{K}\ln(A/B)} = -\frac{\sigma B}{B}\frac{1}{\ln(A/B)}$$

$$\frac{\sigma f_c}{f_c} = \frac{10{,}52}{100}$$

$L = 407{,}68\,\mu H \qquad f_c = 19{,}5\,kHz \qquad \sigma f_c = \dfrac{10{,}52}{100} \cdot f_c = 2{,}05\,kHz$

$\sigma f_c \cdot t = 2{,}05 \cdot 10^3 \cdot 1{,}64 = 3{,}36\,kHz \qquad f_c = 20\,kHz \pm 3\,kHz$

2)



$$f_c = \frac{1}{2\pi RC} = 1{,}1\,kHz$$

$$\frac{1}{\omega C} = 500\,\Omega = \frac{1}{2\pi f C}$$

$$f = \frac{1}{2\pi\, 500 \cdot 11p} = 22{,}7\,MHz$$

---

3) $V_{visual} = |H(f)| \cdot V_{appl.}$

$|H(f)| = e^{-Kf^2}$ $\qquad B_3 \rightarrow |H(f)| = e^{-\frac{\ln\sqrt{2}}{B_3^2} f^2}$ $\qquad$ $B_3 = 420\,MHz$

$$|H(f)|_{f=300MHz} = e^{-\frac{\ln\sqrt{2}}{B_3^2}(300)^2} = 0{,}838$$

$\frac{V_{visual}}{V_{appl.}} = 0{,}838$ $\qquad V_{appl}\left(\frac{1}{0{,}838}\right) = V_{visual}$

$\frac{1}{0{,}838} = 1{,}19$ fatt. correttivo

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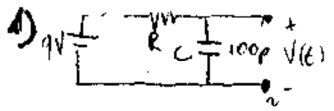
4) $t_m = \sqrt{t_s^2 + t_{ox}^2}$ $\qquad t_{ox} = \frac{340}{B_3} = \frac{340}{420} = 810\,ps$

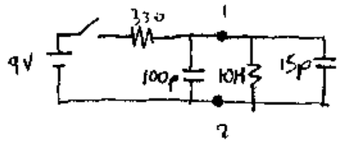
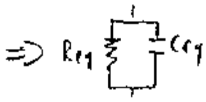
$$t_s = \sqrt{t_m^2 - t_{ox}^2} = \sqrt{(915p)^2 - (810p)^2} = 426\,ps$$

29/01/2004

1) 

$t_m = 10\,M\Omega \,//\, 15\,pF$ $\quad B_3 = 20\,MHz$

$t_{ox} = \frac{340}{B_3}$ se è passa-alto opp. $\frac{350}{B_3}$ se è passa-basso

 $\Rightarrow$ 

$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{330 \cdot 10 \cdot 10^6}{330 + 10 \cdot 10^6} = 329{,}99\ \Omega$

$C_{eq} = C_1 // C_2 = 100 \cdot 10^{-12} + 15 \cdot 10^{-12} = 115\,pF$

$\tau = RC = 329{,}99 \cdot 115 \cdot 10^{-12} = 37\,ns$ $\qquad t_s = 2{,}2\,\tau = 2{,}2 \cdot 37\,n = 83\,ns$

$t_{ox} = \frac{350}{B_3} = \frac{350}{20} = 17{,}5\,ns$ $\qquad t_s = \sqrt{t_m^2 - t_{ox}^2} \Rightarrow t_m = \sqrt{t_s^2 + t_{ox}^2} = \sqrt{83^2 + 17{,}5^2} = \underline{85{,}2\,ns}$

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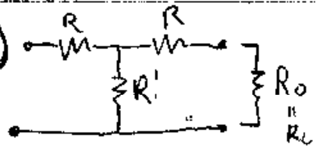
2) 

$R_0 = 50\,\Omega$ $\quad$ A = attenuazione 10 dB

$A = 10 \log \frac{P_1}{P_2} = 10 \log \left(\frac{V_1}{V_2}\right)^2 + 10 \log \left(\frac{R_{in}}{R_L}\right) = 20 \log \frac{V_1}{V_2} + 10 \log \frac{R_{in}}{R_L} =$

$= 20 \log \frac{V_1}{V_2} + \cancel{10 \log \frac{50}{50}} = 20 \log \frac{V_1}{V_2} \Rightarrow 20 \log \frac{V_1}{V_2} = 10 \Rightarrow \frac{V_1}{V_2} = \sqrt{10}$

$$\begin{cases} R = R_0 \frac{\sqrt{10} - 1}{\sqrt{10} + 1} = 50 \frac{\sqrt{10} - 1}{\sqrt{10} + 1} = \underline{26\ \Omega} \\ R' = \frac{2 R_0 \sqrt{10}}{(\sqrt{10})^2 - 1} = \frac{2 \cdot 50 \sqrt{10}}{9} = \underline{35{,}1\ \Omega} \end{cases}$$

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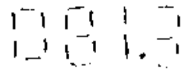
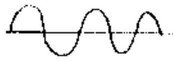
3) multimetro a $3\frac{1}{2} \Rightarrow 0 \div 1999 = 2000$ $\qquad$ portata $200\,\Omega$ (RANGE) 

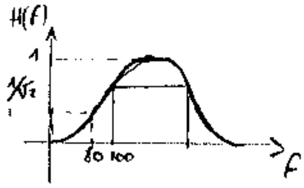
accuratezza $\pm(0{,}5\% + 6$ conteggi) (ACCURACY)

risoluzione $= \frac{\text{range}}{\text{n° cont max}} = \frac{200}{2000} = 0{,}1 \Rightarrow 6\ \text{count} = 6 \cdot 0{,}1 = 0{,}6\,\Omega$

$x \pm \delta x = 81{,}3 \pm \left(\frac{81{,}3 \cdot 0{,}5}{100} + 0{,}6\right) = 81{,}3 \pm 1\,\Omega$ $\qquad$ incertezza $\underline{1\,\Omega}$

Esempio Prova Scritta

1)  $B_3 = 100\,MHz$ $|V| = 100\,mV$ $f = 80\,MHz = \frac{4}{5} B_3$



$H(f)$ = risposta in frequenza dell'oscilloscopio con antenna ...

$H(f) = e^{-Kf^2}$

$H(80MHz) > 100\,mV = \frac{1}{10}\,mV = H\left(\frac{4}{5}B_3\right)$

$H(100\,MHz) = H(B_3) = \frac{1}{\sqrt{2}} = ?$

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$H(B_3) = \frac{1}{\sqrt{2}} = e^{-kB_3^2} = 2^{-1/2} = e^{-kB_3^2} \Rightarrow \frac{1}{2}\ln 2 = kB_3^2 \Rightarrow k = \frac{\ln 2}{2B_3^2}$

$H\left(\frac{4}{5}B_3\right) = e^{-\frac{\ln 2}{2B_3^2}\left(\frac{4}{5}B_3\right)^2} = e^{-\frac{8}{25}\ln 2} = 0,80 \Rightarrow 80\%$ rispetto a B_3

errore % $= (1 - 0,8) \cdot 100 = 20\%$

$80MHz : 100\,mV = 100MHz : X\,mV \Rightarrow X = \frac{100 \cdot 100}{80} = \underline{125\,mV}$

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2) $G = 20\,dB$ $R_{in} = 50\,\Omega$ $R_L = 50\,\Omega$ $P_{max} = 10\,W$

$G = 10\log\frac{P_2}{P_1} = 20\log\left(\frac{V_2}{V_1}\right) + 10\log\left(\frac{R_{in}}{R_L}\right) = 20\log\left(\frac{V_2}{V_1}\right) + \cancel{10\log\left(\frac{50}{50}\right)} \Rightarrow 20\log\frac{V_2}{V_1} = 20$

$\frac{V_2}{V_1} = 10^{20/20} = 10$ $P_2 = 10\,W = V_2^2/R_L$ $V_2 = \sqrt{P_2 R_L} = \sqrt{10 \cdot 50} = \sqrt{500} = 22,4\,V$

$V_1 = \frac{V_2}{10} = \frac{22,4}{10} = \underline{2,24\,\Omega}$

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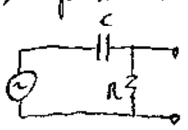
3) passa alto

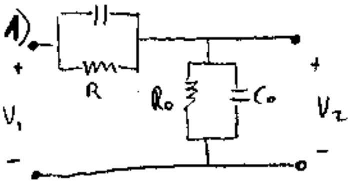


$f = 300\,KHz$ $R_L = 2,5\,\Omega$ $N_{spire} = 8$ $V_L = 15\,mV$ $f = 560\,KHz$

$f_c = \frac{R}{2\pi L}$ $L = \frac{R}{2\pi f_c}$ $M = \frac{L}{N} = \frac{R}{N 2\pi f_c}$

$R_T = \frac{R_L}{N} = 0,3125\,\Omega$ $|Z_T| = \left|\frac{V}{I}\right|$ $|I| = \frac{|V|}{R_T} = \frac{15\,mV}{0,3125\,\Omega} = 48\,mA$

1)



$R_o = 270\,k\Omega$ $C_o = 150\,pF$ $A = 30\,dB$

L'attenuatore compensato ha $RC = R_o C_o$

$$V_2 = \frac{R_o V_1}{R+R_o} \qquad \frac{V_2}{V_1} = \left(\frac{R_o V_1}{R+R_o}\right)\frac{1}{V_1} = \frac{R_o}{R+R_o}$$

$$A = 10\log\frac{P_1}{P_2} \Rightarrow A = 20\log\frac{V_1}{V_2} \Rightarrow \frac{V_1}{V_2} = \sqrt{1000}$$

$$\frac{R_o}{R+R_o} = \frac{1}{\sqrt{1000}} \Rightarrow \sqrt{1000}\,R_o = R+R_o \Rightarrow R = 30{,}62\,R_o = \underline{6{,}74\,M\Omega}$$

$$C = \frac{R_o C_o}{R} = \frac{270\cdot 10^{3}\cdot 150\cdot 10^{-12}}{6{,}74\cdot 10^{6}} = \underline{4{,}9\,pF}$$

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2) portata 320 mA cont max 3200 accuratezza $\pm(2\% + 2\,\text{count})$ 215.2

$$\text{risoluzione} = \frac{320\,m}{3200} = 0{,}1\,mA \qquad 2\,\text{count} = 2\cdot 0{,}1\,m = 0{,}2\,mA$$

$$x \pm \delta x = 215{,}2 \pm \left(\frac{215{,}2\cdot 2}{100} + 0{,}2\,m\right) = 215{,}2 \pm 4{,}5\,A \qquad \text{incertezza } \underline{4{,}5\,A}$$

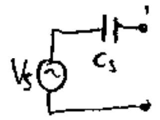
$4\frac{1}{2} \Rightarrow \underbrace{0 \div 19999}_{20000}$ portata 2000 mA accuratezza $\pm(3\% + 5\,\text{count})$

$$\text{risoluzione} = \frac{2000\,m}{20000} = 0{,}1\,mA \qquad 5\,\text{count} = 5\cdot 0{,}1\,m = 0{,}5\,mA$$

$$x \pm \delta x = 215{,}2 \pm \left(\frac{215{,}2\cdot 3}{100} + 0{,}5\,m\right) = 215{,}2 \pm 6{,}95\,A \qquad \text{incertezza } 6{,}95\,A$$

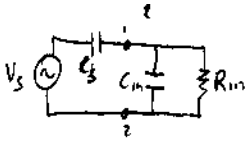
---

3)



$R_{in} = 10\,M\Omega$ $C_{in} = 100\,pF$ $V_s = 25\,V$ $C_s = 50\,pF$ $f = 500\,Hz$

$\omega = 2\pi f$

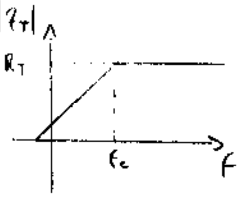


Invece di fare il parallelo delle impedenze $\bar{Z}$ si opta per l'inverso della serie delle ammettenze $\bar{Z} = \frac{1}{\bar{Y}}$ cioè $\left(\frac{1}{\frac{1}{R_{in}} + j\omega C_{in}}\right)$

si fa il partitore di tensione

$$V_{12} = \frac{V_s}{\frac{1}{j\omega C_s} + \frac{R_{in}}{1+j\omega C_{in} R_{in}}}\;\frac{R_{in}}{1+j\omega R_{in} C_{in}} = \frac{j\omega R_{in} C_s}{1+j\omega R_{in}(C_{in}+C_s)}\,V_s$$

$$|V_{12}| = \frac{2\pi f R_{in} C_s |V_s|}{\sqrt{1^2 + (2\pi f R_{in}(C_{in}+C_s))^2}} = \underline{8{,}15\,V}$$

1) 

$f_c = 300\,kHz$ per $f > f_c \Rightarrow$ [illegible]

sonda chiusa su $R = 50\,\Omega$ $|V| = 2\,mV$

$f = 1\,kHz$

$R_T = 2\pi f M$ $M = \frac{R_T}{2\pi f_c}$ $\Rightarrow R_T = 2\pi f \frac{M}{2\pi f_c} = \cancel{2\pi} f \frac{1}{\cancel{2\pi} f_c} = f/f_c = 3{,}3\,m\Omega$

$|I| = \left|\frac{V}{Z}\right| = \frac{2m}{3{,}3m} = 0{,}61\,mA$

1 luglio 03

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2) $F = \frac{A \cdot s}{V} = \frac{s}{\Omega} = s\,\Omega^{-1}$

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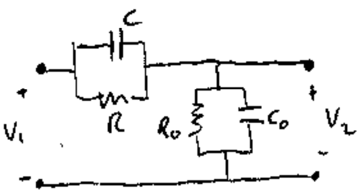
4) 

$\rho = \frac{V_2}{V_1}$ $\rho_1 = \frac{1}{100}$ $\rho_2 = \frac{1}{1000}$

$RC = R_0 C_0$

$$\rho = \frac{V_2}{V_1} = \frac{R_0}{R + R_0}$$

$\rho_1 = \frac{1}{100} = \frac{R_0}{R + R_0} \Rightarrow R + R_0 = 100 R_0 \Rightarrow R = 99 R_0\ \Omega$ $C = \frac{R_0 C_0}{R} = \frac{\cancel{R_0} C_0}{99 \cancel{R_0}} = \frac{C_0}{99}\ F$

$\rho_2 = \frac{1}{1000} = \frac{R_0}{R + R_0} \Rightarrow R + R_0 = 1000 R_0 \Rightarrow R = 999 R_0\ \Omega$ $C = \frac{R_0 C_0}{R} = \frac{\cancel{R_0} C_0}{999 \cancel{R_0}} = \frac{C_0}{999}\ F$

$$99 R_0 \frac{C_0}{99} = 999 R_0 \frac{C_0}{999} = RC$$

1) $f = \frac{3}{5} B_3$ $\quad |H(f)|$ gaussiana $\quad H(f) = e^{-kf^2}$ $\quad k > 0$

22 luglio 03

$H(B_3) = \frac{1}{\sqrt{2}} \Rightarrow \frac{1}{\sqrt{2}} = e^{-kB_3^2} \Rightarrow k = \frac{\ln 2}{2B_3^2}$

$H\left(\frac{3}{5}B_3\right) = e^{-\frac{\ln 2}{2B_3^2}\left(\frac{3}{5}B_3\right)^2} = e^{-\frac{9}{50}\ln 2} = 0{,}883$

errore % $= (1 - 0{,}883) \cdot 100 = 11{,}7\%$

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2) $4\frac{1}{2} \Rightarrow \underbrace{0 \div 19999}_{20000}$ $\quad$ portata 2000 mA $\quad$ accuratezza $\pm(5\% + 8\,\text{count})$ $\quad$ 534.1 mA

risoluzione $= \frac{2000\,m}{20000} = 0{,}1$ mA $\qquad 8\,\text{count} = 8 \cdot 0{,}1\,m = 0{,}8$ mA

$x \pm \delta x = 534{,}1 \pm \left(\frac{534{,}1 \cdot 5}{100} + 0{,}8\,m\right) = 534{,}1 \pm 27{,}5$ mA $\qquad$ incertezza $27{,}5$ mA

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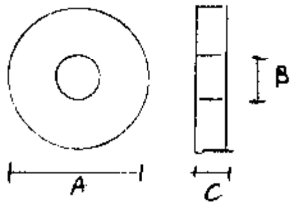
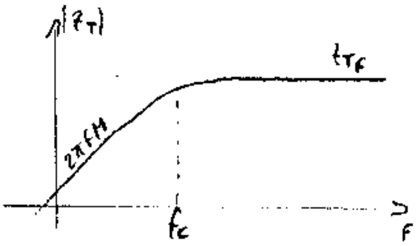
3) $N = 50$ spire $\quad \mu_r = 1000 \quad A = 5$ cm $\quad B = 3$ cm $\quad C = 2$ cm $\quad f_c = ? \quad R_T = ?$ per $f > f_c$

il secondario è chiuso su $R = 100\,\Omega$



se $f > f_c \Rightarrow Z_T \simeq \frac{R}{N} = Z_{TF} \Rightarrow R_T = \frac{RM}{L}$ $\qquad L = M \cdot N$

$f_c = \frac{R}{2\pi L}$



$M = \frac{\Phi_{spire}}{I_{primario}} = \frac{N\mu_r\mu_0 C \ln(A/B)}{2\pi} = \frac{50 \cdot 1000 \cdot 4\pi \cdot 10^{-7} \cdot 0{,}02}{2\pi} \ln\left(\frac{0{,}05}{0{,}03}\right) = 10{,}22 \cdot 10^{-5}$ H

$L = M \cdot N = 10{,}22 \cdot 10^{-5} \cdot 50 = 510{,}82 \cdot 10^{-5}$ H

$f_c = \frac{100}{2\pi \cdot 510{,}82 \cdot 10^{-5}} = 3115{,}64$ Hz

$R_T = \frac{RM}{L} = \frac{100 \cdot 10{,}22 \cdot 10^{-5}}{510{,}82 \cdot 10^{-5}} \simeq 2\,\Omega$

1) $f = \frac{2}{3} B_3$ $\quad |H(f)|$ gaussiano $\quad |H(f)| = e \quad k > 0$

$$|H(B_3)| = \frac{1}{\sqrt{2}} \Rightarrow e^{-kB_3^2} = \frac{1}{\sqrt{2}} \Rightarrow 2^{-1/2} = e^{-kB_3^2} \Rightarrow \frac{1}{2}\ln 2 = kB_3^2 \Rightarrow k = \frac{\ln 2}{2B_3^2}$$

$$\left|H\left(\tfrac{2}{3}B_3\right)\right| = e^{-\frac{\ln 2}{2B_3^2}\left(\frac{2}{3}B_3\right)^2} = e^{-\frac{2}{9}\ln 2} = 0{,}857 \Rightarrow 0{,}86\%$$

21 nov 02

errore % $\Rightarrow (1 - 0{,}857)\cdot 100 = \underline{\underline{14{,}2\%}}$

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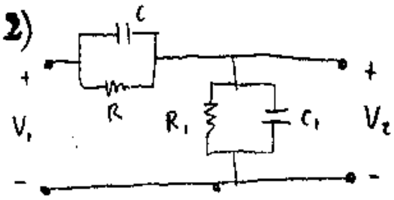
2)



$R_1 = 1M\Omega \quad C_1 = 120\,pF$

$\rho = 1{:}100$ partitore compensato RC

$R = ?\ C = ?\ Z_{in} = ?$

$$RC = R_1 C_1 \qquad \rho = \frac{V_2}{V_1} = \frac{R_1}{R + R_1} \qquad V_2 = \frac{R_1 V_1}{R + R_1} \qquad \frac{V_2}{V_1} = \left(\frac{R_1 V_1}{R + R_1}\right)\frac{1}{V_1} = \frac{R_1}{R + R_1}$$

$$\frac{1}{100} = \frac{R_1}{R + R_1} \Rightarrow R + R' = 100R' \Rightarrow R = 99R_1 = \underline{\underline{99\,M\Omega}}$$

$$C = \frac{R_1 C_1}{R} = \frac{1M \cdot 120p}{99M} = \underline{\underline{1{,}2\,pF}}$$

$$Z_{in} = (R_{in} + R_1) \parallel \left(\frac{C_{in} C_1}{C_{in} + C_1}\right) \Rightarrow \quad C_{in} = \frac{1}{1 + j\omega C_{in}} \quad C = \frac{1}{1 + j\omega C_1} \quad //$$

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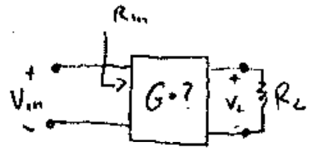
3)



$V_L = 100\,mV$

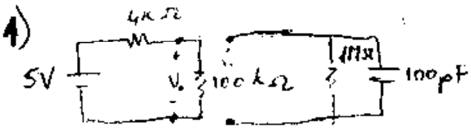
$R_L = 50\,\Omega$

$V_{in} = 10\,mV$

$R_{in} = 1\,k\Omega$

$$G = 20\log\left(\frac{V_L}{V_{in}}\right) + 10\log\left(\frac{R_{in}}{R_L}\right) = 20\log\left(\frac{100m}{10m}\right) + 10\log\left(\frac{1k}{50}\right) =$$

$$= 20 + 13 = 33\,dB$$

4) 

uscita a
visto che la corrente è in continua il

18 sett 2003

$$5 \cdot \frac{100K}{100K+4K} = 4{,}8\ V \Rightarrow V_1$$

$$5 \cdot \frac{\frac{100K \cdot 1M}{100K+1M}}{\left(\frac{100K \cdot 1M}{100K+1M}\right)+4K} = 4{,}789\ V \Rightarrow V_2$$

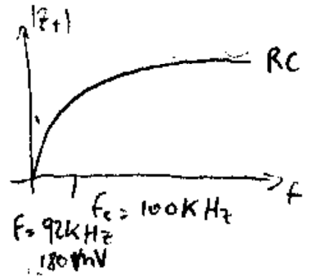
$$\text{errore \%} = 1 - \frac{V_2}{V_1} = 1 - \frac{4{,}789}{4{,}8} = 0{,}2\%$$

2) $4\frac{1}{2}$ portata 200 mV accuratezza 200 mV $\pm(1\% + 8 \text{ conteggi})$

67.83 mV $\quad 0 \div 19999 \to 20000$

$$\text{risoluzione} = \frac{\text{portata}}{\text{n° conteggi}} = \frac{200}{20000} = 0{,}01 \qquad 8 \text{ conteggi} = 8 \cdot 0{,}01 = 0{,}08\ mV$$

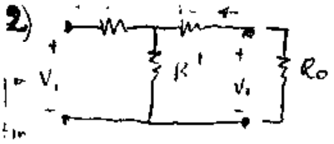
$$x \pm \delta x = 67{,}83 \pm \left(\frac{67{,}83 \cdot 1}{100} + 0{,}08\right) = 67{,}83 \pm 0{,}76\ mV \qquad \text{incertezza} = 0{,}76\ mV$$

3) 

$$|Z_T| = \frac{f/f_c}{\sqrt{1+(f/f_c)^2}} R_T = \frac{f/f_c}{\sqrt{1+(f/f_c)^2}} RC =$$

$$= \frac{\frac{92K}{100K}}{\sqrt{1+\left(\frac{92K}{100K}\right)^2}} \cdot 2 = 1{,}35\ \Omega$$

$$|Z_T| = \left|\frac{V}{I}\right| \Rightarrow |I| = \left|\frac{V}{Z_T}\right| = \frac{180m}{1{,}35} = 0{,}133A = 133mA$$

2) 

$A = 6\ dB$

$A = 10 \log \frac{P_1}{P_2} = 20 \log \frac{V_1}{V_2} = 6 dB \qquad \frac{V_1}{V_2} = \sqrt[20]{10^6} = 1,99 \simeq 2$

$R = R_0 \frac{2-1}{2+1} = \frac{50}{3} = 16,6\,\Omega \qquad R' = \frac{2 \cdot R_0 \cdot 2}{2^2 - 1} = \underline{\underline{66,6\,\Omega}}$

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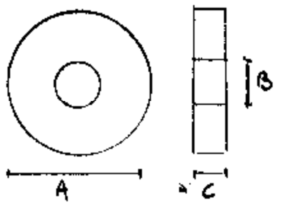
3) 

$\mu_r = 800 \quad A = 3,5\,cm \quad B = 2\,cm \quad C = 1,3\,cm \quad N = 20_{spire}$

sonda chiusa su $R = 50\Omega$ $\qquad |Z_T| = ?$

$Z_T = \frac{J\omega M}{R + J\omega L_2} R \qquad M = \frac{\Phi_{spire}}{I_{primario}} = \frac{N \mu_r \mu_0 C \ln(A/B)}{2\pi} = \frac{20 \cdot 800 \cdot 4\pi \cdot 10^{-7} \cdot 0,013 \ln(0,035/0,02)}{2\pi}$

$= 23,3 \cdot 10^{-5}\,H$

$L_2 = M \cdot N = 23,3 \cdot 10^{-5} \cdot 20 = 4,66 \cdot 10^{-3}\,H = 4,66\,mH$

$Z_T = \frac{J\omega\ 23,3 \cdot 10^{-5} \cdot 50}{50 + J\omega\ 4,66 \cdot 10^{-3}}$ //

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4)

$T = \frac{V \cdot s}{m^2} = \frac{J\,s}{Q\,m^2} = \frac{N \cdot m \cdot s}{A \cdot s \cdot m^2} = \frac{Kg \cdot \cancel{m} \cdot \cancel{s}}{s^2 \cdot A \cdot \cancel{s} \cdot \cancel{m}} = \frac{Kg}{s^2 A}$ //

20/2/03