WIRKLEISTUNG 2 4G MD

1) $R = 1 \cdot 10^6\ \Omega$ $d = 2\,mm$ Reihenschaltung

$C = \varepsilon_0 \frac{A}{d}$ $A = \ell^2 = (20\,cm)^2$ $U = 15\,V$

a) $U_R = U_C$ $U = \sqrt{U_R^2 + U_C^2} = U_R\sqrt{2} \Rightarrow U_R = U_C = \frac{U}{\sqrt{2}}$

$U_R = R\,I = Z_C \cdot I = U_C \Rightarrow R = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$f = (2\pi RC)^{-1} = \left(\frac{d}{2\pi R \varepsilon_0 A}\right) = \frac{0{,}002\,m}{2\pi \cdot 10^6\,\Omega \cdot 8{,}85\cdot 10^{-12}\,\frac{C^2}{Nm^2} \cdot (0{,}2\,m)^2} = 899\,Hz$

b) $Z_{TOT} = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2} = \sqrt{R^2 + R^2} = R\sqrt{2}$

↳ weil Spannung gleich und Strom auch.

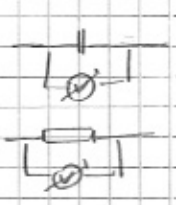
$I = \frac{U}{Z_{TOT}} = \frac{15\,V}{10^6 \cdot \sqrt{2}\,\Omega} = 10{,}6\,\mu A$

c) $U_R = U_C = \frac{U}{\sqrt{2}} = 10{,}6\,V$

d) $Z_{TOT,neu} = \sqrt{(R + R_A)^2 + \underbrace{\left(\frac{1}{\omega C}\right)^2}_{R}}$

$I = \frac{U}{Z_{neu}} = \frac{U}{\sqrt{(R+R_A)^2 + R^2}} = \frac{15\,V}{\sqrt{1101^2 + 1^2} \cdot 10^6\,\Omega} = 10{,}354\,\mu A = 10{,}6\,\mu A$

$\frac{R_i}{Z} = \frac{10\,k\Omega}{\sqrt{2} \cdot 10^6\,\Omega} = 0{,}7\,\%$ → erst bei der 4° Ziffer sichtbar.

e) 

$\frac{R_i}{Z_C} = \frac{R_i}{R} = \frac{30\,k\Omega}{10^6\,\Omega} = 3\,\%$

⇒ R und C werden jeweils fast kurzgeschlossen.

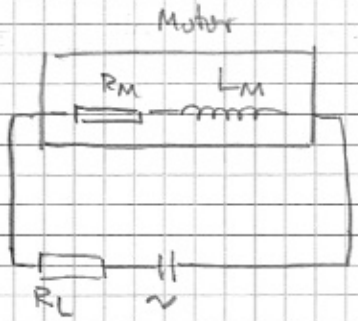
$Z_{TOT} = \sqrt{\left(\frac{1}{R} + \frac{1}{R_i}\right)^{-2} + R^2} = 1000424\,\Omega$

$I = \frac{U}{Z_{TOT}} = 14{,}99\,\mu A$ $U_R = \left(\frac{1}{R} + \frac{1}{R_i}\right)^{-2} \cdot I = \underline{0{,}44\,V}$

statt 10,6 V

2a) $I = \frac{U_M}{Z_M} = \frac{U_M}{\sqrt{R_M^2 + (2\pi f L_M)^2}} = \frac{230\,V}{\sqrt{(80\,\Omega)^2 + (2\pi \cdot 50\,\frac{1}{s} \cdot 0{,}1\,H)^2}} = 2{,}68\,A$

2b)



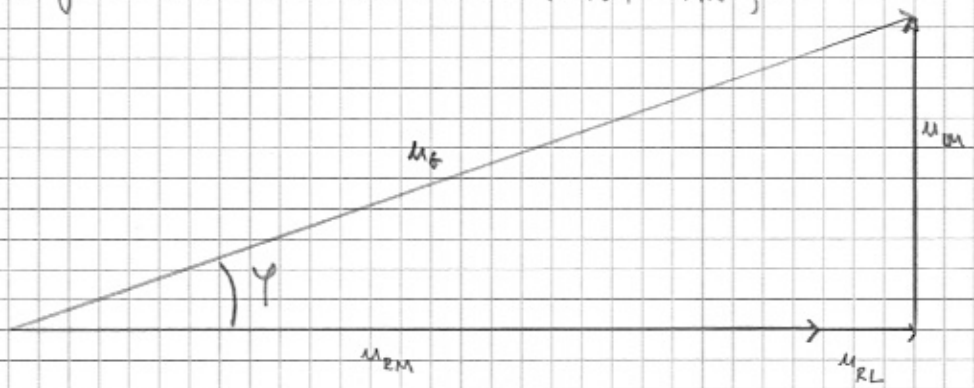
$U_M = 230\,V \quad 50\,Hz$

$U_{RM} = R_M \cdot I \sim 214\,V$

$U_{LM} = Z_L\, I \sim 84\,V$

$U_{RL} = R_L\, I \sim 27\,V$

Wirkspannungen werden addiert (U_{RL}, U_{RM})



2c) $U_G = \sqrt{(U_{RM}+U_{RL})^2 + U_{LM}^2} = I \cdot \sqrt{(R_M+R_L)^2 + (2\pi f L)^2} =$

$= \frac{U_M}{\sqrt{R_M^2 + (2\pi f L)^2}} \cdot \sqrt{(R_M+R_L)^2 + (2\pi f L)^2} = \frac{230\,V \sqrt{(80\Omega+10)^2\Omega^2 + (2\pi\, 50Hz\, 0{,}1H)^2}}{\sqrt{(80\Omega)^2 + (2\pi\, 50Hz \cdot 0{,}1H)^2}} = 255\,V$

$\left[\varphi = \arctan\left(\frac{84}{214+27}\right) = 19{,}2°\right]$

2d) $S = U_M \cdot I = \frac{U_M^2}{\sqrt{R_M^2 + (2\pi f L)^2}} = \frac{(230\,V)^2}{\sqrt{(80\Omega)^2 + (2\pi \cdot 50Hz \cdot 0{,}1H)^2}} = \underline{\underline{615\,VA}}$

$P = I^2 R = \frac{U_M^2 \cdot R_M}{R_M^2 + (2\pi f L)^2} = \frac{(230V)^2 \cdot 80\Omega}{(80\Omega)^2 + (2\pi \cdot 50Hz\, 0{,}1H)^2} = \underline{\underline{573\,W}}$

(auch $S \cdot \cos\varphi$)

$Q = \sqrt{S^2 - P^2} = \frac{U_M^2}{\sqrt{R_M^2 + Z_L^2}} \sqrt{1 - \frac{R_M^2}{R_M^2 + Z_L^2}} = \frac{(230V)^2 \sqrt{1 - \frac{(80\Omega)^2}{(80\Omega)^2 + (2\pi \cdot 50\frac{1}{s} \cdot 0{,}1H)^2}}}{\sqrt{(80\Omega)^2 + (2\pi \cdot 50\frac{1}{s} \cdot 0{,}1H)^2}} =$

$= \underline{\underline{223\,VAR}}$

($[S] = VA \quad [P] = W \quad [Q] = VAR$)