Musterlösung Bonustest 2 GET-B SS 2007

1.1
Version A/B:

$$\underline{Z} = R + \frac{j\omega L \cdot \frac{1}{j\omega C}}{j\omega L + \frac{1}{j\omega C}} = R + \frac{j\omega L}{1 - \omega^2 LC}$$

1.2
Version A:

$$\underline{Z} = 30\Omega + j\frac{2\pi \cdot 200Hz \cdot 10mH}{1 - (2\pi \cdot 200Hz)^2 \cdot 10mH \cdot 80\mu F}$$

$$\underline{Z} = 30\Omega - j47{,}73\Omega = 56{,}37\Omega \cdot e^{-j57{,}84°}$$

Version B:

$$\underline{Z} = 30\Omega + j\frac{2\pi \cdot 200Hz \cdot 10mH}{1 - (2\pi \cdot 200Hz)^2 \cdot 10mH \cdot 47\mu F}$$

$$\underline{Z} = 30\Omega + j48{,}74\Omega = 57{,}24\Omega \cdot e^{+j58{,}39°}$$

1.3
Version A:
...kapazitiv, weil φ<0°.

Version B:
...induktiv, weil φ>0°.

1.4

Version A:

$$\underline{I_0} = \frac{\underline{U_0}}{\underline{Z}} = \frac{12V}{56{,}37\Omega \cdot e^{-j57{,}84°}} = 0{,}21A \cdot e^{+j57{,}84°}$$

$$\underline{Ic} = \frac{j\omega L}{j\omega L + \frac{1}{j\omega C}} \cdot \underline{I_0} = \frac{-\omega^2 LC}{1 - \omega^2 LC} \cdot \underline{I_0} = 4{,}80 \cdot \underline{I_0} = 1{,}01A \cdot e^{+j57{,}84°} = 0{,}54A + j0{,}86A$$

$$\underline{I_L} = \underline{I_0} - \underline{I_C} = -0{,}8A \cdot e^{j57{,}84°} = 0{,}8A \cdot e^{-j122{,}16°}$$

Version B:

$$\underline{I_0} = \frac{\underline{U_0}}{\underline{Z}} = \frac{12V}{57{,}24\Omega \cdot e^{j58{,}39°}} = 0{,}21A \cdot e^{-j58{,}39°}$$

$$\underline{Ic} = \frac{\underline{j\omega L}}{j\omega L + \frac{1}{j\omega C}} \cdot \underline{I_0} = \frac{-\omega^2 LC}{1-\omega^2 LC} \cdot \underline{I_0} = -2{,}88 \cdot \underline{I_0} = -0{,}6A \cdot e^{-j58{,}39°} = 0{,}6A \cdot e^{j121{,}61°}$$

$$\underline{I_L} = \underline{I_0} - \underline{I_C} = 0{,}81A \cdot e^{-j58{,}39°}$$

1.5
Version A:

$$S = U_0 \cdot I_0 = 12V \cdot 0{,}21A = 2{,}52VA$$
$$P = U_0 \cdot I_0 \cdot \cos\varphi = 1{,}34W$$
$$Q = U_0 \cdot I_0 \cdot \sin\varphi = -2{,}13VA$$

Version B:

$$S = U_0 \cdot I_0 = 12V \cdot 0{,}21A = 2{,}52VA$$
$$P = U_0 \cdot I_0 \cdot \cos\varphi = 1{,}32W$$
$$Q = U_0 \cdot I_0 \cdot \sin\varphi = 2{,}15VA$$

1.6
Version A: a – Induktivität

Version B: b – Kapazität

Version A/B:
b – Blindleistung Q_B des Bauelements = negative Blindleistung Q des Netzwerks
c – Das Netzwerk ist nicht mehr kompensiert ($Q \neq 0$ VA)

2.1
Version A:

$$\underline{H}_{(j\omega)} = \frac{R}{R + \frac{1}{j\omega C}} = \frac{j\omega RC}{1 + j\omega RC} = \frac{j\omega RC \cdot (1 - j\omega RC)}{1 + (\omega RC)^2} = \frac{(\omega RC)^2}{1 + (\omega RC)^2} + j\frac{\omega RC}{1 + (\omega RC)^2}$$

$$\tau = RC = 1\Omega \cdot 200mF = 200ms$$

Version B:

$$\underline{H}_{(j\omega)} = \frac{j\omega L}{R + j\omega L} = \frac{j\omega L(R - j\omega L)}{R^2 + (\omega L)^2} = \frac{j\omega LR + (\omega L)^2}{R^2 + (\omega L)^2} = \frac{\left(\omega \frac{L}{R}\right)^2}{1 + \left(\omega \frac{L}{R}\right)^2} + j\frac{\omega \frac{L}{R}}{1 + \left(\omega \frac{L}{R}\right)^2}$$

$$\tau = \frac{L}{R} = \frac{50mH}{1\Omega} = 50ms$$

2.2

Version A/B:

$$\left|\underline{H}_{(j\omega)}\right| = \frac{\sqrt{(\omega\tau)^4 + (\omega\tau)^2}}{1 + (\omega\tau)^2} = \frac{\omega\tau\sqrt{1 + (\omega\tau)^2}}{1 + (\omega\tau)^2} = \frac{\omega\tau}{\sqrt{1 + (\omega\tau)^2}}$$

$$\varphi_{(\omega)} = \arctan\left(\frac{\mathrm{Im}}{\mathrm{Re}}\right) = \arctan\left(\frac{\omega\tau}{(\omega\tau)^2}\right) = \arctan\left(\frac{1}{\omega\tau}\right)$$

2.3

Version A:

$$45° = \arctan\left(\frac{1}{\omega_1\tau}\right)$$

$$\omega_1 = \frac{1}{\tau \cdot \tan 45°} = \frac{1}{\tau}$$

$$\omega_1 = 5s^{-1}$$

$$f = \frac{\omega}{2\pi} = 0{,}80Hz$$

$$\left|\underline{H}_{(j\omega)}\right|_{dB} = 20\log\frac{1}{\sqrt{1+1}} = 20\log\frac{1}{\sqrt{2}} = -3dB$$

Version B:

$$45° = \arctan\left(\frac{1}{\omega_1\tau}\right)$$

$$\omega_1 = \frac{1}{\tau \cdot \tan 45°} = \frac{1}{\tau}$$

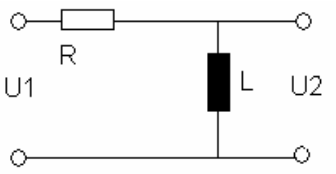
$$\omega_1 = 20s^{-1}$$

$$f = \frac{\omega}{2\pi} = 3{,}18Hz$$

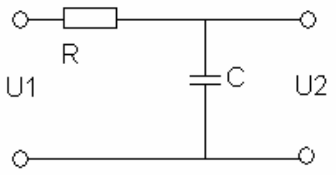
$$\left|\underline{H}_{(j\omega)}\right|_{dB} = 20\log\frac{1}{\sqrt{1+1}} = 20\log\frac{1}{\sqrt{2}} = -3dB$$

2.4

Version A:

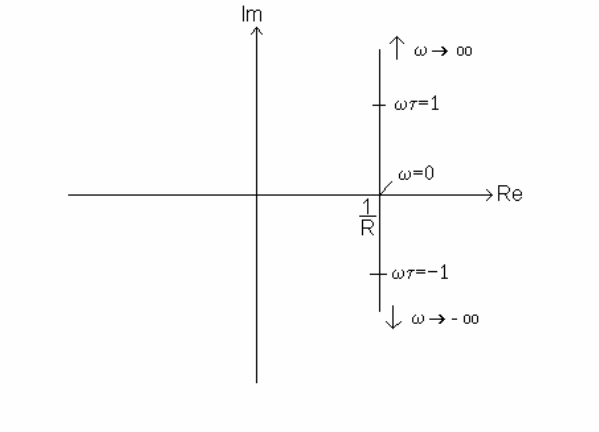


Version B:



2.5

Version A:



Version B: