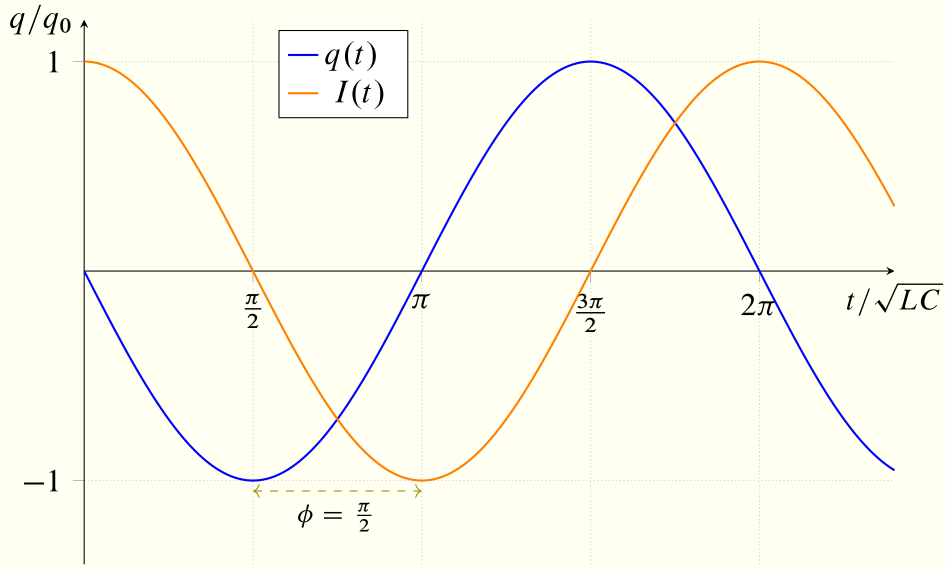
1. LC-Schaltkreis mit/ohne Wechselstrom

(a)

$$\frac{q(t)}{C} = L\frac{\mathrm{d}^2 q}{\mathrm{d}t^2}$$

$$q(t) = q_0 \cos\left(\frac{1}{\sqrt{LC}}t\right)$$



(b) $U(t) = U_{max}\cos(\omega t); \quad U_{max} = 100$ V

$$I_L = \underline{\underline{\frac{U_0}{L\omega}}}$$

$$I_C = \underline{\underline{U_0 C\omega}}$$

$$\phi_L = \underline{\underline{\frac{\pi}{2}}}$$

$$\phi_L = \underline{\underline{-\frac{\pi}{2}}}$$

$$\omega L = \frac{1}{\omega C}$$

$$\omega = \sqrt{\frac{1}{cL}} = 100 \text{ s}$$

$$I_C(t) = \underline{\underline{-U_0 C\omega\sin(\omega t)}}$$

$$I_L(t) = \underline{\underline{\frac{U_0}{L\omega}\sin(\omega t)}}$$

2. Serienschwingkreis

$$L = 0.1\ \mathrm{H}; \quad R = 100\ \Omega; \quad C = 0.47\ \mu\mathrm{F}; \quad U_0 = 3\ \mathrm{V}$$

(a) $U(t) = U_0 \mathrm{e}^{i\omega t}; \quad q(t) = \frac{I_0}{\omega i}\mathrm{e}^{i\omega t}$

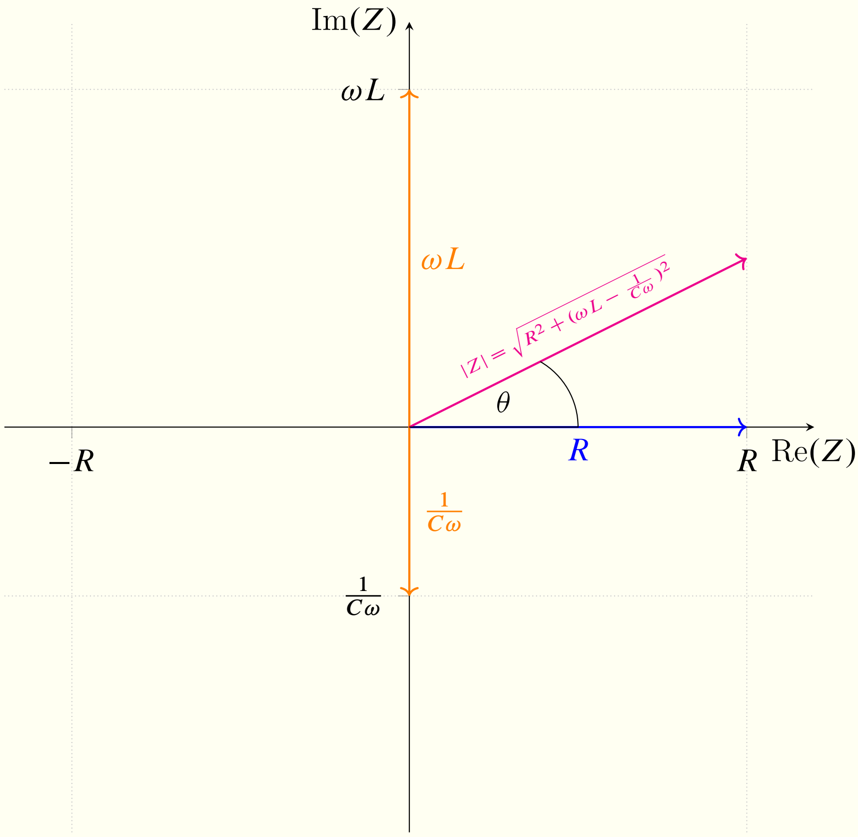
$$U(t) = R\frac{\mathrm{d}q}{\mathrm{d}t} + \frac{q(t)}{C} + L\frac{\mathrm{d}^2 q}{\mathrm{d}t^2}$$

$$U_0 = RI_0 + \frac{I_0}{\omega i C} + LI_0\omega i$$

$$I_0 = \underline{\underline{\frac{U_0}{R + L\omega i - \frac{i}{\omega C}}}}$$

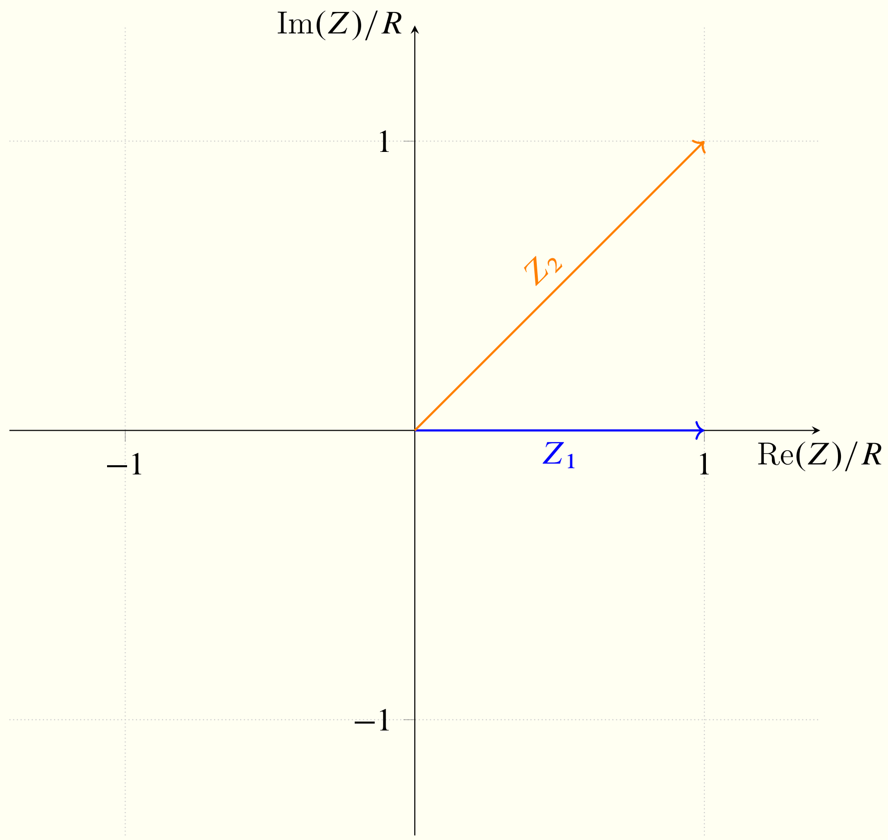
(b)

$$Z = \frac{U}{I} = R + L\omega i - \frac{i}{\omega C} = R + i\left(\omega L - \frac{1}{C\omega}\right)$$



For: $\omega L = \frac{1}{C\omega}$ $\Rightarrow$ $Z_1 = R$

For: $R = \omega L - \frac{1}{C\omega}$ $\Rightarrow$ $Z_2 = R + iR$



(c)

$$\mathrm{Im}(Z) = 0 \quad \Rightarrow \quad \omega L = \frac{1}{C\omega}$$

$$\omega = \sqrt{\frac{1}{cL}} = 4612.67 \text{ s}$$

$$\phi = \underline{\underline{\frac{\pi}{2}}}$$

3. Elektrische Verschiebung

$$\epsilon_1 = 2\epsilon_0; \quad \epsilon_2 = 1.5\epsilon_0$$

(a)

$$\vec{D}_1 = \vec{D}_2 = \underline{\underline{\sigma\hat{z}}}$$

(b)

$$\vec{E}_1 = \frac{\vec{D}_1}{\epsilon_1} = \underline{\underline{\frac{\sigma}{2\epsilon_0}\hat{z}}}$$
$$\vec{E}_2 = \frac{\vec{D}_2}{\epsilon_2} = \underline{\underline{\frac{3\sigma}{2\epsilon_0}\hat{z}}}$$

(c)

$$\vec{P}_1 = \vec{D}_1 - \epsilon_0\vec{E}_1 = \underline{\underline{\frac{\sigma}{2}\hat{z}}}$$
$$\vec{P}_2 = \vec{D}_2 - \epsilon_0\vec{E}_2 = \underline{\underline{\frac{\sigma}{3}\hat{z}}}$$

(d)

$$C = \frac{1}{\frac{a}{A\epsilon_1} + \frac{a}{A\epsilon_2}} = \frac{A\epsilon_1\epsilon_2}{a(\epsilon_1+\epsilon_2)} = \frac{6A\epsilon_0}{7a}$$
$$U = \frac{Q}{C} = \sigma\frac{a(\epsilon_1+\epsilon_2)}{\epsilon_1\epsilon_2} = \underline{\underline{\sigma\frac{7a}{6\epsilon_0}}}$$

(e) From Top to Bottom: $\sigma, -\frac{\sigma}{2}, \frac{\sigma}{2}, -\frac{\sigma}{3}, \frac{\sigma}{3}, -\sigma$

(f)

$$\vec{E}_1 = \frac{\frac{\sigma}{2}}{\epsilon_0} = \underline{\underline{\frac{\sigma}{2\epsilon_0}}}$$
$$\vec{E}_2 = \frac{\frac{2\sigma}{3}}{\epsilon_0} = \underline{\underline{\frac{2\sigma}{3\epsilon_0}}}$$