Exercise week #2
Alternating currents and voltages

Problem 1 (in class):

Consider the electronic circuit shown in Fig. 1. A sinusoidal voltage source $\underline{U}$ with an amplitude of $U = |\underline{U}| = 100$ V at a frequency of $\omega = 2\pi \times 50$ Hz is applied across an impedance $\underline{Z}_1$. The current flowing through the circuit $\underline{I}_1$ has an amplitude of $I_1 = 10$ A. The phase between voltage and current $\phi = \angle(\underline{U}, \underline{I}_1)$ is such that it satisfies $\cos\phi = 0.8$.

Hint: it is a priori not specified if $\underline{I}_1$ lags behind $\underline{U}$, or vice-versa.

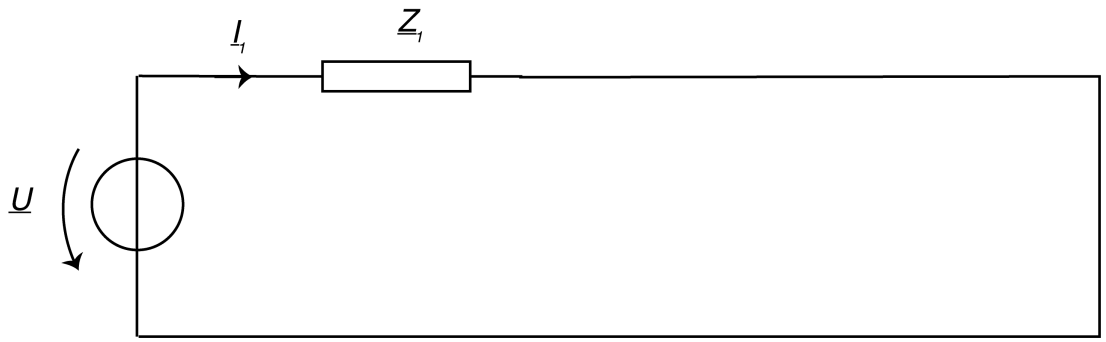

Figure 1: Electronic circuit to be considered.

In a second step, we add a capacitor with capacitance C in series as shown in Fig. 2 with the impedance $\underline{Z}_1$ and we measure a new phase ϕ_c between $\underline{U}$ and $\underline{I}_2$ so that $\cos\phi_c = 0.6$.

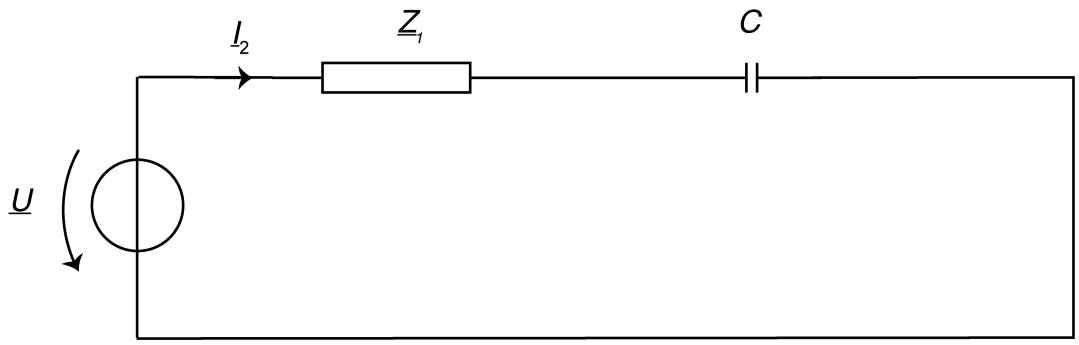

Figure 2: Electronic circuit to be considered.

a) Starting from the first circuit, determine $\underline{Z}_1 = R_1 + jX_1$. Draw possible solutions of $\underline{Z}_1$ in the complex plane.

b) Now consider the second circuit and determine C and I_2. Draw possible solutions for $\underline{Z}$ in the complex plane and find solutions graphically.

c) What can you conclude about ϕ_C after considering the second circuit?

Problem 2 (self-study):

Consider the electronic circuit shown in Fig. 3. A sinusoidal voltage source $\underline{U}$ with an amplitude of $U = |\underline{U}| = 120$ V at a frequency of $\omega = 2\pi \times 800$ Hz is applied across a voltage divider circuit with parameters as follows:

$R = 400\ \Omega$, $L = 50\ mH$, $C_2 = 400\ nF$.

a) Determine C_1 so that $U_2 = |\underline{U}_2| = 80$ V. Draw the possible values for the voltage that drops across the capacitor C_1 (that we call $\underline{U}_1$) and $\underline{U}_2$ in the complex plane to support your argument.

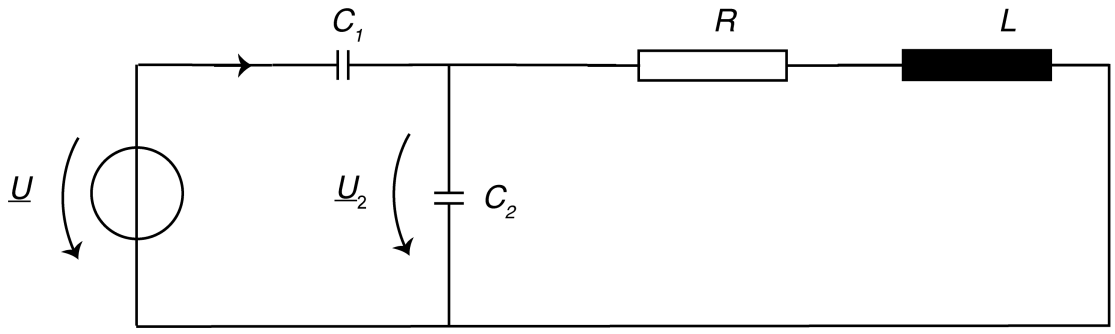

Figure 3: Electronic circuit to be considered.