

# Analysis of electrical power and energy systems

## Practical session 1

16 September 2021

### 1 Exercises<sup>1</sup>

- Express the following voltages as phasors:  
(a)  $v_1(t) = \sqrt{2} \times 100 \cos(\omega t - 30^\circ)$  V  
(b)  $v_2(t) = \sqrt{2} \times 100 \cos(\omega t + 30^\circ)$  V
- The following series R-L-C circuit (Figure 1) is in a sinusoidal steady state at a frequency of 60 Hz.  $V = 120$  V,  $R = 1.5\Omega$ ,  $L = 20$  mH and  $C = 100\mu$ F. Calculate  $i(t)$  in this circuit by using the phasor-domain analysis.

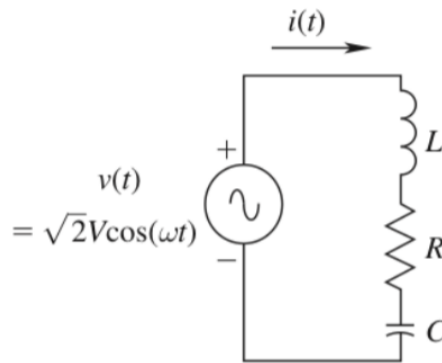


Figure 1: RLC series circuit.

- In a linear circuit in sinusoidal steady state with only one active source  $\bar{V} = 90\angle 30^\circ$  V, the current in a branch is  $\bar{I} = 5\angle 15^\circ$  A. Calculate the current in the same branch if the source voltage were to be  $100\angle 0^\circ$  V.
- To the circuit of Figure 2, if a voltage of  $100\angle 0^\circ$  V is applied, calculate  $P$ ,  $Q$  and the power factor. Show that  $Q = \sum_k I_k^2 X_k$ .
- In the circuit (Figure 3) the complex power drawn by the load impedance was calculated as  $P_L + jQ_L = (1858.4 + j1031.3)$  VA, calculate the capacitive reactance in parallel, necessary to make the overall power factor to 0.9 (leading) if the applied voltage has an rms value of 120 V.

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<sup>1</sup>Exercises 2.1, 2.2, 2.4, 2.5 and 2.9 from Ned Mohan's book "Electric power systems, a first course"

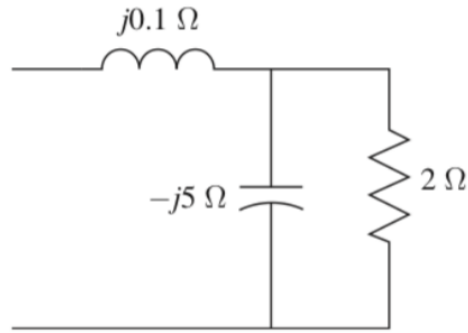


Figure 2: Ex 4 circuit.

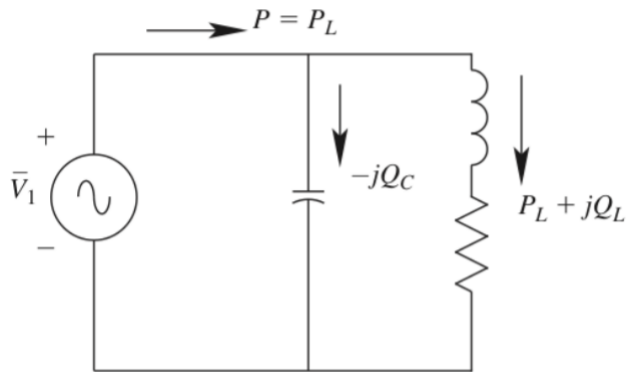


Figure 3: Power factor correction.

## 2 Solutions

- (a) (a)  $\bar{V}_1 = 100\angle -30^\circ$  V (b)  $\bar{V}_2 = 100\angle 30^\circ$  V
- (b)  $i(t) = 6.3\sqrt{2}\cos(376.99t + 1.49)$  A
- (c)  $\bar{I} = 5.556\angle -0.262$  A
- (d)  $P = 5192.64$  W,  $Q = -1775.89$  var,  $\cos\phi = 0.946$ ,  $Q_R = 0$  var,  $Q_L = 301.17$  var,  $Q_C = -2077.06$  var
- (e)  $X_C = -7.46$  Ω,  $C = 0.356$  mF