ELEC-E8422 An Introduction to Electric Energy

Homework 1 - Lecture 1 AC circuits

The voltage over an electric load and the current through it are

$$v = 340\sin(628.318t + 0.5236)\ \mathrm{V}$$
$$i = 100\sin(628.318t - 0.87366)\ \mathrm{A}$$

Calculate

1. The real mean square (rms) values of the source voltage and load current
2. The frequency of the load current
3. The impedance of the load
4. The active and reactive power drawn by the load

Solution of Homework 1

1. The real mean square (rms) values of the voltage and current are calculated as:

$$V = \frac{V_{\max}}{\sqrt{2}}$$
$$= \frac{340}{\sqrt{2}} = 240.42 \text{ V}$$

$$I = \frac{I_{\max}}{\sqrt{2}}$$
$$= \frac{100}{\sqrt{2}} = 70.71 \text{ A}$$

2. The frequency can be calculated from the angular frequency (read from the waveform)

$$\omega = 2\pi f = 628.318$$

$$f = \frac{628.318}{2\pi} = 100 \text{ Hz}$$

3. The impedance of the load is calculated as:

$$\overline{Z} = \frac{\overline{V}}{\overline{I}}$$

$$\overline{V} = 240.42 \angle 30° \text{ V}$$

$$\overline{I} = 70.71 \angle -50° \text{ A}$$

$$\overline{Z} = \frac{240.42 \angle 30°}{70.71 \angle -50°}$$
$$= 3.4 \angle 30° + 50°$$
$$= 3.4 \angle 80° \ \Omega$$

4. The active and reactive power are calculated as:

$$P = VI\cos(\theta)$$
$$= 240.42 * 70.71 * \cos(80°)$$
$$= 2.95 \text{ kW}$$

$$Q = VI\sin(\theta)$$
$$= 240.42 * 70.71 * \sin(80°)$$
$$= 16.741 \text{ kVAr}$$

The positive reactive power means that the load is consuming the power, i.e. it is an inductive load. This could be seen in the phase angle of the impedance, which is positive. Inductances consume the reactive power whereas capacitances generate the reactive power (this is just a convention!).