AC voltage controller - 2 (PE_AC_Controller_2.sqproj)

Question: For the single phase AC voltage controller shown in Fig. 1,

(a) Find the RMS values of the output votage and current if the firing angle $\alpha = 30°$.

(b) Find the output power and input power factor in this case.

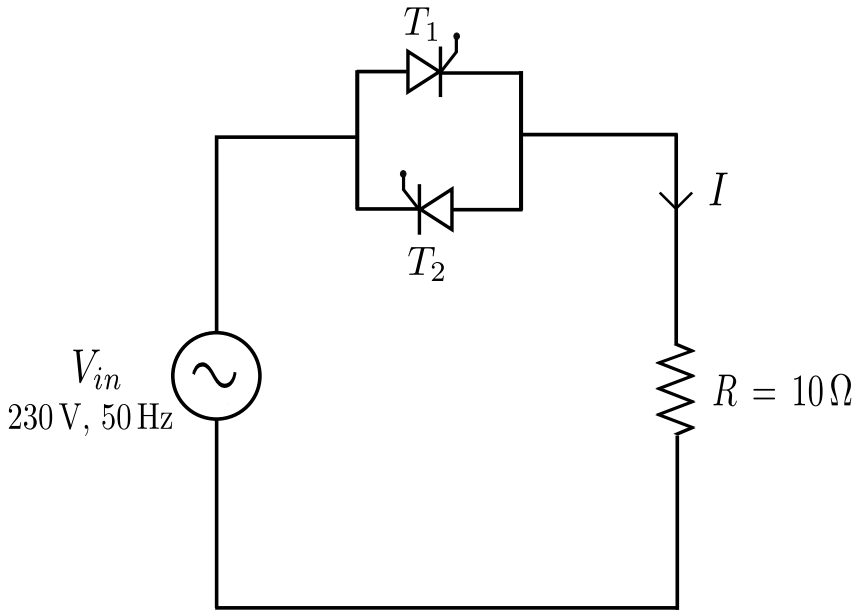

Figure 1: Single phase AC voltage controller with R load

Solution:

(a) For the single phase AC voltage controller circuit in Fig. 1, thyristor T_1 is fired at $\alpha = 30°$ and thyristor T_2 is fired at $\pi + \alpha$. The thyristor T_1 is reversed biased from π to 2π and since T_2 is fired at $\pi + \alpha$, current in the circuit is zero from π to $\pi + \alpha$. Similarly current is zero from 2π to $\pi + \alpha$. Therefore, the output voltage is also zero in these time periods. The output voltage and current waveforms are shown in Fig. 2. The RMS value of output voltage,

$$V_{out} = \sqrt{\frac{1}{\pi}\int_{\alpha}^{\pi}(V_m \sin\omega t)^2 . d\omega t} \tag{1}$$

$$\frac{V_m}{\sqrt{2}}\sqrt{\frac{1}{\pi}\left((\pi-\alpha)+\frac{1}{2}\sin 2\alpha\right)} = 226.5\,\mathrm{V} \tag{2}$$

The RMS value of output current,

$$I_{out} = \frac{V_{out}}{R} = 22.65\,\mathrm{A} \tag{3}$$

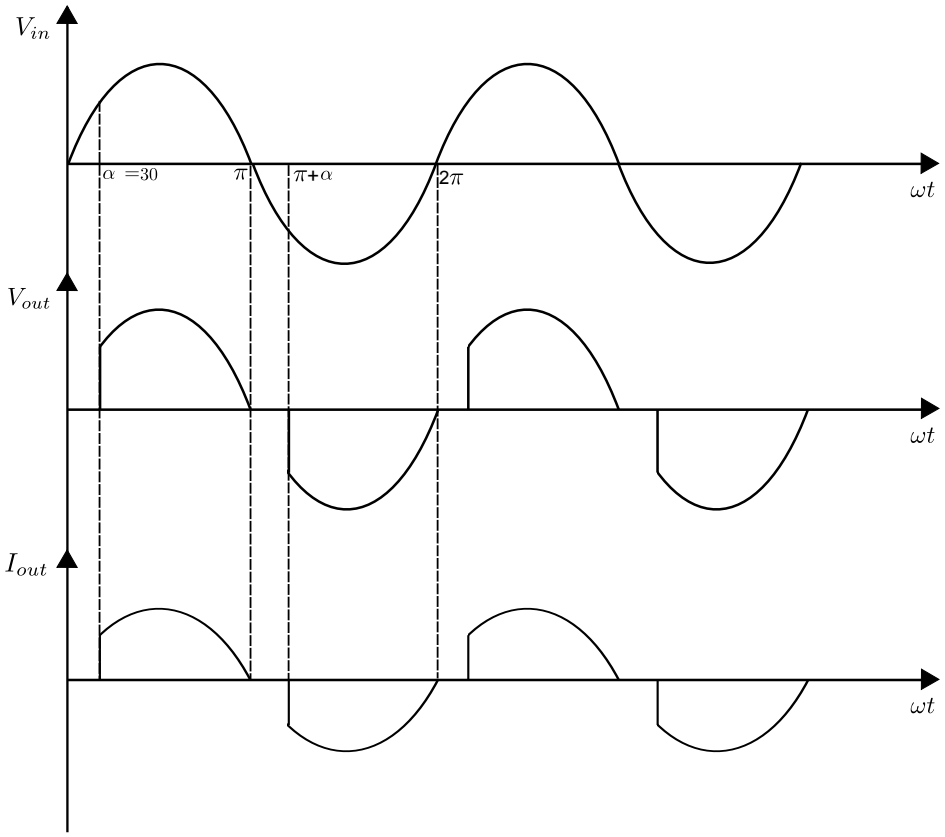

Figure 2: Output waveforms of AC voltage controller with R load

(b) The output power,

$$P_{out} = I_{out}^2 \, R = 5.13 \, k\text{W} \tag{4}$$

Since losses in thyristor switches are assumed to be zero, the input power is equal to output power.

$$P_{in} = V_{in} \, I cos\phi \tag{5}$$

$$P_{out} = V_{out} \, I \tag{6}$$

The input power factor,

$$cos\phi = \frac{V_{out} I}{V_{in} I} = 0.98 \tag{7}$$

SequelApp Exercises:

For the circuit in Fig. 1, find the following.

(a) The load resistance R to get a load power of 10 kW when $\alpha = 0$.

(b) Find the output power and the source power factor for the above value of R when the firing angle α is 45°.

Verify your answers using SequelApp.