Single Phase Semi-Controlled Rectifier - 1 (PE_rectifier_8.sqproj)

Question: For the single phase semi-controlled rectifier circuit shown in Fig. 1,

(a) Find the average output voltage (V_{out}) for the firing angle $\alpha = 30°$.

(b) Find the RMS value of the source current.

(Assume that the inductance is large enough to give a constant load current in steady state.)

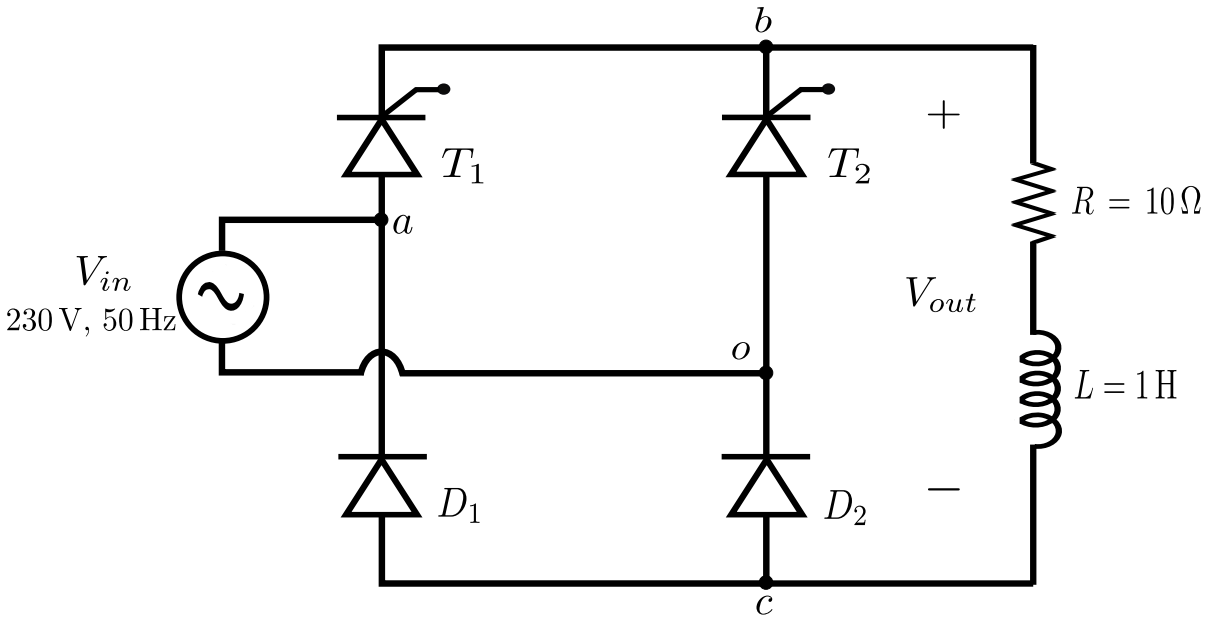

Figure 1: Semi-Controlled rectifier with RL load.

Solution:

(a) For a 1-phase semi-controlled rectifier shown in Fig. 1, the thyristor T_1 is fired at $\alpha = 30$. From α to π thyristor T_1 and diode D_2 conduct. By solving KVL, output

voltage is equal to input voltage in this duration. At $\omega t = \pi$ input voltage V_{in} reverses its polarity and since current is continuous in the load, the current freewheels through T_1 and D_1 until thyristor T_2 is fired. The output voltage V_{out} is zero in this duration.

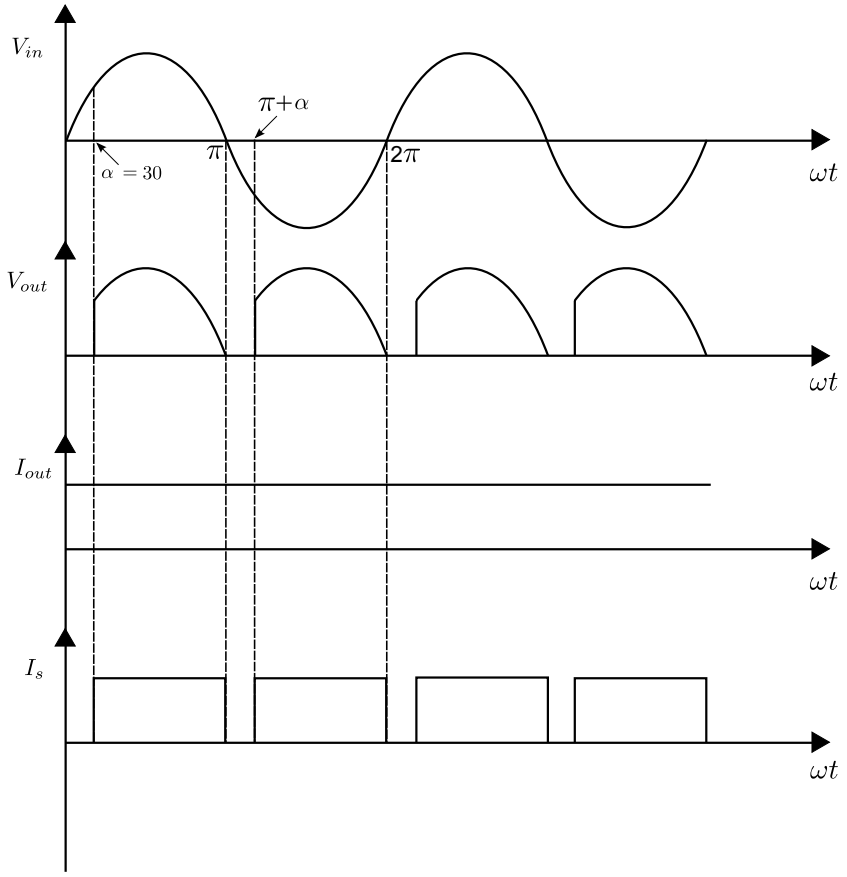

Figure 2: Input and Output waveforms of single phase semi controlled rectifier

In the negative half cycle, the thyristor T_2 is fired at $\pi + \alpha$ .From $\pi + \alpha$ to 2π thyristor T_2 and diode D_1 conduct. By solving KVL, output voltage is equal to $-V_{in}$ in this duration. At $\omega t = 2\pi$ input voltage V_{in} reverses its polarity and since current is continuous in the load, the current freewheels through T_2 and D_2 until thyristor T_1 is fired in the next cycle. The output voltage V_{out} is zero in this duration. The output

voltage waveform is shown in Fig. 2.

From the waveforms, the average value of output voltage,

$$V_{out} = \frac{1}{\pi} \int_{\alpha}^{\pi} V_m \sin(\omega t)\, d(\omega t) = \frac{V_m}{\pi} (1 + \cos\alpha) \tag{1}$$

$$V_{out} = \frac{230\sqrt{2}}{\pi} \left(1 + \frac{\sqrt{3}}{2}\right) = 193\,\mathrm{V} \tag{2}$$

(b) The average load current,

$$I_{out} = \frac{V_{out}}{R} = 19.3\mathrm{A} \tag{3}$$

Given that the current flowing through the load is constant. From α to π in a half cycle, the current to the load is flowing from the source. From π to $\pi + \alpha$, the current freewheels through the zero resistance path. This is shown in Fig. 2.

The RMS value of the source current,

$$I_{sr} = 19.3 \times \sqrt{\frac{150}{180}} = 17.6\,\mathrm{A} \tag{4}$$

SequelApp Exercises:

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

(a) The firing angle (α) to get an average output voltage $V_{out} = 150\,\mathrm{V}$.

(b) The RMS value of the source current (I_{sr}) in this case.

Verify your answers using SequelApp.