Controlled Rectifier with Source Inductance - 1 (PE_rectifier_9.sqproj)

Question: For the circuit shown in Fig. 1,

(a) Find the overlap angle (μ), if the firing angle α= 30°

(b) Find the average output voltage (V_{out}) in the above case.

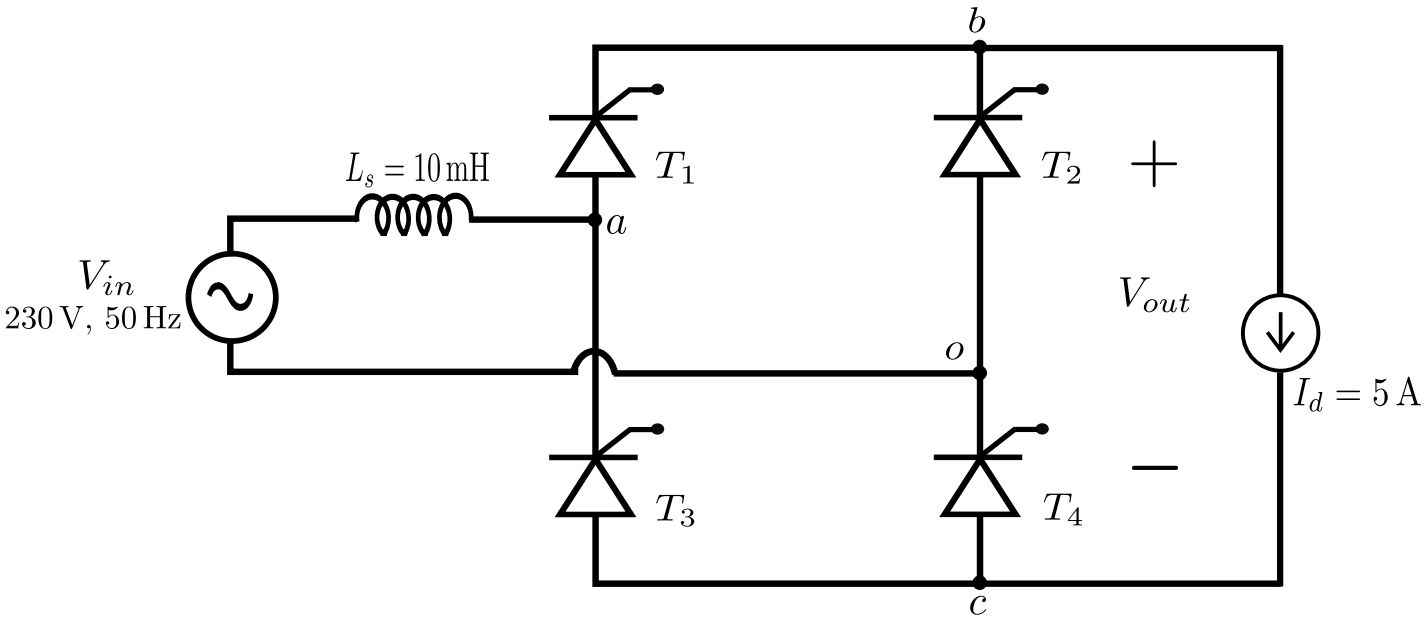

Figure 1: Controlled rectifier with Source Inductance.

Solution:

(a) For a controlled rectifier shown in Fig. 1, the current through source inductance (L_s) cannot change to zero and then to the negative peak instantaneously. This causes every thyristor to conduct together for some period of time. The bridge gets short circuited.

The output voltage V_{out} becomes zero for this overlap interval (μ) as shown in Fig. 2. In this interval V_s is dropped across Ls.

$$V_s = L_s \frac{di_s}{dt} \tag{1}$$

$$\int_{\alpha}^{\alpha+\mu} V_m \sin(\omega t)\, d(\omega t) = \omega L_s \int_{-I_d}^{I_d} di_s = 2\omega L_s I_d \tag{2}$$

$$V_m \ (cos\alpha - cos(\alpha + \mu)) \ = 2\omega L_s I_d \tag{3}$$

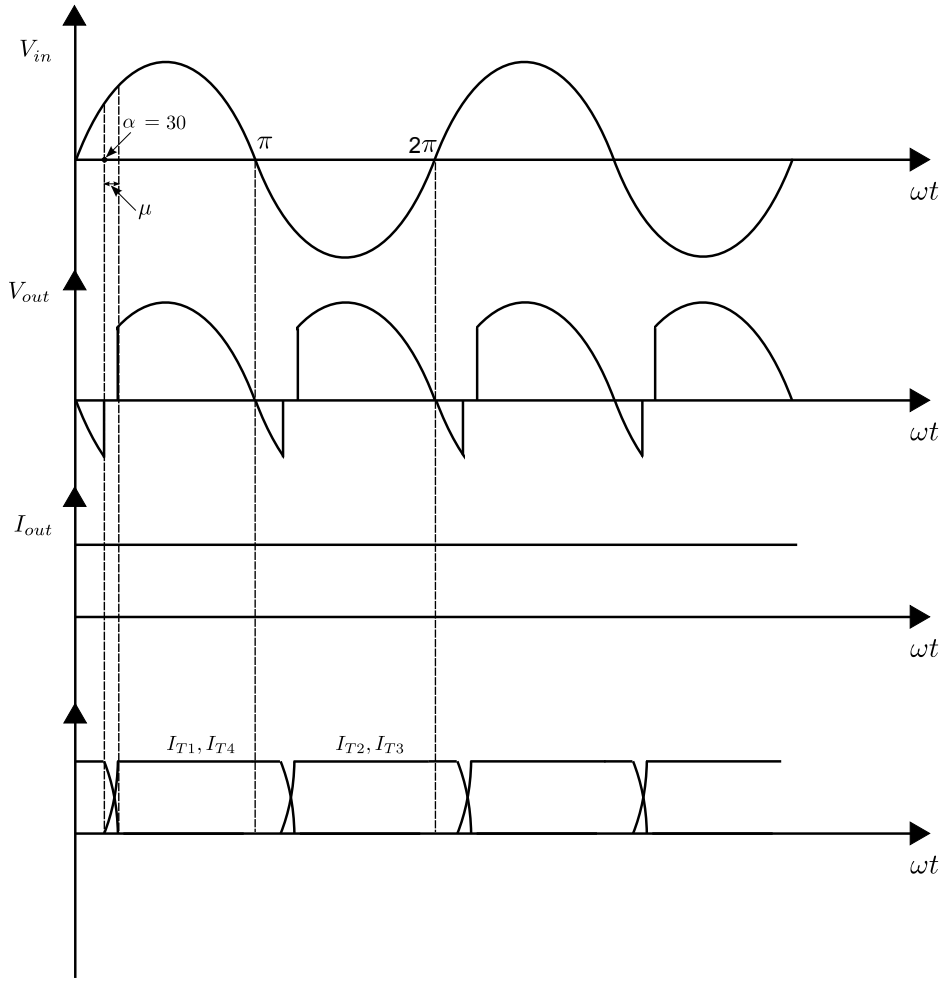

Figure 2: Input and output waveforms of single phase controlled rectifier with source inductance

The overlap angle,

$$\mu = cos^{-1}\left(\frac{\sqrt{3}}{2} - \frac{2 \times 314 \times 10 \times 10^{-3} \times 5}{230\sqrt{2}}\right) - 30^{\circ} = 9.7^{\circ} \tag{4}$$

(b) From eqn. 3, taking the average of area , reduction in output average voltage,

$$\Delta V_{out} = \frac{V_m}{\pi}\ (cos\alpha - cos(\alpha + \mu)) = \frac{2\omega L_s I_d}{\pi} \tag{5}$$

The average output voltage

$$V_{out} = \frac{2V_m}{\pi} cos\alpha - \frac{2\omega L_s I_d}{\pi} \tag{6}$$

$$V_{out} = 179.2 - 10 = 169.2 \text{ V} \tag{7}$$

SequelApp Exercises:

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

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

(b) The overlap angle (μ) in this case.

Verify your answers using SequelApp.