Three Phase Full Wave Controlled Rectifier - 1 (PE_rectifier_6.sqproj)

Question: For the circuit shown in Fig. 1, the input supply is balanced three phase with line-to-line voltage rating of 400 V, 50 Hz.

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

(b) Find the maximum and minimum values of the instantaneous output voltage.

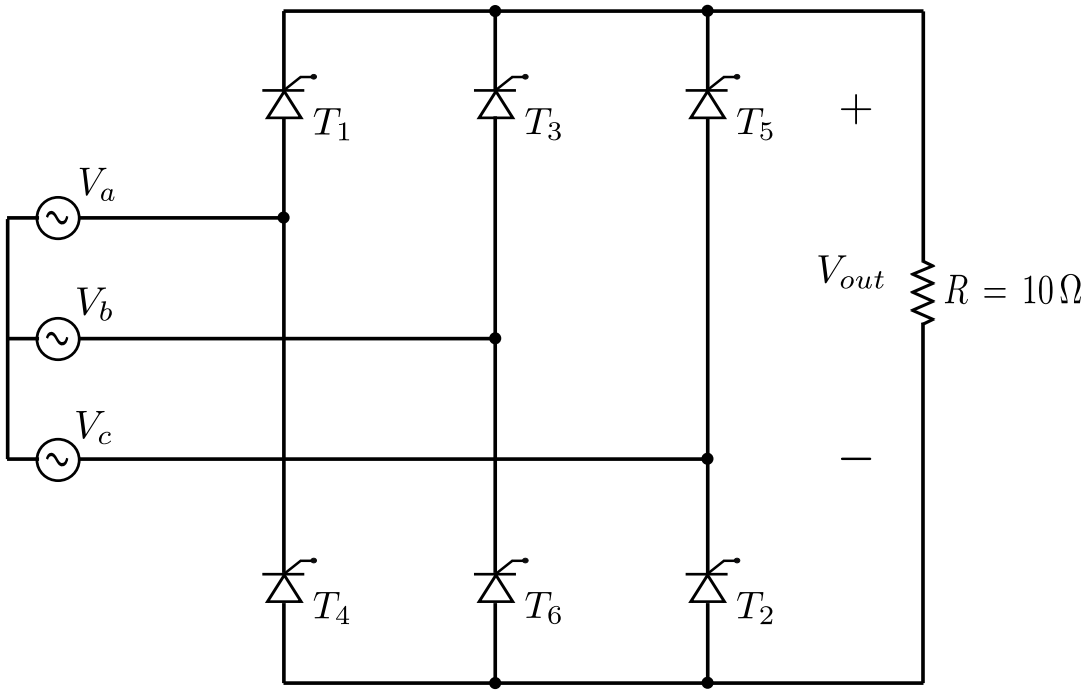

Figure 1: Three phase Fully controlled rectifier with R load.

Solution:

(a) For a 3 - phase full wave controlled rectifier shown in Fig. 1, the ouput voltage is always difference between two phase voltages. At any instant of time two thyristors of different

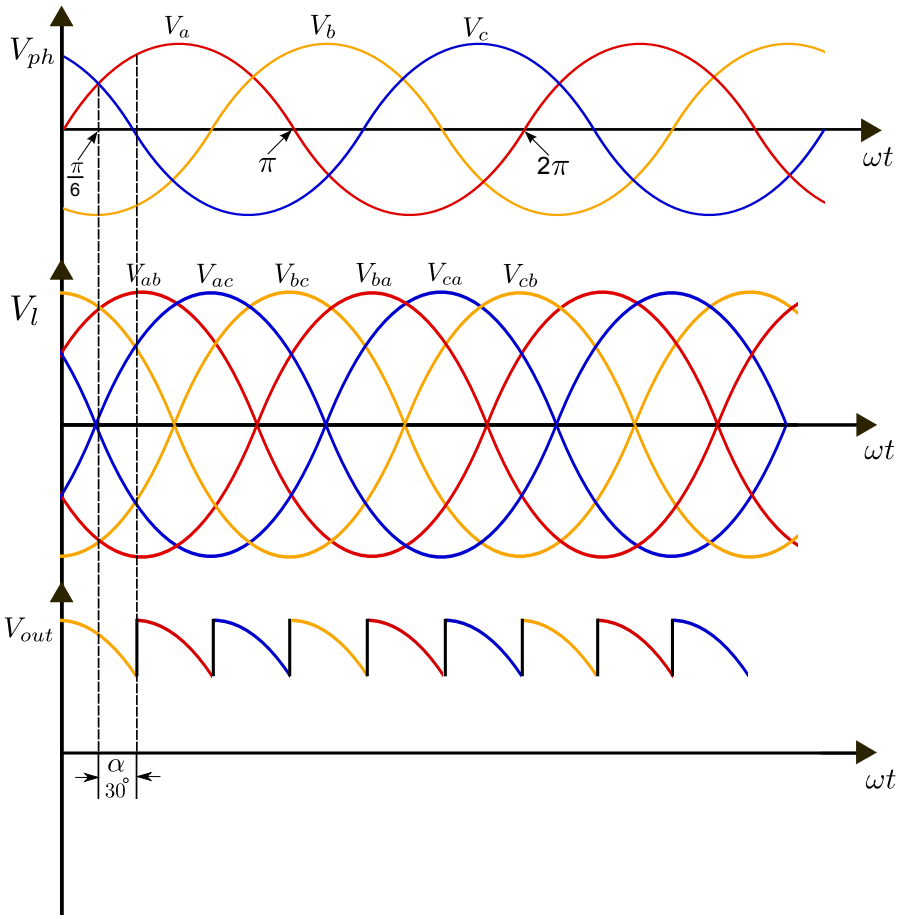

Figure 2: Output voltage waveform of 3-phase full-wave controlled rectifier.

legs conduct. Let us consider the instant at which T_1 and T_6 conduct. Solving KVL, the output voltage V_{out} is equal to the difference between V_a and V_b. Similarly this applies for every other combination of thyristors.

The output waveform for $\alpha = 30°$ is shown in Fig. 2. From the waveform, we can infer that for α equal to 30°, V_{out} is continuous. The average value of output voltage,

$$V_{out} = \frac{3}{\pi} \int_{\frac{\pi}{6}+\alpha}^{\frac{\pi}{2}+\alpha} \sqrt{3} \times V_{mp} \sin(\omega t + 30°)\, d(\omega t) = \frac{3\sqrt{3}}{\pi} V_{mp} \cos\alpha \tag{1}$$

$$V_{out} = \frac{3\sqrt{3}}{\pi}\ 230\sqrt{2}\ \cos 30^\circ = 465\,\mathrm{V} \tag{2}$$

(b) In Fig 1, for $\alpha = 30^\circ$ the current flows from a to b through T_1 and T_6 from 60° to 120° . Applying KVL, the output voltage in this interval is $V_a - V_b$. This is shown in Fig 1. Let us denote $V_{\max}$ and $V_{\min}$ for maximum and minimum instantaneous output voltages respectively. The maximum voltage is seen at 60°.

$$V_{\max} = V_{mp}\ \sin(60^\circ) - V_{mp}\, sin(-60^\circ) = 230\sqrt{2}\ \times \sqrt{3} = 563\,\mathrm{V} \tag{3}$$

The minimum voltage is seen at 120°.

$$V_{\min} = V_{mp}\ \sin(120^\circ) - V_{mp}\, sin(0^\circ) = 230\sqrt{2} \times \frac{\sqrt{3}}{2} = 281.5\,\mathrm{V} \tag{4}$$

SequelApp Exercises:

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

(a) The firing angle (α) to get an average output voltage $V_{out} = 400\,\mathrm{V}$.

(b) The maximum and minimum instantaneous output voltage in this case.

Verify your answers using SequelApp.