Three phase Inverter - 1 (PE_3ph_VSI_1.sqproj)

Question: The three phase inverter circuit shown in Fig. 1 is operating in 180° conduction mode.

(a) Find the RMS value of the output phase voltage and the fundamental component of output phase voltage.

(b) Find the RMS value of output phase current and power delivered to the load.

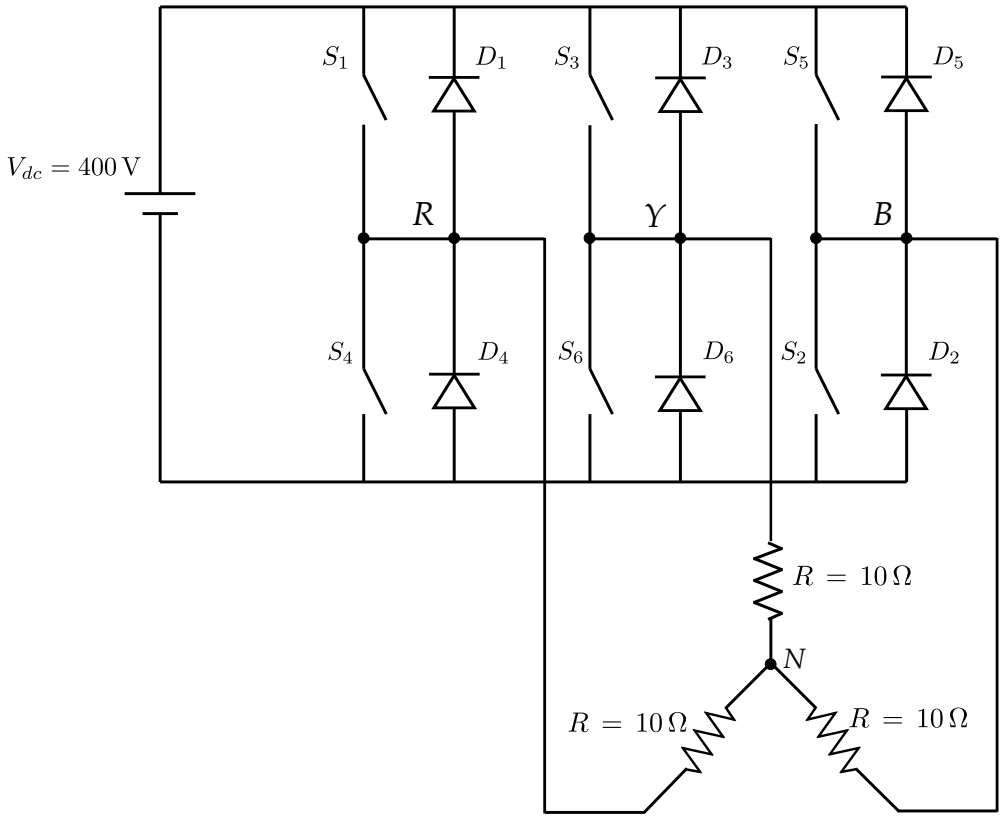

Figure 1: 3-Phase inverter in 180° conduction mode

Solution:

(a) For the three phase inverter operating in 180° conduction mode shown in Fig. 1, the switching sequence is shown in Fig. 2. At any instant of time, exactly one switch from all 3 legs of the inverter conducts. Consider the interval $\omega t = 0$ to $\omega t = \frac{\pi}{3}$. Switches $S_1, S_5$and S_6 conduct in this period. The equivalent circuit for this conduction period is shown in Fig. 3. By solving KVL, we get $V_R = V_B = \frac{V_{dc}}{3}$ and $V_Y = \frac{-2V_{dc}}{3}$. Similarly solving KVL for all the six switching sequence, we get the waveform of output phase voltage as shown in Fig. 2

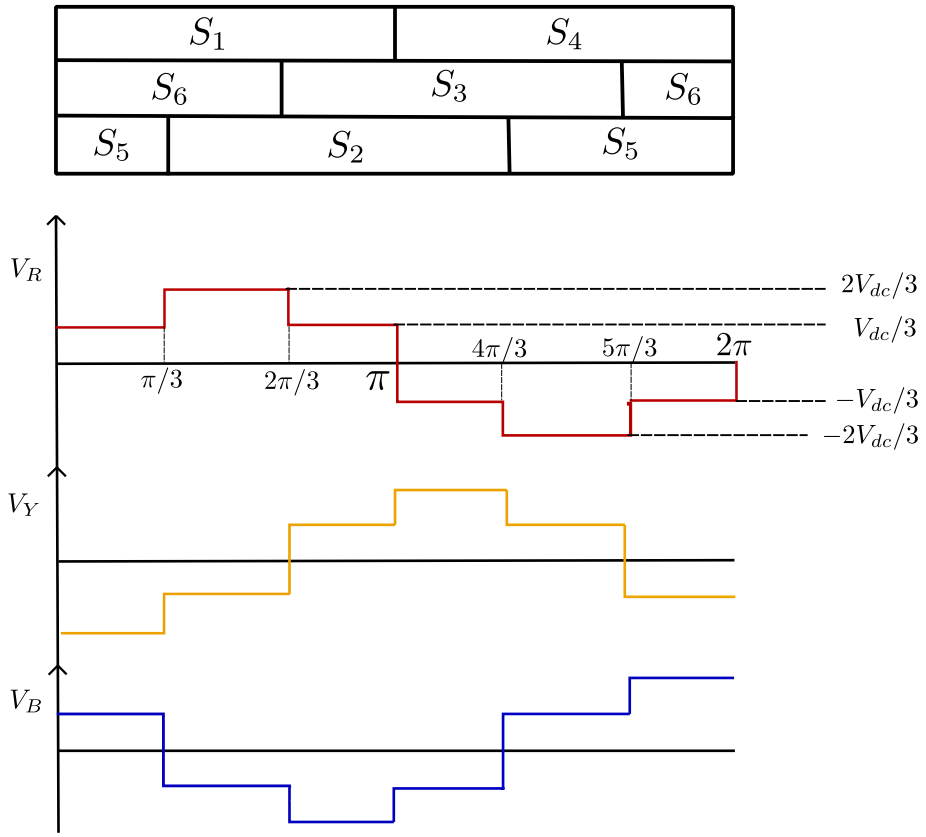

Figure 2: Switching sequence and output phase voltage waveforms

From the waveform, the RMS value of output phase voltage,

$$V_{ph} = \sqrt{\left(\frac{1}{\pi}\left[\left(\frac{V_{dc}}{3}\right)^2 \frac{\pi}{3} + \left(\frac{2V_{dc}}{3}\right)^2 \frac{\pi}{3} + \left(\frac{V_{dc}}{3}\right)^2 \frac{\pi}{3}\right]\right)} \tag{1}$$

$$V_{ph} = \sqrt{\frac{2}{9}}\, V_{dc} = 188.5\,\mathrm{V} \tag{2}$$

The fourier series expression of the phase voltage in Fig. 2 is

$$V_{ph} = \sum_{n=6k\pm1}^{\infty} \frac{2V_{dc}}{n\pi} \sin(n\omega t) \tag{3}$$

By substituting $n = 1$, the fundamental component of output phase voltage,

$$V_{p1} = \frac{2V_{dc}}{\sqrt{2}\pi} = 180.12\,\mathrm{V} \tag{4}$$

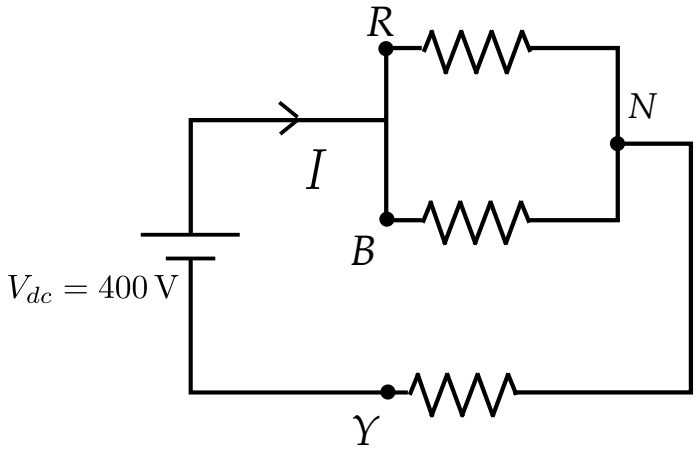

Figure 3: Equivalent circuit for $\omega t = 0$ to $\pi/3$

(b) The output phase current,

$$I_{ph} = \frac{V_{ph}}{R} = \frac{188.5}{10} = 18.85\,\mathrm{A} \tag{5}$$

The output power,

$$P = 3\, I_{ph}^2\, R = 10.6\, kW \tag{6}$$

SequelApp Exercises:

For the circuit in Fig. 1, find the value of R to get an output power of 5 kW.

Verify your answers using SequelApp.