Three phase Inverter - 2 (PE_3ph_VSI_2.sqproj)

Question: The three phase inverter circuit shown in Fig. 1, is operating in 120° conduction mode.

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

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

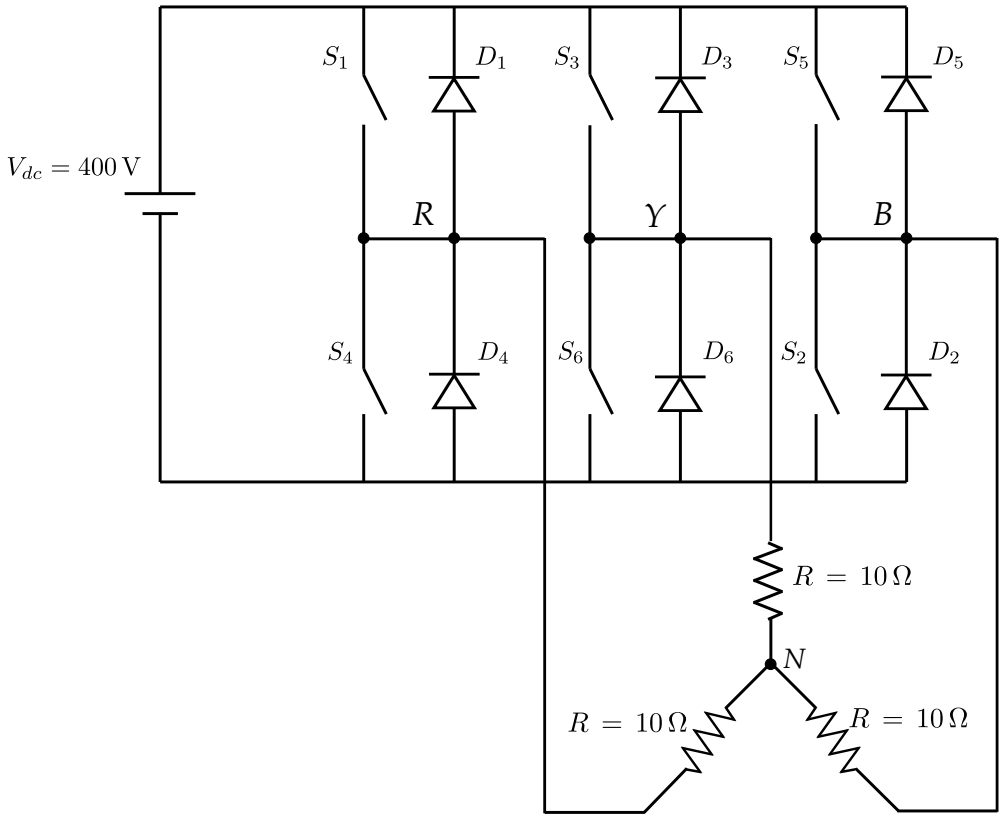

Figure 1: 3-Phase inverter in 120° conduction mode

Solution:

(a) For the three phase inverter operating in 120° conduction mode shown in Fig. 1, the switching sequence is shown in Fig. 2. Every switch conducts for 120° duration. Consider the interval $\omega t = 0$ to $\omega t = \frac{\pi}{3}$. Switches S_1 and S_6 conduct in this period. The equivalent circuit for this conduction period is shown in Fig. 3. By solving KVL, we get $V_R = \frac{V_{dc}}{2}$ and $V_Y = \frac{-V_{dc}}{2}$. Similarly solving KVL for all the six switching sequence, we get the waveform of output phase voltage as shown in Fig. 2

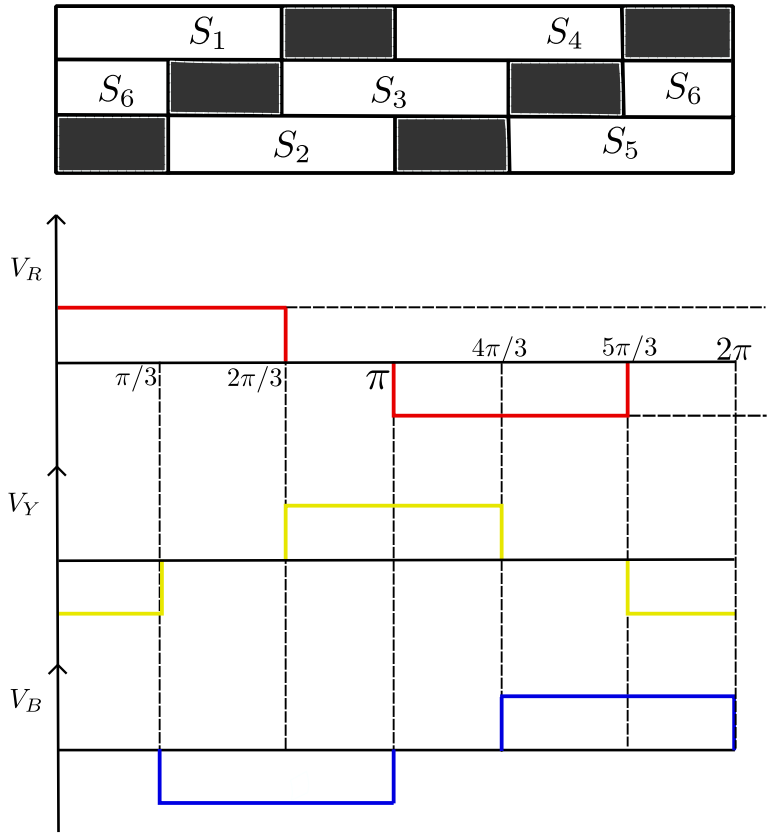

Figure 2: Output phase voltage waveforms

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

$$V_{ph} = \sqrt{\left(\frac{1}{\pi}\int_0^{\frac{2\pi}{3}} \left(\frac{V_{dc}}{2}\right)^2 . d\omega t\right)} \tag{1}$$

$$V_{ph} = \frac{V_{dc}}{\sqrt{6}} = 163.3\,\mathrm{V} \tag{2}$$

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

$$V_{ph} = \sum_{n=2k+1}^{\infty} \frac{2V_{dc}}{n\pi} \cos\frac{n\pi}{6} \sin(n\omega t + \frac{\pi}{6}) \tag{3}$$

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

$$V_{p1} = \frac{2V_{dc}}{\sqrt{2}\pi} \cos\frac{\pi}{6} = 155.9\,\mathrm{V} \tag{4}$$

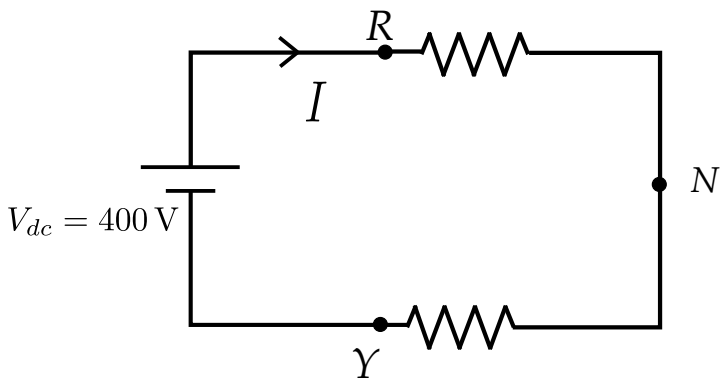

Figure 3: Equivalent circuit for $\omega t = 0$ to $\pi/3$

(b) The output phase current,

$$I_{ph} = \frac{V_{ph}}{R} = \frac{163.3}{10} = 16.33\,\mathrm{A} \tag{5}$$

The output power,

$$P = 3\,I_{ph}^2\,R = 8\,k\mathrm{W} \tag{6}$$

SequelApp Exercises:

For the circuit in Fig. 1, find the following if the value of resistance per phase R = 20 Ω.

(a) The output phase current and switch current to get an output power of 5 kW.

(b) The input voltage V_{dc} in this case.

Verify your answers using SequelApp.