Question 4

Derive expressions for $v(t)$ and $i(t)$ marked in Figure 4 for $-\infty < t < \infty$. Compute the value of R if $v(t)$ is 4V immediately after the switch opens at $t = 0$. In other words, $v(0^+) = 4$V.

(25 marks)

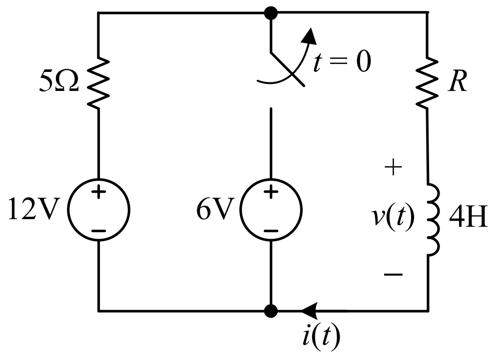

Figure 4

For $t < 0$

$$V_{TH} = 6 + 2\left(\frac{12-6}{5}\right) = 8.4$$

$$R_{TH} = 5 + R$$

$$i(-\infty) = \frac{8.4}{5+R}$$

$$\tau = 4/5+R$$

$$\therefore i_1 = \frac{8.4}{5+R} + \left(0 - \frac{8.4}{5+R}\right) e^{-t/(4)/5+R}$$

$$= \frac{8.4}{5+R} - \frac{8.4}{5+R}\left(e^{-t(5+R)/4}\right)$$

For $t > 0$

$$R_{TH} = 5 + R$$

$$i(\infty) = \frac{12}{5+R}$$

$$\tau = \frac{4}{5+R}$$

$$i_2 = \frac{12}{5+R} + \left(0 - \frac{12}{5+R}\right) e^{-t(5+R)/4}$$

$$i(0^+) = \frac{12}{5+R}$$

$$\therefore R = 8V$$

$$\therefore R = 10$$

$$\frac{12}{5+R} \cdot R = 8 \rightarrow R = 10$$