1. After being closed for a long time, the switch opens at $t = 0$.

The inductance in the above circuit acts as the coil (magnet) for a relay. The relay is designed to stay energized for a short time after the switch is opened. The relay's current waveform is designed to be over-damped. To obtain this over-damped solution, one of the characteristic roots (in units of 1/seconds) is set equal to minus the value of $R_2$ (in units of ohms).

$$s_1 = -R_2$$

The other characteristic root is set equal to minus the value of three times $R_2$:

$$s_2 = -3R_2$$

Find the value of $R_2$ for the circuit, given the above specifications.

2. Using the component values from Problem 1, find a numerical expression for the (downward) inductor current, $i(t)$, for $t > 0$. 
3. \[ i_s(t) = \begin{cases} 
-1 \text{ A} & \text{t < 0} \\
1 \text{ A} & \text{t \geq 0} 
\end{cases} \]

Find a symbolic expression for the Laplace-transformed output, \( V_o(s) \), in terms of not more than \( R_1, R_2, L, C \), and values of sources or constants.

4. Choose a numerical value for \( R_1 \) to make

\[ v_1(t) = v_m e^{-\alpha t} \sin(\beta t) \]

where \( \beta = 7 \text{ k rad/s} \) and \( v_m \) and \( \alpha \) are real-valued constants.

Hint: \( R_1 \) behaves as though it is in parallel with \( L \) and \( C \).

5. Find the values of \( v_m \) and \( \alpha \).