7 (a) Consider a circuit consisting of a resistor of resistance $R$, inductor of inductance $L$ and a capacitor of capacitance $C$ as shown in Figure 7. The capacitor is initially fully charged at time $t = 0$.

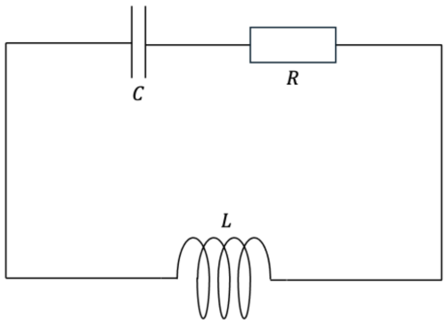


**Figure 7**

Given that the potential difference $V$ in the capacitor is governed by the differential equation

$$\frac{d^2V}{dt^2} + \left(\frac{R}{L}\right)\frac{dV}{dt} + \left(\frac{1}{LC}\right)V = 0$$

Show that $V = Ae^{-\alpha t}\cos\omega t$ is a solution to the differential equation above where $\alpha = \frac{R}{2L}$. Hence, write down an equation for $\omega$ in terms of $R$, $L$ and $C$. [5 marks]

(b)(i) Given that $C = 15.0$ nF, $L = 0.22$ mH and $R = 75.0\ \Omega$, calculate the oscillation frequency of the circuit and the time taken for the amplitude of oscillation to decay to 10.0 % of its original value. [3 marks]

(b)(ii) Calculate the value of $R$ that would result in a critically damped circuit. [2 marks]