Vibrations and waves: exercise sheet 4

Passive amplification via an LRC circuit

Consider a circuit consisting of a series connection of a resistor, inductor and capacitor. Thus circuit is driven by an alternating voltage.

The relevant differential equation is

$$L\ddot{Q} + R\dot{Q} + Q/C = V_0 \cos\omega t$$

Show that this can be reduced to the more conventional form

$$\ddot{Q} + \gamma\dot{Q} + \omega_0^2 Q = \frac{V_0}{L}\cos\omega t$$

Obtain the steady state solution by analogy with previous work, writing your answer in terms of the variables *L*, *C* and *R*.

Differentiate your equation with respect to time, and hence derive and equation for the current.

At which angular frequency will the current have maximum value?

What will be the resonant frequency and *Q* for C = 8 μF, L = 0.02 H and R = 75 Ω?