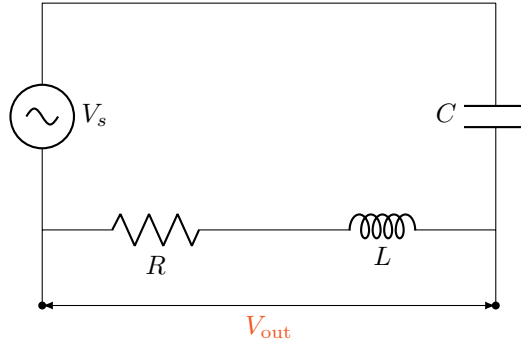


Physics 1C Discussion (Week 5)

Problem 1



Impedance for this RLC circuit is given by

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \quad (1)$$

Then the flowing current in the circuit is given by

$$I(t) = \frac{V_s(t)}{Z_{\text{RLC}}} = \frac{1}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} V_s(t) \quad (2)$$

From this, the voltage between the 2 output nodes V_{out} is given by

$$\begin{aligned} V_{\text{out}}(t) &= I(t) Z_{\text{RL}} \\ &= I(t) \sqrt{R^2 + X_L^2} \\ &= \sqrt{\frac{R^2 + (\omega L)^2}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} V_s(t) \\ &= \begin{cases} V_s(t) & (\omega \rightarrow \infty) \\ 0 & (\omega \rightarrow 0) \end{cases} \end{aligned} \quad (3)$$

The series expansion around $\omega \approx 0$ is given by

$$V_{\text{out}}(t) \approx (CR\omega + \mathcal{O}(\omega^2)) V_s(t) \quad (\text{when } \omega \approx 0) \quad (4)$$

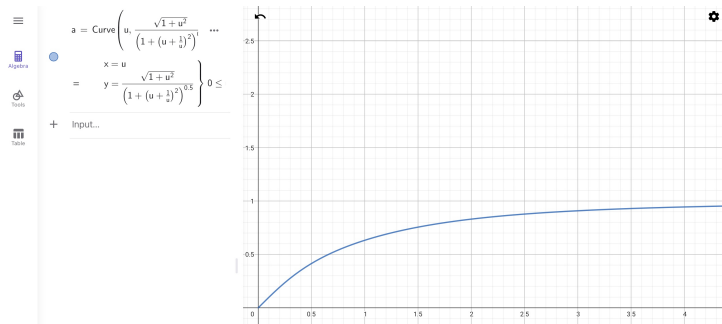


Figure 1: Frequency dependence on V_{out}