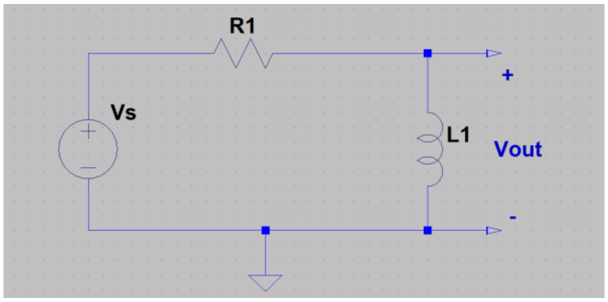
Solve the Simple RL high-pass using Differential Equations:

Here is the circuit diagram



The Kirchoff loop equation is:

$$v_{in(t)} = R * i(t) + L\frac{di}{dt}$$

First solve the Homogeneous Equation to get the Homogeneous "Natural" solution:

$$R * i(t) + L\frac{di}{dt} = 0$$

Dividing both sides by L

$$\frac{R}{L} * i(t) + \frac{di}{dt} = 0$$

The solution to this equation is of the form $K_H\varepsilon^{at}$ and substituting:

$$\frac{R}{L} * \mathrm{K}_H\varepsilon^{at} + \alpha\mathrm{K}_H\varepsilon^{at} = 0$$

Simplifying,

$$\frac{R}{L} + \mathrm{a} = 0$$

or a = -L/R

The **Homogeneous Solution** is therefore:

$$i_H(t) = K_H\varepsilon^{-\frac{t}{L/R}}$$

But $i(\infty) = \frac{V_{in}}{R}$ since the voltage across the inductor decreases to 0 and

$i(\infty) = 0$ Since there is no current at t=0 and current cannot instantaneously change.

Assuming an input voltage of V_{in} volts,

$$i(t) = \frac{V_{in}}{R}\left[1 - \varepsilon^{-\left(\frac{t}{L/R}\right)}\right]$$

But we want the voltage out which is L*di/dt

$$V_L(t) = L * \frac{V_{in}}{R}\left[\frac{R}{L} * \varepsilon^{-\left(\frac{t}{L/R}\right)}\right] = V_{in} * \varepsilon^{-\left(\frac{t}{L/R}\right)}$$