RL Circuit: Current Shutdown in Inductor

- Loop rule: $-IR - L\dfrac{dI}{dt} = 0$
- Differential equation: $L\dfrac{dI}{dt} + IR = 0 \quad \Rightarrow \quad \dfrac{dI}{dt} = -\dfrac{R}{L}I$

$$\Rightarrow \int_{\mathcal{E}/R}^{I} \frac{dI}{I} = -\frac{R}{L}\int_0^t dt \quad \Rightarrow \quad \ln\frac{I}{\mathcal{E}/R} = -\frac{R}{L}t \quad \Rightarrow \quad \frac{I}{\mathcal{E}/R} = e^{-Rt/L}$$

- Current: $I(t) = \dfrac{\mathcal{E}}{R}\, e^{-Rt/L}$
- Rate of current change: $\dfrac{dI}{dt} = -\dfrac{\mathcal{E}}{L}\, e^{-Rt/L}$