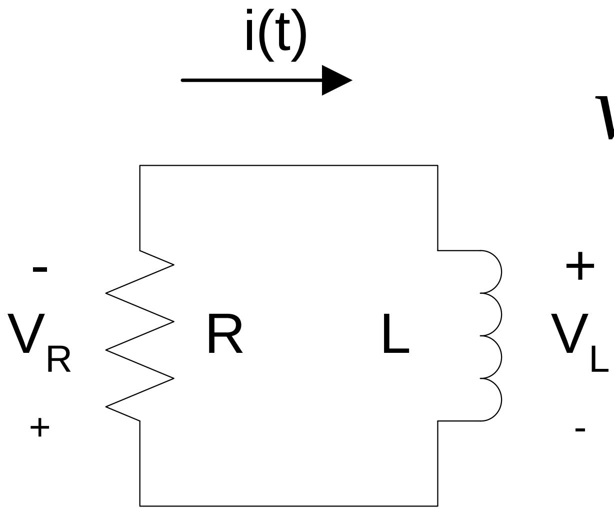
NETWORK ANALYSIS AND SYNTHESIS

RL CIRCUITS

Initial condition
$i(t = 0) = I_o$

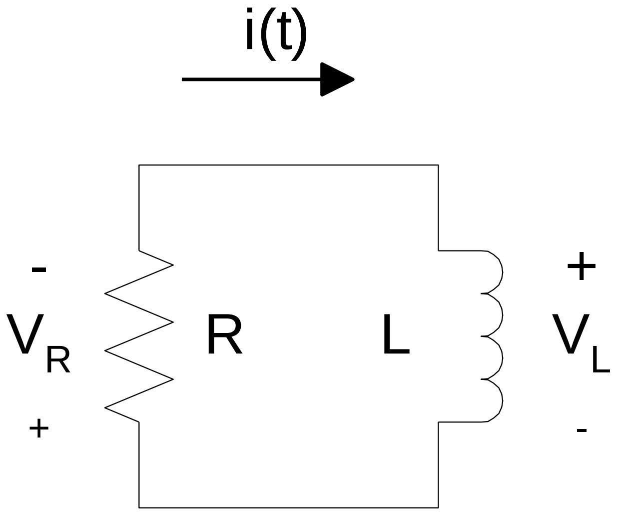


$$v_R + v_L = 0 = Ri + L\frac{di}{dt}$$

$$\frac{L}{R}\frac{di}{dt} + i = 0$$

Solving the differential equation

RL CIRCUITS



Initial condition
$i(t = 0) = I_o$

$$\frac{di}{dt} + \frac{R}{L} i = 0$$

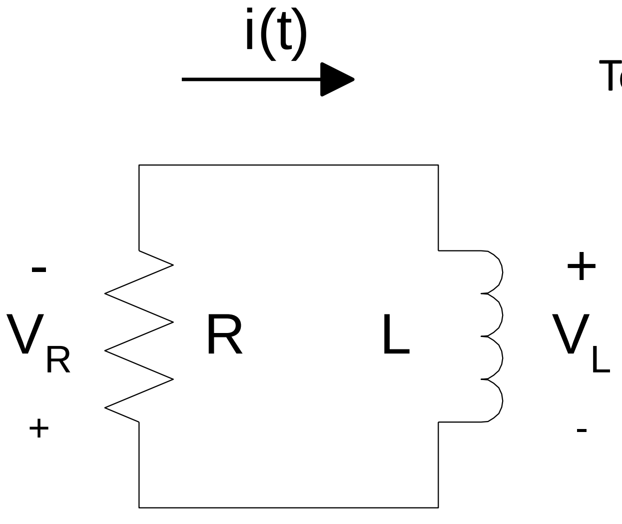
$$\frac{di}{i} = -\frac{R}{L} dt, \quad \int_{I_o}^{i(t)} \frac{di}{i} = \int_{o}^{t} -\frac{R}{L} dt$$

$$\ln i \,\Big|_{I_o}^{i} = -\frac{R}{L} t \,\Big|_{o}^{t}$$

$$\ln i - \ln I_o = -\frac{R}{L} t$$

$$i(t) = I_o e^{-Rt/L}$$

RL CIRCUIT



Power dissipation in the resistor is:

$$p_R = i^2R = I_o^2e^{-2Rt/L}R$$

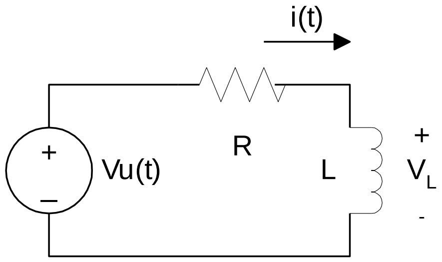
Total energy turned into heat in the resistor

$$W_R = \int_0^\infty p_R dt = I_o^2 R \int_0^\infty e^{-2Rt/L} dt$$

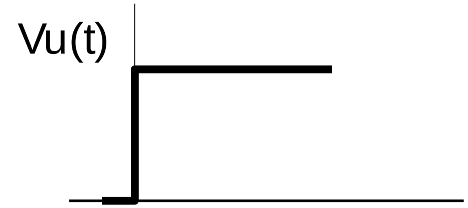
$$= I_o^2 R(-\frac{L}{2R})e^{-2Rt/L} |_0^\infty$$

$$= \frac{1}{2} L I_o^2$$

It is expected as the energy stored in the inductor is $\frac{1}{2} L I_o^2$



RL CIRCUIT



$$Ri + L\frac{di}{dt} = V$$

$$\frac{L\,di}{V - Ri} = dt$$

$$Integrating\ both\ sides,$$

$$-\frac{L}{R}\ln(V - Ri) = t + k$$

$$i(0^+) = 0, thus\ \ k = -\frac{L}{R}\ln V$$

$$-\frac{L}{R}[\ln(V - Ri) - \ln V] = t$$

$$\frac{V - Ri}{V} = e^{-Rt/L} \qquad or$$

$$i = \frac{V}{R} - \frac{V}{R}e^{-Rt/L},\ \ for\, t > 0$$

where *L/R* is the time constant

DC STEADY STATE

The steps in determining the forced response for *RL or RC* circuits with dc sources are:

1. Replace capacitances with open circuits.

2. Replace inductances with short circuits.

3. Solve the remaining circuit.

THANKS….

Queries Please…