Voltage

$V_R = IR$ (voltage across resistors)

$V_C = \frac{Q}{C}$ (voltage across capacitors)

$V_L = L\frac{dI}{dt}$ (voltage across inductors)

Equivalences

$R_{eq} = R_1 + R_2 + R_3 + \dots$ (resistors in series)

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$ (resistors in parallel)

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$ (capacitors in series)

$C_{eq} = C_1 + C_2 + C_3 + \dots$ (capacitors in parallel)

$L_{eq} = L_1 + L_2 + L_3 + \dots$ (inductors in series)

$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots$ (inductors in parallel)

Kirchoff's Laws

$\sum_{k=1}^{n} I_k = 0$ (node rule)

$\sum_{k=1}^{n} V_k = 0$ (loop rule)

Conventions for loop rule

Subtract the voltage if the current direction is same as travel direction. (all except batteries)

Add the voltage if the current direction is opposite to travel direction. (all except batteries)

Add the voltage if the current direction is same as travel direction. (batteries)

Subtract the voltage if the current direction is opposite to travel direction. (batteries)

Time dependent circuits at $t = 0$ and $t \to \infty$

Voltage across capacitor is zero, replace by wire. (at $t = 0$)

Current across inductor is zero, replace by gap. (at $t = 0$)

Voltage across inductor is zero, replace by wire. (at $t \to \infty$)

Current through capacitor is zero, replace by gap. (at $t \to \infty$)

RC circuit at any time t

$q(t) = Q_0 e^{-t/RC} + VC(1 - e^{-t/RC})$ (general solution)

$q(t) = VC(1 - e^{-t/RC}) = Q_f(1 - e^{-t/RC})$ (recharge)

$i(t) = \frac{V}{R}e^{-t/RC} = I_0 e^{-t/RC}$ (recharge)

$q(t) = Q_0 e^{-t/RC}$ (discharge)

$i(t) = \frac{-Q_0}{RC}e^{-t/RC}$ (discharge)

RL circuit at any time t

$i(t) = I_0 e^{-Rt/L} + \frac{V}{R}(1 - e^{-Rt/L})$ (general solution)

$i(t) = I_0 e^{-Rt/L}$ (turn off)

$i(t) = \frac{V}{R}(1 - e^{-Rt/L})$ (turn on)

$V_L(t) = V e^{-Rt/L}$ (both)

LC circuit at any time t

$q(t) = Q\cos(\omega t + \phi)$ (charge)

$i(t) = -Q\omega\sin(\omega t + \phi)$ (current)

$U_e(t) = \frac{1}{2C}Q^2\cos^2(\omega t + \phi)$ (electric energy)

$U_m(t) = \frac{1}{2}LQ^2\omega^2\sin^2(\omega t + \phi)$ (magnetic energy)

$U_t = \frac{1}{2C}Q^2 = \frac{1}{2}LI^2 = \frac{1}{2}Li^2 + \frac{1}{2C}q^2$ (total energy)

$\omega = \frac{1}{\sqrt{LC}}$ (frequency)