Electric Circuit

$i(t)$: current — Amperes (A) — $i(t) = \frac{dq}{dt}$

$q(t)$: flow of charge — coulombs (C)

R : Resistance of a resistor — ohm (Ω)

C : capacitance of a capacitor — Farads (F)

L : inductance of an inductor. — Henrys (H)

} Constants.

$E(t)$: Voltage gain of the current passing through the voltage source

Kirchoff's 2nd law: The sum of voltage drops around a closed circuit $= 0$.

Voltage Drop $\Delta V_R = IR$

$\Delta V_C = \frac{1}{C} q$

$\Delta V_L = L \frac{di}{dt}$

$$0 = \Delta V_R + \Delta V_C + \Delta V_L - E(t) \Rightarrow L\frac{di}{dt} + Ri + \frac{q}{C} = E(t)$$

RC - circuit

$$i + \frac{1}{RC} q = \frac{E}{R} \Rightarrow \frac{dq}{dt} + \frac{1}{RC} q = \frac{E}{R}$$

1st order linear DE. $I(t) = e^{\int \frac{1}{RC} dt} = e^{\frac{t}{RC}}$

$$\left(e^{\frac{t}{RC}} q\right)' = \frac{E}{R} e^{\frac{t}{RC}} \Rightarrow e^{\frac{t}{RC}} q = EC\, e^{\frac{t}{RC}} + D \leftarrow \text{unknown}$$

$$q = EC + De^{-\frac{t}{RC}}$$