Homogeneous Linear Differential Equation:

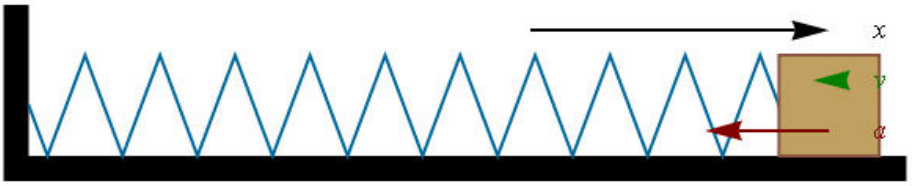
$$(a_2D^2 + a_1D + a_0)y = 0$$

Nonhomogeneous Linear Differential Equation:

$$(a_2D^2 + a_1D + a_0)y = f$$

Spring Motion:

$$(mD^2 + \beta D + k)y(t) = 0$$

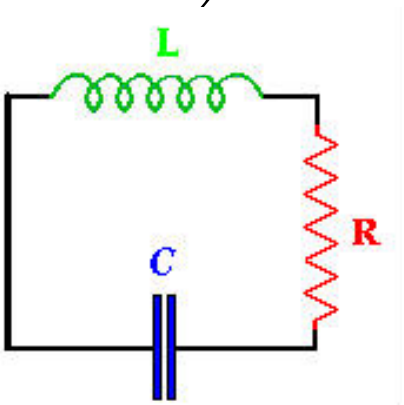


Add gravity consideration to spring motion analysis

$$(mD^2 + \beta D + k)y(t) = mg$$

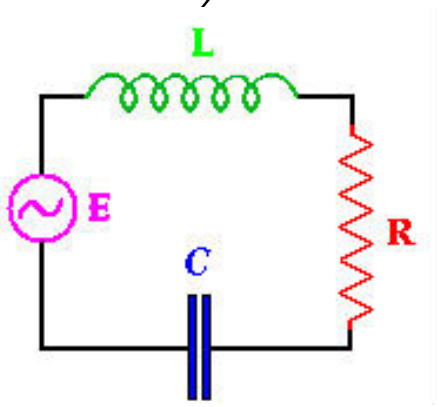
Electric Circuit with Inductor, Resistor, Capacitor

$$\left(\ell D^2 + RD + \frac{1}{C}\right) Q(t) = 0$$



Add a voltage source to the circuit:

$$\left(\ell D^2 + RD + \frac{1}{C}\right) Q(t) = \mathcal{E}(t)$$



Notation:

$$P(D) = a_n D^n + a_{n-1} D^{n-1} + \cdots + a_1 D + a_0$$

$P(D)$ is a linear differential operator

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$P(D)$ is a linear differential operator

$$P(D)(c_1 f_1 + c_2 f_2) = c_1 P(D) f_1 + c_2 P(D) f_2$$

where c_1, c_2 are constants
and $f_1 = f_1(x)$, $f_2 = f_2(x)$ are functions

Homogeneous Equation:

$$P(D)y = 0$$

Nonhomogeneous Equation:

$$P(D)y = f$$