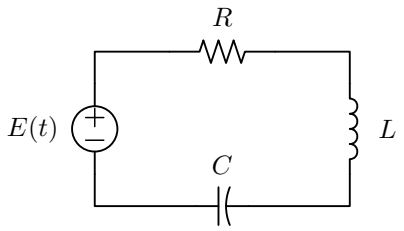
# Computer Project 2. RLC Circuits

**Goal:** Investigate the charge on a capacitor in an $RLC$ circuit with varying voltage.

**Tools needed:** `ode45`, `plot`

**Description:** If $Q(t)$ = charge on a capacitor at time $t$ in an $RLC$ circuit (with $R$, $L$ and $C$ being the resistance, inductance and capacitance, respectively) and $E(t)$ = applied voltage, then Kirchhoff's Laws give the following 2nd order differential equation for $Q(t)$:

$$L\,Q''(t) + R\,Q'(t) + \frac{1}{C}\,Q(t) = E(t) \qquad (*)$$




**Questions:** Assume $L = 1$, $C = 1/5$, $R = 4$ and $E(t) = 10\cos\omega t$.

1. Use `ode45` (and plot routines) to plot the solution of $(*)$ with $Q(0) = 0$ and $Q'(0) = 0$ over the interval $0 \le t \le 80$ for $\omega = 0, 0.5, 1, 2, 4, 8, 16$.

2. Let $A(\omega)$ = maximum of $|Q(t)|$ over the interval $30 \le t \le 80$ (this approximates the amplitude of the steady-stat solution). Experiment with various values of $\omega$ and discuss what appears to happen to $A(\omega)$ as $\omega \to \infty$ and as $\omega \to 0$. Also, interpret your findings in terms of an equivalent spring-mass system.

**Remark:** There is an analogy between spring-mass system and $RLC$ circuits given by:

| **Spring-mass system** | **RLC circuit** |
|---|---|
| $m\,u'' + c\,u' + k\,u = F(t)$ | $L\,Q'' + R\,Q' + \frac{1}{C}\,Q = E(t)$ |
| $u =$ Displacement | $Q =$ Charge |
| $u' =$ Velocity | $Q' = I =$ Current |
| $m =$ Mass | $L =$ Inductance |
| $c =$ Damping constant | $R =$ Resistance |
| $k =$ Spring constant | $1/C =$ (Capacitance)$^{-1}$ |
| $F(t) =$ External force | $E(t) =$ Voltage |