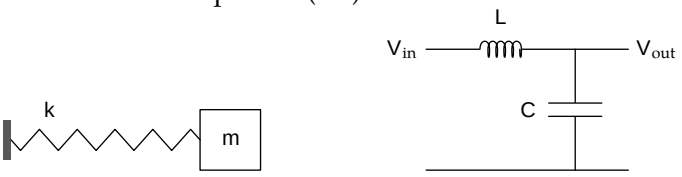
2.5 Analogies

One way to create abstractions is to make an analogy between two systems. Each common feature leads to an abstraction—and each abstraction is a bridge connecting our knowledge of one system to our knowledge of the other system. One piece of knowledge can do double duty, making us smarter.

2.5.1 Electrical–mechanical analogies

An example containing many abstractions is the analogy between a spring–mass system and an inductor–capacitor (LC) circuit.



In the mechanical system, the fundamental variable is the mass's displacement x. In the electrical system, it is the charge Q on the capacitor. These variables are analogous, and their derivatives should also be analogous. Thus, velocity (v), the derivative of position, should be analogous to current (I), the derivative of charge. Keep building analogy bridges. Change in velocity is acceleration (a), so change in current (dI/dt) is its analog.

	mechanical	electrical
fundamental variable	x	Q
first derivative	v	I
second derivative	a	dI/dt

These variables describe the state of the system and how that state changes: They are the kinematics. However, without including the causes of the motion—the dynamics—the systems remain lifeless. In the mechanical system, dynamics results from force, which produces acceleration. Acceleration is analogous to change in current dI/dt, which is produced by applying a voltage to the inductor:

$$V = L\frac{dI}{dt}, \tag{2.10}$$