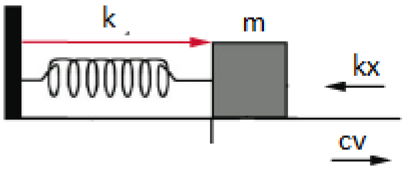
## Answer on Question #66053, Physics / Mechanics | Relativity

Establish the equation of motion of a weakly damped forced oscillator explaining the significance of each term. Differentiate between transient and steady state of the oscillator.

**Answer:**




The motion equation is of the form

$$m\frac{d^2x}{dt^2}+c\frac{dx}{dt}+kx=F_0\cos(\omega t+\varphi)\ \ (1)$$

Newton's 2nd law

$$m\frac{d^2x}{dt^2}+c\frac{dx}{dt}+kx$$

Sinusoidal driving forces

$$F_0\cos(\omega t+\varphi)$$

The general solution of equation (1) is

$$x(t)=\ x_{transient}+\ x_{steady-state}$$

$$x(t)=Ae^{-\gamma t}\sin(\omega' t+\varphi)+A\cos(\omega t+\varphi)$$

The steady-state solution is the solution that applies at long times, and is typically a vibration excited by the driving force. The solution to the unforced oscillator is also a valid contribution to the next solution. In the case of a damped oscillator, this solution decays with time, and hence is the solution at the start of the forced oscillation, and for this reason iscalled the transient solution. This solution will have a different frequency to that of the forcing oscillation, and there will be beating during the transient phase.