# Section 31.10: contd

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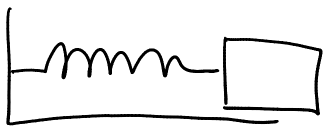
12:03 PM

Hooke's Law: case of no friction, no external force (once mass was let go), ideal spring



$$-kx = m\frac{d^2x}{dt^2}$$

rearranging:

$$m\frac{d^2x}{dt^2} + kx = 0 \qquad \text{homogeneous}$$

$$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0$$

use $n$ instead of $m$ for aux eqn (because $m$ = mass)

$$n^2 + \frac{k}{m} = 0$$

$$n^2 = -\frac{k}{m}$$

$$n = \pm\sqrt{\frac{k}{m}}\,i$$

so $n = \alpha \pm \beta i$ where $\alpha = 0$ and $\beta = \sqrt{\frac{k}{m}}$

$$x = e^{\alpha t}(c_1 \cos\beta t + c_2 \sin\beta t)$$

$$= C_1 \cos\left(\sqrt{\frac{k}{m}}\, t\right) + C_2 \sin\left(\sqrt{\frac{k}{m}}\, t\right)$$

note: this is the same result used in Phys 192
where

$$\omega_0 = \sqrt{\frac{k}{m}}$$

and you wrote

$$x = C_1 \cos \omega_0 t + C_2 \sin \omega_0 t$$

$\omega_0$ is called the natural frequency of oscillation

$\Rightarrow$ simple harmonic motion