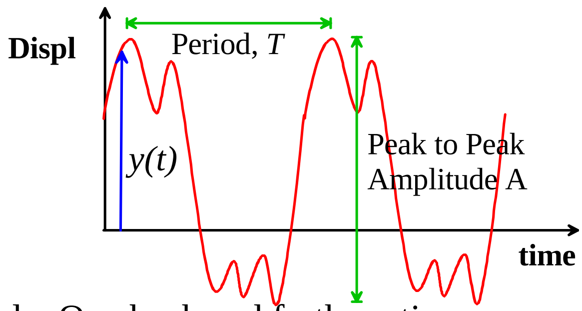
Typical General Vibration Response



Cycle: One back and forth motion

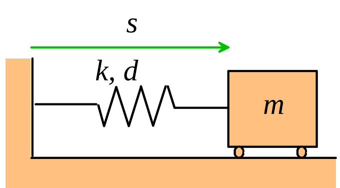
Period: T Time to complete one cycle

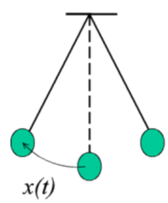
Amplitude: X Max departure from equilbrium=2A

Frequency: $f = \frac{1}{T}$ (Hertz, or cycles per sec),

Angular Frequency $\omega = 2\pi f = \frac{2\pi}{T}$ (radians per sec)

Frequency and Period are **System Dependent**





$T = 2\pi\sqrt{\frac{m}{k}}$ seconds

$T = 2\pi\sqrt{\frac{l}{g}}$ seconds

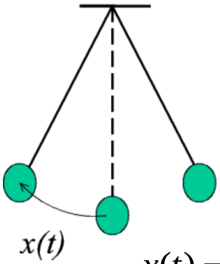
$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ Hertz,

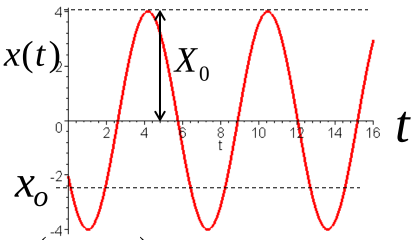
$\omega = \sqrt{\frac{k}{m}}$ radians per sec

$f = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$ Hertz,

$\omega = \sqrt{\frac{g}{l}}$ radians per sec

Amplitude and Phase depend on <u>Initial Conditions</u>: $x(0)=x_o$ and $v(0)=v_o$





$$x(t) = X_0 \sin(\omega t + \phi)$$

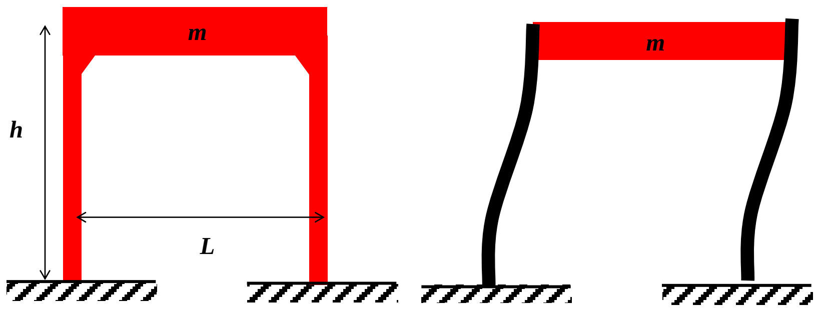
Amplitude: Maximum displacement from static equilib. position

$$X_0 = \sqrt{x_o^2 + v_o^2 / \omega^2}$$

Phase: Describes the ratio of the initial displacement x_0 to the amplitude of vibration X_0

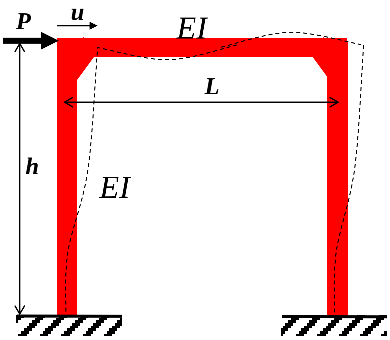
$$\phi = \sin^{-1}\left(\frac{\omega x_o}{X_o}\right) \text{ (radians)}$$

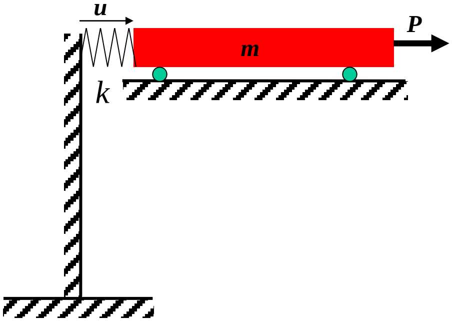
Free Vibration of a single story frame



Spring Mass system, stiffness K

$$P = ku$$



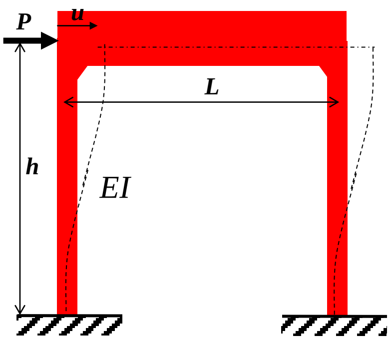


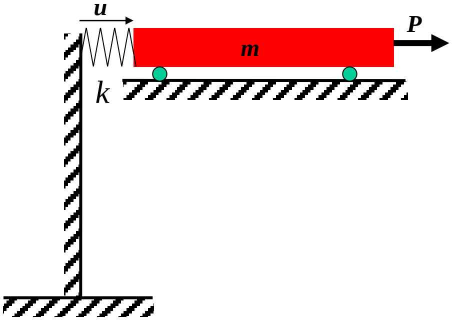
$$k = \frac{P}{u} = \frac{h^3}{12EI}\frac{(3+2L/h)}{(6+L/h)}$$

Hw 9

Spring mass system, stiffness K

$$P = ku$$



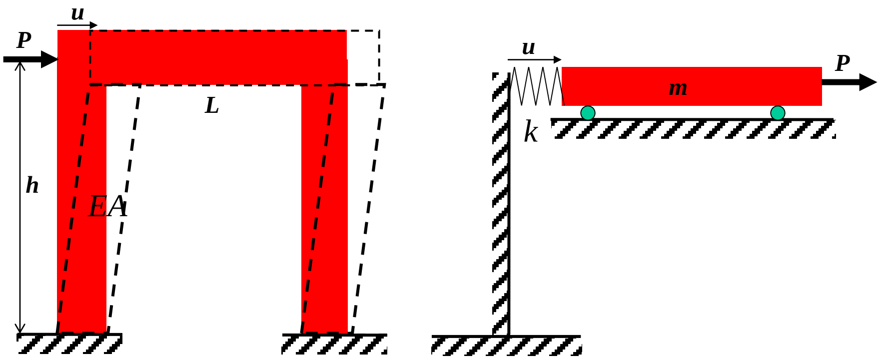


Column Bending, Stiff crossbeam

$$k = \frac{P}{u} = \frac{24EI}{h^3}$$

Spring mass system, stiffness K

$$P = ku$$

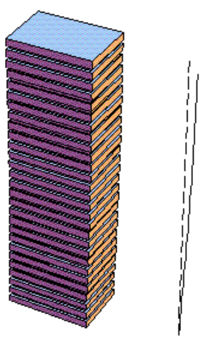


Shearing, stiff floor

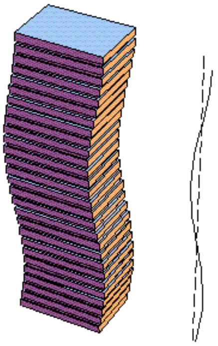
$$k = \frac{P}{u} = \frac{2EA}{h}$$

Vibration of a tall building

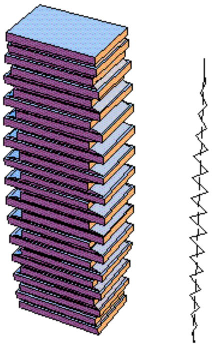
Mode 1 For a tall building



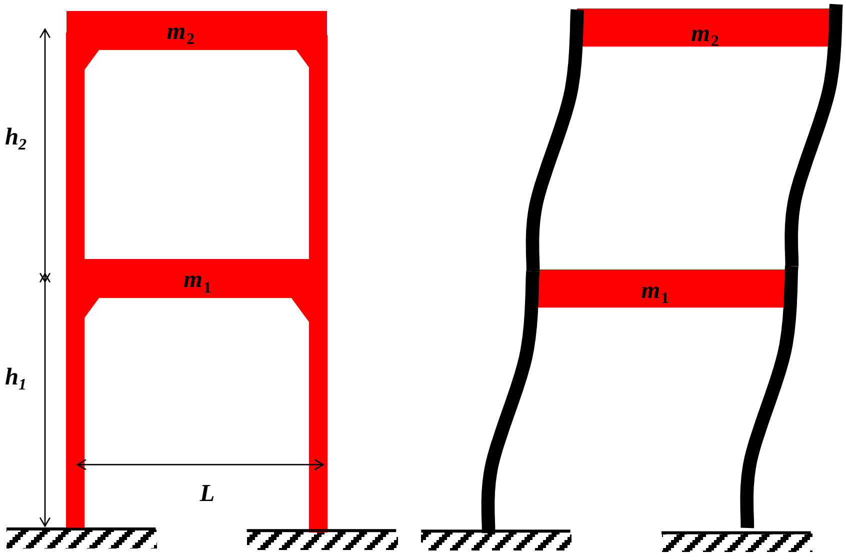
Another Mode (Mode 3)



Mode 28



Free Vibration of a Multi-Degree of freedom structure



Represent walls as lateral springs, stiffness k_i