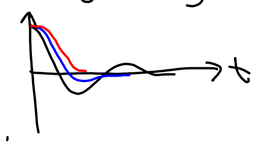
Today – damped oscillations (cont.)
– resonance
– waves

Heavy damping



Apr 26-2:04 PM

Resonance

add driving force that is periodic with angular freq. ω_d

If ω_d equals ω of oscillator we get large-amplitude oscillations

e.g. - break wine glass with sound
- push child on a swing

Apr 26-2:12 PM

- Tacoma Narrows bridge was not resonance (driving force – wind – not periodic)
- Millenium bridge London – was resonance from walking.

We modify the force law

$$F = -kx - b\frac{dx}{dt} + F_{max}\cos(\omega_d t)$$

Gives us new D.E. by combining with $F = m\frac{d^2x}{dt^2}$

Apr 26-2:19 PM

$\Rightarrow \quad m\frac{d^2x}{dt^2} = -kx - b\frac{dx}{dt} + F_m\cos(\omega_d t)$

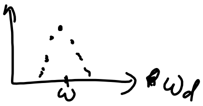
Solve for $x(t)$

Tricky. One solution (after a while) is a sinusoid with freq ω_d ← driving

We are interested in amplitude of this oscillation.

ω = natural freq. $\sqrt{\frac{k}{m}}$

ω_d = driving freq.



Apr 26-2:26 PM

resonance involves driving at or close to the natural freq, so as to produce a large amplitude

Can show (using complex notation) that

$$A = \frac{F_{max}}{\sqrt{(k - m\omega_d^2)^2 + b^2\omega_d^2}}$$

A is big when
- F_{max} is big
- b small
- $k = m\omega_d^2$

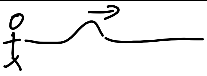
Apr 26-2:37 PM

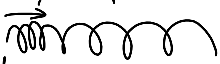
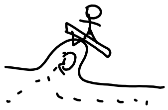
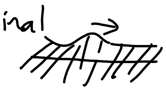
i.e. $\omega_d = \sqrt{\frac{k}{m}}$ ↖ natural freq.

Waves

Mechanical waves – disturbance that moves through a medium.

Apr 26-2:48 PM

Types: - transverse 

- longitudinal / compression
  - "slinky" 
  - sound
- combination - water 
- torsoinal 

Apr 26-2:54 PM