

Forced Oscillations & Resonance

Forced Oscillations:

- Occur when a system that is able to oscillate at some natural frequency has externally applied force acting on it in regular intervals

$$F = F_0 \cos(2\pi f_D t)$$

- Driving Frequency:** the frequency at which the external force is applied to the oscillating system

Forced Oscillations

- Eventually, the oscillating system may oscillate at the same frequency as the driving frequency
- Largest oscillations take place when driving frequency = natural frequency

Graphical analysis: *(graph shown in class)*

- Small damping; peak amplitude occurs at the system's natural frequency
- Lower the degree of damping, higher and steeper the curve
- As damping increases, peak will shift to frequencies LOWER than the natural frequency
- At very low frequencies, the amplitude is essentially at a constant level
- If f_D is very different from f_0 , then oscillation will have a small amplitude

Resonance

- If f_D and f_0 are the same, and if there is a small amount of damping, the resulting oscillations will have the largest amplitude
- **Resonance: The state in which the frequency of the externally applied periodic force equals the natural frequency of the system**

Useful examples of resonance:

- Microwaves in resonance will heat food in a microwave oven
- Musical instruments
- Quartz crystal oscillators—for precision timing and electronics
- Anything else?

Disastrous/Annoying Resonance

- Resonance of airplane wings due to force of air passing over
- Buildings during earthquakes
- Tacoma Narrows Bridge
- Your car can resonate on a bumpy road, with bad shocks, or with a poorly tuned engine
- Anything else?
