Lecture 2, Sep 14, 2021

De omnibus dubitandum: Question everything; keep an open mind

Forces

- A push or a pull that can cause an object to move or deform; by its nature a vector quantity
- Forces are measured in newtons; 1N is about the weight of a small apple; 1kN is about the weight of a football player
  - In imperial units pounds are used
- When objects are not accelerating, $\sum \vec{F} = 0$ (translational equilibrium)
- Forces can be broken down into axis-aligned components

Moments

- Knowing translational forces sometimes isn't enough
- All torques are moments, but not all moments are torques
  - In structural engineering torques are moments where the rotational axis is the long axis of the object
- Rotations need a reference point i, the point about which the rotation happens
- $\vec{d}$ is the lever arm, the distance over which the force is acting
- The moment is $\vec{M} = \vec{F} \times \vec{d}$; this has units of Nm; although this is the same unit as energy they're different, since moment is the cross product and energy is the dot product
- Moments try to rotate an object while translational forces try to move it; the moment is a measure of how much the object wants to rotate
- The same force can cause rotations in different directions depending on the reference point
- Special case: When a pair of forces are going in equal and opposite directions and separated by some distance d, this is called a *couple*
  - Since the forces cancel each other out, there is no translational motion, only rotation
  - Also called a *pure moment*

Unit Conversions

- When converting units, we multiply the quantity by unit conversion fractions equal to 1