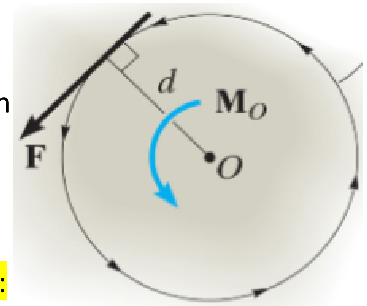
Lecture 6 Note - *Moments I (Moments in 2D)*

Textbook Chapter 4.1-4.4

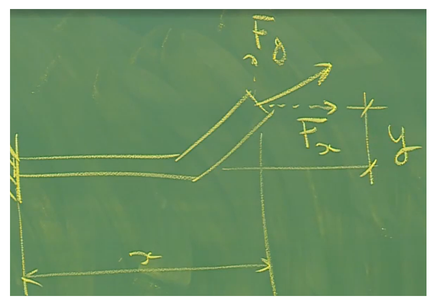
What is a moment?



- A force vector that makes a body turn about an axis
  - They have magnitude, direction, & point of application
  - Affects rigid bodies (an object that can turn)
  - **Moment** = (**Force**)(distance) $\rightarrow$ ***M = Fd***
  - A moment's axis is best imagined as an axle.
  - Where does a moment point? Use the right hand rule: If your hand is *O* and your fingers curl with the rotation, your thumb points with $\boldsymbol{M_a}$

How to solve 2D moment problems:

- In 2D moments rotate either clockwise (CW) or counterclockwise (CCW, + by default).
- A scalar approach can be used to solve 2D problems: *CCW* $(M_R)_O = \sum(Fd)$
- **Varignon's Theorem**: Moments can be broken up into their component pieces and then applied over distance. The moment of a force acting on any point equals the $\sum$ of the moments' components acting on that point.
  - $\boldsymbol{M_o} = F_x y + F_y x$
  - Skip calculating the distance from $\boldsymbol{F_o}$ to *O*!



How to solve 3D moment problems (using cross product):

- 3D problems can be solved with the cross product table method from high school.
- The moment vector of a force about a point can be described by ***A*** × ***B*** = ***C***, such that:
  - ***C*** is the moment about point *O*; ***A*** is its force vector and ***B*** its position vector from *O* to that force vector. ***C*** is perpendicular to the plane containing ***A*** and ***B*** (the cross product of two vectors gives a 3rd vector perpendicular to both)
  - Note that position vector ***B*** doesn't have to be perpendicular to ***A***, as long as it touches ***A***'s line of action. The *d* in *Fd* equals *r sin θ*, where r is the distance from ***B*** to ***A***'s line of action, and *θ is* ***B***'s angle of elevation to ***A'****s* line of action.
  - Key definitions: $\boldsymbol{C} = \boldsymbol{A} \times \boldsymbol{B} = (AB \sin\theta)\mathbf{u_c}$; The magnitude of $C = AB\sin\theta$
  - The direction of ***C*** can be obtained using the right-hand rule mentioned earlier.

- <u>Tip: Pick the simplest position vector with the most 0s to simplify calculations.</u> As long as it starts on the axis of the moment and ends on the line of action of the force, it's OK.

- $\boldsymbol{M_r}$ about point *O* equals the sum of moments $\boldsymbol{M_1} + \boldsymbol{M_2} + \boldsymbol{M_3}$ about point *O*, OR $\mathbf{F_R}$ crossed with a position vector from it to point *O.*