Statics - TAM TAM 211

Lecture 8

September 28, 2018

Announcements

- No classes September 29 – October 7 for National Day Holiday
  - Saturday Sept 29 make-up class cancelled to accommodate for Quiz 1
  - Sunday Sept 30 make-up class cancelled to accommodate for Quiz 2
  - Enjoy your vacation!
- Upcoming deadlines:

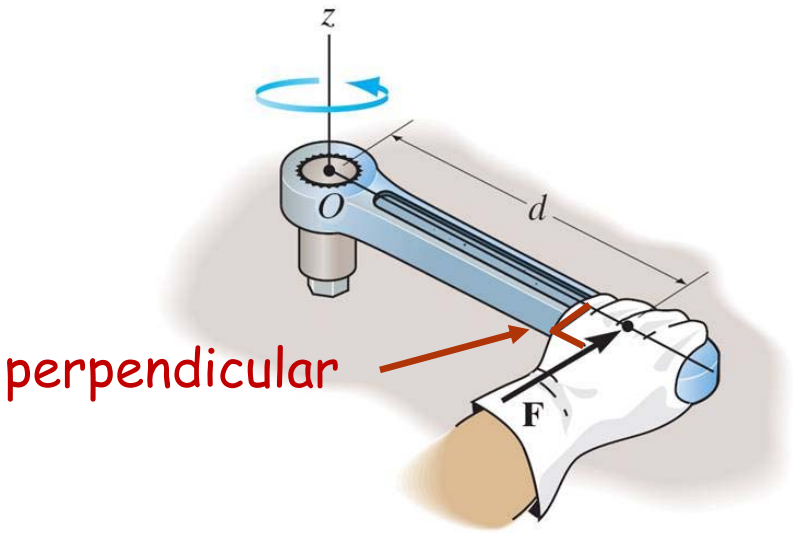
- Friday (today)
  - Written Assignment 2
- Tuesday (10/9)
  - Prairie Learn HW3
- Friday (10/12)
  - Written Assignment 3

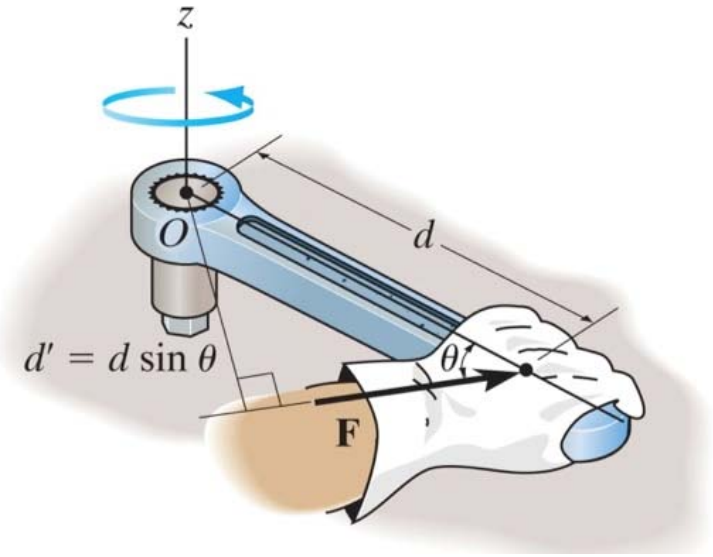
Chapter 4: Force System Resultants

Goals and Objectives

- Discuss the concept of the moment of a force and show how to calculate it in two and three dimensions
- How to find the moment about a specified axis (using Scalar Triple Product)
- Define the moment of a couple
- Finding equivalence force and moment systems
- Reduction of distributed loading

Recap: Moment of a force





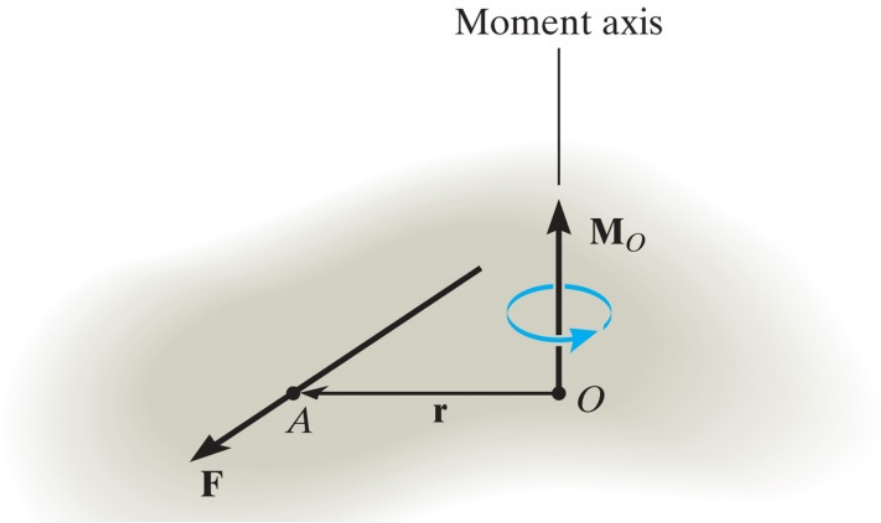
Scalar Formulation: $M_O = F\,d$

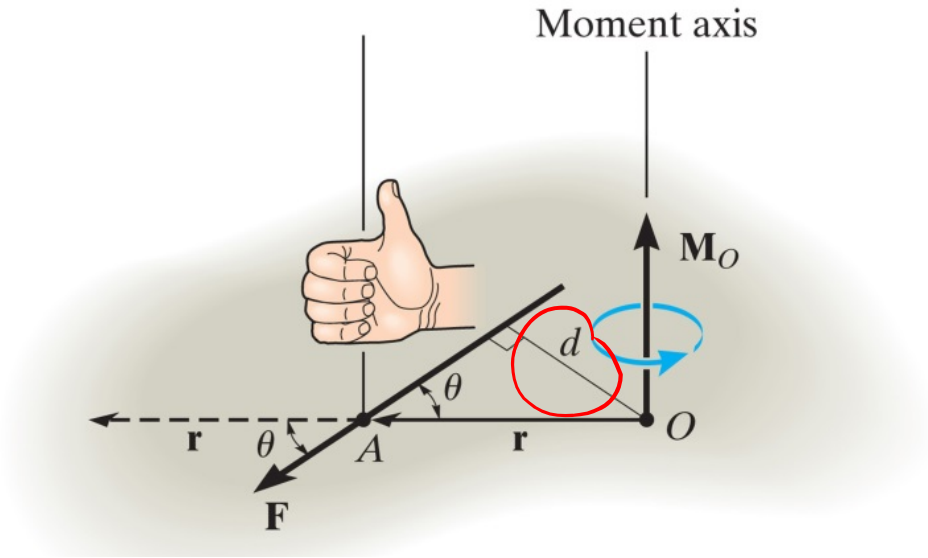
Scalar Formulation: $M_O = F\,d'$

Direction: Moment about point O $\overrightarrow{M_O}$ is perpendicular to the plane that contains the force $\vec{F}$ and its moment arm $\vec{d}$. The right-hand rule is used to define the sense.

Magnitude: In a 2D case (where $\vec{F}$ is perpendicular to $\vec{d}$), the magnitude of the moment about point O is $M_O = F\,d$

Recap: Moment of a force

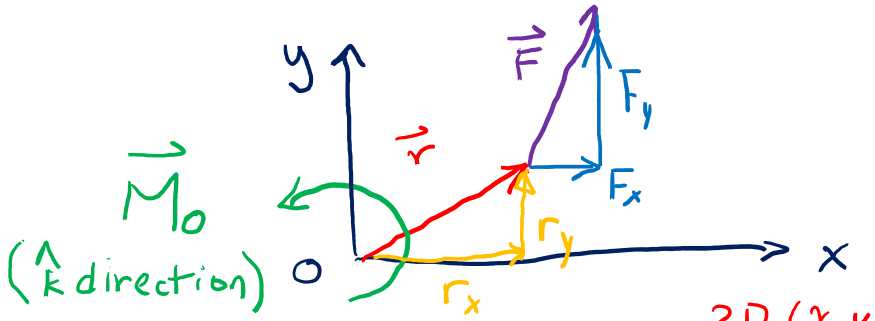




Vector Formulation

Use cross product: $\overrightarrow{M_O} = \vec{r} \times \vec{F}$

Direction: Defined by right hand rule.



2D (x,y) case

$$\overrightarrow{M_O} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} = (r_y F_z - r_z F_y)\hat{\imath} - (r_x F_z - r_z F_x)\hat{\jmath} + (r_x F_y - r_y F_x)\hat{k}$$

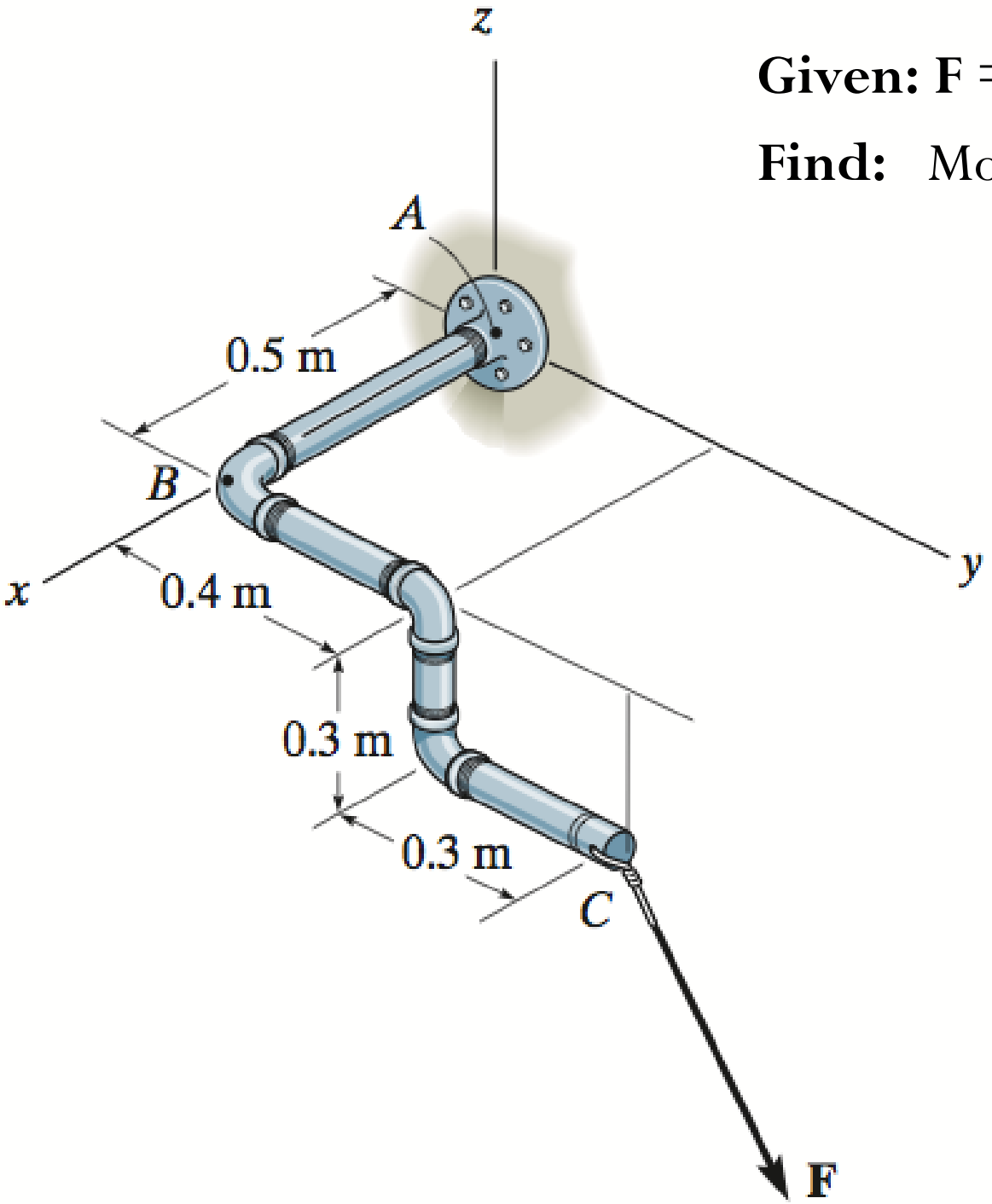
$= \vec{M}_O$ (x,y case)

Magnitude: recall $|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin\theta$

$$M_O = \left|\overrightarrow{M_O}\right| = |\vec{r}|\left|\vec{F}\right| \sin\theta = F(r\sin\theta) = Fd$$

d is the perpendicular distance from O to $\vec{F}$

Example – Vector Formulation

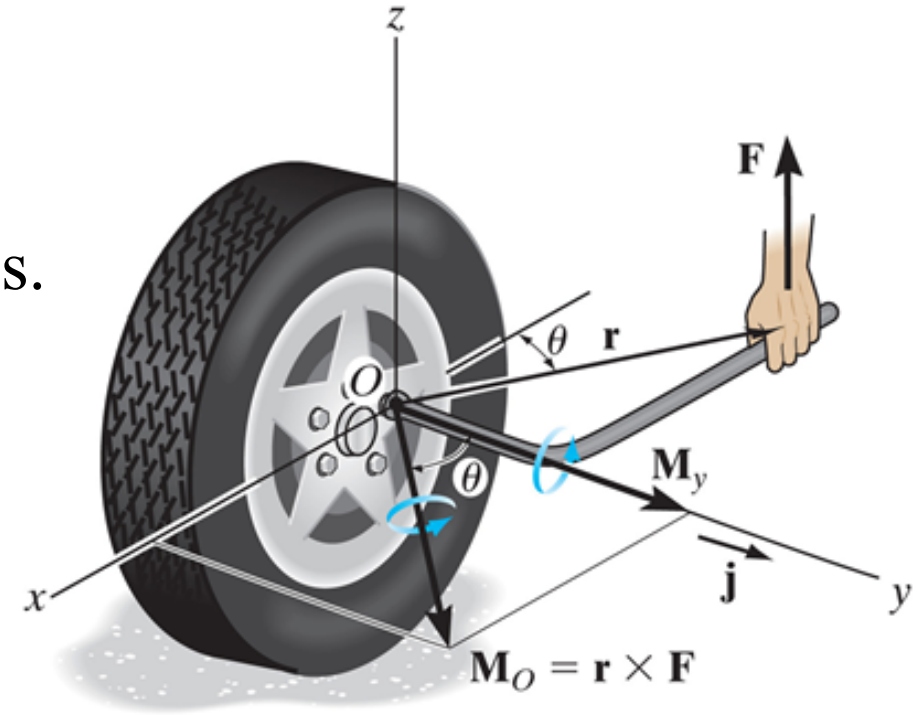


Given: **F** = {600**i** + 800**j** - 500**k**} N

Find: Moment of the force about point *B*.

Moment of a force about a specified axis

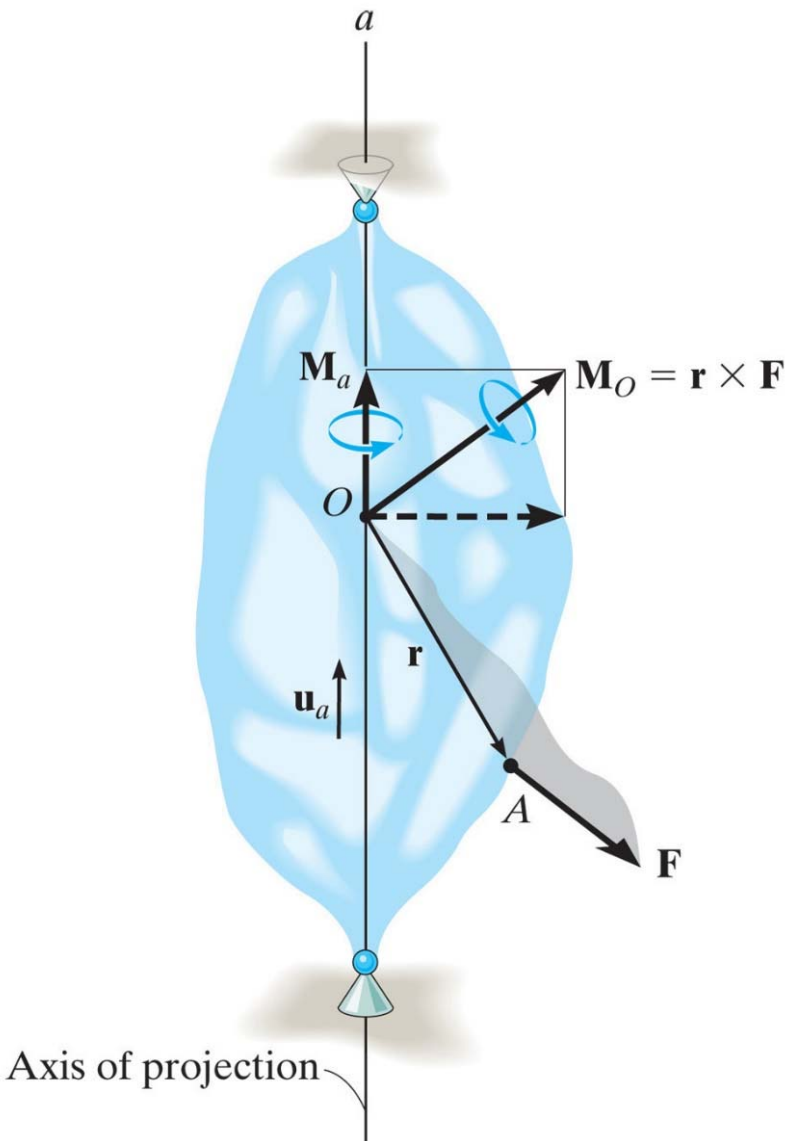
A force is applied to the tool as shown. Find the magnitude of the moment of this force about the *y*-axis.



Recall: the projected component of a vector, $\vec{A}$, along the direction of another, $\vec{B}$, can be determined using the dot product.

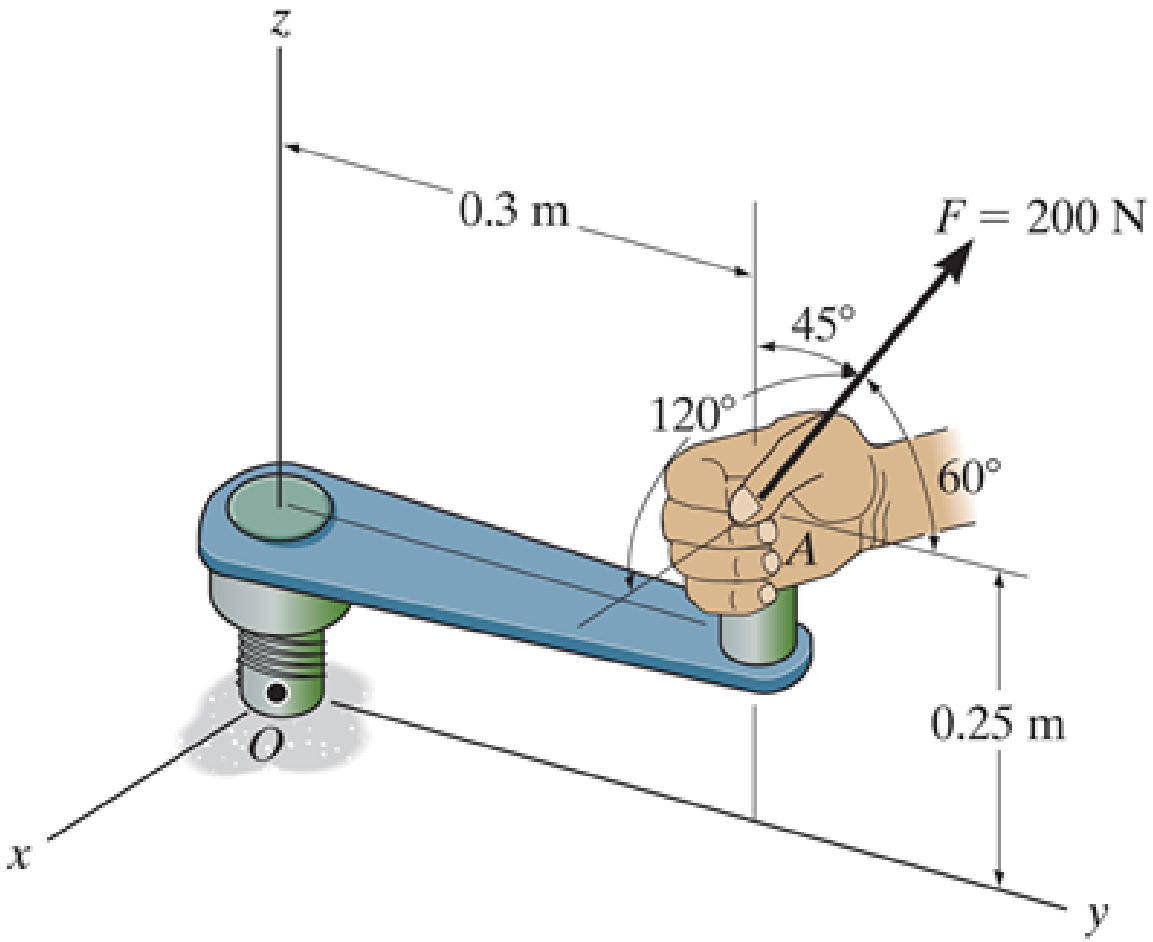
Moment of a force about a specified axis (Scalar Triple Product)

The magnitude of the projected moment about any generic axis *a* can be computed using the scalar triple product:



The direction of the projected moment about any generic axis *a* can be defined using :

where $\overrightarrow{\boldsymbol{u_a}}$ is the unit vector along axis *a*



A force is applied to the tool as shown. Find the magnitude of the moment of this force about the x axis.