Statics - TAM 210 & TAM 211

Lecture 8

February 2, 2018

Announcements

- CBTF has physical calculators!!! Casio fx-300MS (see CBTF website)
- Upcoming deadlines:

- Quiz 1 (1/31-2/2)
  - Reserve testing time at CBTF
  - https://cbtf.engr.illinois.edu/sched/
  - NO MAKE-UP.
  - Lectures 1- 4 material
- Friday (2/1)
  - Mastering Engineering Tutorial 4
- Tuesday (2/6)
  - PL Homework 3
- Quiz 2 (2/7-9)
  - Reserve testing time at CBTF
  - Lectures 5-9

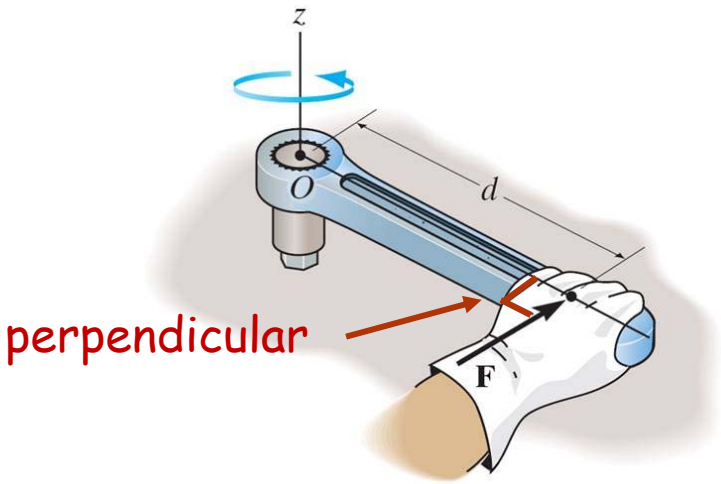
http://www.groundhogday2018shadow.info/2016/11/happy-groundhog-day-images.html

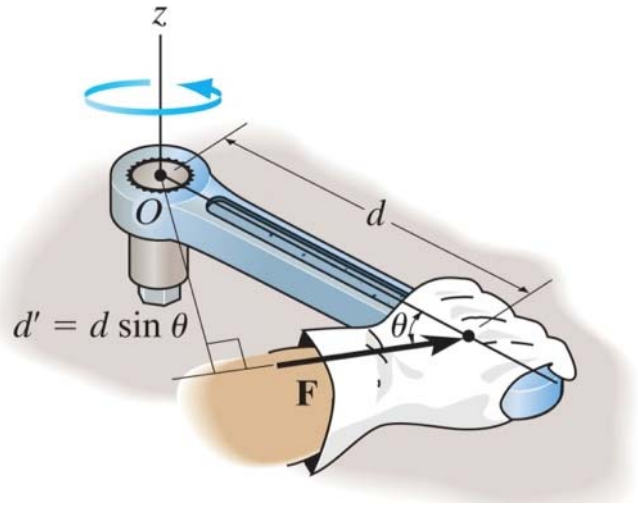
Chapter 4: Force System Resultants

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
- Define the moment of a couple
- Finding equivalence force and moment systems
- Reduction of distributed loading

Recap: Moment of a force





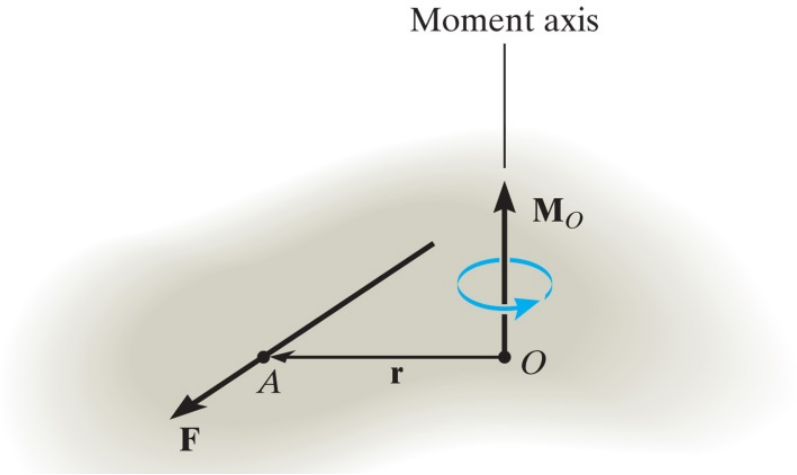
Scalar Formulation: $M_O = F\,d$

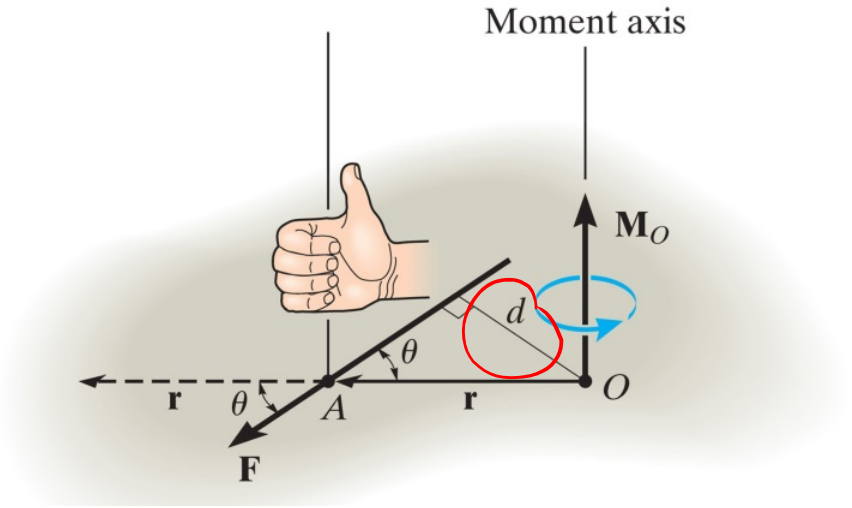
Scalar Formulation: $M_O = F\,d'$

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

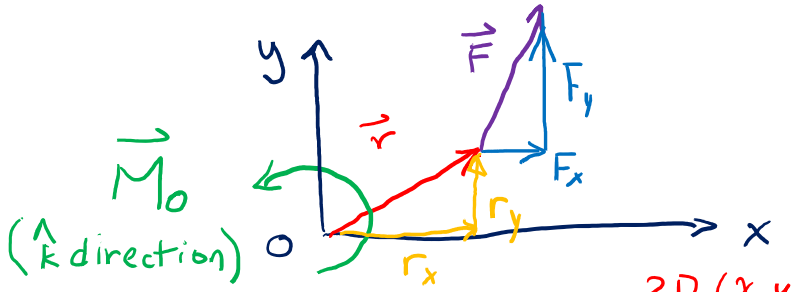




Vector Formulation

Use cross product: $\overrightarrow{\boldsymbol{M}_O} = \vec{\boldsymbol{r}} \times \vec{\boldsymbol{F}}$

Direction: Defined by right hand rule.



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

2D (x,y) case

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

Magnitude:

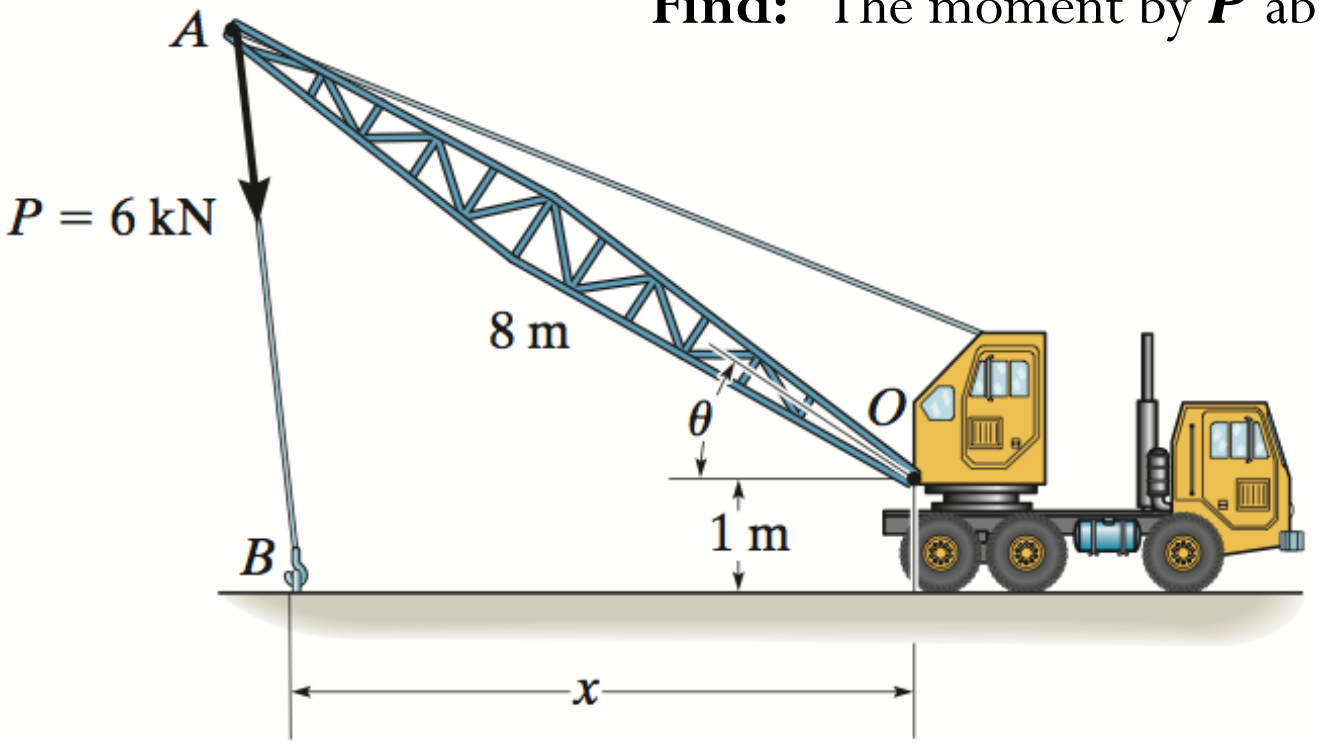
$$M_O = \left|\overrightarrow{\boldsymbol{M}_O}\right| = |\vec{\boldsymbol{r}}|\left|\vec{\boldsymbol{F}}\right| sin\theta = F(rsin\theta) = Fd$$

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

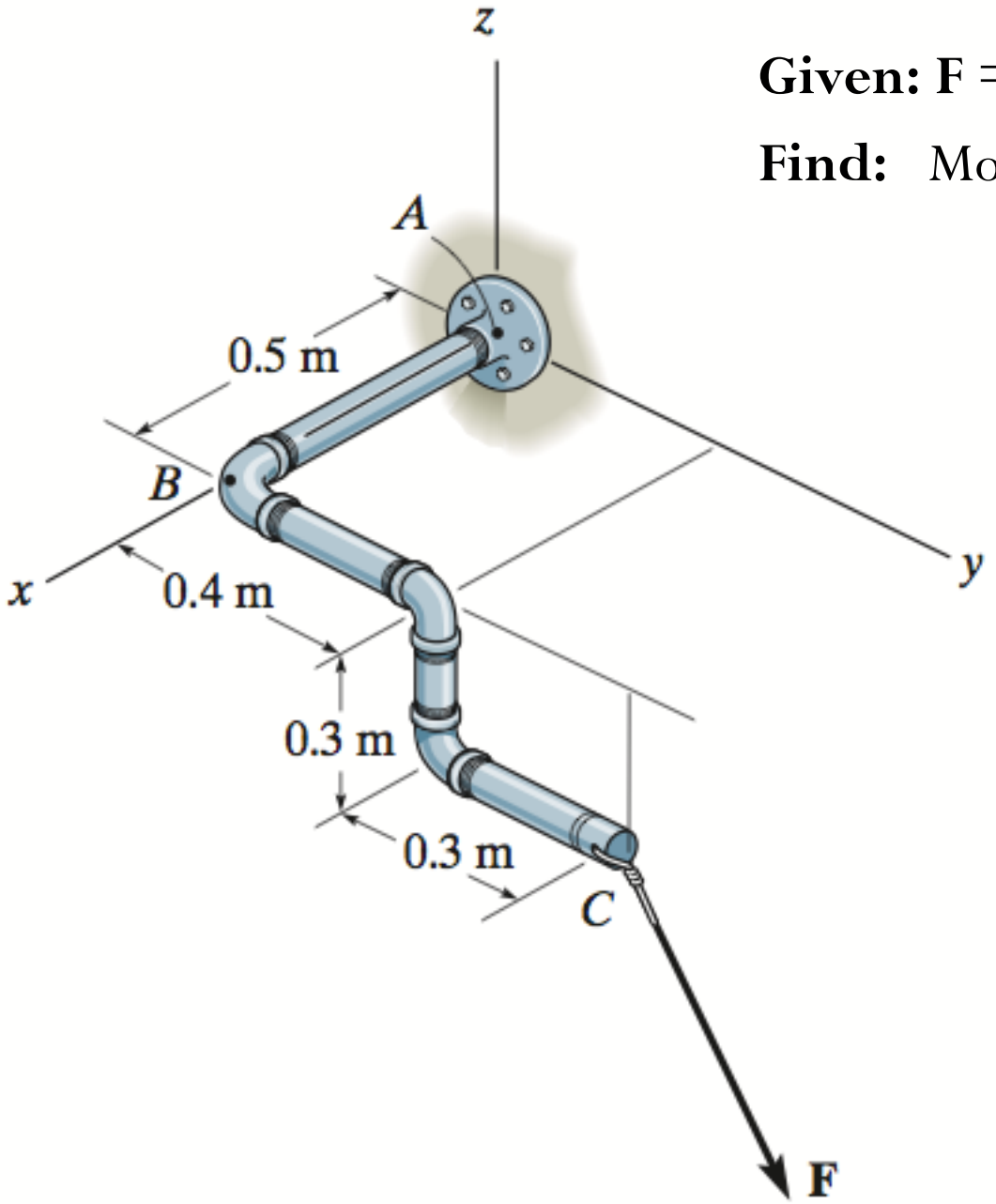
Example

Given: The angle $\theta = 30°$ and $x = 10$ m.

Find: The moment by $\vec{\boldsymbol{P}}$ about point O.



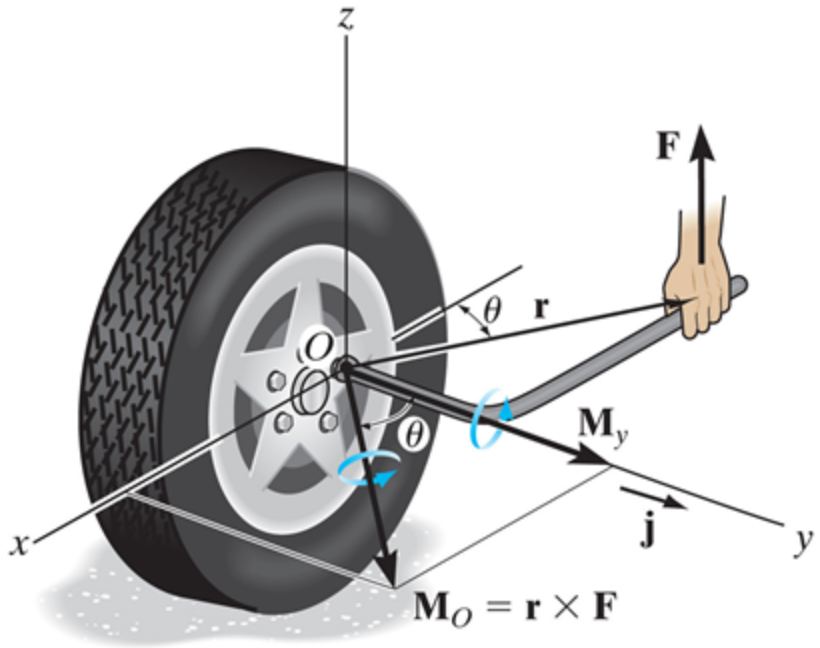
Example – Vector Formulation

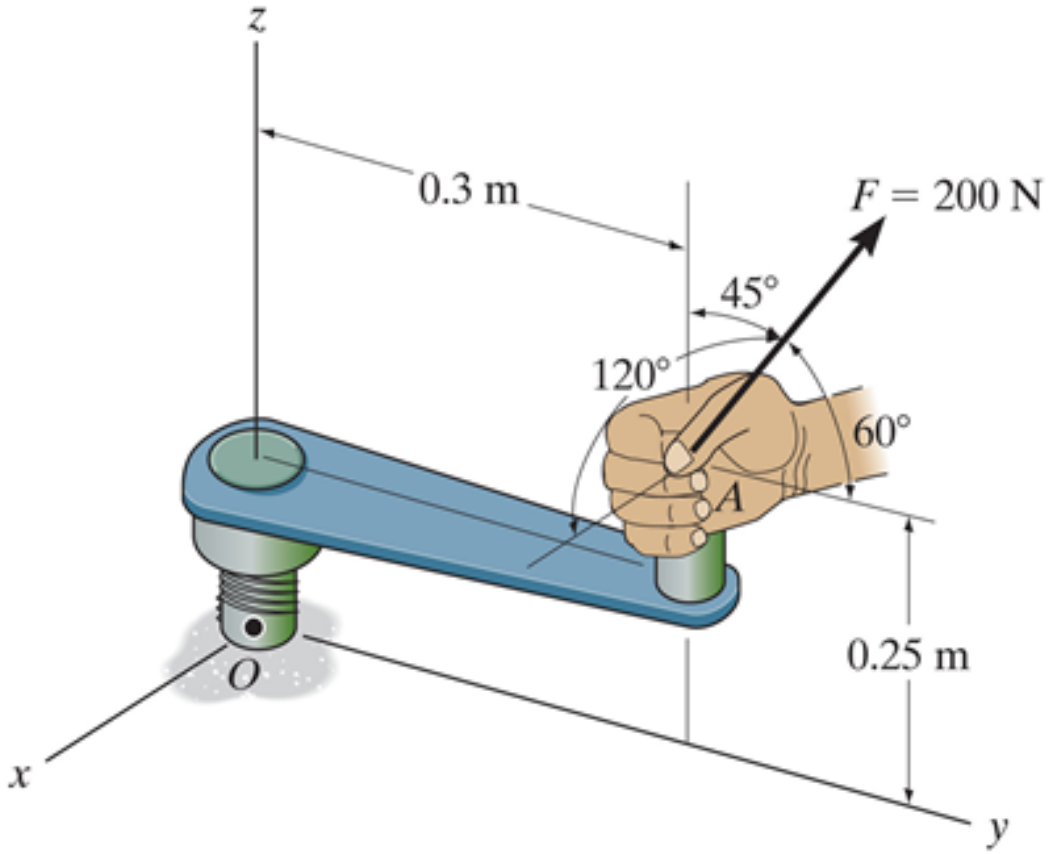


Given: **F** = {600**i** + 800**j** - 500**k**} N

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 x axis.