University of Cihan-Sulaimaniya
Engineering Faculty
Architectural Engineering Department

ENGINEERING MECHANICS

Chapter 4: Force System Resultants

2nd Grade- Fall Semester 2023-2024

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Chapter Description

- Aims
  - To explain the Moment of Force (2D-scalar formulation & 3D-Vector formulation)
  - To explain the Principle Moment
  - To explain the Moment of a Couple
  - To explain the Simplification of a Force and Couple System
  - To explain the Reduction of Simple Distributed Loading
- Expected Outcomes
  - Able to solve the problems of MOF and COM in the mechanics applications by using principle of moments
- References
  - Russel C. Hibbeler. Engineering Mechanics: Statics & Dynamics, 14th Edition

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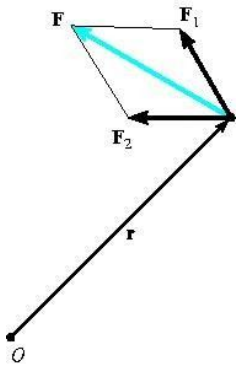
Chapter Outline

1. Moment of Force (MOF) –Part I
2. Principle of Moment –Part II
3. Moment of Couple (MOC) Part III
4. Simplification of a Force and Couple System
5. Reduction of Simple Distributed Loading- part IV

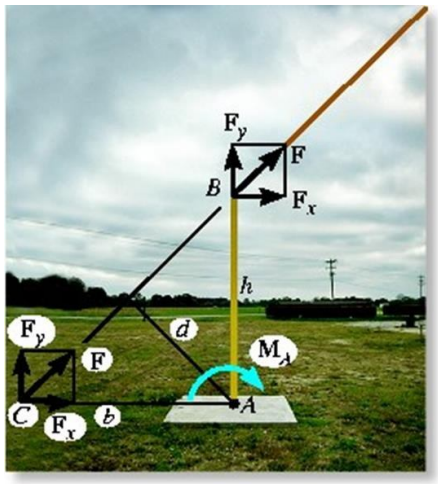
4.2 Principle of Moment

Varignon's Theorem states that "**Moment of a force** about **a point** is **equal** to the **sum of the moments of the forces**' components about the point"

$$\mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2,$$
$$\mathbf{M}_O = \mathbf{r} \times \mathbf{F}_1 + \mathbf{r} \times \mathbf{F}_2$$
$$= \mathbf{r} \times (\mathbf{F}_1 + \mathbf{F}_2)$$
$$= \mathbf{r} \times \mathbf{F}$$



4.2 Principle of Moment



- The guy cable exerts a force **F** on the pole and creates a moment about the base at A

  $M_A = Fd$
- If the force is replaced by $\mathbf{F}_x$ and $\mathbf{F}_y$ at point B where the cable acts on the pole, the sum of moment about point A yields the same resultant moment
- $\mathbf{F}_y$ create zero moment about A

  $M_A = F_x h$
- Apply principle of transmissibility and slide the force where line of action intersects the ground at C, $\mathbf{F}_x$ create zero moment about A

  $M_A = F_y b$

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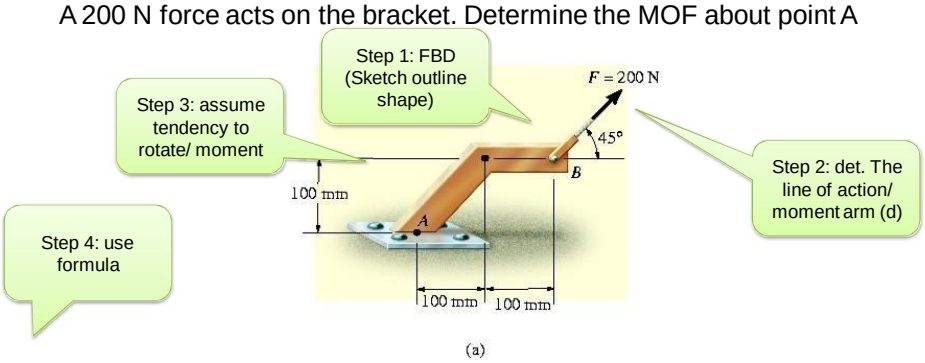
Example 4.5

A 200 N force acts on the bracket. Determine the MOF about point A



$M_O = Fd$

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Solution Example 4.5

A 200 N force acts on the bracket. Determine the MOF about point A

Method 1:

From trigonometry using triangle BCD,

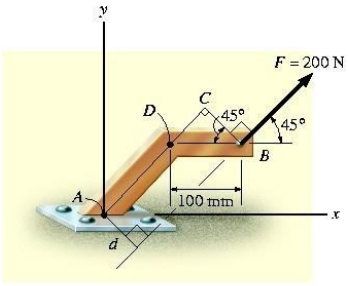
CB = d = 100cos45° = 70.71mm

= 0.07071m

Thus,

$M_A = Fd$ = 200N(0.07071m)

= 14.1N.m (CCW)



(b)

Solution Example 4.5

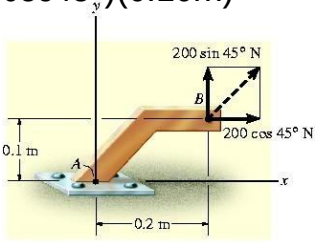
A 200 N force acts on the bracket. Determine the MOF about point A

- Resolve 200N force into x and y components
- Principle of Moments

$M_A = \sum Fd$

M_A = (200sin45°N)(0.20m) – (200cos45°)(0.10m)

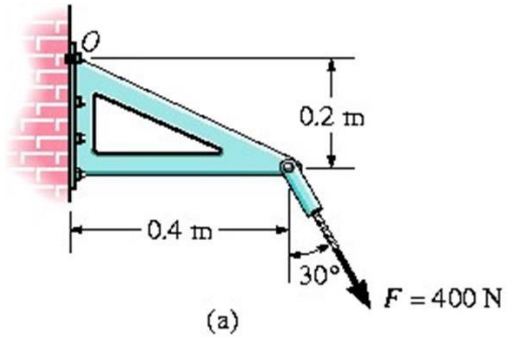
= 14.1 N.m (CCW)



(c)

Example 4.6

The force **F** acts at the end of the angle bracket. Determine the moment of the force about point O



Solution Example 4.6

$M_O = 400\sin30°N(0.2m)-400\cos30°N(0.4m)$

$= -98.6N.m$

$= 98.6N.m$ (CW)

As a Cartesian vector,

$\mathbf{M}_O = \{-98.6\mathbf{k}\}N.m$