

**ARCHITECTURAL STRUCTURES I:
STATICS AND STRENGTH OF MATERIALS**

ENDS 231

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SPRING 2007

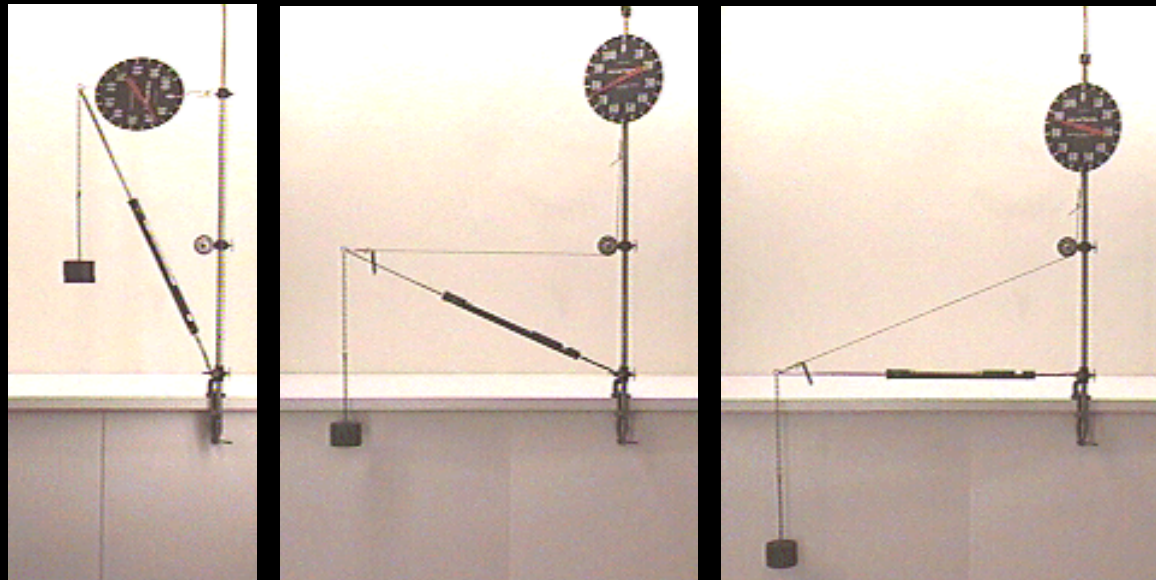
**lecture
three**

moments



Moments

- *forces have the tendency to make a body rotate about an axis*



– same translation but different rotation

Moments

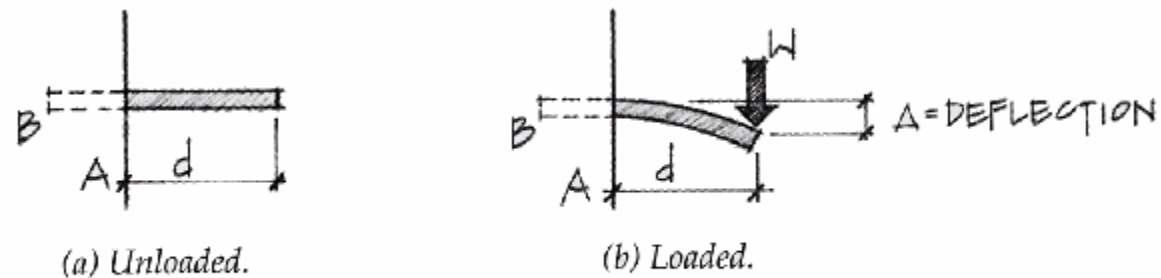


Figure 2.33 Moment on a cantilever beam.

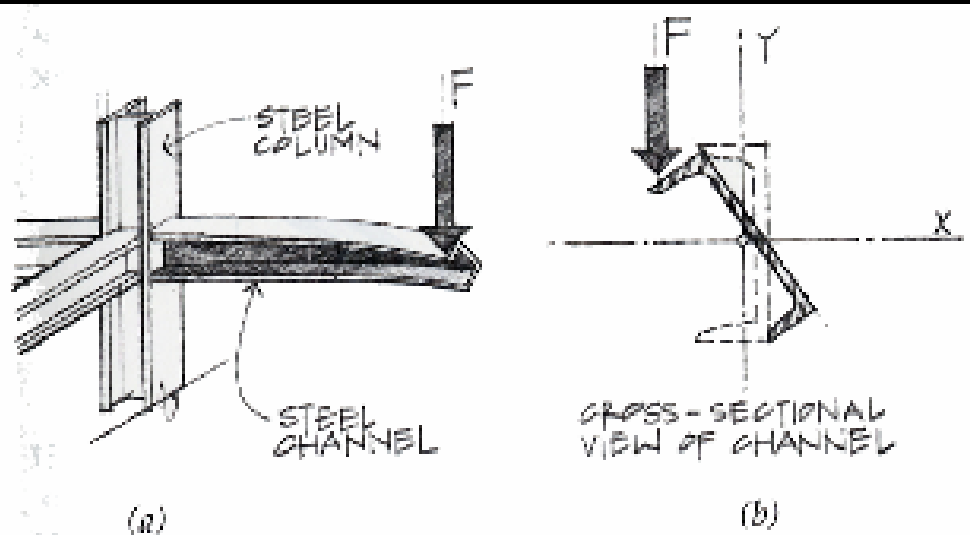
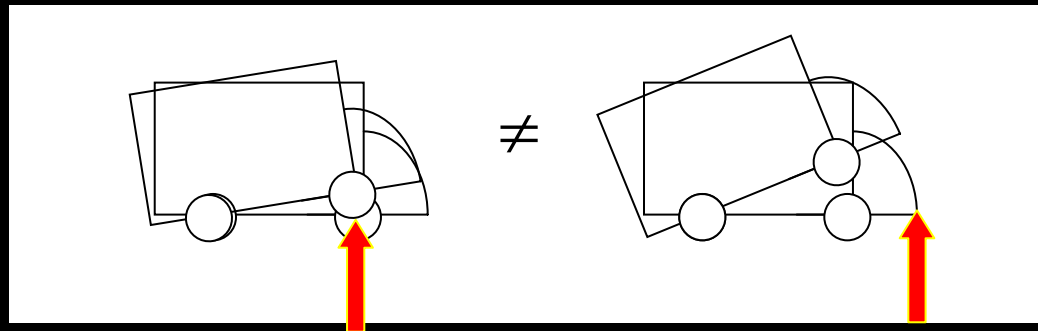


Figure 2.34 An example of torsion on a cantilever beam.

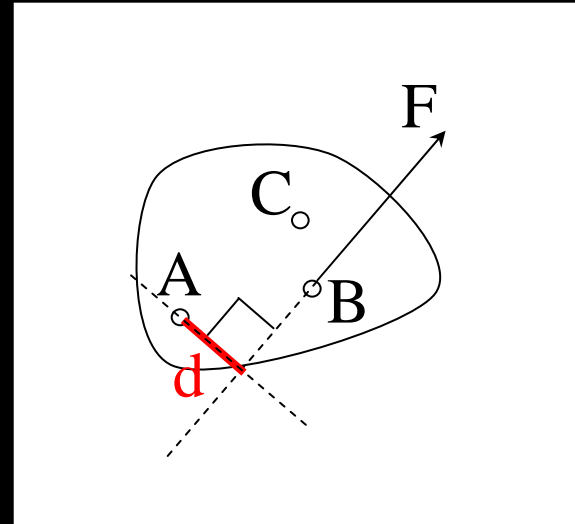
Moments

- a force acting at a different point causes a different moment:



Moments

- *defined by magnitude and direction*
- *units: N·m, k·ft*
- *direction:*
 - + *ccw (right hand rule)*
 - *cw*
- *value found from F and \perp distance*
$$M = F \cdot d$$
- *d also called “lever” or “moment” arm*

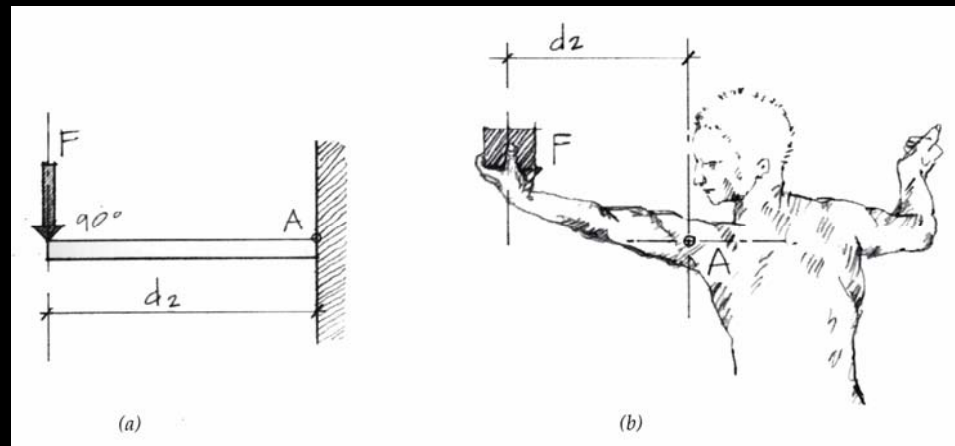
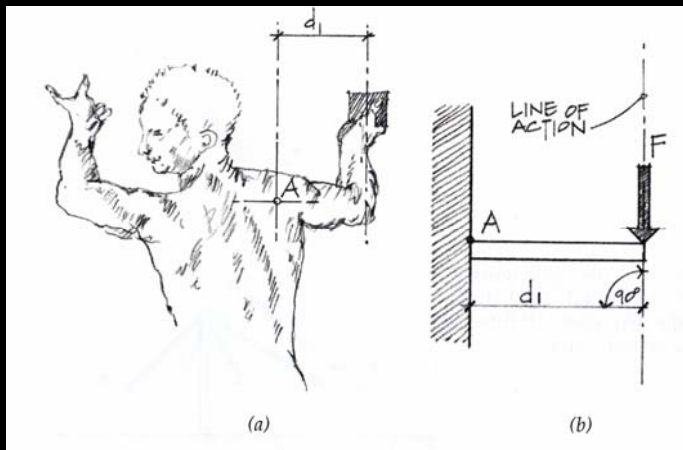


Moments

- with same F :

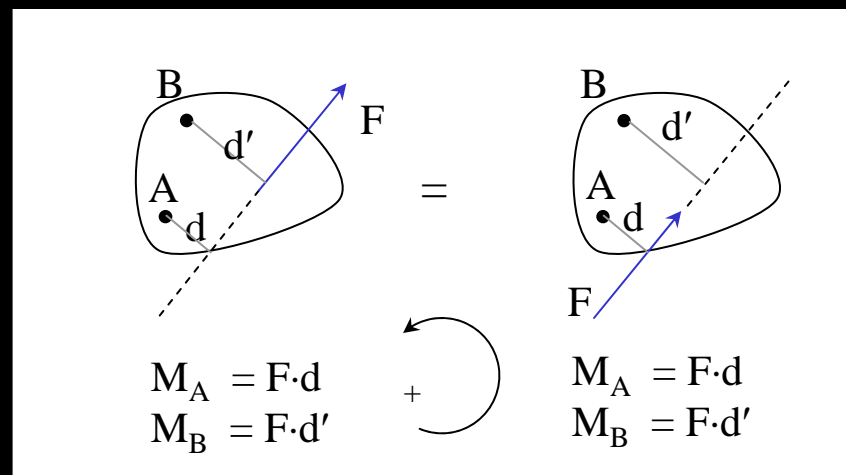
$$M_A = F \cdot d_1 < M_A = F \cdot d_2$$

(bigger)



Moments

- *additive with sign convention*
- *can still move the force along the line of action*

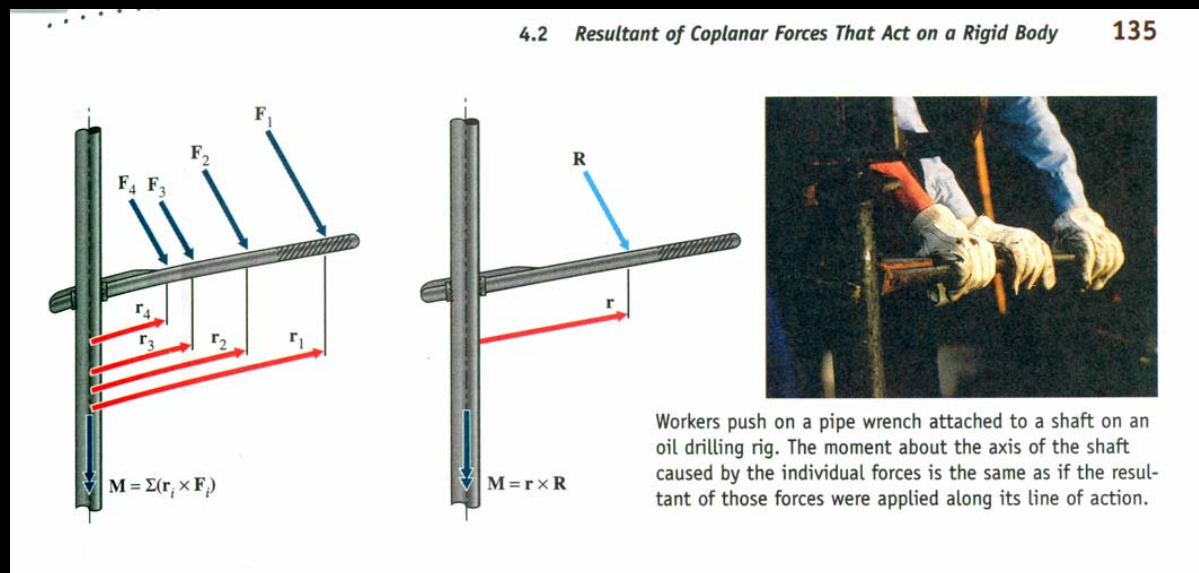


Moments

- *Varignon's Theorem*
 - *resolve a force into components at a point and finding perpendicular distances*
 - *calculate sum of moments*
 - *equivalent to original moment*
- *makes life easier!*
 - *geometry*
 - *when component runs through point, $d=0$*

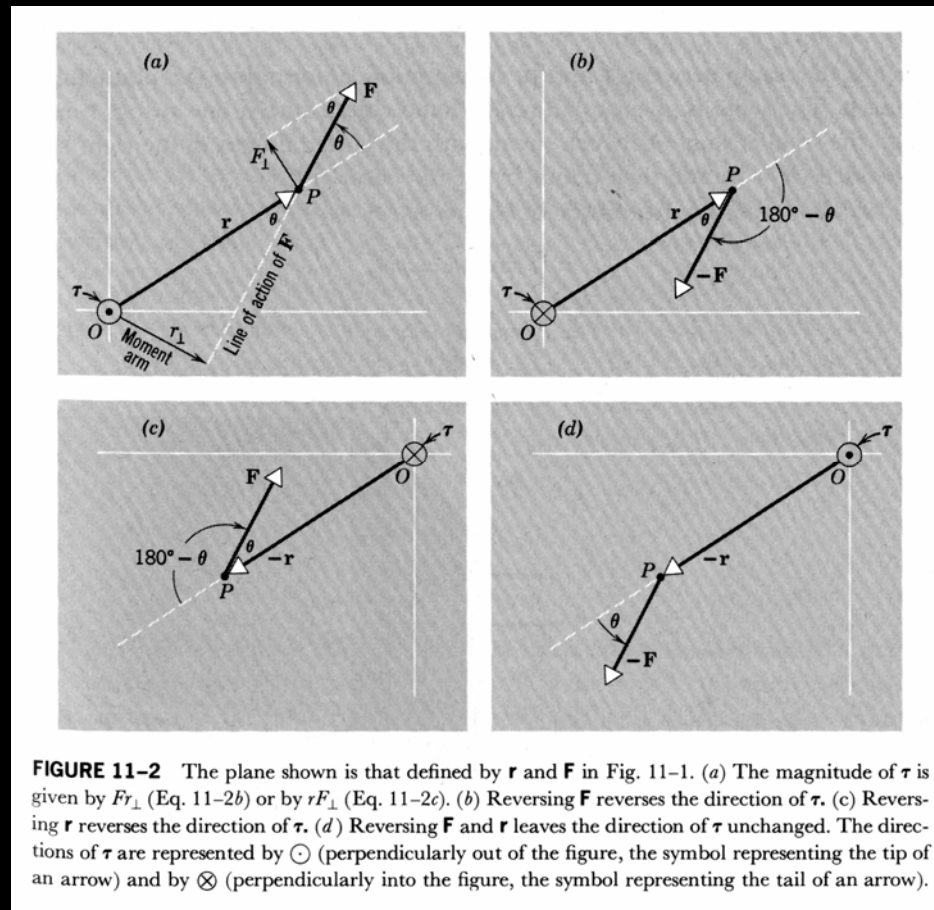
Physics & Moments of a Force

- *moments of a force*
 - *introduced in Physics as “Torque Acting on a Particle”*
 - *and used to satisfy rotational equilibrium*



Physics and Moments of a Force

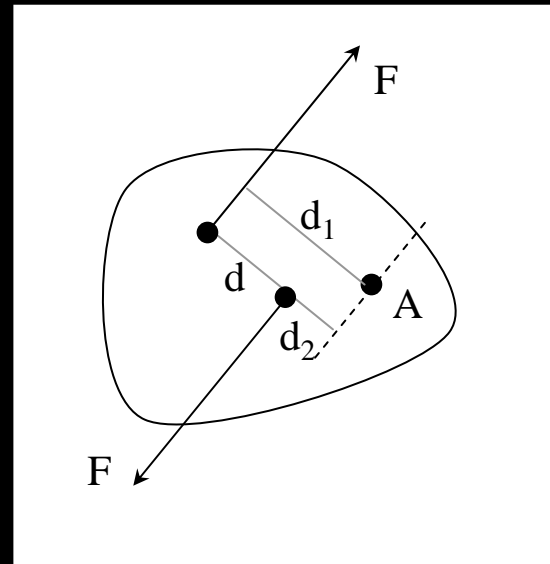
- *my Physics book:*



Moment Couples

- 2 forces
 - same size
 - opposite direction
 - distance d apart
 - CW or CCW

$$M = F \cdot d$$

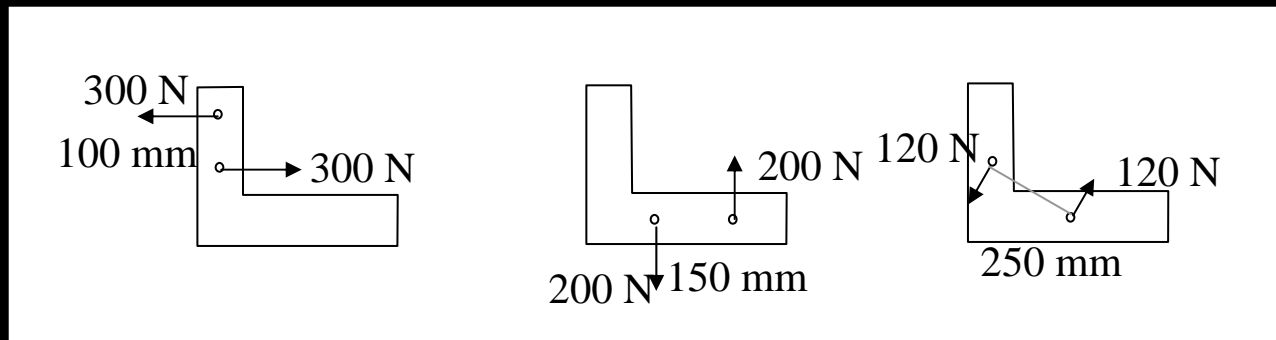


- not dependant on point of application

$$M = F \cdot d_1 - F \cdot d_2$$

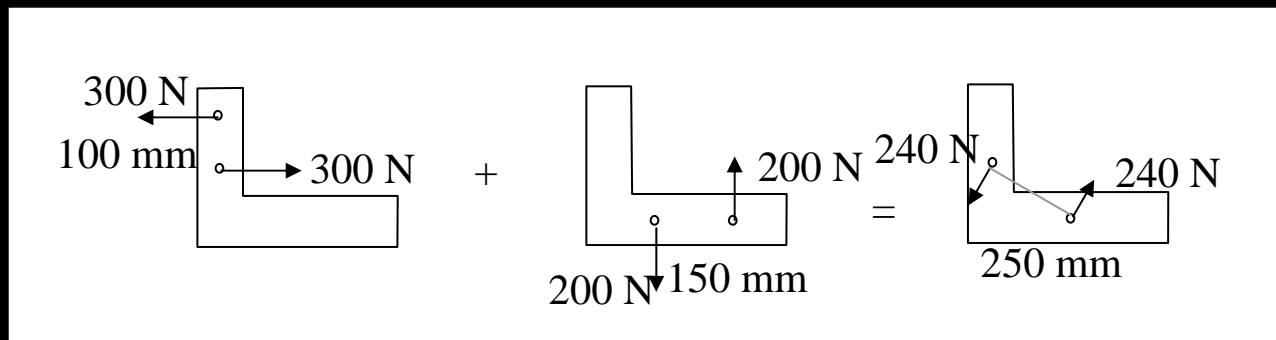
Moment Couples

- *equivalent couples*
 - *same magnitude and direction*
 - *F & d may be different*



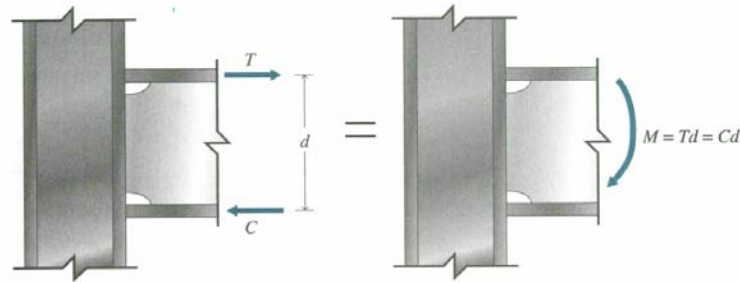
Moment Couples

- *added just like moments caused by one force*
- *can replace two couples with a single couple*

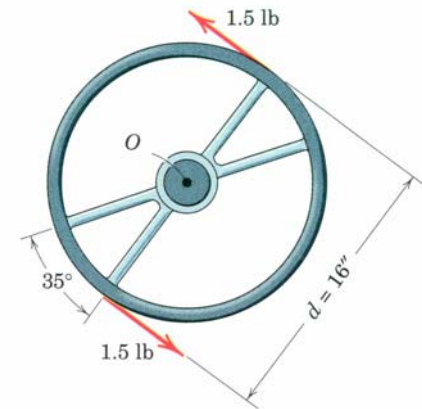


Moment Couples

- *moment couples in structures*



The flanges of a steel beam are welded to the flange of a column. Equal and opposite forces T and C in the beam flanges form a couple with moment M that is transferred into the column.

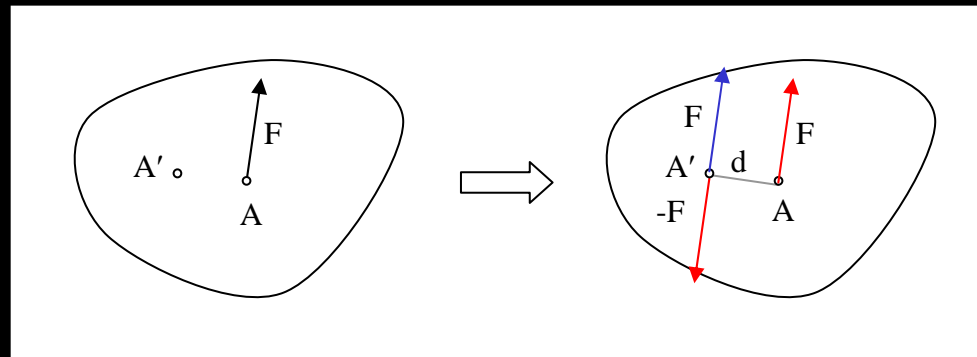


Equivalent Force Systems

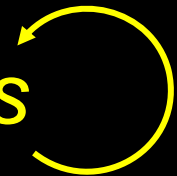
- *two forces at a point is equivalent to the resultant at a point*
- *resultant is equivalent to two components at a point*
- *resultant of equal & opposite forces at a point is zero*
- *put equal & opposite forces at a point (sum to 0)*
- *transmission of a force along action line*

Force-Moment Systems

- *single force causing a moment can be replaced by the same force at a different point by providing the moment that force caused*

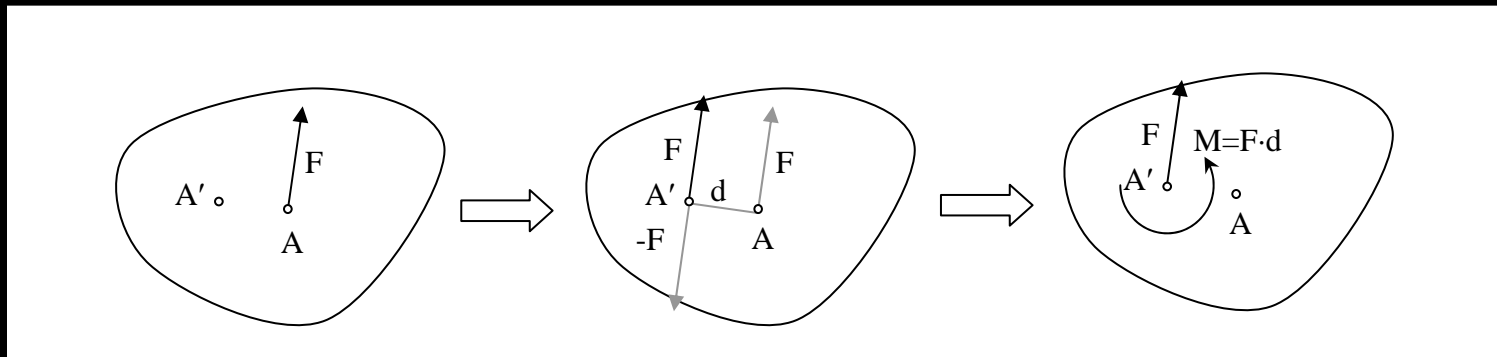


- *moments are shown as arched arrows*



Force-Moment Systems

- a force-moment pair can be replaced by a force at another point causing the original moment



Parallel Force Systems

- forces are in the same direction
- can find resultant force
- need to find location for equivalent moments

