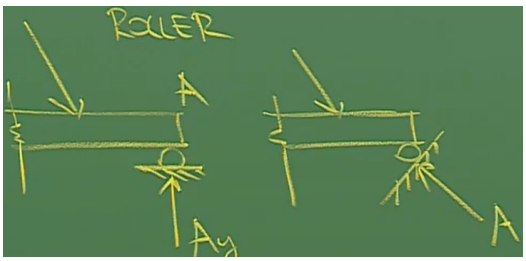
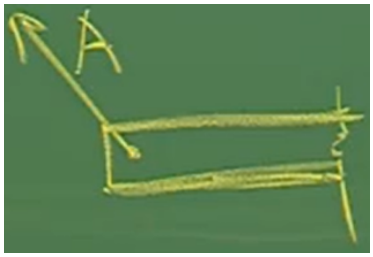
Lecture 11 Note - *2D Rigid Body Equilibrium*

Textbook Chapter 5.1-5.4

What *is* 2D Rigid Body Equilibrium?

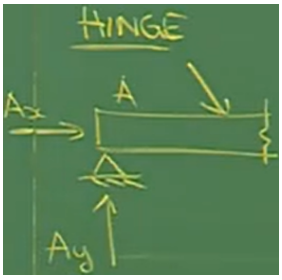
- Recall that a rigid body is an object that has mass and size—it can be moved and rotated. If it is in equilibrium, it is neither moving or rotating. $\boldsymbol{F_R} = \sum \boldsymbol{F} = 0$, & $\boldsymbol{(M_R)_O} = \sum \boldsymbol{M_O} = 0$
- In other words, $\sum F_X = 0$, $\sum F_Y = 0$, *and* $\sum M = 0$. Up to 3 unknowns can be solved.
- To solve a rigid body problem, sketch a FBD, plot all forces acting upon the rigid body.
- Know your supports. Different supports produce different reactionary (stabilizing) forces:
    - Roller: 1 reactionary force perpendicular to the surface the roller's on (left):

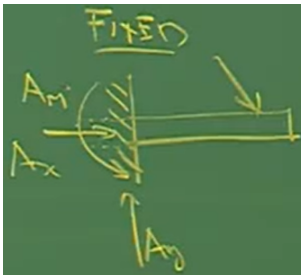




      Cables (right): They too have 1 reactionary force, but away from the body instead.

    - Hinges (left): 2 reactionary forces in the x/y axis. They prevent movement only.





    - Fixed (right): 3 reactionary forces in the x/y/moment axes. They resist all forces.
    - How to find these forces? Start by solving the variable with the LEAST unknowns.
- 2-force members:
    - A member hinged at both ends, with no forces applied to it except at its 2 ends. Regardless of which direction the forces at either end act, they will always line up and be equal to each other because of the pivoting hinges. $\sum F = 0$, $\sum M_O = 0$
- In addition to being in equilibrium, a body must be constrained by supports *to be solvable*.
    - Note that when a body has more supports than needed for equilibrium, it is statically indeterminate. There are more unknown variables than equations.
    - Some bodies are improperly constrained and can't be solved. A body is like this if the (stabilizing) reaction forces are concurrent, intersect on a common axis, are parallel, or are less in number than than equations of equilibrium.