Lecture 12 Note - *3D Rigid Body Equilibrium*

Textbook Chapter 5.5-5.7

What's new after Lecture 11?

- Not much. This lecture is similar but in 3D instead 2D. For a 3D object to be in equilibrium, the $\sum$ of all forces & moments in all axes must = 0. In other words, $\sum F_X$ / $\sum F_Y$ / $\sum F_Z$ and $\sum M_X$ / $\sum M_Y$ / $\sum M_Z$ all equal 0. We can solve for up to 6 unknown variables this way.

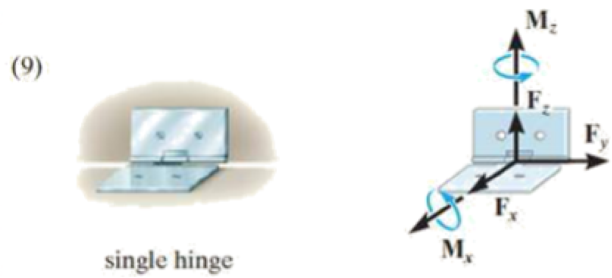
- We have new supports to learn: (# of reactionary forces/moments written in brackets)

smooth surface support

ball and socket

Surface Support (1): Object is free to move, except towards the surface. Free to rotate.
Ball & Socket (3): Object can't move but is free to rotate in any direction.

single journal bearing



single hinge

Single Journal Bearing (4): Object can only move and rotate about one axis.
Hinge (5): Object can't move, can only rotate about one axis.

How to solve a 3D Rigid Body Equilibrium Problem?

- First draw a free body diagram so you can figure out what is going on.
  - Draw an outline of the body
  - Pick a convenient origin point (0,0,0) to set up your coordinate system.
  - Mark all reaction & moment forces (stabilizing forces) coming from the supports. We do this to figure out what forces are holding our object in place (equilibrium).
  - Assume directions for unknown forces.

- Then bring out the equilibrium equations and figure out what you can solve for (don't plug in numbers yet until you have something like 21:50 in the video lecture).
  - Use the scalar equations if possible—they're faster. If not, just use a vector approach (remember that the sum of forces in the ***i***, ***j***, and ***k*** directions all equal 0).