Prepaped by Dr. A. Mekki

Summary of chapter 13

- A rigid body is in **equilibrium** if its net linear momentum and net angular momentum are both **constant**.

- A rigid body is in **static equilibrium** if the net external force and the net external toque acting on it are both **zero**. That is:

$$\sum \vec{F}_{ext} = 0 \quad and \quad \sum \vec{\tau}_{ext} = 0$$

- In the case of two dimensional problem, these two vetor equations reduces to:

$$\sum F_x = 0 \quad and \quad \sum F_y = 0$$

$$\sum \tau_z = 0$$

Important: ***Generally you should choose the z-axis so as to eliminate unknown forces.***

- ***If the free fall acceleration g is the same for all particles in a rigid body, then the center of gravity is the same as the center of mass defined in chapter 9.***

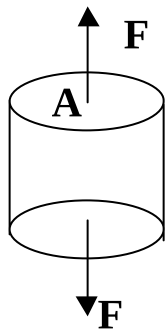
- Rigid bodies can change their dimensions slightly by pulling, pushing, twisting, or compressing them.
  There are three ways that a solid might change its dimensions when external forces act on it:
  - ✓ **Stretching** $\rightarrow$ **tensile stress**
  - ✓ **Shearing** $\rightarrow$ **shear stress**
  - ✓ **Object is in a fluid under high pressure** $\rightarrow$ **hydraulic stress**

Generally, we have a relation between the stress (applied from outside) and the strain (result of the stress):

$$\textit{Stress} = \textit{Modulus} \times \textit{Strain}$$

In the elastic region, the modulus depends on the way the deformation is done:

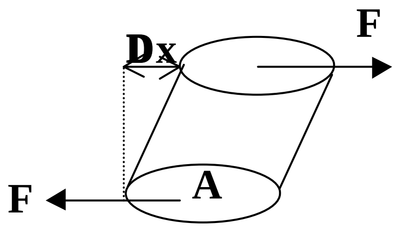
- Tension and compression:



$$\frac{F}{A} = E\frac{\Delta L}{L}$$

E is **Young modulus** and **A is the cross section area**.

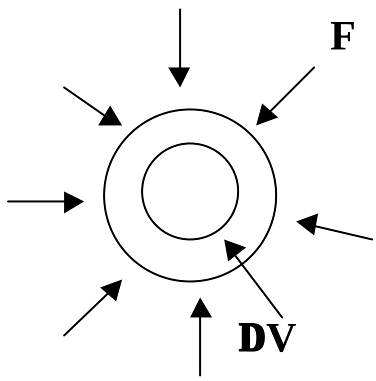
- Shearing:



$$\frac{F}{A} = G\frac{\Delta X}{L}$$

G is the **shear modulus and A the cross section area**.

- Hydraulic stress:



$$P = \frac{F}{A} = B\frac{\Delta V}{V}$$

B is the **bulk modulus and V is the volume of the object.**