2.11 Review

- *Hydrostatic Force on an Inclined Plane Surface*

$$\begin{aligned} F_R &= P_C A \\ x_R &= \frac{I_{xyc}\gamma \sin\theta}{P_C A} \\ y_R &= \frac{I_{xc}\gamma \sin\theta}{P_C A} \end{aligned}$$

  where the subscript $_C$ indicates *centroid*, that is, P_C is the pressure at the centroid of the area of interest, A and the coordinates x_r, y_r are the distances horizontally and down from the *centroid*, respectively. If, and only if, the fluid column above A is a liquid with a free surface then $P_C = \gamma h_c$, where h_c is the depth of liquid over the centroid. However, if gasses or pressurized headspaces are involved then they must be included when determining P_C (i.e., $P_C = \gamma h_c + P_0$ where P_0 is the headspace pressure).

- *Hydrostatic Force on Curved Surfaces* - employ a control volume!
  - Horizontal component of the resultant force is just the force on the vertical projection of the curved surface.
  - Vertical component of the resultant force is the force on the horizontal projection of the curved surface plus (or minus more likely) any fluid weights inside the control volume.

2.12 Buoyancy

$$F_{\mathrm{B}} = \int_{\mathrm{body}} (P_1 - P_1)\, dA_H = -\gamma \int (z_2 - z_1)\, dA_H = \gamma \cdot (\text{body volume})$$

Therefore

$$F_B = F_{V_2} - F_{V_1} = \text{Fluid weight above } S_2 - \text{fluid weight above } S_1$$
$$= \text{weight of fluid occupying the volume of the body}$$

2.12.1 Archimedes' Principal

F_B = Weight of fluid displaced by a body *or* a floating body displaces its own weight of the fluid on which it floats.

2.12.2 Stability of Floating Bodies

The stability of a floating body depends on the location of the buoyancy force and the weight of the body. They each exert a moment – one is a righting moment (the tendency to rotate the object to an upright position) while the other is an overturning moment (the tendency to flip the body over).