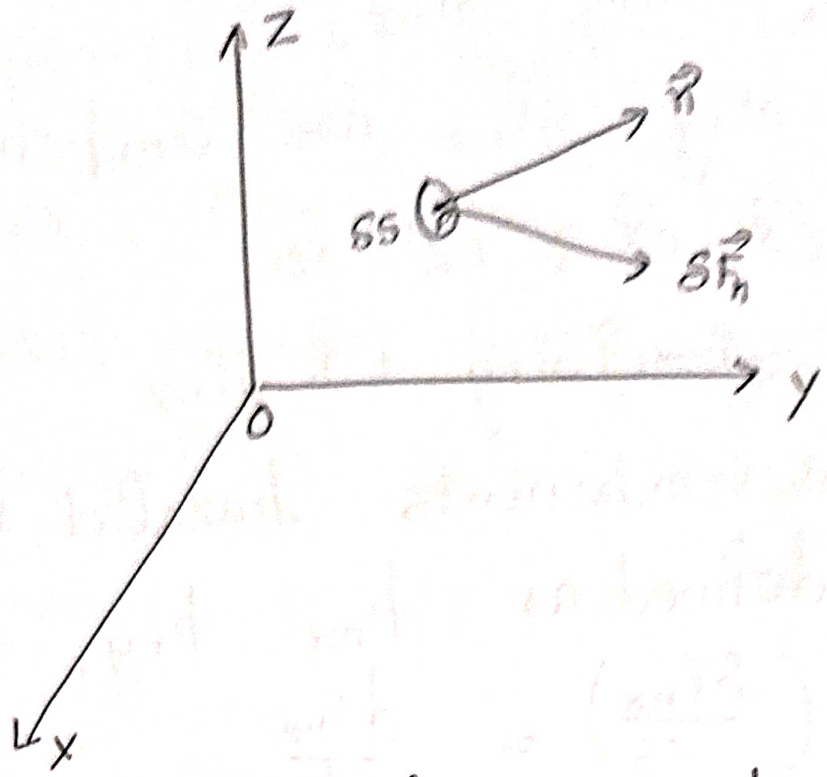
Components in a real fluid →



Let a real fluid element δS at the point P on δS be a small rigid plane area inscribed at a point P in a viscous fluid, Cartesian co-ordinates (x, y, z) are referred to a set of fixed axes ox, oy, oz.

let $\delta\vec{F}_n$ is the force exerted by the moving fluid on one side of δS, let $\vec{n}$ be the unit outward normal to the surface element δS at P on this side.

We know that, in the case of inviscid fluid $\delta\vec{F}_n$ is aligned with $\vec{n}$.

For a viscous fluid, frictional forces are called into play between the fluid and the surface so that $\delta\vec{F}_n$ will also have a component tangential to δS.

We suppose the Cartesian components of $\delta\vec{F}_n$ be $[\delta F_{nx}, \delta F_{ny}, \delta F_{nz}]$ on δS.

Let δF_{nx}, δF_{ny}, δF_{nz} are components of $\delta\vec{F}_n$ along $o\vec{x}$, $o\vec{y}$ & $o\vec{z}$ so

$$\delta\vec{F}_n = \delta F_{nx}\hat{i} + \hat{j}\delta F_{ny} + \hat{k}\delta F_{nz}$$

Now stress components parallel to the axes are defined as p_{nx}, p_{ny}, p_{nz}

$$p_{nx} = \lim_{\delta S \to 0}\left(\frac{\delta F_{nx}}{\delta S}\right) = \frac{dF_{nx}}{dS}$$

$$p_{ny} = \lim_{\delta S \to 0}\left(\frac{\delta F_{ny}}{\delta S}\right) = \frac{dF_{ny}}{dS}$$

$$p_{nz} = \lim_{\delta S \to 0}\left(\frac{\delta F_{nz}}{\delta S}\right) = \frac{dF_{nz}}{dS}$$

In the components p_{nx}, p_{ny}, p_{nz} the first suffix n denotes the direction of the normal to the elemental plane δS, the second suffix x, y or z denotes the direction in which the component is measured.

If we identify $\vec{n}$ in turn with the unit vectors $\hat{i}, \hat{j}, \hat{k}$ in $\overline{ox}$, $\overline{oy}$, $\overline{oz}$, we obtain the following three sets of stress components