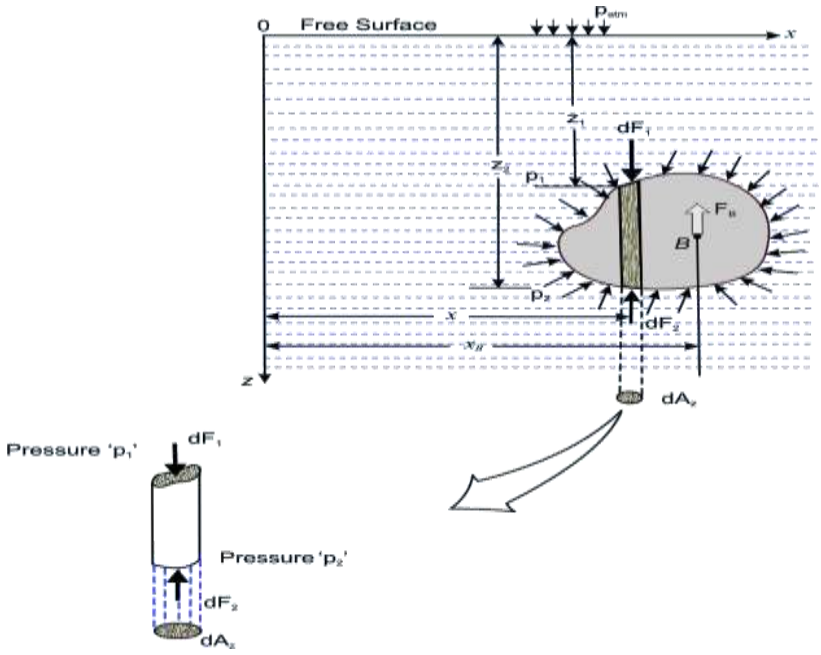
LECTURE 7

BUOYANCY

Buoyancy

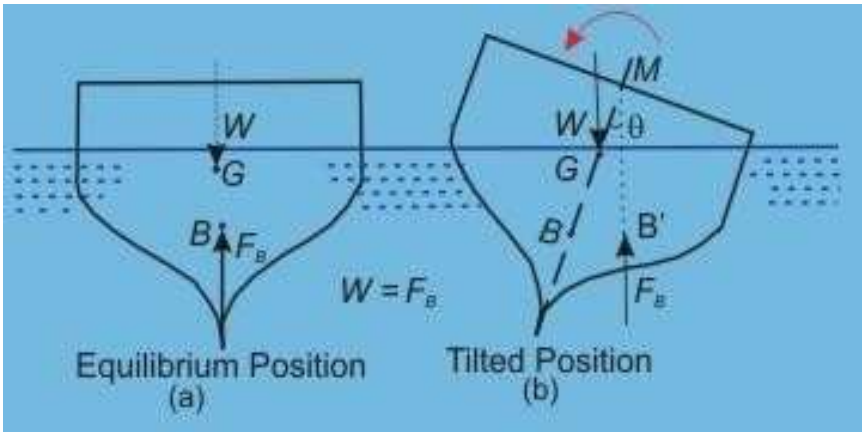
- When a body is either wholly or partially immersed in a fluid, a lift is generated due to the net vertical component of hydrostatic pressure forces experienced by the body.
- This lift is called the buoyant force OR upthrust and the phenomenon is called buoyancy
- Consider a solid body of arbitrary shape completely submerged in a homogeneous liquid as shown in Fig. Hydrostatic pressure forces act on the entire surface of the body.



Stability of Floating Bodies in Fluid

- When the body undergoes an angular displacement about a horizontal axis, the shape of the immersed volume changes and so the centre of buoyancy moves relative to the body.
- As a result of above observation stable equilibrium can be achieved, under certain condition, even when G is above B. Fig illustrates a floating body -a

boat, for example, in its equilibrium position.



POINTS TO BE NOTED:-

a. The force of buoyancy F_B is equal to the weight of the body W

b. Centre of gravity G is above the centre of buoyancy in the same vertical line.

c. Figure b shows the situation after the body has undergone a small angular displacement q with respect to the vertical axis.

d. The centre of gravity G remains unchanged relative to the body but this is not always true for ships where some of the cargo may shift during an angular displacement.

e. During the movement, the volume immersed on the right hand side increases while that on the left hand side decreases. Therefore the centre of buoyancy moves towards the right to its new position B'.

Let the new line of action of the buoyant force (which is always vertical) through B' intersects the axis BG (the old vertical line containing the centre of gravity G and the old centre of buoyancy B) at M. For small values of q the point Impractically constant in position and is known as meta-centre. For the body shown in Fig. M is above G, and the couple acting on the body in its displaced position is a restoring couple which tends to turn the body to its original position. If M were below G, the couple would be an overturning couple and the original equilibrium

would have been unstable. When M coincides with G, the body will assume its new position without any further movement and thus will be in neutral equilibrium. Therefore, for a floating body, the stability is determined not simply by the relative position of B and G, ratherby the relati**ve** position of M and G. The distance of meta-centre above G along the line BG is known as meta-centric height GM which can be written as GM = BM -BG

Hence the condition of stable equilibrium for a floating body can be expressed in terms of meta-centric height as follows:

GM > 0 (M is above G)	Stable equilibrium
GM = 0 (M coinciding with G)	Neutral equilibrium
GM < 0 (M is below G)	Unstable equilibrium

The angular displacement of a boat or ship about its longitudinal axis is known as Rolling.

The angular displacement of a boat or ship about its transverse axis is known as Pitching.