Boundary Layer – Concept.

A Layer of fluid adheres to the boundary or surface of solid body and condition of no slip occurs.

The no slip condition implies that the velocity of fluid at a solid boundary must be the same as that of the boundary itself.

For a boundary at rest, the velocity of fluid must reduce to zero at the boundary surface. farther away from the boundary the velocity will be higher.

Due to this variation of velocity, the velocity gradient will exist.

The variation of velocity takes place in a narrow region in the vicinity of solid boundary. The fluid Layer in the vicinity of the solid boundary where the effects of fluid friction (i.e) variation of velocity are predominant is known as the boundary layer.

Existance:

1. Flow of real fluid past over a solid body
   flow in open channel
   flow over spill way
   flow over the land surface.

When a real fluid flows past a solid body or a solid wall, the fluid particles adhere to the boundary and condition of no slip occurs.

Velocity of fluid close to the boundary will be same as that of the boundary. If the boundary is stationary, the velocity of fluid at the boundary will be zero.

Further away from the boundary, the velocity will be higher and as a result of this variation of velocity, the velocity gradient $\frac{du}{dy}$ will exist. The velocity of fluid increases from zero velocity on the stationary boundary of free stream velocity (U) of the fluid in the direction normal to the boundary.

Def: Boundary Layer

The variation of velocity from zero to free-stream velocity in the direction normal to the boundary takes place in a narrow region in the vicinity of solid boundary. This narrow region of the fluid is called boundary layer.

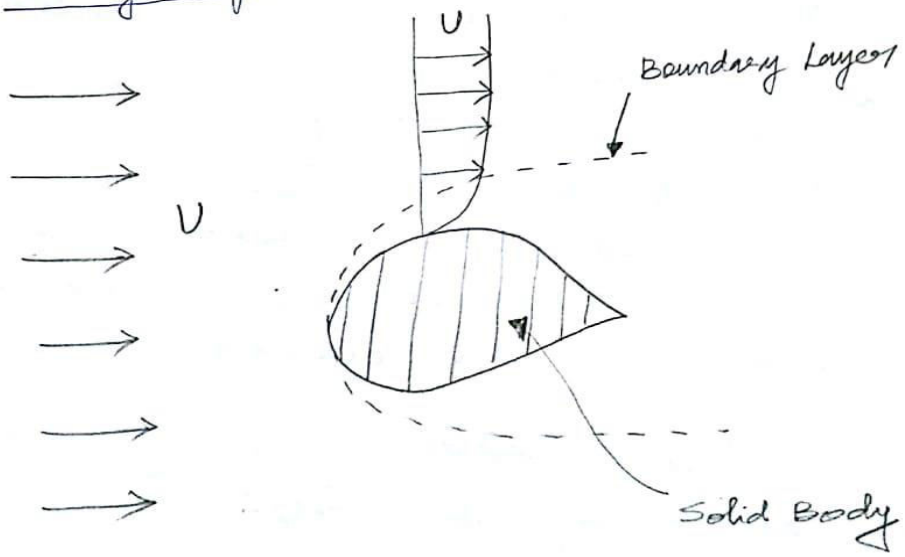
The theory dealing with boundary layer flow is called boundary layer theory.

Continuous flow of fluid along the surface of a thin flat plate with its sharp leading edge set parallel to the flow direction.

The fluid approaches the plate with uniform velocity V known as free stream velocity at the leading edge

The thickness of the boundary layer increases along the plate in the down stream direction. This is referred as growth of boundary layer.

Boundary Layer.

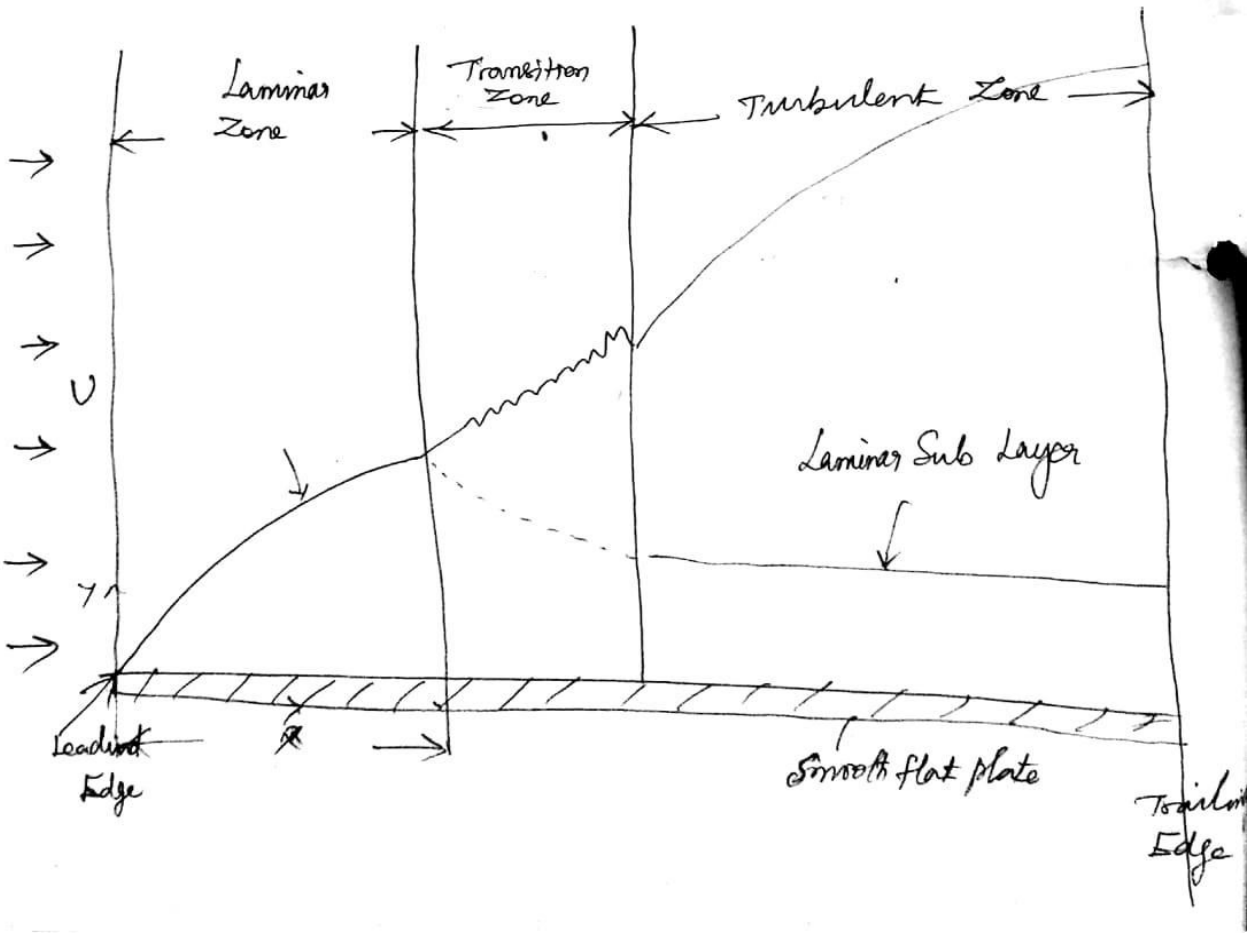


According to boundary layer theory:

Flow of fluid in the vicinity of the solid boundary can be divided into two regions

1. A Thin Layer adjoining the boundary called boundary layer where the viscous effects (effect of fluid friction) takes place.

2. A region outside the boundary layer where the flow can be considered frictionless (i.e) no shear stress) and the potential flow theory is applicable.



Boundary Layer Thickness: (δ)

It is defined as the distance from the boundary of solid body measured in the -Y-direction to the point, where the velocity of the fluid is approximately equal to 0.99 times the free stream velocity (U) of the fluid.

It is denoted by the Symbol δ for Laminar and turbulent Zone it is denoted as

1. δ_{lam} = Thickness of Laminar boundary Layer
2. δ_{tur} = Thickness of Turbulent boundary Layer
3. δ' = Thickness of Laminar Sub Layer.