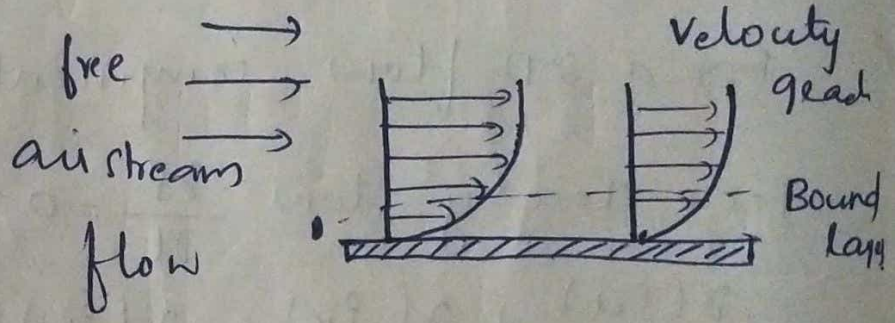
Boundary layer concept

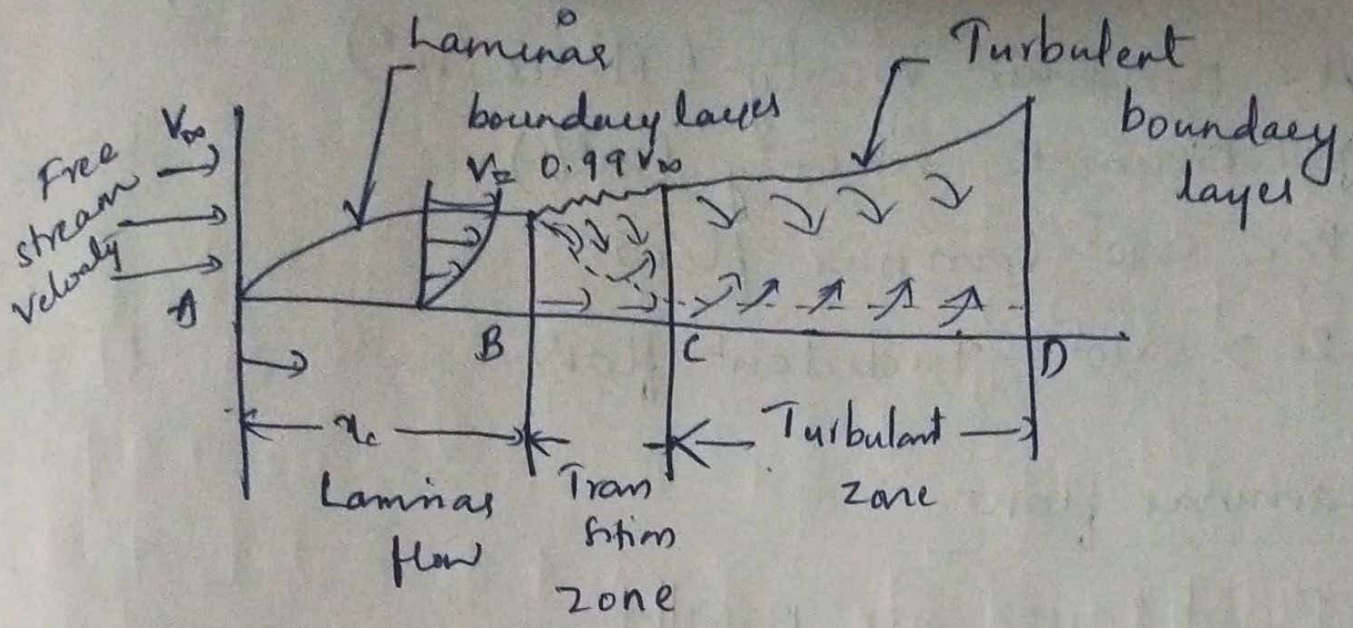
- Velocity and thermal boundary layer are 2 important concepts.

Velocity boundary layer.

- Also known as hydrodynamic boundary layer



- When the fluid flows over a flat plate at the leading edge, all layers of fluid have same velocity
- The region in which flow adjusts from zero velocity at the wall to a maximum in the main stream of flow termed as Velo. B.L



- Thickness of velocity boundary layer, δ is defined as the distance normal to the surface in which velocity of layers varies from 0 to 99% of the free stream velocity.
- Types - Laminar BL
  - Transient BL
  - Turbulant BL
- Type of flow is decided by the non-dimensional numbers called as Reynold's number

$$Re = \frac{\text{Inertia Force}}{\text{Viscous force}} = \frac{\rho V x}{\mu} = \frac{V x}{\nu}$$

ρ - density of fluid (m^3/kg)
v - Velocity of fluid (m/sec)
x - Distance from leading edge (m)

μ - Dynamic viscosity (N-sec/m^2)

ν - kinematic viscosity (m^2/s)

$Re < 5 \times 10^5$ laminar flow.

$Re > 5 \times 10^5$ - Turbulent flow

Laminar flow

- Fluid layers are parallel.
- Velocity is parabolic
- Viscous force is larger than inertia

Transient flow

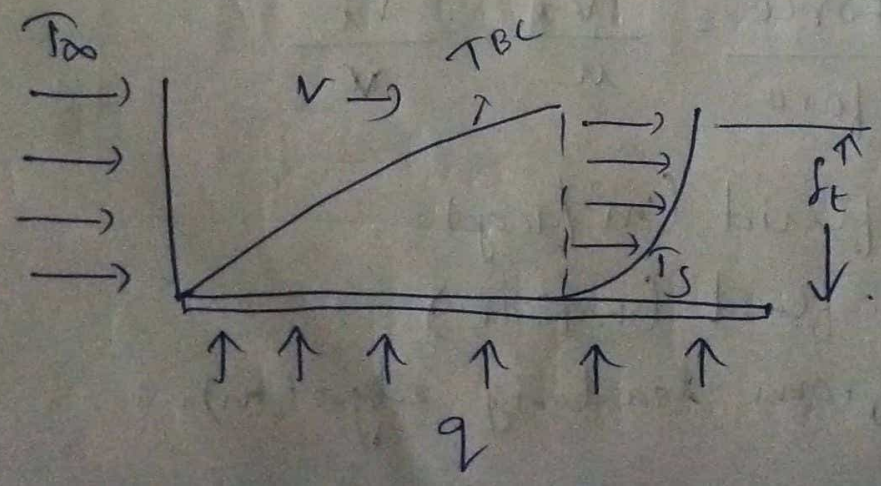
Thickness ↓ abruptly

Turbulent flow

Boundary layer - completely vanished

- This layer over surface - laminar sub layer

* Thermal Boundary layer



$T_s = T_\infty$ as it goes up

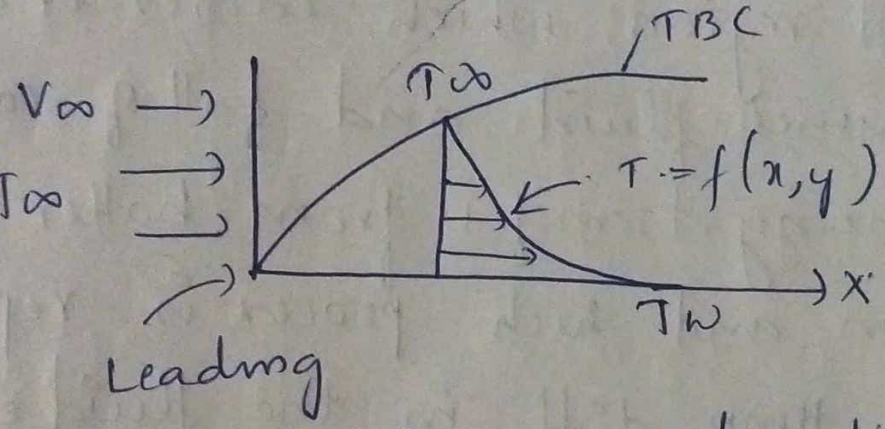
↓

Temp of free stream

- Thermal B.L is developed analogous to velocity boundary layer if the temp of fluid T_∞ is diff from T_s

2 types

1) When flow of fluid over hot plate ($T_\infty < T_w$)



T_w - temp wall

Temp var^n occurs in the y direction, when the fluid is flowing

2) Flow of fluid over cold plate ($T_\infty > T_w$)