Then,
①, ②, ③ becomes:-

$$u^* \frac{\partial u^*}{\partial x^*} + v^* \frac{\partial u^*}{\partial y^*} = \frac{\partial p^*}{\partial x^*} + \frac{1}{Re}\left[\frac{\partial^2 u^*}{\partial x^{*2}} + \frac{\partial^2 u^*}{\partial y^{*2}}\right] \rightarrow ④$$

$$u^* \frac{\partial v^*}{\partial x^*} + v^* \frac{\partial v^*}{\partial y^*} = \frac{\partial p^*}{\partial y^*} + \frac{1}{Re}\left[\frac{\partial^2 v^*}{\partial x^{*2}} + \frac{\partial^2 v^*}{\partial y^{*2}}\right] \rightarrow ⑤$$

$$\frac{\partial u^*}{\partial x^*} + \frac{\partial v^*}{\partial y^*} = 0 \rightarrow ⑥ \quad \text{where } Re = \frac{\rho U_\infty L}{\mu}$$

By the order of magnitude analysis,
$\frac{\partial^2 u^*}{\partial x^{*2}}$ can be dropped (smallest order)

So,
$$\boxed{u^* \frac{\partial u^*}{\partial x^*} + v^* \frac{\partial u^*}{\partial y^*} = -\frac{\partial p^*}{\partial x^*} + \frac{1}{Re} \frac{\partial^2 u^*}{\partial y^{*2}}} \rightarrow ⑥$$

$$\boxed{\frac{\partial p^*}{\partial y^*} = 0}$$

$$\boxed{\frac{\partial u^*}{\partial v^*} + \frac{\partial v^*}{\partial y^*} = 0}$$

→ These are Prandtl's boundary layer equation

Boundary condition's are- Solid surface at $y^* = 0$, $u^* = 0 = v^*$
or at $y = 0$, $a = 0 = v$

and outer ~~be~~ edge of boundary layer-
at $y^* = (\varepsilon) = \frac{\delta}{L}$, $u^* = 1$
is at $y = \delta$, $u = U(x)$ $\Big\} \rightarrow ⑦$

At the outer edge of ~~Boun~~ boundary layer

$$u^* \frac{du^*}{dx^*} = -\frac{dp^*}{dx^*}$$

or in dimensional force -

$$U \frac{du}{dx} = -\frac{1}{\rho} \frac{dp}{dx}$$

On inner edge - $\frac{1}{2} \rho u^2 + p =$ Constant.

Blasius Flow over Flate Plate :-

The classical problem considered by H. Blasius was

1. Two dimensional, steady, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform stream of velocity U_∞.
2. The fluid extends to infinity in all directions from the plate.

- Blasius wanted to determine
  (a) the velocity field solely within the boundary layer.
  (b) the boundary layer thickness (δ).
  (c) the shear stress distribution on the plate.
  (d) the drag force on the plate.

- The ~~Pand~~ Prandtl boundary layer equations in the case under consideration are

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = \nu\frac{\partial^2 u}{\partial y^2} \longrightarrow (1)$$

$$\nu = \frac{\mu}{\rho}$$

$$\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} = 0$$

The boundary conditions are

$$\left.\begin{array}{ll} \text{at } y=0, & u=v=0 \\ \text{at } y=\infty, & u=U_\infty \end{array}\right\} \longrightarrow (2)$$

Now, velocity at two aribitary x locations, namely x_1 & x_2 should satify the equation,

$$\frac{u[x_1, \{y/g(x_1)\}]}{U(x_1)} = \frac{u[x_2 (y/g(x_2)\}]}{U(x_2)} \longrightarrow (3)$$