§1.

$$f' = Ae^{-\eta^2}$$

$$\frac{df}{d\eta} = Ae^{-\eta^2}$$

$$f(\eta) = A\int_0^{\eta} e^{-\xi^2} d\xi + D$$

The B.C. $u(0,t) = U \Rightarrow UD \Rightarrow D = 1$

$$u(y,t) = U\left\{1 + A\int_0^{\eta} e^{-\xi^2} d\xi\right. \quad \text{—— (3)}$$

The I.C. $u(y,0) = 0$

$\forall y \Rightarrow f(\eta) \to 0$ when $\eta \to \infty$

$$0 = U\left\{1 + A\int_0^{\infty} e^{-\xi^2} d\xi\right\}$$

$$0 = U\left\{1 + A\frac{\sqrt{\pi}}{2}\right\}$$

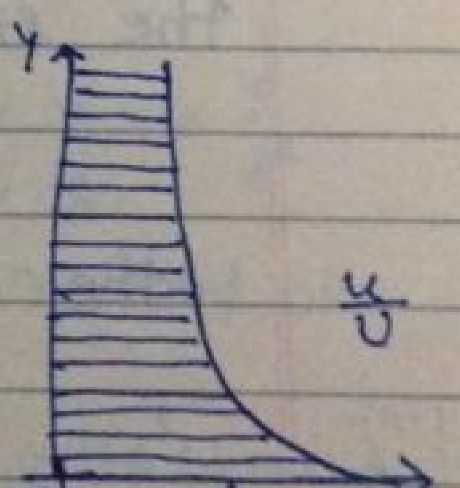
$$\Rightarrow A = \frac{-2}{\sqrt{\pi}} \quad \text{—— (4)}$$

equation (3) And (4) the velocity distributio[n]

$$u(y,t) = U\left\{1 - \frac{2}{\sqrt{\pi}}\int_0^{\eta} e^{-\xi^2} d\xi\right.$$

$$= U(1 - \operatorname{erf}\eta)$$

$$\boxed{u(y,t) = U \operatorname{erfc}\eta}$$



Ques:- Discuse the ~~un~~ steady motion and dimensional velocity Profile which are generated by Similarity Variable

—x—x—

$$= U\alpha^2 t^{-2n} f''$$

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$$\frac{\partial^2 u}{\partial y^2} = \frac{U\alpha^2}{t^{2n}} f'' \quad \text{—} (2)$$

From the relation (2) And (1) we have

$$-\frac{Un\eta}{t} f' = \nu \frac{U\alpha^2}{t^{2n}} f''$$

The explicit time dependence may be eliminated.

By considering $n = \frac{1}{2}$ So we have

$$f'' + \frac{n\eta}{\nu\alpha^2} f' = 0$$

$$\Rightarrow f'' + \left(\frac{\eta}{2\nu\alpha^2}\right) f' = 0 \quad \text{where } \eta = \frac{\alpha y}{t^{1/2}}$$

the dimensions of $\left(\frac{y}{t^{1/2}}\right)$ are a length divided by the square root of time.

So α is taken, $\alpha = \frac{1}{\sqrt{\nu}}$

the similarity variable reduces

$$\eta = \frac{1}{2\sqrt{\nu t}}$$

the differential equation

$$f'' + 2\eta f' = 0$$

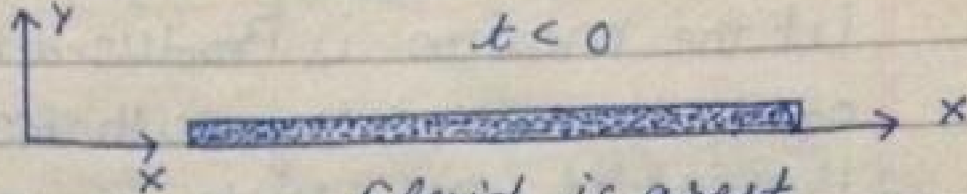
$$\frac{f''}{f'} = -2\eta$$

Integrating, we have

$$\log f' = -\eta^2 + \log A$$

Where $\log A$ is constant.

§11.7 (570) Unsteady Motion of a flat Plate:



Fluid is arest

A semi infinite body of luquid with constant density ρ is bounded on one side by a flat surface. initially the fluid and the solid ~~sphere~~ surface are at rest. time $t=0$ the direction x with the constant velocity U

Equation of continuity $\frac{\partial u}{\partial x} = 0 \Rightarrow u = u(y,t)$

the velocity component $v = u(y,t)$, $v=0, w=0$

there is no Pressure gradiant or gravity force in the X - direction.

the Navier - stoke's equation.

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial y^2} \quad \text{--- (1)}$$

I.C. $u(y,0) = 0$ when $t, 0 \ \forall y$

B.C. $u(0,t) = U \ \forall t > 0$

B.C. $u(\infty, t) = 0 \ \forall t > 0$

Let $u(y,t) = U f(\eta)$

Where $\eta = \alpha \frac{y}{t^n}$

the function $\eta(y,t)$ is know as Similarity solution and α is a constant of Proportionality.

$$\alpha \ \frac{\partial u}{\partial t} = \frac{\partial u}{\partial \eta} \cdot \frac{\partial \eta}{\partial t} = U f'(-n\alpha y t^{-n-1})$$

$$= \frac{U n \eta}{t} f'$$

$$\frac{\partial^2 u}{\partial y^2} = U \alpha t^{-n} f'' \frac{\partial \eta}{\partial y}$$

IV where $B = -\frac{A}{3}$

Let the motion is Produced by a solid sphere of radius a rotating with Angular velocity Ω

- the Liquid extends to ∞ and is rest there we have.

$$r = a, \quad \omega = \Omega$$

$$C = 0, \quad B = a^3 \Omega$$

$$\boxed{\omega = \frac{a^3}{r^3}\Omega} \quad \text{— (11)}$$

Again $r = a, \quad \omega = \Omega$

$r = b, \quad \omega = 0$

From (10) And (12) we have

$$\Omega = \frac{B}{a^3} + c \quad \text{And} \quad 0 = \frac{B}{b^3} + c$$

$$\Rightarrow B = \frac{a^3 b^3}{b^3 - a^3}\Omega, \quad C = -\left(\frac{a^3}{b^3 - a^3}\right)\Omega$$

substituting the values of the constants in (10) we have

$$\boxed{\omega = \frac{a^3}{r^3}\left(\frac{b^3 - r^3}{b^3 - a^3}\right)\Omega} \quad \text{IV}$$

$=\times=\times$