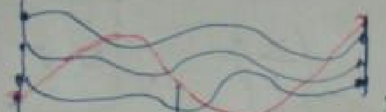
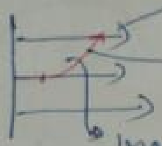
* flow pattern *

- Stream line
- path line
- streak line

*** path line →**

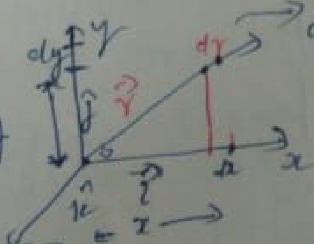


*** stream line →**



→ It is a Imaginary line drawn in a flow field in such a way that the tangent drawn at any point on the stream line represent the ~~drawn~~ direction of velocity vector of the fluid particle at the that point. $\vec{v}$ → direction of velocity vector.

$$v = f(x, y, z, t)$$



$$d\vec{r} = dx\hat{i} + dy\hat{j}$$

position vector

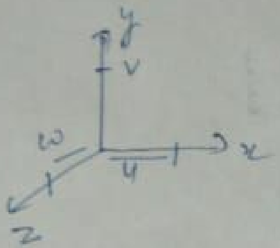
$$\vec{r} = x\hat{i} + y\hat{j}$$

$$r = \sqrt{x^2+y^2}$$

(2-D) $d\vec{r} = dx\hat{i} + dy\hat{j}$

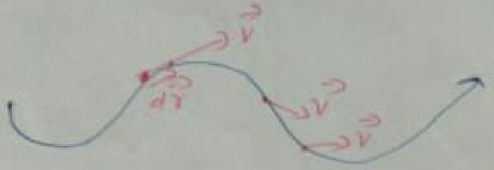
(3-D) $d\vec{r} = dx\hat{i} + dy\hat{j} + dz\hat{k}$

$v = f(x, y, z, t)$



$\left(\frac{x}{t}\right) \hookrightarrow u$

$$\boxed{\vec{V} = u\hat{i} + v\hat{j} + w\hat{k}}$$



* angle between ($\vec{V}$ & $d\vec{r}$) $= 0°$

<u>cross-product</u>.

$\Rightarrow \; d\vec{r} \times \vec{v} = |dr||V| \sin 0° = 0$

$$\Rightarrow \quad d\vec{r} \times \vec{V} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ dx & dy & dz \\ u & v & w \end{vmatrix} = 0$$

$$\left\{ \begin{aligned} d\vec{r} &= \hat{i}\,dx + \hat{j}\,dy + \hat{k}\,dz \\ \vec{V} &= u\hat{i} + v\hat{j} + w\hat{k} \end{aligned} \right\}$$

$\Rightarrow \; \hat{i}\,(w\,dy - v\,dz) - \hat{j}\,(w\,dx - u\,dz) + \hat{k}\,(v\,dx - u\,dy) = 0$

<u>i.e</u>

$$\left.\begin{aligned} (w\,dy - v\,dz) &= 0 \\ (w\,dx - u\,dz) &= 0 \\ (v\,dx - u\,dy) &= 0 \end{aligned}\right\}$$

$\Rightarrow w\,dy - v\,dz = 0$

$\Rightarrow w\,dy = v\,dz$

$$\Rightarrow \boxed{\frac{dy}{v} = \frac{dz}{w}} \text{ --- (I)}$$

Similarly

$$\boxed{\frac{dx}{u} = \frac{dz}{w}} \text{ --- (II)}$$

$$\boxed{\frac{dx}{u} = \frac{dy}{v}} \text{ --- (III)}$$

* 3-D $\boxed{\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w}}$ → equation of stream line in 3-D-flow case

2-D. $\boxed{\frac{dx}{u} = \frac{dy}{v}}$

* path line → It is actual path travelled by a individual fluid particle over some period of time.

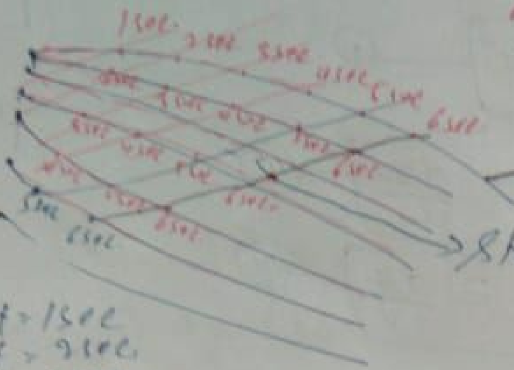
Two path line can intersect each other.

→ Since these are infinite particle of fluid so, each will have own path line this implies that these will be infinite path line in a flow field.

v.v.g ① but two stream line will never intersect each other.

* Streak line

dye for time t



— dotted lines = path line

→ Streak line

→ t = 1sec
t = 2sec.
t = 3sec.
t = 4sec.

→ It is the locaus (co-ordinates) of fluid particles at a particular instant of time which have passed through the same point

* At any time 't' how many streak lines are observed = one only.

→ For steady & uniform then all the three line will be equal i.e. Stream line = path line = streak line

(imaginary)