FLUID FLOW PATTERNS

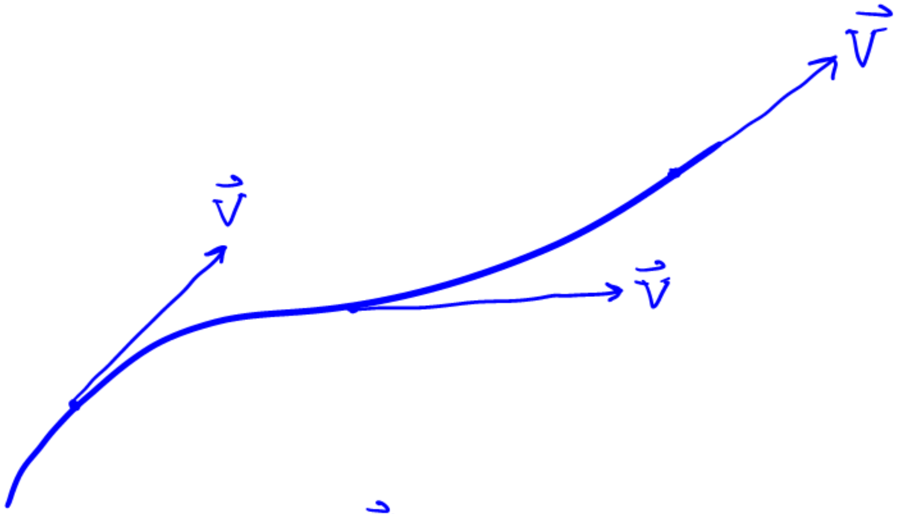
In this lesson, we will:

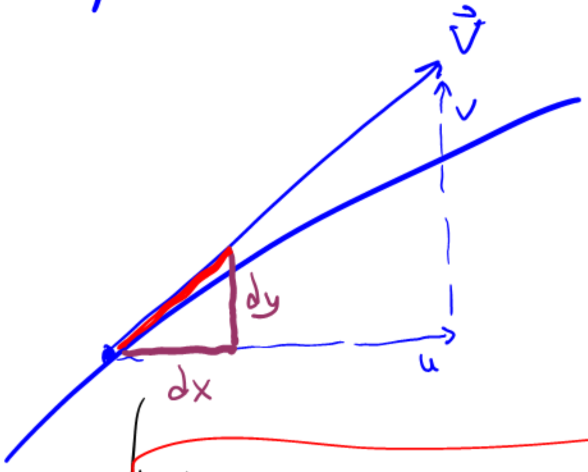
- Define and compare **streamlines**, **pathlines**, **streaklines**, and **timelines**
- Do an example problem

Fluid Flow Patterns

a) Streamline = a curve everywhere tangent to the velocity field

It is instantaneous (at some instant in time)





$$\boxed{\left.\frac{dy}{dx}\right)_{\text{along a streamline}} = \frac{v}{u}}$$

Example Given: $\vec{V} = \underset{u}{3x}\,\vec{i} \; \underset{v}{-3y}\,\vec{j}$

To do: Calc. an eq for the streamlines

Sol'n: $\left.\frac{dy}{dx}\right)_{\text{streamline}} = \frac{v}{u} = \frac{-3y}{3x} = \frac{-y}{x}$

Separate variables → $\frac{dy}{y} = -\frac{dx}{x}$

integrate $\int \frac{dy}{y} = -\int \frac{dx}{x}$

Solve: $\ln y = -\ln x + \boxed{\text{Const}}$ call it $\boxed{-\ln C}$

$\ln y = -\left[\ln x + \ln C\right]$

RECALL:

$\ln a + \ln b = \ln(ab)$

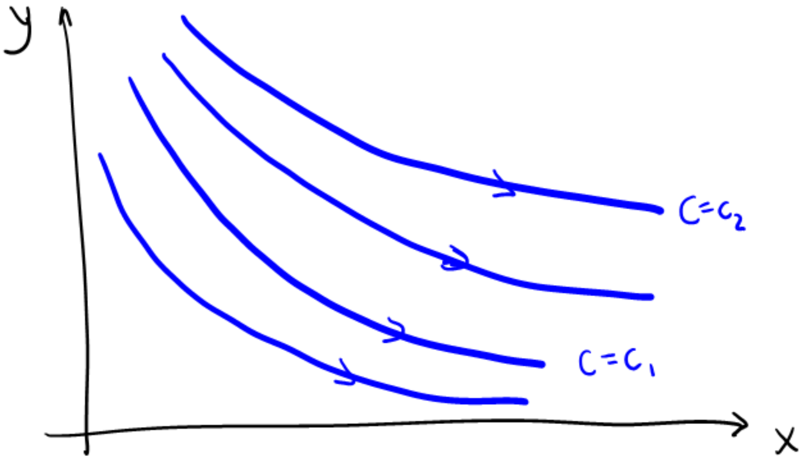
$\ln(a^{-1}) = -\ln a$ → $\ln y = -\ln(cx)$

$\ln y = \ln(cx)^{-1}$

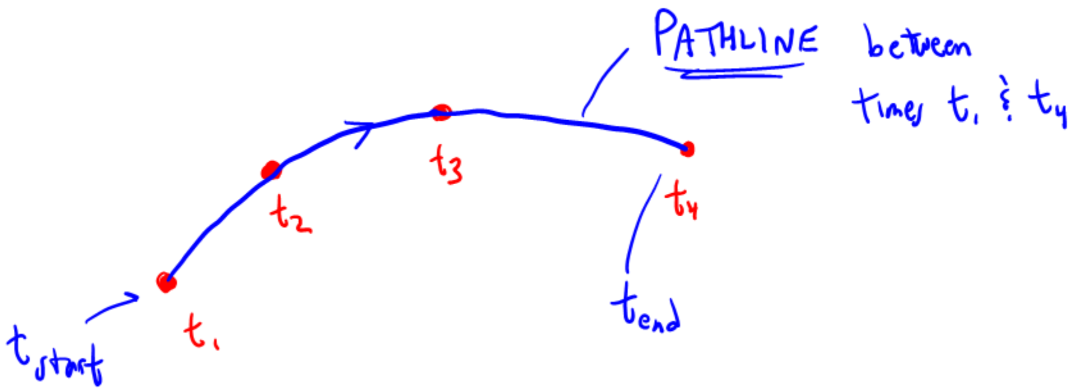
$\ln(a^c) = c\ln a$

$e^{(\,)}$ both sides

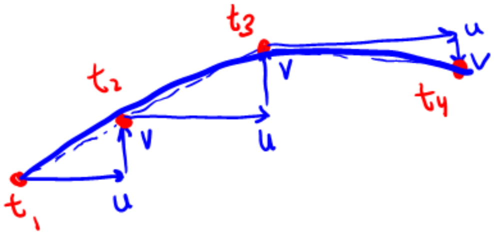
$$\boxed{y = \frac{1}{cx}}$$ ☆ Eq for the streamlines



b. **Pathline** = the path traveled by a marked fluid particle over some time period.

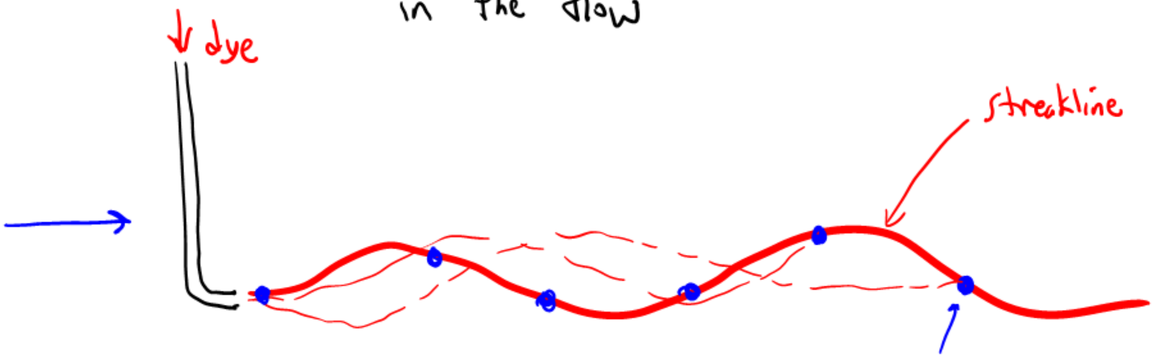


Numerically: March in time, knowing the velocity field @ each location & time



E.g., use Runge-Kutta technique to march in time

c) **Streakline** = locus of fluid particles introduced at a point in the flow

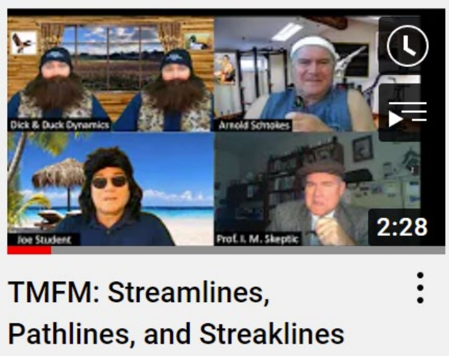


this fluid particle was injected @ some earlier time

A streakline shows some history

FOR STEADY FLOW, Streamlines, Pathlines & streaklines are coincident

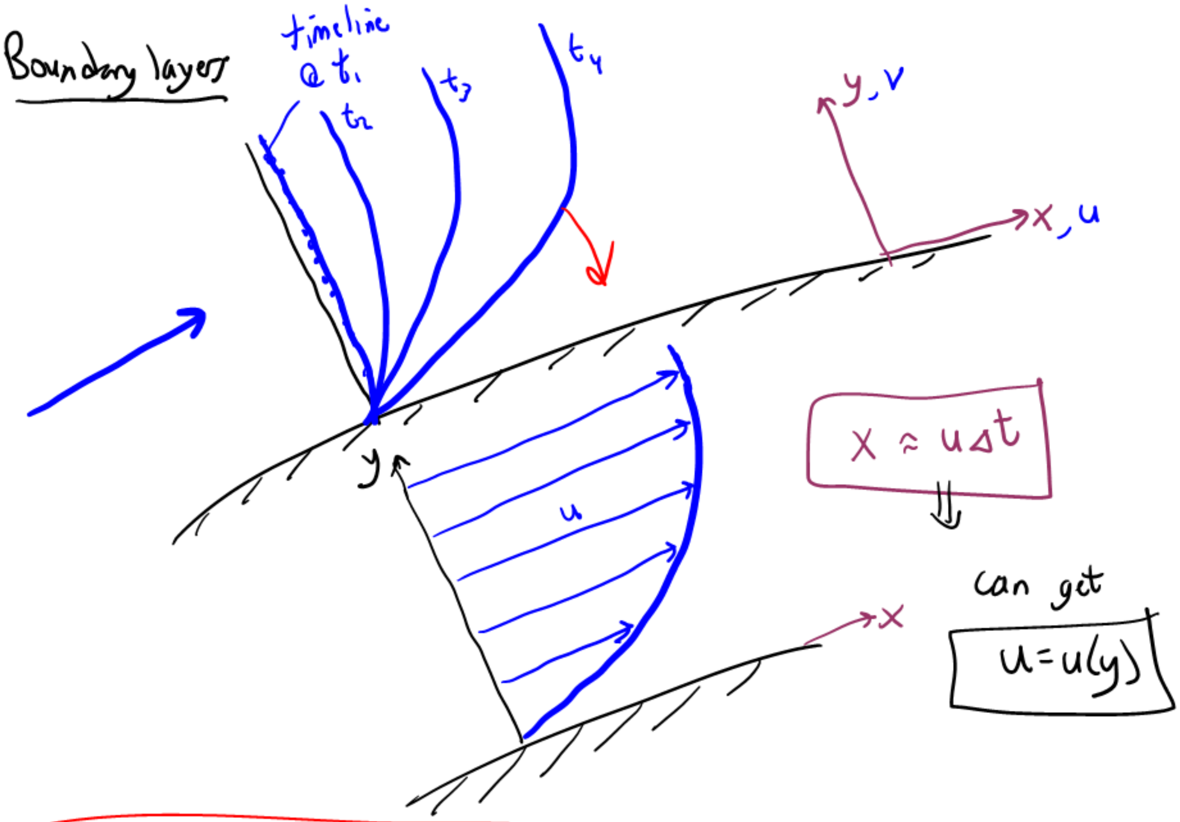
See my short YouTube video called "***Streamlines, Pathlines, and Streaklines***" for some animated examples of these flow patterns.
https://youtu.be/tSoeORgtjgc



TMFM: Streamlines, Pathlines, and Streaklines

d) Timeline = a set of adjacent fluid particles that were marked at the same time (usually in a straight line)

e.g. Boundary layers



Timelines are never coincident with streamlines, pathlines, or streaklines, even in a steady flow