Chapter 3 Elementary Fluid Dynamics & Bernoulli’s Equation

- **Steady state flow:**
  - Nothing in the flow field changes with time.
  - There are changes if following a fluid particle.

- **Streamline**
  - At each point of the line in a flow field, flow velocity is tangential to the line.

- **Pathline**
  - The trajectory of a fluid particle.

- **Streakline**
  - A line fluid particles passed a same point.
Streamline vs. Pathline
- Streamlines do not cross
- Pathlines may cross
- In a steady flow field, a stream line is also a path line,
- In unsteady flows, they are different in general

Viscid vs. Inviscid flows
- All real fluids are viscous
- The flow can be assumed inviscid if the shearing stress is insignificant compared with other force terms
Bernoulli’s Equation

- Assuming a simplified flow field
  - Steady state
  - Incompressible
  - Inviscid flow
  - Along streamline

- Applying Newton’s 2\textsuperscript{nd} Law on a fluids element

\[ p + \frac{\rho V^2}{2} + \rho gh = \text{const} \]
show the derivation by following a fluids elements along a streamline
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Interpretation of Bernoulli’s Equation

\[ p + \frac{\rho V^2}{2} + \rho gh = \text{const} \]

- Is Bernoulli’s equation a momentum equation or an energy equation?

- Pressure head: \( p/\gamma \)
- Velocity head: \( V^2/2g \)
- Elevation head: \( h \)
show derivations for

\[ \frac{\partial p}{\partial n} = -\rho V^2/R \]

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Static, Stagnation, Dynamic & Total Pressure

\[ p + \frac{\rho V^2}{2} + \rho gh = \text{const} \]
Ex: Use of Bernoulli’s Equation

\[ V \]
\[ V_1 = V \]
\[ V_2 = 0 \]

\[ h_{3-1} \]
\[ h \]
\[ h_{4-3} \]
\[ H \]

Pitot Tube
Ex of Bernoulli’s Equation: Water Jet
Ex of Bernoulli’s Equation

Siphon

Flow rate measurement

Orifice

Nozzle

Venturi