Convective Transports

- There are Two types of Conv. Transp.
  - ↳ ① Conv. Transp. In Laminar Flow
  - ② Conv. Transp. In Turbulent Flow

I. Conv. Transp. In Laminar Flow

I-1) For Momentum

↳ Do Differential (or Shell) Momentum Balance (see Pg 216 ~ 220)

↳ Include both Molecular & Convective Momentum Transports

↳ "Equation of Motion" (Pg 467 ~ 469)

↳ Conv. Momentum Transp. Equation In Laminar Flow

I-2) For Energy

↳ Do Differential Energy Balance

↳ Include both Molecular & Convective Energy Transports.

↳ "Thermal Energy Equation" (Pg 471 ~ 472)

↳ Conv. Energy Transp. Equation In Laminar Flow.

I-3) For Mass

↳ Do Differential Mass Balance

↳ Include both Molecular & Convective Mass Transports.

↳ "Species Conservation Equation" (Pg 473)

↳ Conv. Mass Transp. Equation In Laminar Flow (How is it different comparing to "the continuity equation?")

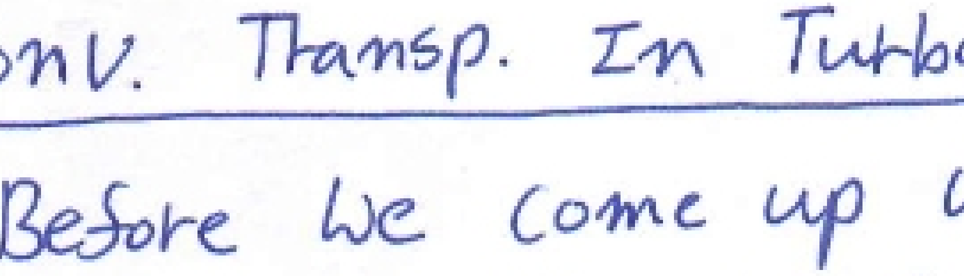
II. Conv. Transp. In Turbulent Flow

↳ Before we come up w/ its Mathmatical descriptions, let us first talk about the Nature of Turbulent Flow.

↳ ① $Re\# = \frac{\rho D V}{\mu}$

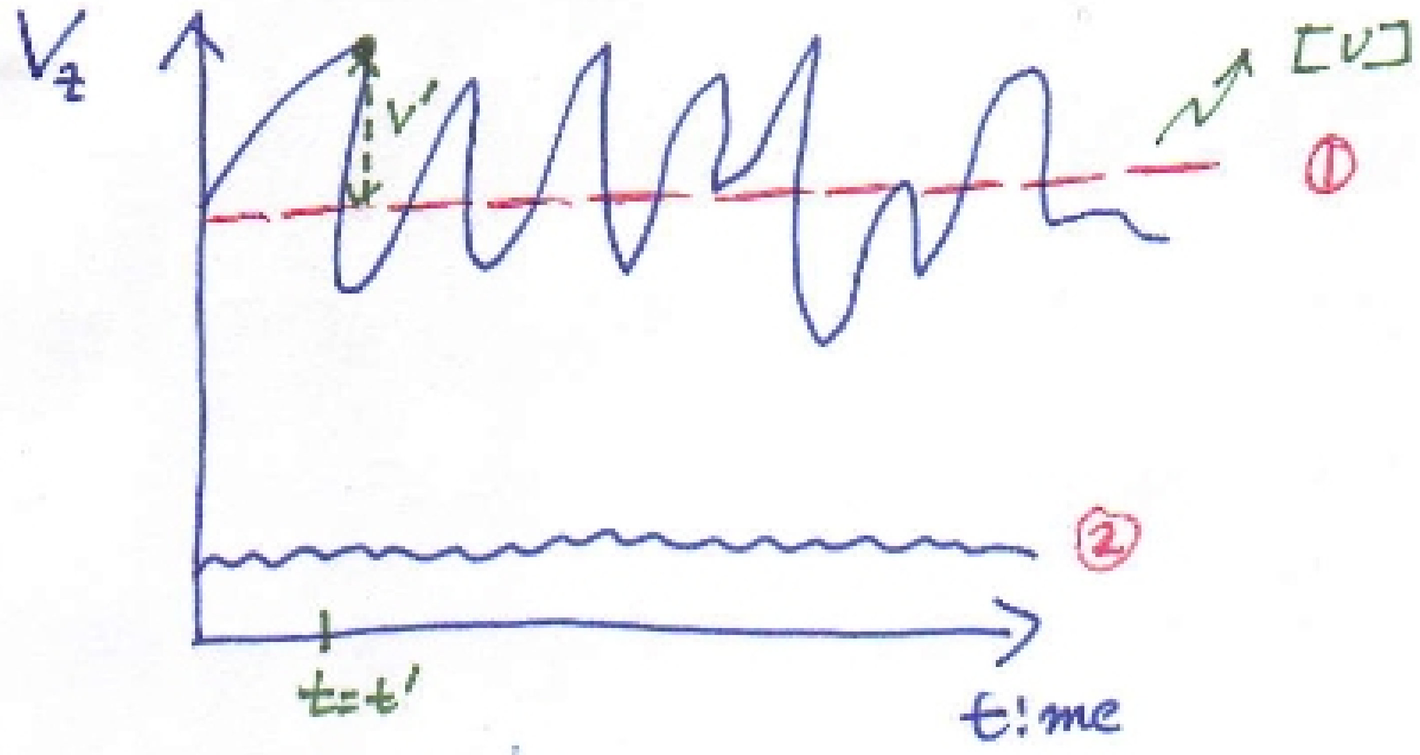
- If $Re\# < 2100$, then Laminar flow prevails
- If $Re\# > 2100$, then Turbulent flow prevails (See Pg 239 ~ 243)

②



"Figure 1"

Turbulent Flow has No Straight Streamlines, instead it has a large eddies.



" Figure 2"

↳ Based on Figure 1

Key Observations from Figures 1 & 2 (of turbulent flow)

↳ Ⓐ Large Eddies

Ⓑ Both magnitude & direction of the Velocity components change with time even through the flow system, on Avg., is time independant.

Ⓒ Velocity @ Point 1 is higher than Point 2.

Ⓓ Velocity Fluctuations is larger @ Point 1 than Point 2.

Ⓔ $$[V] = \frac{\int_{t_1}^{t_2} V\,dt}{\int_{t_1}^{t_2} dt}$$ Where V is the instantaneous Velocity

Ⓕ $V = [V] + V'$ (See pg 241 ~ 243)

- V: Instantaneous Velocity
- $[V]$: Time Avg. Velocity
- V': Fluctuating Velocity