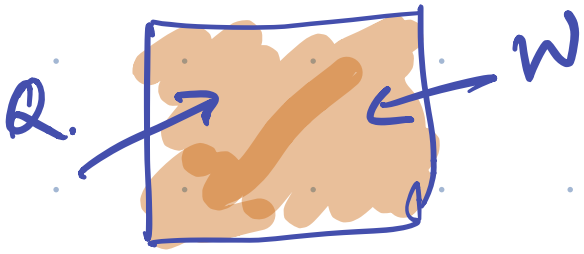
Lecture 1:- Review

What is a compressible flow / Gasdynamics

$$v = v(T, p)$$

Specific Volume w.r.t mass



$$\frac{dv}{v} = \frac{1}{v}\left[\left.\frac{\partial v}{\partial T}\right|_p dT + \left.\frac{\partial v}{\partial p}\right|_T dp\right]$$

$\frac{dv}{v}$ ← Compressibility

$\left.\frac{\partial v}{\partial T}\right|_p$ ← Const-p expansion ⇓ Combustion

$\left.\frac{\partial v}{\partial p}\right|_T$ ← Isothermal compressibility ⇓ Compressible flow.

$$v = \frac{V}{M} \Rightarrow \rho = \frac{1}{v}$$

$$v = \frac{1}{\rho} \Rightarrow \left.\frac{\partial v}{\partial p}\right|_T = \frac{-1}{\rho^2}\left.\frac{\partial \rho}{\partial p}\right|_T$$

Isothermal Compressibility $= \frac{1}{\rho}\left.\frac{\partial \rho}{\partial p}\right|_T$

2nd definition

Mach Number $M = \frac{u}{a}$ → flow velocity; → speed of sound.

$0 < M \leq 0.4/0.3$ → Incompressible

$0.4 < M \leq 1$ → Compressible (Subsonic)

$1 < M \leq 3$ → Compressible (Supersonic)

$3 < M < 7$ → Compressible (Hypersonic)

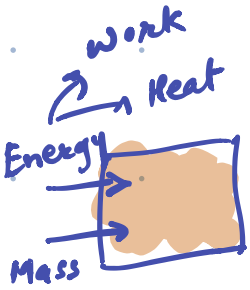
Flow system :-

1. Thermodynamics laws
2. Mechanics laws
3. Gravity laws (Compressible Astrophysical solvers)
4. Chemical reaction laws

Review of thermodynamics

① System / Surroundings.

② Open / Closed systems
(Mass + Energy interaction)
↓
(Energy interaction)

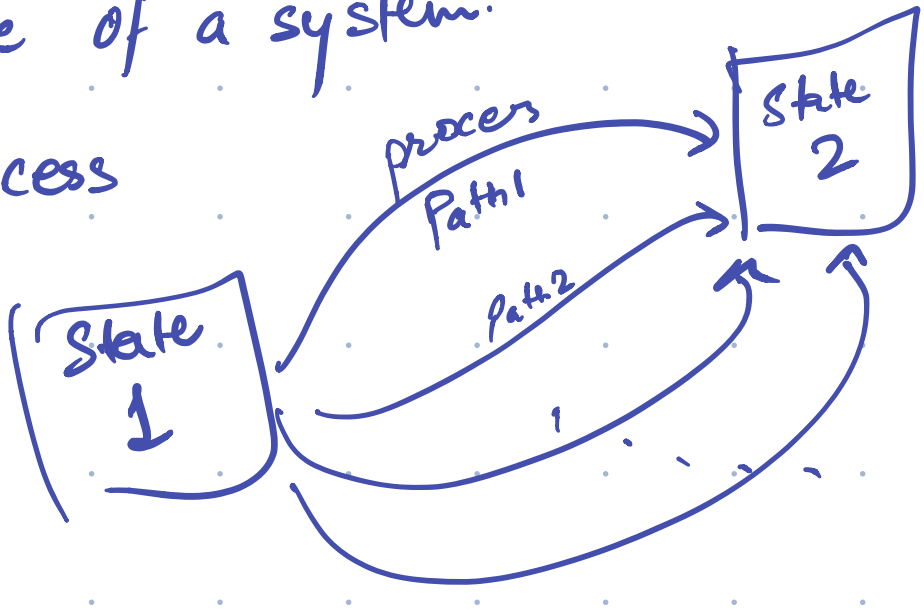


③ Isolated systems

④ State of a system.

⑤ Process

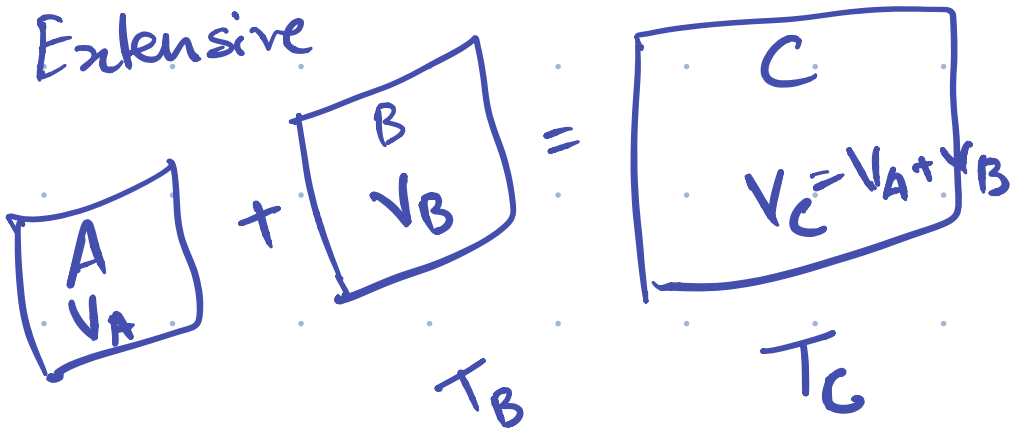
⑥ Paths.



State property

Extensive

Intensive



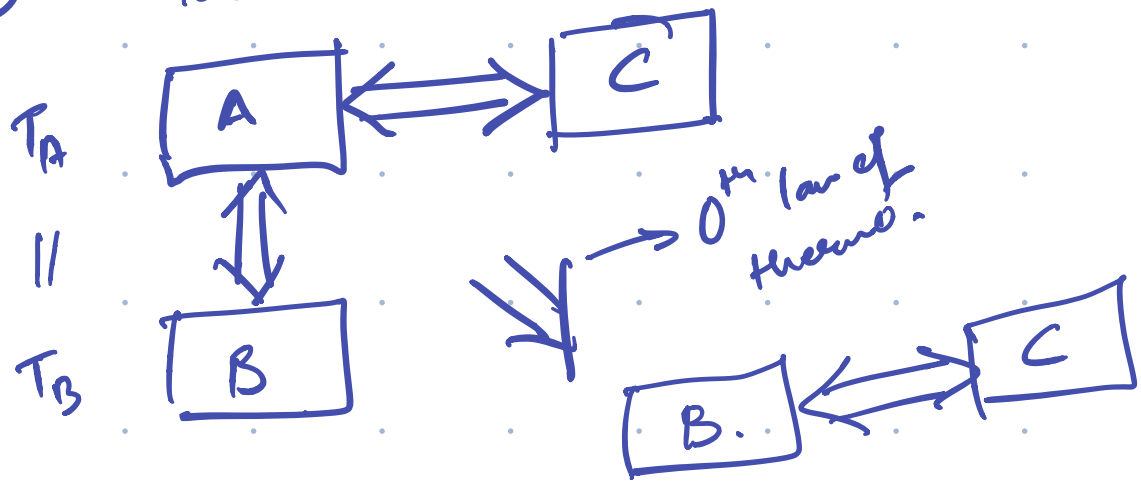
Intensive T_A

Extensive $V / m = v$ → Intensive

$V / n = \hat{v}$ → Specific w.r.t moles

Thermodynamics

(1) 0^{th} law.



(2) 1^{st} law of thermodynm.

Energy is conserved. $(E/e/\hat{e})$

(3) 2^{nd} law of thermodynmic.

$\Delta S \geq 0$

→ Entropy.