H.T.

Conductive
- ↓ S, L, G
- forier eq^n.

$$q = -KA\frac{dT}{dx}$$

- ↓ solids.
  - Metals
    - lattice
    - electron flow,
  - Nonmetals
    - lattice

~~lattice~~ ~~vibration~~

Convection
- ↓ fluids

$$q = hA(T_s - T_\infty)$$

(fluids) liquids & gases

↳ molecular collision

Thermal Radiation

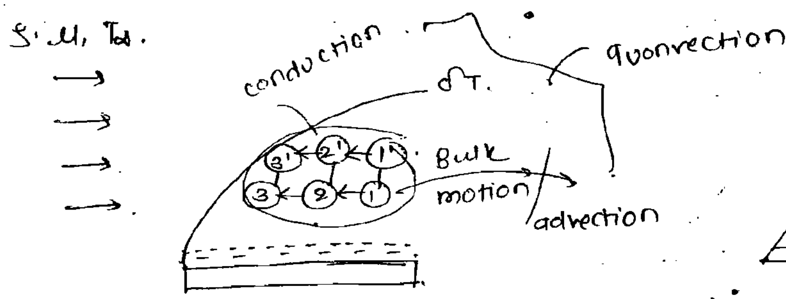
All medium / without medium.

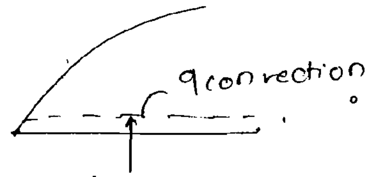
Stefan boltzman law

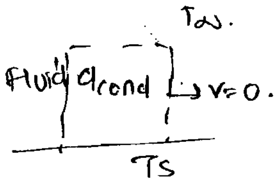
$$E_b = \sigma T^4$$

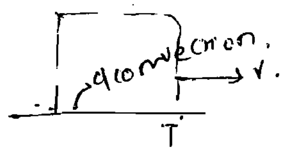
Energy transfer:

- Energy transfer defined by rate of energy transfer known as heat transfer rate.
- If it is due to temp. difference within the body or both bodies.
- The temp. of the body may be function of space & time $\therefore T = f(x, y, z, t)$. So HT rate is due either due to change of temp. within space or with time









conduction

$q_{adv} = 0$.

$q_{convection}$

$= q_{cond} + q_{adv}$

$$Nu = \frac{(q_{conv})}{(q_{cond})_f}.$$

$$Nu = \frac{q_{cond} + q_{adv}}{q_{cond}} = 1 + \frac{q_{adv}}{q_{cond}}.$$

adv = 0 $\longrightarrow$ cond^n.

$\therefore$ Nu = 1.

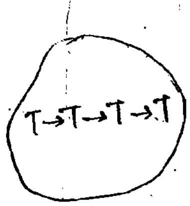
adv $\neq$ 0 $\longrightarrow$ convection

Nu > 1.

$$Nu = \frac{h A (T_s - T_\infty)}{k_f A \frac{(T_s - T_A)}{L_c}} \quad \therefore Nu = \frac{h L_c}{k_f}. \longrightarrow \text{fluid}.$$

<u>Note</u>:-

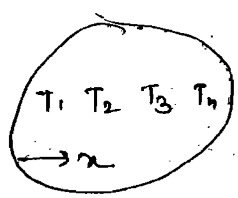
Unifor



$\frac{dT}{dx} = 0$

$T \neq f(x)$

Nonuniform.



$\frac{dT}{dx} \neq 0$.

$T = f(x)$

$T = f(t)$

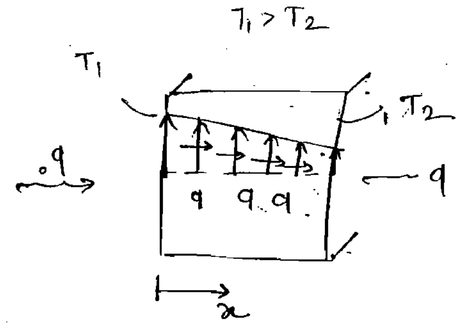
unsteady state

$\frac{\partial T}{\partial t} \neq 0$.

$T \neq f(t)$

steady state

$\frac{dT}{dt} = 0$.



Steady state $\quad q \neq f(x)$

↓

$T \neq f(time)$

↓

$\frac{dT}{dt} = 0$

↓

$T = f(x)$ — Nonuniform

* Application of Heat Transfer:-

Condenser, evaporator, transformer, IC engine, electronic devices, Heat exchanger etc.

Thermodynamic	Heat Transfer.
① It is the science which ~~deals the heat transfer~~ (amount) from one equillibrium state to another without concerned with time.	① It defines the rate of the heat transfer

* Mechanism of Heat transfer:- (mode):-

① Conduction

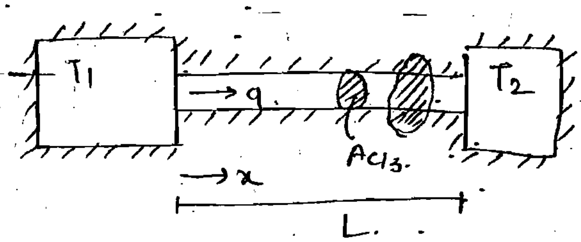
② Convection

③ Radiation

① Conduction mechanism :- (Microscopic form of energy transfer)

- The conduction heat transfer occurs due to temp. difference within the medium (liquids, solids or gases) or betn different mediums. (due to direct physical contact)
- In solids, the conduction is due to lattice vibration and electron flow.
- In metals it is mainly due to electron flow. In nonmetals mainly due to lattice vibration.
- In gases it is due to molecular collision / also known as molecular diffusion.
- In liquids, conduction mechanism is similar to gases
- The conduction heat transfer is given by fundamental law known as fouriers law. ~~as per fouriers law~~
- As per fourier's law,

$q = mc_p \Delta T$



$q \propto (T_1 - T_2)$

$q \propto A_{c/s}$

$q \propto \frac{1}{L}$

$\therefore q \propto A_{c/s} \times \frac{(T_1 - T_2)}{L}$

$$\boxed{q = k A_{c/s} \frac{(T_1 - T_2)}{L}} \text{ W}$$

$q = -kA \frac{dT}{dx}$

$\therefore k = \frac{q}{-A(dT/dx)}$

If $A = 1$, $\frac{dT}{dx} = 1$

$\therefore \boxed{k = q}$

$$k = \frac{q}{A_{cs}\frac{(T_1 - T_2)}{L}} = \frac{W}{m^{\circ}C} \text{ or } \frac{W}{mk}.$$

For temp. diff^n $\frac{W}{m^{\circ}C} = \frac{W}{mk}$.

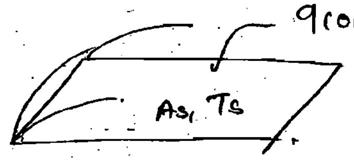
- k = Thermal conductivity of material.
- It is the property of material which defines the heat conduction rate.

② Convection heat transfer :- (Macroscopic form of energy transfer)

- When fluid flows over the ~~relative~~ solid surface (relative) the mode of heat transfer is known as convection heat transfer.
- The convection heat transfer is defined by conduction and advection heat transfer.
- It is given by newtons law of cooling & heating.
- The heat transfer coefficient (h) depends upon :-
  1. Velocity of flow (Forced conv)
  2. Property of fluid
  3. Geometry of Surface.
  4. Type of fluid flow (laminar or turbulent)
  5. Orientation of surface in free convection.

q^* = heat flux.

$q^* = \frac{q}{A}$ $\frac{W}{m^2}$



$q_{conv} = hA_s(T_s - T_\infty)$

$q_{conv} \propto (T_s - T_\infty)$

$q_{conv} = h(T_s - T_\infty)$ $\frac{W}{m^2}$