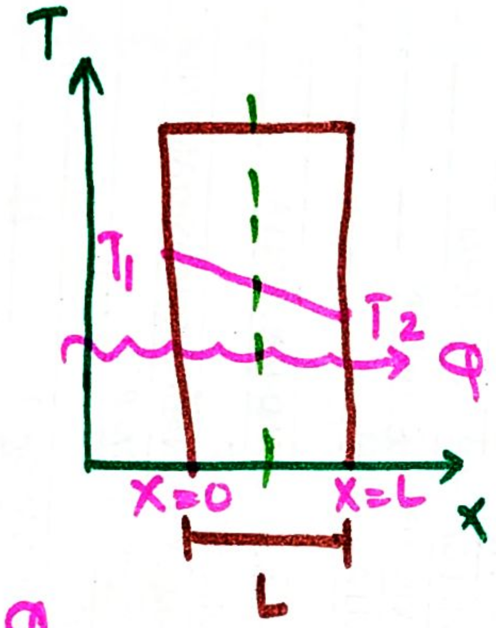
Case-I

Heat Conduction Through a Plane wall



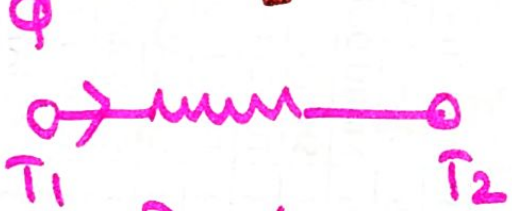
$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} + \frac{q_g}{K} = \frac{1}{\alpha}\frac{\partial T}{\partial \tau}$$

→ 1-D (y, z) not Present

→ $q_g = 0$

→ steady state heat flow

$$\frac{\partial T}{\partial \tau} = 0$$



$R_{th} = \frac{L}{AK}$

$$\frac{\partial^2 T}{\partial x^2} = 0$$

$$\frac{\partial^2 T}{\partial x^2} = 0$$

By integrating above eqn

$$\frac{\partial T}{\partial x} = C_1$$

$$T = C_1 X + C_2 \quad \text{--- (I)}$$

$$Y = mX + C$$

in this case Temp. variation is linear

→ At $X = 0$ $T = T_1$

& At $X = L$ $T = T_2$

$$T_1 = C_1(0) + C_2$$

$$\boxed{C_2 = T_1}$$

$$T_2 = C_1(L) + T_1$$

$$T_2 - T_1 = C_1 \times L$$

$$\boxed{C_1 = \frac{(T_2 - T_1)}{L}}$$

$$T = \frac{(T_2 - T_1)}{L} X + T_1$$

$$Y = m X + C$$

$$m = \frac{T_2 - T_1}{L}$$

$$T = \frac{T_2 - T_1}{L} x + T_1$$

$$T - T_1 = T_2 - T_1 \times \frac{x}{L}$$

$$\frac{T - T_1}{T_2 - T_1} = \frac{x}{L}$$

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

$$\varphi = -kA\left(\frac{T_2 - T_1}{L}\right)$$

$$T = \frac{T_2 - T_1}{L} \times x + T_1$$

$$\frac{dT}{dx} = \frac{T_2 - T_1}{L}$$

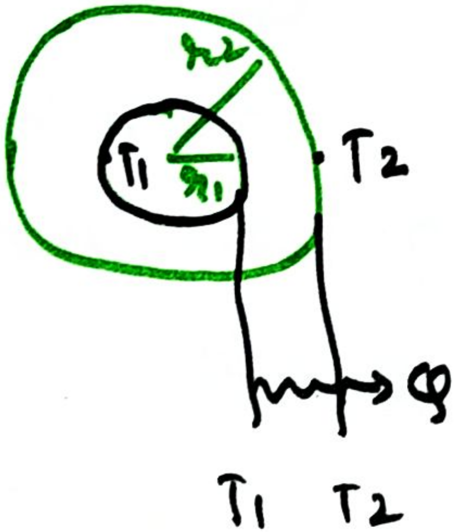
$$\varphi = KA\frac{(T_1 - T_2)}{L}$$

$$\boxed{\varphi = \frac{(T_1 - T_2)}{L/Ak}}$$

Case-II

One Dimensional Heat Conduction Through hollow cylinder

$$\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} = 0$$



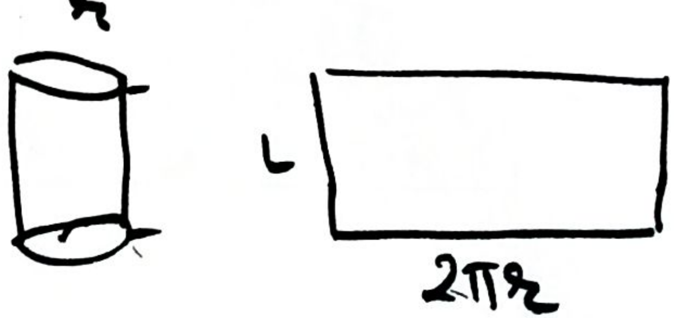
$$\frac{1}{r}\frac{\partial}{\partial r}\left(r \cdot \frac{\partial T}{\partial r}\right) = 0$$

$$\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} + \frac{1}{r^2}\frac{\partial^2 T}{\partial \theta^2} + \frac{\partial^2 T}{\partial z^2} + \frac{q_g}{K} = \frac{1}{\alpha}\frac{\partial T}{\partial \tau}$$

→ Steady State $\frac{\partial T}{\partial \tau} = 0$

→ One Dimensional (θ, z)

→ $q_g = 0$



$$\underbrace{\frac{1}{r}}_{①}\ \underbrace{\frac{\partial}{\partial r}\left(r.\frac{\partial T}{\partial r}\right)}_{②}=0$$

$X \cdot Y = 0$

$X=0$ OR $Y=0$

$r \neq 0$

$$\frac{\partial}{\partial r}\left(r.\frac{\partial T}{\partial r}\right)=0$$

$r.\frac{\partial T}{\partial r} = c_1$ by intergration

$$\frac{\partial T}{\partial r} = \frac{c_1}{r}$$

$$\int dT = \int \frac{c_1}{r}\, dr$$

$$T = c_1 . \ln r + c_2$$

$$\boxed{\int \frac{1}{x}\, dx = \ln x}$$

→ Boundry Condition.

$r = r_1 \quad t = t_1$

$r = r_2 \quad t = t_2$

$T_1 = c_1 \ln r_1 + c_2$

$T_2 = c_1 \ln r_2 + c_2$

$$T_1 - T_2 = c_1 \ln r_1 - c_1 \ln r_2$$

$$T_1 - T_2 = c_1 (\ln r_1 - \ln r_2)$$

$$T_1 - T_2 = c_1 \ln(r_1/r_2)$$

$$\frac{d}{dr}(\ln r) = \frac{1}{r}$$

$$c_1 = \frac{T_1 - T_2}{\ln(r_2/r_1)}$$

$$c_2 = t_1 + \frac{(T_1 - T_2)}{\ln(r_2/r_1)} \ln r_1$$

$$T = T_1 + \frac{T_1 - T_2}{\ln(r_2/r_1)} \cdot \ln r_1 - \frac{(T_1 - T_2)}{\ln(r_2/r_1)} \ln r$$

$$\boxed{\frac{T - T_1}{T_2 - T_1} = \frac{\ln(r/r_1)}{\ln(r_2/r_1)}}$$

$$\phi = -k\,(2\pi r L)\,\frac{\partial T}{\partial r}$$

$$= +k\,(2\pi r L)\left[+\frac{(T_1 - T_2)}{\ln(r_2/r_1)} \cdot \frac{1}{r} \right]$$

$$= \frac{2\pi k \cancel{r} L\,(T_1 + T_2)}{\ln(r_2/r_1)} \cdot \frac{1}{\cancel{r}}$$

$$\phi = \frac{(T_1 - T_2)}{\boxed{\frac{1}{2\pi k L}\ln(r_2/r_1)}}$$

$$R_{th} = \frac{1}{2\pi k L}\ln(r_2/r_1)$$