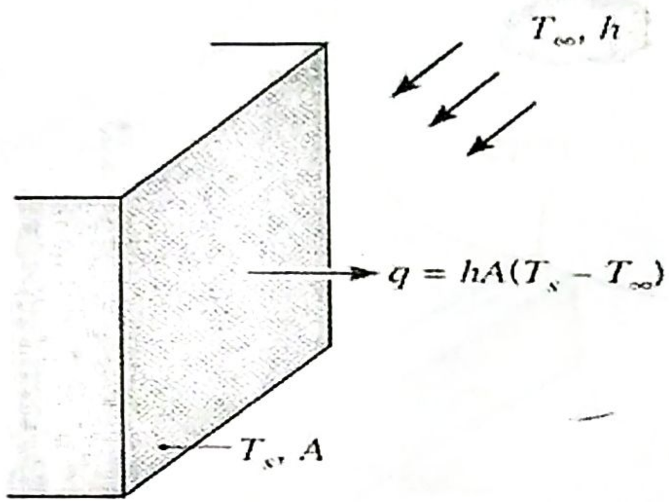
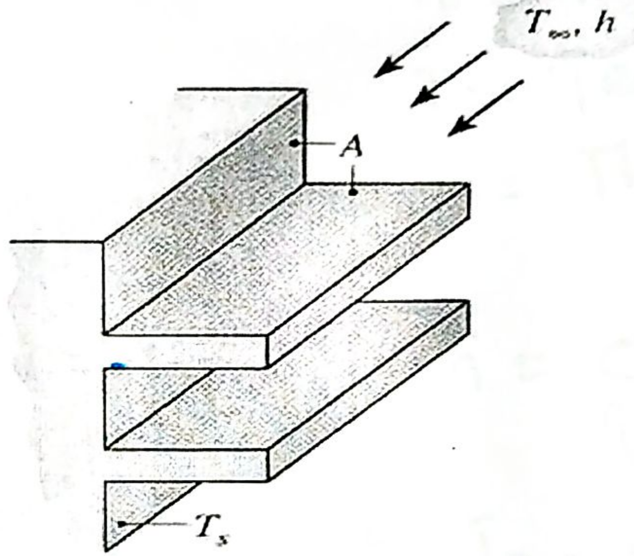
Heat Transfer from Extended Surfaces

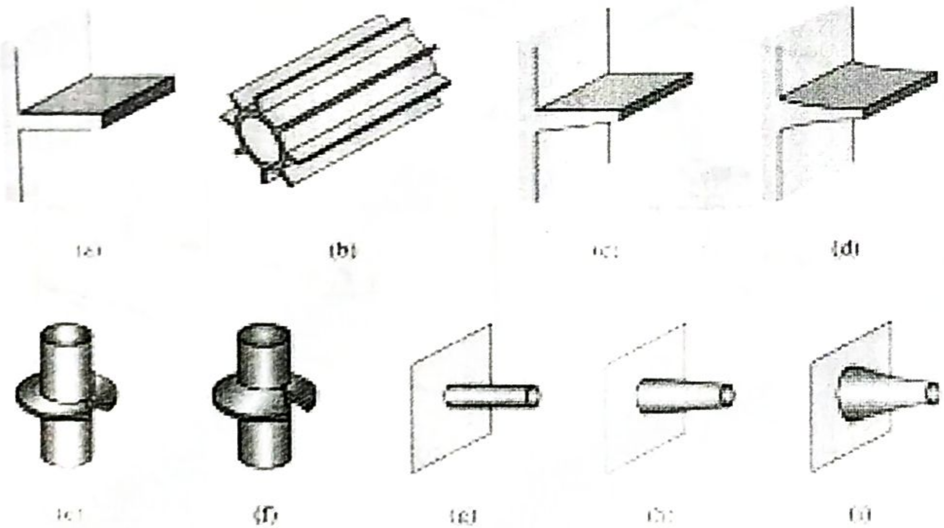
Heat Transfer Enhancement by Fins

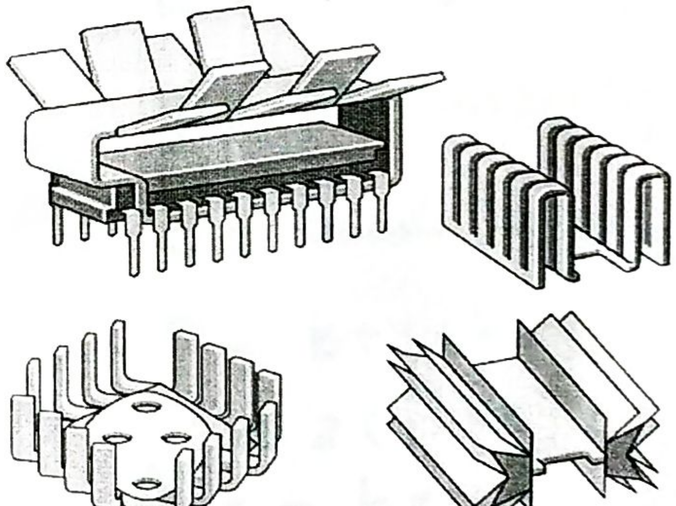
$q = hA\Delta T$



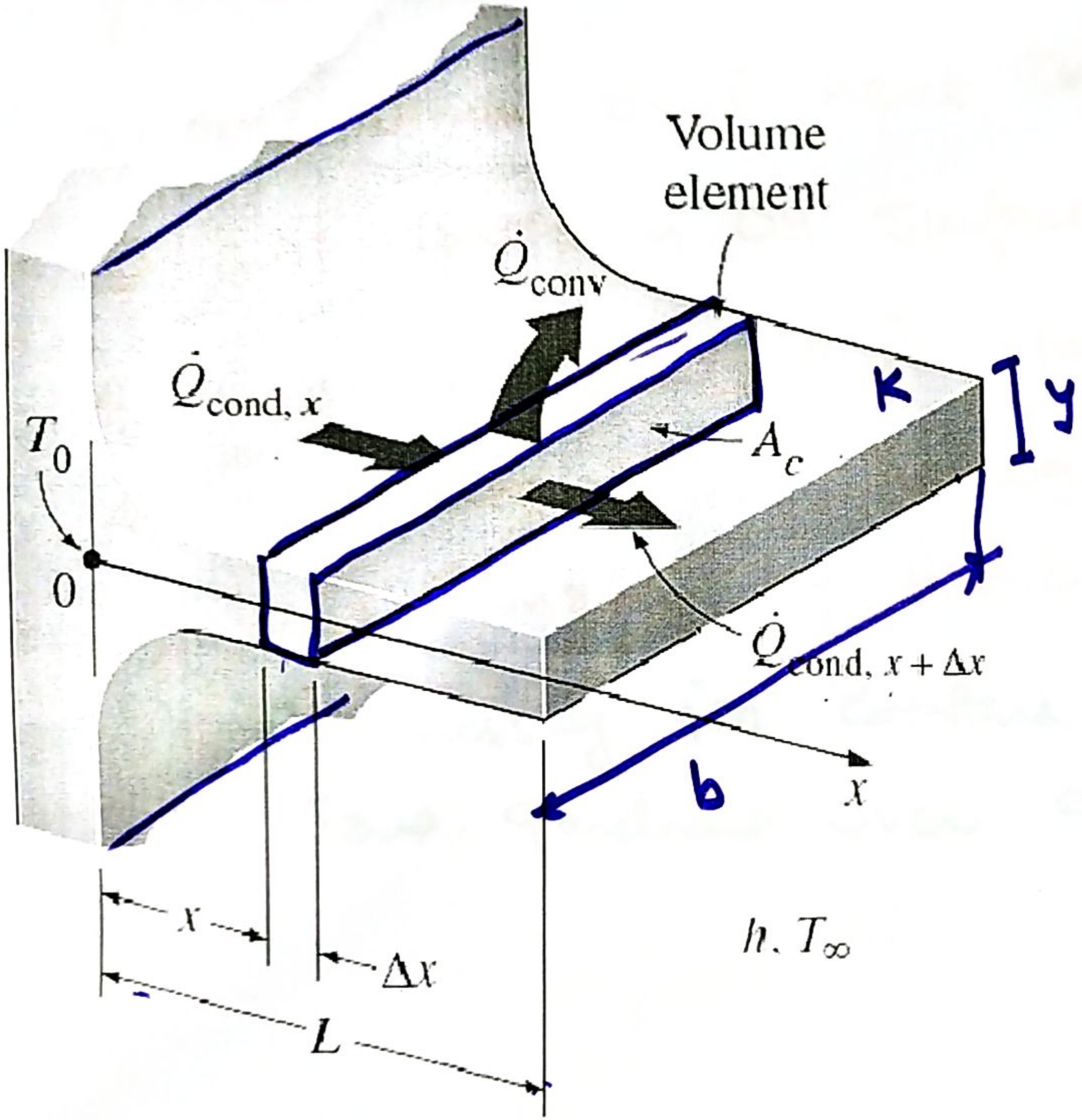


Bare surface **Finned surface**





Heat Flow through "Rectangular Fins"



T_0 = Temp. at base

T = Temp. of surface

K = Thermal Conductivity of fin

h = Convective heat Transfer Cofficient

T_a = air Temp.

L = length.

y = thickness of fin

b = width of fin

P = b+y+b+y
= 2(b+y)

A_{cs} = b×y

→ ASSUMPTION

1) Steady state heat conduction

2) One Dimensional heat Transfer

3) h → uniform on surface of fin

4) Contact thermal Resistance is negligible

5) fin material is homogeneous and isotropic

6) heat Transfer by Radiation is negligible

7) Thickness of fin compare to length is small
Temp. gradient over c/s is neglected.

→ heat conducted into the element at Place x

$$\dot{q}_x = -K\ A_{cs}\left(\frac{dT}{dx}\right)_x$$

→ heat conducted out of the element at Place x+dx

$$\dot{q}_{x+dx} = \dot{q}_x + \frac{d}{dx}(\dot{q}_x).dx + \underline{\frac{d^2}{dx^2}(\dot{q}_x)dx^2}$$

$dx \to 0$

$$\dot{q}_{x+dx} = \dot{q}_x + \frac{d}{dx}(\dot{q}_x).dx$$

T_a

→ heat convection from the element

$$\dot{q}_{conve} = (P.dx)\ h\ (T - T_a)$$

→ Applying energy balance eqn.

$$\dot{\phi}_x = \dot{\phi}_{x+dx} + \phi_{conv.}$$

$$\cancel{\dot{\phi}_x} = \cancel{\dot{\phi}_x} + \frac{d}{dx}(\dot{q}_x).dx + h(P.dx)(T-T_a)$$

$$0 = \frac{d}{dx}\left(-K A_{cs}\left(\frac{dT}{dx}\right)_x\right).dx + h\,P.dx(T-T_a)$$

$$0 = -K A_{cs}\left(\frac{d^2T}{dx^2}\right)_x .dx + h.Pdx\; T-T_a$$

$$K A_{cs}\left(\frac{d^2T}{dx^2}\right)_x .dx = h\,(P.dx).(T-T_a)$$

$$K\left(\frac{d^2T}{dx^2}\right)_x = \frac{hP}{Acs}(T-Ta)$$

$$\frac{d^2y}{dx^2} + x = 0$$

$$\left(\frac{d^2T}{dx^2}\right)_x - \frac{hP}{KAcs}(T-Ta) = 0$$

$$y = C.F + P.I$$

$$y = C.F$$

$$\theta \rightarrow T - Ta$$

$$\theta = T - Ta$$

$$y = C_1 e^{mx} + C_2 e^{-mx}$$

$$\theta_x = T_x - Ta$$

$$\frac{d\theta}{dx} = \frac{dT}{dx}$$

$$\theta_0 = T_0 - Ta$$

$$\frac{d^2\theta}{dx^2} = \frac{d^2T}{dx^2}$$

$$M = \sqrt{\frac{P.h}{Acs\,K}} = \text{fin Constant}$$

$$\boxed{\frac{d^2\theta}{dx^2} - m^2\theta = 0}$$

$$\frac{d^2\theta}{dx^2} - m^2\theta = 0$$

$$\theta = c_1 e^{mx} + c_2 e^{-mx}$$

$$T - T_a = c_1 e^{mx} + c_2 e^{-mx}$$