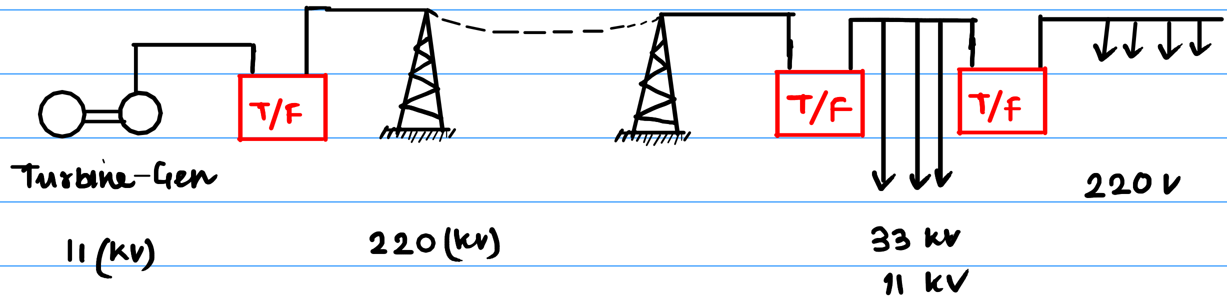
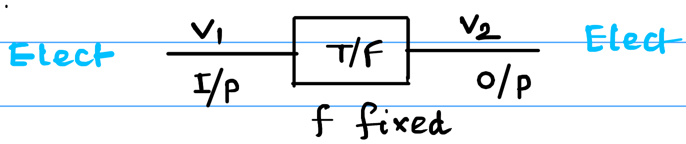
Transformer :-



T/F is a static Device



Efficiency is high (96-98%)

$V_1 > V_2 \Rightarrow$ step down T/F

$V_1 < V_2 \Rightarrow$ Step up T/F

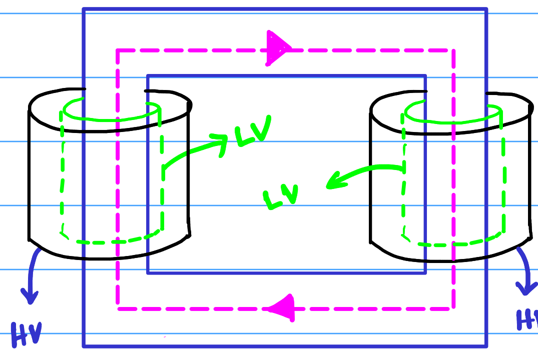
The main components of T/F are $\Rightarrow$

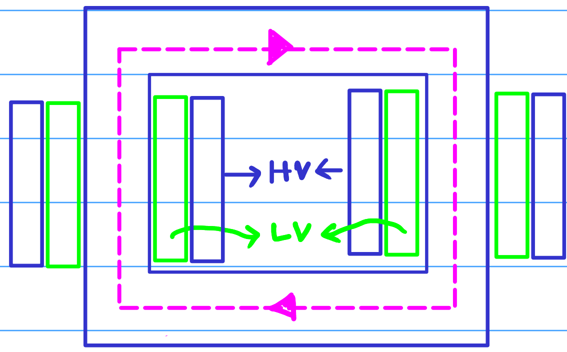
1. Magnetic Core
2. Primary and secondary windings
3. Tank, oil, cooling arrangement

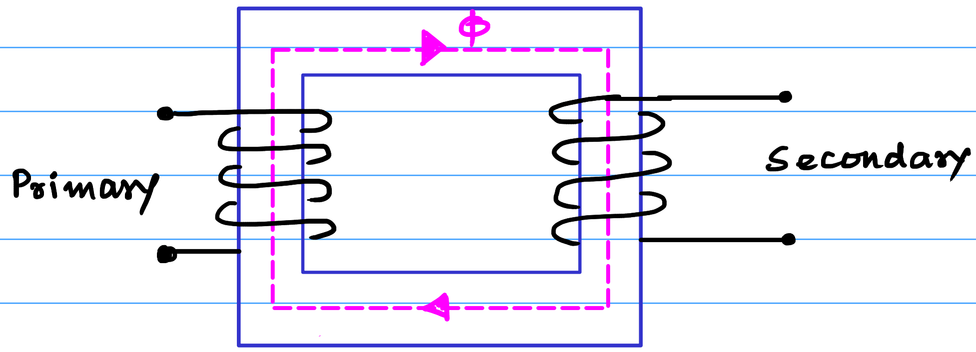
☑ Magnetic Core :-

Base on magnetic core T/F can be of core type and Shell type.

☑ Core Type T/F :-

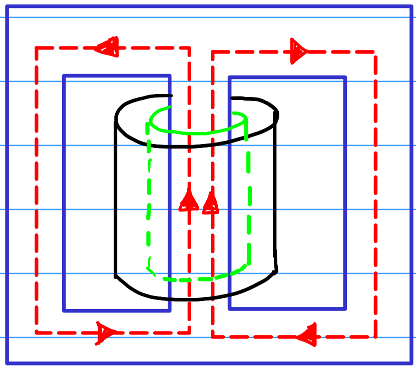


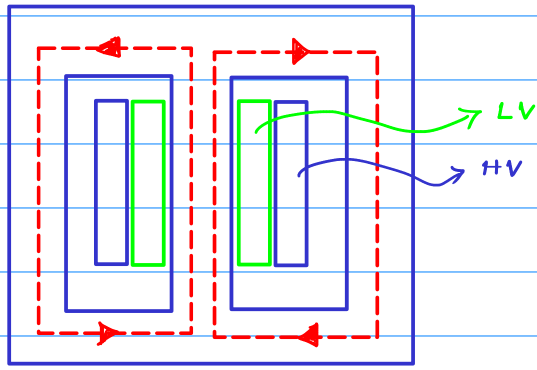


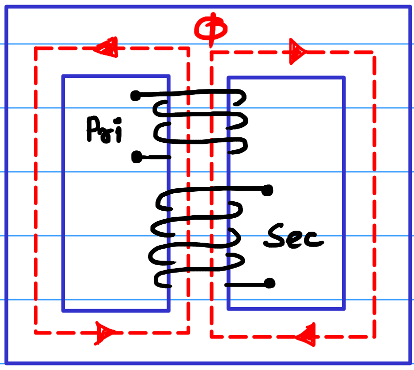


1. One iron path.
2. This is not used for small transformer as the shape makes installation difficulties.

☐ Shell type T/F :-







i) two iron paths
ii) primary and secondary windings are wound on the central limb one above another.

☑ Core :-

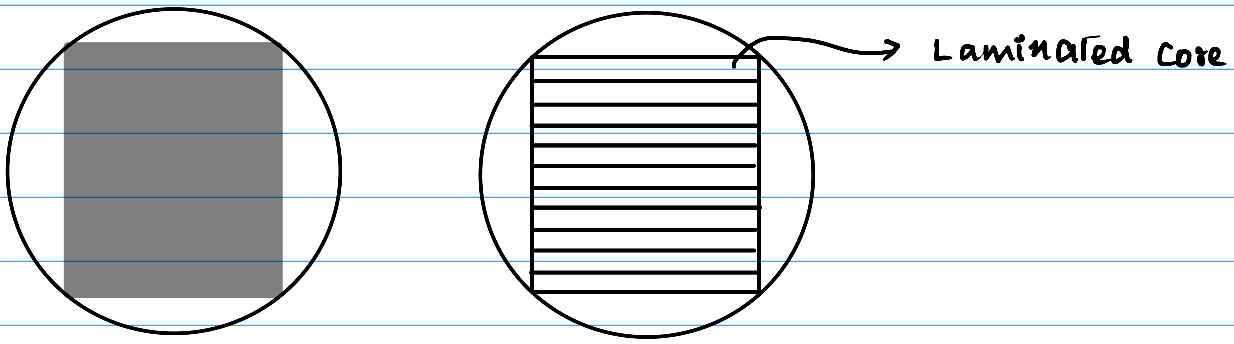
i) Magnetic core is laminated iron core

ii) Thin silicon steel cut into particular sizes and stacked together to form the core.

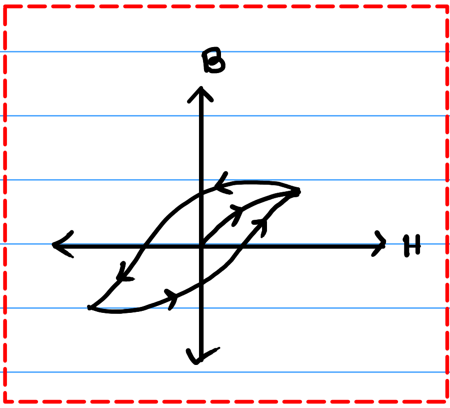
iii) Reduce the eddy current loss.

iv) Laminated sheets are insulated by thick layer of vernish

v) Thickness is 0.4 mm or less.



$$\boxed{R = \rho \frac{l}{A}}$$



(Ferromagnetic Materials)

& Special Si-Steel (Si content 4-5%) is used as lamination.

Hysteresis loss depends on the area of the B-H curve.

Special Si-steel has less area and high saturation flux density.

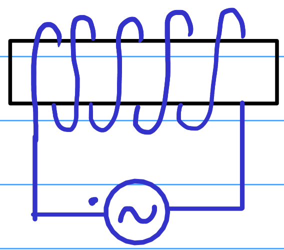
It also has high resistivity that reduces eddy current loss.

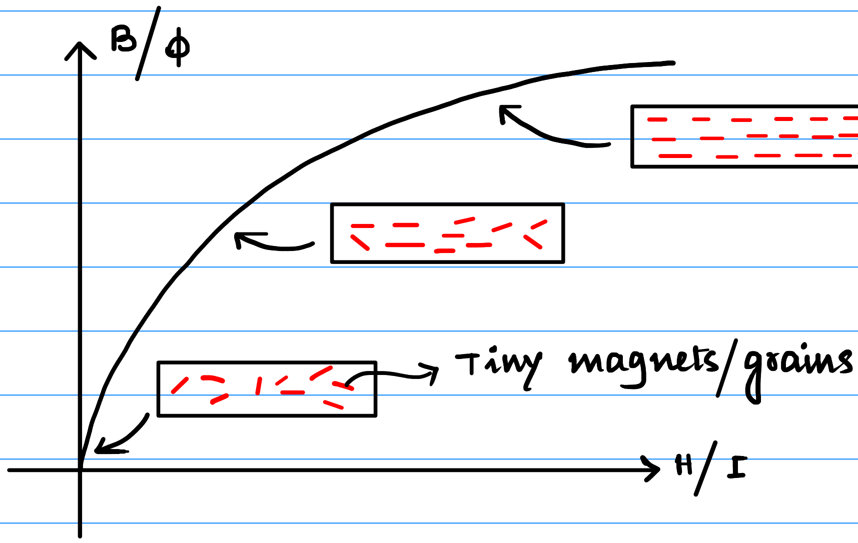
$$P_H = B_m^n f K_H$$
$$P_E = B_m^2 f^2 K_E$$

50 Hz rated T/F can't be used for higher freq.

P_i = Iron loss = $P_H + P_E$

In recent days Cold-rolled-grain-oriented (CRGO) Si-Steel is used for the construction of core.

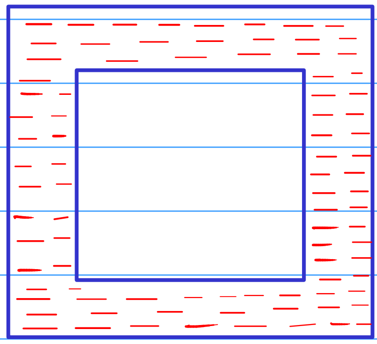


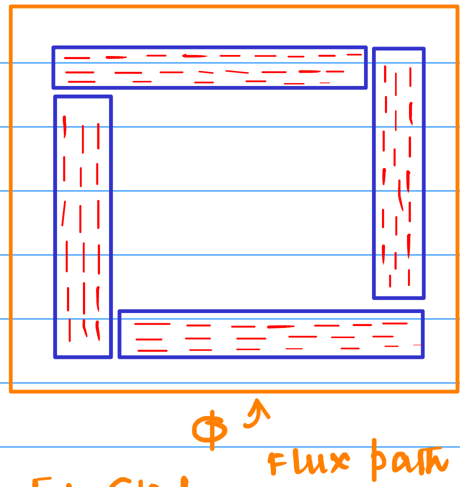


i) By cold-rolling of the laminated sheets, the grains are made to orient to some extent in the dirn of rolling.

ii) Thus required magnetizing current will be small.

iii) Care must be taken to assemble the core in such a manner that the orientation of grains is parallel to the flux path.

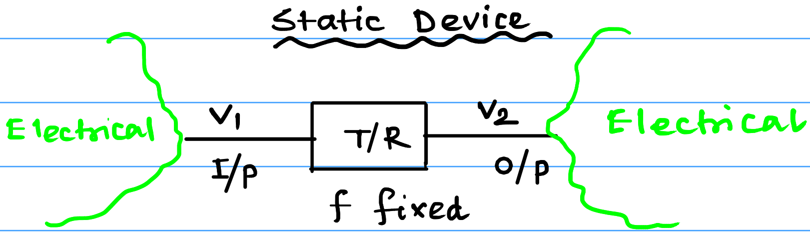




Grain Oriented Steel

TRANSFORMER BASICS :-

Static Device



Efficiency is high
(96-98%)

$V_1 > V_2 \Rightarrow$ Step down T/F

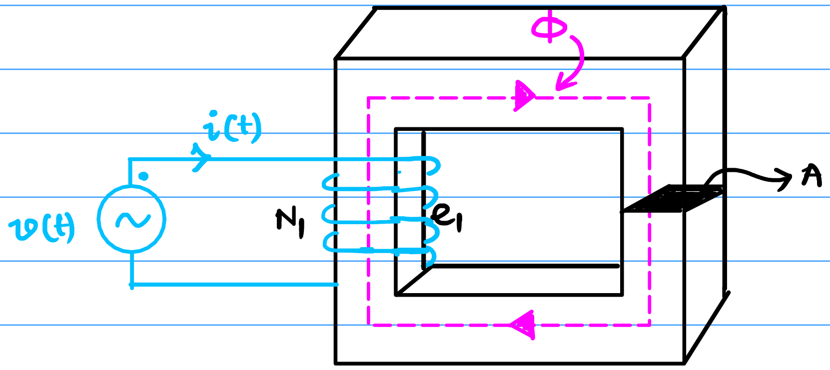
$V_1 < V_2 \Rightarrow$ Step up T/F

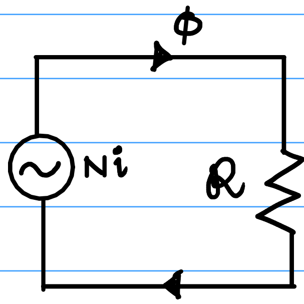
$$e = -N\frac{d\phi}{dt} = -N\frac{d}{dt}(BA) = -NA\frac{dB}{dt} - \cancelto{0}{NB\frac{dA}{dt}}$$

(Static Device)

$$\boxed{e = -\frac{d\lambda}{dt} = -N\frac{d\phi}{dt} = -NA\frac{dB}{dt}}$$

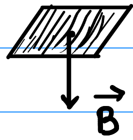
λ = flux linkage = $N\phi$





$$\mathcal{R} = \frac{l}{A\,\mu_0\,\mu_r}$$

$\phi \perp A$



We know $\phi = \vec{B}\cdot\vec{A} = BA\cos\omega t = \phi_m \cos\omega t$

$$e_1 = -N_1 \frac{d\phi}{dt} = N_1 \omega\, \phi_m \sin(\omega t) = (e_1)_m \cos(\omega t - \pi/2)$$

$$E_1 = (e_1)_{rms} = \frac{N_1 \omega \phi_m}{\sqrt{2}} = \sqrt{2}\,\pi f N_1 \phi_m$$

$$\boxed{\phi_m = \frac{E_1}{\sqrt{2}\,\pi f N_1} = \frac{V_1}{\sqrt{2}\,\pi f N_1}}$$

Important Observations:-

i) ϕ_m only depends on V_1, f for a particular coil.

ii) ϕ_m does not depend on permeability μ which varies from core to core. That is for any core is V, f and N are fixed then ϕ_{max} also will be fixed.