Transformer

04.06.09

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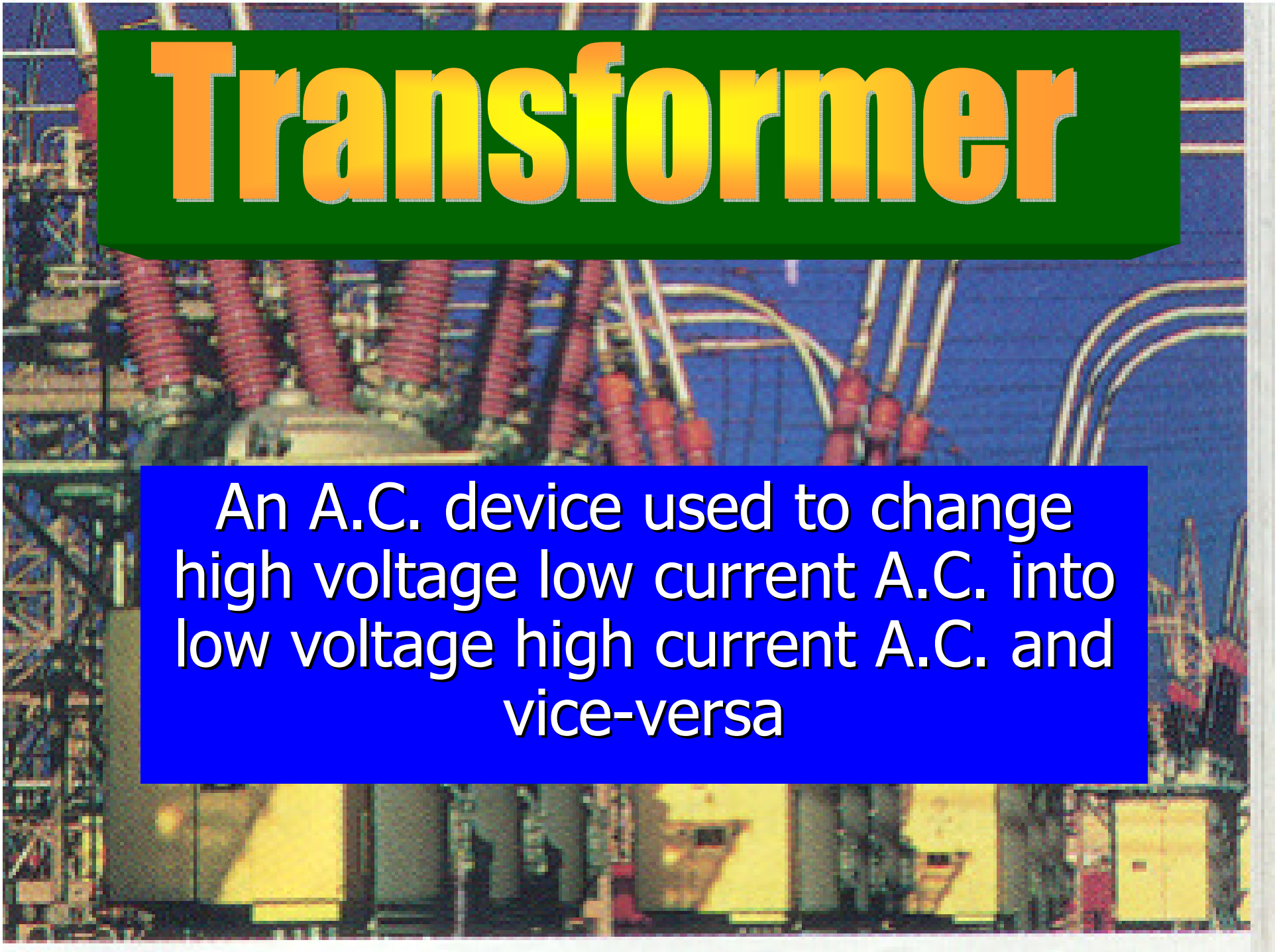
Usual Questions on Transformer in Board Exams

Q 1 : Explain Principle, construction and working of a transformer.

Q 2 : Discuss losses of energy in a transformer.

Q 3 : Why do we use laminated core in a Transformer.

Q 4 : How can we reduce losses due to Eddy currents in Transformers.

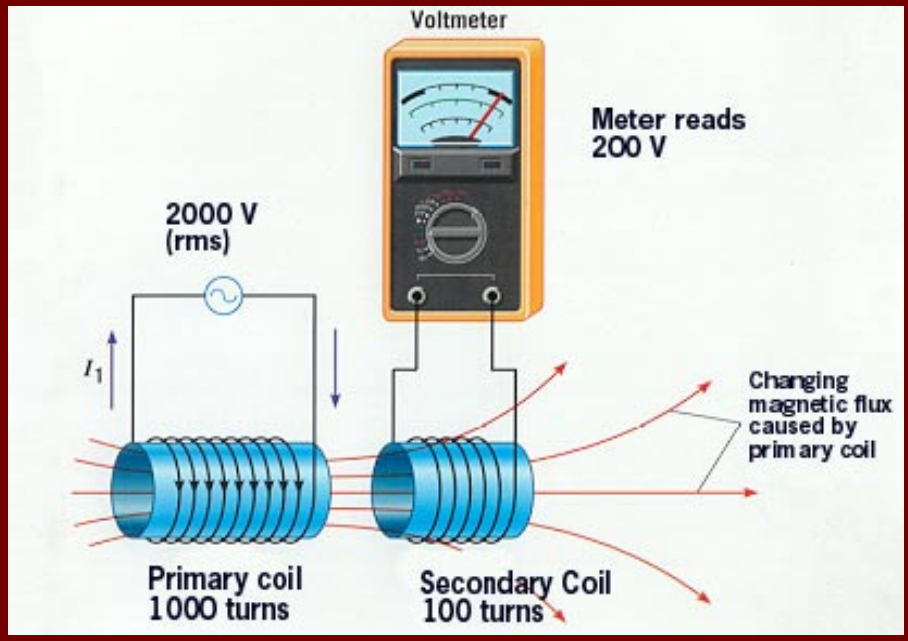

Transformer
An A.C. device used to change high voltage low current A.C. into low voltage high current A.C. and vice-versa

Principle of TRANSFORMER

It is based on principle of

MUTUAL INDUCTION

According to which an e.m.f. is induced in a coil when current in the neighbouring coil changes.

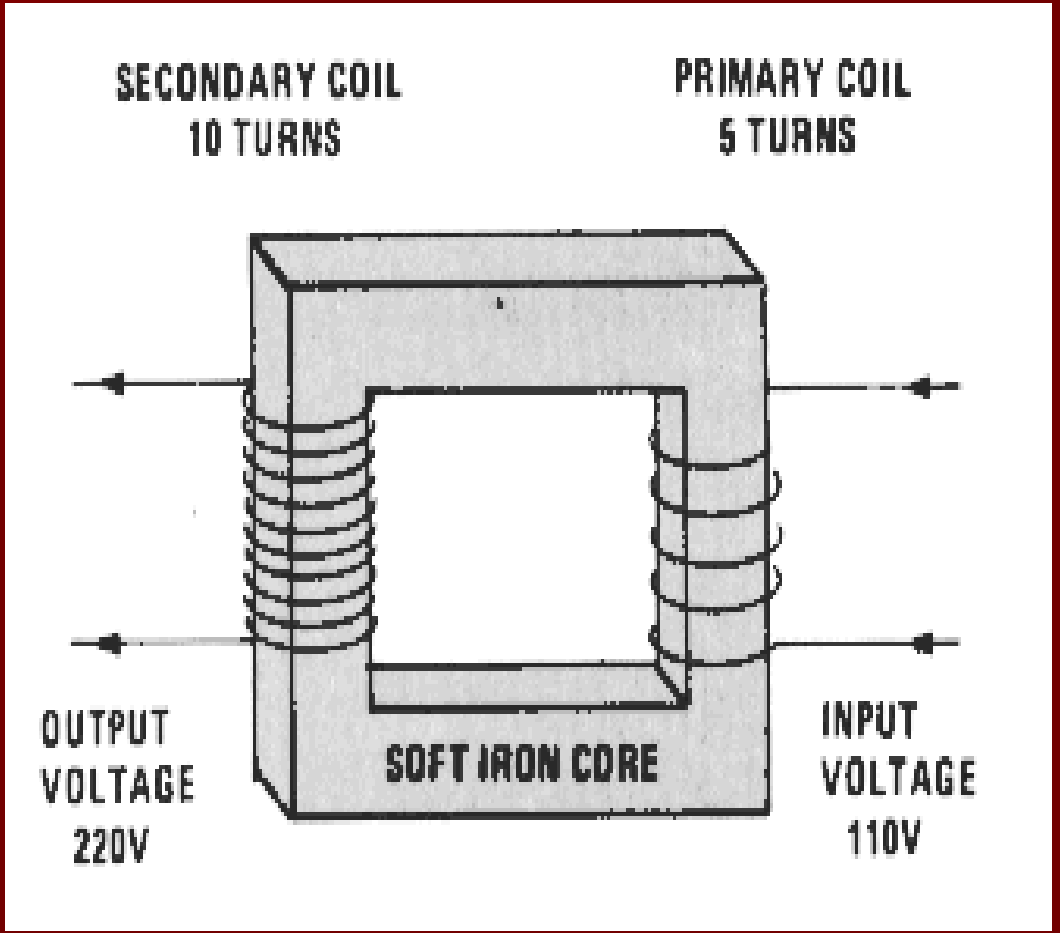


Types of TRANSFORMER

- If a transformer changes low voltage A.C. into high voltage A.C. it is called STEP UP TRANSFORMER
- If a transformer changes high voltage A.C. into low voltage A.C. it is called STEP DOWN TRANSFORMER

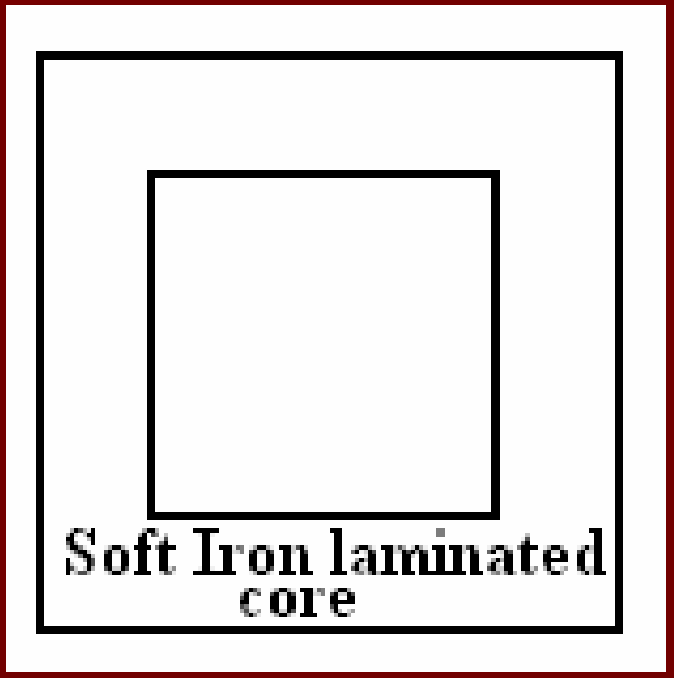
Construction of Transformer

1. It consists of a laminated soft iron core.
2. On which two enameled copper wires are wound
3. One of which is fed with A.C. input called primary
4. Across the other output supply is taken and it is called secondary.



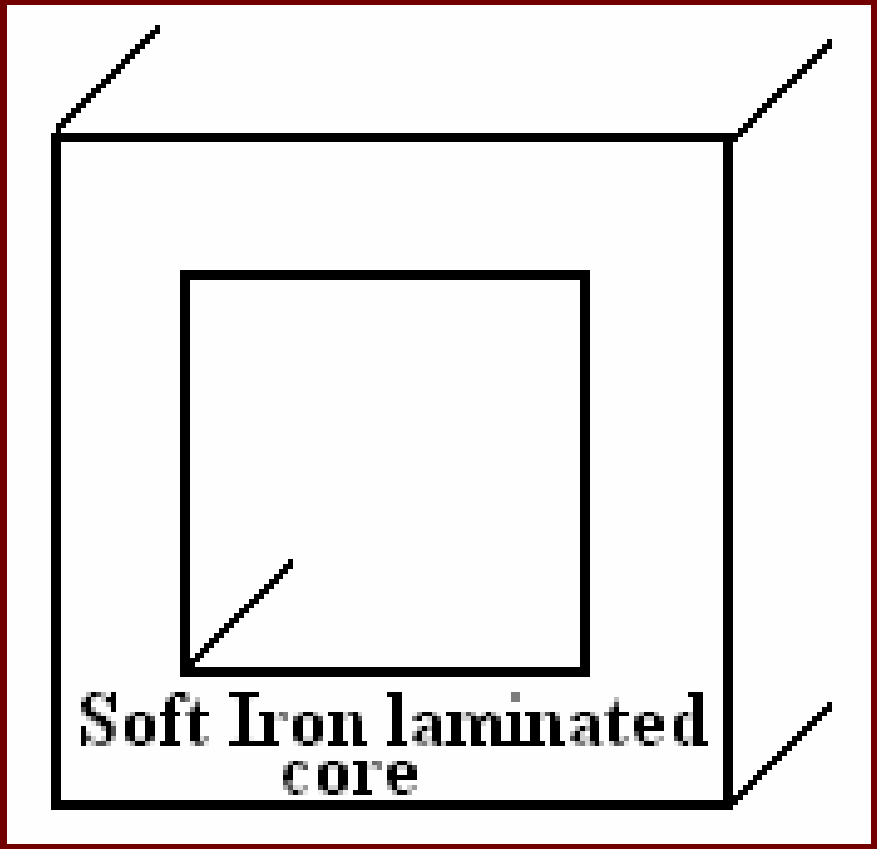
How to draw a transformer

1. Draw a large square
2. Inside it draw a smaller square



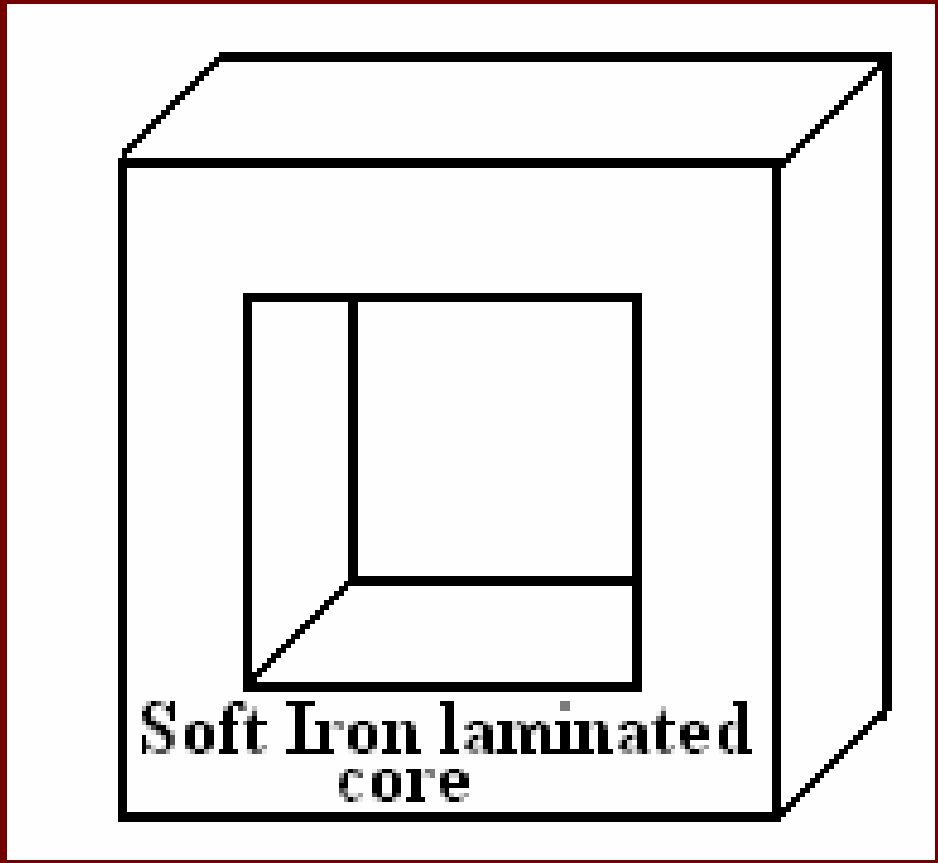
How to draw a transformer

Draw four slanting lines as shown



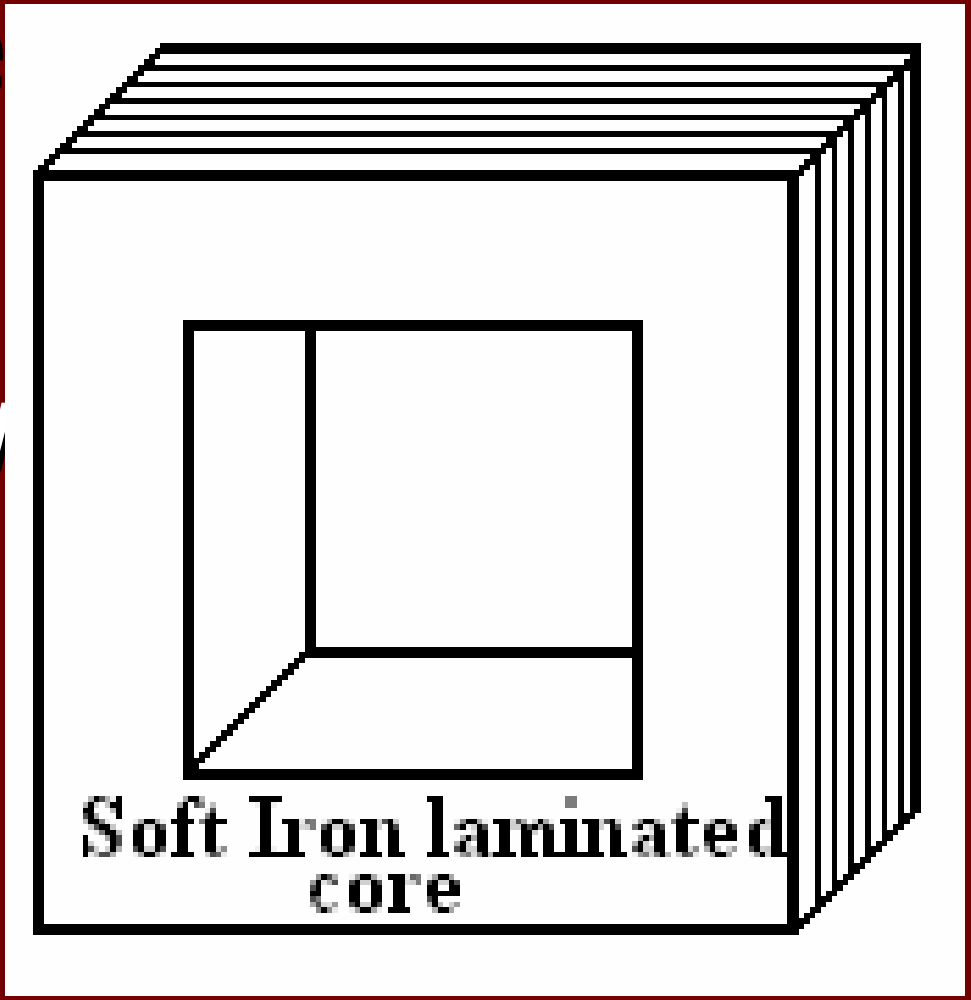
How to draw a transformer

Join their end points to complete the three dimensional block.



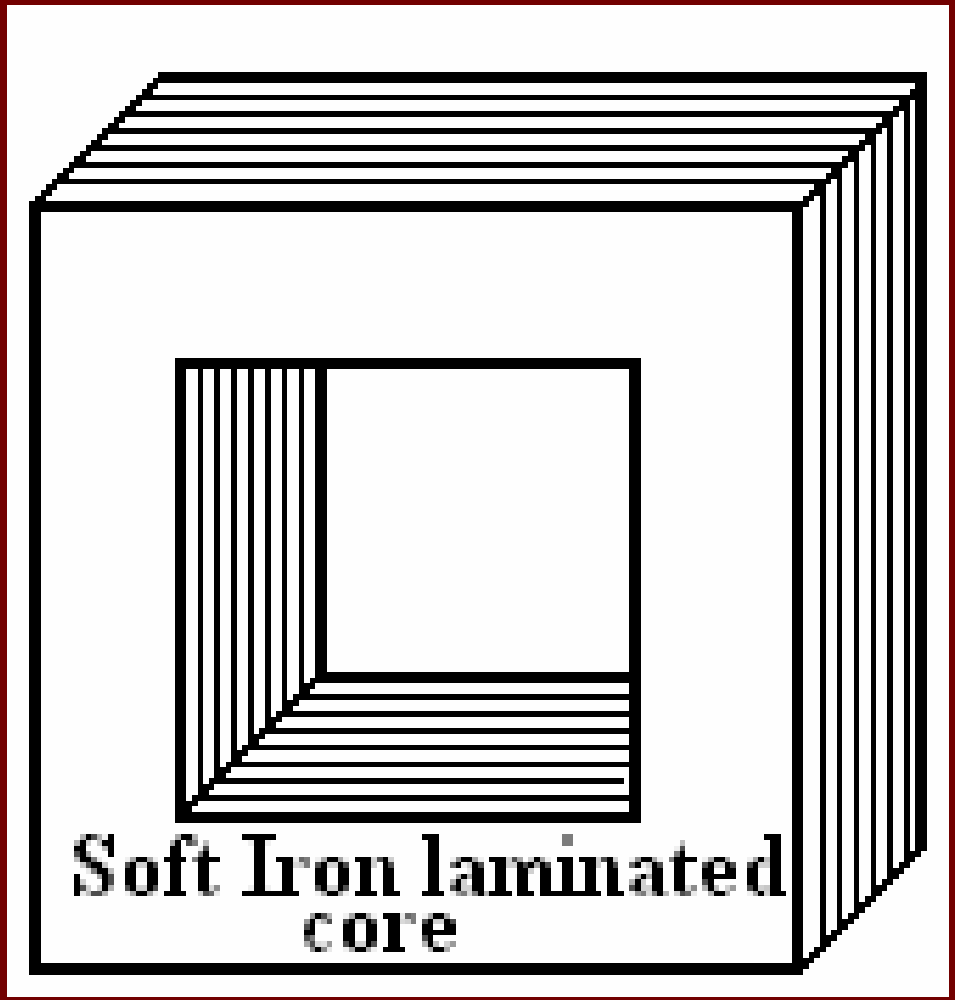
How to draw a transformer

Fill the space at the sides with parallel lines to show the laminated core



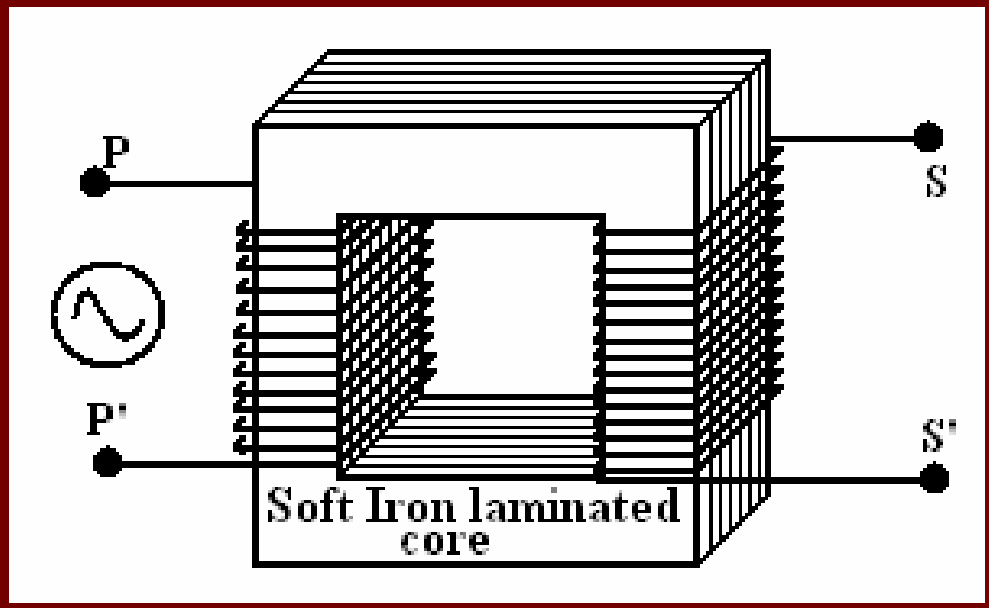
How to draw a transformer

Repeat the same for the inner side also



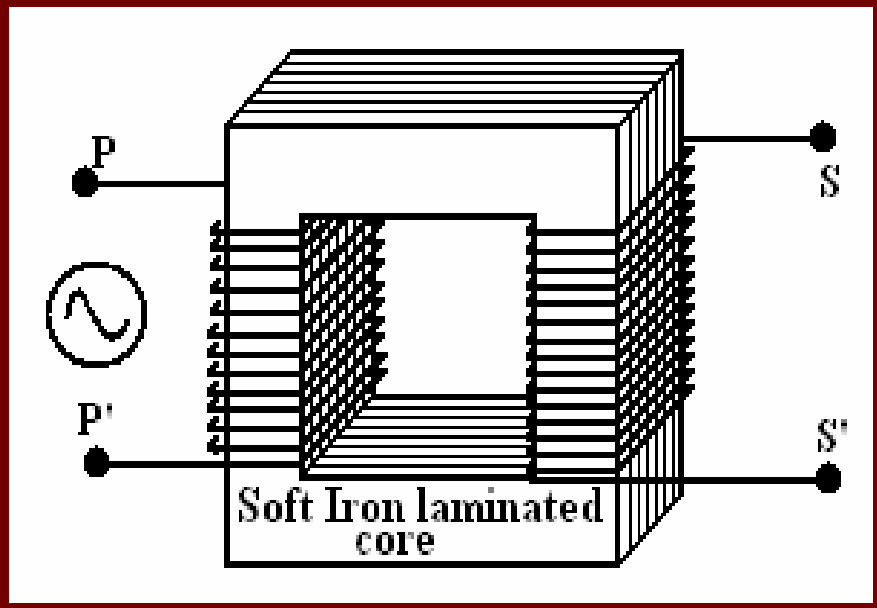
How to draw a transformer

Draw the primary and secondary windings as shown.



Working of a transformer

1. When current in the primary coil changes being alternating in nature, a changing magnetic field is produced
2. This changing magnetic field gets associated with the secondary through the soft iron core
3. Hence magnetic flux linked with the secondary coil changes.
4. Which induces e.m.f. in the secondary.



Mathematical Equations

If N_P is the number of turns of the primary coil and N_s is the number of turns of the secondary coil. Let the rate of change of magnetic flux is

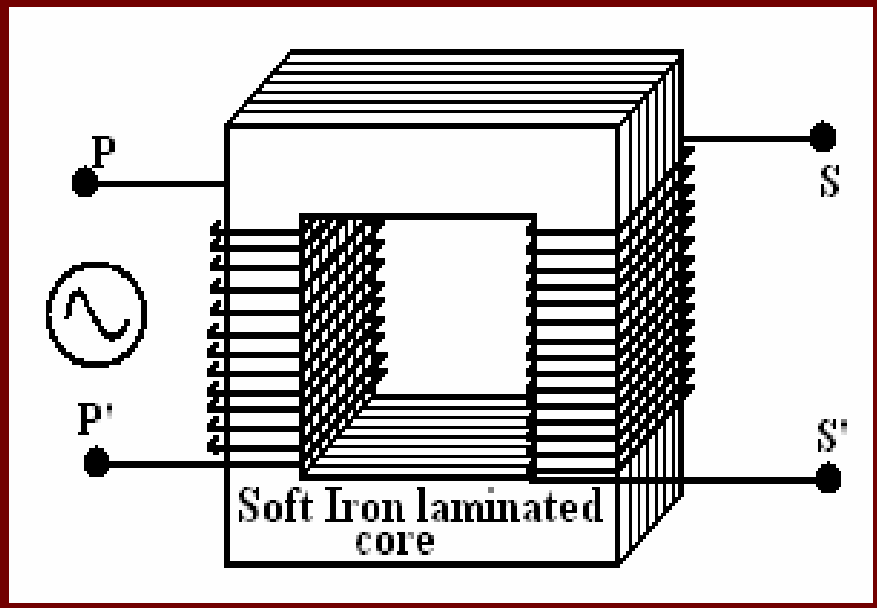
$$\frac{d\phi}{dt}$$

Then e.m.f. of primary coil is

$$E_P = N_P \frac{d\phi}{dt}$$

Similarly e.m.f. of Secondary coil is

$$E_s = N_s \frac{d\phi}{dt}$$

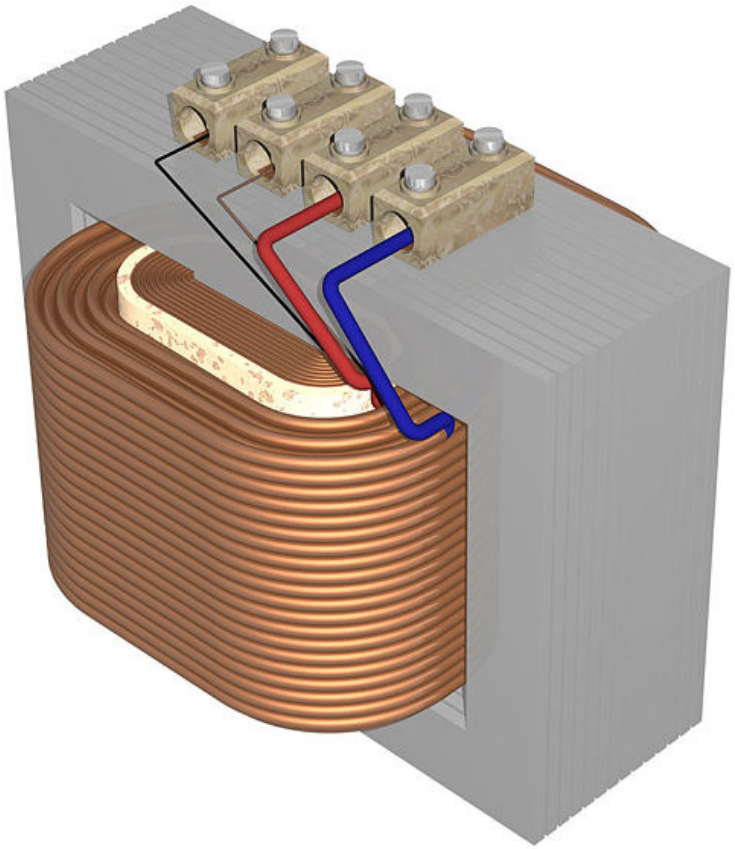


Mathematical Equations

Then ratio of e.m.f.s of primary and secondary coils is

$$\frac{E_P}{E_s} = \frac{N_P \dfrac{d\phi}{dt}}{N_s \dfrac{d\phi}{dt}} = \frac{N_P}{N_s}$$

Hence e.m.f.s are directly proportional to their respective no. of turns.



Mathematical Equations

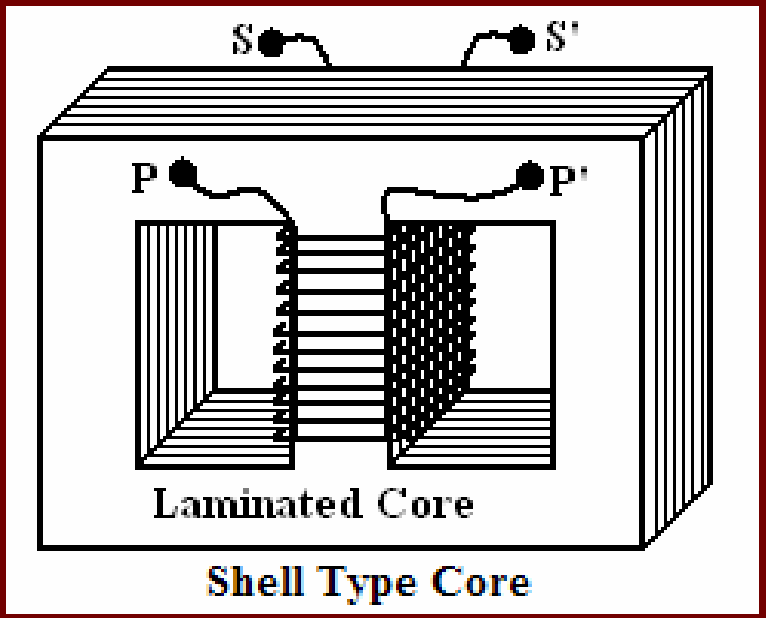
For an ideal transformer input power and output powers are equal, hence

$$E_P . I_P = E_s . I_s$$

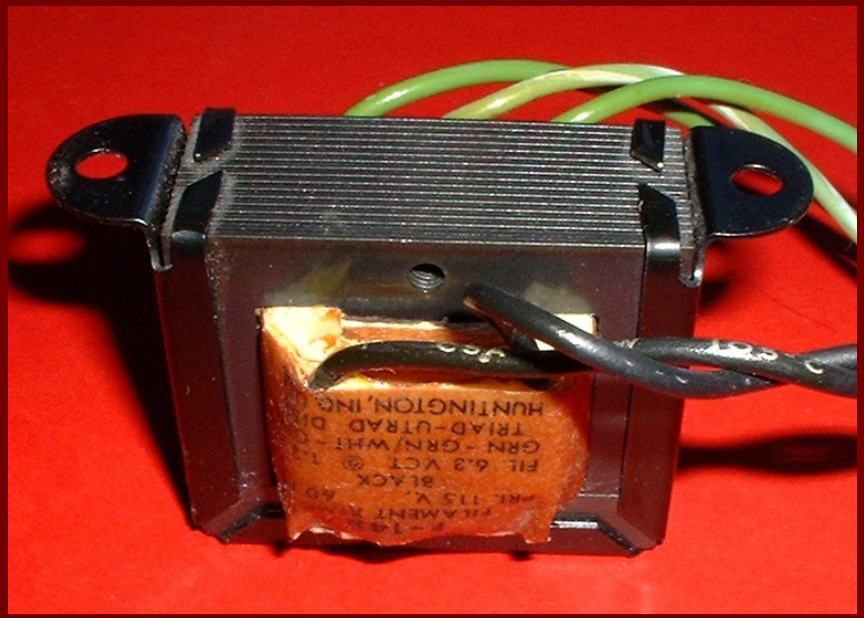
$$\text{or } \frac{E_P}{E_s} = \frac{I_s}{I_P} = \frac{N_P}{N_s}$$

Energy Losses in Transformer

1. **<u>Loss of magnetic flux</u>: -** The coupling between the coils is seldom perfect. So whole of magnetic flux produced by primary coil doe not get linked with the secondary. However in a shell type transformer these losses are less. In shell type transformer the primary and secondary are wound over each other as shown in figure



Shell Type Core



Energy Losses in Transformer

2. **Iron losses:** In actual iron cores, inspite of lamination, some heat is still produced by the eddy currents.
3. **Copper losses: -** In actual practice, coils of the transformer possess some resistance. So a part of energy is lost due to heat produced by the resistance of the coils.

Energy Losses in Transformer

- **4. Hysteresis losses: - The alternating current in the coils repeatedly takes the iron core through complete cycle of magnetization. So energy is lost due to hysteresis.**
- **5. Humming losses: - The alternating current in the transformer may set its parts into vibrations and sound may be produced. This sound produced is called *humming*. Thus a part of energy is lost in the form of sound energy.**

Uses of Transformer

- Transformer is used for transmission of A.C. over long distances by stepping it up.
- It reduces current for a given power requirement, hence reduces losses due to Joule's heating along the resistance of the transmission line.
- At the city A.C. is again stepped down to 220V for the consumption.