RAMA UNIVERSITY

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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-1

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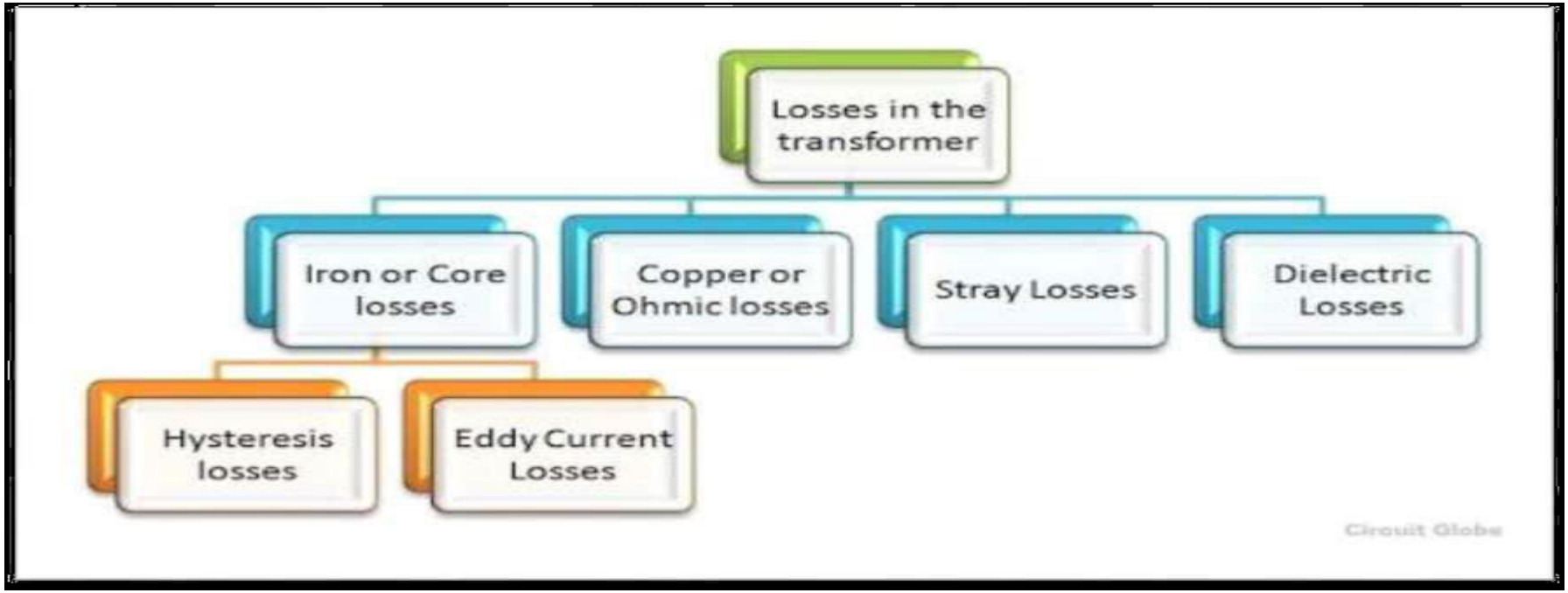
SINGLE PHASE TRANSFORMER

Losses in a transformer

- In any electrical machine, 'loss' can be defined as the difference between input power and output power.
- An electrical transformer is an static device, hence mechanical losses (like windage or friction losses) are absent in it.
- A transformer only consists of electrical losses (iron losses and copper losses).
- All these losses in the transformer are dissipated in the form of heat.



SINGLE PHASE TRANSFORMER

Copper loss

- Copper loss is due to power wasted in the form of I2R, , where 'I' is the current passing through the windings and R is the internal resistance of the windings(primary and secondary).
- it is clear that Cu loss is proportional to square of the current, and current depends on the load. Hence copper loss in transformer varies with the load.
- Hence it is also called as variable loss.

$$\text{Total copper losses.} = I_1^2 . R_1 + I_2^2 R_2 = I_1^2 . R_{01} + I_2^2 R_{02}$$

Core or Iron Losses

There are two types of core or iron losses in a Transformer.

a) Hysteresis Losses

Each time the magnetic field is reversed, a small amount of energy is lost due to hysteresis within the core. For a given core material, the transformer losses are proportional to the frequency, and is a function of the peak flux density to which it is subjected.

We can find Hysteresis losses by this formula.

$$W_h = \eta B^{1.6}_{max} f.v \text{ watt}$$

b) Eddy Current Losses

Ferromagnetic materials are also good conductors, and a core made from such a material also constitutes a single short-circuited turn throughout its entire length. Eddy currents therefore circulate within the core in a plane normal to the flux, and are responsible for resistive heating of the core material.

The eddy current loss is a complex function of the square of supply frequency and inverse square of the material thickness.

We can find Eddy currents losses by this formula.

$$W_e = PB^2_{max} . f^2 t^2 \text{ Watt}$$

Stray losses (leakage Flux)

Leakage inductance is by itself largely lossless, since energy supplied to its magnetic fields is returned to the supply with the next half-cycle. However, any leakage flux that intercepts nearby conductive materials such as the transformer's support structure will give rise to eddy currents and be converted to heat. There are also radiative losses due to the oscillating magnetic field, but these are usually small and negligible.

Dielectric Loss

In the solid insulation or transformer oil i.e. insulation material of the transformer, dielectric loss occurs when the solid insulation get damaged or the oil gets deteriorated or its quality decreases over the time. Hence, the overall efficiency of transformer may be affected due to this loss.