

# Unit - III

## 3.3 Introduction to Transformers

**Dr.Santhosh.T.K.**

# Syllabus

## UNIT – III

10 Periods

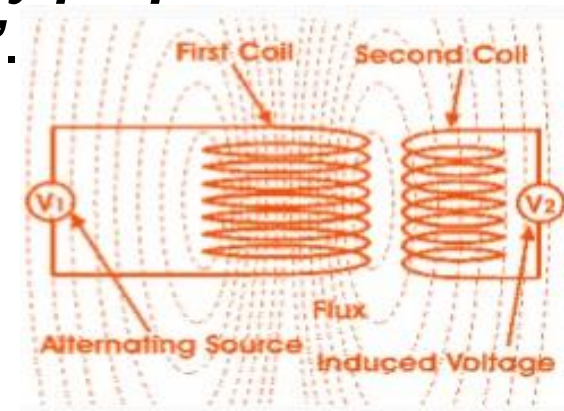
**Principles of Electro Magnetism and Electro-mechanics:** Electricity and Magnetism - magnetic field and faraday's law - self and mutual inductance - Ampere's law - Magnetic circuit - Magnetic material and B-H Curve – Single phase transformer - principle of operation - EMF equation - voltage ratio - current ratio – KVA rating - Electromechanical energy conversion – Elementary generator and motors.

# Problem

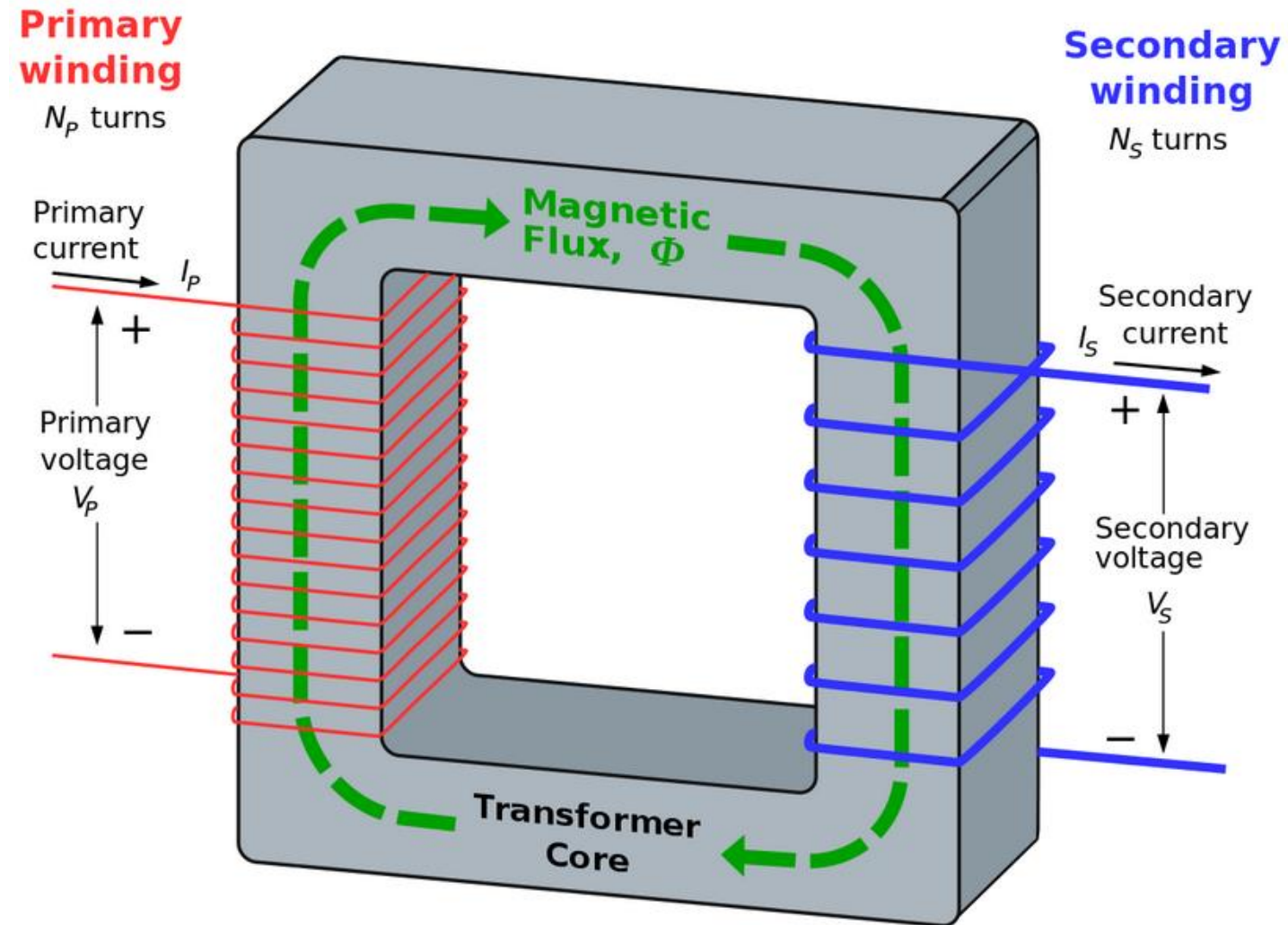
**Example 9.24.** *Two coils A and B of 500 and 750 turns respectively are connected in series on the same magnetic circuit of reluctance  $1.55 \times 10^6$  AT/Wb. Assuming that there is no flux leakage, calculate (i) self-inductance of each coil and (ii) mutual inductance between coils.*

# Transformer

- Transformer is a *static device* which transfers electric power from one circuit to another without changing its frequency
- The principle of operation of a transformer depends upon *Faraday's Law of Electromagnetic Induction*.
- Actually mutual inductance between 2 or more windings is responsible for transformation action in an electrical transformer.
- According to Faraday's Law, “**Rate of change of flux linkages with respect to time is directly proportional to the induced EMF in a conductor or a coil**”.
- $e = M \frac{di}{dt}$  or  $N \cdot \frac{d\phi}{dt}$



# Transformer



# Types of transformer

**Based on terminal voltage,**

- Step-up transformer
- Step down transformer

**Based on supply voltage,**

- Single phase transformer
- Three phase transformer

**Based on construction,**

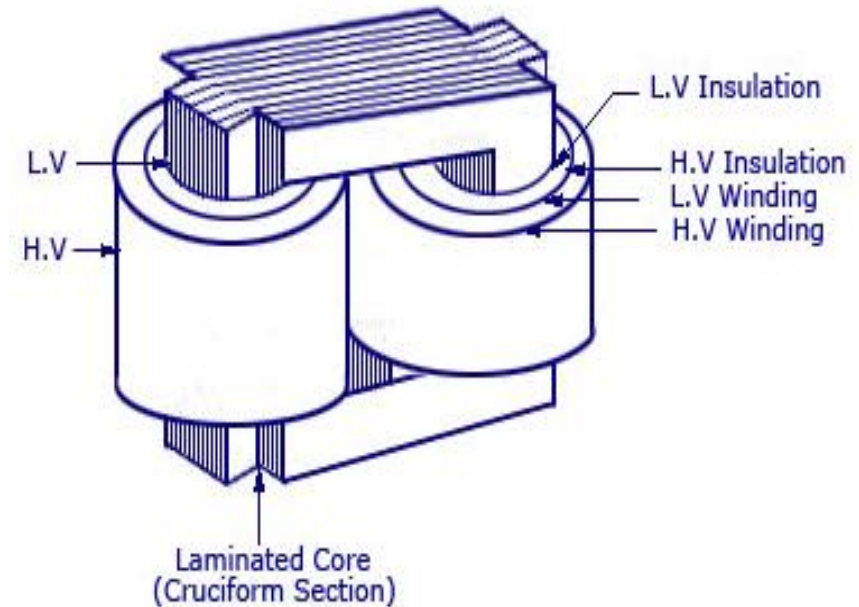
- Core type transformer
- Shell type transformer
- Spiral type or wound core type transformer (spirakore)

**Based on type of cooling,**

- Oil-filled self cooled
- Oil-filled water cooled
- Air blast type

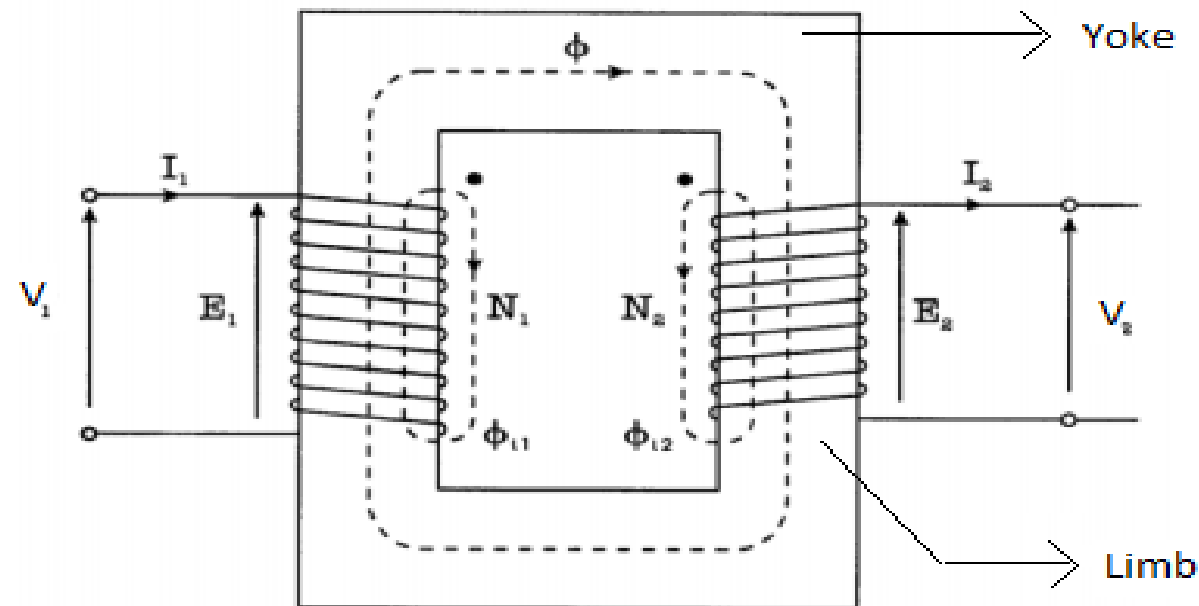
# Core Type Transformer

- The windings surround a considerable part of the core
- It is a single magnetic circuit
- Rectangular in shape having 2 limbs
- The coils used are of cylindrical type.
- The coils are wound in helical layers with different layers insulated from each other by paper or mica or cloth.
- The core is made up of large number of thin laminations.
- LV winding is placed nearest to the core with interleaved structure.



# Construction - Core

- Core is either **square or rectangular** in size
- The vertical portion in which the coils are wound are called the **limb** and **carries the windings**
- The horizontal portion is called the **yoke** which **carries the flux produced** by one winding to another.





## Laminations

- In **core type transformers**, the steel core laminations are in the shape of 'L' , and these laminations are placed one above the other alternatively.



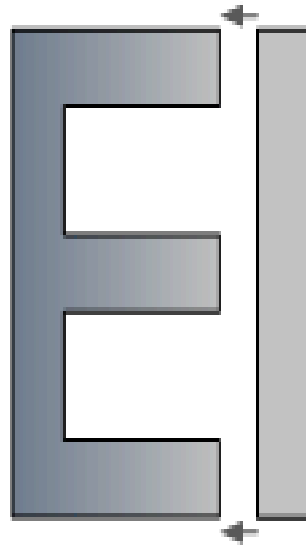
# Laminations

- In **shell type transformers**, the steel core laminations are in the shape of 'E' and 'I' and placed similar to that of core type.

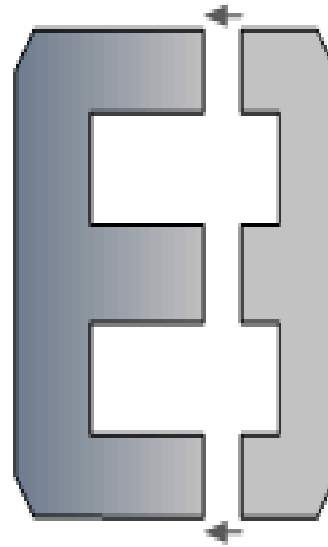


# Types of laminations

Shell-type Laminations

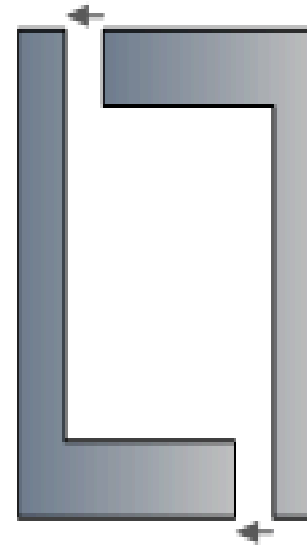


"E-I" Laminations

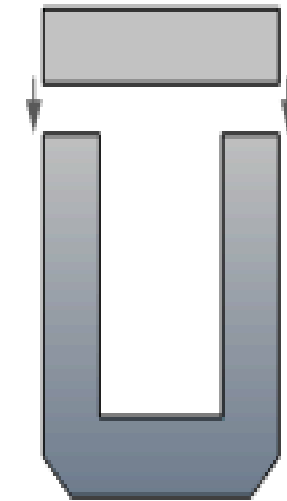


"E-E" Laminations

Core-type Laminations



"L" Laminations



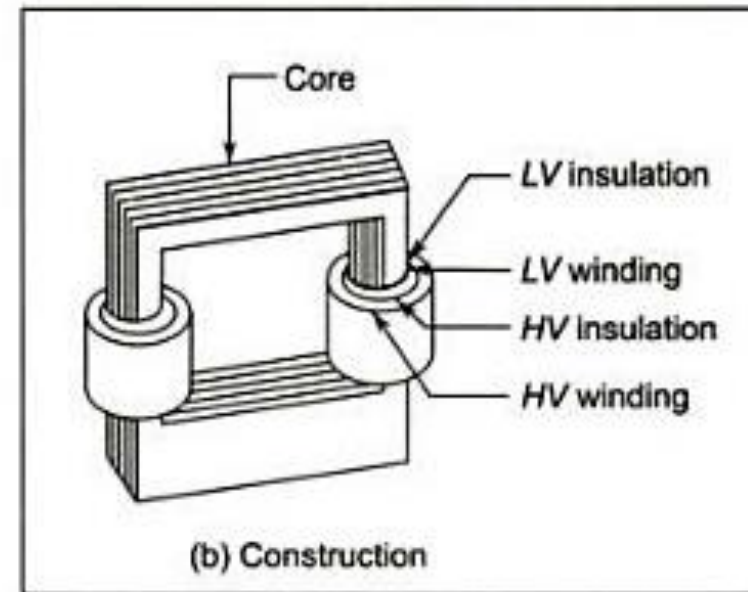
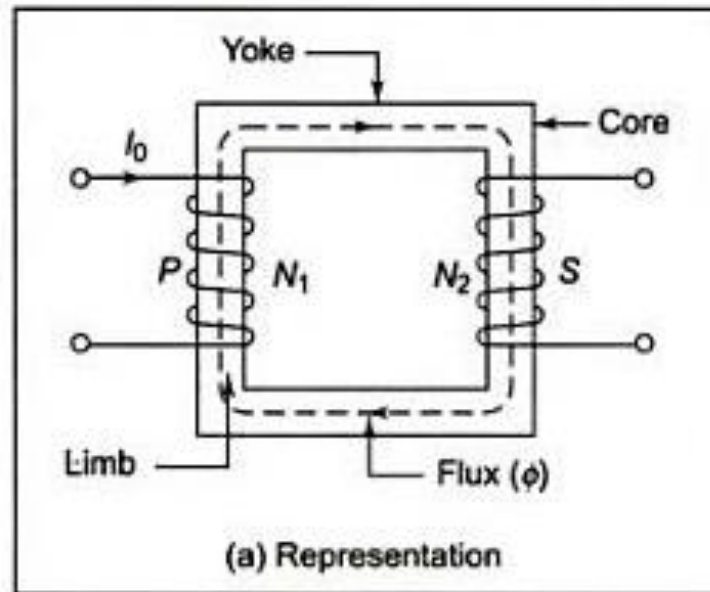
"U-I" Laminations



# Windings

- Transformer windings are made of solid copper or aluminium strip conductors.
- The coils used are wound on the limbs and are insulated from each other.
- It carries the current and produces the flux necessary for the functioning of the transformer.

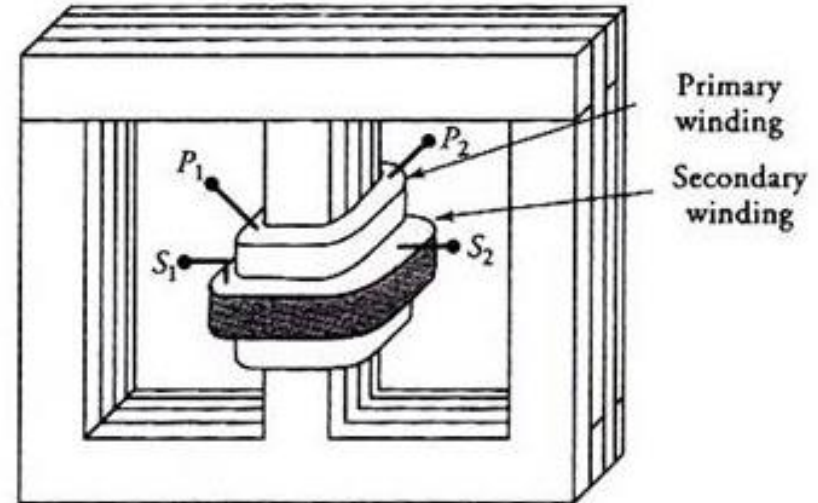
# Core type



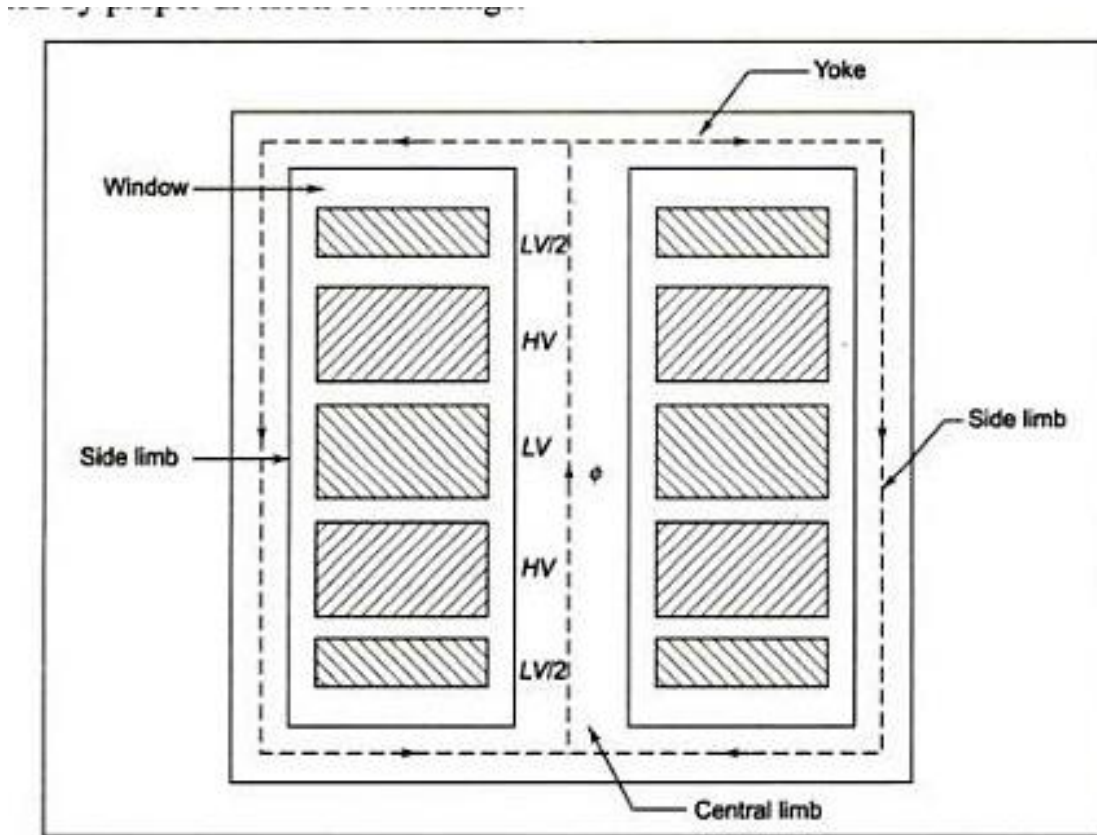
- Windings are wrapped around two sides of a laminated square core.

# Shell type transformer

- The core surrounds a considerable portion of the windings.
- It is a double magnetic circuit
- The core has 3 limbs.
- The coils used are multilayered disc type or sandwich coils.
- The core is laminated.
- All the joints at alternate layers are staggered to avoid narrow airgaps at the joints. Such joints are called as overlapped or imbricated joints.
- Windings are wrapped around the center leg of a laminated core.



# Shell type - sandwich coil structure

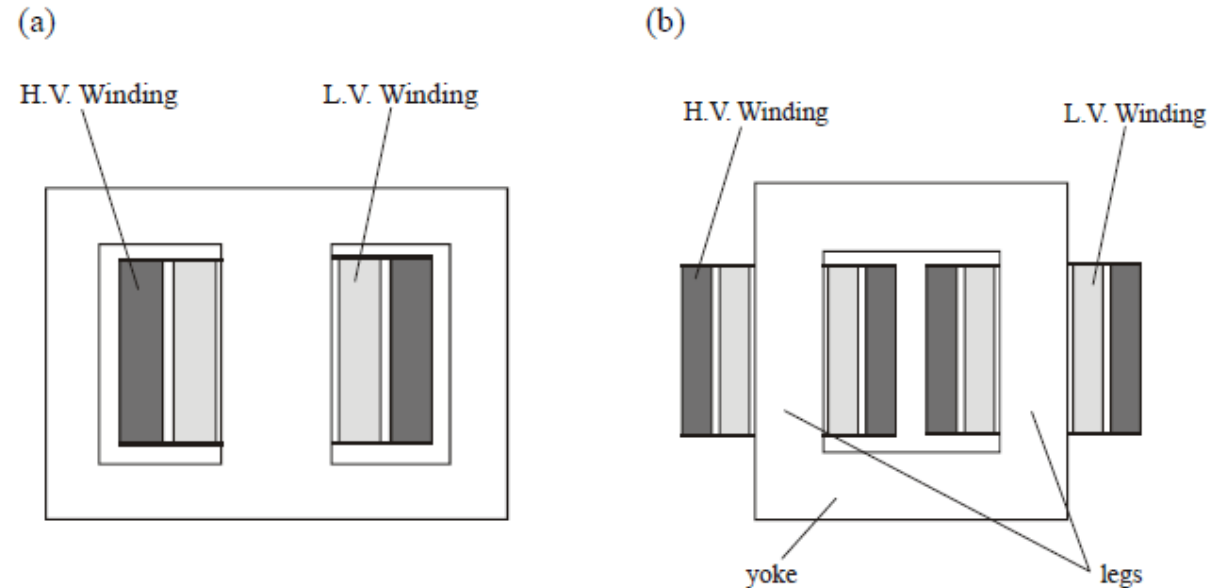


HV winding lies between two LV windings

Controls leakage



# Sectional view of transformer



(a) Shell-type transformer, (b) core-type transformer

Windings are wrapped around the center leg of a laminated core.

- Windings are wrapped around two sides of a laminated square core.



# Comparison between Core & Shell Type

Description	Core Type	Shell Type
<b>Construction</b>	Easy to assemble & Dismantle	<b>Complex</b>
<b>Mechanical Strength</b>	Low	<b>High</b>
<b>Leakage reactance</b>	Higher	<b>Smaller</b>
<b>Cooling</b>	Better cooling of Winding	<b>Better cooling of Core</b>
<b>Repair</b>	Easy	<b>Hard</b>
<b>Applications</b>	High Voltage & Low output	<b>Low Voltages &amp; Large Output</b>

# Summary

- Ideal transformer
- Transformer types
  - Core
  - Shell