

The **mutual inductance** term in the primary circuit represents the load of the secondary. It has the negative sign because it helps the source to produce more current in response to increasing load in the secondary circuit.

$$V_p = I_p R_1 + \frac{L_p \Delta I_p}{\Delta t} - M \frac{\Delta I_s}{\Delta t}$$

The **mutual inductance** term in the secondary represents the coupling from the primary and acts as the voltage source that drives the secondary circuit.

$$M \frac{\Delta I_p}{\Delta t} = I_s R_2 + \frac{L_s \Delta I_s}{\Delta t}$$



When a changing voltage is applied to the primary coil, the back emf generated by the primary is given by Faraday's law:

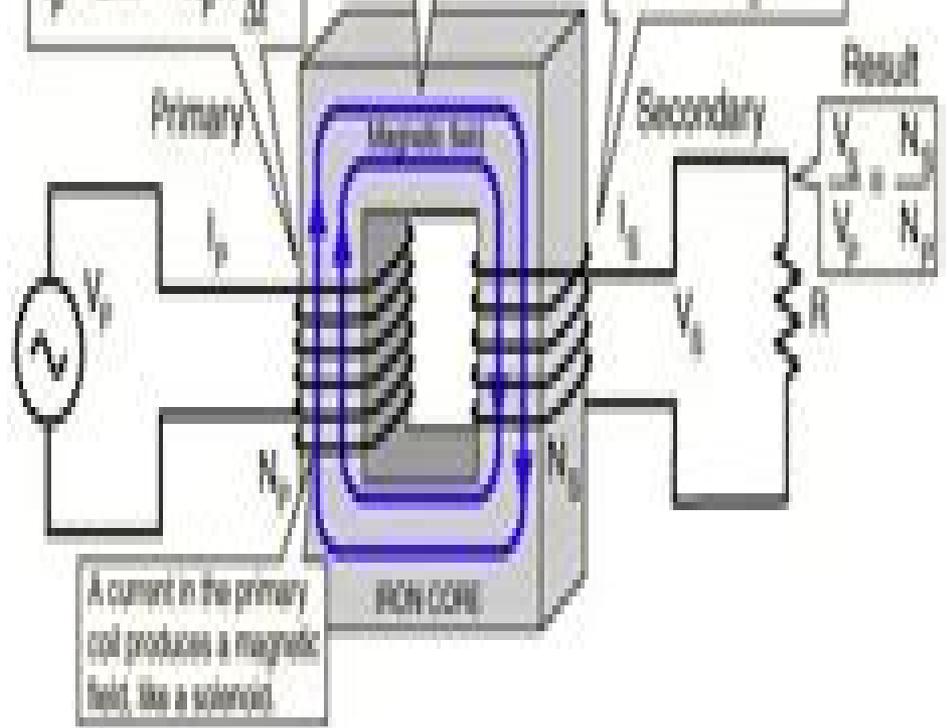
$$V_p = E_{ind} = -N_p A \frac{\Delta B}{\Delta t}$$

Though there is a slight loss to fringe fields, the magnetic field is almost totally contained in the iron core, and coupled around through the secondary coil.

The induced voltage in the secondary coil is also given by Faraday's law:

$$V_s = -N_s A \frac{\Delta B}{\Delta t}$$

The rate of change of flux is essentially the same as that in the primary coil - so the number of turns determines  $V_s$ .



A current in the primary coil produces a magnetic field, like a solenoid.

Result

$$\frac{V_p}{N_p} = \frac{V_s}{N_s}$$

# Transformer Design Principles

**Fang Zhu, Baitun Yang**



## **Transformer Design Principles:**

*Transformer Design Principles, Third Edition* Robert M. Del Vecchio, Bertrand Poulin, Pierre T. Feghali, Dilipkumar Shah, Rajendra Ahuja, 2017-08-09 In the newest edition the reader will learn the basics of transformer design starting from fundamental principles and ending with advanced model simulations The electrical mechanical and thermal considerations that go into the design of a transformer are discussed with useful design formulas which are used to ensure that the transformer will operate without overheating and survive various stressful events such as a lightning strike or a short circuit event This new edition includes a section on how to correct the linear impedance boundary method for non linear materials and a simpler method to calculate temperatures and flows in windings with directed flow cooling using graph theory It also includes a chapter on optimization with practical suggestions on achieving the lowest cost design with constraints

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