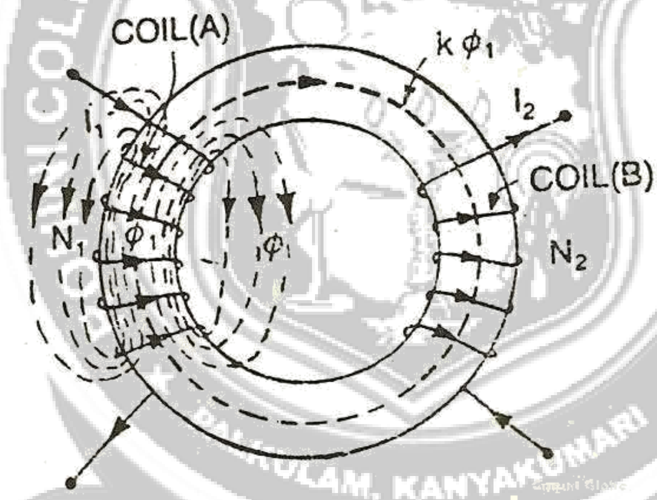
COEFFICIENT OF COUPLING:

The fraction of magnetic flux produced by the current in one coil that links with the other coil is called **coefficient of coupling** between the two coils. It is denoted by (k).

Two coils are taken coil A and coil B, when current flows through one coil it produces flux; the whole flux may not link with the other coil coupled, and this is because of leakage flux by a fraction (k) known as **Coefficient of Coupling.**



k=1 when the flux produced by one coil completely links with the other coil and is called magnetically tightly coupled.

k=0 when the flux produced by one coil does not link at all with the other coil and thus the coils are said to be magnetically isolated.

DERIVATION:

Consider two magnetic coils A and B. When current I1 flows through coil A.

$$L_1 = \frac{N_1\varphi_1}{I_1} \text{ and } M = \frac{N_2\varphi_{12}}{I_1} \ldots\ldots(1) \text{ as } (\varphi_{12} = k\varphi_1)$$

Considering coil B in which current I2 flows

$$L_2 = \frac{N_{2\varphi_2}}{I_2} \ and \ M = \frac{N_{1\varphi_{21}}}{I_2} = \frac{N_1 k\varphi_2}{I_2} \ldots\ldots.(2) \quad as\ (\varphi_2 = k\varphi_2)$$

Multiplying equation (1) and (2)

$$MxM = \frac{N_{2k\varphi_1}}{I_1}\ x\frac{N_{1k\varphi_2}}{I_2}$$

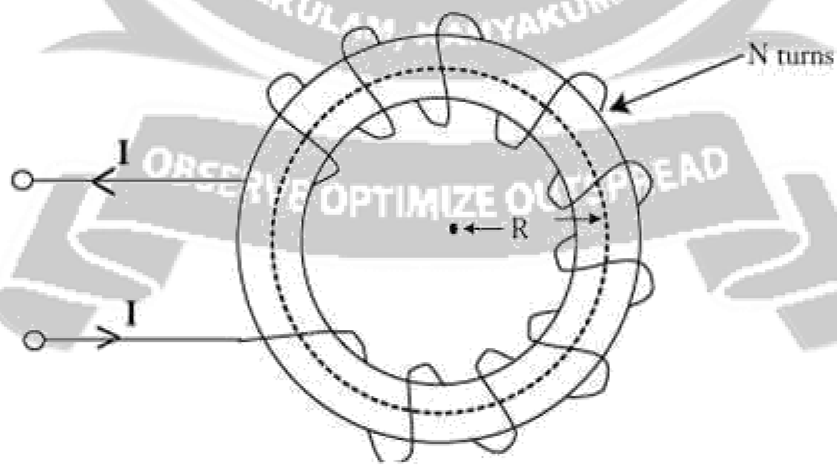
$$M^2 = k^2\frac{N_{1\varphi_1}}{I_1}\ x\ \frac{N_{2\varphi_2}}{I_2} = k^2 L_1 L_2$$

$$\mathrm{M} = \sqrt{L_1 L_2} \quad \ldots\ldots\ldots.(A)$$

The above equation (A) shows the relationship between mutual inductance and self-inductance between two the coils

SERIES MAGNETIC CIRCUIT:

- A series magnetic circuit is analogous to a series electric circuit. A magnetic circuit is said to be series, if the same flux is flowing through all the elements connected in a magnetic circuit. Consider a circular ring having a magnetic path of 'l' meters, area of cross section 'a' m^2 with a mean radius of 'R' meters having a coil of 'N' turns carrying a current of 'I' amperes wound uniformly as shown in below fig

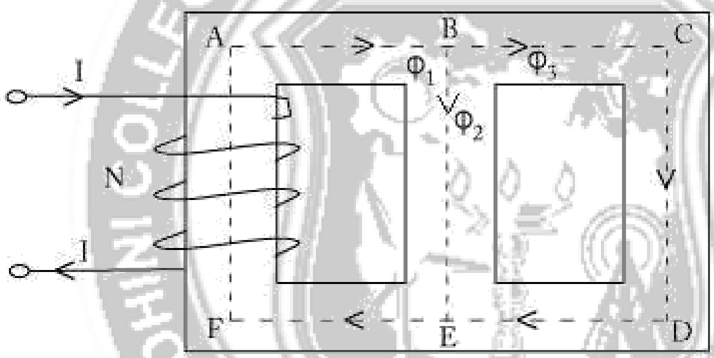


The flux produced by the circuit is given by

In the above equation NI is the MMF of the magnetic circuit, which is analogous to EMF in the electrical circuit.

PARALLEL MAGNETIC CIRCUIT

- A magnetic circuit which has more than one path for magnetic flux is called a parallel magnetic circuit. It can be compared with a parallel electric circuit which has more than one path for electric current. The concept of parallel magnetic circuit is illustrated in fig.
  1. Here a coil of 'N' turns wounded on limb 'AF' carries a current of 'I' amperes. The magnetic flux 'φ1' set up by the coil divides at 'B' into two paths namely
  Magnetic flux passes 'φ2' along the path 'BE'
  Magnetic flux passes 'φ3' along the path 'BCDE' i.e $\varphi_1 = \varphi_2 + \varphi_3$



The magnetic paths 'BE' and 'BCDE' are in parallel and form a parallel magnetic circuit. The AT required for this parallel circuit is equal to AT required for any one of the paths. Let S1= reluctance of path EFAB

Let, S1= reluctance of path EFAB
S2= reluctance of path BE
S3= reluctance of path BCDE

Total MMF= MMF for path EFAB + MMF for path BE or path BCD

$$NI = \Phi_1 S_1 + \Phi_2 S_2 = \Phi_1 S_1 + \Phi_3 S_3$$

COMPOSITE MAGNETIC CIRCUIT:

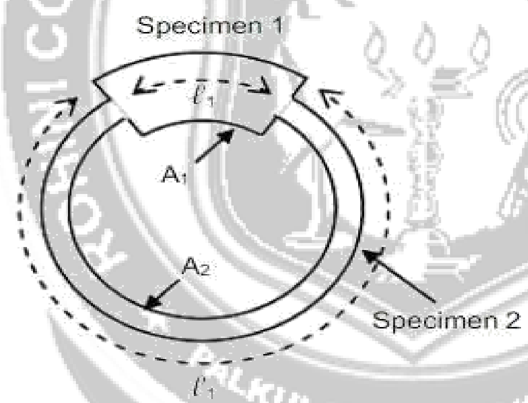
Consider a magnetic circuit which consists of two specimens of iron arranged as shown in figure. Let ℓ_1 and ℓ_2 be the mean lengths of specimen 1 and specimen2 in meters, A_1 and A_2 betheir respective cross-sectional areas in square meters, and 1 and 2 be their respective relative permeability's.

The reluctance of specimen 1 is given as

$$S_1 = \frac{\ell_1}{\mu_0 \mu_1 A_1} \quad (AT/Wb)$$

and that for specimen 2 is

$$S_2 = \frac{\ell_2}{\mu_0 \mu_2 A_2} \quad (AT/Wb)$$



If a coil of N turns carrying a current I is wound on the specimen 1 and if the magnetic flux isassumed to be confined to iron core then the total reluctance is given by the sum of the individual reluctances S_1 and S_2. This is equivalent to adding the resistances of a series circuit. Thus the total reluctance is given by

$$S = S_1 + S_2 = \frac{\ell_1}{\mu_0 \mu_1 A_1} + \frac{\ell_2}{\mu_0 \mu_2 A_2} \quad AT/Wb$$

And the total flux is given by

$$\Phi = \frac{\text{mmf}}{S} = \frac{NI}{\dfrac{\ell_1}{\mu_0\mu_1 A_1} + \dfrac{\ell_2}{\mu_0\mu_2 A_2}} \quad \left(\frac{AT}{(AT/Wb)} \Rightarrow Wb\right)$$