UNIT - II

Transmission line parameters.

Resistance
Inductance
capacitance.

Line resistance

$$R_{dc} = \frac{\rho l}{A}.$$

ρ - resisting l = length   A - cross sectional area

The current distribution is uniform in the cross section of the conductor when it carries dc & it is not uniform when it carries Ac.

This is called skin effect.

temperature ↑. $R_t = R_o(1 + \alpha_o)$

α_o - temperature coefficient.

Line Inductance

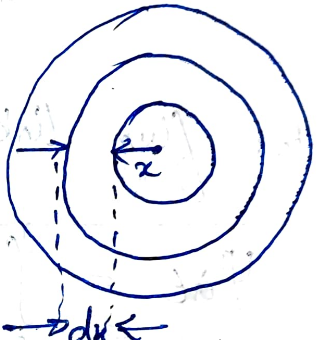
$$L = \frac{\psi}{I}, \text{ henry}$$

Total flux linkage = sum of internal flux + external flux

Inductance of line = $(\psi_{int} + \psi_{ext})/I$

Flux linkage due to Internal flux

consider a long tr. line of radius r, which carries current I as shown in fig. Magnetic field will be created inside and outside the conductor. There will be internal flux which produces internal flux linkage.



Applying ampere's law

$$\oint \bar{H} \cdot dl = I_{enclosed}$$

Magnetic field intensity at a distance x meter from centre.

$$H_x = \frac{I_x}{2\pi x} \quad \text{—— (1)}$$

$$I_x = \frac{I}{\pi r^2} \pi x^2 \quad \text{—— (2)}$$

Sub (2) in (1)

$$H_x = \frac{xI}{2\pi r^2} \text{, AT/m.}$$

Magnetic flux density, $B_x = \mu_0 \mu_r H_x$ Wb/m²

μ_r = relative permitivity = 1, Non magnetic

μ_0 = permeability of free space

$= 4\pi \times 10^{-7}$

$d\phi = B_x \times \text{Area}$

$\text{Area} = dx \times 1 = dx,$

$d\phi = B_x \times dx$

$= \mu_0 \frac{xI}{2\pi r^2} dx, \text{wb}$

flux linkage $d\psi$,

$d\psi_x = \frac{d\phi}{\pi r^2} \pi x^2 = \mu_0 \frac{x^3 I}{2\pi r^4} dx.$

Total flux linkage

$$\psi_{int} = \int_0^r d\psi = \int_0^r \mu_0 \frac{x^3 I}{2\pi r^4} dx$$

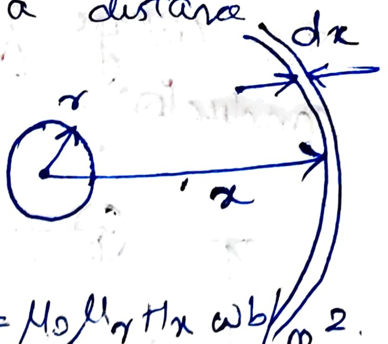
$$= \mu_0 \frac{I}{8\pi} \text{ wb/turn per meter length.}$$

Flux linkage due to External flux

Consider a long cylindrical Tr. line of radius r, which carries current I, magnetic field will be created inside & outside of Conductor.

External flux limits from the conductor surface 'r' to the ∞.

Magnetic field intensity at a distance x metre from centre



$$H_x = \frac{I}{2\pi x}$$

Magnetic flux density $B_x = \mu_0 \mu_r H_x$ wb/m².

$\mu_r = 1$ for air

$\mu_0 = 4\pi \times 10^{-7}$

$$B_x = \mu_0 H_x = \mu_0 \frac{I}{2\pi x} \text{ wb/m}^2.$$

$d\phi = B_x \times \text{Area}$

$\text{Area} = dx \times 1 = dx.$

$$d\phi = B_x \times dx = \mu_0 \frac{I}{2\pi x} dx \text{ wb.}$$

External flux $d\phi$

$$d\psi = d\phi = \mu_0 \frac{I}{2\pi x} dx.$$

External flux from r to ∞.

$$\psi_{ext} = \int d\psi = \int_r^{\infty} \mu_0 \frac{I}{2\pi x} dx \text{ wb-turn per meter length.}$$

Total flux linkage of a single conductor is sum of internal flux & external flux

$$\psi = \psi_{int} + \psi_{ext} = \mu_0 \frac{I}{2\pi}\left[\frac{1}{4} + \int_r^{\infty} \frac{dx}{x}\right], \text{ wb/m.}$$