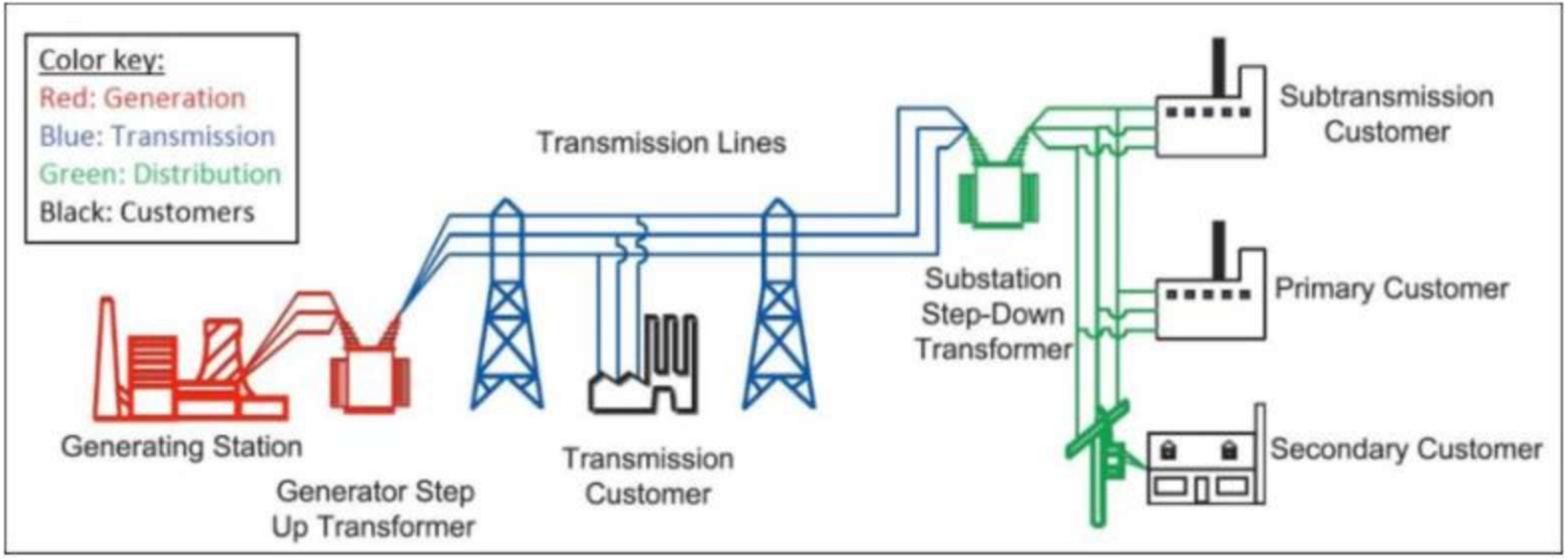
WELCOME TO Adda247

Hard work matters!

Transmission line parameters



Topics to be covered today:

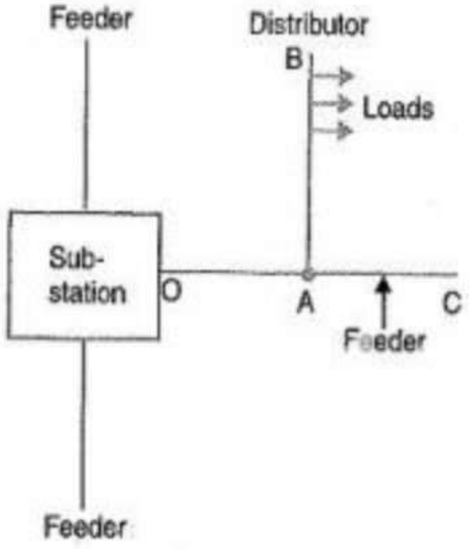
- Parts of transmission system
- Operating voltage
- Conductor materials
- Transmission line parameters
- Skin effect

Parts of transmission system

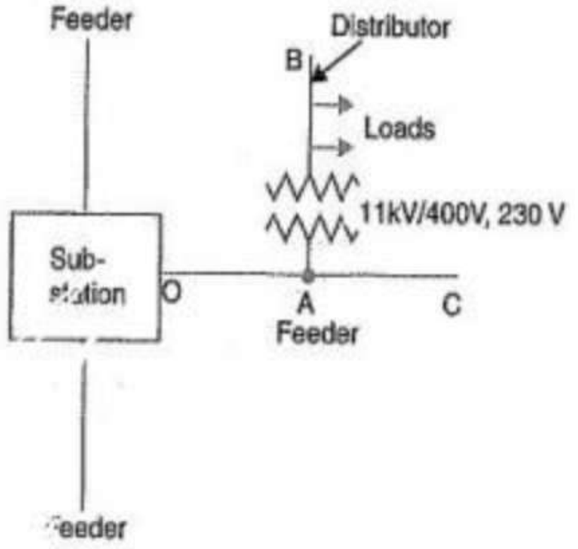
1. Transmission line: Line connecting generating station to substation is called transmission line

2. FEEDER

2. Feeder: line connecting substation to distributor is called feeder



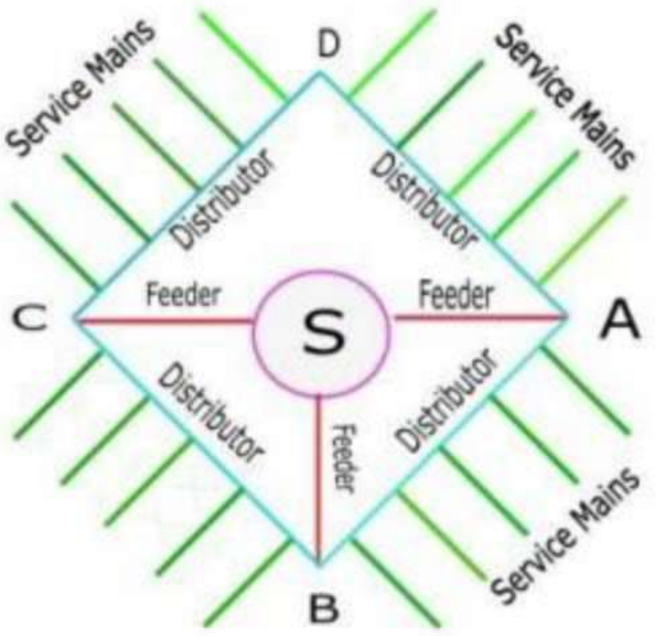
(i)



(ii)

3. Distributor

3. Lines connecting secondary substation to service main is called distributor.



Operating voltage level:

- High voltage: 11 kv,33 kv
- Extra high voltage: 66 kv,132 kv,220kv,400kv
- Ultra high voltage:765 kv or above

Conductor materials:

- The material used as conductor must possess the following props:

1. Low specific resistance
2. High tensile strength
3. Low specific gravity to give low weight
4. Low cost in order to use over long distance

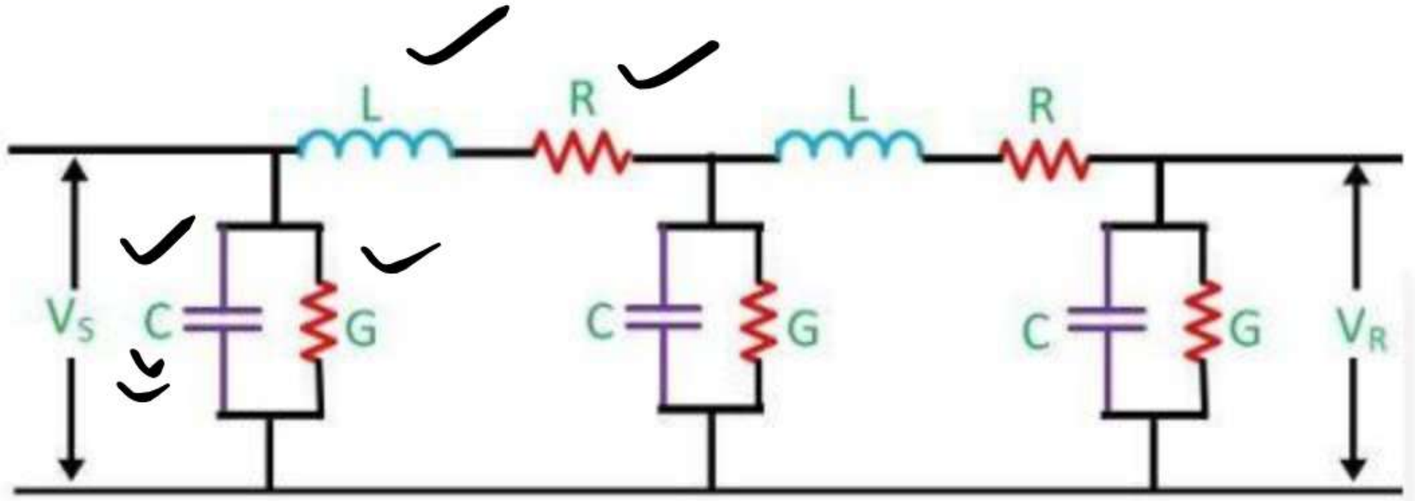
Types of conductors:

1. Solid conductors

2. Stranded conductors

3. Hollow conductors

Parameters of transmission lines:



Tranmission Line Model

Z = R + jwL, Y = G + jwC

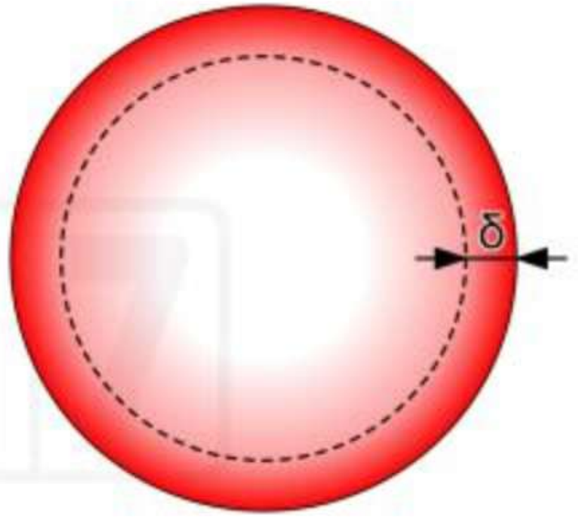
Resistance:

$$R = \frac{\rho l}{A}$$

$$\sim R \Rightarrow \frac{\rho l \times l}{A \times l} = \frac{\rho l^2}{Al} = \frac{\rho l^2}{Vol.}$$

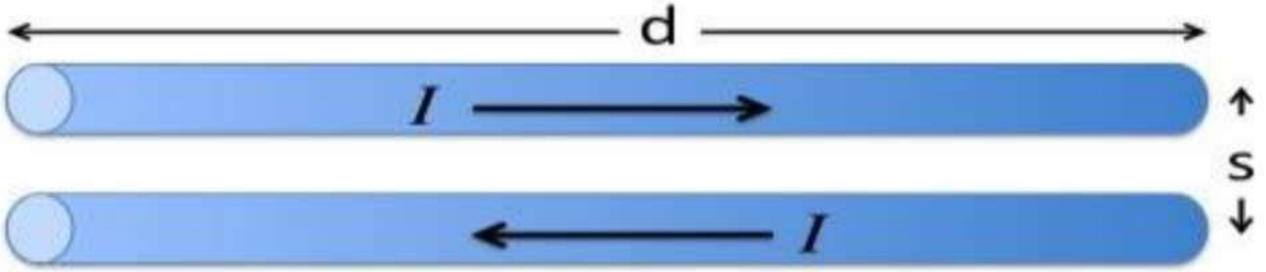
$$\sim R = \frac{\rho l \times A}{A \times A} = \frac{\rho . Vol}{A^2}$$

Skin effect:

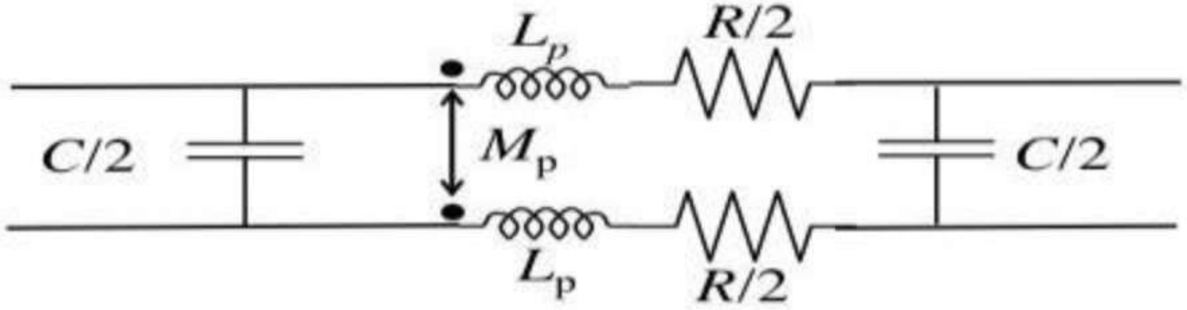


Inductance of transmission lines:

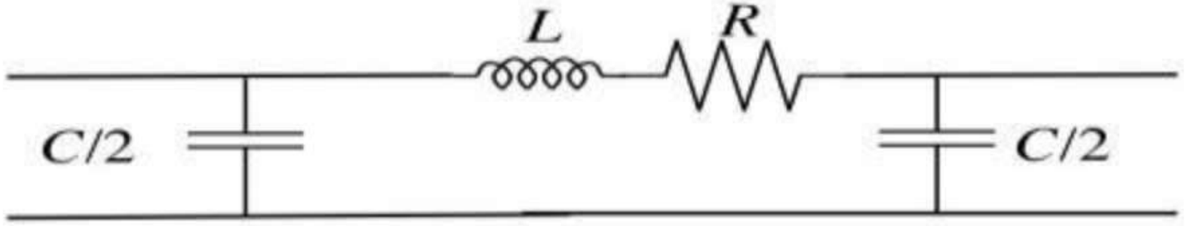
Physical two-wire transmission line



Equivalent circuit with partial inductances and resistances



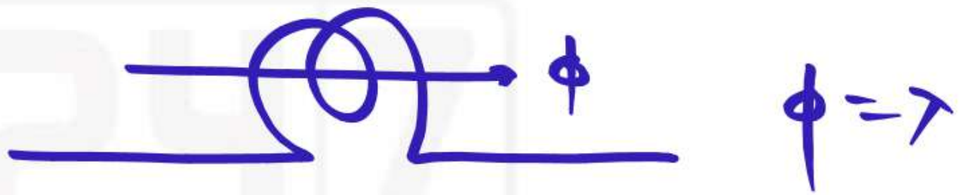
Simpler equivalent circuit with loop inductance and resistance



Inductance of transmission lines:

Due to the alternating nature of current, the flux linkages with the conductor change and hence causes inductance (induced emf) to be present in the conductor.

$$L = \frac{N\phi}{I} = \frac{\lambda}{I} \quad (\lambda)$$



1. $\int H \cdot dl = I_{net}$ $\quad H = ?$

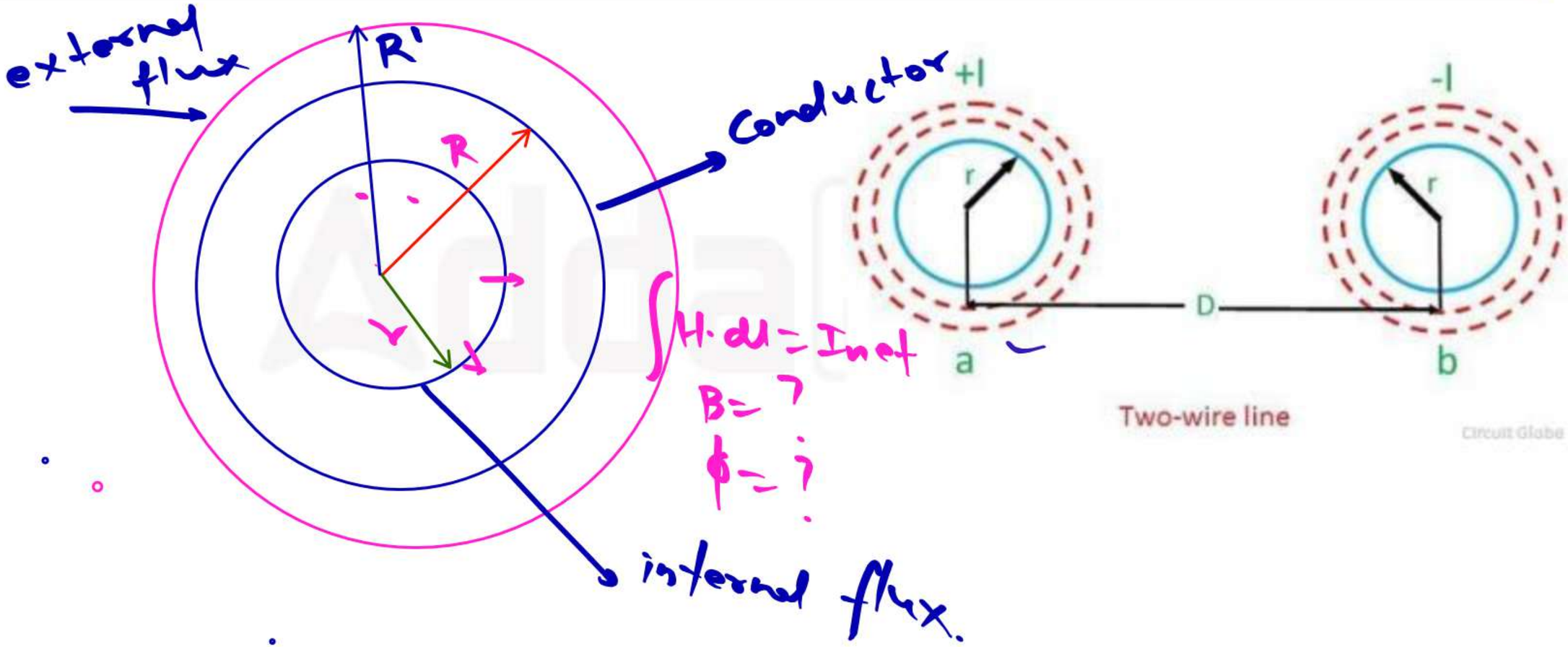
2. $B = \mu_0 \mu_r H$

3. $\phi = B \cdot A$

4. $\lambda = N\phi$

5. $\left(L = \frac{\lambda}{I}\right)$ $\quad \lambda = N\phi$

Inductance due to two flux:



Inductance due to two flux:

$$\lambda = \left[\frac{\mu_0 \mu_r}{8\pi} I\right] \text{wb-T/m}$$

Normally $\mu_r \to 1$.

$$L_{int} = \frac{1}{2} \times 10^{-7} \text{ H/m}$$

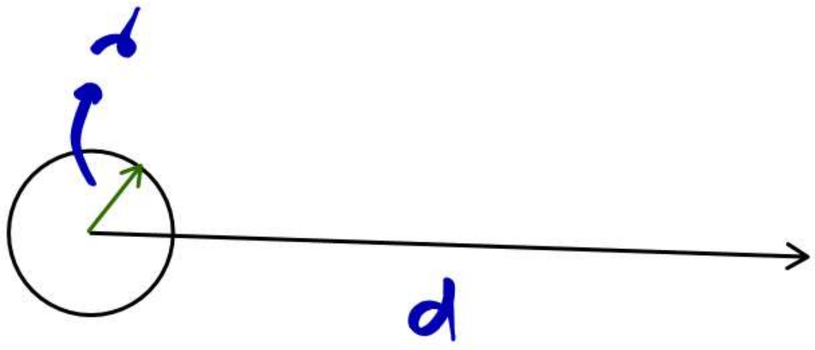
$L = \frac{\lambda}{I}$

$L_{solid} > L_{Hollow}$

$L \uparrow \uparrow X_L = \omega L \uparrow$

$\downarrow P_e \propto \frac{1}{X_L \uparrow}$

→ bay extension → Hollow Condr



$$L_{ext} = 2\times10^{-7} \ln\frac{d}{r} \ H/m$$

$$L = L_{int} + L_{ext} = \left[\frac{1}{2}\times10^{-7} + 2\times10^{-7}\ln\frac{d}{r}\right]$$

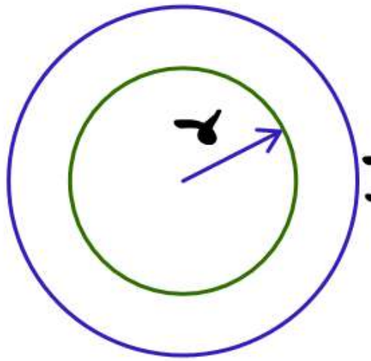
$$= 2\times10^{-7}\left[\frac{1}{4} + \ln\frac{d}{r}\right]$$

$$L = 2\times10^{-7}\left[\frac{1}{4} + \ln\frac{d}{r}\right]$$

$$= 2\times10^{-7}\left[\ln e^{1/4} + \ln\frac{d}{r}\right]$$

$$= 2\times10^{-7}\ln\frac{d}{re^{-1/4}} = \underline{2\times10^{-7}\ln\frac{d}{r'}\ H/m}$$

Hollow Cond^r



$$\int H \cdot dl = I_{net} = 0 \Rightarrow H = 0$$

$$\Phi = 0$$

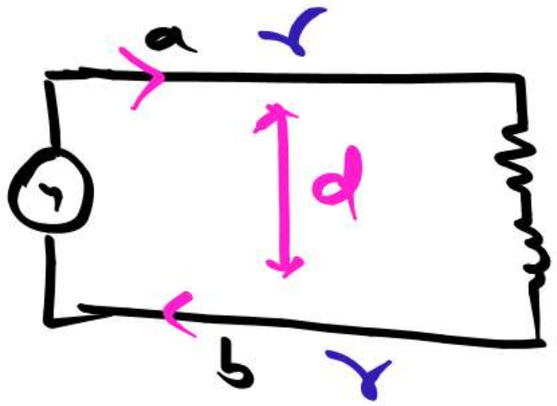
$$L_{int} = 0$$

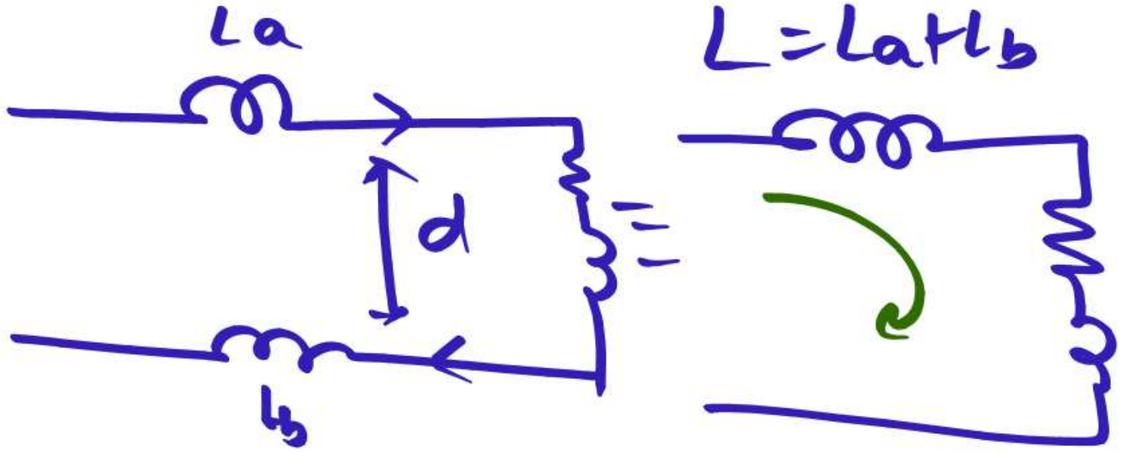
$$L_H = 2 \times 10^{-7} \ln \frac{d}{(r)} \text{ H/m}$$

$$L_{solid} = 2 \times 10^{-7} \ln \frac{d}{(r')} \text{ H/m}$$

$$r' = r e^{-1/4} = .7788\, r$$

$$L = 2 \times 10^{-7} \ln \frac{d}{r'} \text{ H/m} \rightarrow \underline{\text{Solid Cond}^{r}}$$





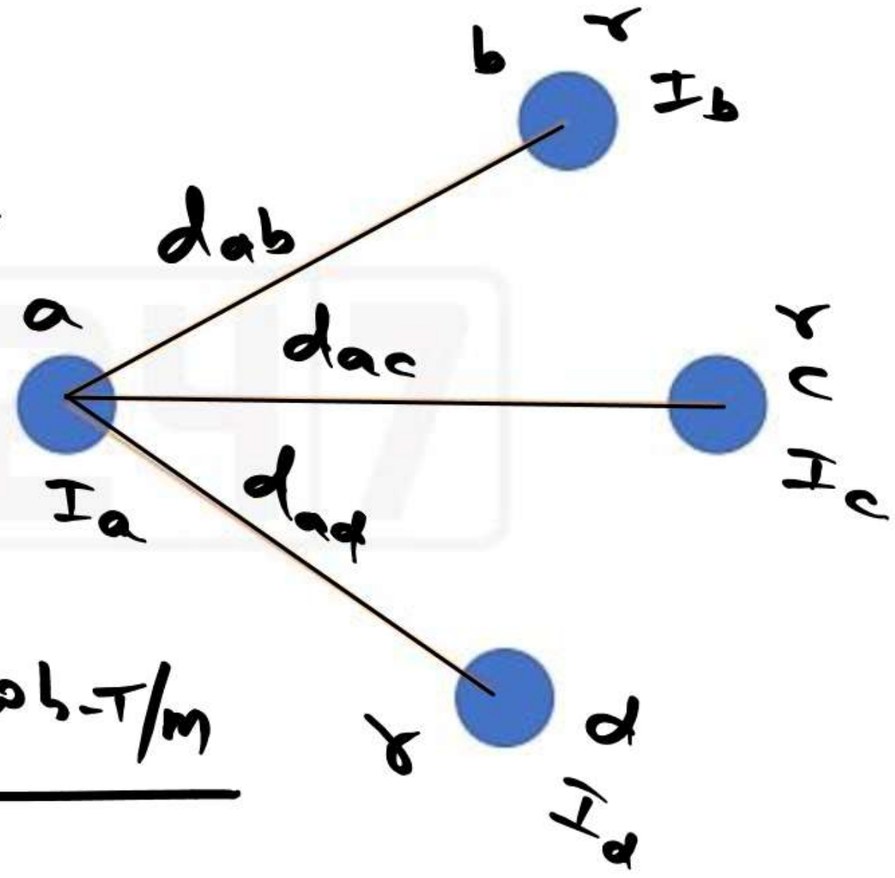
$$\Rightarrow L = 4 \times 10^{-7} \ln \frac{d}{r'} \text{ H/m}$$

loop inductance

flux linkage of conductor in a group of conductors:

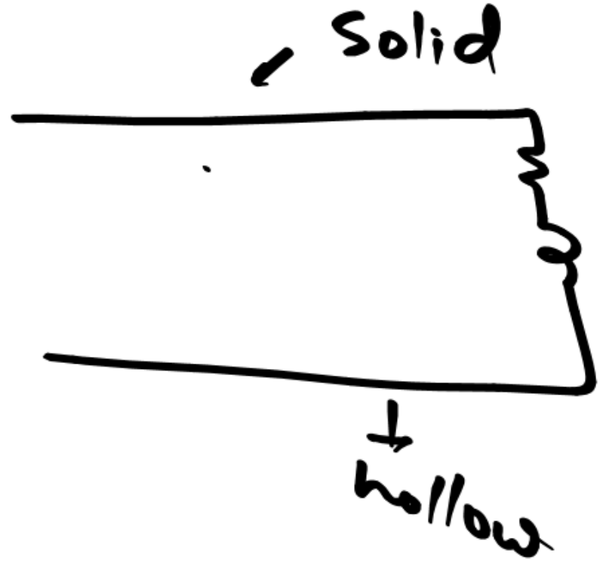
$$\lambda_a \to 2\times10^{-7}\left[I_a \ln\frac{1}{r'} + I_b \ln\frac{1}{d_{ab}} + I_c \ln\frac{1}{d_{ac}} + I_d \ln\frac{1}{d_{ad}}\right] \text{ wb-T/m}$$

$I_a + I_b + I_c + I_d = 0$



$$L = \left[\frac{\mu_0 \mu_r}{8\pi} + 2 \times 10^{-7} \ln \frac{d}{r} \right] \text{ H/m}$$

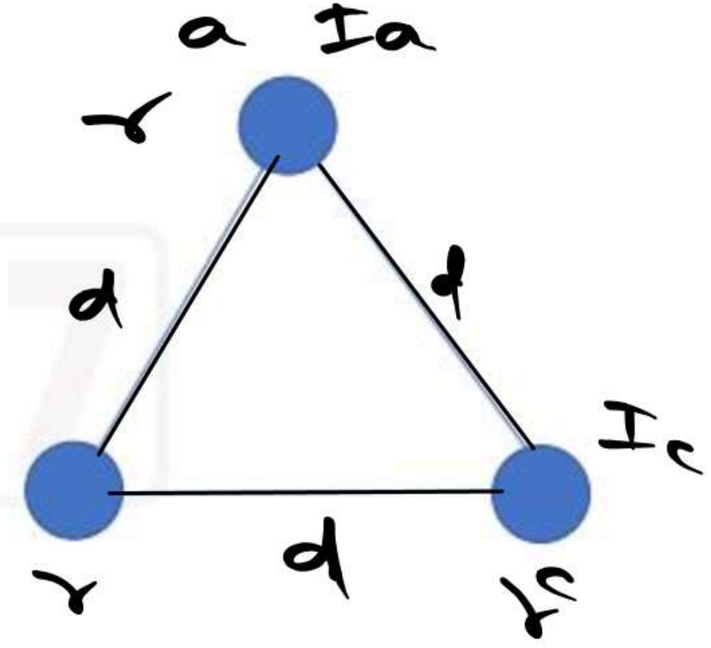
x



$$L = \left[2 \times 10^{-7} \ln \frac{d}{r_1} + 2 \times 10^{-7} \ln \frac{d}{r} \right]$$

Inductance of 3 phase system(symmetric):

$$\lambda_a = 2\times10^{-7}\left[I_a \cdot \ln\frac{1}{r'} + I_b \cdot \ln\frac{1}{d} + I_c \ln\frac{1}{d}\right]$$

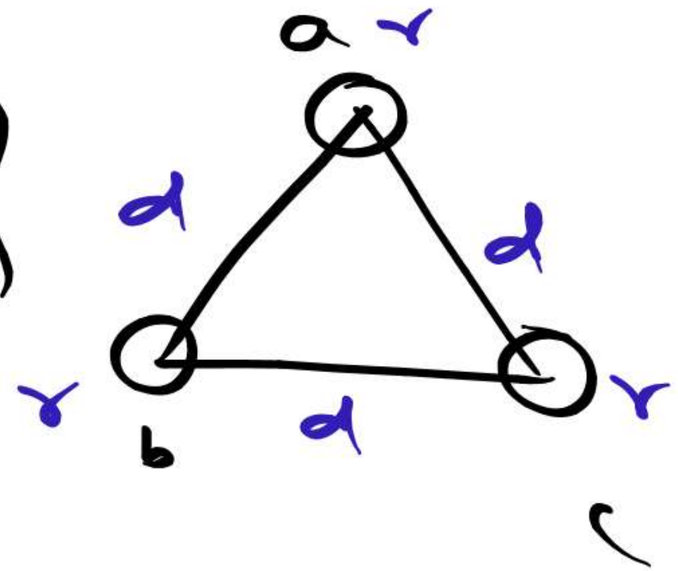


$$I_a + I_b + I_c = 0 \Rightarrow I_b + I_c = -I_a$$

$$\lambda_a = 2\times10^{-7}\left[I_a \ln\frac{1}{r'} - I_a \ln\frac{1}{d}\right] = 2\times10^{-7} \cdot I_a \ln\frac{d}{r'} \text{ wb-T/m}$$

$$\tau_a = 2 \times 10^{-7} I_a \cdot \ln \frac{d}{r_1} \quad \text{wb-T/m}$$

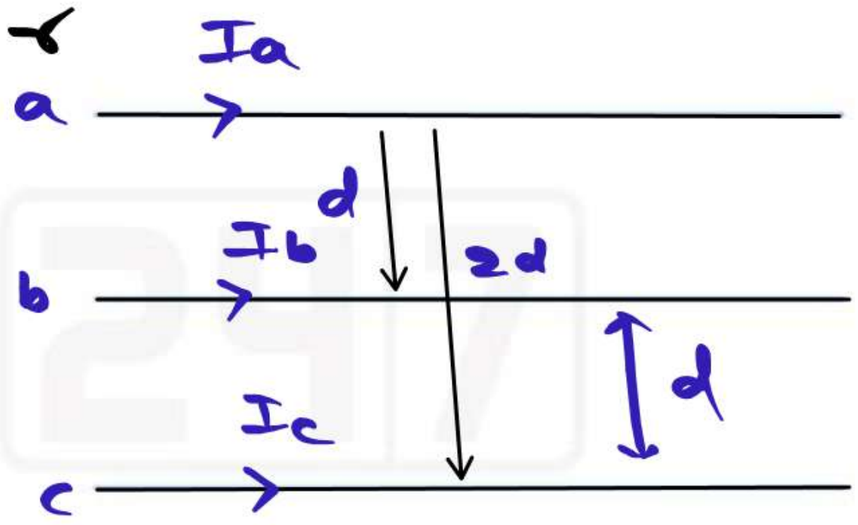
$$\left\{ L_a = 2 \times 10^{-7} \ln \frac{d}{r_1} \quad \text{H/m} \right\}$$



Inductance of 3 phase system(unsymmetric):

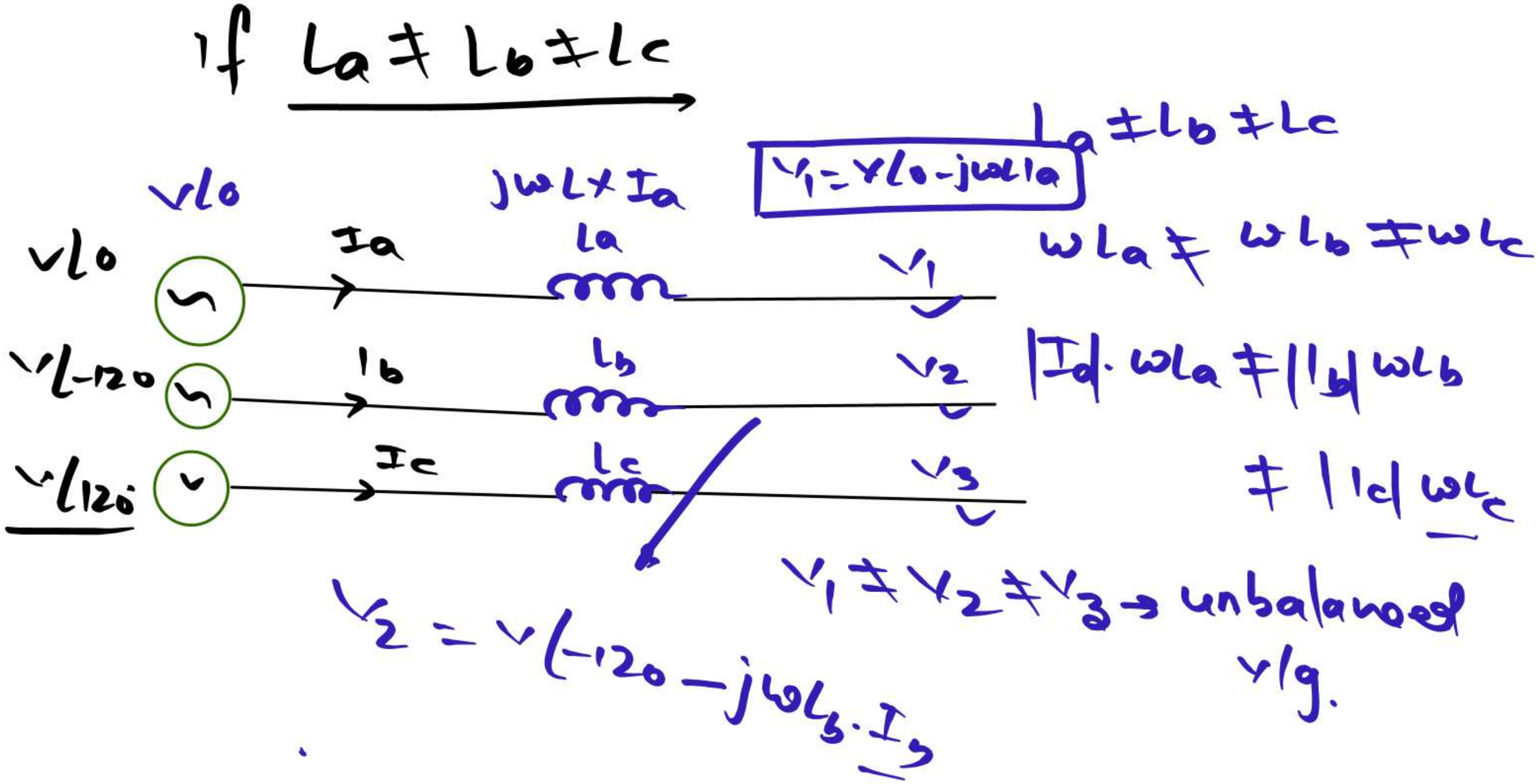
$$\lambda_a \rightarrow 2\times10^{-7}\left[I_a \ln\frac{1}{r_1} + I_b \ln\frac{1}{d} + I_c \ln\frac{1}{2d}\right]$$

$$\lambda_b = 2\times10^{-7}\left[I_b \ln\frac{1}{r_1} + I_a \ln\frac{1}{d} + I_c \ln\frac{1}{d}\right]$$

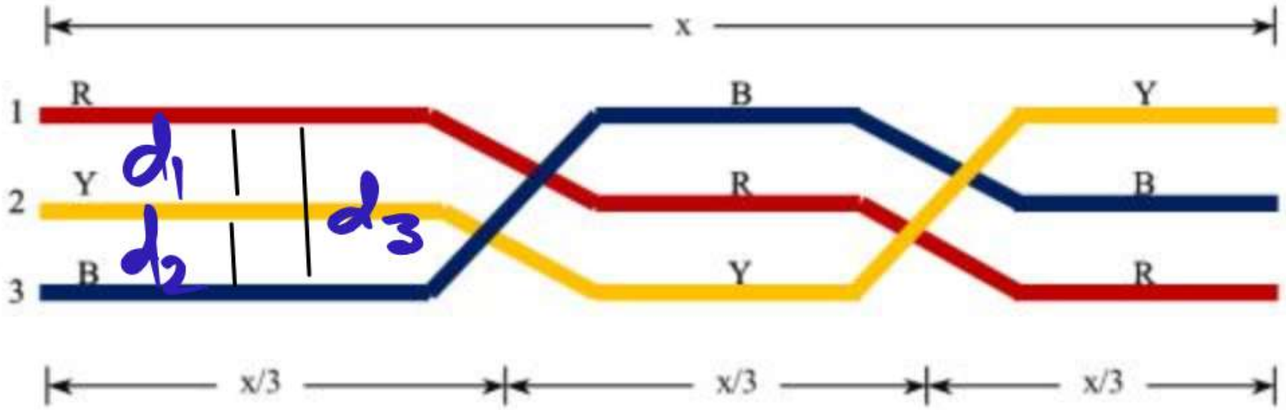


$\lambda_a \neq \lambda_b$

$\frac{\lambda_a}{I_a} \neq \frac{\lambda_b}{I_b} \Rightarrow L_a \neq L_b$

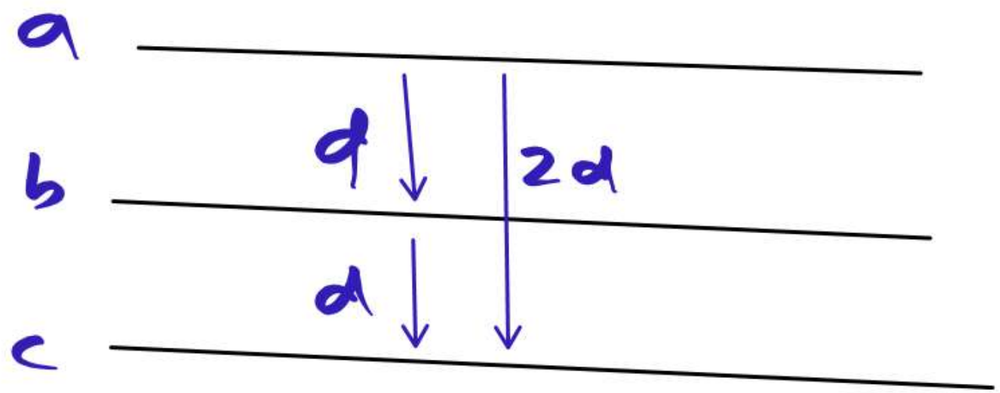

if La ≠ Lb ≠ Lc
Vl0
jωL × Ia
La ≠ Lb ≠ Lc
V1 = Vl0 - jωLIa
Vl0
Ia
La
V1
ωLa ≠ ωLb ≠ ωLc
Vl-120
Ib
Lb
V2
|Id| ωLa ≠ |Ib| ωLb
Vl120
Ic
Lc
V3
≠ |Ic| ωLc
V1 ≠ V2 ≠ V3 → unbalanced
V2 = Vl-120 - jωLb . Ib
Vlg.

Inductance of 3phase system(transposition):



$L_R = L_Y = L_B$

$L_R = L_Y = L_B = 2 \times 10^{-7} \ln \frac{(d_1 d_2 d_3)^{1/3}}{r'}$ H/m.

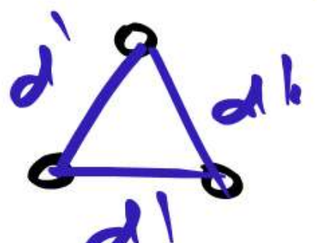


after transposition,

$L_a = L_b = L_c$

$$\left[L = 2\times10^{-7} \ln \frac{d \cdot 2^{1/3}}{r'} \text{ H/m} \right] = 2\times10^{-7} \ln \frac{(d \times d \times 2d)^{1/3}}{r'}$$

In case of symm. Conf.



$$L = 2 \times 10^{-7} \ln \frac{d'}{r'} \text{ H/m}$$

For the same value of inductance.

$$2 \times 10^{-7} \ln \frac{d'}{r'} = 2 \times 10^{-7} \ln \frac{2^{1/3} \cdot d}{r'}$$

$$d' = 2^{1/3} \cdot d = 1.26d$$

Bundled conductors(GMD/GMR):

TFS

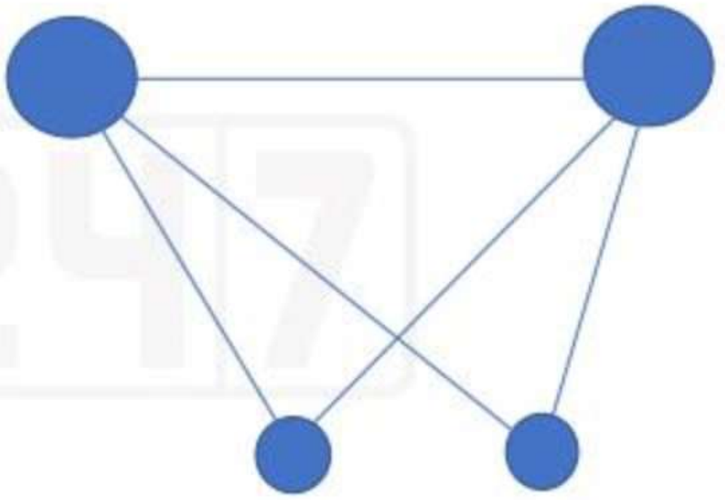
6 pm

N/w by Ravi Sir →

MTW

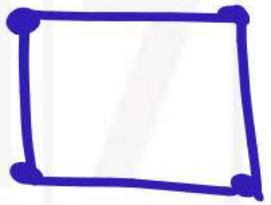
Bundled conductors(GMD/GMR):

Interference:



Topics to study in next lecture:

- bundled Cond^{2}
- Interference
- Capacitance



THANKS FOR

Watching

Adda247