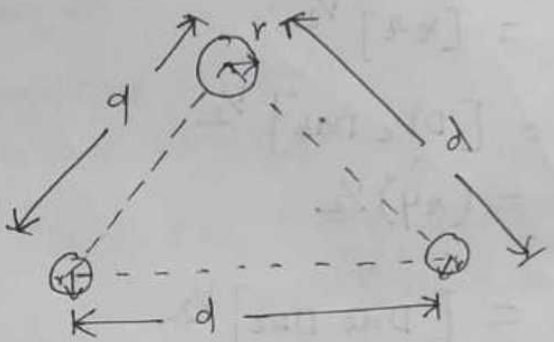
Three phase Transmission line :

⇒ Three phase conductor configuration

- ① symmetrical configuration
- → ② Asymmetrical configuration.

Symmetrical configuration

- The three conductor are placed at the corners of an equilateral triangle.



a-phase mutual b & c

GMD :→

$$D_{ma} = \left[D_{ab}\, D_{ac}\right]^{1/2} = D$$

$$D_{mb} = \left[D_{ab}\, D_{bc}\right]^{1/2} = D$$

$$D_{mc} = \left[D_{ac}\, D_{bc}\right]^{1/2} = D$$

GMR : $(GMRa)_a = (GMR)_b = (GMR)_c$

$= r'$

$$L_a = \frac{\mu_0}{2\pi} \ln \frac{GMD}{GMR}$$

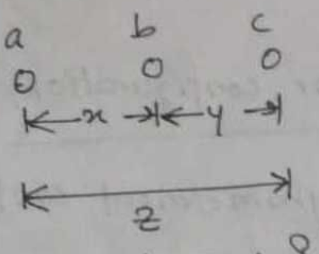
$$= \frac{\mu_0}{2\pi} \ln \frac{D}{r'}$$

$$L_b = L_c = \frac{\mu_0}{2\pi} \ln D/r'$$

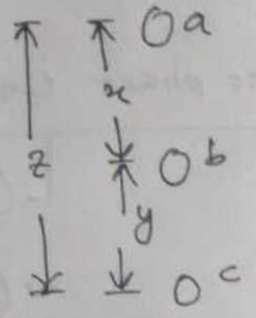
∴ Symmetrical $\boxed{L_a = L_b = L_c}$

Asymmetrical configuration

radius = r,



Horizontal spacing



Vertical spacing.

$$\therefore GMD = (GMD)_a = (D_m)_a$$

$$= [D_{ab} D_{ac}]^{1/2}$$

$$= [xz]^{1/2}$$

$$(D_m)_b = [D_{bc} D_{ab}]^{1/2}$$

$$= (xy)^{1/2}$$

$$(D_m)_c = [D_{ac} D_{bc}]^{1/2}$$

$$= (zy)^{1/2}$$

if radius 'r' is same in all phase, then –

$$(GMR)_a = (GMR)_b = (GMR)_c = r'$$

Therefore, inductance, $L = \frac{\mu_0}{2\pi} \ln \frac{GMD}{GMR}$

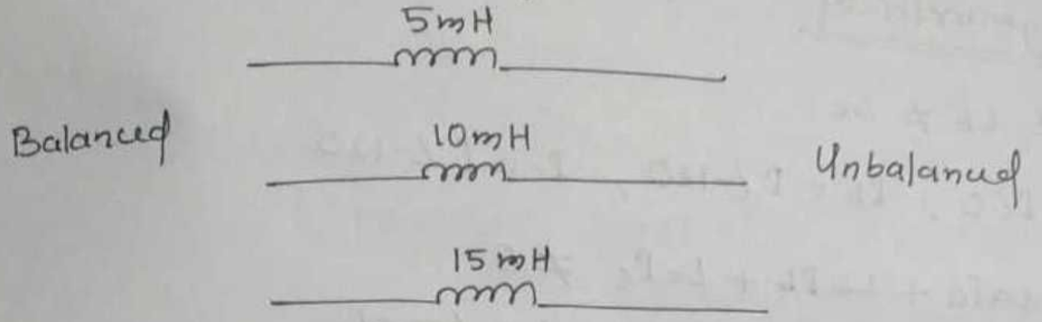
$$L_a = \frac{\mu_0}{2\pi} \ln \frac{D_{ma}}{r'}$$

$$L_b = \frac{\mu_0}{2\pi} \ln \frac{D_{mb}}{r'}$$

$$L_c = \frac{\mu_0}{2\pi} \ln \frac{D_{mc}}{r'}$$

Since, mutual GMD are unequal, ~~their~~ Their inductance are also unequal.

*. consider balanced voltage.



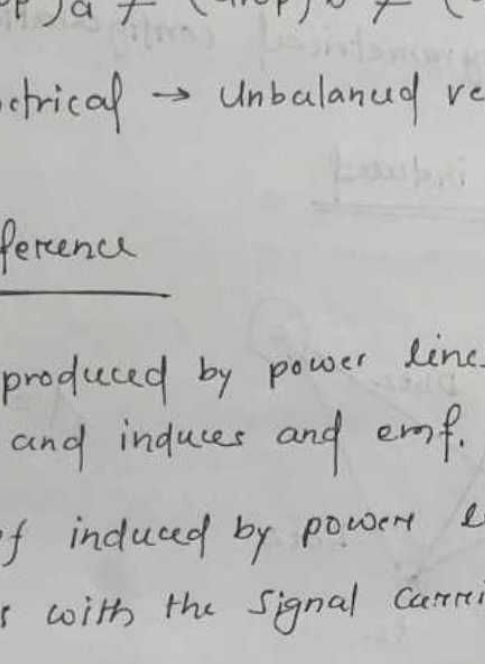
$$(\text{drop})_a \neq (\text{drop})_b \neq (\text{drop})_c$$

Asymmetrical → Unbalanced receiving end voltages

Radio Interference

⇒ The flux produced by power lines links the telephone conductors and induces and emf.

⇒ The emf induced by power line in Telephone line interferces with the signal carried by Telephone conductors.



Faraday's law ⇒ emf.

⇒ Symmetrical and Asymmetrical

symmetrical:

$L_a = L_b = L_c$

$I_a = I\angle 0$

$I_b = I\angle -120$

$I_c = I\angle 120$

$\psi = LI$

$\psi = L_a I_a + L_b I_b + L_c I_c$

$= L(I_a + I_b + I_c)$

$= 0$, emf $= 0$,

⇒ so, symmetrical does not cause any Disturbance.

Asymmetrical

$La \neq Lb \neq Lc$

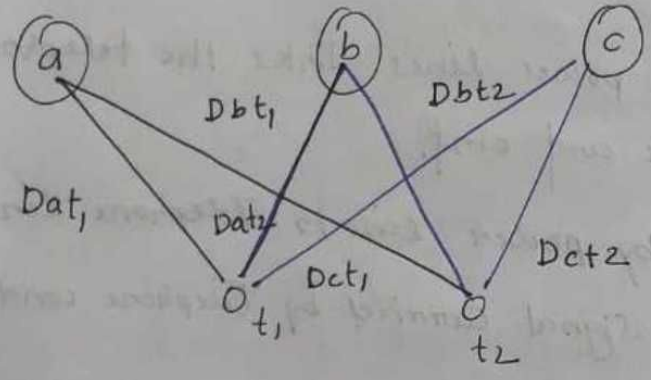
$Ia = I\angle 0 \,,\; Ib = I\angle{-120} \,,\; Ic = I\angle{-120}$

$\psi = LaIa + LbIb + LcIc \neq 0$

$e \neq 0$ ~~[illegible]~~

⇒ Radio interference in asymmetrical configuration.

EMF induced



$$\lambda = \frac{\mu_0}{2\pi} \sum_{j=1}^{n} Ij \ln \frac{1}{Dij}$$

$$\lambda_{t1} = \frac{\mu_0}{2\pi} \left[\vec{I}a \ln \frac{1}{Dat_1} + \vec{I}b \ln \frac{1}{Dbt_1} + \vec{I}c \ln \frac{1}{Dct1} \right]$$

$$\lambda_{t_2} = \frac{\mu_0}{2\pi} \left[\vec{I}a \ln \frac{1}{Dat2} + \vec{I}b \ln \frac{1}{Dbt_2} + \vec{I}c \ln 1/Dct_2 \right]$$

$$e = -\frac{d\lambda}{dt} \,,\quad e = -j\omega\lambda$$

⇒ '$-j$' emf lags λ by 90°

$$e_1 = -j\omega\lambda_{t_1} \,,\quad e_2 = -j\omega\lambda t_2$$

$$e_{net} = e_1 - e_2$$

$$= -j\omega(\lambda t_1 - \lambda t_2)$$

$$\lambda = \lambda t_1 - \lambda t_2$$

$$\lambda = \frac{\mu_0}{2\pi}\left[I_a \ln \frac{D_{at2}}{D_{at1}} + I_b \ln \frac{D_{bt2}}{D_{bt1}} \right] \quad \because \log(a-b) = \log(a/b)$$

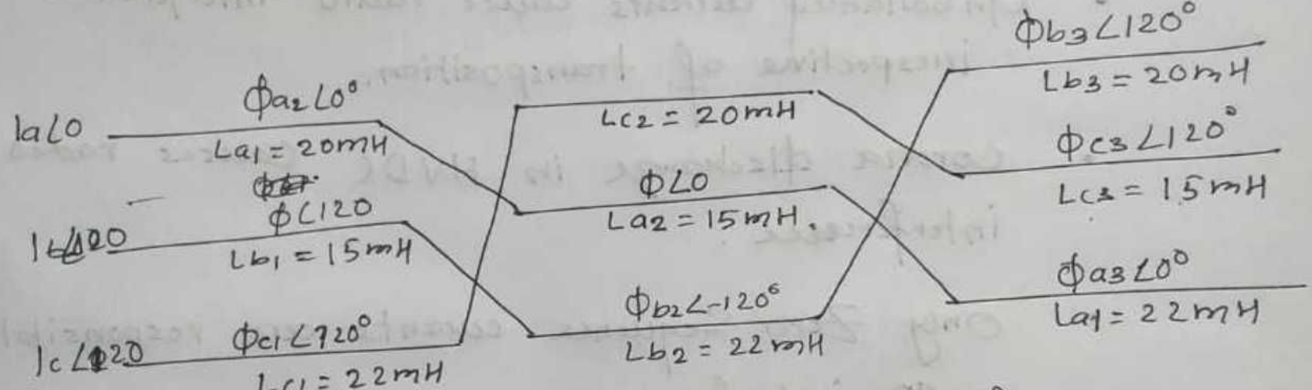
λ = determined

$M = \frac{\lambda}{I}$ M = mutual inductance

I = rms current carried by power line

$E = \omega\lambda$ = emf.

Transposition



⇒ change their position at regular interval.

L → GMD, GMR
↓ radius.
↓ conductor position

⇒ L = f(GMD, GMR)

GMR = r'

GMD = depends on conductor position.

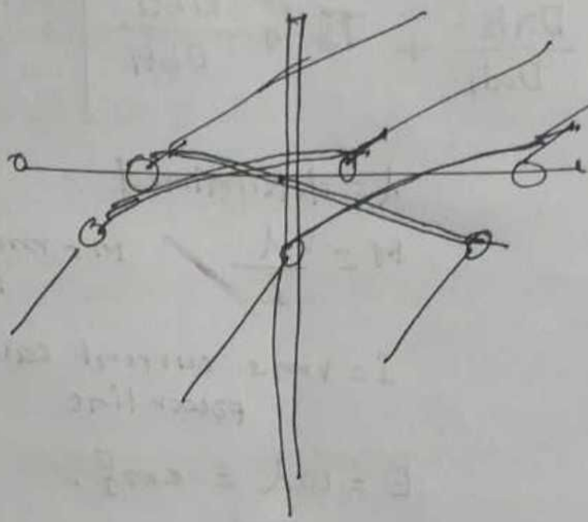
⇒ inductance does not depend on the phase current it depends on position of the conductor.

$\phi_a = 20mH\, I_a + 15mH\, I_a + 22mH\, I_a$

$L = 20mH + 15mH + 22mH$

$= 57mH$

$\boxed{L_b = L_c = L_a.}$



after ICM.

Unbalanced currents

- Unballanced currents cause radio interference irrespective of transposition.
- Corona discharge in HVDC causes radio interference.
- Only Zero Sequence currents are responsible for radio interference.