mmf method (Ampere-turn method)

→ It is based on the concept of replacing the effect of Armature leakage reactance by an equivalent additional armature reaction mmf so that this mmf may be combined with armature reaction mmf F_{ar}

$$\bar{F}_r = \bar{F}_f + \bar{F}_{ar} \quad \text{——— (1)}$$

$$\bar{V}_t = \underbrace{\bar{E}_r - j\bar{I}_a X_l}_{\bar{E}_r'} \mp \bar{I}_a R_a$$

or, $$\bar{V}_t = \bar{E}_r' - \bar{I}_a R_a \quad \text{— (2)}$$

where $$\bar{E}_r' = \bar{E}_r - j\bar{I}_a X_l \quad \text{— (3)}$$

we can write.

$$\bar{E} = -jK\bar{F}$$

Similarly for leakage reactance voltage drop

$$-j\bar{I}_a X_l = -jK\bar{F}_{al}$$

$\bar{F}_{al}$ → equivalent mmf.

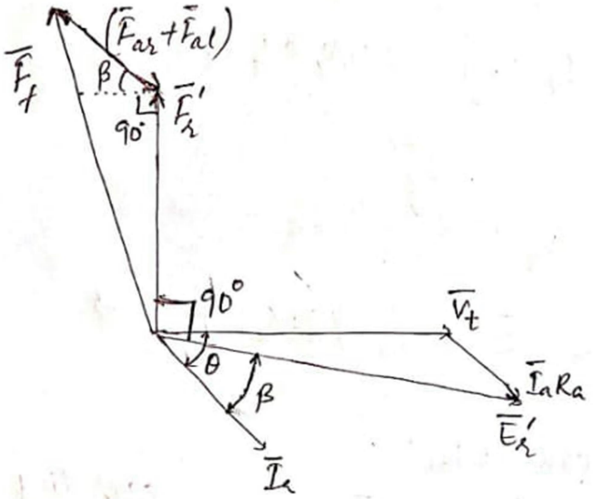
operating point is considered to lie on air gap line

Similarly eqn 3 can be written in equivalent mmf eqn.

$$\bar{F}_r' = \bar{F}_r + \bar{F}_{al} \quad \Big| \; -jK \text{ cancels out.}$$

$$\Rightarrow \bar{F}_r = \bar{F}_f + (\bar{F}_{ar} + \bar{F}_{al})$$

$\bar{F}_{ar}$ and $\bar{F}_{al}$ are in phase with $\bar{I}_t$.

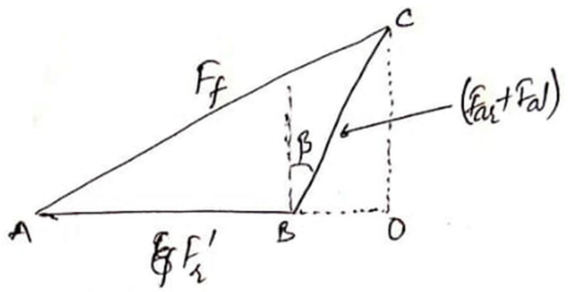


Phasor diagram of mmf method.

Under short circuit at rated current I_{sc}(rated), the field excitation is consumed in balancing armature reaction mmf and the balance induces emf to balance I_{sc}(rated) X_l voltage drop.

I_f at rated SC current $= I_{f,ar} + I_{f,al}$

$\bar{F}_f$ can be found by drawing mmf phasor diagram to scale



$$F_f = \sqrt{(AB + BC\sin\beta)^2 + (BC\cos\beta)^2} \quad \text{— (4)}$$

Steps to compute voltage Regulation.

1. For V_t and I_a both at rated value and specified Pf. find E_r'
2. From OCC find F_r'
3. From SCC at rated current Find $(F_{ar} + F_{al})$
4. From mmf phasor diagram or eqn (4) determine F_f
5. From OCC find $E_f = V_t$ (no load)
6. compute voltage Regulation