$$\text{fault} \Rightarrow \begin{cases} \text{1 line to ground} \\ \text{2 lins to grand} \\ \text{1 line to 1 line} \\ \text{3 lines together} \end{cases}$$

$$\text{open} \begin{cases} \text{1 conductor open} \\ \text{2 conductor open} \end{cases}$$

---

load current $\ll$ fault current $\Rightarrow$

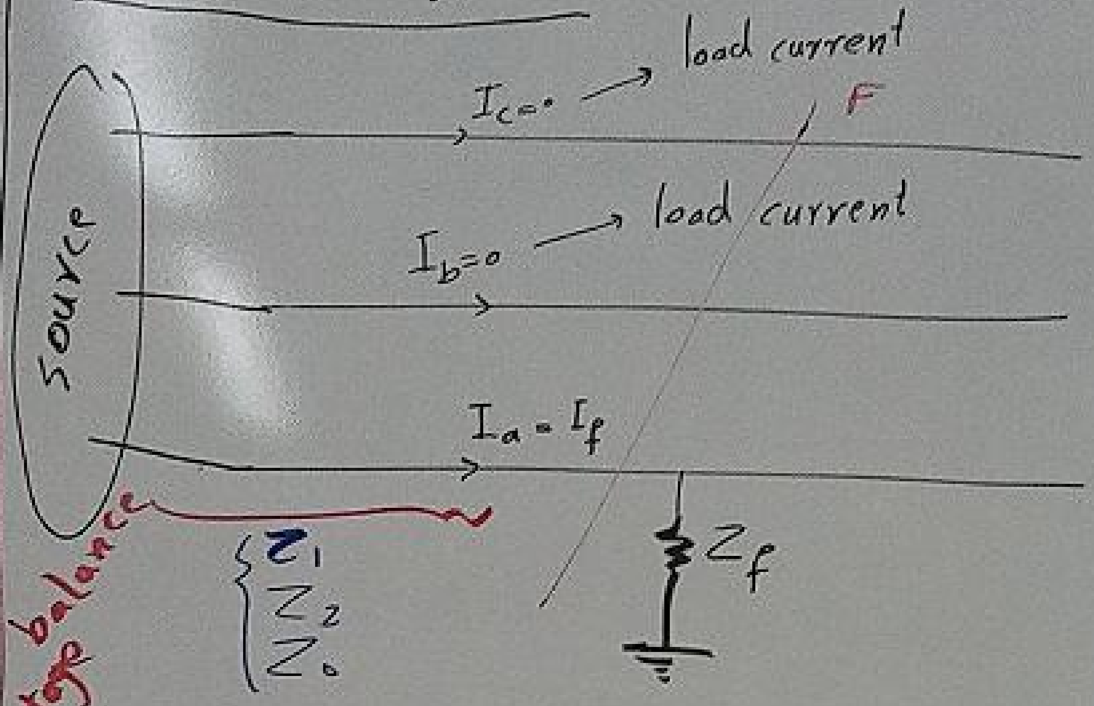
$\boxed{\text{omit load current}}$

$V_{source} \leftarrow \boxed{\text{no change}}$

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} V_0 + V_1 + V_2 \\ - \quad - \\ - - - \end{bmatrix}$$

1 line to ground

70%



$F: \left\{ V_a, V_b, V_c \right.$ unbalance

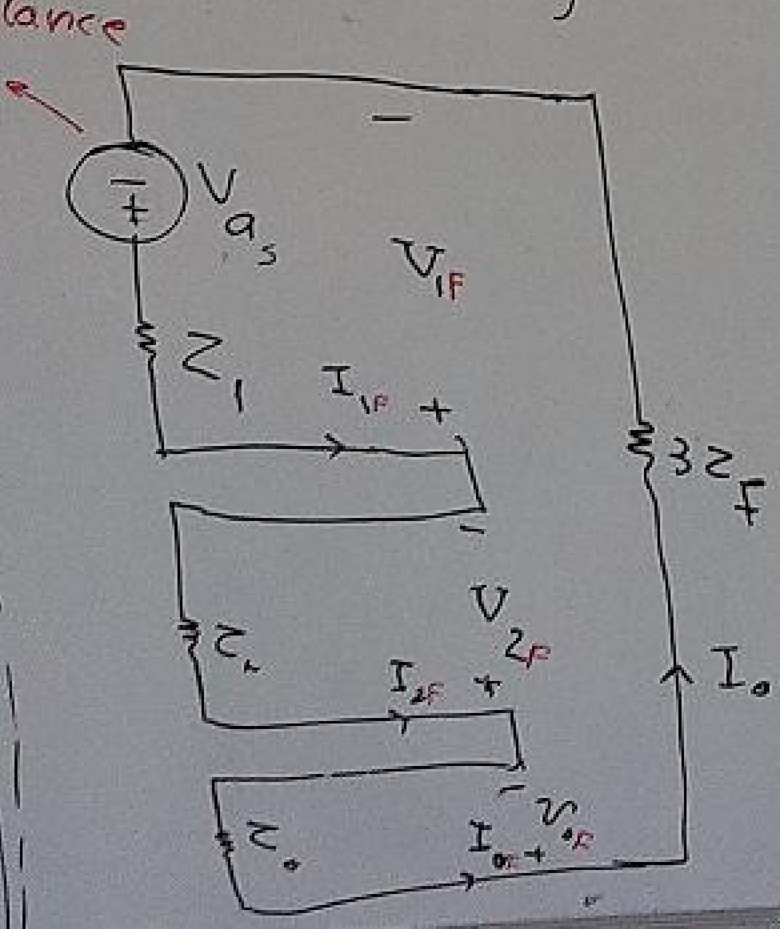
faulted phase $\equiv a$

$$V_a = Z_f I_a$$

$$\begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix} \begin{bmatrix} I_a \\ 0 \\ 0 \end{bmatrix} = \frac{1}{3} \begin{bmatrix} I_a \\ I_a \\ I_a \end{bmatrix}$$

$$\left. \begin{aligned} & I_0 = I_1 = I_2 = \tfrac{1}{3} I_a \\ & V_a = V_0 + V_1 + V_2 \\ & V_0 + V_1 + V_2 = 3 Z_f I_f \end{aligned} \right\} \Rightarrow \begin{aligned} & I_0 = I_1 = I_2 \\ & V_a = V_0 + V_1 + V_2 \end{aligned}$$

balance



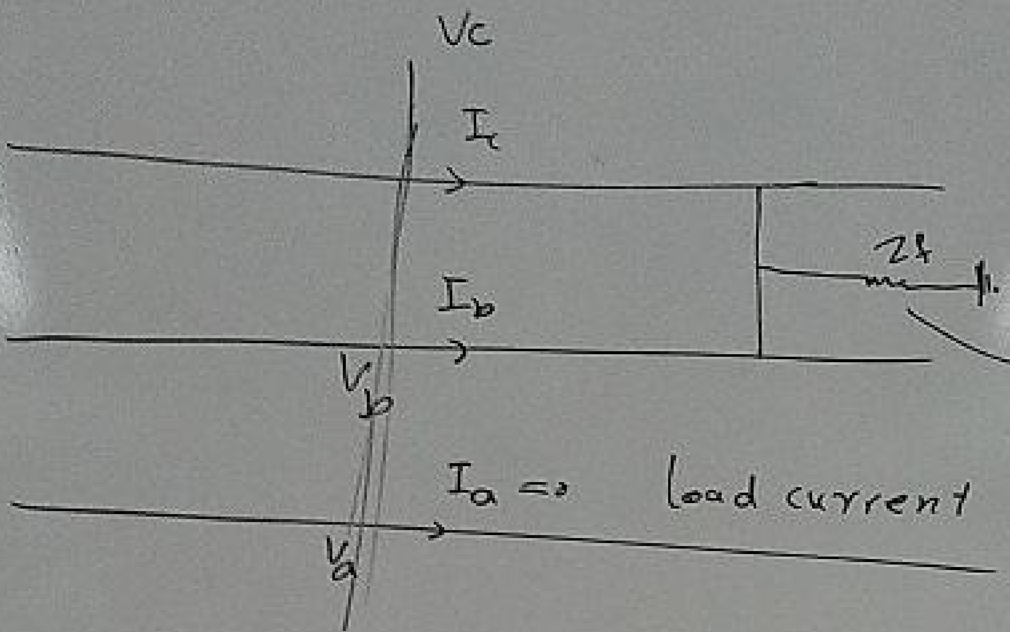
$$I_0 = I_1 = I_2 = \frac{V_a}{Z_1 + Z_2 + Z_0 + 3Z_f}$$

$$I_a = \frac{3 V_a}{Z_1 + Z_2 + Z_0 + 3Z_f}$$

$$\left\{ \begin{aligned} V_1 &= V_a - Z_1 I_1 \\ V_2 &= - Z_2 I_2 \\ V_0 &= - Z_0 I_0 \end{aligned} \right. \Rightarrow \left\{ \begin{aligned} & V_a \\ & V_b \\ & V_c \end{aligned} \right.$$

2 lines to ground

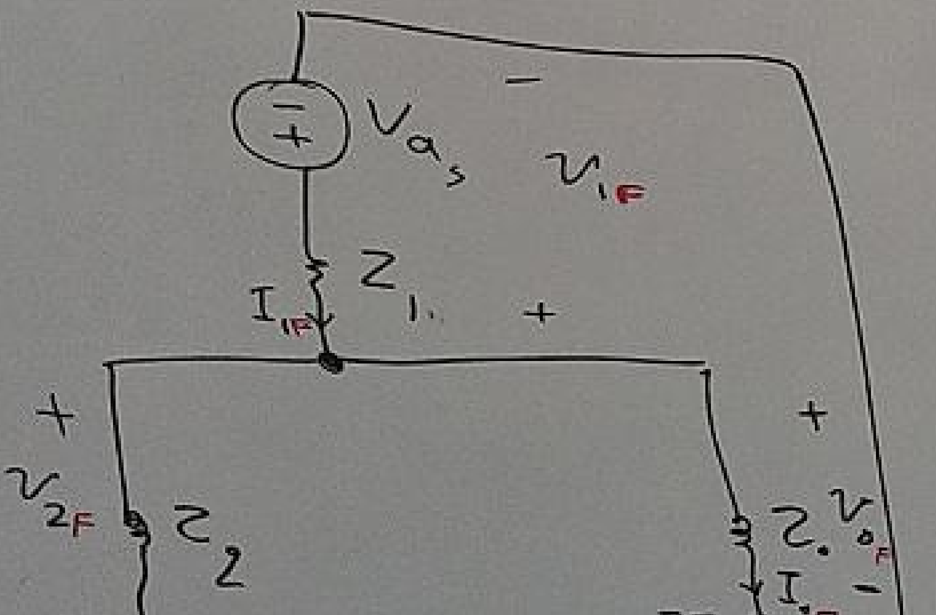
1.7



Normal phase $\equiv a$

$$V_c = V_b = Z_f (I_b + I_c)$$

$$\begin{cases} I_1 + I_2 + I_0 = 0 \\ v_1 = v_2 , \quad v_0 = v_1 + 3Z_0 I_0 \end{cases}$$



I_0 . . . –

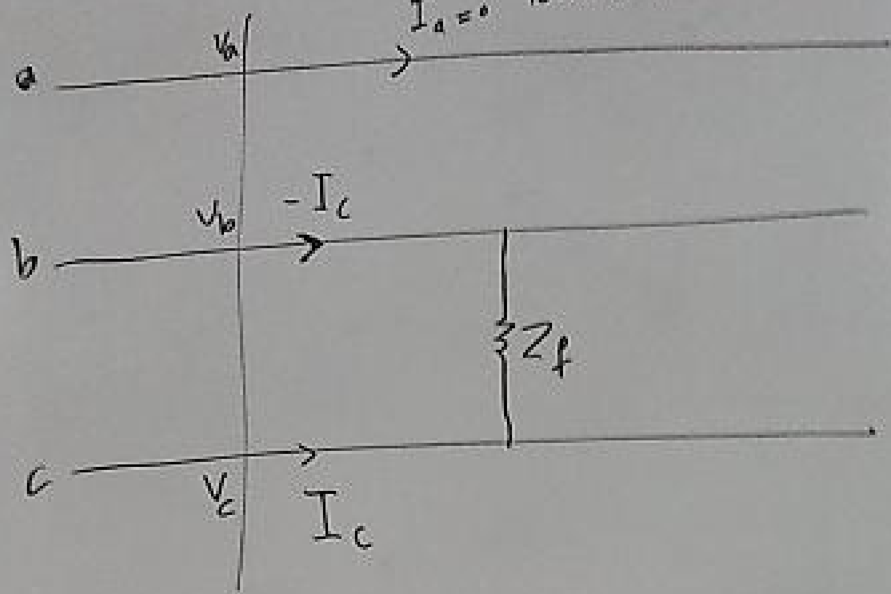
I_1 . . –

– .

v_1 . . . .

15/.

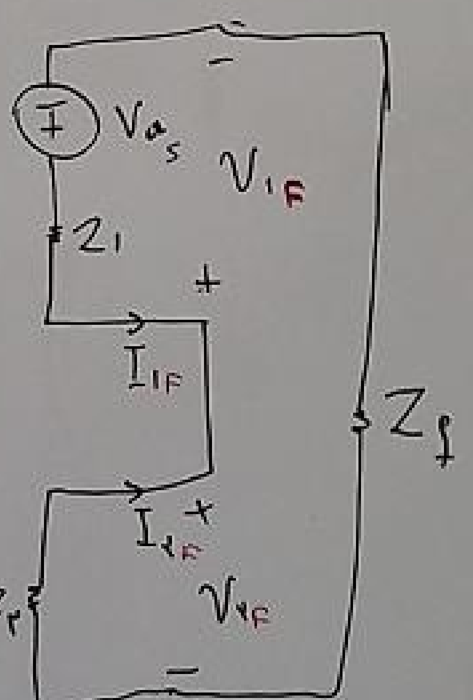
1 line to 1 line



Normal phase ≡ a

$$V_c - V_b = Z_f I_c \quad , \quad I_b = -I_c$$

$$\begin{cases} I_0 = 0 \quad , \quad I_2 = -I_1 \\ V_1 - V_2 = Z_f I_1 \quad , \quad V_1 = V_2 \end{cases}$$



I_0

I_1 —

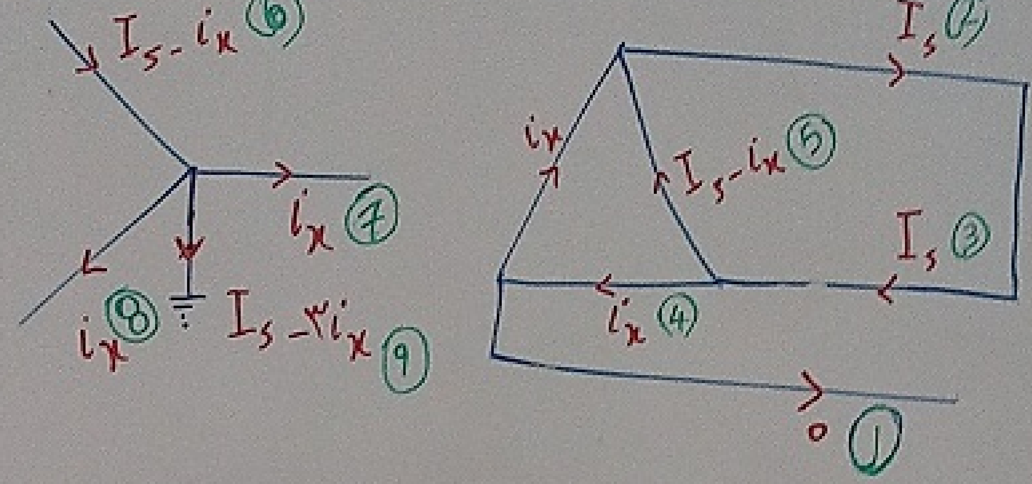
V_1

V_2 —

V_a —

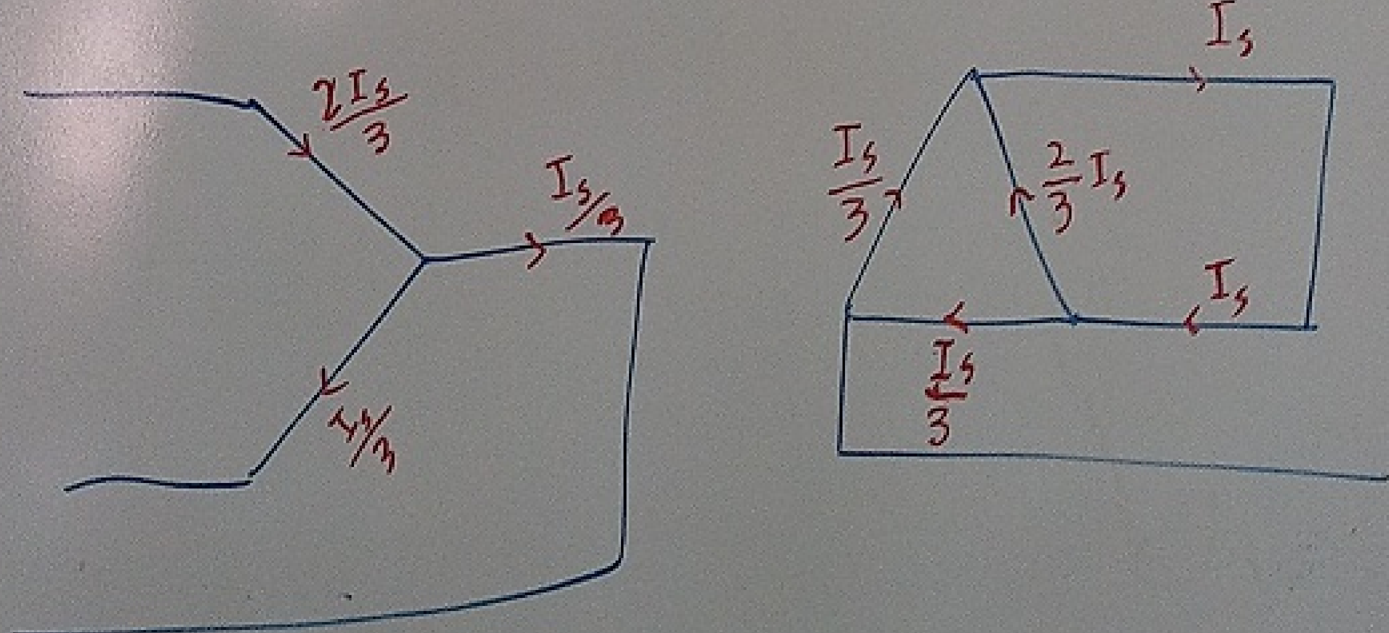
V_b

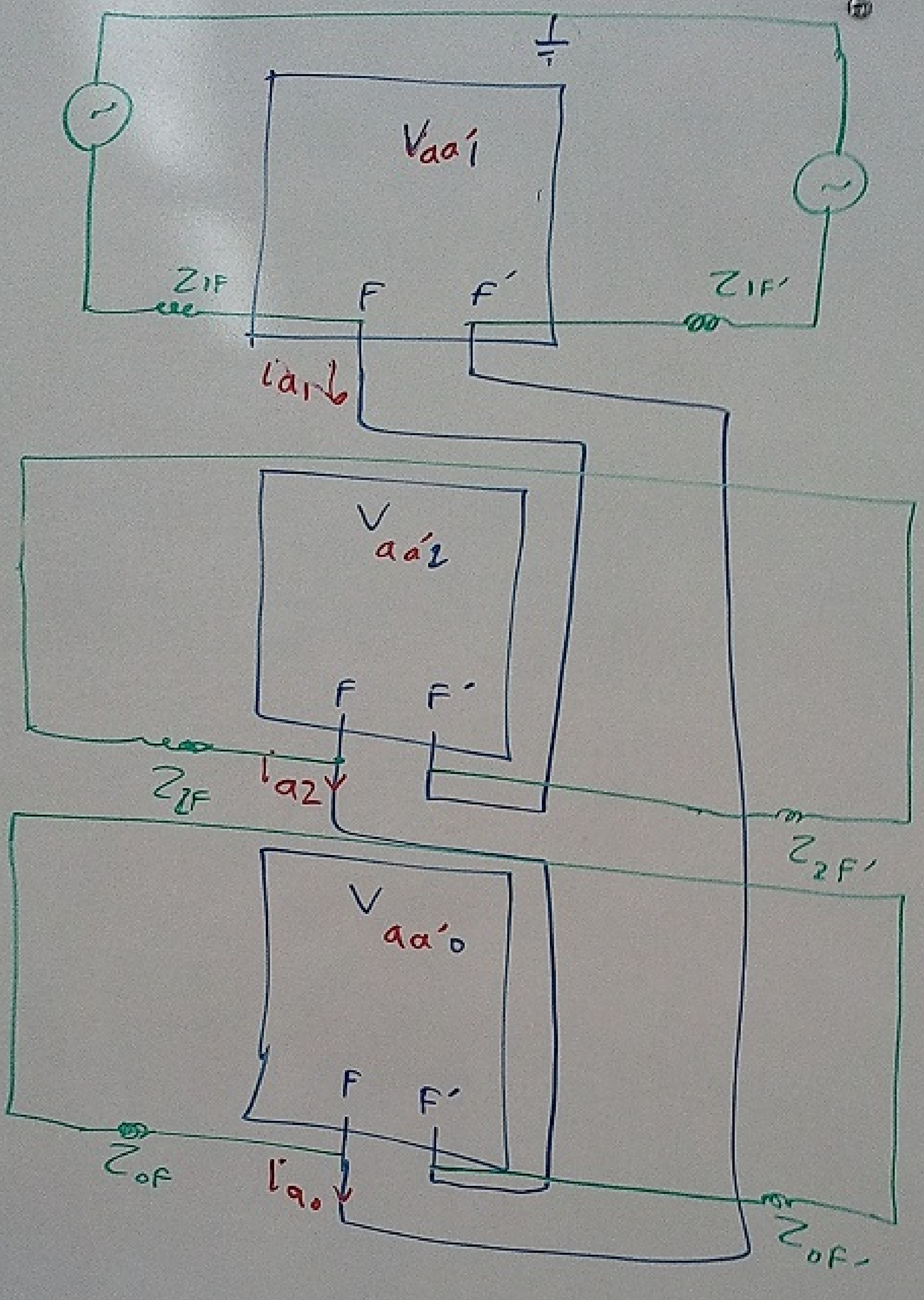
2 phase fault for Y-Δ transformer



minimum reluctance $\Longrightarrow \sum \phi = 0 \Longrightarrow$

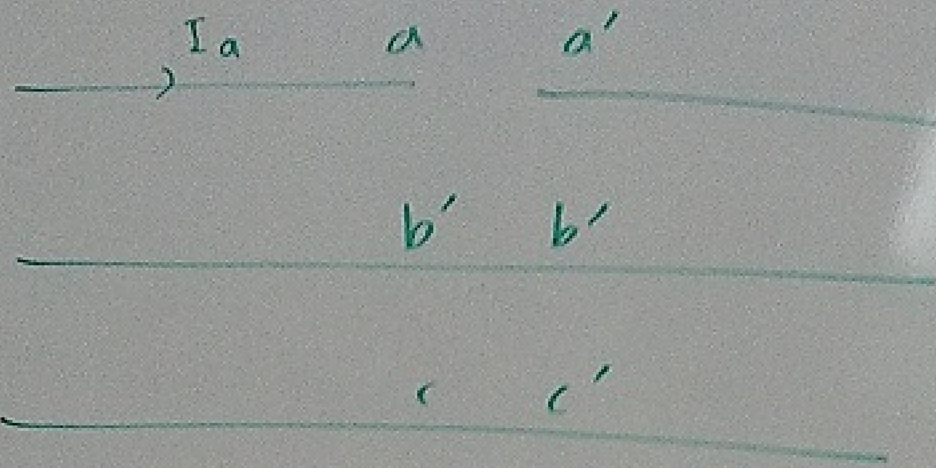
$$I_s - ۳ i_x = 0 \Longrightarrow i_x = \frac{I_s}{۳} \quad (10)$$





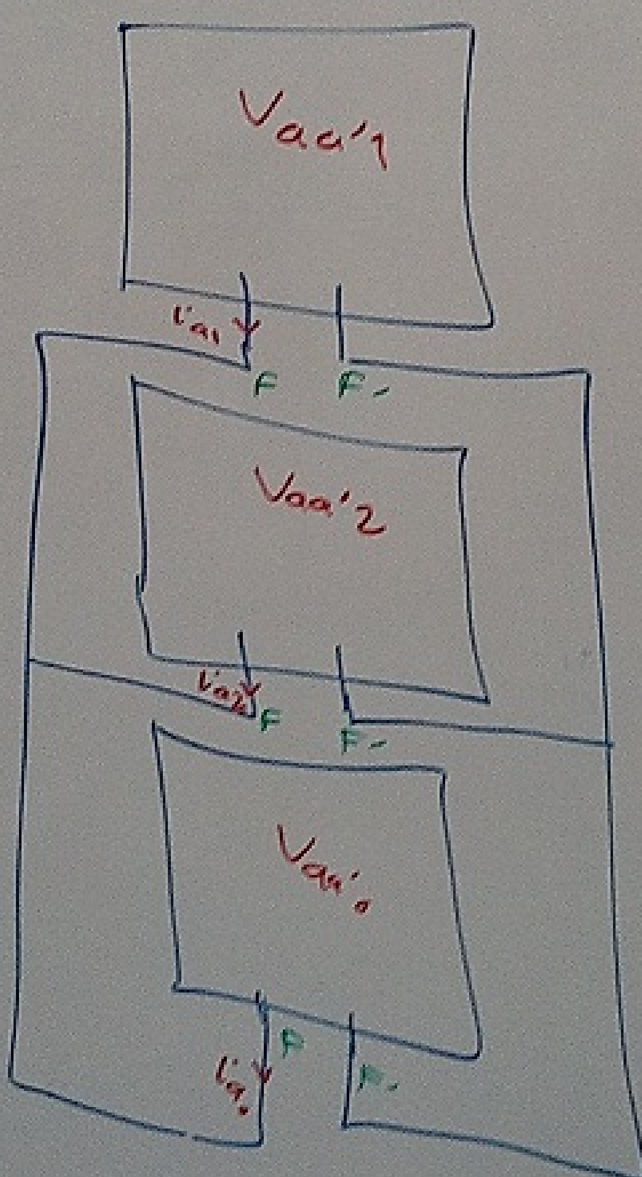
Vaa'1
Z1F
F
F'
Z1F'
ia1
Vaa'2
F
F'
Z2F
ia2
Z2F'
Vaa'0
F
F'
Z0F
ia0
Z0F'

one conductor opens:



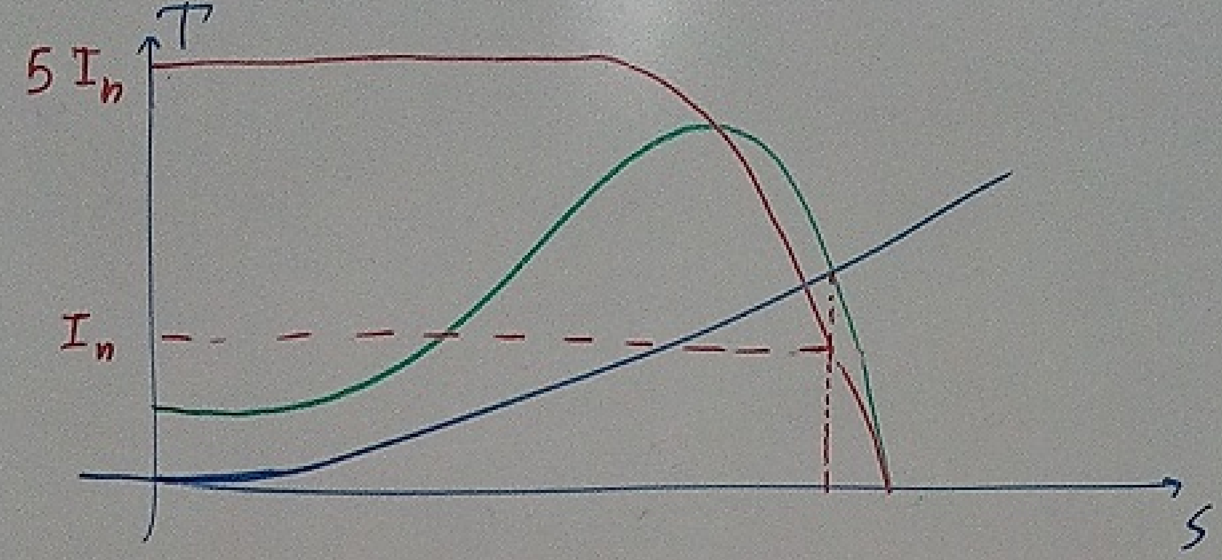
$$I_a = 0 \Rightarrow I_{a0} + I_{a1} + I_{a2} = 0$$

$$V_{bb'} = V_{cc'} = 0 \Rightarrow V_{aa'0} = V_{aa'1} = V_{aa'2}$$



motor starting:

induction motor graph:



direct connection

with driver

⇓

a set of power electronic switches & controling instruments

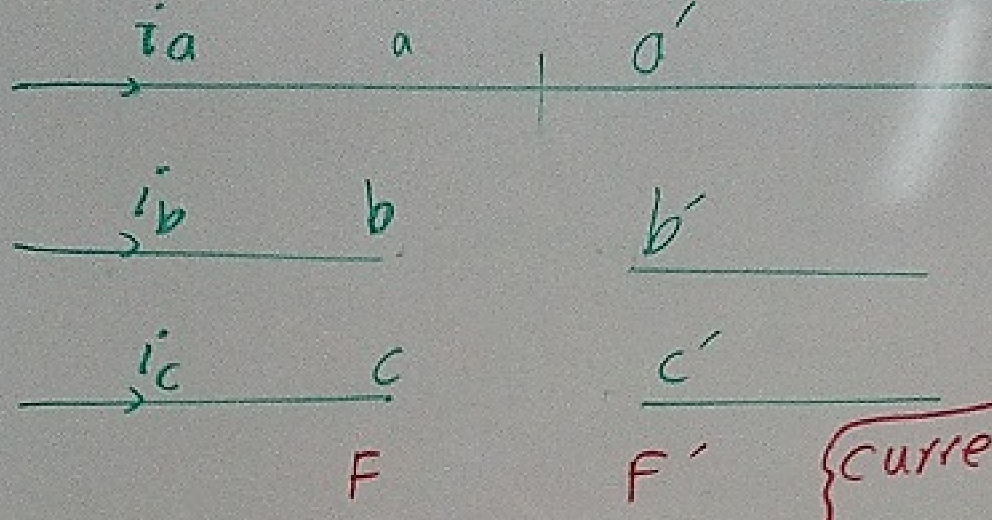
2 type ⇒ single (uni-) direction ⇒ give active power to motor

double (bi-) direction ⇒ give active power motor & give active power to grid

in s.c. condition behave similar to generator open conductor:

two-conductor open

two conductors open



current: $\cancel{I_{load}}$, I''_{sc}

current of the faulted line is high (X', X'')

difference between $\begin{cases} \text{to ground} \\ \text{open conductor} \end{cases}$

current: load, 0

no $\cancel{X', X''}$

$$\begin{cases} V_{aa'} = 0 \\ I_b = I_c = 0 \end{cases} \Longrightarrow \begin{cases} V_{aa'0} + V_{aa'1} + V_{aa'2} = 0 \\ I_{a0} = I_{a1} = I_{a2} = \frac{1}{3} I_a \end{cases}$$

based phasor is "a" i.e. $\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix}$