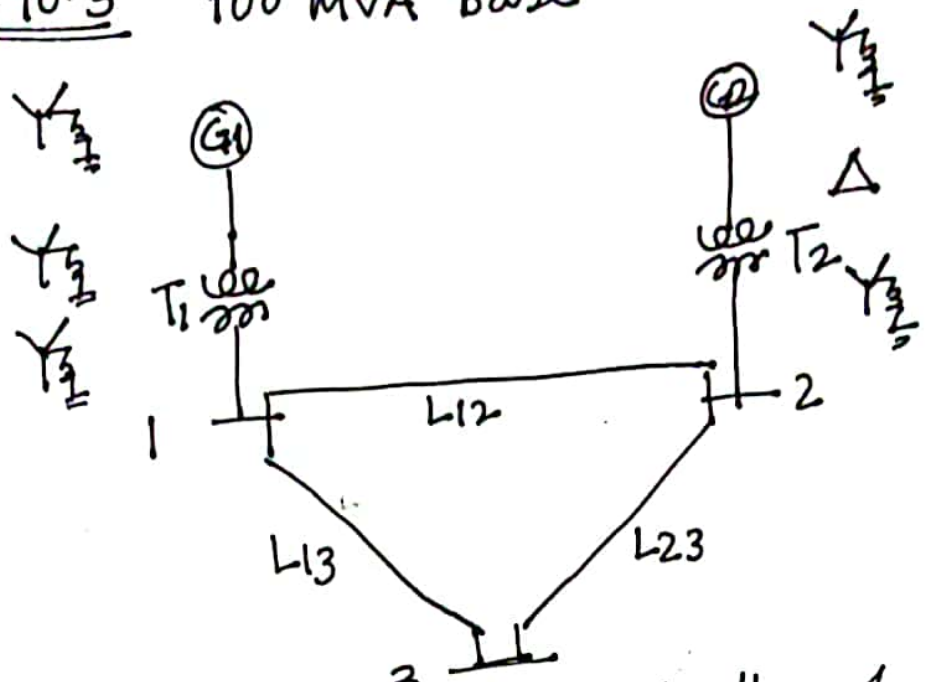
8 April 21
MC-A Eve

Ex. 10.5 100 MVA base



Zero-seq

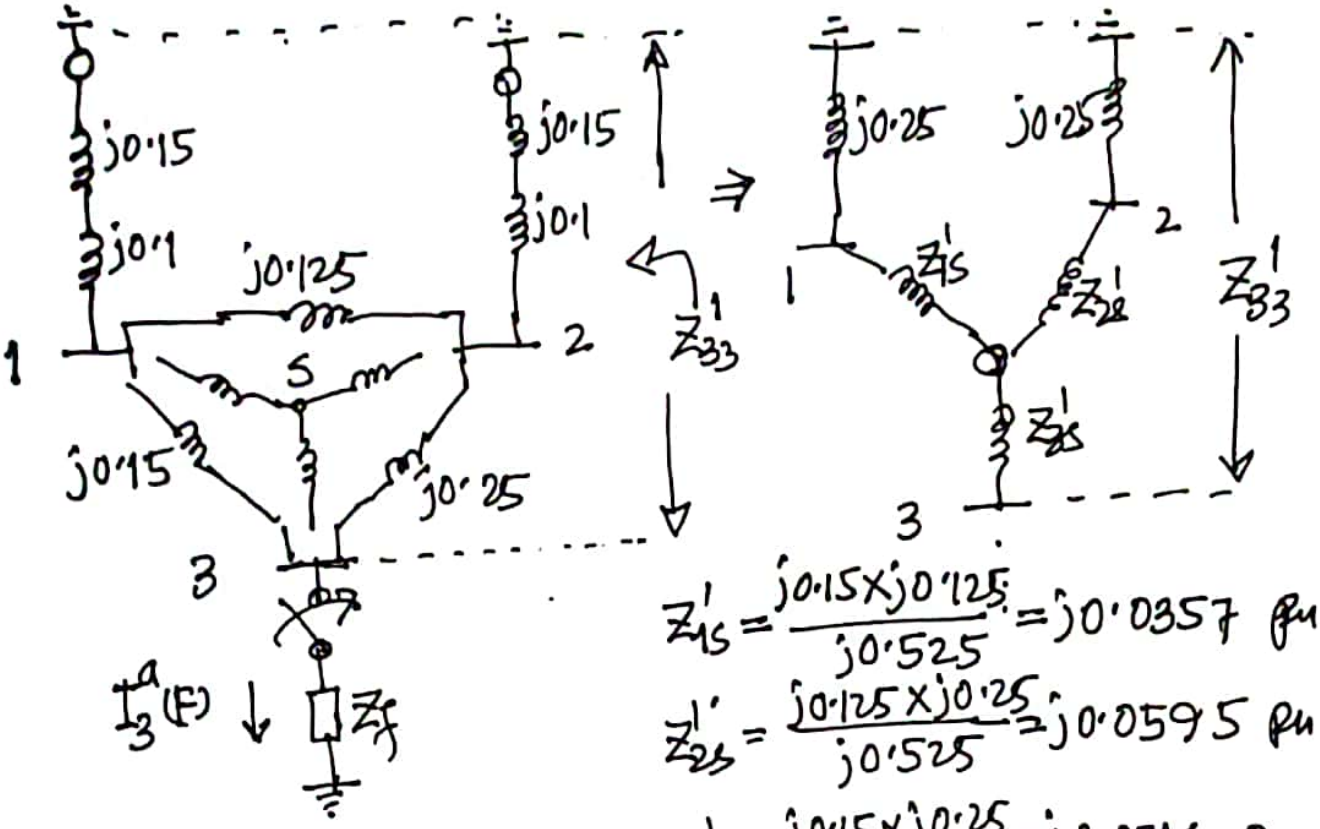
Each generator is grounded through a reactor of 0.25/3 pu. Fault impedance, $Z_f = j0.1$ pu.
Calculate- fault current for

① 3-ϕ balanced fault at bus 3
② L-G fault at bus 3
③ L-L fault at bus 3
④ L-L-G fault at bus 3

Request
H.W.
Bus 1
Bus 2

Solution:

Positive sequence impedance network



$$Z_{1s}^1 = \frac{j0.15 \times j0.125}{j0.525} = j0.0357 \text{ pu}$$

$$Z_{2s}^1 = \frac{j0.125 \times j0.25}{j0.525} = j0.0595 \text{ pu}$$

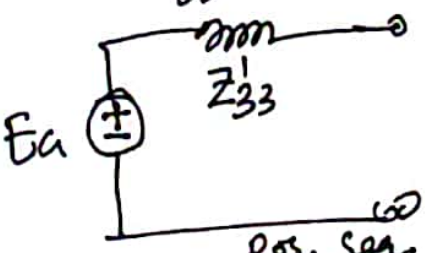
$$Z_{3s}^1 = \frac{j0.15 \times j0.25}{j0.525} = j0.0714 \text{ pu}$$

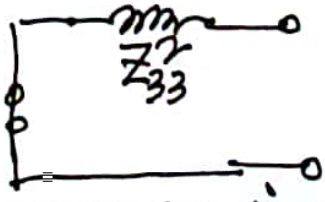
Thevenin's equivalent impedance

$$Z_{33}^1 = Z_{3s}^1 + (j0.25 + Z_{1s}^1) \parallel (j0.25 + Z_{2s}^1)$$
$$= j0.0714 + (j0.2857 \parallel j0.3095)$$
$$= j0.0714 + j0.1486 = j0.22 \text{ pu.}$$

Since, the negative sequence impedance of each element is same as positive sequence impedance.

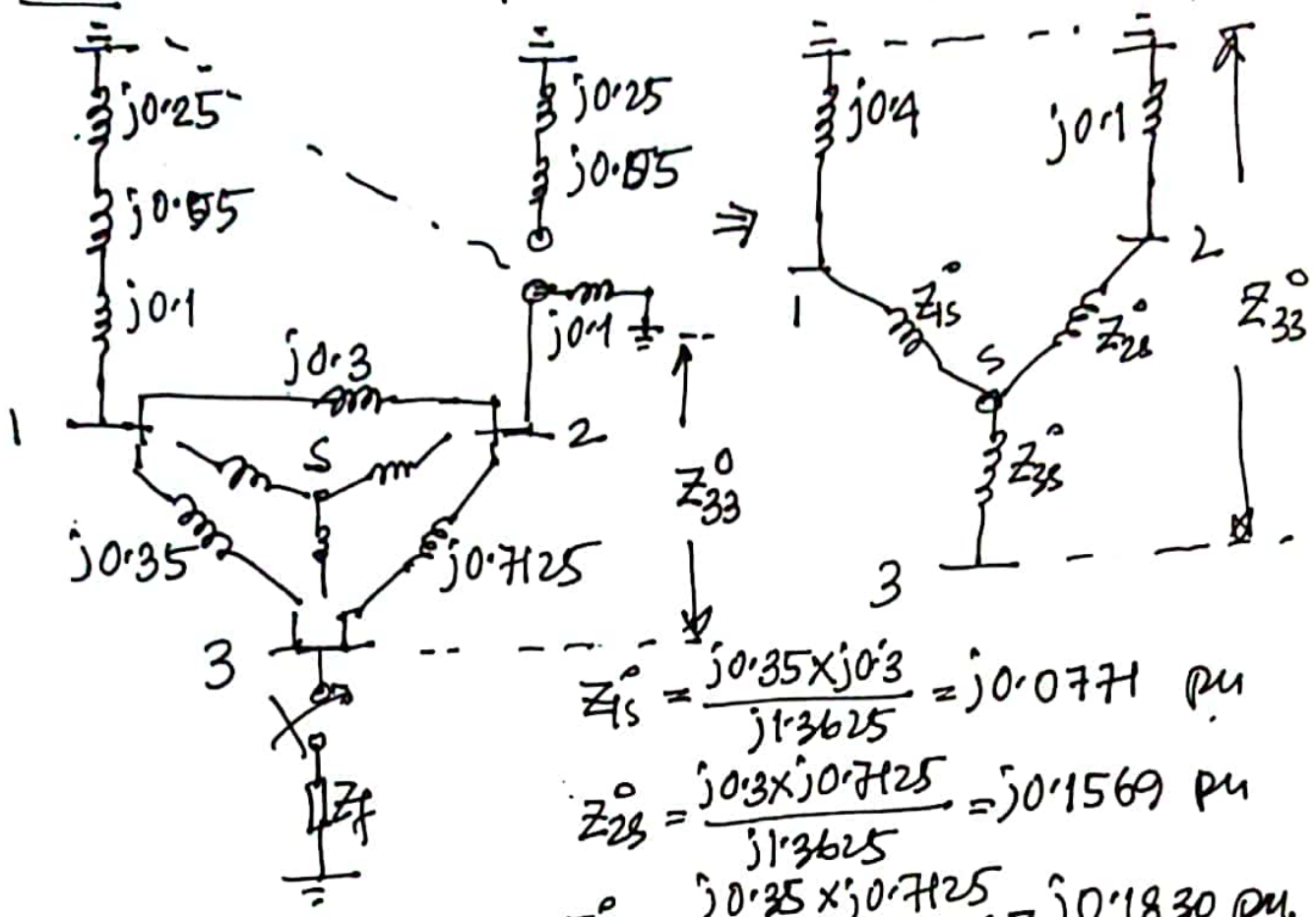
Then, $Z_{33}^1 = Z_{33}^2 = j0.22$ pu.





Z^0/X^0

Zero sequence impedance network



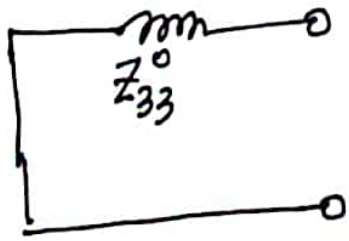
$$Z_{1S}^0 = \frac{j0.35 \times j0.3}{j1.3625} = j0.0771 \text{ pu}$$

$$Z_{2S}^0 = \frac{j0.3 \times j0.7125}{j1.3625} = j0.1569 \text{ pu}$$

$$Z_{3S}^0 = \frac{j0.35 \times j0.7125}{j1.3625} = j0.1830 \text{ pu.}$$

Thevenin's equivalent impedance

$$Z_{33}^0 = Z_{3S}^0 + (j0.4 + Z_{1S}^0) \parallel (j0.1 + Z_{2S}^0)$$
$$= j0.1830 + (j0.4771 \parallel j0.2569)$$
$$= j0.1830 + j0.167 = j0.35 \text{ pu}$$



Zero-seq. network

① 3-ϕ balanced fault at bus 3 / $V_1(0) = V_2$ ---

Let pre-fault bus voltages, $V_1(0) = V_2(0) = V_3(0) = 1.0$ pu

Fault current, $I_3^a(F) = \dfrac{V_3^a(0)}{Z_{33}^1 + Z_f} = \dfrac{1.0}{j0.22 + j0.1}$

$= -j3.125$ pu

② L-G fault at bus 3

Fault current, $I_3^a(F) = 3 . I_3^{a,0}$

where, $I_3^{a,0} = \dfrac{V_3^a(0)}{Z_{33}^1 + Z_{33}^2 + Z_{33}^0 + 3Z_f}$

$= \dfrac{1.0}{j0.22 + j0.22 + j0.35 + 3 \times j0.1}$

$= -j0.9174$ pu.

Then, Fault current, $I_3^a(F) = 3 \times (-j0.9174)$

$= -j2.7523$ pu.

③ L-L fault at bus 3

Fault current, $I_3^b(F) = -j\sqrt{3} . I_3^{a,1}$

where, $I_3^{a,1} = \dfrac{V_3^a(0)}{Z_{33}^1 + Z_{33}^2 + Z_f} = \dfrac{1.0}{j0.22 + j0.22 + j0.1}$

$= -j1.852$ pu.

Then, fault current,

$I_3^b(F) = -j\sqrt{3} \times (-j1.852) = -3.2078$ pu.

④ L-L-G fault at bus 3

Fault current, $I_3(F) = I_3^b + I_3^c = 3.I_3^{a,0}$

where, $I_3^{a,0} = -\dfrac{V_3^a(0) - I_3^{a,1} \times Z_{33}^1}{Z_{33}^0 + 3Z_f}$

and, $I_3^{a,1} = \dfrac{V_3^a(0)}{Z_{33}^1 + \dfrac{Z_{33}^2(Z_{33}^0 + 3Z_f)}{Z_{33}^2 + (Z_{33}^0 + 3Z_f)}}$

$$= \frac{1.0}{j0.22 + \dfrac{j0.22 \times (j0.35 + 3 \times j0.1)}{j0.22 + (j0.35 + 3 \times j0.1)}}$$

$$\Rightarrow I_3^{a,1} = \frac{1.0}{j0.22 + j0.1644} = -j2.6015 \text{ pu}$$

Then, $I_3^{a,0} = -\dfrac{1.0 - (-j2.6015 \times j0.22)}{j0.35 + 3 \times j0.1}$

$$= -\frac{1.0 - 0.57233}{j0.65}$$

$$= j0.658 \text{ pu.}$$

Finally, fault current,

$$I_3(F) = 3 \times I_3^{a,0} = 3 \times j0.658 = j1.974 \text{ pu}$$

Home work : Fault at

* Bus – 1
* Bus – 2

} Ref. Ex 9.1