OKOLOCHA KENALD UGOCHUKWU

17/ENG04/1089

4/01

ELECT

POWER SYSTEMS ASSIGNMENT

$S_{base,new} = 25MVA$

$V_{base_1\ new} = 11KV$

$V_{base_2,new} = 10.8KV$

$V_{base_3,new} = 11KV$

Gen = 25MVA, 11KV, 20%.

M_1 = 15MVA, 10KV, 25%.

M_2 = 7.5MVA, 10KV, 25%.

T_1 = 30MVA, 10.8KV, 10%.

T_2 = 30MVA, 10.8KV, 10%.

$X_L = 100\Omega$

$$X_{gen,pu} = \frac{20}{100} \times \left(\frac{25}{25}\right) \times \left(\frac{11}{11}\right)^2 = j0.2pu$$

$$X_{m_1} = \frac{25}{100} \times \left(\frac{25}{35}\right) \times \left(\frac{10}{11}\right)^2 = j0.344pu$$

$$X_{m_2} = \frac{25}{100} \times \left(\frac{25}{7.5}\right) \times \left(\frac{10}{11}\right)^2 = j0.689pu$$

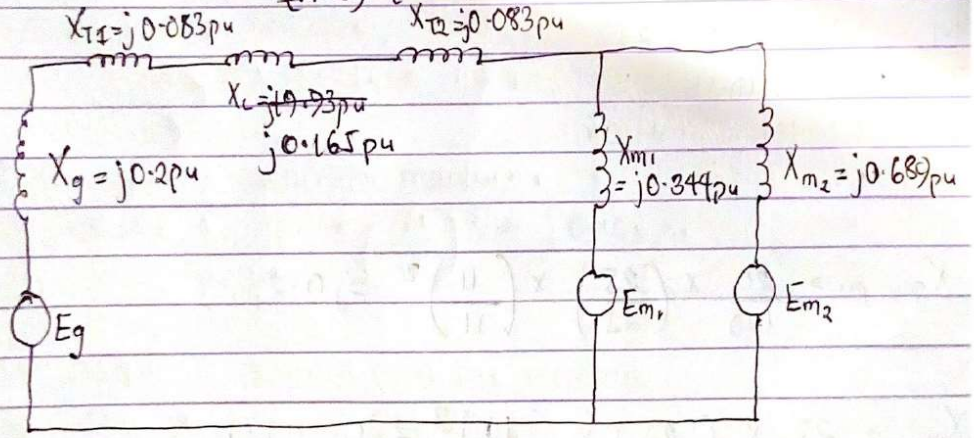
$$X_{T1} = \frac{10}{100} \times \left(\frac{25}{30}\right) \times \left(\frac{10.8}{10.8}\right)^2 = j0.083pu$$

$$X_{T2} = \frac{10}{100} \times \left(\frac{25}{30}\right) \times \left(\frac{10.8}{10.8}\right)^2 = j0.083pu$$

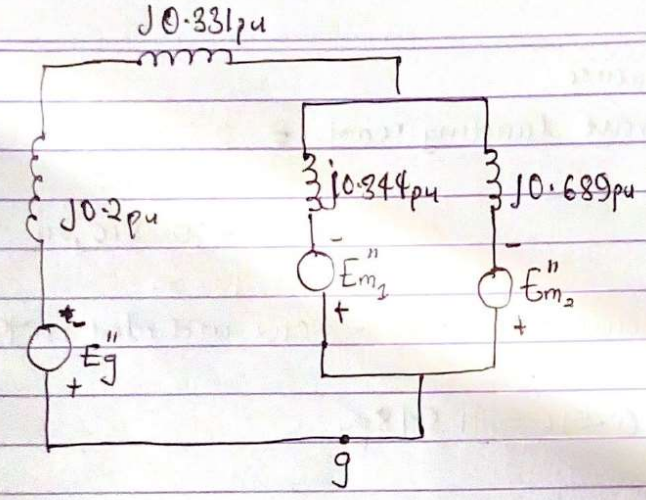
Base voltage for transmission line;

$$= 11 \times \frac{110}{11} \frac{121}{10.8} = 123.2\,KV$$

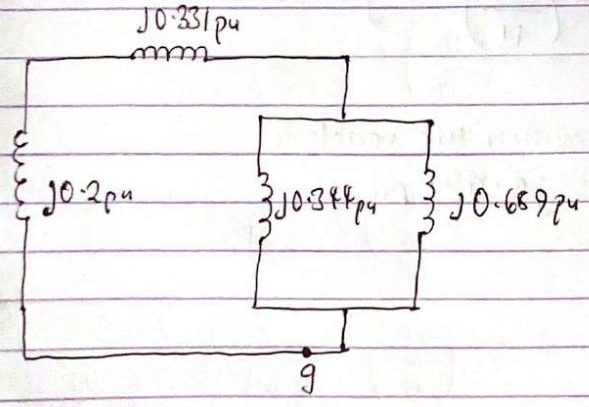
$$X_{L,pu} = 100 \times \frac{25}{(123.2)^2} = j0.165\,pu$$



Per Unit diagram of the system



positive sequence network



negative sequence network

for the zero sequence

reactance of current limiting reactor $= 2.5 \times \frac{25}{11^2}$

$= j0.516$ pu

reactance of the current limiting reactor included in the zero sequence network;

$3 \times 0.516 = j1.548$ pu

zero sequence generator reactance

$0.06 \times \frac{25}{25} \times \left(\frac{11}{11}\right)^2 = j0.06$ pu

zero sequence transmission line reactance

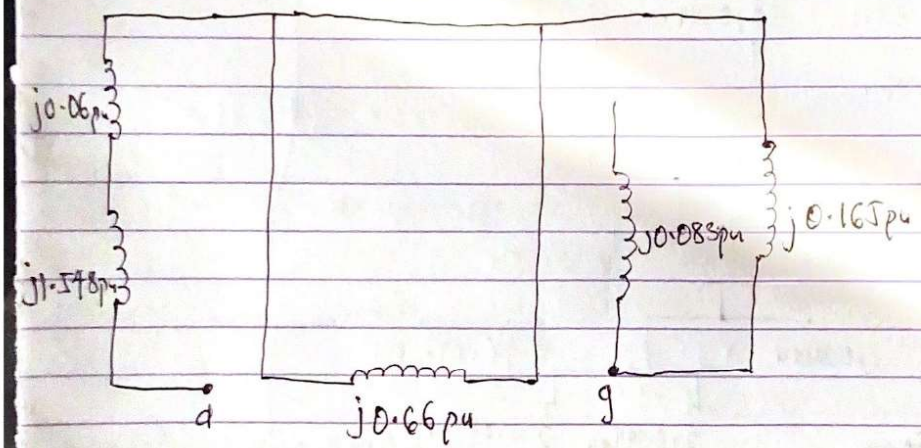
$300 \times \frac{125}{(123.2)^2} = j0.494$ pu

$X_{T1} = j0.08$ pu

$X_{T2} = j0.08$ pu

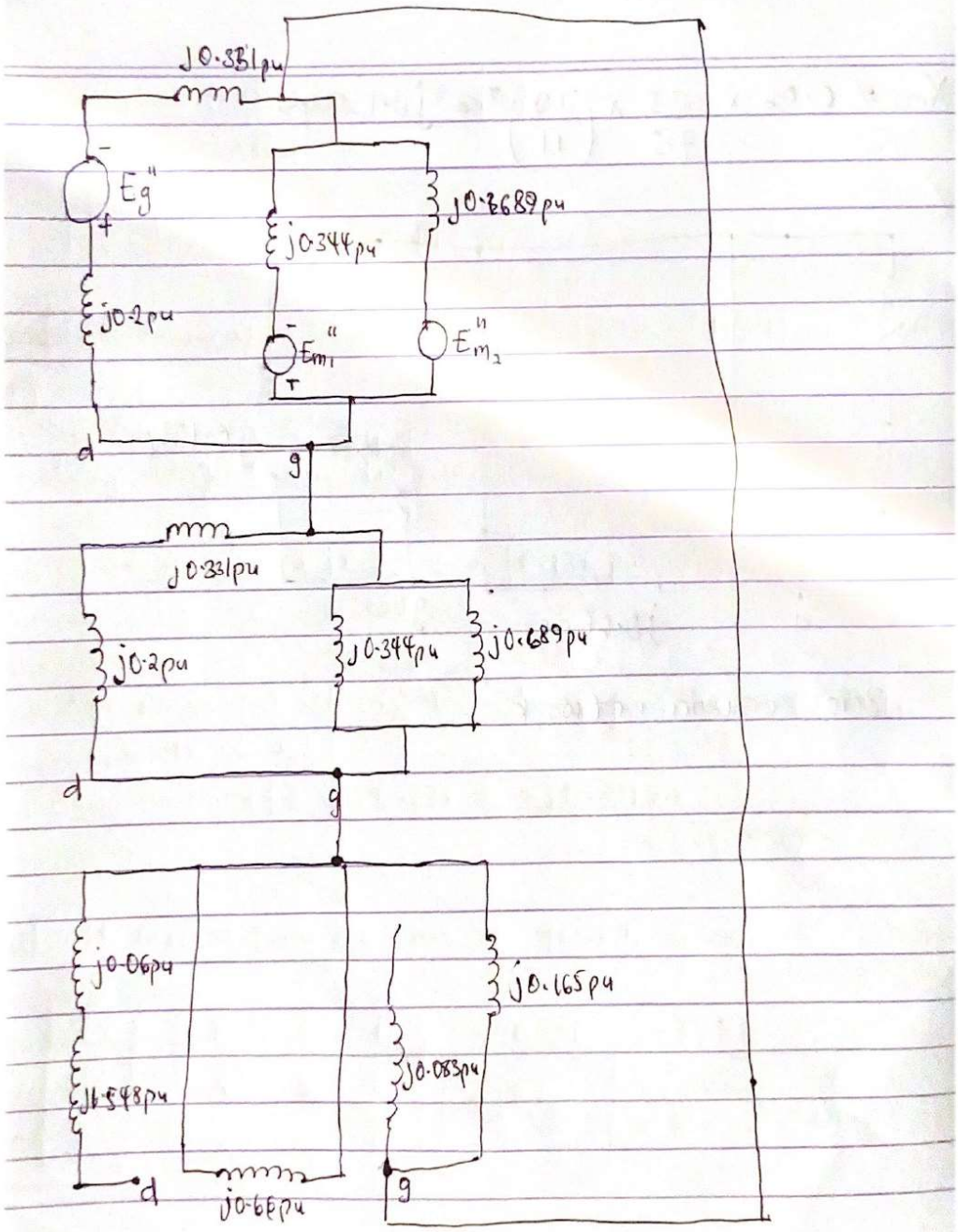
$X_{m1} = 0.06 \times \frac{25}{15} \times \left(\frac{10}{11}\right)^2 = j0.083$ pu

$$X_{m_2} = 0.06 \times \frac{25}{7.5} \times \left(\frac{10}{11}\right)^2 = j0.165 \text{ pu}$$

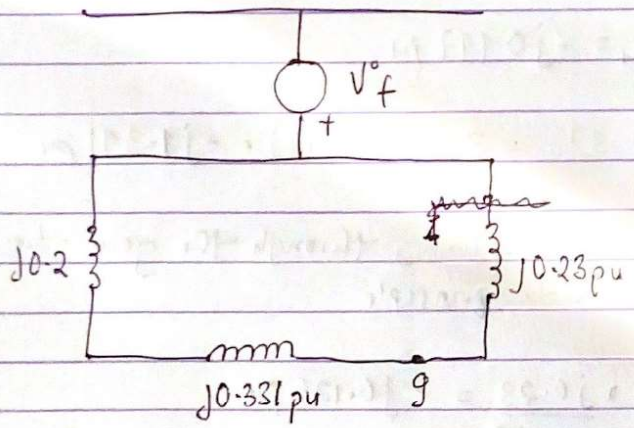


Zero sequence network

CONNECTION OF THE SEQUENCE NETWORKS



6) Taking the thevenin's equivalent of the positive sequence network



$$Z_1 = \frac{(j0.2 + j0.331) \times j0.23}{(j0.2 + j0.331) + j0.23} = j0.161 \text{ pu}$$

$$Z_1 = Z_2 = j0.161 \text{ pu}$$

from the sequence connection

$$I_{a1} = \frac{V°f}{Z_1 + Z_2 + Z_0}$$

$$V°f = Eg'' = E''m_1 = Em''_2 = \frac{10}{11} = 0.909 \text{ pu}$$

$$\therefore I_{a_1} = \frac{0.909}{j2.032} = -j0.447 \text{ pu}$$

$$I_{a_2} = I_{a_0} = I_{a_1} = -j0.447 \text{ pu}$$

fault current $= 3I_{a_0} = 3 \times (-j0.447) = -j1.341$ pu

a) The component of I_{a_1} flowing through the generator.

Using current divider principle

$$-j0.447 \times \frac{j0.23}{j0.755} = -j0.136 \text{ pu}$$

- Its component flowing towards g from the motor side

Using KCL

$$-j0.447 + j0.136 = -j0.311 \text{ pu}$$

Fault current from the generator towards g are;

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ \alpha^2 & \alpha & 1 \\ \alpha & \alpha^2 & 1 \end{bmatrix} \begin{bmatrix} -j0.136 \\ -j0.136 \\ 0 \end{bmatrix} = \begin{bmatrix} -j0.272 \\ -j0.136 \\ +j0.136 \end{bmatrix} \text{ pu}$$

Fault current from the motor towards g

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ \alpha^2 & \alpha & 1 \\ \alpha & \alpha^2 & 1 \end{bmatrix} \begin{bmatrix} -j0.311 \\ -j0.311 \\ -j0.477 \end{bmatrix} = \begin{bmatrix} -j1.069 \\ -j0.136 \\ -j0.136 \end{bmatrix} \text{ pu}$$

Positive and negative sequence are shifted $+90^\circ$ & -90° respectively

Positive sequence current $= -j \times (-j0.136) = -0.136$ pu

negative sequence current $= j \times (-j0.136) = 0.136$ pu

zero sequence current $= 0$

$\therefore$ Line a current on the transmission line

$= -0.136 + 0.136 + 0 = 0$