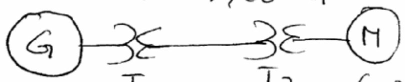
Solution Assignment #1

Q1 Base Power 100 MVA

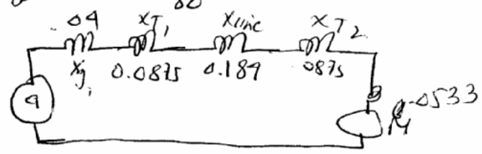


T_1 T_2

$[13.8]$ $(230kV)$ $(13.8kV)$

$$X_{g_1} = 0.04\,\frac{(100)}{(100)}\cdot\frac{13.8^2}{13.8^2} = \underline{\underline{0.04}}\;;\quad X_M = 0.04\,\frac{(100)}{75}\cdot\frac{13.8^2}{13.8^2} = \underline{\underline{0.0533}}$$

$$X_{T_1} = X_{T_2} = 0.07\left(\frac{100}{80}\right) = \underline{\underline{0.0875}}\;;\quad X_{line} = \frac{100}{230^2}(100) = \underline{\underline{0.189}}$$



Q2 (i)

$$\begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}\begin{bmatrix} 177\angle 0 \\ 156\angle -100 \\ 105\angle 220 \end{bmatrix} = \begin{bmatrix} 19.96 - j63.86 \\ 98.58 + j62.09 \\ 48.865 + j31.29 \end{bmatrix};$$

(ii)

$$\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix}\begin{bmatrix} 0 + j3.0 \\ -0.8 - j2.6 \\ 0 - j2.2 \end{bmatrix} = \begin{bmatrix} -0.8 - j7.6 \\ 0.066 - j0.1 \\ -1.66 - j0.4 \end{bmatrix}$$

Q3

Q3 Two generators are connected through two transformers to a high voltage bus which supplies a line. The line is open –circuited at the remote. The pre-fault voltage at the end of the line is 515 KV. The system is shown below and the system data is given in the following a table.

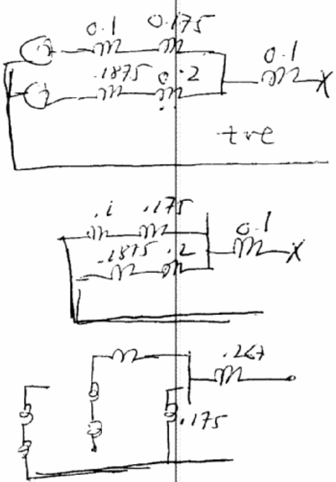
Table 2 System data

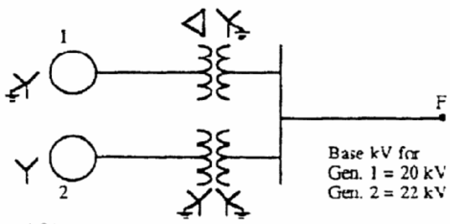
Equipment	Rated power (MVA)	Rated voltage (KV)	X_1 Per unit	X_2 Per unit	X_0 Per unit
G_1	1000	20	0.1	0.1	0.05
G_2	800	22	0.15	0.15	0.08
T_1	1000	500Y/20Δ	0.175	0.175	0.175
T_2	800	500Y/22Y	0.16	0.16	0.16
Transmission Line	1500	500	0.15	0.15	0.07

Work on a base power of 1000 MVA and base voltage 500 kV on the transmission line.
The neutral of Generator G_1 is grounded through a reactance of 0.04 Ohms.

Find the value of the fault current in amperes for the faults at the end of line for the following cases:

(i) Single-line-ground
(ii) Line-line
(iii) Line-line-ground





$X_{g_2} = 0.15 \times \frac{1000}{800} = 0.1875$

$X_{T_2} = 0.16 \times \frac{1000}{800} = 0.2$

$X_{line} = 0.15 \times \frac{1000}{1500} = 0.1$; $X_0 = 0.4 \times \frac{1000}{1500} = 0.267$

$Z_1 = \underline{0.261}$; $Z_2 = 0.261$; $Z_0 = \underline{0.442}$

$I_{base} = \frac{1000 \times 10^3}{\sqrt{3}(500)} = 1154.73$

a) $I_1 = \frac{1.03}{\sum Z} = -j4.33$; $\underline{I_F = 15000A}$

b) $I_1 = I_2 = \frac{1.03}{Z_1 + Z_2} = -j1.973$; $I_B = (a^2 - a)I_1 = 3.417$ pu $= \underline{3958A}$

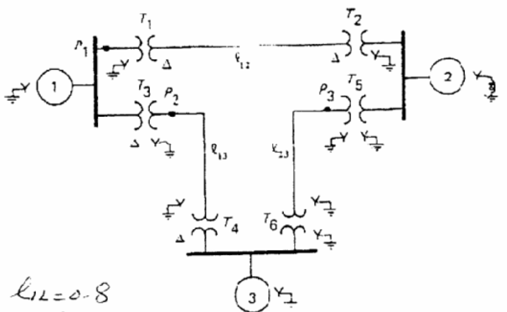
c) $I_1 = \frac{1.03}{Z_1 + (Z_2 \parallel Z_0)} = \frac{1.03}{.261 + .164} = 2.42$ pu ; $\underline{I_2 = 1.52}$ $\underline{I_0 = 0.898}$

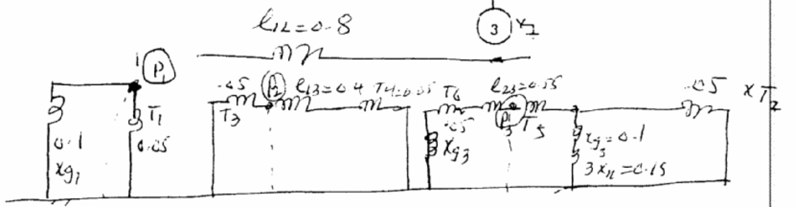
Q4. (a) Draw the zero sequence impedance diagram of the following network. The zero sequence impedance of each component is given in per cent to the same base.

Table 1

Equipment	Reactance (per unit)
G_1-G_3	0.1
T_1-T_6	0.05
X_n	0.05
X_{l12}	0.80
X_{l13}	0.40
X_{l23}	0.55

(b) Obtain the Thevenin equivalent zero sequence impedance for faults at points P1, P2 and P3.





P_1 $\quad Z_0 = 0.1 // 0.05 = \underline{\underline{0.0333}}$

P_2 $\quad Z_0 = 0.05 // (0.45) = \underline{\underline{0.045}}$

~~$P_3 = (0.05+0.1) // ($~~

$P_3 = (0.1+0.05+0.55) // \left(0.05 + (0.25 // 0.05)\right) = \underline{\underline{0.081}}$