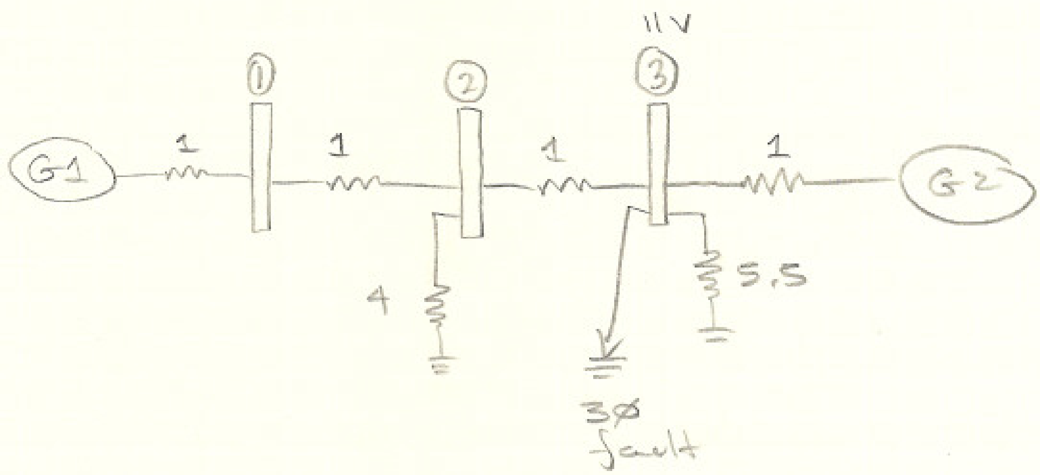


$$\underline{Y}_{bus} = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2.25 & -1 \\ 0 & -1 & 2.18 \end{bmatrix} \Omega^{-1}$$

inverting $\underline{Y}_{bus}$

$$\underline{Z}_{bus} = \begin{bmatrix} 0.6935 & 0.3871 & 0.1774 \\ 0.3871 & 0.7742 & 0.3548 \\ 0.1774 & 0.3548 & \boxed{0.6209} \end{bmatrix}$$

← Z_{33} this is what we are interested in.

$V_{3g} = V_{30} = 11\,V$

$I_f = \frac{-11}{0.6209} = -17.72\,A$

$V_{1f} = -17.72 \cdot 0.1774 = -3.14\,V$

$V_{2f} = -17.72 \cdot 0.3548 = -6.28\,V$

$V_{3f} = -17.72 \cdot 0.6209 = -11 V$

$I_{12f} = \frac{-3.14 - (-6.28)}{1} = 3.14 A$

$I_{2gf} = -\frac{6.28 - 0}{4} = -1.57 A$

$I_{23f} = \frac{-6.28 - (-11)}{1} = 4.72 A$

$I_{G11f} = \frac{0 - (-3.14)}{1} = 3.14 A$

$I_{G23f} = \frac{0 - (-11)}{1} = 11 A$

$I_{120} = \frac{11.5 - 10}{1} = 1.5 A$

$\therefore \quad I_{12} = I_{120} + I_{12f}$

$= 1.5 + 3.14 = 4.64 A.$

$V_1 = V_{10} + V_{1f} = 11.5 + (-3.14) = 8.36 V$

$V_2 = V_{20} + V_{2f} = 10 + (-6.28) = 3.72 V$

$V_3 = V_{30} + V_{3f} = 11 + (-11) = 0 V$

Note: One the Z_{bus} (or column of it) is found the solution for the fault voltages and current flows immediately

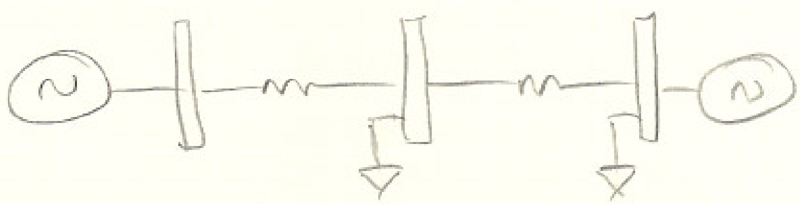
Note: If the fault occurs on bus #2 (to ground) then the fault at bus 2 is

$$I_{2f} = \frac{-10}{0.7742} = -12.92A$$

Note: the prefault voltages are generally obtained from the load flow solution of the system, for this load flow solution; an admittance matrix Y_{bus} is known. This matrix however omits generator and load branch impedances. To form the Y_{bus}, all is nessessary is to add generator and load admitances to the diagonal elements of Y_{bus}

$$\underline{Y}_{bus} = \underline{Y}_{bus} + \begin{bmatrix} \text{diagonal} \\ \text{source and} \\ \text{Load} \\ \text{admittances} \end{bmatrix}$$

EX: Building up your Y_{bus} for the previous example.



$$\underline{Y}_{bus} = \begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{bmatrix}$$

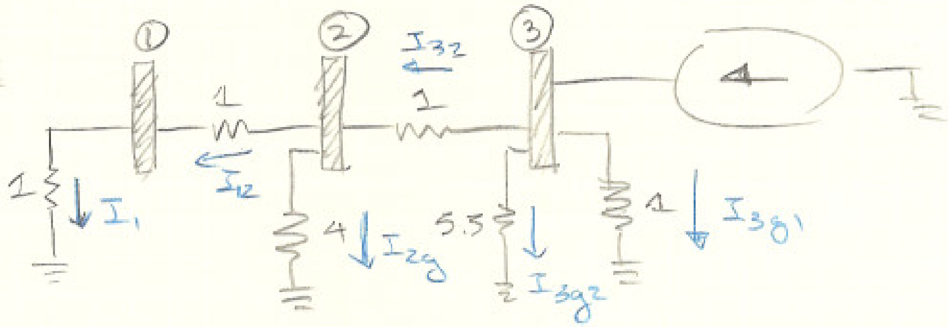
Including source and load admittances, then

$$\underline{Y}_{bus} = \begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.25 & 0 \\ 0 & 0 & 1.18 \end{bmatrix}$$

BUILDING ZBUS

The terms of Z_{bus} can also be found directly by injecting a current into each bus in turn finding the corresponding bus voltages

EX:



let $I_1 = 1$ could be any value.

$V_1 = 1$

$I_{12} = 1$

$V_2 = 2V$

$I_{2g} = 0.5A$

$I_{32} = 1.5A$

$V_3 = 2 + 1.5 = 3.5V$

$I_{3g2} = 0.64A$

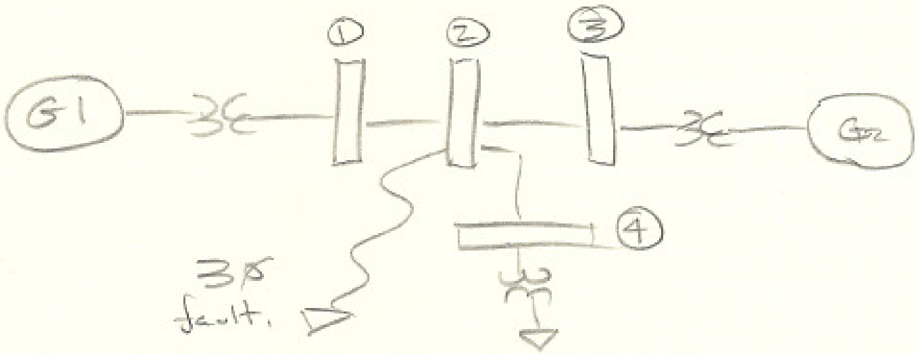
$I_{3g1} = 3.5A$

$I_3 = 5.64A$

$\therefore \frac{V_1}{I_3} = Z_{13} = 0.1774 \qquad \frac{V_2}{I_3} = Z_{23} = 0.3548$

$\therefore \quad \frac{V_3}{I_3} = Z_{33} = 0.6210$

<u>EX</u>: Given the following, determine the system voltages and currents for a 3ϕ fault on bus #2, solve directly without the use of Z_{bus} method.



$Z_{12} = Z_{23} = Z_{24} = j0.1$ pu

$Z_{G1} = Z_{g2} = j0.3$ pu

$Z_{T1} = Z_{T2} = Z_{T3} = j0.1$ pu

prefault load flow solution gave

	V	S
1	$1.06 + j0.12$	$0.4 + j0.26$
2	$1.04 + j0.08$	$0 + 0j$
3	$1.06 + j0.12$	$0.4 + j0.26$
4	$1 + 0j$	$-0.8 - j0.4$