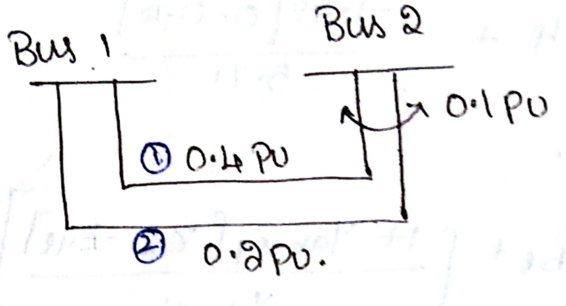
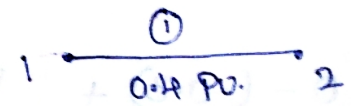
1. A transmission line exist between buses 1 & 2 with per unit impedance 0.4 another line of impedance 0.2 pu is connected in parallel with it making it a double ckt with mutual impedance of 0.1 pu obtain the impedance of the 2ckt system



Take node ① as the reference.

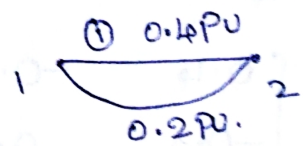
for element ①.



Then $Z_{bus} = \begin{array}{c|c} & 2 \\ 2 & [0.4] \end{array}$

for element ②

$$Z_{bus} = \begin{array}{c|c} & \begin{matrix} 2 & l \end{matrix} \\ \begin{matrix} 2 \\ l \end{matrix} & \begin{bmatrix} 0.4 & Z_{2l} \\ Z_{l2} & Z_{ll} \end{bmatrix} \end{array}$$



for primitive network

$$Z = \begin{array}{c|c} & \begin{matrix} ① & ② \end{matrix} \\ \begin{matrix} ① \\ ② \end{matrix} & \begin{bmatrix} 0.4 & 0.1 \\ 0.1 & 0.2 \end{bmatrix} \end{array}, \quad Y = \frac{1}{Z} = \frac{1}{(0.08-0.01)} \begin{bmatrix} 0.2 & -0.1 \\ -0.1 & 0.4 \end{bmatrix}$$

$$Y = \begin{bmatrix} 2.857 & -1.428 \\ -1.428 & 5.712 \end{bmatrix}$$

$Y_{\underset{2}{ab}-\underset{1}{xy}} = -1.428$, $\quad Y_{\underset{2}{ab}-\underset{2}{ab}} = 5.712.$

$a = 1, \; b = 2$ $\qquad x = 1, \; y = 2$

$$Z_{li} = Z_{ai} - Z_{bi} + \left[\frac{Y_{ab-xy}\,(Z_{xi} - Z_{yi})}{Y_{ab-ab}} \right]$$

$i = 2.$

the

$$Z_{l2} = Z_{12} - Z_{22} + \frac{Y_{ab-xy}\,[Z_{12} - Z_{22}]}{Y_{ab-ab}}$$

$$= 0 - 0.4 + \frac{-1.42\,[0 - 0.4]}{5.71}$$

$$= -0.3,$$

$$Z_{ll} = Z_{al} - Z_{bl} + \left[\frac{1 + Y_{ab-xy}\,[Z_{xl} - Z_{yl}]}{Y_{ab-ab}} \right]$$

$$Z_{ll} = Z_{1l} - Z_{2l} + \frac{1 + Y_{ab-xy}\,[Z_{1l} - Z_{2l}]}{Y_{ab-ab}}$$

$$= 0 - (-0.3) + \frac{1 + (-1.42)\,[0 - (-0.3)]}{5.71}$$

$$= 0.4.$$

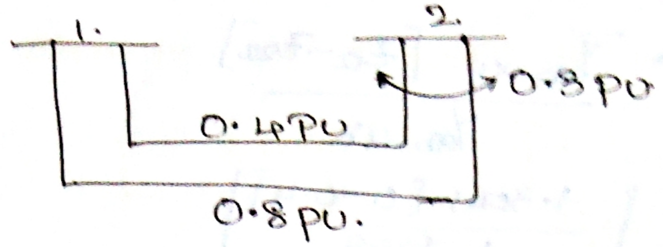
$$Z_{Bus} = \begin{bmatrix} 0.4 & -0.3 \\ -0.3 & 0.4 \end{bmatrix}$$

$$Z_{modified} = Z_{Bus} - \frac{Z_{il}\,Z_{lj}}{Z_{ll}}$$

$$= 0.4 - \frac{-0.3 \times -0.3}{0.4.}$$

$$Z_{modified.} = [0.175]$$

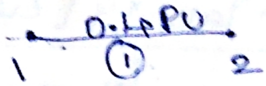
1.

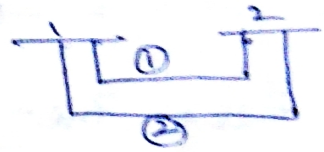


Sol. Node ① as reference.

for Element ①

then $Z_{Bus} = \begin{array}{cc} & 2 \\ 2 & [0.4] \end{array}$.





for Element ②.

It forms a link.

Then $Z_{Bus} = \begin{array}{ccc} & 2 & l \\ 2 & \multicolumn{2}{c}{\begin{bmatrix} 0.4 & Z_{2l} \\ Z_{l2} & Z_{ll} \end{bmatrix}} \\ l & & \end{array}$

Primitive network

$$Z = \begin{array}{ccc} & 1 & 2 \\ 1 & 0.4 & 0.3 \\ 2 & 0.3 & 0.8 \end{array}$$

$$Y = \frac{1}{Z} = \frac{1}{(0.8)(0.4) - 0.3(0.3)} \begin{bmatrix} 0.8 & -0.3 \\ -0.3 & 0.4 \end{bmatrix}$$

$$= 4.347 \begin{bmatrix} 0.8 & -0.3 \\ -0.3 & 0.4 \end{bmatrix}$$

$$Y = \begin{bmatrix} 3.477 & -1.3041 \\ -1.3041 & 1.7388 \end{bmatrix}$$

$Y_{ab-xy} = -1.3041$ (2 1)

$Y_{ab-ab} = 1.7388$. (2 2.)

$a = 1,\ b = 2$

$x = 1,\ y = 2$.

$$Z_{li} = Z_{ai} - Z_{bi} + \left[\frac{Y_{ab-xy}[Z_{xi} - Z_{yi}]}{Y_{ab-ab}} \right]$$

$$Z_{\ell 2} = Z_{12} - Z_{22} + \frac{\overline{Y}_{ab-xy}\left[Z_{12} - Z_{22}\right]}{Y_{ab-ab}}$$

$$= 0 - 0.4 + \left[\frac{-1.3041\left[0 - 0.4\right]}{1.7388}\right]$$

$$= -0.1$$

$$Z_{\ell\ell} = Z_{1\ell} - Z_{2\ell} + \frac{1 + Y_{ab-xy}\left[Z_{1\ell} - Z_{2\ell}\right]}{Y_{ab-ab}}$$

$$= 0 - (-0.3) + \frac{1 + (-1.3041)\left[0 - (-0.1)\right]}{1.7388}$$

$$= 0.8$$

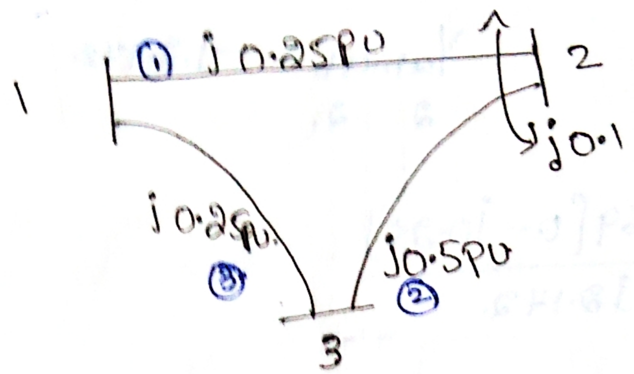
$$Z_{Bus} = \begin{bmatrix} 0.4 & -0.1 \\ -0.1 & 0.8 \end{bmatrix}$$

$$Z_{modified} = Z_{Bus} - \frac{Z_{2\ell} Z_{\ell 2}}{Z_{\ell\ell}}$$

$$= 0.4 - \frac{-0.1 \times -0.1}{0.8}$$

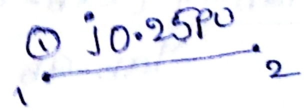
$$= 0.3875$$

Compute the bus impedance matrix for the system sh[own] by adding element by element take bus ① as reference



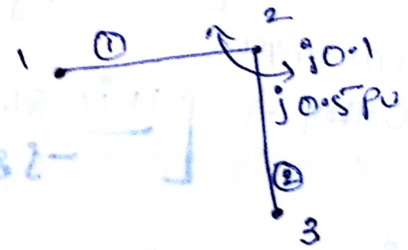
Sol: take node ① as reference

for Element ①



$$Z_{Bus} = \begin{array}{c} \\ 2 \end{array}\begin{array}{c} 2 \\ \left[j0.25 \right] \end{array}$$

for Element ②



$$Z_{Bus} = \begin{array}{c} \\ 2 \\ b \end{array}\begin{array}{c} \begin{array}{cc} 2 & b \end{array} \\ \begin{bmatrix} j0.25 & Z_{2b} \\ Z_{b2} & Z_{bb} \end{bmatrix} \end{array}$$

Primitive

$$Z = \begin{bmatrix} j0.25 & j0.1 \\ j0.1 & j0.5 \end{bmatrix}$$

$$Y = \frac{1}{Z} = \frac{1}{(j0.25)(j0.5) - (j0.1)(j0.1)} \begin{bmatrix} j0.5 & -j0.1 \\ -j0.1 & j0.5 \end{bmatrix}$$

$$Y = \begin{bmatrix} -j4.34 & j0.869 \\ j0.869 & -j2.172 \end{bmatrix}$$

$a = 2,\ b = 3,\quad x = 1,\ y = 2\quad i = 2.$

$$Z_{bi} = Z_{ai} + \frac{Y_{ab\,xy}\left[Z_{xi} - Z_{yi}\right]}{Y_{ab\text{-}ab}}$$

$$Z_{b2} = Z_{22} + \frac{Y_{ab\text{-}xy}\left[Z_{12} - Z_{22}\right]}{Y_{ab\text{-}ab}}$$

$$\underset{2\quad 1}{Y_{ab\text{-}xy}} = j0.869 \qquad \underset{2\quad 2}{Y_{ab\text{-}ab}} = -j2.172$$

$$Z_{b2} = j0.25 + \frac{j0.869\left[0 - j0.25\right]}{-j2.172}$$

$$Z_{b2} = Z_{2b} = \cancel{j0.149}\ j0.3499$$

$$Z_{bb} = Z_{ab} + \left[\frac{1 + Y_{ab\text{-}xy}\left[Z_{xb} - Z_{yb}\right]}{Y_{ab\text{-}ab}}\right]$$

$$Z_{bb} = Z_{b2} + \left[\frac{1 + j0.869\left[Z_{13} - Z_{2b}\right]}{-j2.172}\right]$$

$$= \overset{j0.3499}{\cancel{j0.149}} + \left[\frac{1 + j0.869\cdot\left[0 - j0.149\right]}{-j2.172}\right]$$

$$Z_{bb} = j0.149 + j0.52$$

$$Z_{bb} = j0.669$$

$$Z_{Bus} = \begin{bmatrix} j0.25 & j0.149 \\ j0.149 & j0.669 \end{bmatrix}.$$

for Element (3) :-

It forms a link. then

$$Z_{Bus} = \begin{array}{c} \\ 2 \\ 3 \\ \ell \end{array}\begin{array}{c} \begin{array}{ccc} 2 & 3 & \ell \end{array} \\ \begin{bmatrix} j0.25 & j0.149 & Z_{2\ell} \\ j0.149 & j0.67 & Z_{3\ell} \\ Z_{\ell 2} & Z_{\ell 3} & Z_{\ell\ell} \end{bmatrix} \end{array}$$

$$Z_{\ell i} = Z_{ai} - Z_{bi} + \frac{Y_{ab\text{-}xy}\left[Z_{xi} - Z_{yi}\right]}{Y_{ab\text{-}ab}}$$

$a = 1, \; b = 3, \qquad x = 1, \; y = 2$

for $i = 2$

$$Z_{2l} = Z_{12} - Z_{32} = 0 - j0.15 = -j0.15$$

for $i = 3$

$$Z_{3l} = Z_{13} - Z_{33} = 0 - j0.7 = -j0.67.$$

$$Z_{ll} = Z_{al} - Z_{bl} + \left[\frac{1+0}{Y_{ab\text{-}ab}}\right] = Z_{1l} - Z_{3l} + Z_{ab\text{-}ab}$$

$$= 0 + j0.67 + j0.25 = j0.92.$$

$$Z_{Bus} = \begin{array}{c c} & \begin{array}{ccc} 2 & 3 & l \end{array} \\ \begin{array}{c} 2 \\ 3 \\ l \end{array} & \begin{bmatrix} j0.25 & j0.15 & -j0.15 \\ j0.15 & j0.67 & -j0.67 \\ -j0.15 & -j0.67 & j0.92 \end{bmatrix} \end{array}$$

$$Z_{Bus\,modified} = Z_{Bus} - \frac{Z_{2l} \cdot Z_{3l}}{Z_{ll}}.$$

$$Z_{22} = Z_{bus} - \frac{Z_{2l} Z_{l2}}{Z_{ll}}$$

$$= j0.25 - \frac{-j0.15 \times -j0.15}{j0.92} = j0.225$$

$$Z_{23} = Z_{23} - \frac{Z_{2l} \times Z_{l3}}{Z_{ll}} = j0.15 - \frac{-j0.15 \times -j0.67}{j0.92}$$

$$= j0.0407.$$

$$Z_{33} = Z_{33} - \frac{Z_{3l} Z_{l3}}{Z_{ll}} = j0.67 - \frac{-j0.67 \times -j0.67}{j0.92}$$

$$= j0.182$$