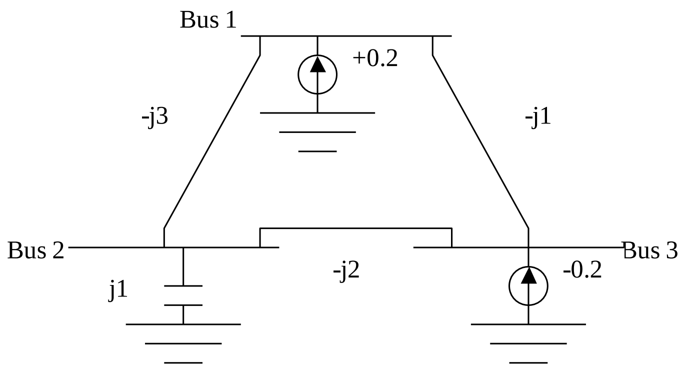
Solutions to Problems

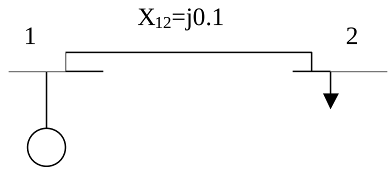
1. Form the matrix equation YV=I for the network below.



Answer:

$$\begin{bmatrix} -j4 & j3 & j1 \\ j3 & -j4 & j2 \\ j1 & j2 & -j3 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0.2 \\ 0 \\ -0.2 \end{bmatrix}$$

2. Form the Y-bus for the following two-bus power system, in both rectangular and polar notation. The reactance X_{12} is given in per unit.



Answer:

$$y_{12} = \frac{1}{x_{12}} = \frac{1}{j0.1} = -j10$$

$$Y_{bus} = \begin{bmatrix} Y_{12} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} -j10 & j10 \\ j10 & -j10 \end{bmatrix} = \begin{bmatrix} 10\angle -90^\circ & 10\angle 90^\circ \\ 10\angle 90^\circ & 10\angle -90^\circ \end{bmatrix}$$

3. Draw the network, in terms of branches only, for the following admittance matrix

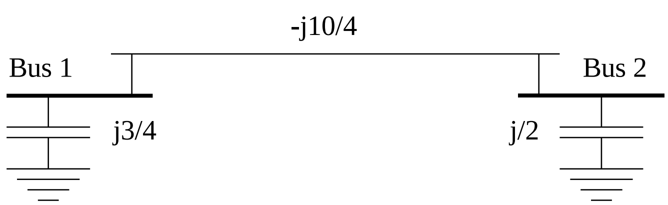
$$\underline{Y} = \begin{bmatrix} -\dfrac{j7}{4} & \dfrac{j10}{4} \\ \dfrac{j10}{4} & -j2 \end{bmatrix}$$

Answer:

$$Y_{11} = y_{12} + y_1 \qquad Y_{22} = y_{21} + y_2$$

$$\frac{-j7}{4} = \frac{-j10}{4} + y_1 \qquad -j2 = \frac{-j10}{4} + y_2$$

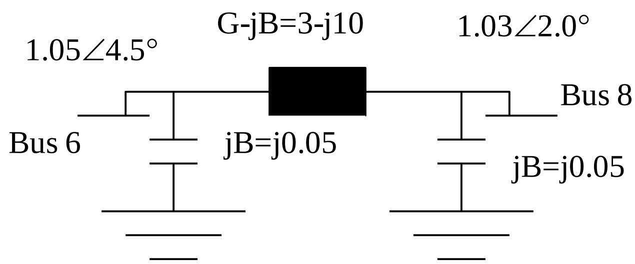
$$y_1 = \frac{j3}{4} \qquad y_2 = \frac{j}{2}$$



7. George and Clara read the output from an industrial-grade power flow program; part of it is as follows:

From bus no.	To bus no.	Pflow (MW)	Qflow (MVAR)
6	8	53.8	2.4

The voltages and transmission line admittance parameters are given on the diagram below. All parameters are on a 100 MVA base.



They thought the power flow program had a "bug" because they did the following per unit calculations and compared the result to the Qflow of the power flow program output.

$$I_{6,8} = (V_6 - V_8)(G - jB) = (1.05\angle 4.5° - 1.03\angle 2.0°)(3 - j10) = 0.518\angle -3.83°$$

$$S_{6,8} = V_6 I_{6,8}^{\,*} = (1.05\angle 4.5°)(0.518\angle 3.83°) = 0.544\angle 8.33° = 0.538 + j0.079$$

$$\Rightarrow P_{6,8} = 53.8\,\text{MW}, \qquad Q_{6,8} = 7.9\,\text{MVARS}$$

Were George and Clara correct? Explain.

Answer:

George and Clara are computing S = P + jQ without including the effects of the reactive power injection from the charging capacitance. $C_{charge} = (100)(0.05)(1.05)^2 = 5.5125$