Tutorial 1

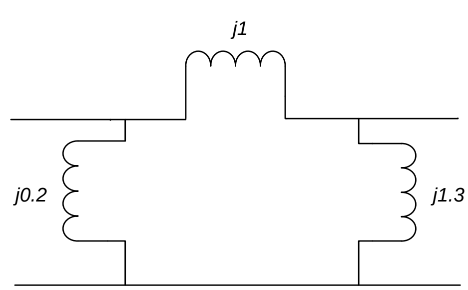
<u>Power Flow and Bus Admittance Matrix</u>

1. (a) The sending end voltage and receiving end voltage of a short transmission line are 80 V and 60 V, respectively. If the reactance of the line is 6 Ω, find the line average reactive power.

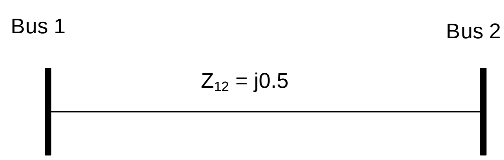
   (b) The sending end and receiving end voltages of a short transmission line are 80 V and 60 V, respectively. Find the value of the reactance if $Q_{av} = 80$ var.

   (c) The average reactive power of the short transmission line is 100 var. If the sending end voltage 80 V and the line reactance is 10 Ω, then find the receiving end voltage.

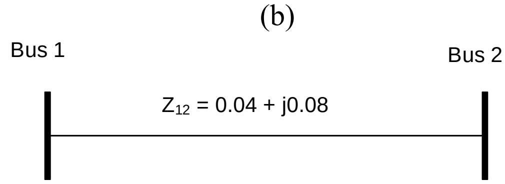
2. The pu impedances are shown in Figure 1. Determine the $\vec{Y}_{bus}$ matrices of the single-line diagrams as shown.



(a)



(b)



(c)

Figure 1.

3. Determine the $\vec{Y}_{bus}$ matrix of the single-line diagram as shown in Figure 2. The impedance values are given in pu.

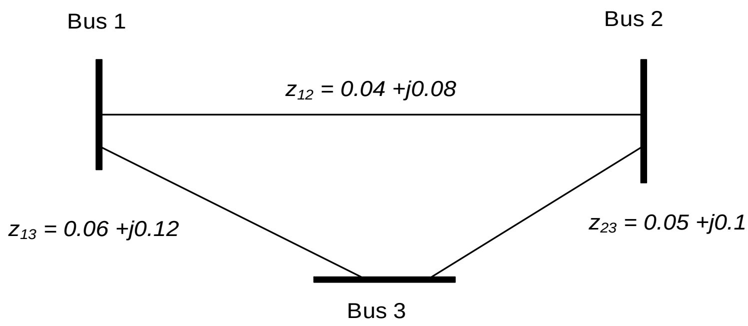


Figure 2.

4. Determine the $\vec{Y}_{bus}$ matrix of the single-line diagram as shown in Figure 3. The impedance values are given in pu.

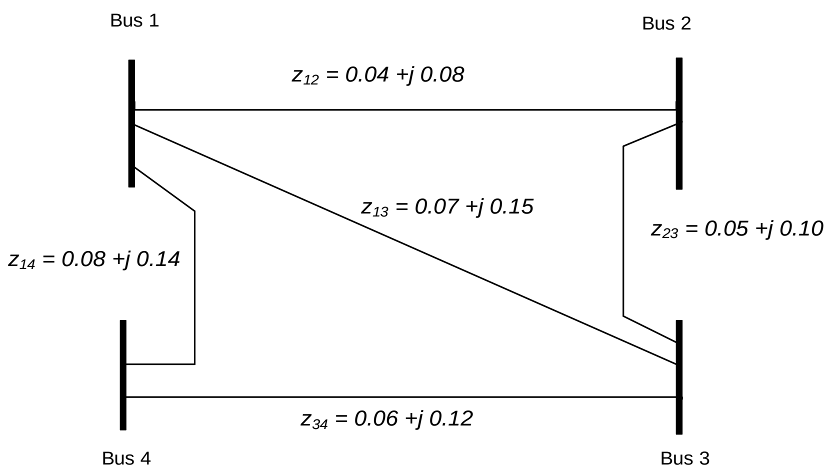


Figure 3.

Answers:

1. (a) 233.33 var, (b) 17.5 Ω, (c) 66.33 V

2. (a) $\vec{Y}_{bus} = \begin{bmatrix} -j6 & j \\ j & -j1.77 \end{bmatrix}$, (b) $\vec{Y}_{bus} = \begin{bmatrix} -j2 & j2 \\ j2 & -j2 \end{bmatrix}$, (c) $\vec{Y}_{bus} = \begin{bmatrix} 5-j10 & -5+j10 \\ -5+j10 & 5-j10 \end{bmatrix}$

3. $\vec{Y}_{bus} = \begin{bmatrix} 8.33-j16.67 & -5+j10 & -3.33+j6.67 \\ -5+j10 & 9-j18 & -4+j8 \\ -3.33+j6.67 & -4+j8 & 7.33-j14.67 \end{bmatrix}$

4. $\vec{Y}_{bus} = \begin{bmatrix} 10.63-j20.86 & -5+j10 & -2.56+j5.47 & -3.08+j5.38 \\ -5+j10 & 9-j18 & -4+j8 & 0 \\ -2.56+j5.47 & -4+j8 & 9.89-j20.1 & -3.33+j6.67 \\ -3.08+j5.38 & 0 & -3.33+j6.67 & 6.4-j12.05 \end{bmatrix}$

Tutorial 2

Gauss-Siedel and Newton Raphson Methods

1. A load of 125 MW and 55 Mvar is connected to a generator through a transmission line with series impedance and shunt admittance as shown in Figure 1. The voltage, impedance and admittance are in pu on a common 100 MVA base. Use the Gauss-Siedel method to determine the (i) voltage at bus 2 after two iterations, and (ii) after several iterations the bus voltage at bus 2 converges to $\vec{V}_2 = 0.89479 - j0.0812$ pu. Determine the line flows and line losses and the slack bus real and reactive power.

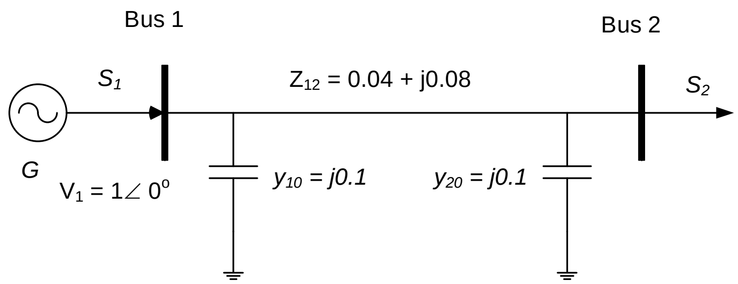


Figure 1.

2. A two-bus single-line diagram with a series impedance is shown in Figure 2. The voltage, impedance and load are in pu on a common 100 MVA base. Use the Newton-Raphson method to determine $\vec{V}_2$ after one iteration. After several iterations, the bus voltage converges to $\vec{V}_2 = 0.9112\angle - 2.5161^o$ pu. Determine the slack bus real and reactive power and the line flows and line losses.

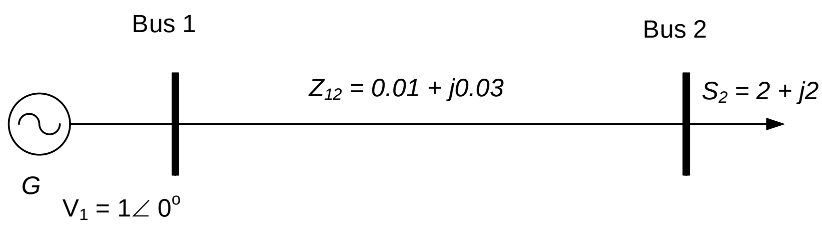


Figure 2.

Answers:

1. $\vec{V}_2^1 = 0.9130 - j0.0823$ pu, $\vec{V}_2^2 = 0.8971 - j0.0798$ pu, $P_1 = 133.8$ MW , $Q_1 =$ 54.59 Mvar

2. $0.92\angle - 2.292^o$ pu, $P_1 = 2.0965$ pu, $Q_1 = 2.289$ pu, $\vec{S}_{12} = 2.0965 + j2.28$ pu, $\vec{S}_{21} = -2.0002 - j2.0002$ pu, $\vec{S}_{L12} = 0.0965 + j0.289$ pu