Diagnostic Test

EE 5308

Fall 2010
1. For the following three-phase power system consider a common base of 100 MVA and 22 kV on the generator side. The system data is given as follow:

Generator: 90 MVA 22 kV X = 18 %
Transformer 1: 50 MVA 22/220 kV X = 10 %
Transformer 2: 40 MVA 220/11 kV X = 6.0 %
Transformer 3: 40 MVA 22/110 kV X = 6.4 %
Transformer 4: 40 MVA 110/11 kV X = 8.0 %
Motor: 66.5 MVA 10.45 kV X = 18.5 %
Load: 57 MVA 10.45 kV power factor of 0.6
Line 1: R= 48.4 Ω X = 65.43 Ω
Line 2: R= 48.4 Ω X = 65.43 Ω

A. Draw an impedance diagram with all impedances marked in per unit.
B. Determine the generator bus voltage.
C. Determine generator and motor internal emf
2. For the following power system determine the followings:
A) Using the Gauss-Seidel method, determine the phaor values of the voltage at Buses 2 and 3 after two iteration.
B) Find the slack bus real and reactive power.
C) Determine the line flows and line losses.
3. A large network has the following bus-impedance matrices.

\[ Z_{bus}^+ = Z_{bus}^- = j \begin{bmatrix} 0.05 & 0.01 & 0.03 & 0.02 \\ 0.01 & 0.06 & 0.04 & 0.03 \\ 0.03 & 0.04 & 0.05 & 0.02 \\ 0.02 & 0.03 & 0.02 & 0.05 \end{bmatrix} \]

\[ Z_{bus}^0 = j \begin{bmatrix} 0.1 & 0.06 & 0.04 & 0.06 \\ 0.06 & 0.07 & 0.01 & 0.01 \\ 0.04 & 0.01 & 0.03 & 0.01 \\ 0.06 & 0.01 & 0.01 & 0.01 \end{bmatrix} \]

Calculate the fault current, \( I_f \) and the resulting phase voltages for each phase \( V_a \), \( V_b \), and \( V_c \) of all four buses for a single-line to ground fault at bus 4.

You may use the following formulas:

\[
V^{(v+1)}_i = \frac{1}{y_{ii}} \left[ \frac{P_i - Q_i}{V_i} - \sum_{k=1, k \neq i}^{n} y_{ik} V^{(v')}_k \right] \quad i = 2, \ldots n
\]

\[
Q_i = -\sum_{k=1}^{n} y_{ik} |V_i| |V_k| \sin(\delta_k - \delta_i + \gamma_{ik})
\]

\[
I^+_k = I^-_k = I^0_k = \frac{V^f}{Z_{kk}^+ + Z_{kk}^- + Z_{kk}^0 + 3Z^f}
\]

\[
V^0_i = -Z^0_{ik} I^0_k
\]

\[
V^-_i = -Z^-_{ik} I^-_k
\]

\[
V^+_i = V^f - Z^+_ik I^+_k
\]