EE341 Project Guide

Review: Using iteration to solve load flow problem

Problem 1: \( V_2 \) given, \( S \) given, find \( V_1 \)  
Circuit theory problem

\[
I = \left( \frac{S}{V_2} \right)^* \\
V_1 = V_2 + I \cdot Z
\]

Problem 2: \( V_1 \) given, \( S \) given, find \( V_2 \)  
Load flow problem

\[
\begin{align*}
I &= \left( \frac{S}{V_2} \right)^* \\
V_2 &= V_1 - I \cdot Z
\end{align*}
\]

Since \( V_2 \) is unknown, the current \( I \) cannot be computed directly from the power \( S \). A second order complex equation needs to be solved for \( V_2 \). (EE740)

Another way to solve these equations is to use iterative method. Detailed as below: 
(Use \( S^*, V_1^*, Z^* \) to indicate they are given values)

1. \( k=0 \), assume \( V_2^{(0)} = 1z0^o \) (initial guess)

   Compute \( I^{(0)} = \left( \frac{S^*}{V_2^{(0)}} \right)^* \) (the outer * means conjugate)

2. \( k=k+1 \),

   Compute \( V_2^{(k+1)} = V_1^* - Z^* \cdot I^{(k)} \)
   \( S^{(k+1)} = V_2^{(k+1)} \cdot I^{(k)*} \)

   If \( \Delta S = \left| S^{(k+1)} - S^* \right| \leq 10^{-6} \), then stop. And \( V_2^{(k+1)} \) is the solution

   Else \( I^{(k+1)} = \left( \frac{S^*}{V_2^{(k+1)}} \right)^* \), repeat (2) till \( \Delta S = \left| S^{(k+1)} - S^* \right| \leq 10^{-6} \), and then \( V_2^{(k+1)} \) is the solution.
Step 1: Compute the per-unit equivalent circuit:

Choose \( S_b = 1000 \text{ kVA} \)

- \( V_{b1} = 480 \text{ V} \)
- \( V_{b2} = 13,800 \text{ V} \)
- \( V_{b3} = 480 \text{ V} \)
- \( V_{b4} = 240 \text{ V} \)

Power Company

1

\[ S_1 \]

\[ 480/13,800 \text{V} \]

\[ 1000 \text{ kVA} \]

\[ R=0.01 \text{pu} \]

\[ X=0.04 \text{pu} \]

T1

Line

\[ Z_{l1} = 0.6+j4.8 \Omega \]

\[ j0.001 \Omega \]

2

T3

\[ 13,800/240 \text{V} \]

\[ 400 \text{ kVA} \]

\[ R=0.03 \text{pu} \]

\[ X=0.08 \text{pu} \]

\[ j0.001 \Omega \]

3

S2

\[ 13,800/480 \text{V} \]

\[ 500 \text{ kVA} \]

\[ R=0.02 \text{pu} \]

\[ X=0.06 \text{pu} \]
Step 2: Problem (a) - Use iteration method to solve $V_3$ and $V_4$

Given: $S_1, S_2, S_3, Z_{T1}, Z_{T2}, Z_{T3}, Z_{line1}, Z_{line2}, Z_{line3}, V_1 = (465 / 480)\angle 0^\circ$
Step 3: Problem (b) - Add reactive power \((Q_{c2} \text{ and } Q_{c3})\) to bus 3 and 4 to adjust \(V_3\) and \(V_4\).
k=0, Assume: $Q_{c_2}^{(0)} = 0, Q_{c_3}^{(0)} = 0$

$k=k+1$

| $|V_3| < 0.95$? | Yes |
|---|---|
| No |

| $Q_{c_2}^{(k+1)} = Q_{c_2}^{(k)} - j0.001$ |

| $|V_3| > 1.05$? | Yes |
|---|---|
| No |

| $Q_{c_2}^{(k+1)} = Q_{c_2}^{(k)} + j0.001$ |

| $|V_4| < 0.97$? | Yes |
|---|---|
| No |

| $Q_{c_3}^{(k+1)} = Q_{c_3}^{(k)} - j0.001$ |

| $|V_4| > 1.03$? | Yes |
|---|---|
| No |

| $Q_{c_3}^{(k+1)} = Q_{c_3}^{(k)} + j0.001$ |

$S_{2,new} = S_{2,old} + Q_{c_2}, S_{3,new} = S_{3,old} + Q_{c_3}$

Compute $V_3$ and $V_4$ as in problem (a)

<table>
<thead>
<tr>
<th>$V_3$ and $V_4$ meet requirement?</th>
<th>Yes</th>
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</thead>
<tbody>
<tr>
<td>No</td>
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Solved