Attachment for Errata 082016

Pages 255-257: corrections for Example 7.5 and Solution:

Example 7.5

Solve the following three nonlinear equations by using Newton-Raphson method.

$$x_1^2 + x_2^2 - x_3^2 = -1$$

$$x_1^2 - x_1 x_2 + 4x_3 = 12$$

$$2x_1 + x_1 x_2 + x_3^2 = 17$$

Assume that the initial solutions are $x_1^0 = x_2^0 = 1,\ \ x_3^0 = 2$ and the convergence criterion is ε=0.0001.

Solution:

Rearrange the equations as follows.

$$f_1 = x_1^2 + x_2^2 - x_3^2 + 1 = 0$$

$$f_2 = x_1^2 - x_1 x_2 + 4x_3 - 12 = 0$$

$$f_3 = 2x_1 + x_1 x_2 + x_3^2 - 17 = 0$$

According to Equations (7.16) and (7.17), we have

$$\mathbf{J} = \begin{bmatrix} 2x_1 & 2x_2 & -2x_3 \\ 2x_1 - x_2 & -x_1 & 4 \\ 2 + x_2 & x_1 & 2x_3 \end{bmatrix} \text{ and } \mathbf{\Delta f^0} = \begin{bmatrix} -f_1^0 \\ -f_2^0 \\ -f_3^0 \end{bmatrix} = \begin{bmatrix} -2 \\ 8 \\ 13 \end{bmatrix}$$

For the first iteration, we have

$$\begin{bmatrix} 2 & 2 & -4 \\ 1 & -1 & 4 \\ 3 & 1 & 4 \end{bmatrix} \begin{bmatrix} \Delta x_1^0 \\ \Delta x_2^0 \\ \Delta x_3^0 \end{bmatrix} = \begin{bmatrix} -2 \\ 8 \\ 13 \end{bmatrix}$$

$$\begin{bmatrix} \Delta x_1^0 \\ \Delta x_2^0 \\ \Delta x_3^0 \end{bmatrix} = \begin{bmatrix} 2 & 2 & -4 \\ 1 & -1 & 4 \\ 3 & 1 & 4 \end{bmatrix}^{-1} \begin{bmatrix} -2 \\ 8 \\ 13 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 1.25 \end{bmatrix}$$

The estimated solutions for next iteration are

$$\begin{bmatrix} x_1^1 \\ x_2^1 \\ x_3^1 \end{bmatrix} = \begin{bmatrix} x_1^0 + \Delta x_1^0 \\ x_2^0 + \Delta x_2^0 \\ x_3^0 + \Delta x_3^0 \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \\ 3.25 \end{bmatrix}$$

The same process repeats after 5 iterations and the convergence criterion is met. The final solutions are $x_1 = x_2 = 2$ and $x_3 = 3$. Table 7.5 lists the iterative results.

Table 7.5

k	x_1	x_2	x_3
0	1	1	2
1	2	3	3.25
2	2.234568	1.861111	2.871914
3	2.024026	1.973407	2.991379
4	2.000495	1.999443	2.999765
5	2.000000	2.000000	3.000000

MATLAB program for Example 7.5 (ex7_5.m):

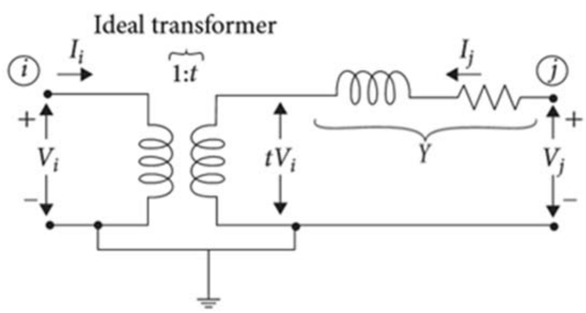
```
% M-file for Example 7.5: ex7_5.m
clc
clear all
% The three nonlinear equations are given by
% x1^2 + x2^2 - x3^2 = -1
% x1^2 - x1x2 + 4x3    = 12
% 2x1 + x1x2 + x3^2 = 17;
% The initial solutions : x1=x2=1,    x3=1
x = [1 ; 1; 2];
deltax =[10;10;10];                          % Assuming deltax is greater than 0.0001
i=0;                                         % Iteration count : i
while(max(abs(deltax))>=0.0001)    % Convergence criterion
disp(['The number of iteration : ' num2str(i)])
i=i+1;
% The three nonlinear equations
F = [ x(1)^2+x(2)^2-x(3)^2;
      x(1)^2-x(1)*x(2) + 4*x(3) ;
      2*x(1)+x(1)*x(2)+ x(3)^2];
% Jacobian matrix
```

```
J = [2*x(1) 2*x(2) -2*x(3); 2*x(1)-x(2) -x(1) 4; 2+x(2) x(1) 2*x(3)]
% Equation mismatch
df =[-1 ;12 ;17] - F ;
    deltax =J\df
    x = x+deltax
end
```

Page 274: correction of Equation (7.55)

$$\underbrace{\begin{bmatrix} \frac{\partial P_2}{\partial \delta_2} & \cdots & \frac{\partial P_2}{\partial \delta_N} & \frac{\partial P_2}{\partial |V_2|} & \cdots & \frac{\partial P_2}{\partial |V_N|} \\ \vdots & \mathbf{J}_{11} & \vdots & \vdots & \mathbf{J}_{12} & \vdots \\ \frac{\partial P_N}{\partial \delta_2} & \cdots & \frac{\partial P_N}{\partial \delta_N} & \frac{\partial P_N}{\partial |V_2|} & \cdots & \frac{\partial P_N}{\partial |V_N|} \\ \frac{\partial Q_2}{\partial \delta_2} & \cdots & \frac{\partial Q_2}{\partial \delta_N} & \frac{\partial Q_2}{\partial |V_2|} & \cdots & \frac{\partial Q_2}{\partial |V_N|} \\ \vdots & \mathbf{J}_{21} & \vdots & \vdots & \mathbf{J}_{22} & \vdots \\ \frac{\partial Q_N}{\partial \delta_2} & \cdots & \frac{\partial Q_N}{\partial \delta_N} & \frac{\partial Q_N}{\partial |V_2|} & \cdots & \frac{\partial Q_N}{\partial |V_N|} \end{bmatrix}}_{\text{Jacobian}} \underbrace{\begin{bmatrix} \Delta\delta_2 \\ \vdots \\ \Delta\delta_N \\ \Delta|V_2| \\ \vdots \\ \Delta|V_N| \end{bmatrix}}_{\text{Corrections}} = \underbrace{\begin{bmatrix} \Delta P_2 \\ \vdots \\ \Delta P_N \\ \Delta Q_2 \\ \vdots \\ \Delta Q_N \end{bmatrix}}_{\text{Mismatches}} \qquad (7.55)$$

Page 282: correct Figure 7.10



Pages 293, 294: correct Figure 7.16 and solution:

Example 7.15

For the power system of Fig. 7.16, bus 1 is the slack bus with a zero phase angle of bus voltage. Use DC power-flow method to determine (a) the phase angle of each bus voltage, (b) the real power generation of the slack bus, and (c) real power flow in each branch of the transmission network. (Note: the line admittance is in per unit)

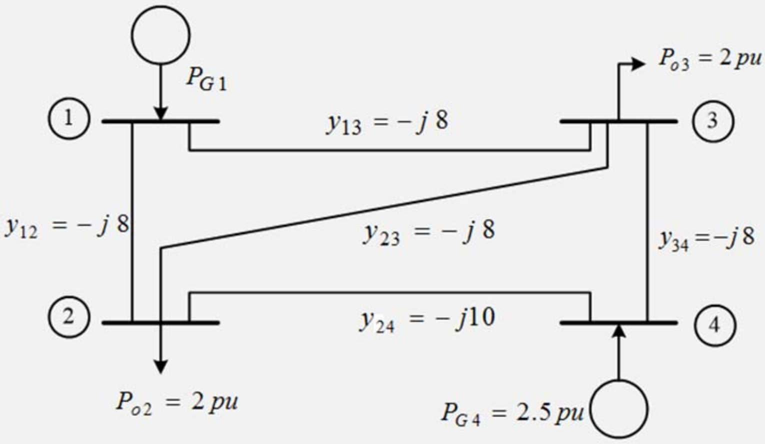


Fig. 7.16
Four-bus network for DC power-flow analysis.

Solution.

(a) Since bus 1 is slack bus, we have

$$\mathbf{Y_{bus}} = \begin{bmatrix} -j16 & j8 & j8 & 0 \\ j8 & -j26 & j8 & j10 \\ j8 & j8 & -j24 & j8 \\ 0 & j10 & j8 & -j18 \end{bmatrix}$$

and $$\mathbf{B} = -\begin{bmatrix} -26 & 8 & 10 \\ 8 & -24 & 8 \\ 10 & 8 & -18 \end{bmatrix}$$

(b) Since $\mathbf{P} = \mathbf{B}\boldsymbol{\delta}$, we have

$$\begin{bmatrix} 26 & -8 & -10 \\ -8 & 24 & -8 \\ -10 & -8 & 18 \end{bmatrix} \begin{bmatrix} \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} = \begin{bmatrix} -2 \\ -2 \\ 2.5 \end{bmatrix}$$

$$\begin{bmatrix} \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} = \begin{bmatrix} -0.0895 \\ -0.0980 \\ 0.0456 \end{bmatrix} \text{rad} \quad \text{or} \quad \begin{bmatrix} \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} = \begin{bmatrix} -5.13^\circ \\ -5.61^\circ \\ 2.61^\circ \end{bmatrix}$$

(c) The real power generation at bus 1 and real power flow in each branch are as follows.

$$P_{G1} = 2 + 2 - 2.5 = 1.5 \quad \text{pu}$$

$$P_{12} = -P_{21} = \frac{0 - (-0.0895)}{0.125} = 0.716 \quad \text{pu}$$

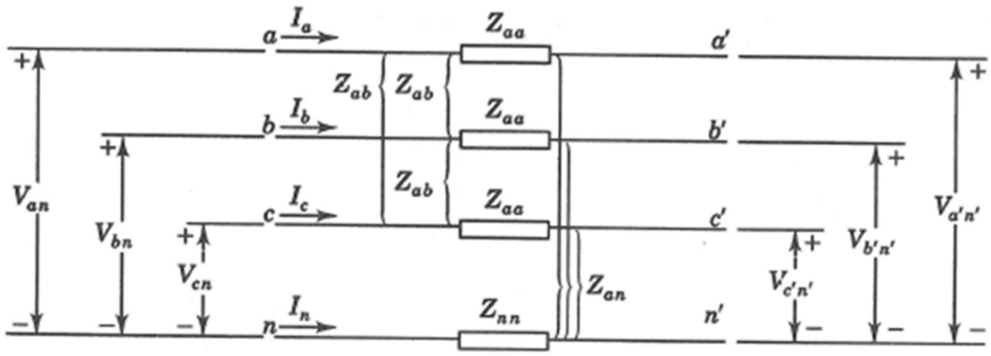
$$P_{13} = -P_{31} = \frac{0-(-0.098)}{0.125} = 0.784 \quad \text{pu}$$

$$P_{23} = -P_{32} = \frac{-0.0895+0.098}{0.125} = 0.068 \quad \text{pu}$$

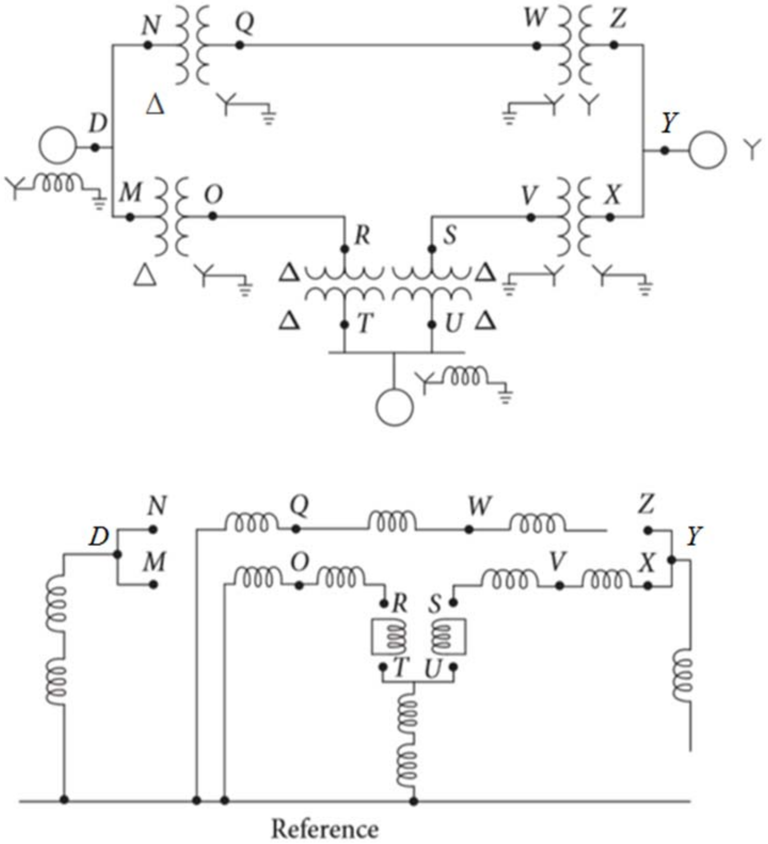
$$P_{24} = -P_{42} = \frac{-0.0895-0.0456}{0.1} = -1.351 \quad \text{pu}$$

$$P_{34} = -P_{43} = \frac{-0.098 - 0.0456}{0.125} = -1.149 \quad \text{pu}$$

Page 353, correct Figure 9.11:



Page 378, correct Figure 9.28:



Page 387, correct Figure 10.2(a):

(a) Single-line diagram of balanced three-phase system