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clear;clc;

% PARAMETERS THAT ARE THE SAME FOR ALL CASES
V1 = 1.00 + 0.0i; %(voltage of slack bus bar)
base_power = 100; % Base power (MVA) delivered to loads

% Load power at busbars
SD2 = -0.75 - 0.50i;
SD3 = -0.50 - 0.25i;
SD4 = -0.25 - 0.75i;
SD5 = -0.25 - 0.25i;
SD6 = -0.75 - 0.25i;

% Loads (in pu) connected to busbars 2-6
Z = zeros(6,6);
Z(1,2) = 0.010 + 0.02i;
Z(1,3) = 0.020 + 0.03i;
Z(2,3) = 0.010 + 0.04i;
Z(3,4) = 0.020 + 0.03i;
Z(4,5) = 0.010 + 0.03i;
Z(1,6) = 0.020 + 0.04i;
Z(5,6) = 0.020 + 0.03i;

for i = 6:-1:1
    for j = 6:-1:1
        if i == j
            Z(i,j) = 0;
        else
            Z(i,j) = Z(j,i);
        end
    end
end
Z;

% Bus admittance matrix (Y Bus)
Y = zeros(6,6);
for i = 1:6
    for j = 1:6
        if i == j
            for k = 1:6
                if Z(i,k) == 0
                    % neglect this one
                else
                    Y(i,j) = Y(i,j) + 1/Z(i,k);
                end
            end
        else
            if Z(i,j) == 0
                % neglect this one
            else

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        Y(i,j) = -1/Z(i,j);
    end
end
end
Y

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Y = 6x6 complex
 45.3846 -83.0769i -20.0000 +40.0000i -15.3846 +23.0769i  0.0000 + 0.0000i ...
-20.0000 +40.0000i  25.8824 -63.5294i -5.8824 +23.5294i  0.0000 + 0.0000i
-15.3846 +23.0769i -5.8824 +23.5294i  36.6516 -69.6833i -15.3846 +23.0769i
 0.0000 + 0.0000i  0.0000 + 0.0000i -15.3846 +23.0769i  25.3846 -53.0769i
 0.0000 + 0.0000i  0.0000 + 0.0000i  0.0000 + 0.0000i -10.0000 +30.0000i
-10.0000 +20.0000i  0.0000 + 0.0000i  0.0000 + 0.0000i  0.0000 + 0.0000i

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% Create a matrix to summarise all the cases (used later for line loss table)
cases = zeros(8,6);

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% Summarise locations of the new generator and capacitor bank for each case
% (used later for generated power at busbars)

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SG = [0, 0, 0, 0, 0;
      (0.5 + 0.5i), 0, 0, 0, 0;
      0, (0.5 + 0.5i), 0, 0, 0;
      0, 0, (0.5 + 0.5i), 0, 0;
      0, 0, 0, (0.5 + 0.5i), 0;
      0, 0, 0, 0, (0.5 + 0.5i)];

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for c = 1:6

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    % Generated power at busbars (using summary created earlier)

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    SG2 = SG(c,1);
    SG3 = SG(c,2);
    SG4 = SG(c,3);
    SG5 = SG(c,4);
    SG6 = SG(c,5);

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    % Total power at busbars

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    S2 = SG2 + SD2;
    S3 = SG3 + SD3;
    S4 = SG4 + SD4;
    S5 = SG5 + SD5;
    S6 = SG6 + SD6;

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    % Voltage at each busbar (using Gauss-Seidle iteration method)

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    % start with non-zero values

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    V2(1) = 0.5 + 0i;
    V3(1) = 0.5 + 0i;
    V4(1) = 0.5 + 0i;
    V5(1) = 0.5 + 0i;
    V6(1) = 0.5 + 0i;

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    for j=1:1:99

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        V2(j+1) = (1/Y(2,2))*(conj(S2/V2(j)) - Y(2,1)*V1 - Y(2,3)*V3(j) -
Y(2,4)*V4(j) - Y(2,5)*V5(j) - Y(2,6)*V6(j));
        V3(j+1) = (1/Y(3,3))*(conj(S3/V3(j)) - Y(3,1)*V1 - Y(3,2)*V2(j) -
Y(3,4)*V4(j) - Y(3,5)*V5(j) - Y(3,6)*V6(j));
        V4(j+1) = (1/Y(4,4))*(conj(S4/V4(j)) - Y(4,1)*V1 - Y(4,2)*V2(j) -
Y(4,3)*V3(j) - Y(4,5)*V5(j) - Y(4,6)*V6(j));
        V5(j+1) = (1/Y(5,5))*(conj(S5/V5(j)) - Y(5,1)*V1 - Y(5,2)*V2(j) -
Y(5,3)*V3(j) - Y(5,4)*V4(j) - Y(5,6)*V6(j));
        V6(j+1) = (1/Y(6,6))*(conj(S6/V6(j)) - Y(6,1)*V1 - Y(6,2)*V2(j) -
Y(6,3)*V3(j) - Y(6,4)*V4(j) - Y(6,5)*V5(j));
end

% Use these final values
V2(100);
V3(100);
V4(100);
V5(100);
V6(100);

% Power generated at busbar 1 (S1 = V1 x I1*)
% (use the final voltage values Vj(100))
S1 = V1*(Y(1,1)*V1 + Y(1,2)*V2(100) + Y(1,3)*V3(100) + Y(1,4)*V4(100) +
Y(1,5)*V5(100) + Y(1,6)*V6(100));

% Line flows (pu)
I12 = Y(1,2)*(V1 - V2(100));
I21 = -I12;
I13 = Y(1,3)*(V1 - V3(100));
I31 = -I13;
I16 = Y(1,6)*(V1 - V6(100));
I61 = -I16;
I23 = Y(2,3)*(V2(100) - V3(100));
I32 = -I23;
I34 = Y(3,4)*(V3(100) - V4(100));
I43 = -I34;
I45 = Y(4,5)*(V4(100) - V5(100));
I54 = -I45;
I56 = Y(5,6)*(V5(100) - V6(100));
I65 = -I56;

S12 = V1*conj(I12);
S21 = V2(100)*conj(I21);
S13 = V1*conj(I13);
S31 = V3(100)*conj(I31);
S16 = V1*conj(I16);
S61 = V6(100)*conj(I61);
S23 = V2(100)*conj(I23);
S32 = V3(100)*conj(I32);
S34 = V3(100)*conj(I34);
S43 = V4(100)*conj(I43);

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S45 = V4(100)*conj(I45);
S54 = V5(100)*conj(I54);
S56 = V5(100)*conj(I56);
S65 = V6(100)*conj(I65);

% Line losses (pu)
SL12_pu = S12 + S21;
SL13_pu = S13 + S31;
SL16_pu = S16 + S61;
SL23_pu = S23 + S32;
SL34_pu = S34 + S43;
SL45_pu = S45 + S54;
SL56_pu = S56 + S65;

% Line losses (MW & MVAR)
SL12 = SL12_pu*base_power;
SL13 = SL13_pu*base_power;
SL16 = SL16_pu*base_power;
SL23 = SL23_pu*base_power;
SL34 = SL34_pu*base_power;
SL45 = SL45_pu*base_power;
SL56 = SL56_pu*base_power;

% Total Line loss (pu)
SL_total_pu = SL12_pu + SL13_pu + SL16_pu + SL23_pu + SL34_pu + SL45_pu +
SL56_pu;

% Total Line loss (MW & MVAR)
SL_total = SL12 + SL13 + SL16 + SL23 + SL34 + SL45 + SL56;

% Summarise the line losses for this case
cases(1,c) = SL12;
cases(2,c) = SL13;
cases(3,c) = SL16;
cases(4,c) = SL23;
cases(5,c) = SL34;
cases(6,c) = SL45;
cases(7,c) = SL56;
cases(8,c) = SL_total;
end

cases

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cases = 8x6 complex
-1.3737 - 2.7474i -0.3850 - 0.7700i -0.8878 - 1.7755i -0.9790 - 1.9579i ...
-2.1891 - 3.2837i -1.6272 - 2.4407i -0.8052 - 1.2077i -1.0398 - 1.5598i
-2.5705 - 5.1409i -2.4072 - 4.8144i -2.1151 - 4.2302i -1.5030 - 3.0060i
-0.0809 - 0.3235i -0.2063 - 0.8254i -0.0055 - 0.0220i -0.0127 - 0.0510i
-1.1869 - 1.7804i -1.2877 - 1.9315i -1.4767 - 2.2150i -0.1887 - 0.2831i
-0.0452 - 0.1357i -0.0440 - 0.1319i -0.0538 - 0.1615i -0.1012 - 0.3035i
-0.3799 - 0.5698i -0.3227 - 0.4841i -0.2432 - 0.3649i -0.1031 - 0.1546i
-7.8262 -13.9814i -6.2800 -11.3980i -5.5873 - 9.9768i -3.9275 - 7.3159i

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```
% TABULATE line losses for each case
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```
T = array2table(cases,...
    'VariableNames',{'non-existent' 'at busbar 2' 'at busbar 3' 'at busbar 4' 'at
busbar 5' 'at busbar 6'}, ...
    'RowNames',{'SL12';'SL13';'SL16';'SL23';'SL34';'SL45';'SL56';'SL_total'}));
disp(T)
```

	non-existent	at busbar 2	at busbar 3	at busbar 4	at busbar 5
SL12	-1.3737-2.7474i	-0.38498-0.76997i	-0.88777-1.7755i	-0.97896-1.9579i	-1.0833-2.1667i
SL13	-2.1891-3.2837i	-1.6272-2.4407i	-0.80516-1.2077i	-1.0398-1.5598i	-1.3114-2.6111i
SL16	-2.5705-5.1409i	-2.4072-4.8144i	-2.1151-4.2302i	-1.503-3.006i	-1.0644-2.1667i
SL23	-0.08088-0.32352i	-0.20634-0.82536i	-0.0054897-0.021959i	-0.012743-0.050971i	-0.023639-0.095861i
SL34	-1.1869-1.7804i	-1.2877-1.9315i	-1.4767-2.215i	-0.18874-0.28311i	-0.3477-0.5311i
SL45	-0.045242-0.13572i	-0.043966-0.1319i	-0.053825-0.16147i	-0.10115-0.30346i	-0.17007-0.5311i
SL56	-0.37985-0.56978i	-0.32275-0.48412i	-0.24324-0.36486i	-0.1031-0.15465i	-0.095861-0.30346i
SL_total	-7.8262-13.981i	-6.28-11.398i	-5.5873-9.9768i	-3.9275-7.3159i	-4.0967-6.28i

```
T = table(T,'VariableNames',{'Line losses (MW & MVAR)' 'New generator
location '}); % Nested table
disp(T)
```

Line losses (MW & MVAR)	New generator location
1x6 table	
1x6 table	
1x6 table	
1x6 table	
1x6 table	
1x6 table	
1x6 table	
1x6 table	