Lab Report

Alexandria university

Faculty of Engineering

Electrical Power and Machines Engineering Program

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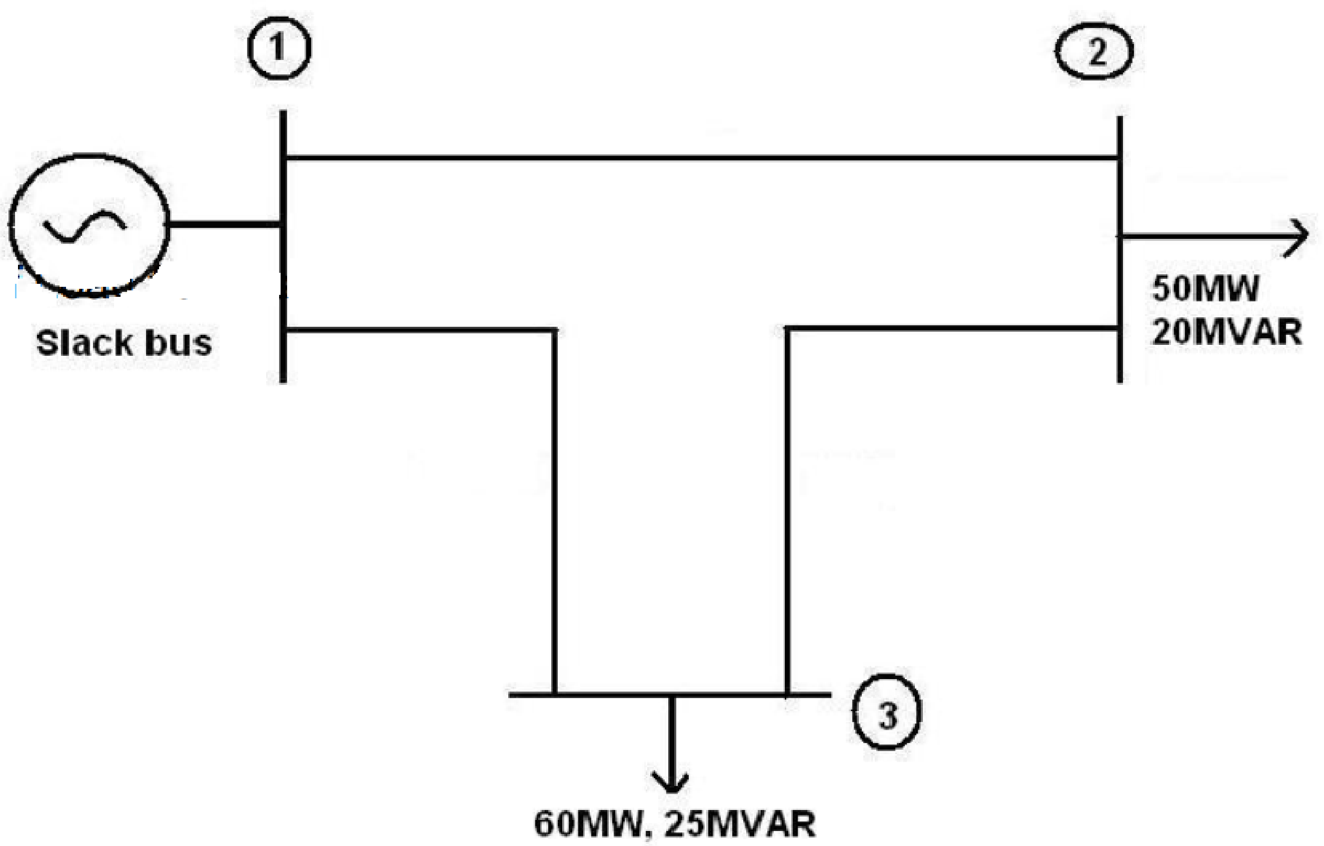
Load Flow Analysis
Using
Gauss-Seidel Method

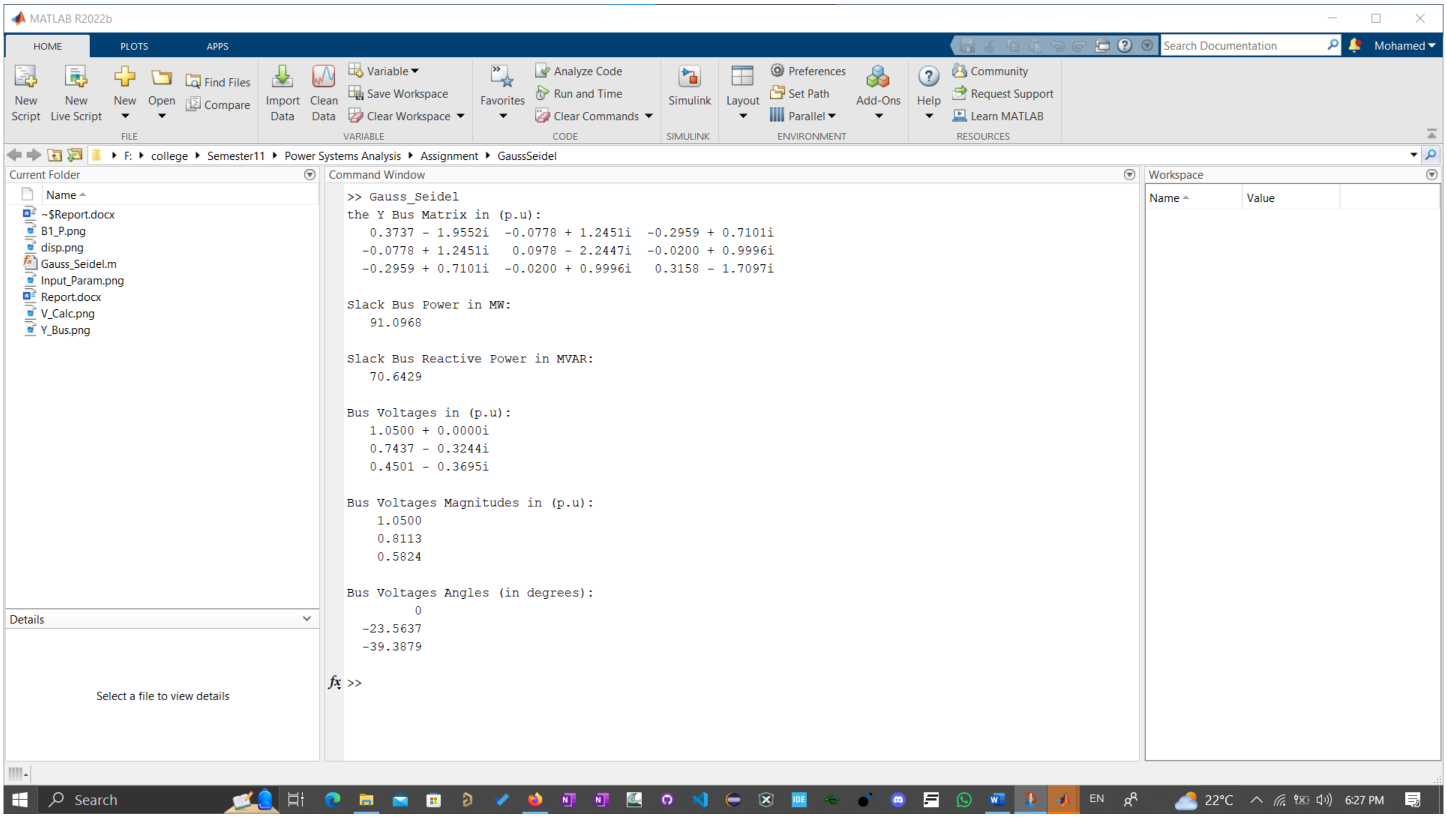
Introduction

I am using the Gauss-Seidel numerical method to obtain an approximate solution to the 3-bus system provided in the image below.



I calculated the voltages magnitudes and angles for the 3 buses and the injected power for the slack bus (BUS 1).

The Results


MATLAB R2022b
Current Folder
~$Report.docx
B1_P.png
disp.png
Gauss_Seidel.m
Input_Param.png
Report.docx
V_Calc.png
Y_Bus.png
Command Window
>> Gauss_Seidel
the Y Bus Matrix in (p.u):
0.3737 - 1.9552i -0.0778 + 1.2451i -0.2959 + 0.7101i
-0.0778 + 1.2451i 0.0978 - 2.2447i -0.0200 + 0.9996i
-0.2959 + 0.7101i -0.0200 + 0.9996i 0.3158 - 1.7097i
Slack Bus Power in MW:
91.0968
Slack Bus Reactive Power in MVAR:
70.6429
Bus Voltages in (p.u):
1.0500 + 0.0000i
0.7437 - 0.3244i
0.4501 - 0.3695i
Bus Voltages Magnitudes in (p.u):
1.0500
0.8113
0.5824
Bus Voltages Angles (in degrees):
0
-23.5637
-39.3879
>>
Workspace
Select a file to view details

A zoomed in version of the results

Command Window

```
>> Gauss_Seidel
the Y Bus Matrix in (p.u):
   0.3737 - 1.9552i  -0.0778 + 1.2451i  -0.2959 + 0.7101i
  -0.0778 + 1.2451i   0.0978 - 2.2447i  -0.0200 + 0.9996i
  -0.2959 + 0.7101i  -0.0200 + 0.9996i   0.3158 - 1.7097i

Slack Bus Power in MW:
   91.0968

Slack Bus Reactive Power in MVAR:
   70.6429

Bus Voltages in (p.u):
   1.0500 + 0.0000i
   0.7437 - 0.3244i
   0.4501 - 0.3695i

Bus Voltages Magnitudes in (p.u):
    1.0500
    0.8113
    0.5824

Bus Voltages Angles (in degrees):
         0
  -23.5637
  -39.3879

fx >>
```

The input parameters for the these results:

```
% Line impedances
Z12 = 0.05 + 0.8i;
Z13 = 0.5 + 1.2i;
Z23 = 0.02 + 1i;

% Complex power injections (S) at each bus
S_IN_MVA = [0; -50-20i; -60-25i]; % Set the slack bus power to 0
BASE_MVA = 100;
S = S_IN_MVA ./ BASE_MVA;
```

The code (A Text Version Provided at the End)

The input parameters:

```
% Line impedances
Z12 = 0.05 + 0.8i;
Z13 = 0.5 + 1.2i;
Z23 = 0.02 + 1i;

% Complex power injections (S) at each bus
S_IN_MVA = [0; -50-20i; -60-25i]; % Set the slack bus power to 0
BASE_MVA = 100;
S = S_IN_MVA ./ BASE_MVA;
```

Y Bus Calculations:

```
% Admittance matrix
Y = zeros(3, 3);

% Calculate the diagonal elements of Y
Y(1, 1) = 1 / Z12 + 1 / Z13;
Y(2, 2) = 1 / Z12 + 1 / Z23;
Y(3, 3) = 1 / Z13 + 1 / Z23;

% Calculate the off-diagonal elements of Y
Y(1, 2) = -1 / Z12;
Y(2, 1) = Y(1, 2);

Y(1, 3) = -1 / Z13;
Y(3, 1) = Y(1, 3);

Y(2, 3) = -1 / Z23;
Y(3, 2) = Y(2, 3);
```

Gauss-Seidel iterations:

```
% Initial values
V = ones(3, 1); % Voltage magnitudes

V(1) = 1.05;

% Maximum number of iterations and tolerance
maxIterations = 100;

% Gauss-Seidel iterations
for iter = 1:maxIterations
    % Iterate for each bus, excluding the slack bus (starting from bus 2)
    for i = 2:3
        current = 0;
        for j = 1:3
            if(j ~= i)
                current = current + Y(i,j) * V(j);
            end
        end
        V(i) = ( (conj(S(i))/conj(V(i))) - current) / Y(i,i);
    end
end
```

Slack Bus power calculation:

```
I = 0;
for k = 1:3
    I = I + (Y(1,k) * V(k));
end
SlackBus_Power = conj(conj(V(1)) * I);

SlackBus_Power =  SlackBus_Power * BASE_MVA;
```

Displaying the Results:

```
% Display results
disp('the Y Bus Matrix in (p.u):');
disp(Y);
disp('Slack Bus Power in MW:');
disp(real(SlackBus_Power));
disp('Slack Bus Reactive Power in MVAR:');
disp(imag(SlackBus_Power));
disp('Bus Voltages in (p.u):');
disp(V);
disp('Bus Voltages Magnitudes in (p.u):');
disp(abs(V));
disp('Bus Voltages Angles (in degrees):');
disp(rad2deg(angle(V)));
```

```matlab
function Gauss_Seidel()

% Line impedances
Z12 = 0.05 + 0.8i;
Z13 = 0.5 + 1.2i;
Z23 = 0.02 + 1i;

% Complex power injections (S) at each bus
S_IN_MVA = [0; -50-20i; -60-25i]; % Set the slack bus power to 0
BASE_MVA = 100;
S = S_IN_MVA ./ BASE_MVA;

% Admittance matrix
Y = zeros(3, 3);

% Calculate the diagonal elements of Y
Y(1, 1) = 1 / Z12 + 1 / Z13;
Y(2, 2) = 1 / Z12 + 1 / Z23;
Y(3, 3) = 1 / Z13 + 1 / Z23;

% Calculate the off-diagonal elements of Y
Y(1, 2) = -1 / Z12;
Y(2, 1) = Y(1, 2);

Y(1, 3) = -1 / Z13;
Y(3, 1) = Y(1, 3);

Y(2, 3) = -1 / Z23;
Y(3, 2) = Y(2, 3);


% Initial values
V = ones(3, 1); % Voltage magnitudes

V(1) = 1.05;

% Maximum number of iterations and tolerance
maxIterations = 100;

% Gauss-Seidel iterations
for iter = 1:maxIterations
    % Iterate for each bus, excluding the slack bus (starting from bus 2)
    for i = 2:3
        current = 0;
        for j = 1:3
            if(j ~= i)
                current = current + Y(i,j) * V(j);
            end
        end
        V(i) = ( (conj(S(i))/conj(V(i))) - current) / Y(i,i);
    end
end

I = 0;
for k = 1:3
    I = I + (Y(1,k) * V(k));
end
SlackBus_Power = conj(conj(V(1)) * I);

SlackBus_Power =  SlackBus_Power * BASE_MVA;
```

```
% Display results
disp('the Y Bus Matrix in (p.u):');
disp(Y);
disp('Slack Bus Power in MW:');
disp(real(SlackBus_Power));
disp('Slack Bus Reactive Power in MVAR:');
disp(imag(SlackBus_Power));
disp('Bus Voltages in (p.u):');
disp(V);
disp('Bus Voltages Magnitudes in (p.u):');
disp(abs(V));
disp('Bus Voltages Angles (in degrees):');
disp(rad2deg(angle(V)));

end
```