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MTE 204

Project 1 – Circuit Analysis – System of Linear Equations

For this project, the Gauss Seidel method was tested using derivations from circuit 1 and circuit 3. Convergence was demonstrated using an approximate relative error of 0.000001. Before creating the Matlab program, the equations of the circuits were derived using Kirchhoff's Voltage Law and Kirchhoff's Current Law.

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Circuit 1: 6 equations, 6 unknowns
KCL equations:
 0 = i1 - i2 - i6
 0 = i2 - i3
 0 = i3 - i4
 0 = i4 - i5 + i6
KVL equations:
 -200 = 10*i1 + 25*i5 + 5*i6
 0 = 20*i2 + 2*i3 + 5*i4 - 5*i6
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Circuit 3: 5 equations, 5 unknowns
KCL equations:
 0 = i1 - i2 - i4
 0 = i2 + i3 - i5
KVL equations:
 -80 = 5*i1 + 15*i4
 0 = 10*i2 - 15*i4 + 25*i5
 -50 = 20*i3 + 25*i5
```

The equations of each circuit were then rearranged into a diagonally dominant matrix. Knowing that the matrices could be arranged to be diagonally dominant, the initial guesses for both circuits were all zeroes. The Gauss Seidel function was programmed using the following equation.

$$x_i^{new} = \lambda x_i^{new} + (1 - \lambda) x_i^{old}$$

The function was tested using three different values of λ as the relaxation parameter. The relaxation parameter was set for no relaxation, under relation, and successive over relaxation at 1, 0.98, and 1.02 respectively.

Circuit 1 Iterations:

λ	**Iterations**
0.98	35
1	66
1.02	302

Circuit 3 Iterations:

λ	**Iterations**
0.98	48
1	66
1.02	100

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As expected, the amount of iterations required to reach convergence is decreased when relaxation parameter is less than one compared to using the Gauss Seidel method with no relaxation. In contrast, when the relaxation parameter is greater than one, the number of iterations required is increased. Each value of relaxation parameter still produced the same current values as seen in the following tables.

Circuit 1:

	i1	i2	i3	i4	i5	i6
No relaxation	-5.0996	-0.79682	-0.79682	-0.79682	-5.0996	-4.3028
Over relaxation	-5.0996	-0.79682	-0.79682	-0.79682	-5.0996	-4.3028
Under relaxation	-5.0996	-0.79681	-0.79681	-0.79681	-5.0996	-4.3028
Matlab solution	-5.0996	-0.79681	-0.79681	-0.79681	-5.0996	-4.3028
Inverse	-5.0996	-0.79681	-0.79681	-0.79681	-5.0996	-4.3028

Circuit 3:

	i1	i2	i3	i4	i5
No relaxation	-4.972	-1.2961	-0.39101	-3.676	-1.6872
Over relaxation	-4.9722	-1.296	-0.39115	-3.6759	-1.6872
Under relaxation	-4.9721	-1.2961	-0.39108	-3.676	-1.6871
Matlab solution	-4.9721	-1.2961	-0.39106	-3.676	-1.6872
Inverse	-4.9721	-1.2961	-0.39106	-3.676	-1.6872

Given the resistor values and the results of the current values, voltage was calculated using Ohm's Law.

$$V = IR$$

Circuit 1:

	v1	v2	v3	v4	v5	v6
No relaxation	-50.996	-15.936	-1.5936	-3.9841	-127.49	-21.514
Over relaxation	-50.996	-15.936	-1.5936	-3.9841	-127.49	-21.514
Under relaxation	-50.996	-15.936	-1.5936	-3.984	-127.49	-21.514
Matlab solution	-50.996	-15.936	-1.5936	-3.9841	-127.49	-21.514
Inverse	-50.996	-15.936	-1.5936	-3.9841	-127.49	-21.514

Circuit 3:

	v1	v2	v3	v4	v5
No relaxation	-24.86	-12.961	-7.8203	-55.14	-42.179
Over relaxation	-24.861	-12.96	-7.823	-55.139	-42.179
Under relaxation	-24.86	-12.961	-7.8216	-55.14	-42.179
Matlab solution	-24.86	-12.961	-7.8212	-55.14	-42.179
Inverse	-24.86	-12.961	-7.8212	-55.14	-42.179

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The results from using the Gauss Seidel method were compared to using the same system of equations with the Matlab equation solver and Inverse solution. All values using the Gauss Seidel method were equivalent to those of the Matlab equation solver and Inverse solution.