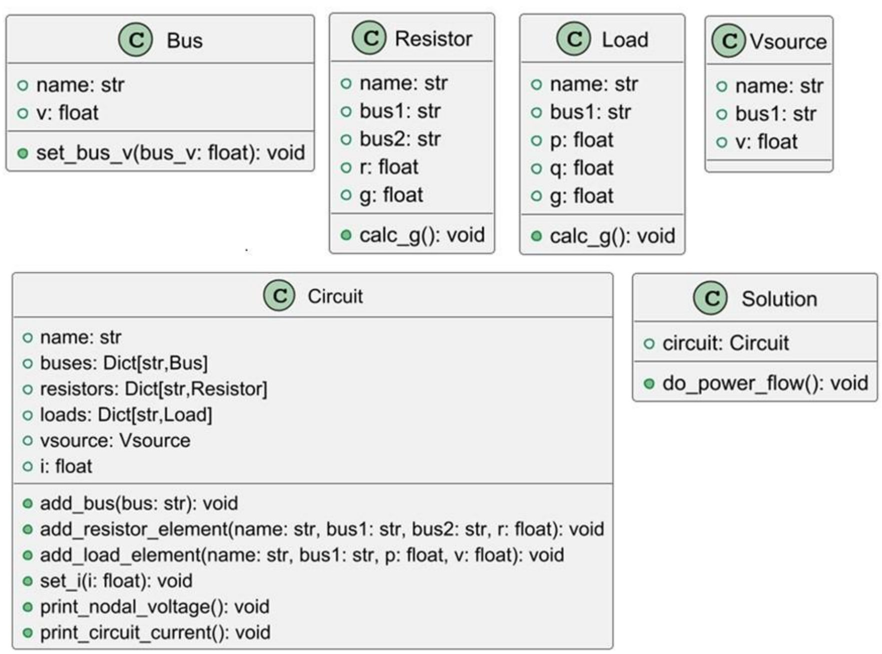
Project Overview:

The purpose of the Simple Circuit Simulator was to calculate the nodal voltages and total current of a circuit consisting of variable amounts of buses, resistors, loads, and voltage sources. For this specific problem, we were tasked with solving the circuit with two buses, one resistor, one load, and one voltage source. The implementation of our power flow calculation function effectively solves the current and nodal voltage at buses A and B. This function was implemented by first calculating the total current in the circuit through the given voltage at the source and each element's conductance. Then, the current was used to find the voltage drop across the resistor. Using the given voltage from the voltage source, which is also the voltage at bus A, in addition to the calculated voltage drop, the voltage at bus B was calculated.

Although this Simple Circuit Simulator is by design very rudimentary, it shows the benefit of analyzing power systems through a computer system. If there was a change of resistor or load value, or if there was a new element that was added to the circuit, it would be very easy to make those changes. This computer analysis system saves time and will allow for modeling of more complex systems as our circuits become further advanced.

Class Diagrams:



***note:** *.puml file is in project repository*

Relevant Equations:

Equation 1.) $G = 1 \div R$

Equation 2.) $G = P \div V^2$

Equation 3.) $P = V^2 \div R$

- Equation 1 is used in the resistor class internal function to calculate the conductance. It is equal to the reciprocal of the resistance.
- Equation 2 is used in the load class internal function to calculate the inductance. It is equal to the power divided by the voltage squared. This equation derives from Equation 3 which is the standard relationship between power, voltage, and resistance.

Equation 4.) $R = 1 \div G$

Equation 5.) $R\_eq = R1 + R2$

Equation 6.) $I\_tot = V\_a \div R\_eq$

- Equation 4 is used to convert the conductance to resistance for both the resistor and load classes. This was done as per the instructions for the project.
- Equation 5 is used to obtain total resistance of the simulated circuit.
- Equation 6 is used to calculate the total current flowing through the circuit.

Equation 7.) $V\_B = V\_A – I\_tot \times R\_a$

- Finally, Equation 7 is used to solve the nodal voltage at Bus B. This equation uses the voltage source, the nodal voltage at Bus A, and subtracts the voltage drop across the resistor to find the nodal voltage at Bus B. The voltage drop across the resistor is calculated through Oms's Law with the total current and resistance.

Example Case:

1. The same circuit will be solved with the following different parameters: 150.0-volt source, 60.0-ohm resistor, and 1125.0-watt load.

2. The solution process is identical as described above in the equation section. The conductance of the load is solved using Equation 2. Then, using Equation 4, the resistance of the load can be calculated. The resistor's resistance is solved similarly by using Equation 4 with the conductance value of the resistor. The total resistance within the circuit is solved using Equation 5. Then, using Equation 6, the total current within the circuit is calculated. Finally, the last nodal voltage at Bus B can be calculated with Equation 7 using the voltage at Bus A and the voltage drop across the resistor to calculate the voltage at Bus B.

3. The expected output voltage should be as follows:

   Bus A: 150.0V → (Voltage of source)

   Resistor Resistance: 60.0Ω (1 ÷ 60.0S)

   Load Resistance: 20.0Ω (150.0V ÷ 1125.0W)

   Total Resistance: 80.0Ω (60.0Ω + 20.0Ω)

   Current: 1.875A → (150.0V ÷ 80.0Ω)

   Bus B: 37.5V → (150.0V – 1.875A × 60.0Ω)

4. Output from computer program

```
Nodal Voltages:
A: 150.0 V
B: 37.5 V

Circuit Current:
1.875 A

Process finished with exit code 0
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