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ECE 2774 – Project 1 Documentation

Project 1 Overview

The objective of Project 1 is to develop a Python program that models and solves a DC circuit that incorporates basic circuit elements such as a voltage source, a series resistance, and a DC resistive load which is connected between two buses. The program calculates and displays the voltage at each bus and the current flowing in the circuit.

The simulation, however simple, could be used in the real world to save time with hand calculations regarding simple DC circuits. Since it is customizable it can be applied to many different circuit configurations.

Class Descriptions

The program is customizable, allowing the user to define the circuit element parameters. Buses can be created and defined with a name and its voltage can be set using a voltage source attached to it or will be updated after the power flow calculation is performed. Resistors can be defined by giving it a name, specifying which buses it is connected between and its resistance value. A load can be named and placed at a specified bus. In addition, its rated voltage and power must be detailed. A voltage source is initiated at the first bus and its voltage must be indicated. A circuit object is created which manages all the circuit elements under consideration. It is in this class in which elements are added to the circuit. In the main script, the circuit is defined, and a power flow method is called.

- Bus
    - Attributes:
        - name (str): The user should provide this as an argument when defining the object.
        - v (float): Represents the voltage at the bus. For buses connected to a voltage source, the voltage updates when the source is created. For all other buses, the voltage updates during the power flow calculation.
    - Methods:
        - set_bus_v(bus_v: float): Sets the voltage at the bus.

- Resistor
  - Attributes:
    - name (str): The user should provide this as an argument when defining the object.
    - bus1 (str): The user should provide this as an argument when defining the object.
    - bus2 (str): The user should provide this as an argument when defining the object.
    - r (float): The user should provide this as an argument when defining the object.
    - g (float): It should be calculated internally using the calc_g method.
  - Methods:
    - calc_g(): Calculates the conductance value.

$$g_{resistor} = \frac{1}{r}$$

- Load
  - Attributes:
    - name (str): The user should provide this as an argument when defining the object.
    - bus1 (str): The user should provide this as an argument when defining the object.
    - p (float): The user should provide this as an argument when defining the object.
    - q (float): The user should provide this as an argument when defining the object.
    - g (float): It should be calculated internally using the calc_g method.
  - Methods:
    - calc_g(): Calculates the conductance value.

$$g_{load} = \frac{P_{load}}{V_{load}^2}$$

- Vsource
  - Attributes:
    - name (str): The user should provide this as an argument when defining the object.
    - bus1 (str): The user should provide this as an argument when defining the object.
    - v (float): The user should provide this as an argument when defining the object.

The class diagram shows how the objects are structured. The Bus, Resistor, Load and Vsource objects are created and housed in the Circuit class. The Circuit class is a subclass of the Solution class.

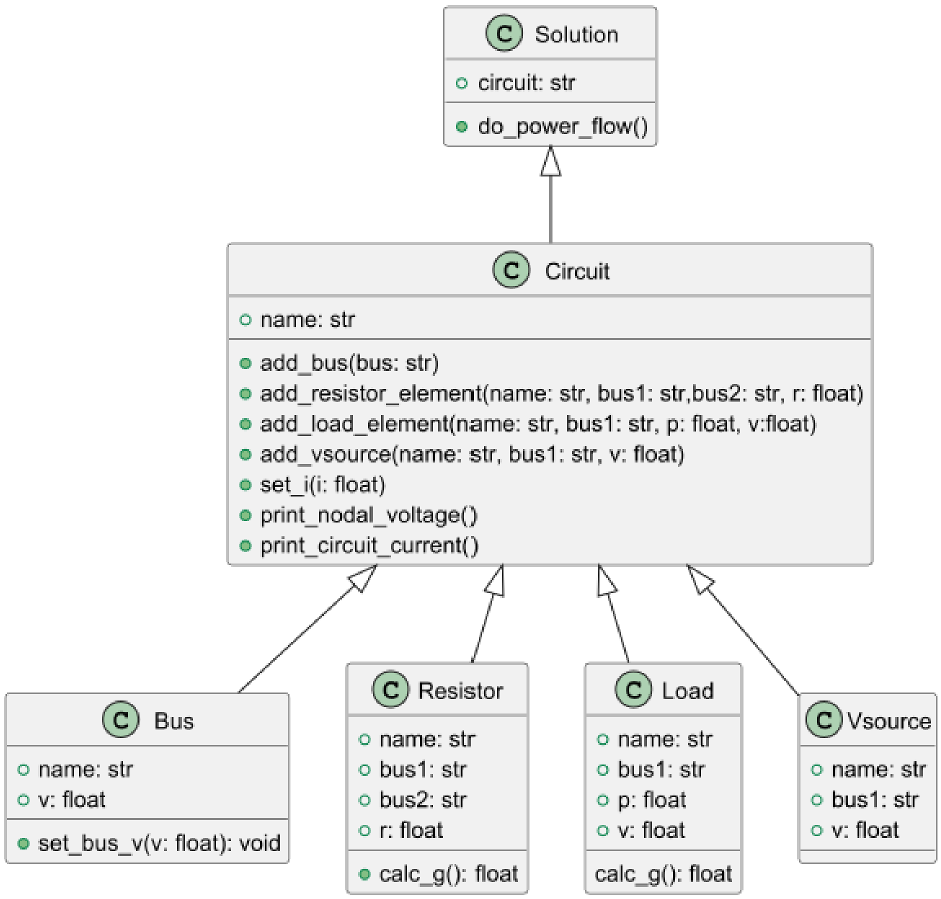

Figure 1 - Class Diagram

Relevant Equations

The equations used in the power flow method are:

$$V_a = V_{source}$$

$$I = \frac{V_a}{\frac{1}{g_{resistor}} + \frac{1}{g_{load}}}$$

$$V_b = \frac{I}{g_{load}}$$

Example Circuit

An example circuit is created and demonstrated with the following parameters:

A 250 VDC source is added to bus #1 which is then connected to a resistor having a value of 15 ohms. Bus #2 is the node just after the resistor to which a 2000 watt, 250 VDC load is placed. The expected output should match the calculations below:

$$g_{resistor} = \frac{1}{r} = \frac{1}{15} = 0.0667\ S$$

$$g_{load} = \frac{P_{load}}{V_{load}^2} = \frac{2000}{250^2} = 0.032\ S$$

$$V_a = V_{source} = 250\ V$$

$$\mathrm{I} = \frac{\mathrm{V_a}}{\frac{1}{\mathrm{g_{resistor}}} + \frac{1}{\mathrm{g_{load}}}} = \frac{250}{\frac{1}{.0667} + \frac{1}{0.032}} = 5.41\ A$$

$$\mathrm{V_b} = \frac{\mathrm{I}}{\mathrm{g_{load}}} = \frac{5.41}{0.032} = 168.9\ V$$

The ouput of the code matches the expected value:

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C:\Users\jjdre\AppData\Local\Programs\
Example Circuit:
bus A voltage = 250.00 V
bus B voltage = 168.92 V
Circuit current = 5.41 A
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The simulator solves the voltage at bus A by simply taking the value of the Vsource that is added to the circuit. Then, the current is solved for using the equation listed above, basically the voltage applied at Bus A divided by the sum of the inverses of the conductance's of the resistor and load. Bus B is calculated using the value of the current calculated and dividing by the load conductance.