**README**

**GROUP CONTRIBUTION:**

**G.S. Sasank (1910110152):** Coded the Directed Graph Data Structure implementation using Incidence Matrix Method in the program and implemented the main function and sleep functions. Also made the README file and PDF file. Contributed to debugging.

**Abhishek Akshat (1910110019):** Coded the functions to find branch voltages and branch currents. Also implemented Cramer’s rule for solving the system of linear equations that are obtained in terms of node voltages. Contributed to debugging.

**Prerit Singh (1910110287):** Coded the functions for finding transpose of incidence matrix, & multiplication of incidence, conductance and transpose matrices. Also wrote function to find determinant of a matrix.

**Arnav Jhatta (1910110088):** Contributed to algorithm and pseudo-code but was hospitalized due to illness soon after.

**Ajay Gaur (1910110037):** Coded the function of multiplication of input matrices made using multidimensional array for implementation of incident and conductance matrix which are used for applying Cramer’s Rule. Contributed to debugging.

**INSPIRATIOIN AND OUTCOME OF THE PROGRAM:**

Instead of using 3RD Party Software for simple circuit analysis, we made a program that can solve all the complicated matrix multiplications involved in Nodal Analysis, faster and simpler than most commercial software. It also employs a completely different approach to solving Simple Circuits by using **Directed Graph Data Structures** and **2-D Arrays.**

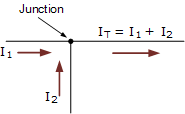
**CONCEPT:**

**Kirchhoff’s Current Law (KCL) –**

KCL or Junction Rule is one of the fundamental laws used for circuit analysis. His current law states that for a parallel path **the total current entering a circuits junction is exactly equal to the total current leaving the same junction**. This is because it has no other place to go as no charge is lost.

In other words, the algebraic sum of ALL the currents entering and leaving a junction must be equal to zero as: Σ IIN = Σ IOUT.

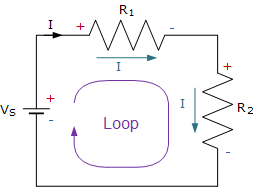
This idea by Kirchhoff is commonly known as the **Conservation of Charge**, as the current is conserved around the junction with no loss of current.



**Kirchhoff’s Voltage Law (KVL) –**

**Kirchhoff’s Voltage Law** is the second of his fundamental laws we can use for circuit analysis. His voltage law states that for a closed loop series path **the algebraic sum of all the voltages around any closed loop in a circuit is equal to zero**. This is because a circuit loop is a closed conducting path, so no energy is lost.

In other words, the algebraic sum of ALL the potential differences around the loop must be equal to zero as: ΣV = 0. Note here that the term “algebraic sum” means to consider the polarities and signs of the sources and voltage drops around the loop.



**ΣV = 0**

**Incidence Matrix –**

**Incidence matrix** is that matrix which represents the graph such that with the help of that matrix we can draw a graph. This is the implementation of a Directed Graph Data Structure. This matrix can be denoted as [A] As in every matrix, there are also rows and columns in **incidence matrix** [A].  
The rows of the matrix [A] represents the number of nodes and the column of the matrix [A] represents the number of branches in the given graph. If there are ‘n’ number of rows in each incidence matrix, that means in a graph there are ‘n’ number of nodes. Similarly, if there are ‘m’ number of columns in that given incidence matrix, that means in that graph there are ‘m’ number of branches.

The entries of incidence matrix are always -1, 0, +1

|  |  |
| --- | --- |
| CURRENT FLOW | VALUE |
| Originates from a node. | +1 |
| Terminates at a node. | -1 |
| Does not touch the node. | 0 |

**Conductance Matrix [G]:**

A matrix of order BXB where B is total number of branches.   
Store value of conductance associated with the branch.

Conductance is multiplicative inverse of resistance.

In this case **[G] =**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **B0** | **B1** | **B2** | **Bn** |
| **B0** | **1/R1** | **0** | **0** | **0** |
| **B1** | **0** | **1/R2** | **0** | **0** |
| **B2** | **0** | **0** | **1/R3** | **0** |
| **Bn** | **0** | **0** | **0** | **1/Rn** |