# Instructions Booklet


**DS Project**

# HOW TO USE:

**NOTE: It is taken into the account that the person using the application has prior knowledge of topics such as formation of graph of a circuit, nodal analysis of a circuit.**

**Step 1**: On a piece of paper form the graph of the given circuit.

**Step 2**: Input the number of branches and nodes present in the graph. Make sure that you only count the branches with resistors and start naming them from 0. Start naming nodes from 0 and consider the grounded node as the $0^{th}$ node.

**Step 3**: Since we are using a DiGraph Data Structure with an Incidence Matrix Implementation enter the direction of current into/out of the node via a given branch. Enter 0 if node and circuit are not connected, 1 if the current is flowing inward to the node and -1 if the current is flowing outward from the node and it does all the necessary conversions inside the program.

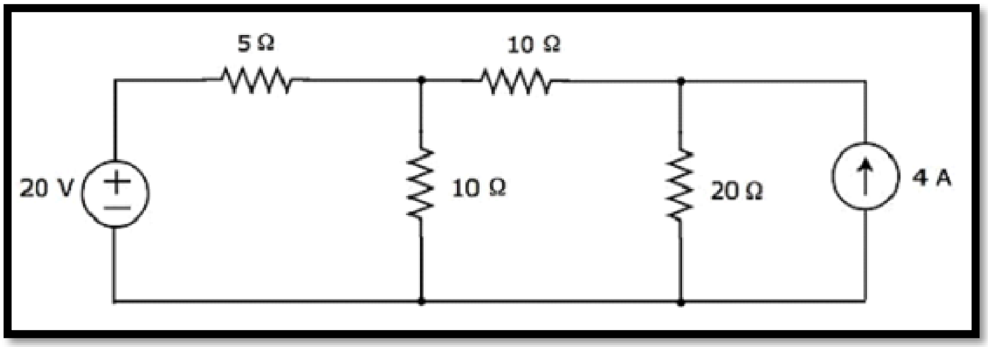
**Step 4**: You will be prompted with the conductance matrix after filling the incidence matrix. All you need to do is simply enter the resistance of the branches when the particular branch is prompted and the function converts it into a conductance matrix.

**Step 5**: You will then be prompted to fill in the Current Matrix in which all you need to do is enter the value of the Current Source along with proper direction and then if any voltage sources are present, ignore the current source and then using I= V/R (Ohm's Law) (where R is the total resistance ) get all the values I current and fill them in the Current Matrix (direction should be consistent).

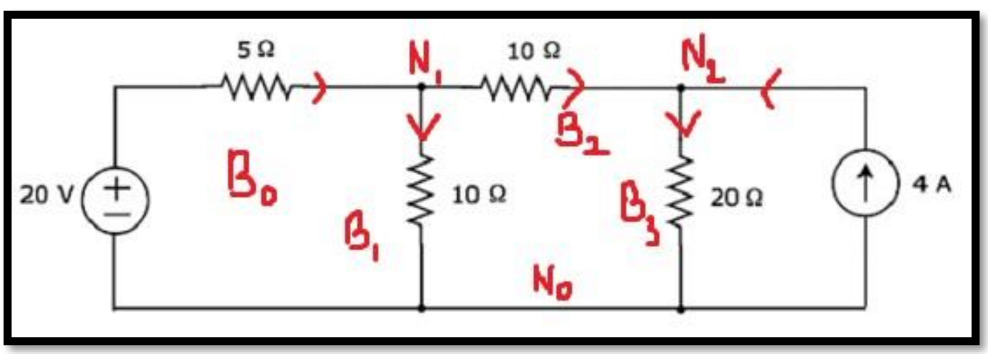
**Step 6:** If all the inputs are correct then by clicking on the on-screen prompt, you will be able to calculate branch voltage, branch current and nodal voltage. If you are getting any values negative, it means the current direction has been reversed somewhere and the -ve sign is just direction.

SAMPLE QUESTION:

**Let us consider this circuit and explain the concepts.**

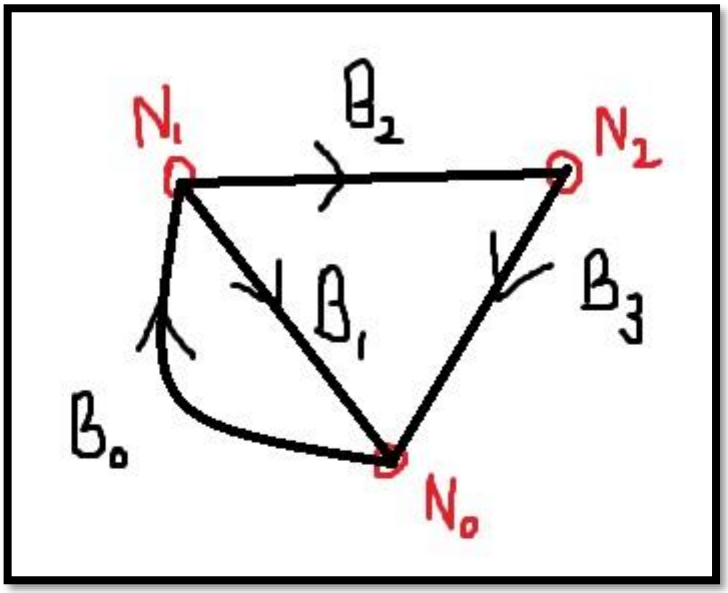



**If we mark the nodes and the flow of currents then,**




**NOTE: only branches with circuit elements such as resistors, capacitors, inductors are considered as a branch.**

**Now graph of the circuit would become:**




**The resulting Incidence Matrix [A] will be follows:**

| | $B_0$ | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $N_0$ | 1 | -1 | 0 | -1 |
| $N_1$ | -1 | 1 | 1 | 0 |
| $N_2$ | 0 | 0 | -1 | 1 |

**Reduced Incidence Matrix [$A_r$]**

A reduced incidence matrix is formed when the reference node is neglected from the [A]. It's of the order (N-1)XB.

Generally, reference node is taken to be the one which has maximum number of branches. In this case $N_0$ became the reference node.

| | $B_0$ | $B_1$ | $B_2$ | $B_3$ |
|---|---|---|---|---|
| $N_1$ | -1 | 1 | 1 | 0 |
| $N_2$ | 0 | 0 | -1 | 1 |

**Source Current Matrix [$I_t$]**

A column matrix of order (N-1)X1 where N is number of nodes. Contains value of currents from a current or voltage source either flowing in or out of a node.

In this case **$[I_t]$ =**

| |
|---|
| V/R=20/5 |
| 4 |

Here R is total resistance if we consider the current source to be a short circuit.

V is the Voltage of the Voltage Source.

**Node Voltage Matrix $[V_n]$ :**

A column matrix of order (N-1)X1 where N is total number of nodes. Store value of node voltages.

In this case **$[V_n]$ =**

| |
|---|
| **$V_{n1}$** |
| **$V_{n2}$** |

**Branch Voltage Matrix $[V_b]$ :**

A column matrix of order BX1 where B is total number of branches. Store value of potential drop across each branch.

In this case **$[V_b]$ =**

| |
|---|
| **$V_{b0}$** |
| **$V_{b1}$** |
| **$V_{b2}$** |
| **$V_{b3}$** |

**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] =**

| | **$B_0$** | **$B_1$** | **$B_2$** | **$B_3$** |
|---|---|---|---|---|
| **$B_0$** | **1/5** | **0** | **0** | **0** |
| **$B_1$** | **0** | **1/10** | **0** | **0** |
| **$B_2$** | **0** | **0** | **1/10** | **0** |
| **$B_3$** | **0** | **0** | **0** | **1/20** |

**KVL AND KCL EQUATIONS IN MATRIX FORM**

**KVL:** $[A_r]^T [V_n] = [V_b]$

**KCL:** $[A_r][G] [A_r]^T [V_n] =[I_t]$

$[I_b]=[G] [V_b]$

**If you solve it manually using KVL, KCL equations then (the equations formed below are based on the flow of currents that we decided to make the graph of the circuit.)**

**KCL for node 1:**

$$(20 - V_{N1})/5 = V_{N1}/10 + (V_{N1} – V_{N2})/10$$

**KCL for node 2:**

$$(V_{N1} – V_{N2})/10 + 4 = V_{N2}/20$$

**On solving these:**

$V_{N1} = 20$ V

$V_{N2} = 40$ V

For Any Queries Contact:

GS Sasank

Abhishek Akshat