

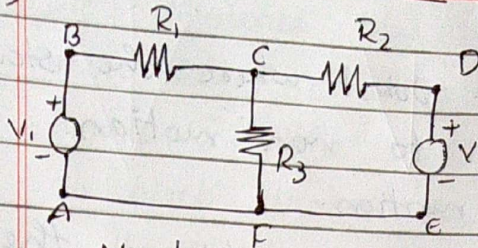
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Date: Page:

## Network theory

→



Node: It is defined as that point in a network to which two or more circuit elements if connected. Ex: Node B

Number of Nodes - 4

- Junction Node: It is defined as that point in a network to which 3 or more circuit elements if connected. Example: Junction Node C:  $\rightarrow R_1, R_2, R_3$

- Branch: It is defined as that path in a n/w which traces from one junction point to the next junction point.

Eg: FC, CDEF, FABC

Branches in the n/w is 3

- Loop or Mesh: It is defined as that closed path in a n/w which traces from one point to the same path. Ex: BCDEFAB is mesh, COEFC is another mesh. There are 3 mesh in this CKT.

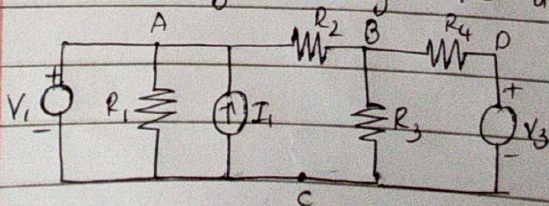
BCDEFAB is called overlapping loop.

- Branch Currents and Mesh Currents:

Branch current is a current flowing through the branch. whereas, the Mesh current is a current flowing through all the elements of a closed loop or mesh.

Branch current  $\rightarrow I_1, I_2, I_3$  }  $I_1 = i_1, I_2 = i_2$   
Mesh current  $\rightarrow i_1, i_2$  }  $I_3 = i_1 - i_2$

- Node Voltage: Voltage b/w any 2 nodes in a N/w.



Nodes-4

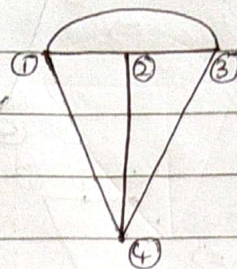
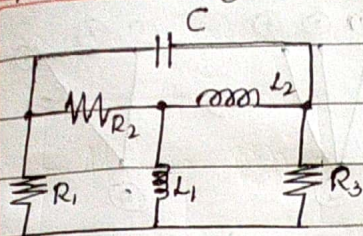
Junction-3

Branches-6

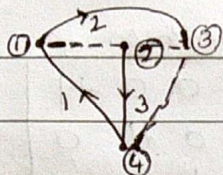
Loops-4



# Graph theory (N/w theory):

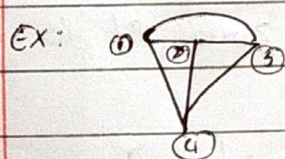


- Branch - All the elements.
- Nodes - Terminals of branches are called nodes.
- Degree of nodes - No. of branches connected to single node.
- Tree -



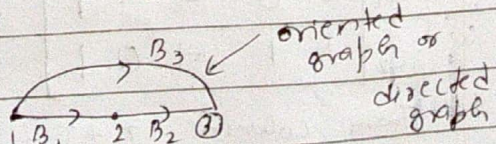
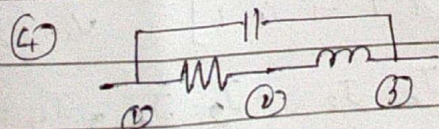
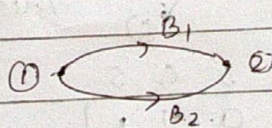
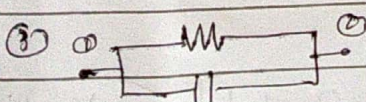
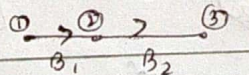
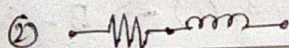
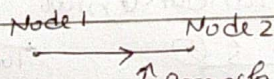
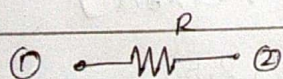
- Tree branch: All the branch of tree is called Tree branch.
- Tree Link - The remaining branch of a tree branch in the graph is called as link.
- Loop - The closed contour selected in a graph.
- Tree branch  $\rightarrow$  Twig (TWIG)
- Relationship b/w link & TWIG.

$N$  - No. of nodes in a graph, So the no. of twigs will be  $(N-1)$  if  $L$  = no. of links in a graph then  $L = B - (N-1)$   
 $L = B - N + 1$ ,  $B$  - is total no. of branch in the graph.



$$N = 4, T = 3, L = 3$$

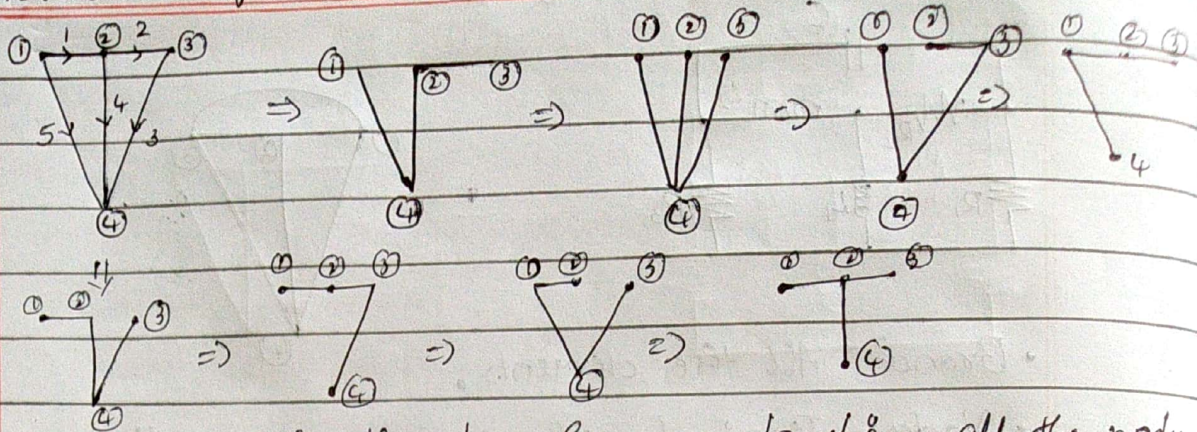
$$L = 6 - 4 + 1 = 3 \rightarrow \text{No. of Links.}$$



oriented graph or directed graph.

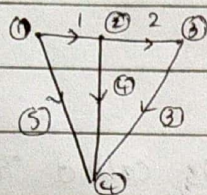


## Formation of Incidence matrix.



In this graph the branches are touching all the nodes, with no loops, are called tree.

## Incidence matrix: Branches: 5



Nodes	1	2	3	4	5
1	+1	0	0	0	+1
2	-1	+1	0	+1	0
3	0	-1	+1	0	0
4	0	0	-1	-1	-1

This is called incidence matrix

outgoing branch = +1 in Node 1

Incoming branch = -1

add

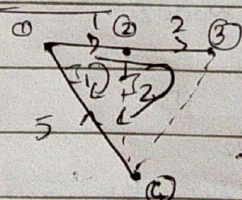
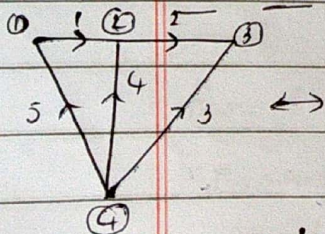
property of this matrix is if we add any column it gives 0

If node 4 is Reference node then the incidence matrix is

Nodes	1	2	3	4	5
1	1	0	0	0	1
2	-1	1	0	1	0
3	0	-1	1	0	0

Here the sum may not be zero, it is called reduced incidence matrix.

## Tie-set Matrix [Fundamental loop matrix]



Twig (1, 2, 5)

link K (3, 4)  $\rightarrow B - N + 1 = 5 - 4 + 1 = 2$

There are 2 fundamental loops

	1	2	3	4	5
$I_1$	1	0	0	-1	1
$I_2$	1	1	-1	0	1

	1	2	3	4	5
$I_1$	1	0	0	-1	1
$I_2$	1	1	-1	0	1

$$V_1 + V_5 - V_4 = 0 \rightarrow 0$$

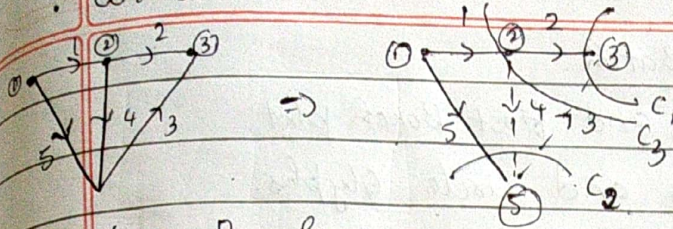
$$V_1 + V_2 - V_3 + V_5 = 0 \rightarrow 0$$

from column:  $I_1 + I_2 = I_1$ ,  $I_2 = I_2$ ,  $-I_2 = I_3$ ,  $I_4 = +I_1$ ,  $I_5 = I_1 + I_2$

$I_1, I_2, I_3, I_4, I_5$  are branch currents.



• Cut-set matrix:



There are only 3 cuts:

Cutsets	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>	B <sub>5</sub>
C <sub>1</sub>	0	+1	+1	0	0
C <sub>2</sub>	0	0	-1	+1	+1
C <sub>3</sub>	+1	0	+1	-1	0

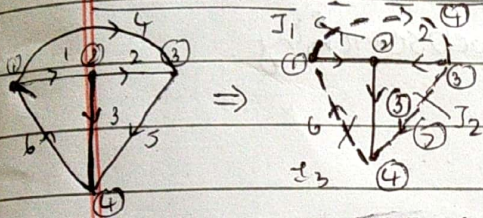
← Fundamental cutset matrix

$$i_2 + i_3 = 0 \rightarrow ①$$

$$-i_3 + i_4 + i_5 = 0 \rightarrow ②$$

$$i_1 + i_3 - i_4 = 0 \rightarrow ③$$

• Application of Tie set matrix: (Kirchoff's voltage law):



Twig (1, 2, 3)  
Link (4, 5, 6)

$$\begin{matrix} I_1 \\ I_2 \\ I_3 \end{matrix} \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ -1 & 1 & 0 & 1 & 0 & 0 \\ 0 & -1 & -1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \Rightarrow [B][V_b] = 0$$

For any loop total voltage is zero.

$$-V_1 + V_2 + V_4 = 0 \rightarrow ①, \quad -V_2 - V_3 + V_5 = 0 \rightarrow ②, \quad V_1 + V_3 - V_6 = 0 \rightarrow ③$$

• Application of cut-set matrix: (Kirchoff's current law):

$$[A][I_b] = 0 \quad \begin{bmatrix} +1 & 0 & 0 & +1 & 0 & -1 \\ -1 & -1 & +1 & 0 & 0 & 0 \\ 0 & +1 & 0 & +1 & +1 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$[A][I_b] = 0$$

$$I_1 + I_4 - I_6 = 0 \rightarrow ①$$

$$-I_1 - I_2 + I_3 = 0 \rightarrow ②$$

$$I_2 + I_5 - I_6 = 0 \rightarrow ③$$



## • Python:

- Introduction to Batch.
- Installing Bokeh, and first Bokeh plot.
- Plotting triangles and circle glyphs.
- Using Bokeh with Pandas.
- Plotting Education Data.
- Note on loading Excel files.
- Visual attributes
- Time series plots.
- Mouse Tool implementation
- Section Introduction.
- The concept behind websearching.
- Request Headers.

→ Interactive Data visualization with Bokeh.

→ Install with pip from the terminal, pip install bokeh.

→ Plotting - triangles and circle glyphs (practice).

→ Use triangle and circle instead of line.

→ The pandas library may require the xlrd library as a dependency, if you get an error like Module Not Found Error; No module named

'xlrd' you can fix the error by installing xlrd;

Pip install xlrd

pip3 install xlrd

• plot properties: added to change the style of the plot., Import pandas.

• plotting weather data, Visual Attributes, Time-series plot.

→ web scraping with python BeautifulSoup.

- Section introduction.
- The concept behind web scraping.
- Request Headers.
- Web scraping Examples.