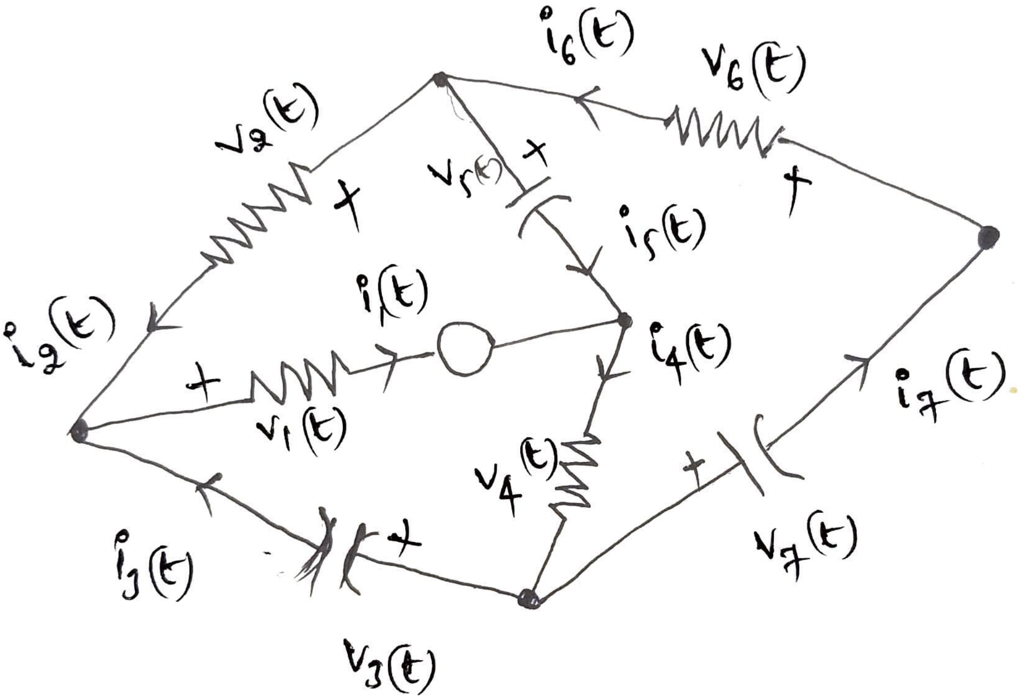
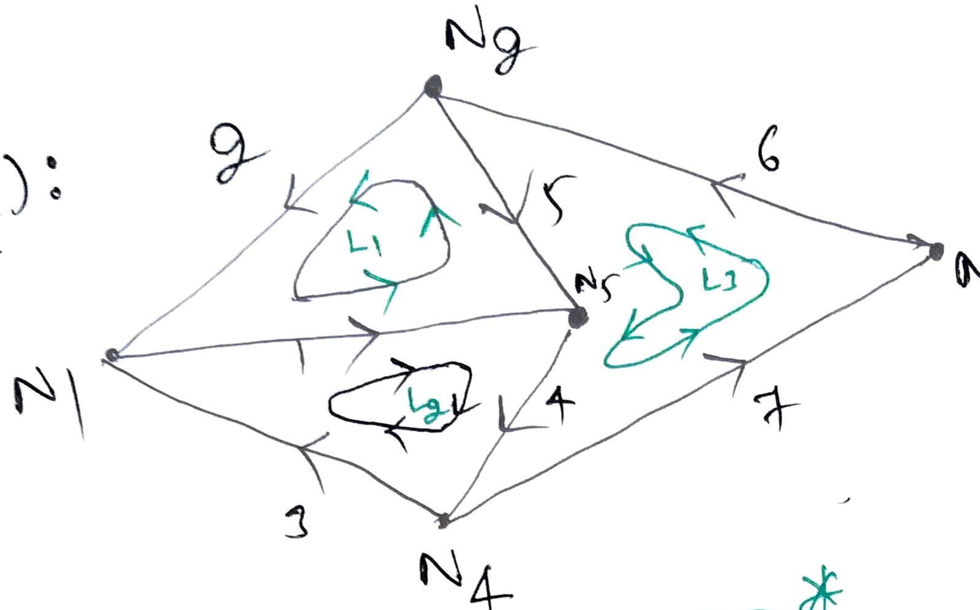
# Electrical Network Analysis by GRAPH THEORY

Let $G$ be a connected directed graph of '$e$' edges and '$n$' vertices, representing an electrical network.




The digraph representation of this electrical network is given as follows:

Fig(1):



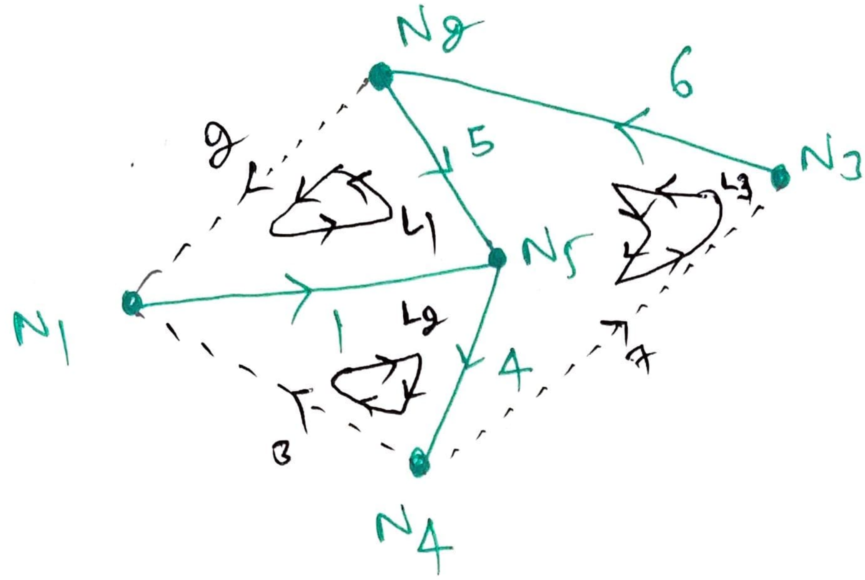

Each of the e edge currents can be expressed as a linear combination of K quantities $i_{L1}(t)$, $i_{L2}(t)$, .... $i_{LK}(t)$ known as loop currents which represent the current flowing in K independent circuit.

The edge current vector (the currents flowing through the edges at a given time) can be expressed as loop current vector as

$$i(t) = B_f^T \, i_L(T)$$

Where $B_f$ is the fundamental circuit matrix.

Consider a spanning ~~digraph of fig(1)~~ tree from the digraph given in fig(1)




$$B_f = \begin{array}{c} \\ L_1 \\ L_2 \\ L_3 \end{array} \begin{array}{c} \begin{array}{ccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array} \\ \left[\begin{array}{ccccccc} 1 & 1 & 0 & 0 & -1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array}\right] \end{array}$$

The edge current vector in terms of loop-current vector is

$$i(t) = B_f^T \, i_L(t)$$

$$\begin{bmatrix} i_1(t) \\ i_2(t) \\ i_3(t) \\ i_4(t) \\ i_5(t) \\ i_6(t) \\ i_7(t) \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ i_{L3}(t) \end{bmatrix}$$

ex: $i_1(t) = i_{L1}(t) + i_{L2}(t)$

## ** Edge voltages in terms of node voltages **

The edge voltages in terms of the node voltages are given by

$$v(t) = A_f^T\, v_N(t)$$

related to a reference vertex.

where $A_f$ is reduced incidence matrix.

(Refer Narsing Deo)