UNIT -1

POWER SYSTEM NETWORK MATRICES

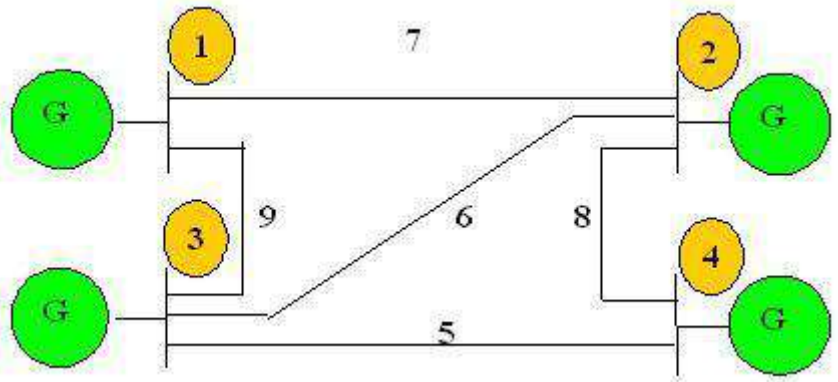
GRAPH THEORY

- The geometrical interconnection of the various branches of a network is called the *topology* of the network.
- The connection of the network topology, shown by replacing all its elements by lines is called a *graph.*

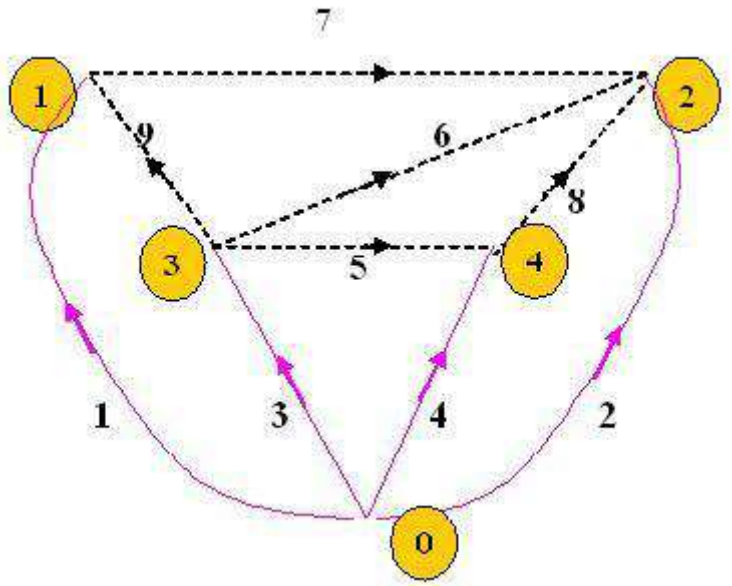
DEFINITIONS

- Connected Graph
- Sub-graph
- Loop
- Cutset
- Tree
- Co-Tree

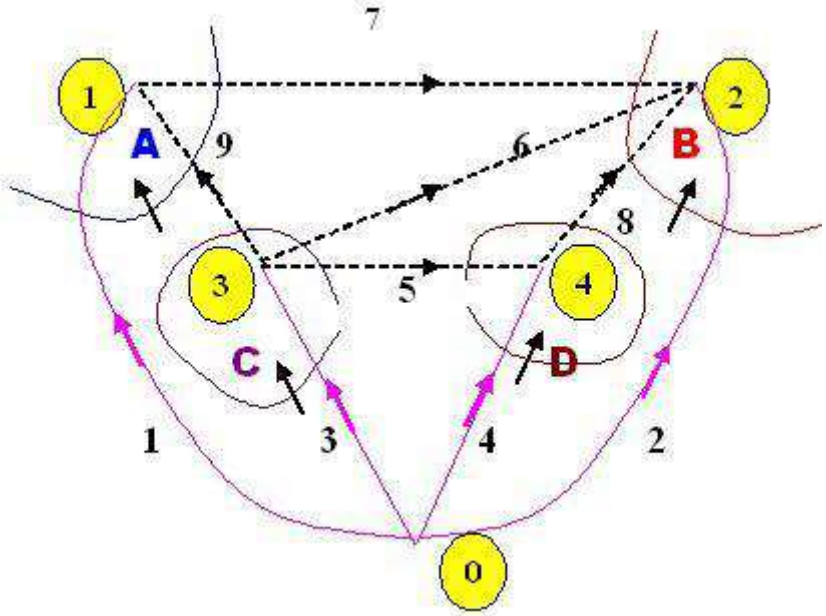
EXAMPLE



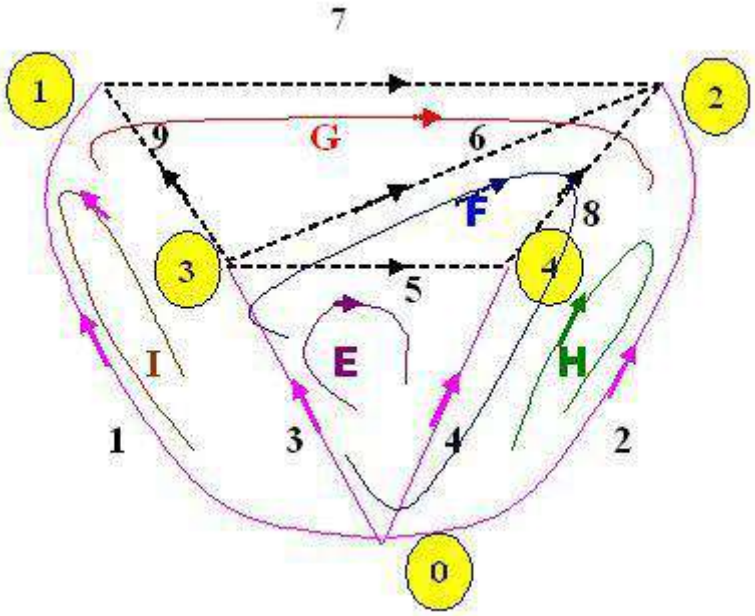
ORIENTED GRAPH



BASIC CUTSETS



BASIC LOOPS

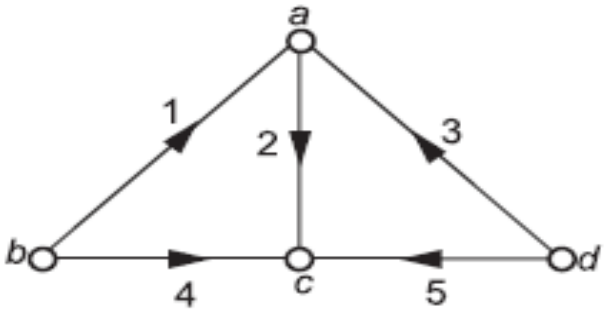


INCIDENCE MATRICES

Element–node incidence matrix:

- The incidence of branches to nodes in a connected graph is given by the element-node

EXAMPLE



$$A_n = \begin{array}{c} \\ \text{Nodes} \\ \text{a} \\ \text{b} \\ \text{c} \\ \text{d} \end{array} \begin{array}{c} \text{Branches} \\ \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} -1 & 1 & -1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & -1 & -1 \\ 0 & 0 & 1 & 0 & 1 \end{bmatrix} \end{array}$$

PRIMITIVE NETWORKS

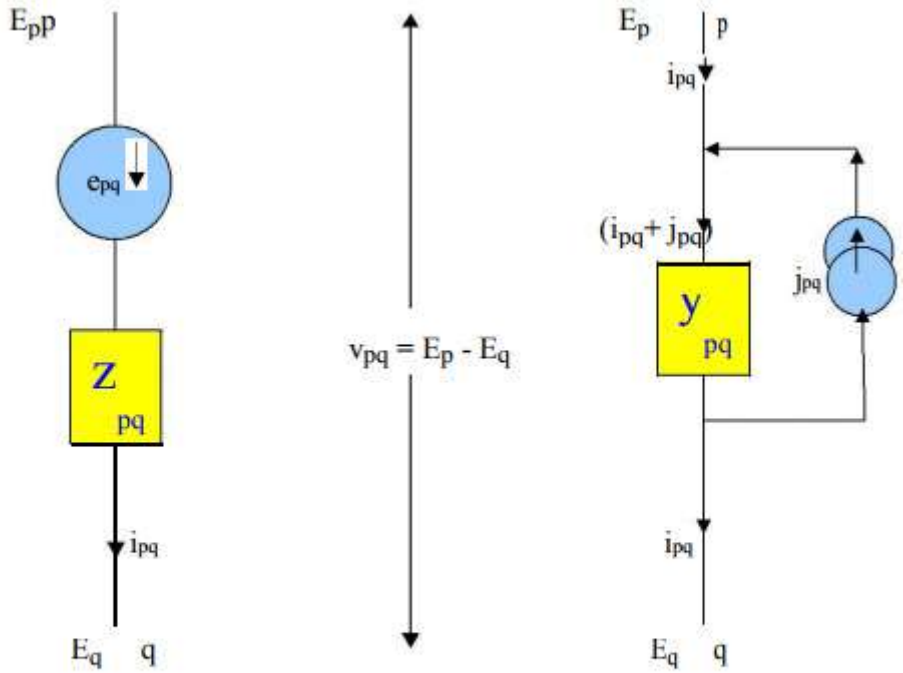


Fig.2 Representation of a primitive network element

(a) Impedance form (b) Admittance form

PRIMITIVE NETWORKS

v_{pq} = voltage across the element p-q,

e_{pq} = source voltage in series with the element pq,

i_{pq}= current through the element p-q,

j_{pq}= source current in shunt with the element pq,

z_{pq}= self impedance of the element p-q and

y_{pq}= self admittance of the element p-q.

PERFORMANCE EQUATION

$v_{pq} + e_{pq} = z_{pq} i_{pq}$ (in its impedance form)

$i_{pq} + j_{pq} = y_{pq} v_{pq}$ (in its admittance form)

BUS ADMITTANCE(Y BUS) MATRIX

- Y BUS can be formed by 2 methods
- 1.Inspection method
- 2.Singular transformation

$$\text{Y BUS} = \begin{pmatrix} Y_{11} & Y_{12} \bullet\bullet & Y_{1n} \\ Y_{21} & Y_{22} \bullet\bullet & Y_{2n} \\ Y_{n1} & Y_{n2} \bullet\bullet & Y_{nn} \end{pmatrix}$$

INSPECTION METHOD

For n bus system

Diagonal element of Y BUS

$$Y_{ii} = \sum_{j=1}^{n} y_{ij}$$

- Off Diagonal element of Y BUS

$$Y_{ij} = -y_{ij}$$

SINGULAR TRANSFORMATION METHOD

Y BUS $= A^T \left[y \right] A$

Where [y]=primitive admittance

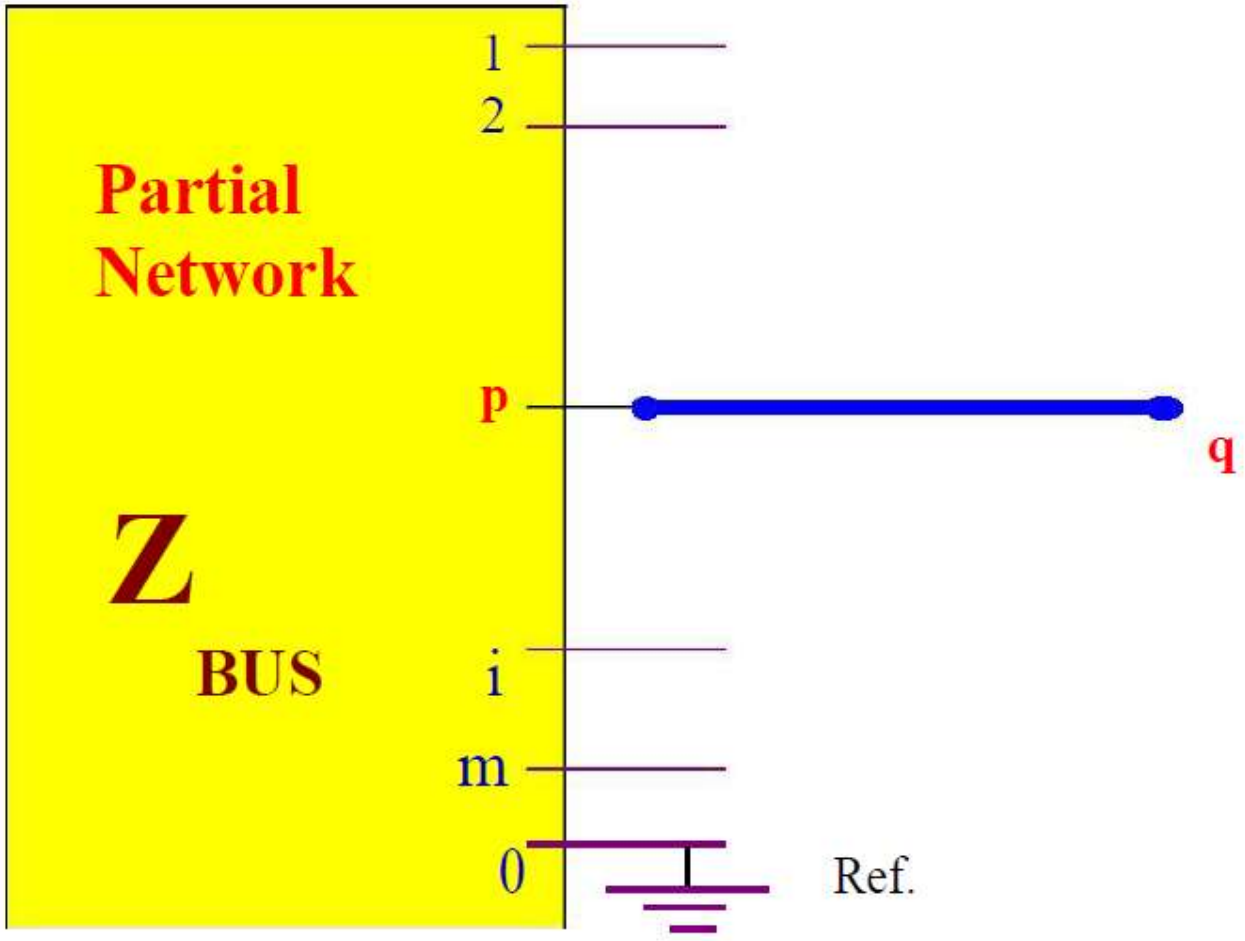
A=bus incidence matrix

FORMATION OF ZBUS

- *p* is an existing bus in the partial network and *q* is a new bus; in this case *p*-*q* is a **branch** added to the p-network

- Both *p* and *q* are buses existing in the partial network; in this case *p*-*q* is a **link** added to the p-network

ADDITION OF BRANCH P-Q



ADDITION OF LINK P-Q