PRIMITIVE NETWORKS

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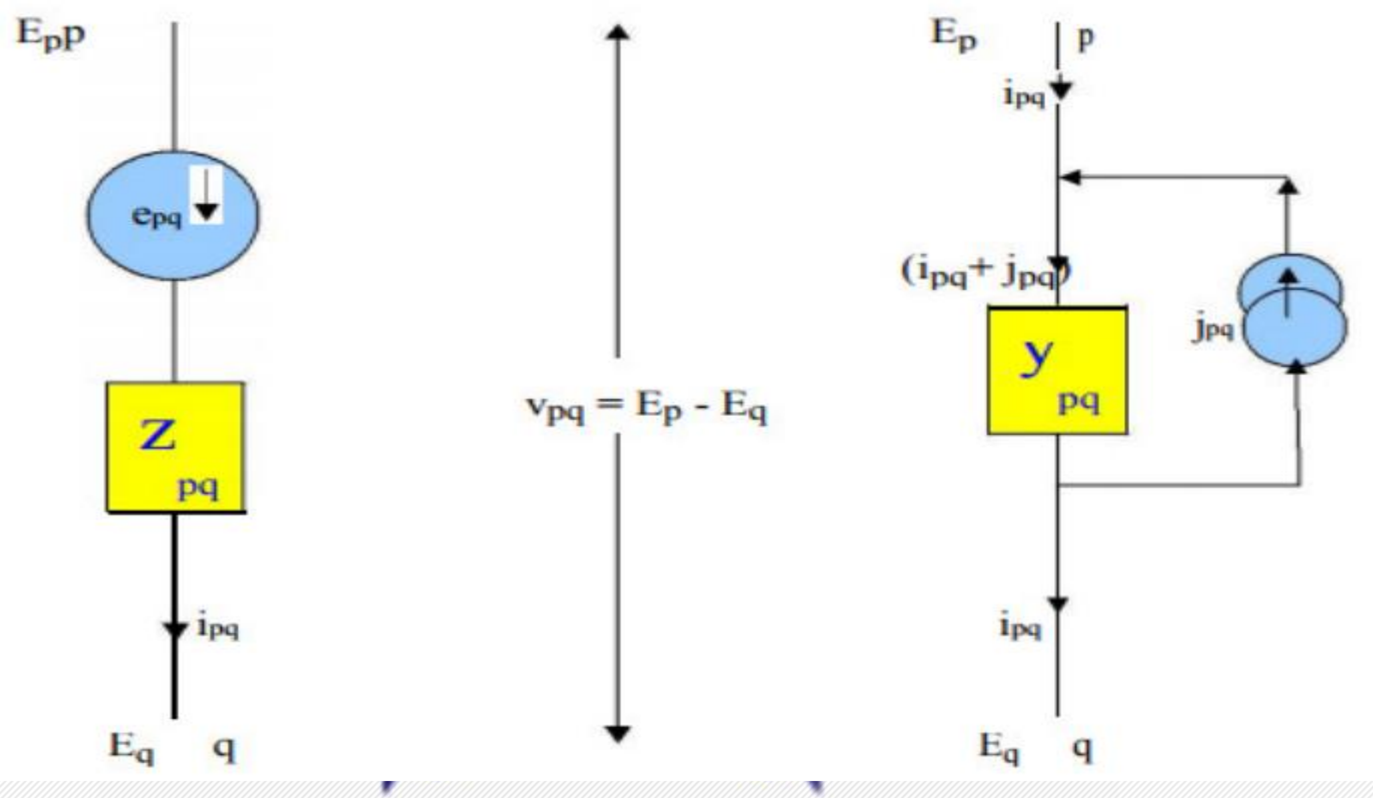
Primitive Networks

- Incidence matrices contain complete information about the network connectivity, the orientation of current, the loops and cut sets.
- However, these matrices contain no information on the nature of the elements which form the interconnected network.
- The complete behaviour of the network can be obtained from the knowledge of the behaviour of the individual elements which make the network, along with the incidence matrices.
- An element in an electrical network is completely characterized by the relationship between the current through the element and the voltage across it.

Primitive Networks

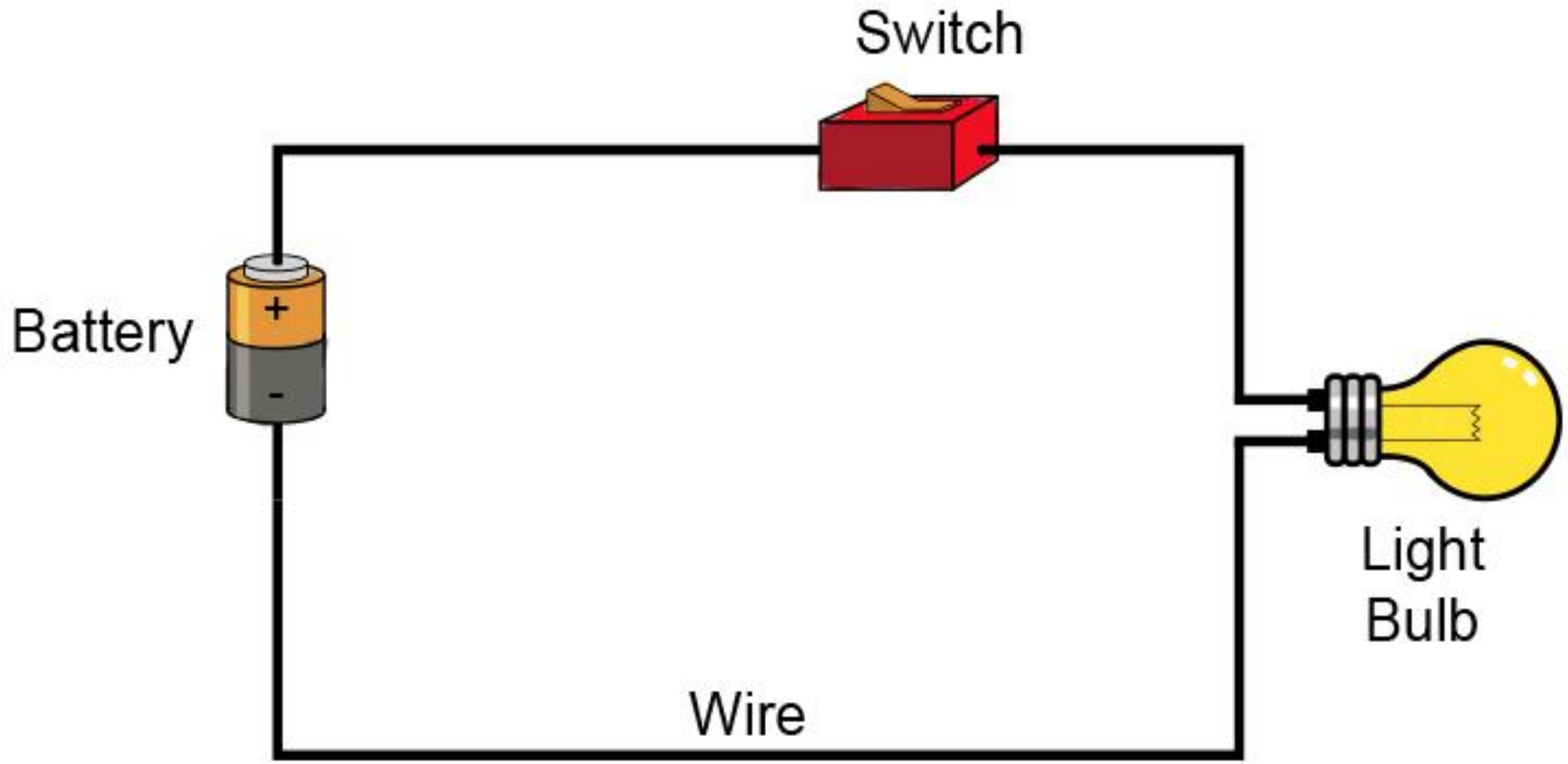
Impedance Network



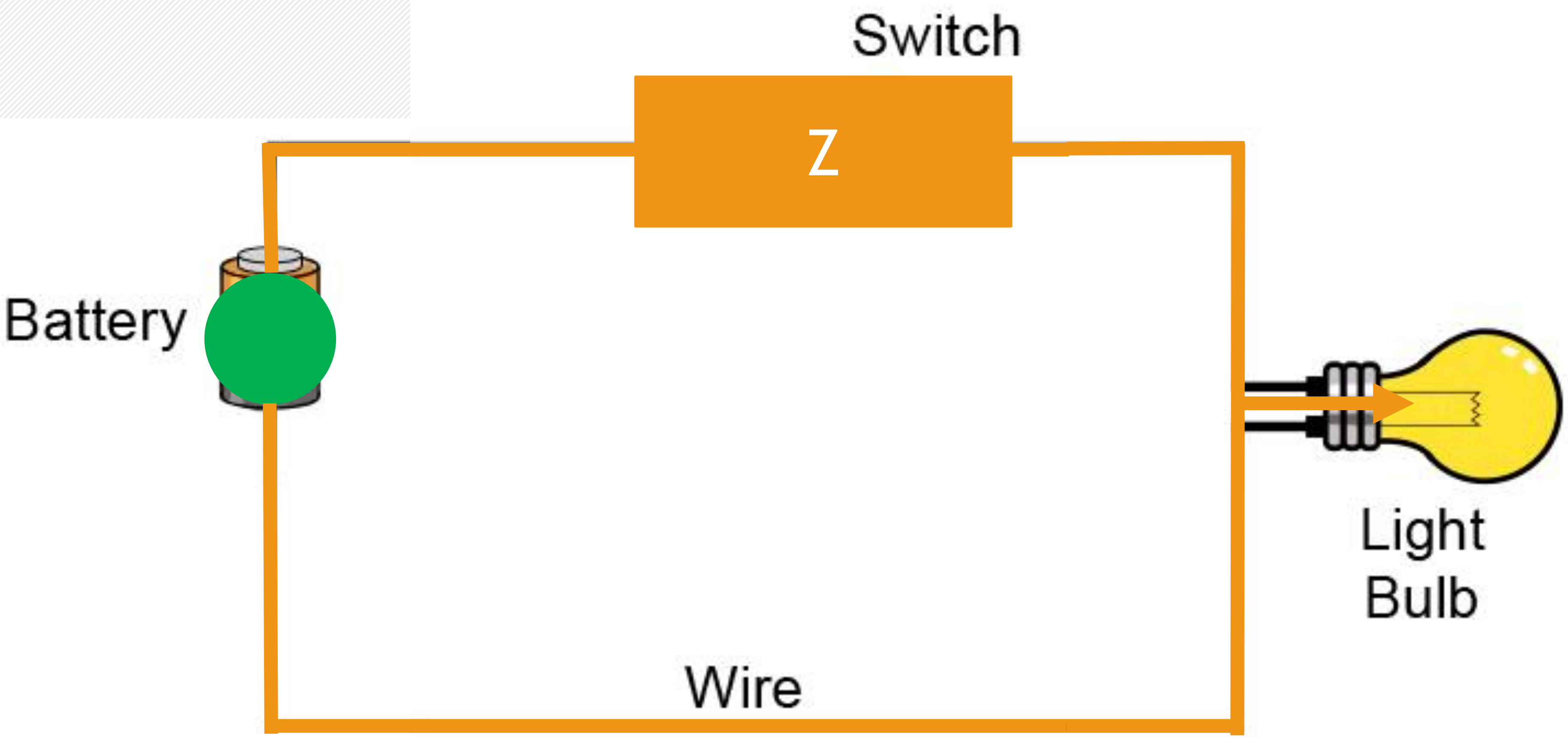
Admittance Network

- The network performance can be represented by using either the impedance or the admittance form of representation.

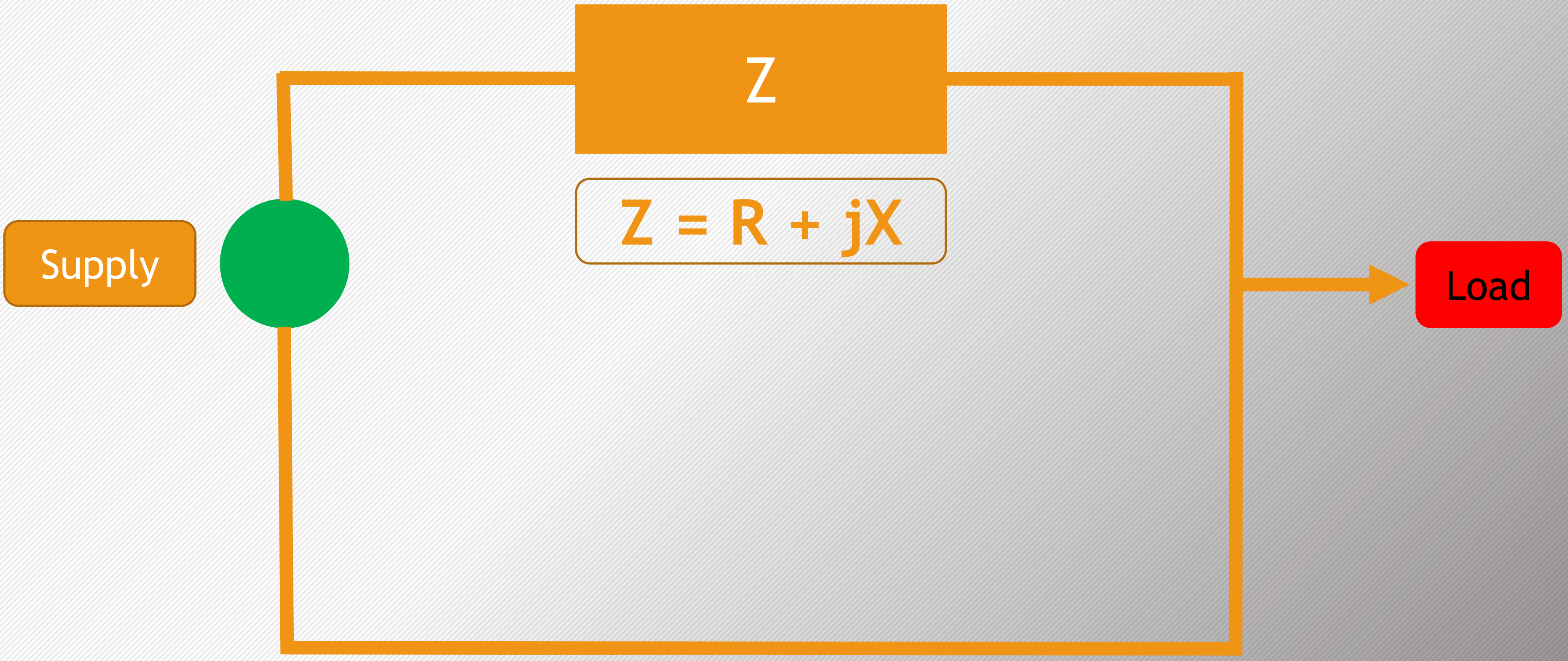
Primitive Networks



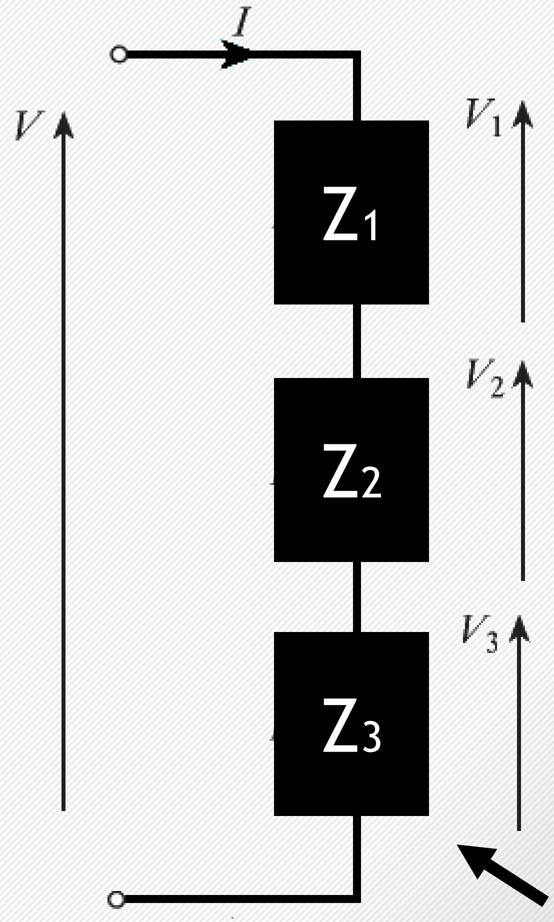
Primitive Networks



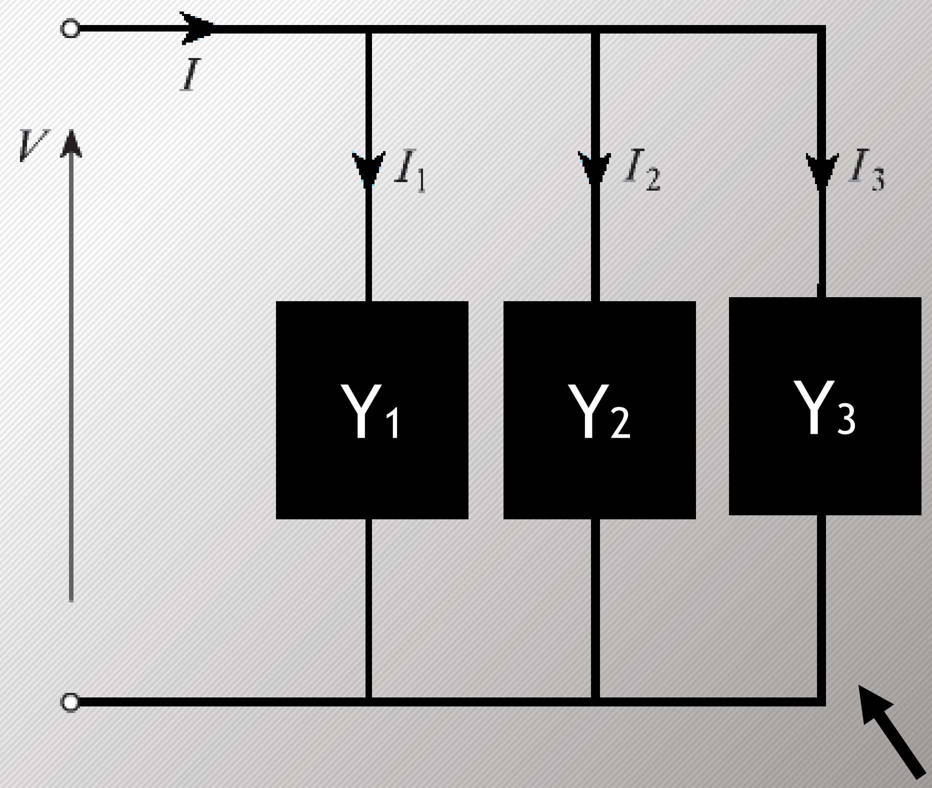
Primitive Networks



Primitive Networks

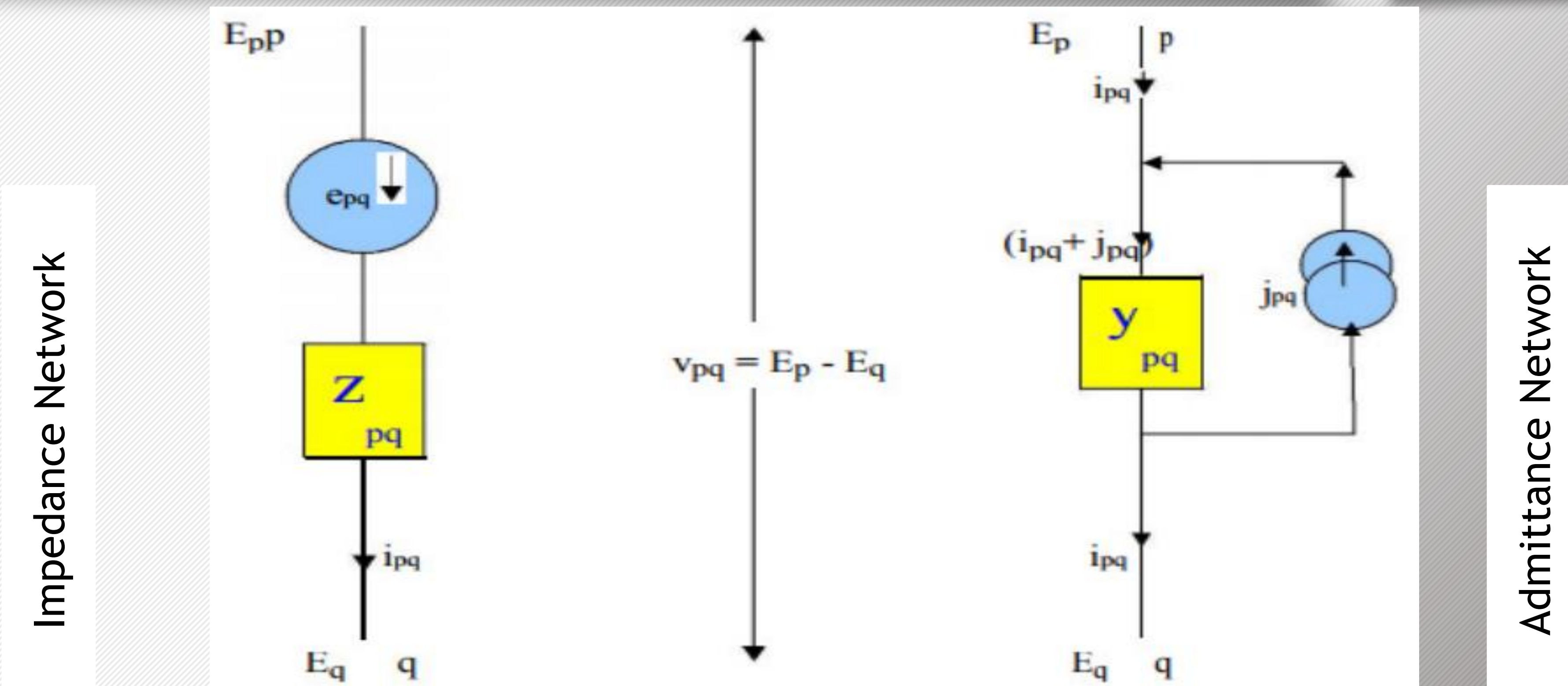


Impedance Network



Admittance Network

Primitive Networks



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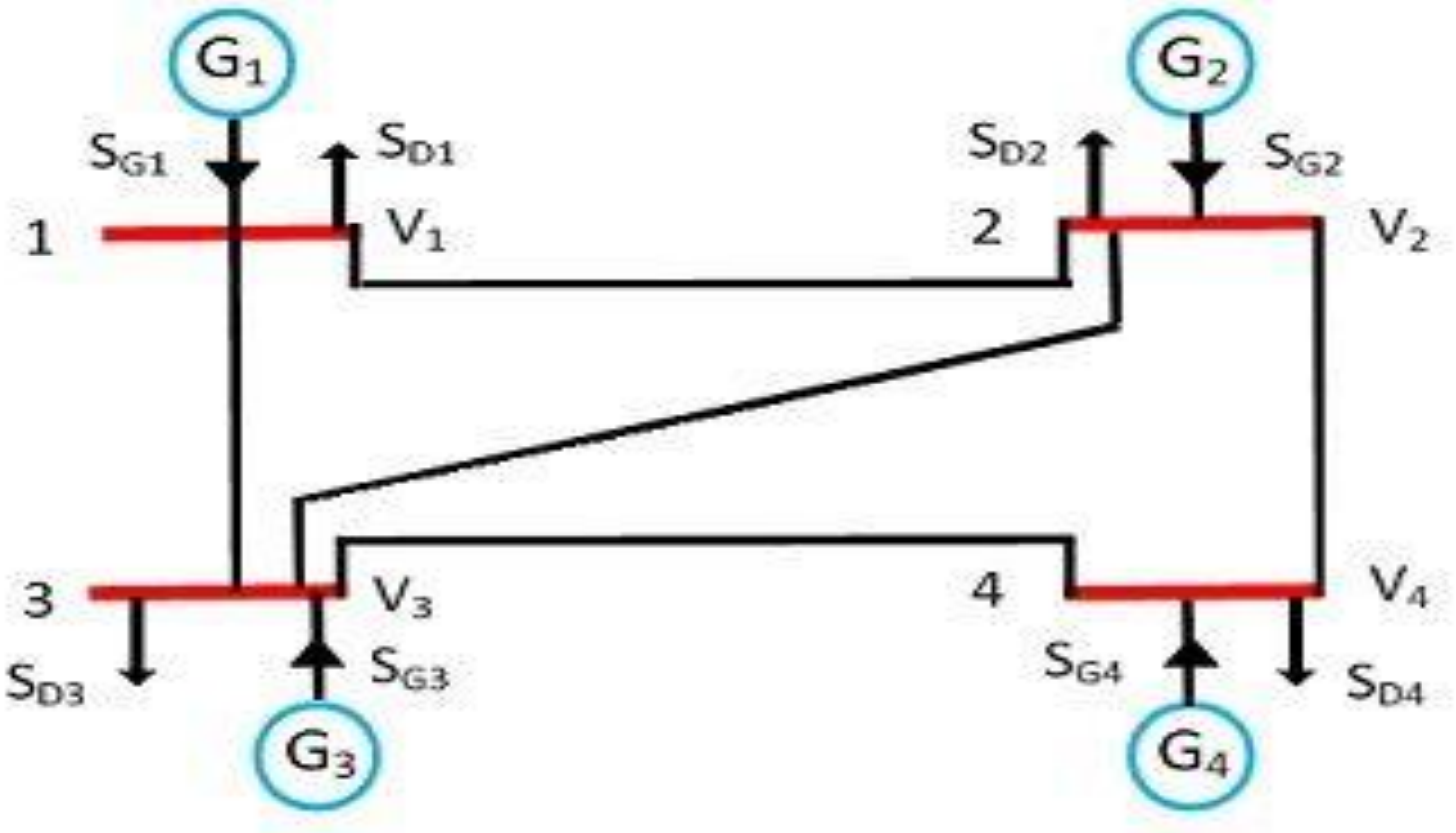
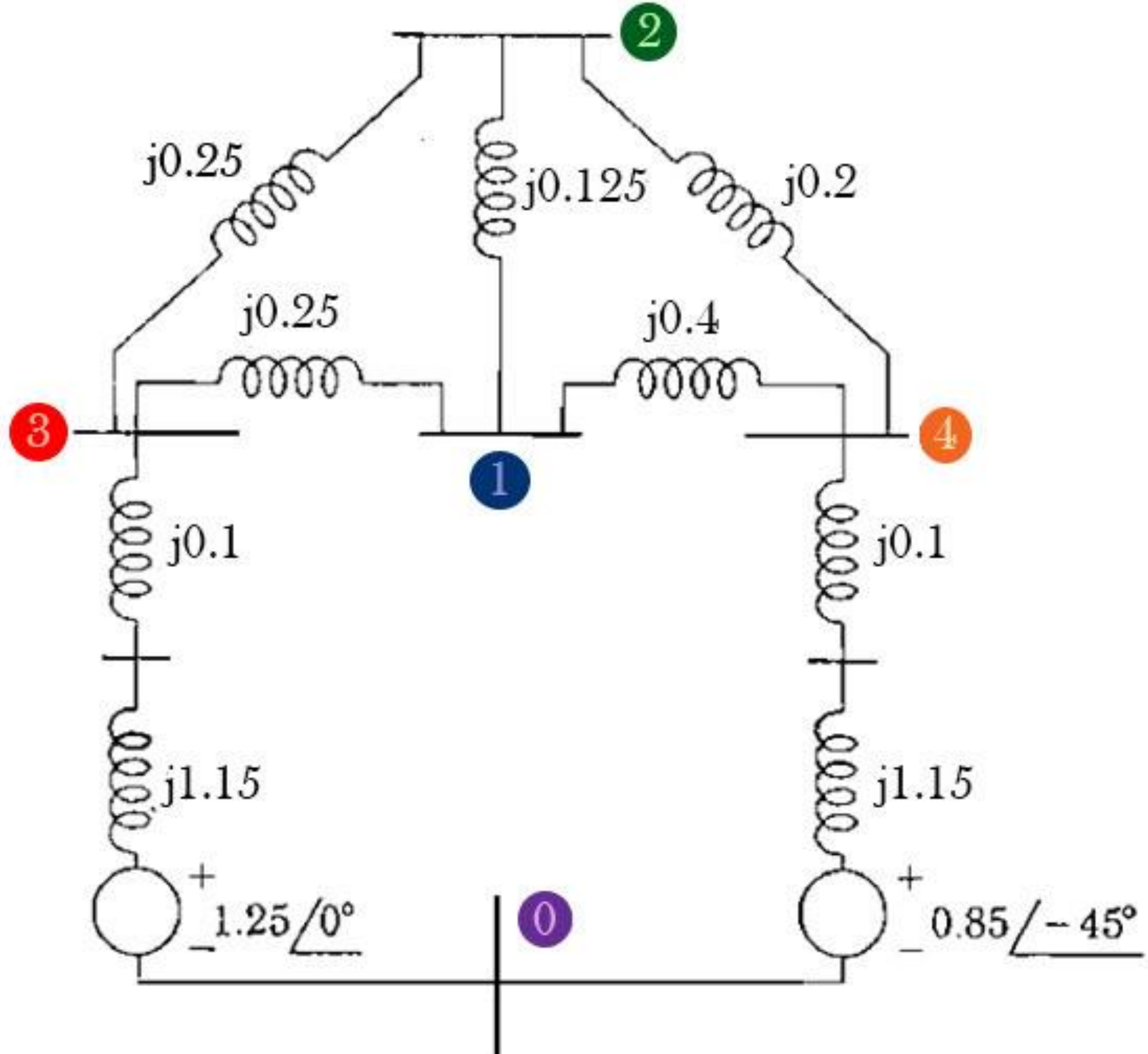
Primitive Networks



One Line Diagram of a 4-Bus System

Primitive Networks

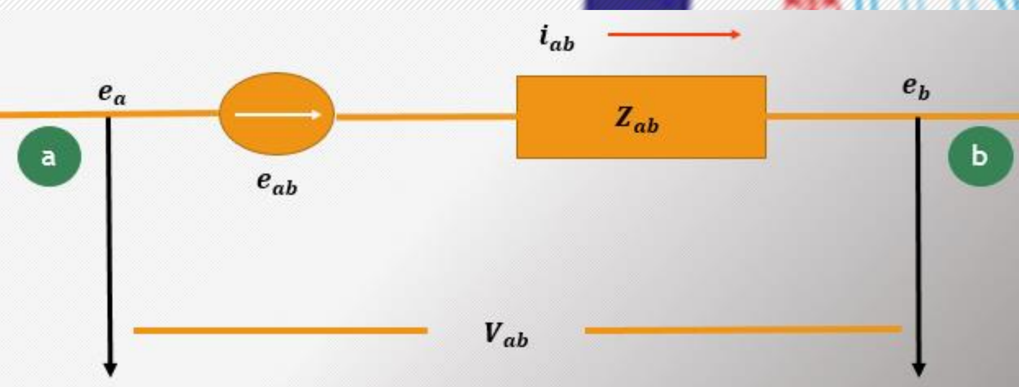


Primitive Networks

- Impedance Form

Primitive Networks

- Impedance Form



$$V_{ab} = e_a - e_b$$

$$e_a + e_{ab} - Z_{ab} i_{ab} = e_b$$

$$e_a - e_b + e_{ab} = Z_{ab} i_{ab}$$

$$V_{ab} + e_{ab} = Z_{ab} i_{ab}$$

$$V + e = [Z]\, i$$

Where,

$V_{ab} = Voltage\ across\ element\ ab$

$e_{ab} = Voltage\ Source\ in\ series\ with\ element\ ab$

$i_{ab} = Current\ through\ element\ ab$

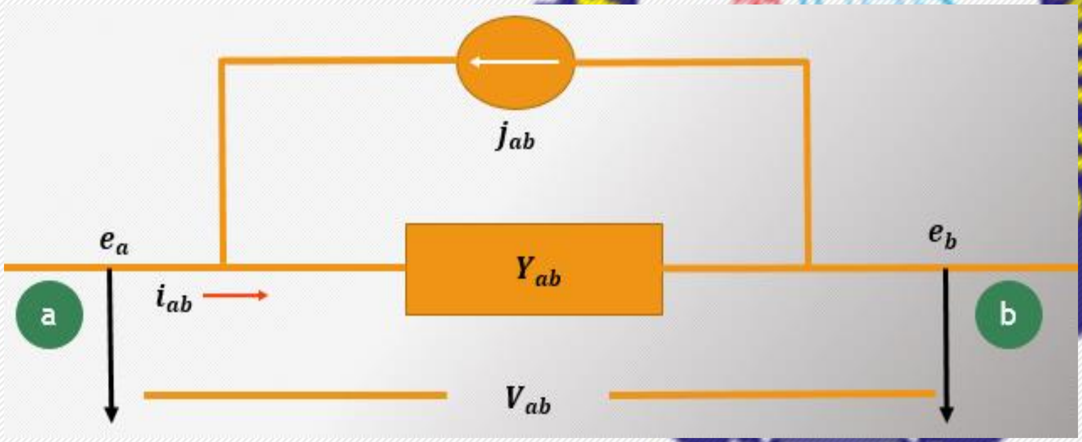
$Z_{ab} = Impedance\ matrix\ of\ element\ ab$

Primitive Networks

- Admittance Form

Primitive Networks

- Admittance Form



$$i_{ab} + j_{ab} = y_{ab}V_{ab}$$

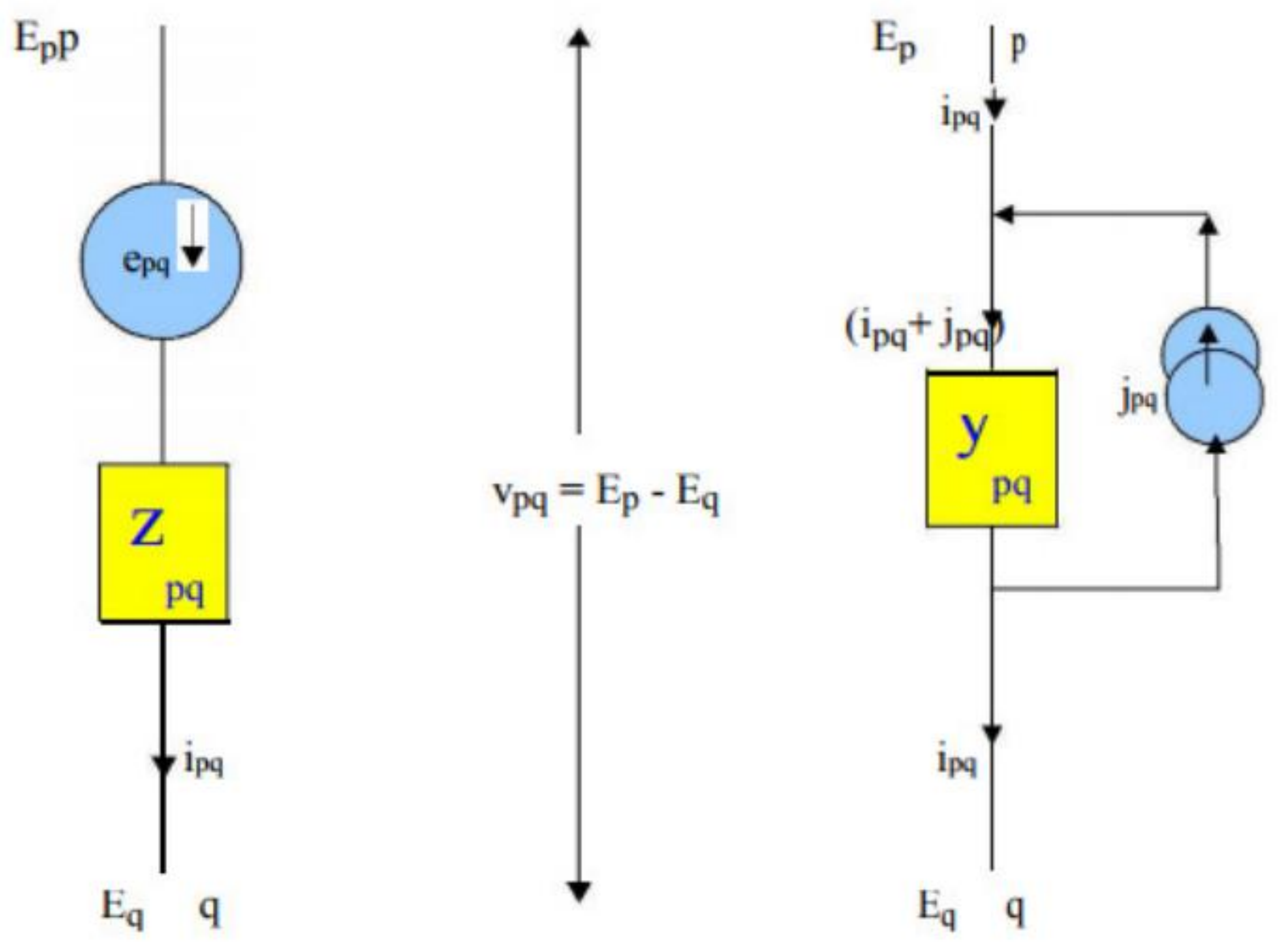
$$i + j = [y]\,V$$

Where,

$j_{ab} = Current\ Source\ between\ element\ ab$

$y_{ab} = Admittance\ matrix\ of\ branch\ ab$

Primitive Networks



With respect to the element, p-q.

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

Primitive Networks

- Performance equation:
  - Each element p-q has two variables, V_{pq} and i_{pq}.
  - The performance of the given element p-q can be expressed by the performance equations as under:

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

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

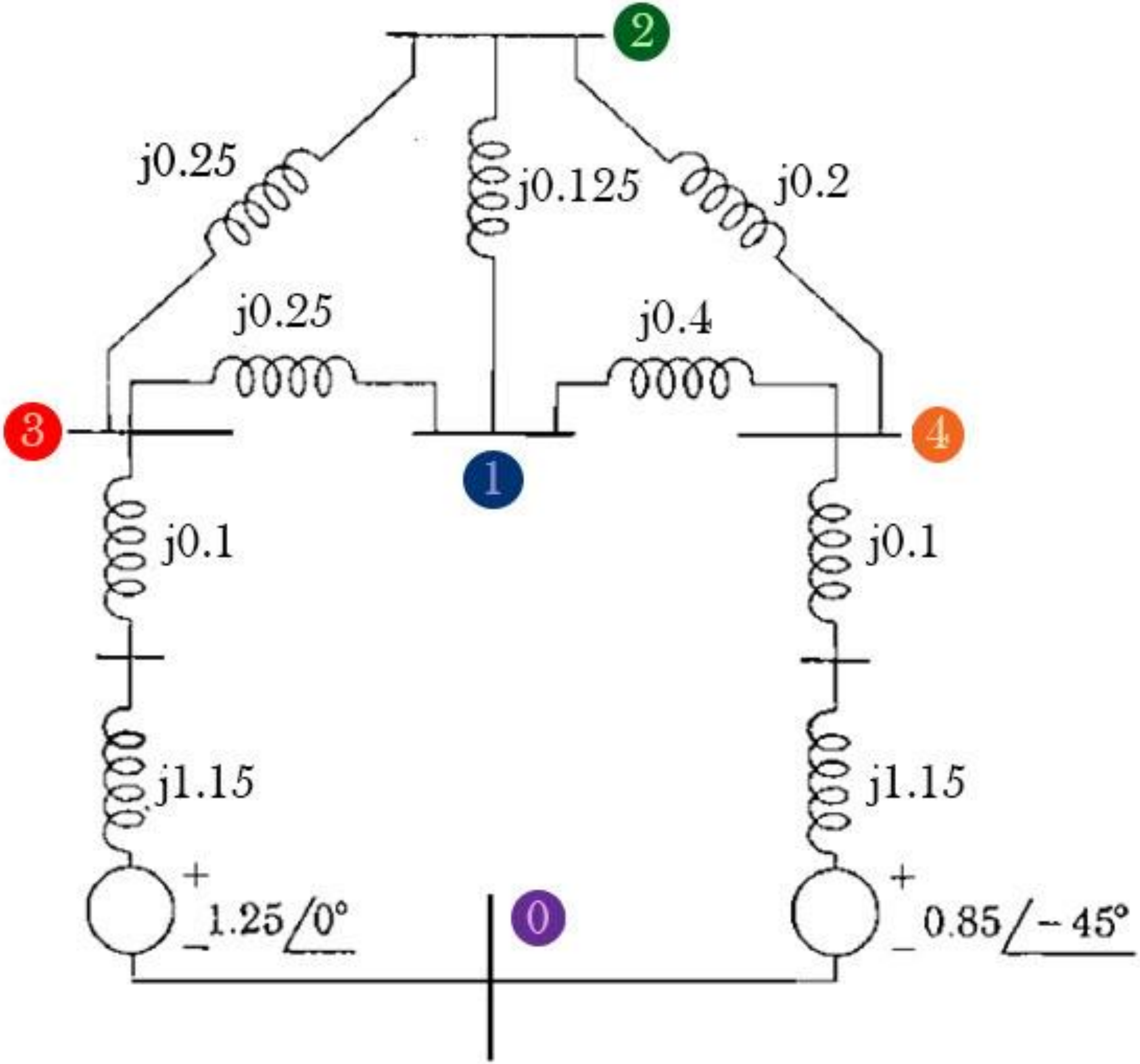
Primitive Networks

- A set of non-connected elements of a given system is defined as a primitive Network and an element in it is a fundamental element that is not connected to any other element.
- In the equations above, if the variables and parameters are replaced by the corresponding vectors and matrices, referring to the complete set of elements present in a given system, then, we get the performance equations of the primitive network in the form as under:

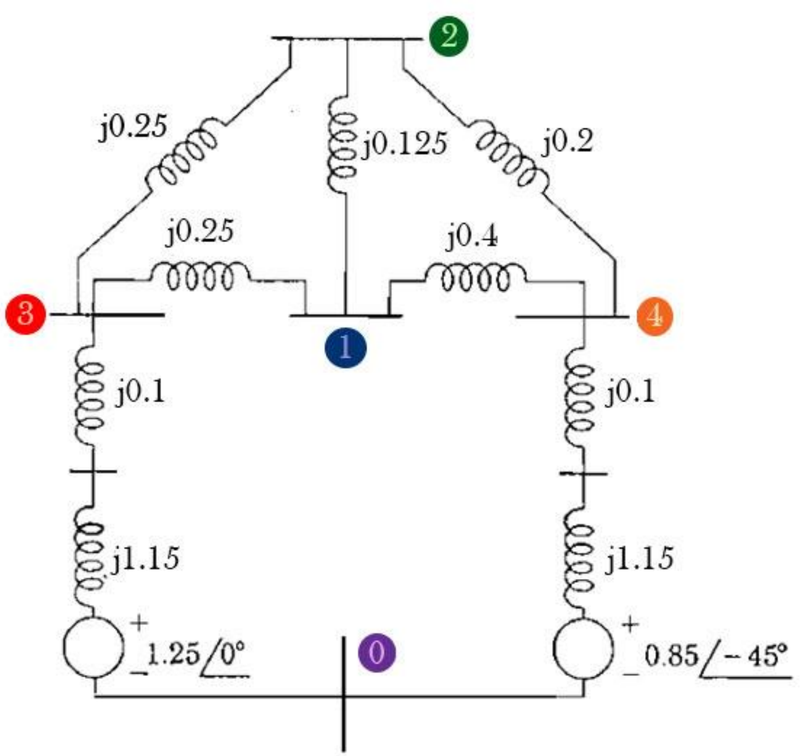
$$v + e = [z]\, i$$

$$i + j = [y]\, v$$

- Four Bus system



Primitive Networks



$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} & Z_{13} & Z_{14} \\ Z_{21} & Z_{22} & Z_{23} & Z_{24} \\ Z_{31} & Z_{32} & Z_{33} & Z_{34} \\ Z_{41} & Z_{42} & Z_{43} & Z_{44} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

Primitive Networks

- A diagonal element in the matrices, [z] or [y] is the self impedance Zpq-pq or self admittance, Ypq-pq.
- An off-diagonal element is the mutual impedance, Zpq-rs or mutual admittance, Ypq-rs, the value present as a mutual coupling between the elements p-q and r-s.
- The primitive network admittance matrix, [y] can be obtained also by inverting the primitive impedance matrix, [z].

Primitive Networks

- Further, if there are no mutually coupled elements in the given system, then both the matrices, [z] and [y] are diagonal.
- In such cases, the self impedances are just equal to the reciprocal of the corresponding values of self admittances, and vice-versa.

Thank You