

## Overview

'NodeVr' is a MATLAB program that solves resistive networks with constant sources using node voltage analysis. It provides node voltages relative to a reference node and voltage, current and power supplied or absorbed for all circuit elements.

## Network Elements

All basic resistive circuit elements are allowed: independent and dependent sources, conductances and resistances. In addition, two special elements: the short circuit and open circuit are provided.

Network elements and topology are entered by means of a comma delimited "netlist". The general form of each entry is:

Reference Designator, Node A, Node B, Value, Control Element

### **Reference Designator**

The Reference Designator is a required field for all network elements that may be up to seven alphanumeric characters in length. The element type is determined by the first character of the Reference Designator except for a dependent source which is determined by the first four characters:

G	Conductance
I	Independent Current Source
O	Open-circuit
R	Resistance
S	Short-circuit
V	Independent Voltage Source
VCVS	Voltage-controlled Voltage Source
VCCS	Voltage-controlled Current Source
CCVS	Current-controlled Voltage Source
CCCS	Current-controlled Current Source

### **Node A and Node B**

Node A and Node B are required numeric fields to specify the location of the element in the network. Network nodes are assumed to be numbered sequentially starting at zero for the Reference Node.

The passive convention is used for element voltages and currents. Element voltages are specified and later calculated as measured at Node A with respect to Node B. Element currents are specified and later calculated as flowing from Node A to Node B.

### **Value**

Value is a numeric field specifying the magnitude of the circuit element. Standard SI units corresponding to the element type are assumed, e.g. volts for a voltage source, ohms for a resistance. Value is a required field for all element types except open- and short-circuits (O and S). For those two element types, Value must be omitted. For dependent sources, Value represents the multiplier of the element.

## Control Element

Control Element is an alphanumeric string that specifies the Reference Designator of the controlling element for a dependent source. It is required for all dependent sources and must be omitted for all other network elements.

## Error Checking

Limited error checking is provided for network elements. Invalid element types are flagged as well as entries with the incorrect number of parameters.

## Solution Approach

'NodeVr' uses node voltage analysis to construct and solve the matrix equation  $\mathbf{Ax} = \mathbf{b}$  where  $\mathbf{x}$  is the vector of unknown node voltages, source currents and control element currents.

The first part of the program gathers and parses the netlist information that describes the network elements and topology. Various counters necessary to the program are updated and limited data entry error checking is performed to preclude invalid circuit elements.

The middle part of the program builds the coefficient matrix  $\mathbf{A}$  and the vector of knowns  $\mathbf{b}$  from the data contained in the netlist. At each node a Kirchoff current law equation of the form:

$$\sum \text{currents leaving the node} = 0$$

is constructed. Each source of any type causes the creation of an unknown current for that source, i.e. "supernode" techniques are not used. Each current controlled dependent source causes the creation of an additional unknown control element current. In addition to the node voltage equations, sufficient auxiliary equations using the unknowns are formed to generate a solvable system of linear equations.

The final part of the program displays the network solution. First, node voltages relative to the reference node are given. Second, information on voltage, current and power supplied for each source (both independent and dependent) is provided. For consistency the passive convention is used for all network elements in 'NodeVr'. For all sources this means that either the displayed voltage or current will be a negative quantity. Third, the voltages, currents and powers absorbed for all resistors and conductances are given. Lastly, voltage or current information is presented for any open- or short-circuit elements.

## External References

'NodeVr' requires the subroutine 'num2metric'.