Node Voltage Method (Nodal Analysis)

The Node Voltage Method, also referred to as Nodal Analysis, is the systematic application of Kirchhoff's Current Law (KCL) to solve for the voltages across and the current through each circuit element.

Definitions:

Node (N): An electrical juncture connecting two or more circuit elements.

Essential Node (EN): An electrical juncture connecting three or more circuit elements.

Super Node (SN): A composite node comprising two or more ENs connected by branches containing only one or more independent and/or a dependent voltage sources.

Reference Node (gnd): An essential node referenced to zero volts or ground.

Nodal Analysis:

1. Identify and label all ENs - assume there are "n" ENs.
2. Identify and label all SNs - assume a SN contains "m" ENs.
3. Choose and label one EN as the reference node - call this reference node ground (zero Volts).
4. Generate one KCL equation for each EN excluding the reference node and any EN which is part of a SN.
5. Generate one KCL equation for each SN which does not contain the reference node.
6. Generate "m-1" constraint equations for each SN in terms of the EN voltages.
7. Generate one constraint equation for each dependent voltage source and dependent current source in terms of the RN voltages - assume there are "d" dependent sources.
8. This process will generate a linear system of "d+n-1" equations with "d+n-1" unknowns. Solve the system of equations to determine the EN voltages and the values of the dependent sources.
9. Use the calculated values of the EN voltages from step 8 to solve for the voltages across and the current through each circuit element.