# The Divide & Conquer Algorithm in Circuit Analysis

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***Abstract*—In the field of electrical engineering, blablablabla**

***Keywords*—Determinants, Divide & Conquer, Mesh, Node.**

## I. Introduction

Kirchoff's Law and Ohm's Law are fundamental laws in circuit analysis. By applying these two laws, scientists develop two powerful techniques in circuit analysis: nodal analysis and mesh analysis. This analysis methods can be solved using the matrices concepts because it will involve several linear equations.

There are several possible ways when we have to deal with the matrices. In this paper, we are going to develop a Divide & Conquer (D&C) algorithm to compute the determinant value of a matrix.

Many times, the D&C can be a powerful problem solving strategy. The most well known D&C algorithm is when they are used to deal with the sorting problem (merge sort and quicksort).

## II. Background

### *A. Node, Branch and Loop*

There are several terms that we have to understand when we are about to discuss the field of circuit analysis. Two of the important ones are node & branch.

A branch represents a single element such as a voltage source or a resistor.

Node is the point of connection between two or more branches.

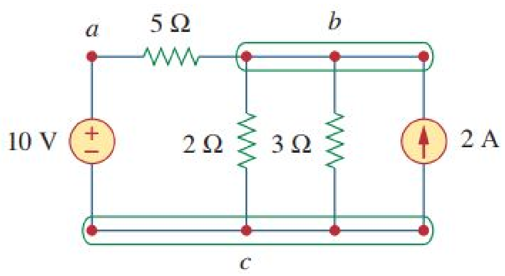


Figure 1. Nodes, Branches, and Loops.
Source: M. N. O. Sadiku, *Fundamentals of Electric Circuits*.

In figure 1, there are 5 branches, namely, the 5, 2, and 3 ohms resistors, the 10 volts voltage source and 2 amperes current source. There are 3 nodes and they are represented by the letter a, b, c as they are the point of connection between branches.

A loop is any closed path in a circuit. A loop is said to be independent if it contains at least one branch which is not a part of any other independent loop. Independent loops or paths result in independent sets of equations.

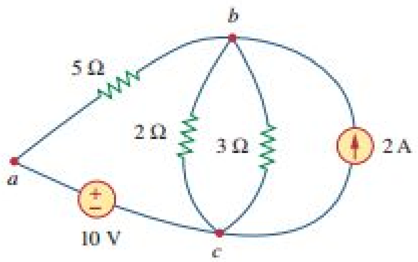


Figure 2. The 3 nodes circuit of Figure 1 is redrawn.
Source: M. N. O. Sadiku, *Fundamentals of Electric Circuits*.

It's possible to form an independent set of loops. In figure 2, abca with the 2Ω resistor is independent. A second loop with the 3Ω resistor and the current source is independent. The third loop could be the one with the 2Ω resistor in parallel with the 3Ω resistor. This does form an independent set of loops.

### *B. Ohm's Law and Kirchoff's Law*

Georg Simon Ohm (1787–1854), found the relationship between current and voltage for a resistor. This relationship is known as Ohm's Law. Ohm's law states that the voltage v across a resistor is directly proportional to the current i flowing through the resistor. That is,

$$\boldsymbol{v \sim i} \qquad \text{Eq. 1}$$

Ohm defined the constant of proportionality for a resistor to be the resistance, R. Thus, Eq. 1 becomes

$$V = IR \qquad \text{Eq. 2}$$

which is the mathematical form of Ohm's law. R in Eq. 2 is measured in the unit of ohms.

Kirchhoff's laws were first introduced in 1847 by the German physicist Gustav Robert Kirchhoff (1824–1887). These laws are formally known as Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL).

## III. Gaussian Elimination to Compute Determinants

There are many methods to compute a matrix determinant, like the cofactor expansion method and this Gaussian elimination. This is one of the most common way to compute a determinant.

Gaussian elimination allows the computation of the determinant of a square matrix, we have to recall how the elementary row operations change the determinant:

1. Swapping two rows multiplies the determinant by −1
2. Multiplying a row by a nonzero scalar multiplies the determinant by the same scalar
3. Adding to one row a scalar multiple of another does not change the determinant.

If Gaussian elimination applied to a square matrix A produces a row echelon matrix B, let d be the product of the scalars by which the determinant has been multiplied, using the above rules. Then the determinant of A is the quotient by d of the product of the elements of the diagonal of B:

$$\det(A) = \frac{\prod \operatorname{diag}(B)}{d}.$$

Computationally, for an n × n matrix, this method needs only O(n3) arithmetic operations, while solving by elementary methods requires O(2n) or O(n!) operations. Even on the fastest computers, the elementary methods are impractical for n above 20.

## V. Conclusion

Dodgson's method to solve determinant is a good upgrade from the Gaussian method.

## VI. Acknowledgment

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## Video Link

https://www.youtube.com/watch?v=ZJVCRIr3Itw&t=68s

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## Pernyataan

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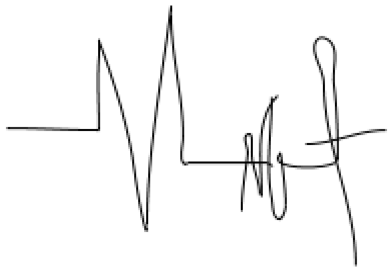

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