

Linear Equation System Study on Electrical Circuits Using Matlab

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ABSTRACT

In everyday life, especially in the electrical circuit, there are many usage of matrix. One use of a matrix is found in the system of linear equations. In the field of electrical circuits there are also problems involving systems of linear equations in matrix form. To solve the system of linear equations in matrix form, in addition to using elementary row operations, also used matlab.

Keywords: *Kirchoff law, matlab.*

INTRODUCTION

In the field of scientific engineering, known to many branches of science such as civil engineering sciences, electrical engineering and information engineering sciences. In the science of electrical engineering, there are various problems such as science of electric field phenomena, telecommunications engineering science and electrical circuitry. In the science of electrical circuits, also known kirchoff laws. There are two kirchoff laws: first kirchoff law and second kirchoff law. Using both kirchoff laws, a linear equation system can be established.

If in an electrical circuit, there is one loop, then only one linear equation system will be formed. Where there are more than one loop, more than one system of linear equations can be formed, according to the number of loops available. If there are many linear equations, it would be easy to construct a system of linear equations.

To solve the system of linear equations, it can be used several ways such as substitution method, elimination method. Both of these methods are suitable for solving systems of linear equations that have only two variables. If the system of linear equations has more than two variables, then the solution of this system of linear equations, using elementary row operation methods and also using matlab.

MATLAB is short for MATrix LABoratory because every data in MATLAB uses basic matrix. MATLAB is a high, closed, and case sensitive programming language in numerical computing environments developed by MathWorks. One of its most popular advantages is the ability to create graphics with the best customization support.

MATLAB has many tools that can help various disciplines. This is one of the causes of industry using MATLAB. In addition MATLAB has many libraries that are helpful for solving mathematical problems such as simulating functions, mathematical modeling and GUI design.

MATLAB is used by students, technicians, researchers at the University, Research Institutions and Industries to perform mathematical computations in a variety of purposes. MATLAB is typically used for research, systems development and system design. Unlike other programming languages, MATLAB is a closed programming language. To be able to compile you must use software from MathWorks itself.

Here are some examples of MATLAB applications in various disciplines

1. Math

As a science known as "The Mother of Science" is certainly, MATLAB can help solve various problems of mathematics both from ordinary calculations, function simulations and mathematical modeling.

2. Statistics

Statistics is a branch of mathematics that studies how to plan, collect, analyze, interpret, and present data. MATLAB also provides various statistical tools such as time series, neural network etc. to help solve statistical problems.

3. Financial

Financial problems can be solved with MATLAB such as inflation, interest rates and

other complex issues. Many tools such as financial time series.

4. Engineering and Computing

MATLAB can assist in designing a system design and analysis of an algorithm. There are various tools such as fuzzy logic designer, control system tuner, control system designer, linear system analyzer, neuro fuzzy designer, and system identification.

5. Biology

The development of the world is more advanced, two sciences with different bases between biology and technology can now be put together. MATLAB allows for the analysis of organ systems, tissues, even human DNA, and the design of artificial organs. Many tools can be used such as molcul viewer, Symbiology

6. Communication and Networking

The world's major industries use MATLAB in the analysis of communication and network systems development. Many MATLAB tools for this discipline such as Bit Error Rate Analysis, signal analysis and others.

TYPES OF MATRICES

There are various types of matrices that are adjusted to the order and position of the elements.

The types of matrices are:

1. Square Matrix

The square matrix is the matrix with the number of rows and the same number of columns $n \times n$. An example of a square matrix is a 2×2 matrix.

2. Diagonal matrix

Is a square matrix in which elements other than the diagonal element are 0. The diagonal element is the element a_{ij} where $i = j$.

3. Identity Matrix

It is a diagonal matrix whose all diagonal elements are 1.

4. Unit Matrix

Is a matrix whose elements contain only one or zero.

5. Triangle Matrix

There are two divisions. Namely the upper triangular matrix is the square matrix that all elements below the diagonal element are zero. In contrast the lower triangular matrix is a square matrix that all elements above the diagonal element are zero.

6. Symmetry Matrix

Is a square matrix where for each element in the index row i column j , it has the same

value as the element in the row index of column i . ($a_{ij} = a_{ji}$).

TERMS ON MATRIX

1. Transpose Matrix

The transpose matrix is denoted by A^t . Trasposing a matrix A can be done by converting the row in the matrix A into the column of the A^t matrix

2. Determinate Matrices

The determinant of the matrix is a scalar function with the square matrix domain. Determinants in the matrix are used in analyzing a matrix such as checking for the absence of an inverse matrix, determining system solutions of linear equations, vector base checks and others. The determinant of a matrix is represented by replacing the square brackets in the matrix into a downward vertical line.

3. Inverse Matrix

If there is a square matrix A and B and of the same order, and I is the identity matrix. If there is an equation $A \cdot B = I$, then it can be said that B is the inverse of A , and A is the inverse of B . Invers is denoted by a negative one. In this case $A^{-1} = B$, and $B^{-1} = A$.

OPERATION ON MATRICES

In the matrix there are also operations. Operations that can be done on the matrix include:

1. Matrix summation

The sum of the matrix can only be applied to matrices having the same order size. If $A = (a_{ij})$ and $B = (b_{ij})$ are equal-sized matrices, then $A + B$ is a matrix $C = (c_{ij})$ where $(c_{ij}) = (a_{ij}) + (b_{ij})$ or $[A] + [B] = [C]$

have the same size and element $(c_{ij}) = (a_{ij}) + (b_{ij})$.

2. Matrix Reduction

As with matrix summation, matrix reduction can only be done on matrices of the same size. If the size is different then the result matrix is undefined.

3. Multiplication of Matrix Scalar

If k is a scalar number and $A = (a_{ij})$ then the matrix $kA = (ka_{ij})$ is a kA matrix obtained by multiplying all elements of matrix A with k . Multiplying a matrix with a scalar can be written in front of or behind the matrix. For example

$[C] = k [A] = [A] k$ and $(c_{ij}) = (ka_{ij})$.

4. Multiplication Matrix with Matrix

If A is the matrix of the $m \times n$ and B is the $n \times p$ matrix, then the matrix A product with B , eg C , is the new matrix of the $m \times p$ beam.

5. The Matrix of Cage Length

If A is a rectangular matrix, then the appointment of matrix A is defined as follows. If A is a

rectangular matrix, then the appointment of matrix A is defined as follows.
 $A^2 = A.A$. $A^3 = A.A^2$.

E. LEGAL MATRIX

If A, B, and C are equivalent matrices to be multiplied, then the matrix multiplication properties are applied: Not commutative, Associative, Distributive and There is an identity matrix I so that $AI = IA = A$.

KIRCHOFF'S FIRST LAW

This law states that the current entering the branching point is as large as the current leaving the point. If i_1 and i_4 are currents entering the branching point, whereas i_2 and i_3 are currents coming out of the branching point, $i_1 + i_4 = i_2 + i_3$. This is called Kirchhoff's Law, Kirchhoff's point law, Kirchhoff branching law, or KCL (Kirchhoff's Current Law). The principle of conservation of electric charge says that: At each branching point in the electrical circuit, the sum of

the currents entering the point is equal to the amount of current coming out of that point. Or The total number of currents at a point is zero. Whereas the second law of kirchoff states the sum of all voltages around the loop (round) equal to zero.

OPERATION LINE ELEMENTER (OBE)

The elementary row operation (OBE) is an operation performed in order to simplify an augmented matrix. OBE in the process is an arithmetic operation (involving addition and multiplication) imposed on each element in a certain row of a matrix. In the process the elementary row operations include:

1. Line exchange
2. Multiplication of a row with non-zero constants
3. The sum of a row with the other row multiplication with non-zero constants.

II. METHODOLOGY

Diagram Block Research

The research block diagram is written as follows:

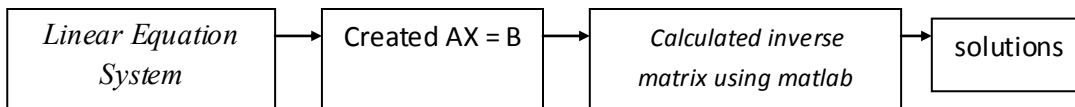
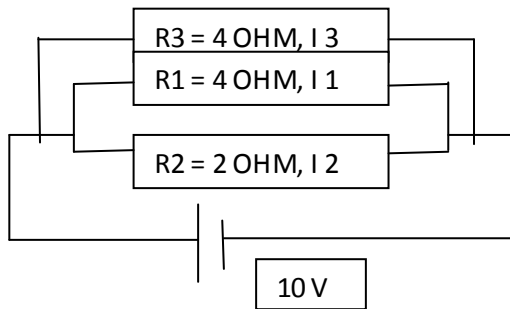


Fig 1. Research Block Design

Case Study



In the above sequence, if R_3 is known to be 4 ohm, R_1 is 4 ohms, and R_2 is 2 ohms, and V is 10 volts. Determine I_1 , I_2 , and I_3 !

Resolution:

In the series according to Kirchoff's first and second laws are obtained

Loop 1

$R1I1 - R1I3 + R2I1 - R2I2 = 0$

Equivalent to:

$(R1 + R2) I1 - R2I2 - R1I3 = 0$

$6 I1 - 2 I2 - 4 I3 = 0 \dots\dots\dots (1)$

Loop 2

$-V + R2I2 - R2I1 = 0$

Equivalent to:

$R2I2 - R2I1 = V$

$2I2 - 2 I1 = 10 \dots\dots\dots (2)$

Loop 3

$R3I3 + R1I3 - R1I1 = 0$

Equivalent to

$-R1 I1 + (R1 + R3) I3 = 0$

$-4 I1 + 8 I3 = 0 \dots\dots\dots (3)$

From the resulting equation it can be transformed into the matrix $AX = B$, ie

$[A] [X] = [B]$

$$\begin{bmatrix} 6 & -2 & -4 \\ -2 & 2 & 0 \\ -4 & 0 & 8 \end{bmatrix} \begin{bmatrix} I1 \\ I2 \\ I3 \end{bmatrix} = \begin{bmatrix} 0 \\ 10 \\ 0 \end{bmatrix}$$

Next use matlab to calculate the value of matrix X as follows. To get started, type one of these: helpwin, helpdesk, or demo.

```
A = [ 6 -2 -4 ; -2 2 0 ; -4 0 8 ];
» y = inv(A)
y =
    0.5000    0.5000    0.2500
    0.5000    1.0000    0.2500
    0.2500    0.2500    0.2500
» B = [0 ; 10 ; 0];
» x = y*B
x =
    5.0000
   10.0000
    2.5000
```

Based on the above calculation results can be concluded the value of the variable $I_1 = 5$ amperes, $I_2 = 10$ amperes and $I_3 = 2.5$ amperes.

III. CONCLUSION

By using matlab, we can calculate the first, second and third currents in the electrical circuit

REFERENCES

- Aljabar Linear Dan Aplikasinya edisi 5 . Penerbit Erlangga 3. Mursita D. (2000).
- Anton, Howard and rorres, Cris, "Elementary Linear Algebra with Aplications , 9th Edition , John Wiley and Sons, 2005
- Diktat Kuliah Aljabar Linear Elementer. STT Telkom.
- Harry Octavianus Purba. IF2123 Paper Algebra Geometry. Completion of SPL in Electrical Circuits. First Semester of 2015/2016. School of Electrical Engineering and Informatics. ITB. Bandung.