

1. Introduction to MATLAB

February 9, 2005

In this tutorial, we will introduce MATLAB and shows few examples about the basic operation in MATLAB.

1 Overview

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The name MATLAB stands for matrix laboratory.

Typical uses include Math and computation Algorithm development Data acquisition Modeling, simulation, and prototyping Data analysis, exploration, and visualization Scientific and engineering graphics Application development, including graphical user interface building

Example 1 *Compute 3+5 in MATLAB.*

You can either use command window straight forward to get the answer by type in "3 + 5". MATLAB displays the ans = 8.

There are more than one way to complete such operation.

Alternative 1 *Instead of using command window you can use m file to compute such operation.*

1. *Open new m file;*
2. *type in "3 + 5";*
3. *Save the file. For example save the file as "test";*
4. *At the command window calling the file by type in "test".*

Alternative 2 *Or still using command window but assigning value into different variables¹*

1. *type in "x = 3";*
2. *type in "y = 5";*

¹Matlab is case sensitive

3. type in "x + y";

4. Matlab displays "ans = 8".

In this method, it might took a little longer time to declare variables but it would be useful for dealing with complicated questions.

2 Matrix

In MATLAB, all number are considering in rectangular array of number. In previous example when we assign $x = 3$, the x is a one by one matrix which is a scalar in Matlab. For matrix only has one column or row is called vector.

You can enter matrices into MATLAB in several different ways:

1. Enter an explicit list of elements.
2. Load matrices from external data files.
3. Generate matrices using built-in functions.
4. Create matrices with your own functions in M-files.

There are few basic conventions:

1. Separate the elements of a row with blanks or commas.
2. Use a semicolon";" to indicate the end of each row.
3. Surround the entire list of elements with square brackets, [].

Example 2 compute $a + b$ if $a = \begin{bmatrix} 4 & 3 \\ 2 & 9 \end{bmatrix}$

$$b = \begin{bmatrix} 7 & 1 \\ 5 & 8 \end{bmatrix}$$

1. Go to Command Window type in "a = [4 3; 2 9]";
2. Type in b = "[7 1 ; 5 8]";

3. Type in "a + b". 4. Matlab displays "ans = $\begin{bmatrix} 11 & 4 \\ 7 & 17 \end{bmatrix}$ "

When adding and subtracting matrices, the dimensions of each matrix must be identical.

Note that matrix addition and subtraction are:

Cummative: $A+B=B+A$

Associative: $(A+B)+C=A+(B+C)$

You can also change certain element of the matrix by using $a(i, j) = \text{new value}$. In the case type in, $a(1, 1) = 2$. Matlab displays the new matrix a

$$a = \begin{bmatrix} 2 & 3 \\ 2 & 9 \end{bmatrix} \text{ instead of the old } a = \begin{bmatrix} 4 & 3 \\ 2 & 9 \end{bmatrix}$$

There are other arithmetic operations providing by Matlab such as array multiplication, left division and transpose. The details description can be found in the Help manual. ²

There are few other matrix operations such as Inverse, Rank and size provides by Matlab.

Example 3 Find matrix a 's inverse matrix if $a = \begin{bmatrix} 2 & 3 \\ 2 & 9 \end{bmatrix}$

In the command window, type in "inv(a)".

Matlab display

$$ans = \begin{bmatrix} 0.7500 & -0.2500 \\ -0.1667 & 0.1667 \end{bmatrix}$$

3 Using Matlab to solve electrical circuit

Since Matlab is a pretty powerful tool to use, it is possible to use Matlab to solve a circuit as introduce during the lecture.

Example 4 Mesh Analysis A DC circuit model shows in Figure 1. It is a three wire electrical distribution service to residential and commercial buildings. The two ideal sources and the resistances R_4 and R_5 represent the equivalent circuit of the distribution system. $R_1 = 15\Omega$; $R_2 = 40\Omega$; $R_3 = 16\Omega$; $R_4 = R_5 = 1.3\Omega$ and $V_{S1} = V_{S2} = 110v$. Determine the voltage across the three resistors R_1 , R_2 and R_3 .

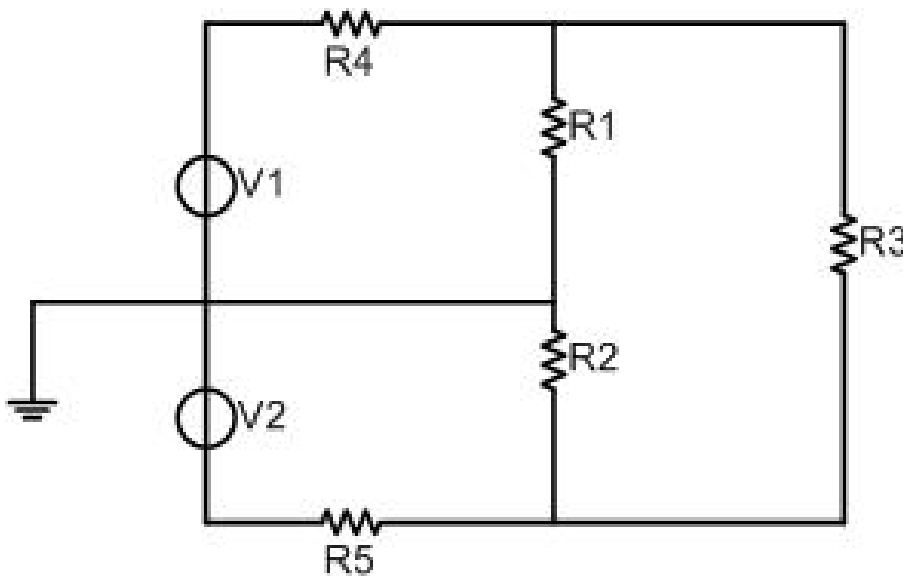


Figure 1

²When Multiplying two matrices, the number of columns of the first matrix must equal the number of rows of the second matrix.

By using mesh current analysis method, we can obtain the following three equations.

$$\begin{aligned} V_{S1} - R_4 I_4 - R_1(I_1 - I_3) &= 0 \\ V_{S2} - R_2(I_2 - I_3) - R_5 I_2 &= 0 \\ -R_1(I_3 - I_1) - R_3 I_3 - R_2(I_3 - I_2) &= 0 \end{aligned}$$

Rearrange these three equations, we can obtain

$$\begin{aligned} -(R_1 + R_4)I_1 + R_1 I_3 &= -V_{S1} \\ -(R_2 + R_5)I_2 + R_2 I_3 &= -V_{S2} \\ R_1 I_1 + R_2 I_2 - (R_1 + R_2 + R_3)I_3 &= 0 \end{aligned}$$

Substitute numerical numbers into the equations

$$\begin{bmatrix} -16.3 & 0 & 15 \\ 0 & -41.3 & 40 \\ 15 & 40 & -71 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -110 \\ -110 \\ 0 \end{bmatrix}$$

which can be expressed as

$$[R][I] = [\nu]$$

therefore

$$[I] = [R]^{-1}[V]$$

Type in the values $[R], [\nu]$ in Matlab command window. Then "inv(R)" which we will get the following matrix

$$[R]^{-1} = \begin{bmatrix} -0.1072 & -0.0483 & -0.0499 \\ -0.0483 & -0.0750 & -0.0525 \\ -0.0499 & -0.0525 & -0.0542 \end{bmatrix}$$

Then if we type in "inv(R) * [nu]" in the command window, we can obtain the solution to the current matrix

Matlab displays following matrix

$$ans = \begin{bmatrix} 17.11 \\ 13.57 \\ 11.26 \end{bmatrix}$$

Therefore, we can find

$$\begin{aligned} V_{R1} &= R_1(I_1 - I_3) = 87.75\nu \\ V_{R2} &= -R_2(I_2 - I_3) = -92.40\nu \\ V_{R3} &= R_3 I_3 = 180.16\nu \end{aligned}$$