CGN 2420
Working with Matrices in Mathcad

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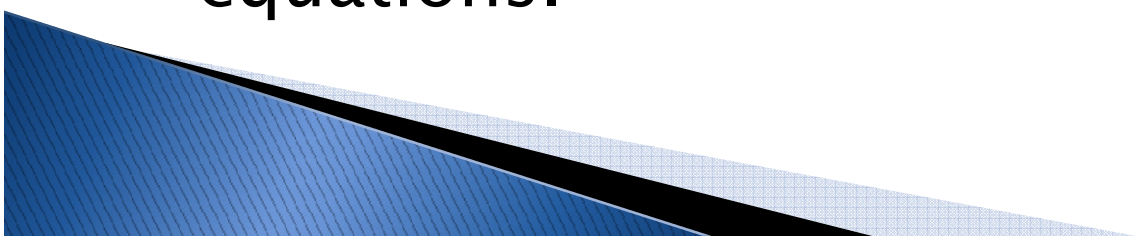
Objectives

- Know several ways to create a matrix and fill it with values.
- Be able to perform basic matrix operations using Mathcad.
- Be aware of Mathcad's built-in functions to manipulate matrices.
- Use linear algebra to solve systems of equations.

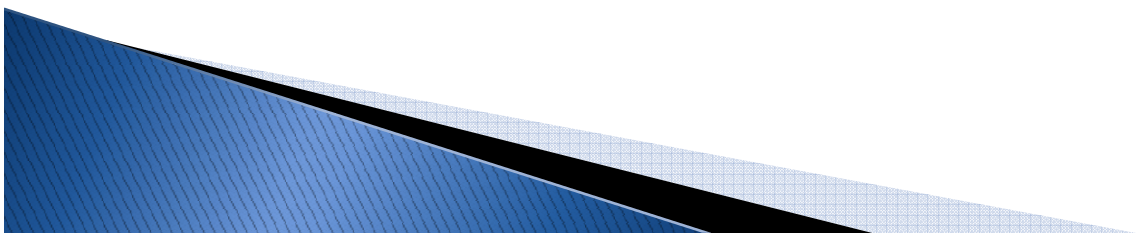


Matrix

A matrix is a collection of numbers, called elements, that are related in some way.

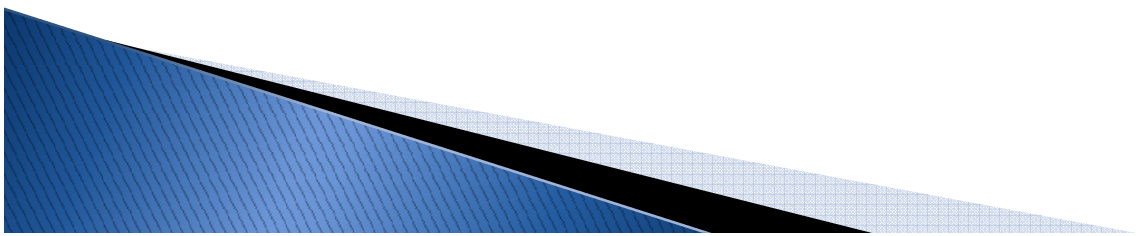
Definitions used in Mathcad's help files:

- Array argument (A): either a matrix or a vector.
- Matrix argument (M): an array with two or more rows or columns.
- Vector argument (v):an array containing a single row or column.



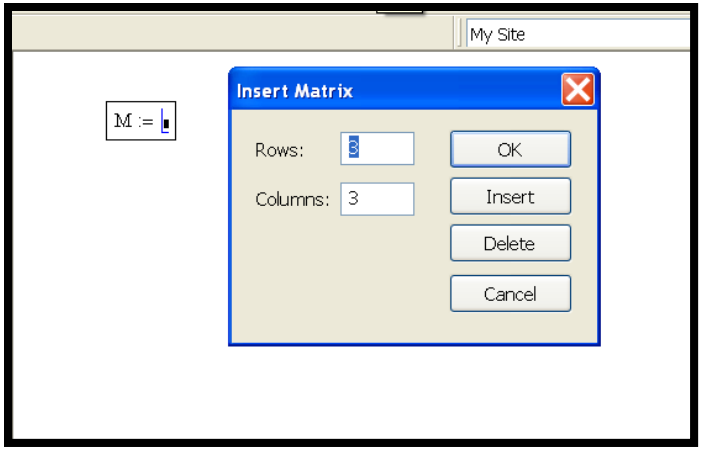
Defining a Matrix

- There are several ways to initialize a matrix in Mathcad:
  - Type in the values from the keyboard.
  - Read the values from a file.
  - Use an input table to fill the matrix.
  - Compute the values by using a function or a range variable.
  - Copy and paste values from another Windows program.



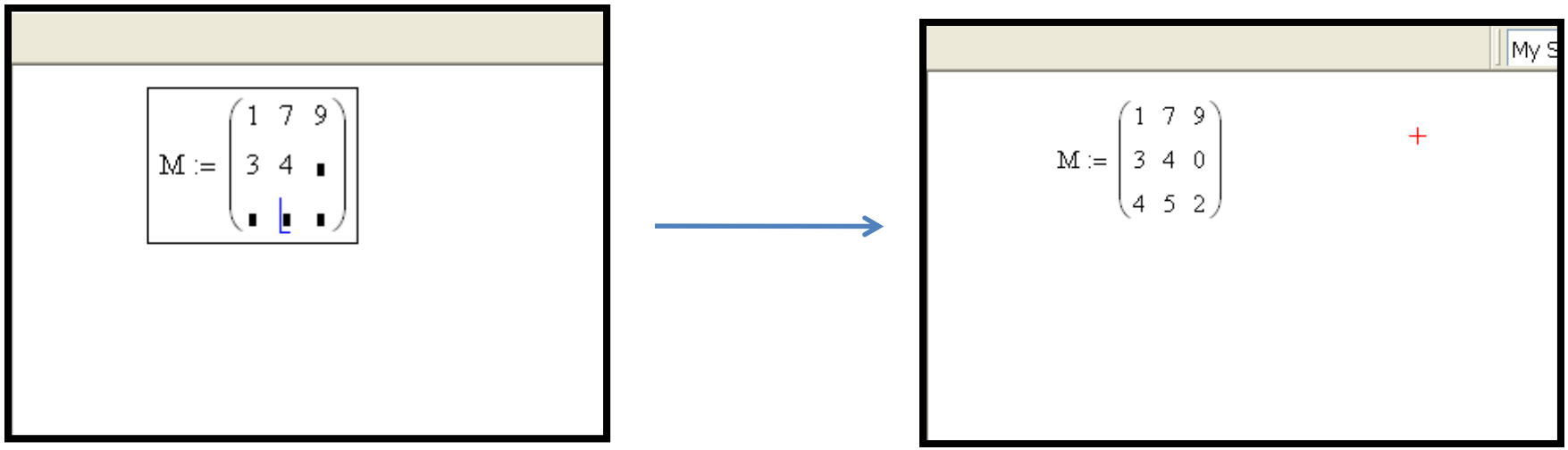
Defining a Matrix

- Step 1: Create the empty arrange
  - Begin by choosing a variable name and using the assignment operator (:=).
  - Then open the Insert Matrix Dialog.
  - Tell Mathcad how many rows and columns the matrix should contain.



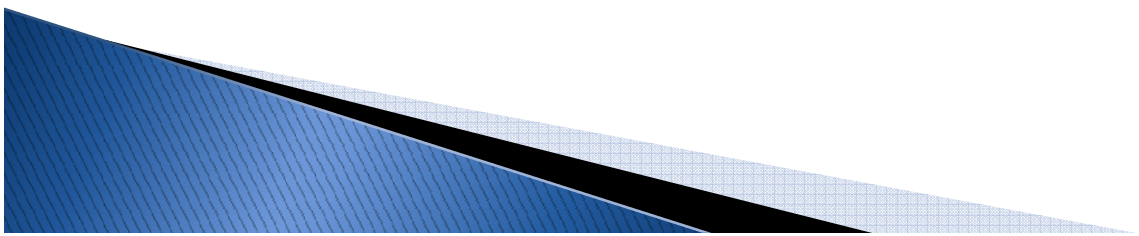
Defining a Matrix

- Step 2: Fill the placeholders to assign a value to each matrix element.



Modifying Matrices

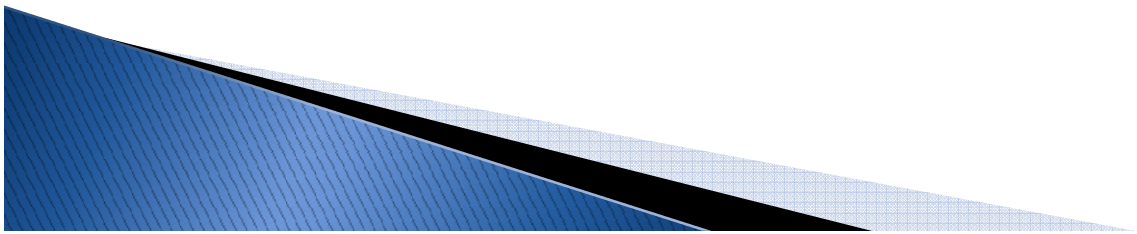
- Use the Insert Matrix Dialog to **insert** a row and/or a column into an existing array.
- Use the Insert Matrix Dialog to **delete** a row and/or a column of an existing array
- To join two arrays together side to side, use the **augment()** function.



Modifying Matrices (Cont)

- To put one array on top of the another use the **stack()** function.

- Portions of an array can be selected by:
  - *Column operator*, < > to grab a single column from an array.
  - *Submatrix() function*, to grab a part of an array.



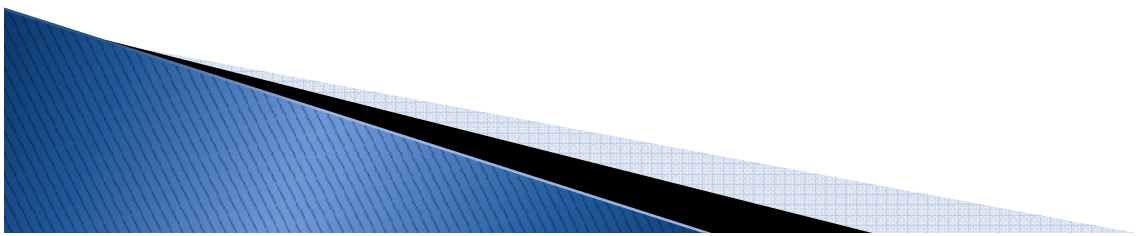
Copying and Pasting Values from an Spreadsheet

- Define an array in Mathcad.
- In the spreadsheet, select and copy the values.
- In Mathcad, click the placeholder on the right side of the assignment operator in the new matrix definition.
- Paste the values by using the menu options Edit/Paste, or keyboard shortcut [Ctrl+V].

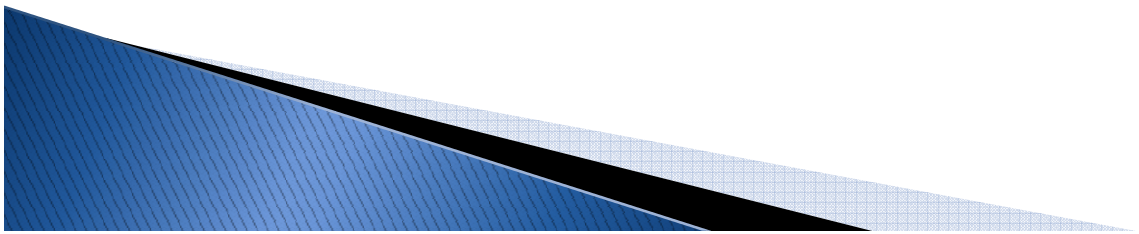
Reading Data from Text Files

Data can be read directly into an array definition by using the READPRN() function.

- The READPRN(path) function takes the path name of the file.
- The text file can be tab-delimited or comma-delimited.



Matrix Properties



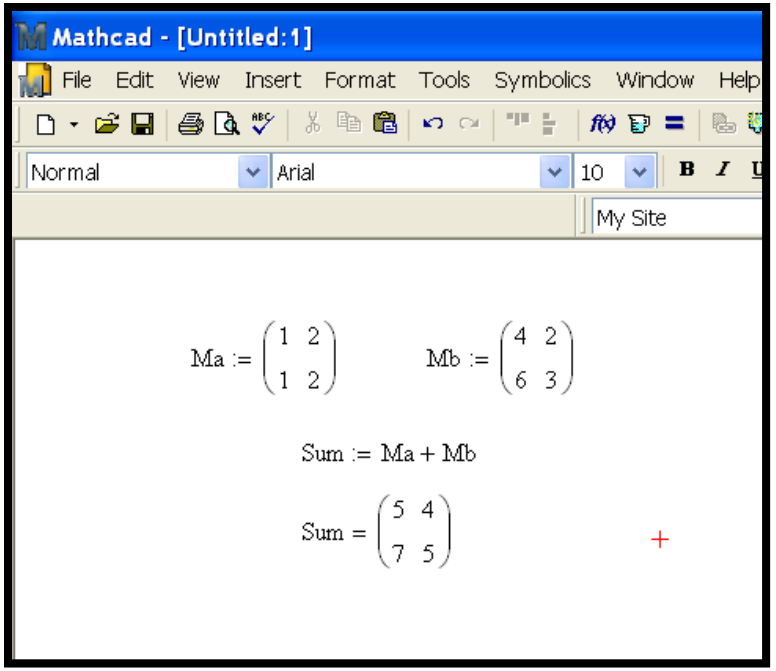
Matrix Addition or Subtration

- **Requirement:**

  The arrays to be added must be the same size.

- **Procedure:**

  Each element of the first array is added (or subtracted from) the same element of the second array.



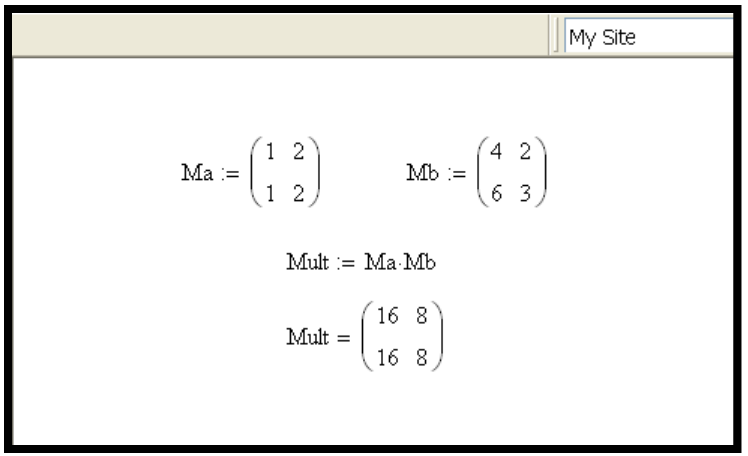
Matrix Multiplication

- **Requirement:**

  The inside dimensions of the arrays to be multiplied must be equal.

- **Procedure:**

  Working across the columns of the first array and down the rows of the second array, add the product of each pair of elements.



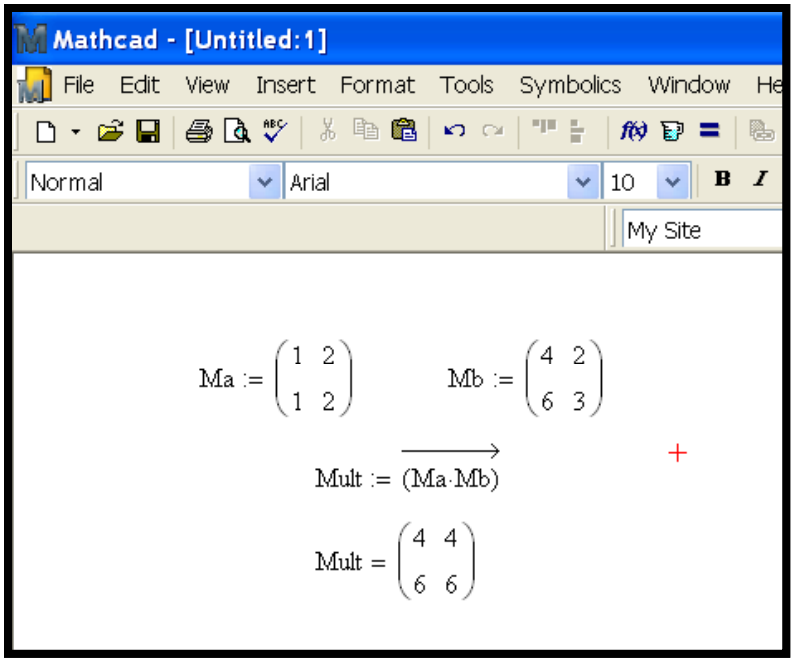
Element-by-Element Multiplication

- **Requirement:**

  The arrays must be the same size.

- **Procedure:**

  Multiply each individual element of the first matrix by the corresponding element of the second matrix.



Transposing a Matrix

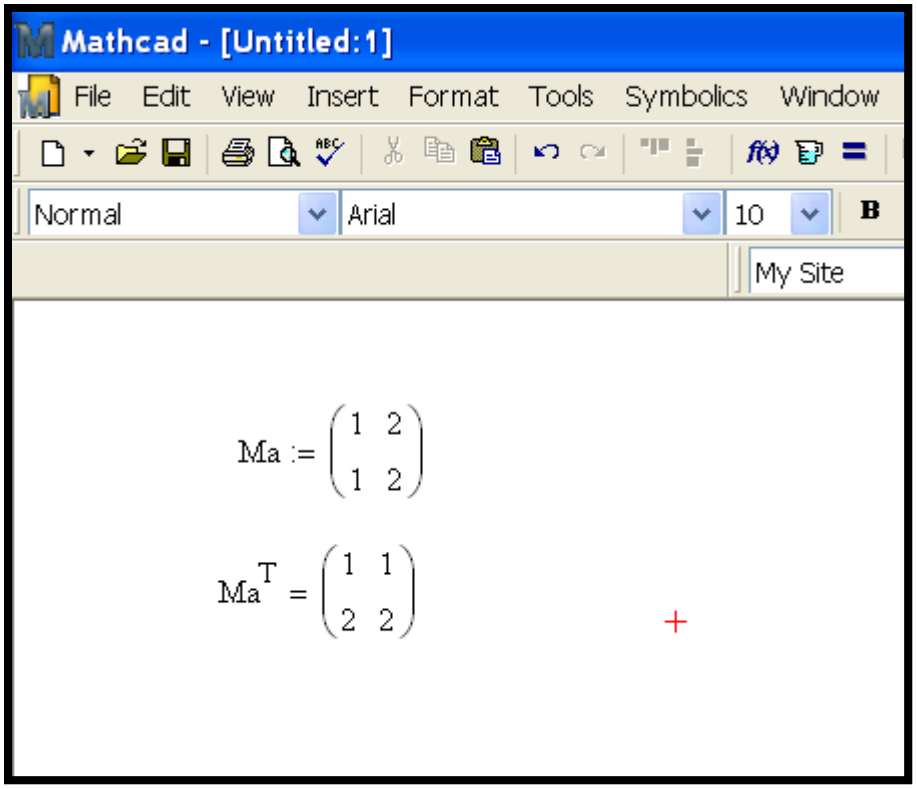
- **Requirement:**

  Any array can be transposed.

- **Procedure:**

  Interchange row and column element.

  The transpose operator is available on the matrix tool bar or [Ctrl+1].



Inverting a Matrix

- **Requirement:**

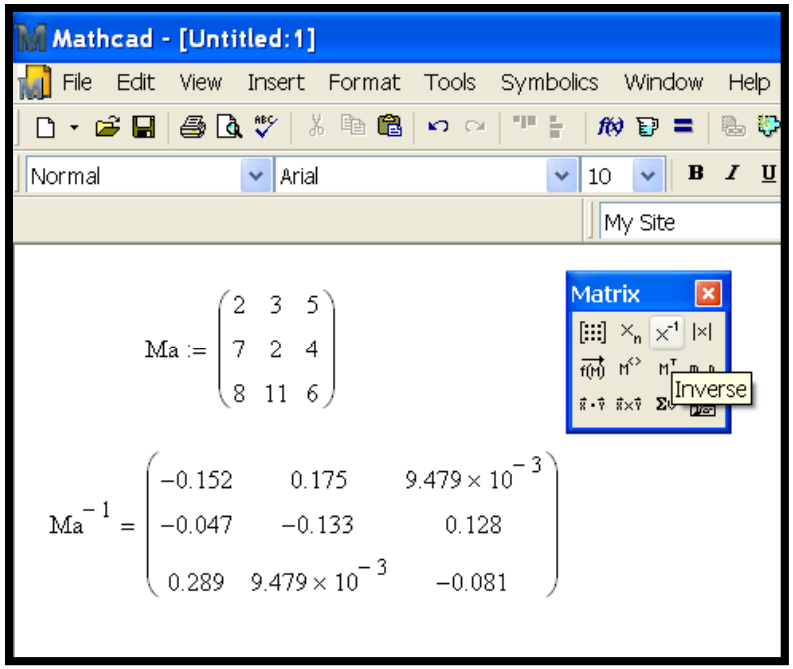
  Only square and non-singular (Det≠0) matrices can be inverted.

- **Procedure:**

  Quite involved!

  See textbook pg. 118

  The inverse operator is available on the matrix tool bar.



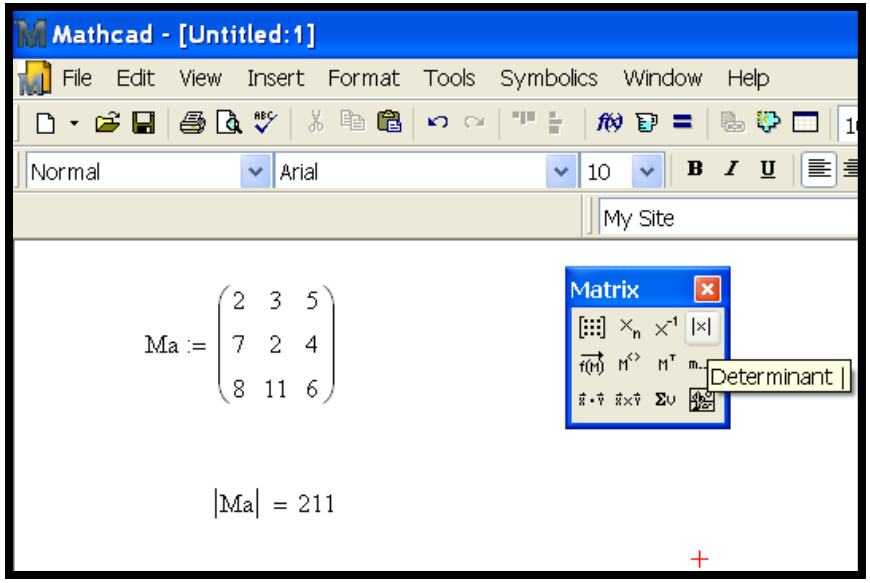
Determinant of a Matrix

- **Requirement:**

  Matrix must be square.

- **Procedure:**

  The determinant operator is available on the matrix tool bar.



Solving Systems of Linear Algebraic Equations (LAE)

- **Requirements:**

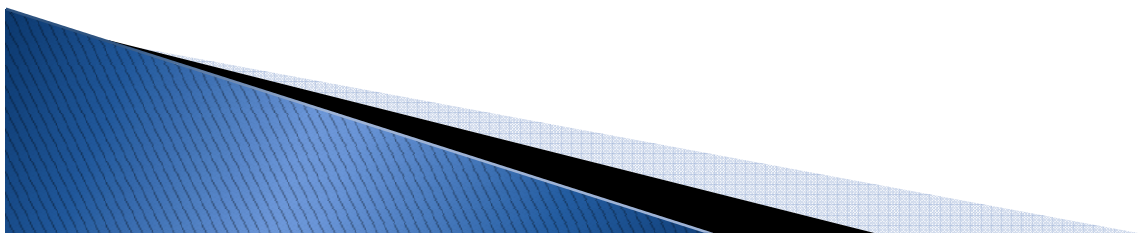
  A non homogeneous system of linear equations has a unique solution if the determinant of the system's matrix is nonzero (i.e., the matrix is nonsingular).

$$8x_1 + 4x_2 - 3x_3 = 14$$

$$6x_1 + 2x_2 - 4x_3 = -4$$

$$4x_1 - 3x_2 + 6x_3 = 32$$

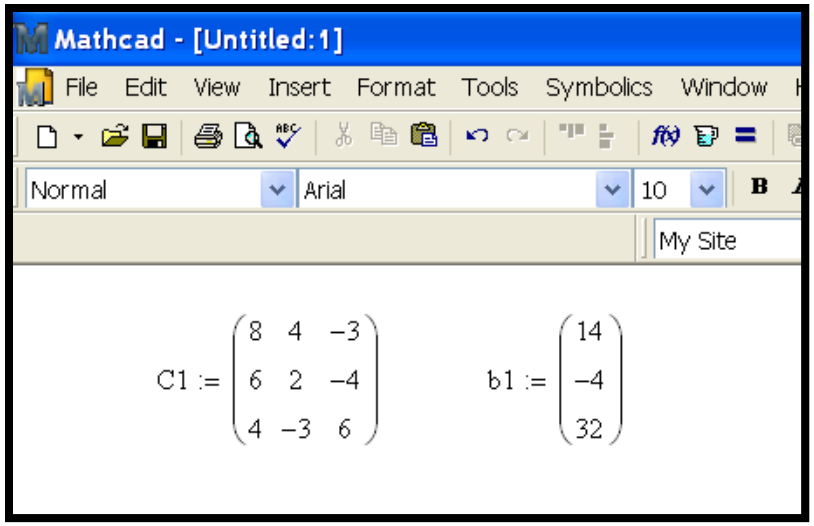
$$C.X = b$$



Steps to Solve LAE

- **Step 1**:
  Write the set of equations in proper matrix form.

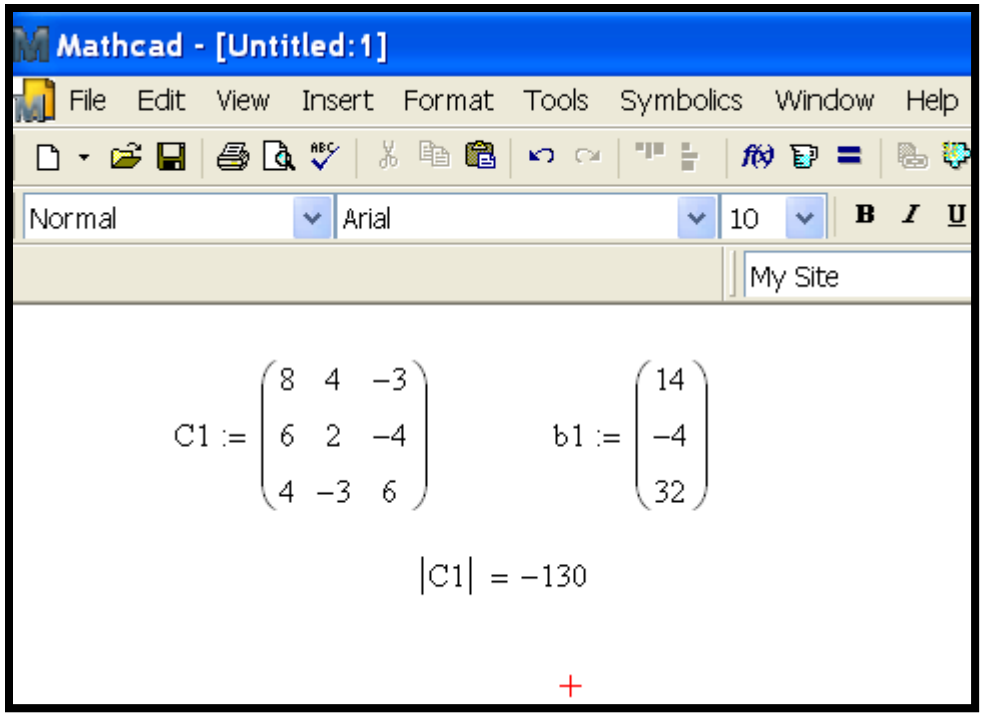
$$8x_1 + 4x_2 - 3x_3 = 14$$
$$6x_1 + 2x_2 - 4x_3 = -4$$
$$4x_1 - 3x_2 + 6x_3 = 32$$



Steps to Solve LAE

- Step 2:
  Calculate the determinant of the coefficient to see of a solution exists.

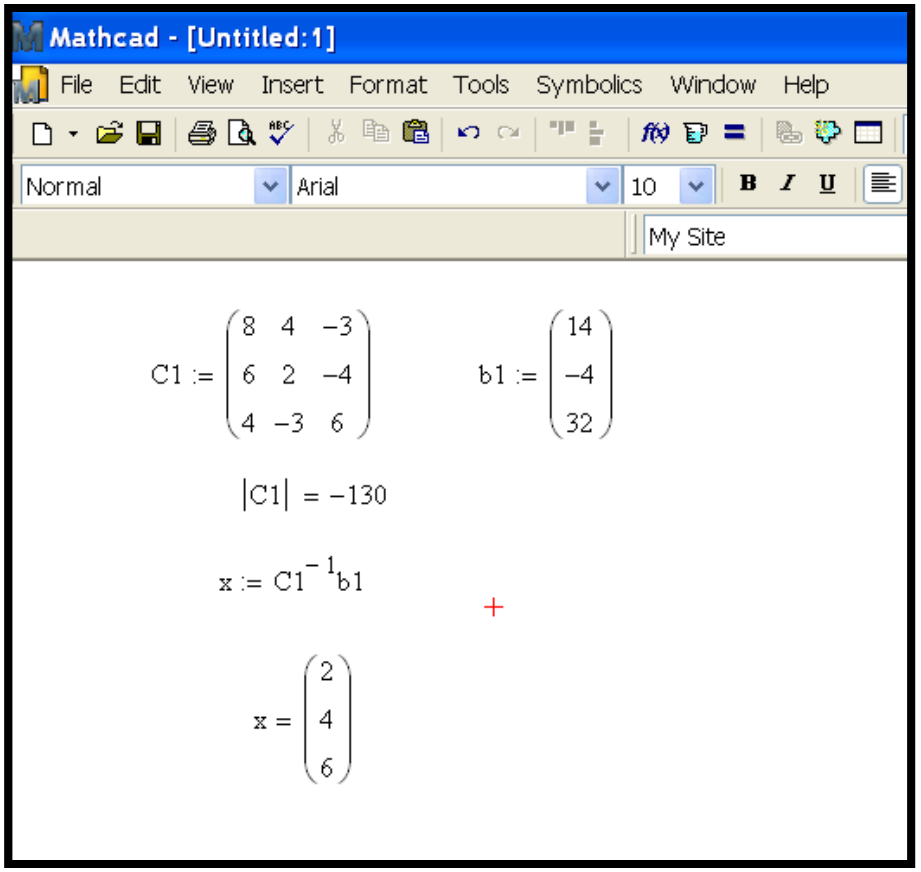
  If the determinant of the coefficient matrix is zero, there is no solution to the set of equations.



Steps to Solve LAE

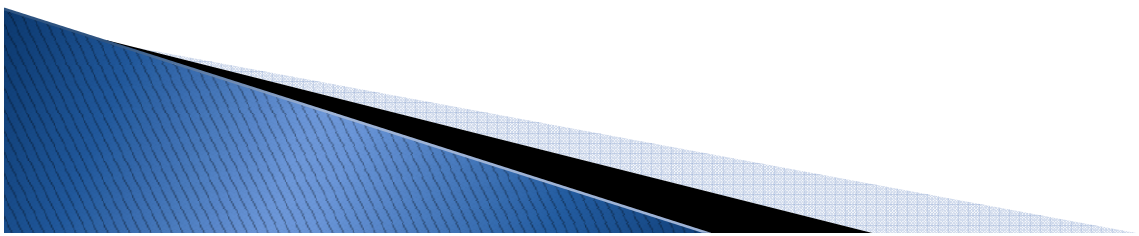
- Step 3:
  Determine the element values of the unknown vector by inverting the coefficient matrix and multiplying the result with the right-hand-side vector as:

  x:=C^-1*r

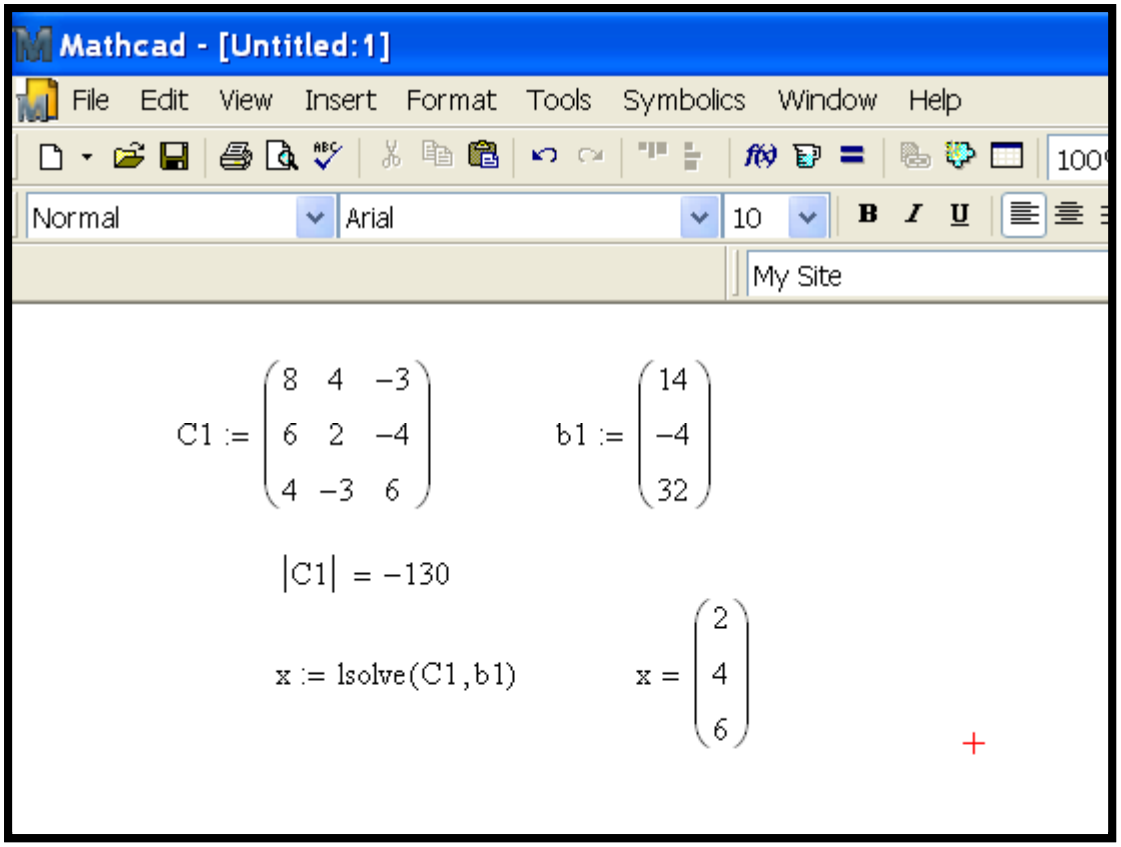


Using lsolve() to solve LAEs

- Other option to calculate LAE in Mathcad is using the function “lsolve()”
- “lsolve()” receives the coefficient matrix and right-hand-side vector as argument, and returns the solution vector, x.



Using lsolve() to solve LAEs



Other Array Functions

max (A) … Maximum value in an array
min (A) … Minimum value in an array

cols (A) … number of columns in array A
rows (A) … number of rows in array A

last (V) … returns the index number of last element in vector V.

sort (V) … arranges elements of the vector in ascending order.
reverse (v) …reverses the order of elements in a vector.

csort (A,n) … sort array A so elements in column n are in ascending order.
rsort (A,n) … sort array A so elements in row n are in ascending order.

ORIGIN:=1 must be used to initialize arrays index in 1.