

Simultaneous Linear Equations (with complex number elements)

$$A = \begin{bmatrix} A_{11} & A_{12} & A_{13} & \dots & A_{1n} \\ A_{21} & A_{22} & A_{23} & \dots & A_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ A_{n1} & A_{n2} & \dots & \dots & A_{nn} \end{bmatrix}, X = \begin{bmatrix} X_1 \\ X_2 \\ \dots \\ X_n \end{bmatrix}, B = \begin{bmatrix} B_1 \\ B_2 \\ \dots \\ B_n \end{bmatrix}$$

$$AX = B$$

\$1. Usage

1. Execute the Microsoft Excel.

(This application software requires the Microsoft Excel.)

2. Input matrix elements A_{ij} and constants B_i of the simultaneous linear equations in the cells of the Microsoft Excel.

(1) When putting a check mark in the check box (i.e. complex number elements):

Each row has a pair of real part and imaginary part of each element, like $A_{i1}(\text{Re})$, $A_{i1}(\text{Im})$, $A_{i2}(\text{Re})$, $A_{i2}(\text{Im})$,, $A_{in}(\text{Re})$, $A_{in}(\text{Im})$, $B_i(\text{Re})$, and $B_i(\text{Im})$.

Note: Both of real and imaginary parts of an element must always be inputted, even 0.

An example is as follows;

	A	B	C	D	E	F	G	H	I
1	1	0	-1	0	-1	0	0	0	
2	10	0	0	0	3	0	5	0	
3	0	0	2	0	-3	0	2	0	
4	A21 Real Part		A21 Imaginary Part		B2 Real Part		B2 Imaginary Part		
5									
6	A					B			

(2) If NO check mark in the check box (i.e. real number elements):

Each row has real number elements, like A_{i1} , A_{i2} ,, A_{in} , and B_i .

An example is as follows;

	A	B	C	D
1	1	-1	-1	0
2	10	0	3	5
3	0	2	-3	2
4	A21		B2	
5				
6	A		B	

In these examples, matrix A has 3x3 elements and constants vector B has 3 elements.

3. Press the left mouse button at the upper-left cell and drag the mouse to the lower-right cell, by holding the mouse button down.

An example is as follows;

(1) When putting a check mark in the check box (i.e. complex number elements):

	A	B	C	D	E	F	G	H
1	1	0	-1	0	-1	0	0	0
2	10	0	0	0	3	0	5	0
3	0	0	2	0	-3	0	2	0
4								

(2) If NO check mark in the check box (i.e. real number elements):


	A	B	C	D
1	1	-1	-1	0
2	10	0	3	5
3	0	2	-3	2
4				

4. Select the Excel menu <Edit> → <Copy>, for copying the data to the Clipboard.

Note: In the case of saving the inputted data as an Excel file, first save it at #2 step and then copy it to the Clipboard after #3 step.

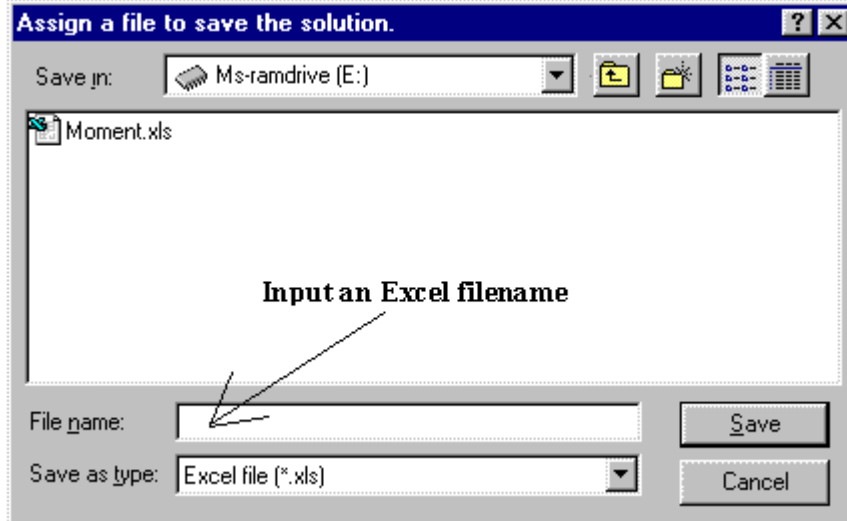
5. Close the Microsoft Excel.

6. Then, execute this application software (Simultaneous Linear Equations).

7. Press <Solution> button ().

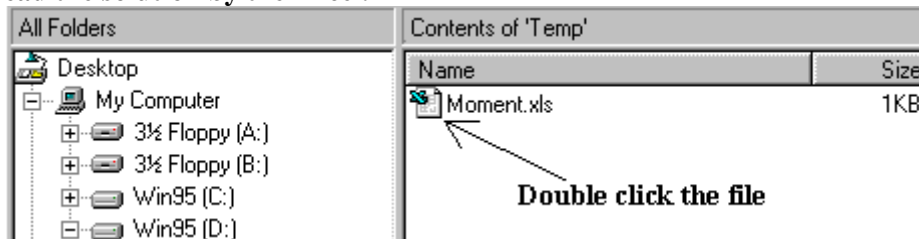
8. A dialog box which prompts to input a filename for saving the solution appears on the screen, if no error occurred.

Input an Excel filename (xxxx.XLS) to save the solution, and then press <Save> button.



9. After saving the solution to the assigned Excel file, a success message appears.

10. Look for the assigned Excel file by using a filer (e.g. Explorer), and double click the file. Then, you can read the solution by the Excel.



The data of the results file are expressed by exponent formats.

The data format can be changed to a standard format by the following procedures;

(1) Drag the mouse from the upper-left corner to the lower-right corner of the whole data area so as the background color being inverted.

(2) Select Excel menu <Format> → <Cells...>, and select <Number> tab of the dialog.

(3) Then, select "General" in the selection box of the dialog, and press <OK> button.

Note: Sometimes, a part of the Excel table has "#####."

In this case, please carry out one of the following two procedures;

(A) Execute the above (1), (2) and (3) procedures.

(B) Execute the above (1) and (2) procedures. After that, select "Scientific" in the selection box of the dialog, and set "8" in the "Decimal places" box. Then, press <OK> button.

\$2. Data input to the Excel cells

1. Confirm no data in the Excel cells. Then, press the left mouse button at the upper-left cell and drag the mouse to the lower-right cell, by holding the mouse button down, corresponding to the whole cells in which data are inputted.

2. Select the Excel menu <Format> → <Cells...> → sheet <Number> of a dialog appeared.

3. Select one of the following two processes.

(1) In the case of the input by standard numerical value format;

Select "General" in a selection box of the dialog, and press <OK> button.

In this case, only input by standard numerical value format (e.g. 10, -3, 14.32, -0.03333, etc.) is allowed at the following #4 step.

Allowed characters for inputting are as follows;

0 1 2 3 4 5 6 7 8 9 . -

(2) In the case of the input by several numerical value formats;

Select “Text” in a selection box of the dialog, and press <OK> button.

In this case, input by several numerical value formats (e.g. 12, -3.5, 1.3E-2, -2/3, 3/7E2, 3E-2/7, etc. (*)) is allowed at the following #4 step.

(*) : 3/7E-2 is same as 3/(7E-2), and 3E-2/7 is same as (3E-2)/7.

Allowed characters for inputting are as follows;

0 1 2 3 4 5 6 7 8 9 . - E /

An example is as follows;

	A	B	C	D	E	F	G	H	
1	1/3	0	-1	0	-1/3E1	0	0	0	
2	1.0E1	0	0	0	3	0	4.5E1	0	
3	0	0	2.0E2/3	0	-3	0	2	0	
4									

4. Then, start data input to the Excel cells.

\$3. Condition Number (C_N)

For the simultaneous linear equations $A \mathbf{X} = \mathbf{B}$, the condition number (C_N) is given by the product of “norm of the matrix A ($\|A\|$)” and “norm of the inverse matrix A^{-1} ($\|A^{-1}\|$).”

Roughly speaking, even changing one of constants B_i to $B_i \pm 0.1/C_N$ (i.e. even changing one tenth of “inverse of the condition number”), the solution of simultaneous linear equations does not change largely (if any solution obtained is not zero (nor, nearly zero)).

Example 1:

$$0.947 X_1 + 0.644 X_2 = 0.303$$

$$0.922 X_1 + 0.627 X_2 = 0.295$$

In this case, $C_N = 2.55E6$. Therefore, $0.1/C_N = 4E-8$. So, even changing the constant from 0.303 to 0.30300004, the solution of simultaneous linear equations does not change largely.

Example 2:

$$0.947 X_1 + 0.644 X_2 = 0.303$$

$$0.922 X_1 - 0.627 X_2 = 1.549$$

In this case, $C_N = 2.15$. Therefore, $0.1/C_N = 5E-2$. So, even changing the constant from 0.303 to 0.353, the solution of simultaneous linear equations does not change largely.