Chapter **7**

Equation Calculations

Your graphic calculator can solve the following three types of equations:

- Linear equations with two to six unknowns
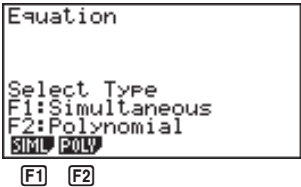- Quadratic equations
- Cubic equations

7

7-1 Before Beginning an Equation Calculations

Before beginning an equation calculation you have to first enter the correct mode, and you must also clear the equation memories of any data that might be left over from a previous calculation.

■ Entering an Equation Calculation Mode

Highlight the **EQUA** icon on the Main Menu and then press [EXE].

```
Equation


Select Type
F1:Simultaneous
F2:Polynomial
SIML POLY
```
[F1] [F2]

[F1](SIML) .... Linear equation with two to six unknowns

[F2](POLY) ...... Quadratic or cubic equation

■ Clearing Equation Memories

After entering an equation calculation mode (SIML or POLY), clear the calculation memory for that mode. In the case of SIML, use the function keys to specify the number of unknowns, from two ([F1]) to six ([F5]). In the case of POLY, use the function keys to specify either two ([F1]) or three ([F2]) polynomials.

```
SOLV DEL CLR
```
[F2]

[F2](DEL)

```
YES                           NO
```
[F1]   [F6]

Press [F1] (YES) to clear the equation memories of that mode (SIML or POLY), or [F6] (NO) to abort the clear operation without clearing anything.

7-2 Linear Equations with Two to Six Unknowns

You can use the procedures described here to solve linear equations with unknowns that match the following formats:
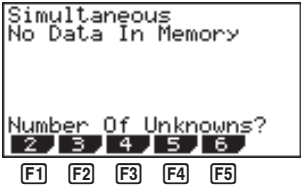
Two unknowns
$$a_1x + b_1y = c_1$$
$$a_2x + b_2y = c_2$$

$\vdots$ $\vdots$

Six unknowns
$$a_1x + b_1y + c_1z + d_1t + e_1u + f_1v = g_1$$
$$a_2x + b_2y + c_2z + d_2t + e_2u + f_2v = g_2$$
$$a_3x + b_3y + c_3z + d_3t + e_3u + f_3v = g_3$$
$$a_4x + b_4y + c_4z + d_4t + e_4u + f_4v = g_4$$
$$a_5x + b_5y + c_5z + d_5t + e_5u + f_5v = g_5$$
$$a_6x + b_6y + c_6z + d_6t + e_6u + f_6v = g_6$$

• You can also solve linear equations with three, four, and five unknowns. In each case, the format is similar to those shown above.

■ Entering the Linear Equation Mode for Two to Six Unknowns

While the Equation Mode is displayed, press [F1] (SIML).

[F1](SIML)

```
Simultaneous
No Data In Memory



Number Of Unknowns?
 2   3   4   5   6
```
[F1] [F2] [F3] [F4] [F5]

[F1](2) .... Linear equation with two unknowns

[F2](3) .... Linear equation with three unknowns

[F3](4) .... Linear equation with four unknowns

[F4](5) .... Linear equation with five unknowns

[F5](6) .... Linear equation with six unknowns

■ Solving Linear Equations with Three Unknowns

Example   To solve the following linear equations for x, y, and z:

$$4x + y - 2z = -1$$
$$x + 6y + 3z = 1$$
$$-5x + 4y + z = -7$$

While in the Linear Equation Mode (SIML), press F2 (3), because the linear equations being solved have three unknowns.

F2(3)

Coefficient input cells

anX+bnY+CnZ=dn
a   b   c   d
1[0   0   0   0]
2[0   0   0   0]
3[0   0   0   0]

0

SOLV DEL CLR

Value being input into highlighted cell

Input each coefficient.

4 EXE 1 EXE (−) 2 EXE
(−) 1 EXE
1 EXE 6 EXE 3 EXE 1 EXE
(−) 5 EXE 4 EXE 1 EXE
(−) 7 EXE

anX+bnY+CnZ=dn
a   b   c   d
1[4   1   -2   -1]
2[1   6   3   1]
3[-5   4   1   -7]

-7

SOLV DEL CLR

F1

Each time you press EXE, the input value is registered in the highlighted cell. Each press of EXE inputs values in the following sequence:

coefficient $a_1 \rightarrow$ coefficient $b_1 \rightarrow$ coefficient $c_1 \rightarrow$ coefficient $d_1 \rightarrow$
coefficient $a_2 \rightarrow$ coefficient $b_2 \rightarrow$ coefficient $c_2 \rightarrow$ coefficient $d_2 \rightarrow$
coefficient $a_3 \rightarrow$ coefficient $b_3 \rightarrow$ coefficient $c_3 \rightarrow$ coefficient d_3

• You can input fractions and value memory contents as coefficients.

After inputting the coefficients, solve the equations.

F1(SOLV)

anX+bnY+CnZ=dn
x[0]
y[-1]
z[2]

1

REPT

F1

Highlighted solution cell value

- Internal calculations are performed using a 15-digit mantissa, but results are displayed using a 10-digit mantissa and 2-digit exponent.
- This unit performs simultaneous linear equations by placing the coefficients inside of a matrix. Because of this, as the coefficient matrix approaches zero, precision in the inverse matrix is reduced and so precision in the results produced also deteriorates. For example, the solution for a linear equation with three unknowns would be calculated as shown below.

$$
\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}^{-1} \begin{bmatrix} d_1 \\ d_2 \\ d_3 \end{bmatrix}
$$

- An "Ma ERROR" occurs whenever the unit is unable to solve the equations.
- Pressing [F1] (REPT) returns to the initial display of the Linear Equation Mode.

Depending on the coefficients that you use, it may take considerable time for the calculation result of simultaneous linear equations to appear on the display. Failure of a result to appear immediately does not mean that the unit is not functioning properly.

■ Changing Coefficients

You can change a coefficient either before or after you register it by pressing [EXE].

●To change a coefficient before registering it with [EXE]

Press the [AC] key to clear the current value and then input another one.

●To change a coefficient after registering it with [EXE]

Use the cursor keys to highlight the cell that contains the coefficient that you want to change. Next, input the value that you want to change to.

■ Clearing All the Coefficients

While in the Linear Equation Mode, press the [F3] (CLR) function key. This operation clears all the coefficients to zero.

[F3](CLR)

|SOLV |DEL| CLR|

[F3]

7-3   Quadratic and Cubic Equations

This calculator can also solve quadratic and cubic equations that match the following formats (when $a \neq 0$):

- **Quadratic:** $ax^2 + bx + c = 0$
- **Cubic:** $ax^3 + bx^2 + cx + d = 0$

■ Entering the Quadratic/Cubic Equation Mode

While in the Equation Mode, press F2 (POLY).

F2 (POLY)

```
Polynomial
No Data In Memory



Degree?
 2   3
```
F1 F2

F1(2) .... Quadratic equation
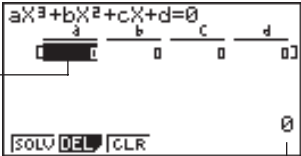F2(3) .... Cubic equation

■ Solving a Quadratic or Cubic Equation

Example   **To solve the following cubic equation:**
$x^3 - 2x^2 - x + 2 = 0$

Press F2 (3) to enter the Cubic Equation Mode.

F2(3)
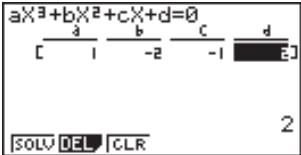
```
aX³+bX²+cX+d=0
   a    b    c    d
 [      0    0    0]


                    0
SOLV DEL CLR
```

Cell for input of coefficients

Value being input into highlighted cell

Input each coefficient.

1 EXE (−) 2 EXE
(−) 1 EXE 2 EXE

```
aX³+bX²+cX+d=0
   a    b    c    d
 [  1   -2   -1   2]


                    2
SOLV DEL CLR
```
F1

- Each time you press EXE, the input value is registered in the highlighted cell. Each press of EXE inputs values in the following sequence:
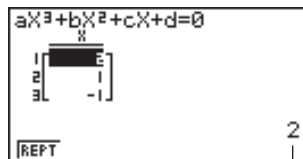
  coefficient a → coefficient b → coefficient c → coefficient d

  Input for coefficient d is required only for cubic equations.
- You can input fractions and value memory contents as coefficients.

After inputting the coefficients, press F1 (SOLV) to solve the equations.

F1(SOLV)

```
aX³+bX²+cX+d=0
    x
 1 ┌─────┐ 5
 2 │     │ 1
 3 └    -1┘
                  2
REPT
```

Highlighted solution cell value

- Internal calculations are performed using a 15-digit mantissa, but results are displayed using a 10-digit mantissa and 2-digit exponent.
- An "Ma ERROR" occurs whenever the unit is unable to solve the equations.
- Pressing F1 (REPT) returns to the initial display of the Cubic Equation Mode.

■ Quadratic equations that produce multiple root (1 or 2) solutions or imaginary number solutions
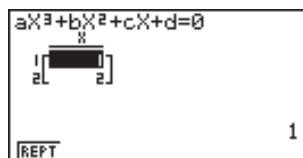
The following examples illustrate how multiple-root solutions and imaginary number solutions are handled.

●To solve a cubic equation that produces a multiple-value solution

Example   To solve the following cubic equation:
$$x^3 - 4x^2 + 5x - 2 = 0$$

1 EXE (−) 4 EXE 5 EXE (−) 2 EXE
F1(SOLV)

```
aX³+bX²+cX+d=0
    x
 1 ┌─────┐ 1
 2 └    2┘
                  1
REPT
```
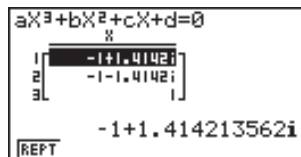
●**To solve a cubic equation that produces an imaginary number solution**

Example   **To solve the following cubic equation:**
$$x^3 + x^2 + x - 3 = 0$$

1 EXE 1 EXE 1 EXE (–) 3 EXE
F1 (SOLV)

```
aX3+bX2+cX+d=0
        X
1   -1+1.4142i
2   -1-1.4142i
3           1
      -1+1.414213562i
REPT
```

It may take considerable time for the calculation result of cubic equations to appear on the display. Failure of a result to appear immediately does not mean that the unit is not functioning properly.

■ Changing Coefficients

You can change a coefficient either before or after you register it by pressing EXE.

●**To change a coefficient before registering it with EXE**

Press the AC key to clear the current value and then input another one.

●**To change a coefficient after registering it with EXE**

Use the cursor keys to highlight the cell that contains the coefficient that you want to change. Next, input the value that you want to change to.

■ Clearing All the Coefficients

While in the Quadratic or Cubic Equation Mode, press the F3 (CLR) function key. This operation clears all the coefficients to zero.

F3 (CLR)

```
SOLV DEL CLR
         F3
```

7-4 What to Do When an Error Occurs

●**Error during coefficient value input**

Press the AC key to clear the error and return to the value that was registered for the coefficient before you input the value that generated the error. Try inputting a new value again.

●**Error during calculation**

Press the AC key to clear the error and display coefficient a. Try inputting values for the coefficients again.

  • Note that even when you press the AC key, the values assigned for coefficients are retained.