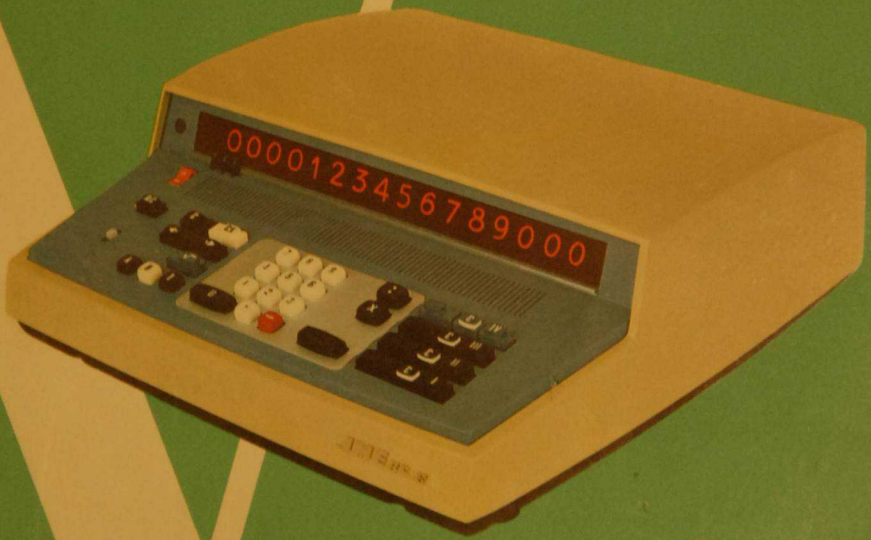
IME 86 S

instruction manual



INDUSTRIA MACCHINE ELETTRONICHE IME S.p.A. - ROMA

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Introduction

The IME 86s is a second generation, solid state desk top computer. It is, in its price range, the most powerful desk top unit to be offered to date. As it is extremely flexible it handles every type of figure-work problems, from the most ordinary to the most complex, in a straight-forward manner with virtually no resetting.

This flexibility makes the IME 86s models highly adaptable to commercial, engineering and scientific calculations.

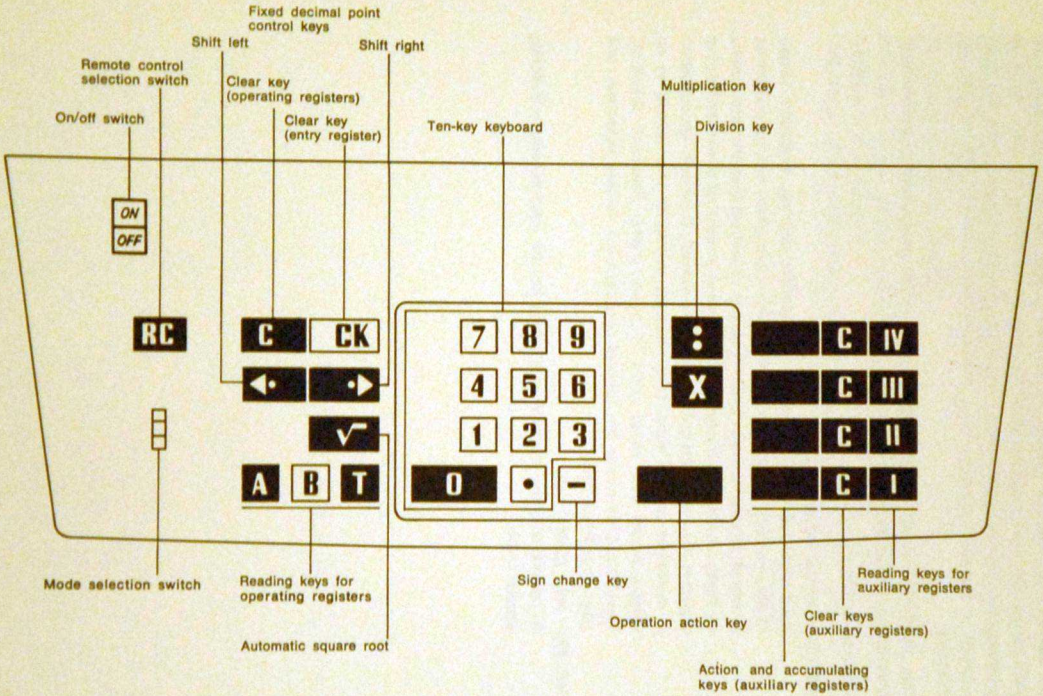
The models are as follows:

IME 86s - without square root

Solid state, 10-key calculator with automatic clearing, automatic re-use of results from all registers, fixed decimal point which can be positioned in any of 16 places, chain operations with or without intermediate results, 16 digits plus sign and decimal point stored in each of seven ferrite-core registers (four of which are accumulative stores), automatic accumulation of multipliers or item count when desired, raising of any number to an integral power with visual proof of power index, automatic round-off, input/output connector for optional programmers, remote keyboards and other peripheral units.

IME 86s - with square root

As above with the addition of a single key for instantaneously exacting square roots.


Fixed decimal point control keys
Shift left
Shift right
Remote control selection switch
Clear key (operating registers)
On/off switch
Clear key (entry register)
Ten-key keyboard
Multiplication key
Division key
ON
OFF
RC
C
CK
7 8 9
4 5 6
1 2 3
0
A B T
C IV
C III
C II
C I
Mode selection switch
Reading keys for operating registers
Automatic square root
Sign change key
Operation action key
Action and accumulating keys (auxiliary registers)
Clear keys (auxiliary registers)
Reading keys for auxiliary registers

Characteristics

The Keyboard

The IME 86s has a single 10-key keyboard on which all figures are entered for all operations. It is designed for speed and simplicity. The control keys are located adjacent to the keyboard and arranged for ease of operation and the convenience of the operator.

Reading Keys for Operating Register

A This key displays the « A » Register without clearing it

B This key displays the « B » Register without clearing it

T This key displays the « T » Register without clearing it

Note: Any number on display from any register may be operated upon immediately & in any way, without a so-called back-transfer operation.

Clearing Keys

C Clear key

Clears the contents of operating registers - A, B and T

CK Clear key (entry register only)

Clears the contents of the « B » register. This is used in correcting entries made in error.

Keys for the Fundamental Operations

− Sign change key

Used for changing the sign of any number in the display.

X Multiplication key

A touch of the Multiplication key transfers whatever number is on display into the « A » Register to be used as a multiplier. The number so operated upon may be a number that was entered through the keyboard, or the result of some previous calculation. If the Multiplication key is depressed repeatedly, the number is multiplied by itself, for example, in raising to a power.

÷ Division key

A touch of the Division key transfers whatever number is on display into the «A» Register to be used as a dividend. It may be a number that was entered throught the keyboard or the result of some previous calculation.

▬ Operation Action key

Produces & Displays the results of Additions & Subtractions, Multiplications, Division & Raising to an Integral Power. In the Absence of a previous **X** or **÷** instruction, this key functions as the main Add button. When it is so used for addition, a second depression will cause the total to be displayed. Sub-totals may of course be read at any time, by using the **T** key.

Keys for Special Operations

Decimal Control Keys

A touch of the left or right Decimal Control Key shifts the decimal point in the display. Automatic decimal point control is maintained in all registers and corresponds to the decimal position as indicated in the display. When the Decimal Control Keys are used (right or left) the data in the display also shifts, and remains decimally correct. All numbers in the Auxiliary Registers are also under automatic decimal point control and always move to correspond to the decimal point as selected in the display.

Automatic Square Root Key

Automatically extracts the square root of the modulus (or absolute value) of any number.

Note: Operation of the square root key clears register IV automatically.

Keys for Auxiliary Registers

Each of the four auxiliary registers is controlled by three keys.

The central key bears the letter ' C '. Depression of this key clears its own register and the display but does not clear any other register. If a white collar is visible around the " C " key, it indicates that an entry has been made into the register by means of the left hand key described below.

The key on the right reads the contents of the register without clearing it. The act of reading a register does not affect the contents of any other register.

The unmarked operation key on the left produces & displays the individual results of multiplications, divisions & raising to an integral power, & simultaneously stores the result, accumulatively, in the appropriate auxiliary register.

Alternatively, when used on its own, without a previous X or ÷ instruction, it accumulates the number on display into the appropriate auxiliary register.

Remember when accumulating to start from zero in the auxiliary register by clearing it first with the appropriate clearance key.

Mode Switch (controlling IV auxiliary register)

This is a three position switch performing the following functions:

In the up position an item count is automatically provided in register IV. This counts the number of mathematical operations performed (remember to clear register IV in order to start the count from zero).

In the down position multipliers are automatically accumulated in register IV.

In the middle position register IV is a standard accumulating register, except that it is automatically cleared by operation of the key, or by the act of raising a number to an integral power by successive depressions of the X key.

It should be noted that the position of this switch in no way affects the result of a square root or raising-to-a-power operation.

Remote Control

RC Operates the « reservation » of the calculator when it is used in connection with the auxiliary keyboards.
If the calculator is connected with a peripheral programmer or output device, this key commands the starting of the program, etc.

Connection to power

The IME 86s will tolerate a voltage variation of ± 10 % with respect to the nominal value specified on the machine.

To begin operating the machine, after switching it on, it is sufficient to press the C key twice and the clearing keys of the auxiliary registers, one at a time.

Capacity

The IME 86s has a capacity of 16 digits in all registers. This means that operations such as the following may be performed:

99999999 × 99999999 = 9999999800000001
9999999999999 × 9 = 8999999999999991

By virtue of automation of the decimal point and of automatic round-off of excessive decimal digits it is possible to perform calculations such as:

1.27447312197345 × 1.47642132774349 = 1.88165929891743
1.2734768312^{6} = 4.26526788786

without exceeding the machine capacity; the last digit of a multiplication result is automatically rounded-off, upwards or downwards, as necessary.

Any overflow of the machine's capacity is indicated, for any operation, by the lighting of a red lamp at the right of the display. The result which appears under this condition on the display is meaningless.

When moving the decimal point towards the left with the ◄ key, the red lamp lights up if capacity is exceeded in any one of the registers. It is possible to restore the initial situation in the operative and auxiliary registers by pressing the ◄ key until the decimal point is relocated to a position immediately preceding the one which caused the lighting of the overflow lamp.

► Operations may truncate numbers on display or in store, or in any register, even though not visible, & the truncated portions will be cleared from the machine.

Division by zero

If a division by zero is accidentally performed, all registers including the keyboard entry register, are shut off from the display and consequently cannot be acted upon or cleared, and no entry will be accepted via the keyboard until the main 'C' key is depressed ONCE. The number upon which a division by zero was attempted is still in the 'A' register and the previous contents of I, II, III, and IV can now also be read. Do not attempt to clear registers I, II, III, & IV whilst the machine is in the 'divide by zero' state.

A division by zero effect will of course be produced if the ÷ key is pressed twice in succession, or if the × or √ keys are pressed immediately after a depression of the ÷ key.

Entering of data

The number entered on the keyboard is stored in the entry register 'B'.
For negative numbers press the − key after entry.
For entry of decimal numbers press the . key after entering the units digit.
The IME 86s operates with an automatically fixed decimal point in each operation. However the position of the decimal point is adjustable at any time in any position between the 1st and 15th digit and may be changed during calculation. A change in the decimal point position is simultaneous in all registers.
In the event of an incorrect entry, press the CK key and enter the correct figures.
It is possible to completely modify or substitute either the integral or decimal portion of a number leaving the other portion unchanged.
For the decimal portion, press the . key and enter again the decimal digits.
For the integral portion it is necessary to first press the B key. The 0 key must then be depressed as many times as is necessary to make the integral digits shift off the left hand end of the display; this accomplished, the correct digits can be entered in the normal manner.

Rounding-off of results

The IME 86s automatically rounds off all multiplication results in one position to the right of the extreme right hand displayed digit. Operating with the decimal point in second position, for example, we have:

$12.6 \times 147.78 = 1862.03$

with the decimal point in third position, instead, we have:

$12.6 \times 147.78 = 1862.028$

Re-utilization of results

Each factor or result of any calculation on display may be immediately utilized for successive operations without the need for so-called "back transfer" operations.

Clearing

Clearing of the contents of the entry register B is automatic with each new entry, except when the contents of B register have been diliberately displayed by pressing the B key.
Clearing of the other operating registers always takes place automatically & is sequential so that no register is cleared until it has to be.
Clearing of the auxiliary registers is performed by means of the appropriate keys, which require to be pressed fully but never simultaneously.
The act of using any clearance key clears the display, regardless of which register was being displayed. Nevertheless only the register whose clearance key was depressed, will have actually been cleared. The contents of any other register may be restored to the display by depressing the appropriate "read,, key.

Basic operations

Addition and subtraction

Example

1.23 − 4.5 + 23.757 + 74.6 = 95.087

N.B. - Subtraction is performed by the addition of a negative number.

Method

Decimal point in 3rd position

1.23		[redacted]
4.5	⊟	[redacted]
23.757		[redacted]
74.6		[redacted]
[redacted]	95.087	

By pressing the A key after the addition key, it is possible to re-read the last addend added. This allows the execution of operations with repeated addend (as indicated in the following example), or allows the correction of that entry by merely changing the sign, & pressing the [redacted] key.

Note that the total is obtained by two depressions of the [redacted] key after the last entry. This will also set the T register to clear automatically before accepting a new entry.

Addition and subtraction with repeated addends

Example

1.47 + 1.59 + 1.59 + 1.59 + 0.274 = 6.514

Method

Decimal point in 3rd position

	1.47	[redacted]
	1.59	[redacted]
A	1.59	[redacted]
A	1.59	[redacted]
	0.274	[redacted]
[redacted]	6.514	

Addition and subtraction with count of addends

Example

1.23 − 4.5 + 6.3 − 21.121 = − 18.091

Method

Decimal point in 3rd position

Mode switch in up position

Clear contents of auxiliary register IV

1.23 [redacted]

4.5 ⊟ [redacted]

6.3 [redacted]

21.121 ⊟ [redacted]

[redacted] − 18.091

[redacted] IV 4

Note that both positive & negative items are counted positively.

Multiplication

Example a)

15.42 × 7.23 = 111.487

Method

Decimal point in 3rd position

15.42 X

7.23

[redacted] 111.487

Example b)

− 5.36 × 2.43 = − 13.025

Method

Decimal point in 3rd position

5.36 ⊟ X

2.43

[redacted] − 13.025

Press A and B keys, to check multiplicand and multiplier, each with its correct sign.

Press the T key to check the product.

Division

Example

13 : 3 = 4.333

Method

Decimal point in 3rd position

13 ÷

3

= 4.333

Press the A key to display the divison remainder (0.001).

Press the B key to check the divisor (3).

Press the T key to read the quotient again.

A division operation should not be effected with a divisor which occupies the extreme left-hand digit position of the display. Any result produced as a result of doing so will cause the red overflow lamp to light up and should be regarded as incorrect.

Raising to a power

Example

$(-1.018)^5 = -1.093$

Method

Decimal point in 3rd position

1.018 ⊟ X

X 2

X 3

X 4

X 5

= − 1.093

It will be noticed that during the operation of raising a number to an integral power by successive depressions of the X key, an item count is automatically displayed from register IV. This of course represents the exponent, or power to which the number has been raised. When the required index is reached, any of the actuation keys may be depressed to obtain the answer.

To check what has been done,

Press A to display the number operated upon.

Press B to show the power to which it has been raised.

Press T to see the result again.

Extraction of square root

Example

$\sqrt{12.27} = 3.502$

Method

Decimal point in 3rd position

12.27

[√] 3.502

Note that the square root operation requires the use of auxiliary register IV. The contents of this register are cleared at the moment of extraction of the square root.

Chain operations

Example

$$\frac{15.4 \times 7.23}{12.6} = 8.836$$

Method

Decimal point in 3rd position

15.4 [X]

7.23 [÷]

12.6

[ ] 8.836

If it is required to read the intermediate results, operate as follows:

15.4 [X]

7.23

[ ] 111.342 [÷]

12.6

[ ] 8.836

Accumulation in the auxiliary registers

Example a)

$$\begin{array}{rl} 1.3 \times 4.52 = & 5.876 \\ -\ 0.15 \times 2.25 = & -\ 0.338 \\ & \hline 5.538 \end{array}$$

Decimal point in 3rd position

1.3 [X]

4.52

[ ] 5.876

0.15 [−] [X]

2.25

[redacted] − 0.338

[redacted] 5.538

Example b)

$$\frac{1}{3} + \frac{1}{5} + \frac{1}{7} = 0.67618$$

Decimal point in 5th position

1 [redacted]

3

[redacted] 0.33333

1 [redacted]

5

[redacted] 0.20000

1 [redacted]

7

[redacted] 0.14285

[redacted] 0.67618

Sum of multiplicands and products

Example a)

$$12 \times 145 = 1740$$
$$19 \times 231 = 4389$$
$$\overline{31} \qquad \overline{6129}$$

Method

Mode switch in down position ('S')

Clear contents of the auxiliary register IV.

12 [redacted]

145

[redacted] 1740

19 [redacted]

231

[redacted] 4389

[redacted] 6129

[redacted] 31

Example b)

$12 \times 145 \times 17 = 29580$
$19 \times 231 \times 21 = 92169$
$16 \times 250 \times 18 = 72000$
$10{,}129 \qquad 193749$

Method

Mode switch in down position (' S ')

Clear contents of the auxiliary register IV.

12 X
145 X
17
I 29580
19 X
231 X
21
I 92169
16 X
250 X
18
I 72000
I 193749
IV 10129

(i.e. sum of end products)

(i.e. sum of intermediate products)

Constant factor operations

Example a)

$12.473 \times 11.6 = 144.687$
$8.2 \times 11.6 = 95.120$

Method

Decimal point in 3rd position

11.6 I
12.473 X
I 11.6
144.687
8.2 X
I 11.6
95.120

or

11.6 [X]

12.473

[ ] 144.687

[A] 11.6 [X]

8.2

[ ] 95.120

Example b)

1483.6 : 6.2 = 239.290

1.2 : 6.2 = 0.193

Method

Decimal point in 3rd position

6.2 [ ]

1483.6 [:]

[ ] 6.2

[ ] 239.290

1.2 [:]

[ ] 6.2

[ ] 0.193

Inverse value calculation

If the reciprocal of a calculated result is required, the process set out below avoids the use of the auxiliary registers.

Example

$$\frac{1}{\sqrt{a}}$$

$$\frac{1}{\sqrt{2}} = 0.707$$

Method

Decimal point in 3rd position

2

[$\sqrt{\ }$] 1.414

1 [:]

[1/x] 1.414

[ ] 0.707

Interplay between working registers

Example a)

$$\frac{a}{a + b}$$

$$\frac{3.27}{3.27 + 4.15} = 0.440$$

Method

Decimal point in 3rd position

	4.15	[redacted]
	3.27	[redacted]
[redacted]	7.42	
A	3.27	[redacted]
T	7.42	
[redacted]	0.440	

Example b)

$a \times b^3$

27×2.25^3

Method

Decimal point in 3rd position

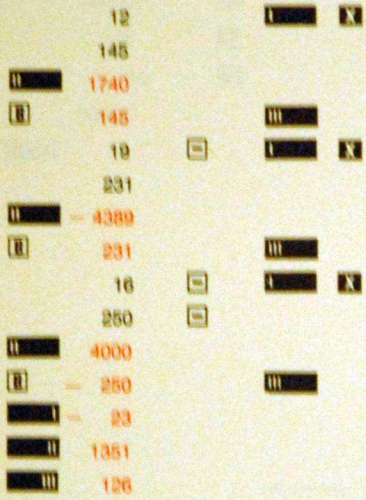
	27.	X
	2.25	
[redacted]	60.75	
B	2.25	X
T	60.75	
[redacted]	136.688	
A	2.25	X
T	136.688	
[redacted]	307.548	

Sum of products, with independent summations of both factors

Example

12 ×	145 =	1740
− 19 ×	231 =	− 4389
− 16 ×	− 250 =	4000
− 23	126	1351

Method



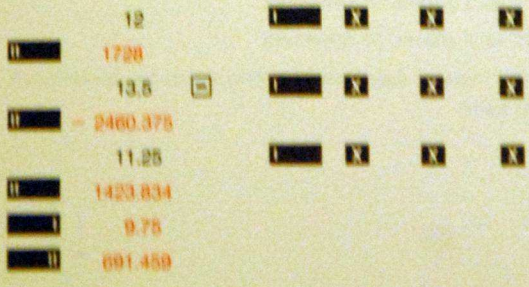
Sum of cubes, with sum of values used

Example

12^3 =		1728
− 13.5^3	=	− 2460.375
+ 11.25^3 =		1423.828
9.75 =		691.453

Method

Decimal point in 3rd position



Examples of applications

Percentage analysis

41.16	1.777 %
1447.36	62.480 %
821.7	35.471 %
6.31	0.272 %
2316.53	100.000 %

Method

Decimal point in 5th position

	41.16	[redacted]
	1447.36	[redacted]
	821.7	[redacted]
	6.31	[redacted]
[redacted]	2316.5300	[redacted]
(*)	100	
[redacted]	23.16530	
	41.16	[redacted]
[redacted]	23.16530	
[redacted]	1.77679	(1.777 to 3 places of decimals)
	1447.36	[redacted]
[redacted]	23.16530	
[redacted]	62.47965	(62.480 to 3 places of decimals)
	821.7	[redacted]
[redacted]	23.16530	
[redacted]	35.47115	(35.471 to 3 places of decimals)
	6.31	[redacted]
[redacted]	23.16530	
[redacted]	0.27239	(0.272 to 3 places of decimals)
[redacted]	99.99998	(100.000 to 3 places of decimals)

(*) If apportionment is required instead, substitute the amount to be apportioned in place of the '100' at this point.

Interest calculation

Interest on £ 15,000 for 120 days at 6.5 % per year

$$I = \frac{15{,}000 \times 120 \times 6.5}{365 \times 100} = 320{,}5479$$

Method

Decimal point in 4th position

15,000 [X]

120 [X]

6.5 [÷]

36,500

[■] 320.5479

Loan reypayment instalment calculation

Property is purchased for £ 128,500. £ 62,000 are paid in cash.

The remainder of the sum must be paid in 6 annual instalments at a yearly interest rate of 7.5 %.

Calculate the amount of the single instalments

$$R = (128{,}500 - 62{,}000)\frac{(1 + 0.075)^6 \times 0{,}075}{(1 + 0.075)^6 - 1} = £\ 14167.494147$$

Method

Decimal point in 6th position

	128,500		[redacted]
	62,000	⊟	[redacted]
	1		[redacted]
	0.075		[redacted]
[redacted]	1.075		X
			X (2)
			X (3)
			X (4)
			X (5)
			X (6)
[redacted]	1.543301		
[redacted]	66,500.000000		X
[redacted]	1.543301		X
	0.075		
[redacted]	7,697.213738		
	1	⊟	[redacted]
[redacted]	7,697.213738		[redacted]
[redacted]	0.543301		
[redacted]	14,167.494147		

Invoicing

16 × 2,141 =	34,256.00
24 × 311 =	7,464.00
	41,720.00
Less 15 % discount	6,258.00
	35,462.00
Plus 4 % Sales tax	1,418.48
	36,880.48
Less 3 % discount	1,106.41
Total	35,774.07

Method

Decimal point in 2nd position

Evaluation of a polynomial

Evaluate $y = x^4 + 7.1\,x^3 + 6.72\,x^2 + 4\,x - 16 = -131.5668$

For $x = -4.3$

Method

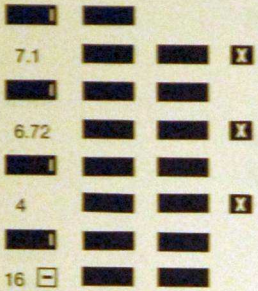
Decimal point in 4th position

	4.3	⊟	[redacted]
[redacted]	– 4.3000	X	
		X	(2)
		X	(3)
		X	(4)
[redacted]	341.8801		
[redacted]	– 4.3000	X	
		X	(2)
		X	(3)
[redacted]	– 79.5070	X	
	7.1		
[redacted]	– 564.4997		
[redacted]	– 4.3000	X	
		X	(2)
[redacted]	18.4900	X	
	6.72		
[redacted]	124.2528		
[redacted]	– 4.3000	X	
	4		
[redacted]	– 17.2000		
	16	⊟	[redacted]
[redacted]	– 131.5668		

A more elegant & economical method is to re-write the polynomial in " nested " form, thus:

$$\Big[\Big(\Big[\Big(\big[(x - 7.1)x\big] + 6.72\Big)x\Big] + 4\Big)x\Big] - 16$$

And then proceed as follows:



Solution of a system of equations

$$11x + 6.7y - 4.2z = 12$$

$$4.1x - 3y + 0.7z = 1$$

$$21.7x - 8y - 14z = -16$$

By adopting the Cramer method it is sufficient to find the value of the four determinants:

$$\Delta = \begin{vmatrix} 11 & 6.7 & -4.2 \\ 4.1 & -3 & 0.7 \\ 21.7 & -8 & -14 \end{vmatrix} \qquad \Delta x = \begin{vmatrix} 12 & 6.7 & -4.2 \\ 1 & -3 & 0.7 \\ -16 & -8 & -14 \end{vmatrix}$$

$$\Delta y = \begin{vmatrix} 11 & 12 & -4.2 \\ 4.1 & 1 & 0.7 \\ 21.7 & -16 & -14 \end{vmatrix} \qquad \Delta z = \begin{vmatrix} 11 & 6.7 & 12 \\ 4.1 & -3 & 1 \\ 21.7 & -8 & -16 \end{vmatrix}$$

after that we have:

$$x = \frac{\Delta x}{\Delta} \qquad y = \frac{\Delta y}{\Delta} \qquad z = \frac{\Delta z}{\Delta}$$

We show the calculation for the result of only one of the examined determinants, since the procedure is identical for all calculations.

We use the known Sarrus rule for the development:

$$\Delta = [11 \times (-3) \times (-14)] + [6.7 \times 0.7 \times 21.7] + [4.1 \times (-8) \times (-4.2)] + -[(-4.2) \times (-3) \times 21.7] - [0.7 \times (-8) \times 11] - [6.7 \times 4.1 \times (-14)] = 874.293$$

Method

Decimal point in 3rd position

11 X

3 ⊟ X

14 ⊟

462.000

6.7 X

0.7 X

21.7

101.773

4.1 X

8 ⊟ X

4.2 ⊟

137.760

4.2 ⊟ X

3 ⊟ X

21.7 ⊟

− 273.420

0.7 X

8 ⊟ X

11 ⊟

61.600

6.7 X

4.1 X

14 ⊟ ⊟

384.580

874.293

Solution of a second degree equation

$3.6\,x^2 + 4.1\,x - 7 = 0$

$$x_{1,2} = \frac{-4.1 \pm \sqrt{4.1^2 + 4 \cdot 7 \cdot 3.6}}{2 \cdot 3.6} \qquad (x_1 = 0.937),\ (x_2 = -2.075)$$

Method

Decimal point in 3rd position

	4.1	X	
		X	(2)
I	16.810		
	4	X	
	7	X	
	3.6		
I	100.800		
I	117.610		
√	10.844	:	
	2	:	
	3.6		
II	1.506		
	4.1	:	
	2	:	
	3.6		
III	− 0.569		
II	1.506		
III	− 0.569		
	0.937		(x_1)
III	− 0.569		
II	1.506	−	
	− 2.075		(x_2)

Arithmetical average

$$\frac{-6.27 \quad +9.8 \quad -12.3 \quad +4.6 \quad +8.731}{5} = 0.912$$

Method

Decimal point in 4th position

Mode switch in up position (N)

Clear contents of auxiliary register IV

	6.27	⊟
	9.8	
	12.3	⊟
	4.6	
	8.731	
	4.561	
IV	5	
	0.912	

Note that both positive & negative values are counted positively.

Weighted average

$$\frac{(12 \times 145) + (19 \times 231) + (16 \times 250)}{12 + 19 + 16} = 215.468$$

Method

Decimal point in 3rd position

Mode switch in down position (' S ')

Clear contents of auxiliary register IV

	12	X
	145	
I	1740	
	19	X
	231	
I	4389	
	16	X
	250	
I	4000	
I	10129	
IV	47	
	215.510	

Positive and negative multipliers are all accumulated positively by register IV.

Standard deviation & arithmetic mean

$$\sigma x = \sqrt{\frac{\Sigma x^2 - \left(\frac{\Sigma x}{n}\right)(\Sigma x)}{n \cdot 1}} = 1.250$$

$x_1 = 7.124$

$x_2 = 4.126$

$x_3 = 6.127$

$x_4 = 5.983$

Method

Decimal point in 3rd position

Mode switch in down position (' S ')

Clear contents of the auxiliary register IV

	7.124	X
A	7.124	
I	50.751	
	4.126	X
A	4.126	
I	17.024	
	6.127	X
A	6.127	
I	37.540	
	5.983	X
A	5.983	
I	35.796	
IV	23.360	÷
	4	
III	5.840	(= mean of x)
		X
IV	23.360	−
I	136.422	
I	4.689	÷
	3	
	1.563	
√	1.250	