SANYO

CZ-0911PG

PROGRAM LIBRARY

PROGRAM LIBRARY FOR ELECTRONIC CALCULATOR Model CZ-0911PG

This booklet has been prepared as a program library for the Sanyo programmable Scientific Calculator, Model CZ-0911PG.

Program examples from a wide variety of fields are described with the following format:

1. PROGRAM TITLE

General titles are used so that the user will be readily able to understand the contents of the program.

2. DEG-RAD

This column shows the position of the DEG-RAD slide switch.

When the position is not specified, "Arbitrary" is marked and no operation of this switch is necessary.

3. DPS

The position of the decimal point is marked. Before beginning the program in the RUN mode, depress the DPS key and then the N (N=0, 1, 2······9) key to set the specified decimal point.

4. PROGRAM NO.

Programs are classified into the following fields:

A. Mathematics
B. Statistics and Probabilities
C. Surveying
D. Electrical engineering
E. Architecture
F. Civil engineering
G. Mechanical engineering
H. General business
I. Unit conversion

5. FORMULA

Necessary formulas and expression for programs are explained in this section.

Gary Sharp.

6. EXAMPLES

Concrete input data and output data which should be obtained from the programs are described in this section.

7. OPERATION

After entering the program in the LOAD mode, the mode switch should be changed to the RUN mode.

Referring to the NOTES column, if any data are needed to store into the data memories, data storing operation should be completed just after the mode switch is changed to the RUN mode.

Then program is executed by operating the items in order.

8. NOTES

Initial data setting, notation of program operation and other references are described in this column.

9. DATA MEMORY

Contents of memory for this operation are described.

10. PROGRAM

1. Key operations for entering program in the LOAD mode are described.
2. Concrete meaning of the program instruction or name of items to be executed are described in NOTE of the program column.

INDEX

(A) Mathematics

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		3

PROGRAM TITLE	Hyperbolic functions	PROGRAM NO.	A-1

FORMULA

1. $\sinh x = \frac{e^x - e^{-x}}{2}$
2. $\cosh x = \frac{e^x + e^{-x}}{2}$
3. $\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$
4. $\mathrm{csech}\, x = \frac{1}{\sinh x} \quad (x \neq 0)$
5. $\mathrm{sech}\, x = \frac{1}{\cosh x}$
6. $\coth x = \frac{1}{\tanh x} \quad (x \neq 0)$

EXAMPLES

⟨input⟩	⟨output⟩	
$x=2$	sinh 2 = 3.627	csech 2 = 0.276
	cosh 2 = 3.762	sech 2 = 0.266
	tanh 2 = 0.964	coth 2 = 1.037

OPERATION

1. [GTO] [0] [0]
2. Input of Data x
3. [R/S]
4. Display of sinh x
5. [GTO] [1] [0]
6. Input of Data x
7. [R/S]
8. Display of cosh x
9. [GTO] [2] [0]
10. Input of Data x
11. [R/S]
12. Display of tanh x

NOTES

Csech x, sech x and coth x can be obtained after the operation No. 4, No. 8 and No. 12 respectively, by pressing the key [1/x].

DATA MEMORY

M_0	e^x
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	e^x	
1	−	
2	X⇄Y	
3	1/X	
4	÷	
5	2	
6	=	
7	R/S	Display of sinh x
8		
9		
10	e^x	
11	+	
12	X⇄Y	
13	1/X	
14	÷	
15	2	
16	=	
17	R/S	Display of cos hx
18		
19		
20	e^x	
21	SM	
22	0	
23	−	
24	X⇄Y	
25	1/X	
26	÷	
27	(5	
28	RM	
29	0	
30	+	
31	X⇄Y	
32	1/X	
33	5)	
34	=	
35	R/S	Display of tanh x
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Inverse hyperbolic functions	PROGRAM NO.	A-2

FORMULA

1. $\sinh^{-1}x = \mathrm{Ln}(x+\sqrt{x^2+1})$ $(-\infty < x < +\infty)$
2. $\cosh^{-1}x = \mathrm{Ln}(x+\sqrt{x^2-1})$ $(1 \leq x)$
3. $\tanh^{-1}x = \mathrm{Ln}\sqrt{\dfrac{1+x}{1-x}}$ $(-1 < x < +1)$

EXAMPLES

⟨input⟩	⟨output⟩
$x = 0.5$	$\sinh^{-1} 0.5 = 0.4812$
$x = 5$	$\cosh^{-1} 5 = 2.2924$
$x = 0.5$	$\tanh^{-1} 0.5 = 0.5493$

OPERATION

1. [GTO] [0] [0]
2. Input of Data x
3. [R/S]
4. Display of $\sinh^{-1}x$
5. [GTO] [2] [0]
6. Input of Data x
7. [R/S]
8. Display of $\cosh^{-1}x$
9. [GTO] [4] [0]
10. Input of Data x
11. [R/S]
12. Display of $\tanh^{-1}x$

NOTES

DATA MEMORY

M_0	x
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	SM	
1	0	
2	F $\sqrt{X}$	x^2
3	+	
4	1	
5	=	
6	$\sqrt{X}$	
7	+	
8	RM	
9	0	
10	=	
11	F e^x	Ln
12	R/S	Display of $\sin h^{-1} x$
13		
14		
15		
16		
17		
18		
19		
20	SM	
21	0	
22	F $\sqrt{X}$	x^2
23	−	
24	1	
25	=	
26	$\sqrt{X}$	
27	+	
28	RM	
29	0	
30	=	
31	F e^x	Ln
32	R/S	Display of $\cos h^{-1} x$
33		
34		
35		
36		
37		
38		
39		
40	SM	
41	0	
42	+	
43	1	
44	÷	
45	(5	
46	1	
47	−	
48	RM	
49	0	
50	=	
51	$\sqrt{X}$	
52	F e^x	Ln
53	R/S	Display of $\tan h^{-1} x$
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		3

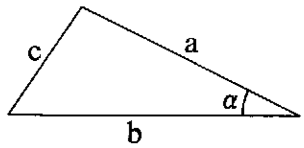
PROGRAM TITLE	Cosine rule and area of triangle	PROGRAM NO.	A-3

FORMULA

Given two sides and a included angle, the remaining side and the area of the triangle is computed by the following fomulas :

$$c = \sqrt{a^2 + b^2 - 2ab\cos\alpha}$$

$$\text{Area } S = \frac{1}{2}ab\sin\alpha$$



EXAMPLES

〈Input〉	〈output〉
$a = \sqrt{3}$	$c = 1.000$
$b = 2$	$S = 0.866$
$\alpha = 30°$	

OPERATION

(Calculation of c)

1. GTO 0 0
2. Input of a
3. R/S
4. Input of b
5. R/S
6. Input of α
7. R/S
   Display of c

(Calculation of S)

1. GTO 30
2. Input of a
3. R/S
4. Input of b
5. R/S
6. Input of α
7. R/S
   Display of S

NOTES

DATA MEMORY

M_0	a
M_1	b
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	SM	
1	0	
2	F√X	X^2
3	+	
4	R/S	Input of b
5	SM	
6	1	
7	F√X	X^2
8	−	
9	(5	
10	R/S	Input of α
11	COS	
12	×	
13	RM	
14	0	
15	×	
16	RM	
17	1	
18	×	
19	2	
20	=	
21	√X	
22	R/S	Display of c
23		
24		
25		
26		
27		
28		
29		
30	×	
31	R/S	Input of b
32	×	
33	R/S	Input of α
34	SIN	
35	÷	
36	2	
37	=	
38	R/S	Display of S
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		3

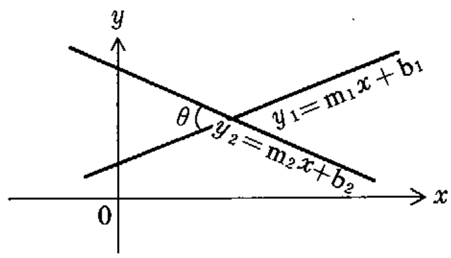
PROGRAM TITLE	Angle between two straight lines	PROGRAM NO.	A-4

FORMULA

This program calculates the angle between two straight lines, $y_1 = m_1 x + b_1$ and $y_2 = m_2 x + b_2$

$$\theta = \tan^{-1}\left(\frac{m_1 - m_2}{1 + m_1 m_2}\right)$$

Where θ is the angle measured clock wise from m_1 line to m_2 line.



EXAMPLES

〈input〉	〈output〉
$y_1 = \frac{1}{2}x + 2$	$\theta = 71.565°$
$y_2 = -x + 5$	

OPERATION

1. GTO 0 0
2. Input of m_1
3. R/S
4. Input of m_2
5. R/S

   Display of θ
6. Repeat steps 1 through 5

NOTES

DATA MEMORY

M_0	m_1
M_1	m_2
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	SM	
1	0	
2	−	
3	R/S	Input of m_2
4	SM	
5	1	
6	÷	
7	〔5	
8	1	
9	+	
10	〔5	
11	RM	
12	0	
13	×	
14	RM	
15	1	
16	=	
17	F TAN	TAN^{-1}
18	R/S	Display of θ
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		3

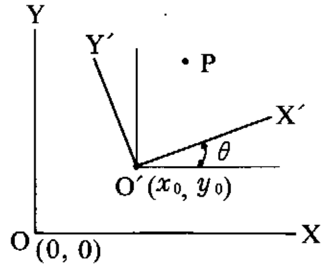
PROGRAM TITLE	Coordinate translation and rotation	PROGRAM NO.	A-5

FORMULA

The origin is translated from O (0, 0) to a new point, O′ (x_0, y_0), and the X and Y axes are then rotated through an angle θ to give new axes, X′ and Y′. Suppose that a point P has coordinates (x, y) with respect to the old system of X and Y axes.
The following formulas are given to find the coordinates (x', y') of P with respect to new system.

$$x' = (x - x_0)\cos\theta + (y - y_0)\sin\theta$$

$$y' = -(x - x_0)\sin\theta + (y - y_0)\cos\theta$$



EXAMPLES

〈input〉	〈output〉
$x_0 = 2$	$x' = 2.828$
$y_0 = 1$	$y' = 1.7 \times 10^{-8} \fallingdotseq 0$
$\theta = 45°$	
$x = 4$	
$y = 3$	

OPERATION

1. [GTO] [0] [0]
2. Input of x
3. [R/S]
4. Input of y
5. [R/S]
   Display of x'
6. [R/S]
   Display of y'
7. Repeat steps 1 through 6

NOTES

1. The values of M_0, M_1 and M_2 must be entered precedingly by users.

DATA MEMORY

M_0	x_0
M_1	y_0
M_2	θ
M_3	$\cos\theta$
M_4	$\sin\theta$
M_5	x
M_6	y
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	SM	
1	5	
2	−	
3	RM	
4	0	
5	×	
6	RM	
7	2	
8	COS	
9	SM	
10	3	
11	+	
12	(5	
13	(5	
14	R/S	Input of y
15	SM	
16	6	
17	−	
18	RM	
19	1	
20	5)	
21	×	
22	RM	
23	2	
24	SIN	
25	SM	
26	4	
27	=	
28	R/S	Display of x'
29	RM	
30	5	
31	−	
32	RM	
33	0	
34	×	
35	RM	
36	4	
37	+⇄−	
38	+	
39	(5	
40	(5	
41	RM	
42	6	
43	−	
44	RM	
45	1	
46	5)	
47	×	
48	RM	
49	3	
50	=	
51	R/S	Display of y'
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Simultaneous equations in 2 unknowns	PROGRAM NO.	A-6

FORMULA

Let $a_1x_1 + b_1x_2 = c_1$

and $a_2x_1 + b_2x_2 = c_2$

be a system of two equations in two unknowns.

The following formulas are given to find the solution.

$$x_1 = \frac{b_1c_2 - b_2c_1}{a_2b_1 - a_1b_2} \qquad x_2 = \frac{c_1 - a_1x_1}{b_1}$$

EXAMPLES

<input>		<output>
$a_1 = 1$	$a_2 = 1$	$x_1 = 1.00$
$b_1 = -1$	$b_2 = 1$	$x_2 = 2.00$
$c_1 = -1$	$c_2 = 3$	

OPERATION

1. GTO 0 0
2. R/S
   Display of x_1
3. R/S
   Display of x_2

NOTES

1. The values of M_0, M_1, M_2, M_3, M_4 and M_5 must be entered precedingly by users.

DATA MEMORY

M_0	a_1
M_1	b_1
M_2	c_1
M_3	a_2
M_4	b_2
M_5	c_2
M_6	x_1
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	1	
2	×	
3	RM	
4	5	
5	−	
6	〔5	
7	RM	
8	4	
9	×	
10	RM	
11	2	
12	5〕	
13	÷	
14	〔5	
15	RM	
16	3	
17	×	
18	RM	
19	1	
20	−	
21	〔5	
22	RM	
23	0	
24	×	
25	RM	
26	4	
27	=	
28	SM	
29	6	
30	R/S	Display of x_1
31	RM	
32	2	
33	−	
34	〔5	
35	RM	
36	0	
37	×	
38	RM	
39	6	
40	5〕	
41	÷	
42	RM	
43	1	
44	=	
45	R/S	Display of x_2
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Quadratic equation	PROGRAM NO.	A-7

FORMULA

The roots x_1, x_2 of $ax^2+bx+c=0$ $(a\neq 0)$

are given by $x_1, x_2 = \dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$

EXAMPLES

⟨input⟩	⟨output⟩
a = 3	$x_1 = 0.33$
b = 2	$x_2 = -1.00$
c = −1	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of a
4. [R/S]
5. Input of b
6. [R/S]
7. Input of c
8. [R/S]
   Display of x_1
9. [R/S]
   Display of x_2
10. Repeat steps 3 through 9

NOTES

1. If $b^2-4ac<0$, "error" is displayed

DATA MEMORY

M_0	working
M_1	$\frac{b}{2a}$
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of a or display of x_2
1	SM	
2	0	
3	×	
4	2	
5	÷	
6	R/S	Input of b
7	X⇆Y	
8	=	
9	SM	
10	1	
11	F√X	X^2
12	−	
13	(5	
14	R/S	Input of c
15	÷	
16	RM	
17	0	
18	5)	
19	=	
20	SKP	
21	GTO	
22	2	
23	8	
24	√X	
25	GTO	
26	0	
27	0	
28	√X	
29	SM	
30	0	
31	−	
32	RM	
33	1	
34	=	
35	R/S	Display of x_1
36	RM	
37	1	
38	+	
39	RM	
40	0	
41	=	
42	+⇆−	
43	GTO	
44	0	
45	0	
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		0

PROGRAM TITLE	Complex arithmetic (+, −, ×)	PROGRAM NO.	A-8

FORMULA

Let $z_1 = a_1 + b_1 i$ and $z_2 = a_2 + b_2 i$ be two complex numbers. The arithmetic operations +, −, × are defined as follows.

1. $z_1 + z_2 = (a_1 + a_2) + (b_1 + b_2) i$
2. $z_1 - z_2 = (a_1 - a_2) + (b_1 - b_2) i$
3. $z_1 z_2 = (a_1 a_2 - b_1 b_2) + (a_1 b_2 + b_1 a_2) i$

EXAMPLES

⟨input⟩	⟨output⟩
$a_1 = 1$	$z_1 + z_2 = 4 + 6i$
$b_1 = 2$	$z_1 - z_2 = -2 - 2i$
$a_2 = 3$	$z_1 z_2 = -5 + 10i$
$b_2 = 4$	

OPERATION

1. GTO 0 0
2. R/S
   Display of Real part$(a_1 + a_2)$ of addition
3. R/S
   Display of Imaginary Part $(b_1 + b_2)$ of addition
4. R/S
   Display of Real part$(a_1 - a_2)$ of subtraction
5. R/S
   Display of Imaginary Part $(b_1 - b_2)$ of subtraction
6. R/S
   Display of Real part$(a_1 a_2 - b_1 b_2)$ of multiplication
7. R/S
   Display of Imaginary Part $(a_1 b_2 + b_1 a_2)$ of multiplication

NOTES

1. The values of M_0, M_1, M_2 and M_3 must be entered precedingly by users.

DATA MEMORY

M_0	a_1
M_1	b_1
M_2	a_2
M_3	b_2
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	0	
2	+	
3	RM	
4	2	
5	=	
6	R/S	Display of $(a_1 + a_2)$
7	RM	
8	1	
9	+	
10	RM	
11	3	
12	=	
13	R/S	Display of $(b_1 + b_2)$
14	RM	
15	0	
16	−	
17	RM	
18	2	
19	=	
20	R/S	Display of $(a_1 - a_2)$
21	RM	
22	1	
23	−	
24	RM	
25	3	
26	=	
27	R/S	Display of $(b_1 - b_2)$
28	RM	
29	0	
30	×	
31	RM	
32	2	
33	−	
34	(5	
35	RM	
36	1	
37	×	
38	RM	
39	3	
40	=	
41	R/S	Display of $(a_1 a_2 - b_1 b_2)$
42	RM	
43	0	
44	×	
45	RM	
46	3	
47	+	
48	(5	
49	RM	
50	1	
51	×	
52	RM	
53	2	
54	=	
55	R/S	Display of $(a_1 b_2 + b_1 a_2)$
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		1

PROGRAM TITLE	Determinant and inverse of a 2×2 matrix	PROGRAM NO.	A-9

FORMULA

Let $r=\begin{bmatrix} r_{11} & r_{12} \\ r_{21} & r_{22} \end{bmatrix}$ be a 2×2 matrix

The determinant of r denoted by Det r is evaluated by the following formula:

$$\text{Det } r = r_{22}r_{11} - r_{12}r_{21}$$

The multiplicative inverse r^{-1} of r is evaluated by the following formula:

$$r^{-1}=\begin{bmatrix} r_{22}/\text{Det } r & -r_{12}/\text{Det } r \\ -r_{21}/\text{Det } r & r_{11}/\text{Det } r \end{bmatrix}$$

EXAMPLES

<input>

$$r=\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$$

<output>

Det r = −2.0

$$r^{-1}=\begin{bmatrix} -2.0 & 1.5 \\ 1.0 & -0.5 \end{bmatrix}$$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
   Display of Det r
3. [R/S]
   Display of r_{22}/ Det r
4. [R/S]
   Display of $-r_{12}$/ Det r
5. [R/S]
   Display of $-r_{21}$/ Det r
6. [R/S]
   Display of r_{11}/ Det r

NOTES

1. The values of M_0, M_1, M_2 and M_3 must be entered precedingly by users.

DATA MEMORY

M_0	r_{11}
M_1	r_{12}
M_2	r_{21}
M_3	r_{22}
M_4	Det r
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	3	
2	×	
3	RM	
4	0	
5	−	
6	(5	
7	RM	
8	1	
9	×	
10	RM	
11	2	
12	=	
13	SM	
14	4	
15	R/S	Display of Det r
16	RM	
17	3	
18	÷	
19	RM	
20	4	
21	=	
22	R/S	Display of r_{22}/Det r
23	RM	
24	1	
25	÷	
26	RM	
27	4	
28	=	
29	+⇄−	
30	R/S	Display of $-r_{12}$/Det r
31	RM	
32	2	
33	÷	
34	RM	
35	4	
36	=	
37	+⇄−	
38	R/S	Display of $-r_{21}$/Det r
39	RM	
40	0	
41	÷	
42	RM	
43	4	
44	=	
45	R/S	Display of r_{11}/Det r
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

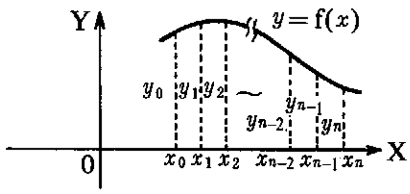
DEG	RAD	DPS
	○	4

PROGRAM TITLE	Simpson's rule for numerical integration	PROGRAM NO.	A-10

FORMULA

Let $x_0, x_1, \cdots\cdots, x_n$ be equally spaced points such that $x_i = x_0 + ih$ for $i = 0, 1, 2, \cdots\cdots, n$ at which corresponding values $f(x_0), f(x_1), \cdots\cdots, f(x_n)$ of a function $f(x)$ are known. Simpson's rule is:

$$\int_{x_0}^{x_n} f(x)\,dx \cong \frac{h}{3}\left[f(x_0) + 4f(x_1) + 2f(x_2) + \cdots\cdots + 4f(x_{n-3}) + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n) \right]$$



EXAMPLES

⟨input⟩

$h = \frac{\pi}{8}$, $f(x) = \sin^2 x$

i	0	1	2	3	4	5	6	7	8
x_i	0	$\pi/8$	$\pi/4$	$3\pi/8$	$\pi/2$	$5\pi/8$	$3\pi/4$	$7\pi/8$	π
$f(x_i)$	0	0.1464	0.5	0.8536	1	0.8536	0.5	0.1464	0

⟨output⟩

$S = \int_0^{\pi} \sin^2 x\,dx$

$\cong 1.5708$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input h
4. [R/S]
5. Input of $f(x_0)$
6. [R/S]
7. Input of $f(x_n)$
8. [R/S]
9. Input of $f(x_i)$
10. [R/S]
11. Input of $f(x_{i+1})$
12. [R/S]
13. Repeat steps 9 through 12

NOTES

1. Press [RM] [1], after the completion of input of all $f(x_i)$, then S is displayed.

DATA MEMORY

M_0	h/3
M_1	working
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of h
1	÷	
2	3	
3	=	
4	SM	
5	0	
6	×	
7	R/S	Input of $f(x_0)$
8	=	
9	SM	
10	1	
11	R/S	Input of $f(x_n)$
12	×	
13	RM	
14	0	
15	=	
16	F+	M^+
17	1	
18	R/S	Input of $f(x_i)$
19	×	
20	RM	
21	0	
22	×	
23	4	
24	=	
25	F+	M^+
26	1	
27	R/S	Input of $f(x_{i+1})$
28	×	
29	RM	
30	0	
31	×	
32	2	
33	=	
34	F+	M^+
35	1	
36	GTO	
37	1	
38	8	
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	7

PROGRAM TITLE	Numerical solution to differential equations	PROGRAM NO.	A-11

FORMULA

Let $y' = f(x, y)$ be a first order differential equations with initial values x_0, y_0.

The solution is a numerical solution, which calculates y_i for $x_i = x_0 + ih$, where h is an increment specified by the user and $i = 1, 2, \cdots$.

The program uses a modified Euler method:

$$\hat{y}_{i+1} = y_i + hf(x_i, y_i)$$

$$y_{i+1} = y_i + \frac{h}{2}\left[f(x_i, y_i) + f(x_{i+1}, \hat{y}_{i+1})\right]$$

The definition of function $f(x, y)$ is performed by storing into the program memory the information of key operation required for determining $f(x, y)$.

EXAMPLES

$y' = y$, $y(0) = 1$ (Answer $y = e^x$)

⟨Input⟩	⟨Output⟩
$h = 0.01$	$y(0.01) = 1.0100500$
$x_0 = 0$	(true value 1.0100502)
$y_0 = 1$	$y(0.02) = 1.0202010$
	(true value 1.0202013)

OPERATION

1. GTO 0 0
2. R/S
3. Input of h
4. R/S
5. Input of x_0
6. R/S
7. Input of y_0
8. R/S
9. Display of $y(x_0 + h)$
10. R/S

    Display of $y(x_0 + 2h)$

    ⋮

NOTES

1. The definition of function $f(x, y)$ is performed by storing into the program memory the information of key operation required for determining $f(x, y)$.

DATA MEMORY

M_0	h
M_1	$x_i(x_{i+1})$
M_2	$y_i(\hat{y}_{i+1})$
M_3	working
M_4	x_i
M_5	y_i
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of h
1	SM	
2	0	
3	R/S	Input of x_0
4	SM	
5	1	
6	SM	
7	4	
8	R/S	Input of y_0
9	SM	
10	2	
11	SM	
12	5	
13	C	
14	SM	
15	3	
16	RM	} $f(x, y)$ (steps 16–26)
17	2	
18		
19		
20		
21		
22		
23		
24		
25		
26		
27	×	
28	RM	
29	0	
30	=	
31	F+	M^+
32	3	
33	RM	
34	4	
35	−	
36	RM	
37	1	
38	=	
39	SKP	
40	GTO	
41	6	
42	1	
43	F−	M^-
44	4	
45	RM	
46	3	
47	÷	
48	2	
49	+	
50	RM	
51	5	
52	=	
53	R/S	Display of y_{i+1}
54	SM	
55	2	
56	SM	
57	5	
58	GTO	
59	1	
60	3	
61	RM	
62	0	
63	F+	M^+
64	1	
65	RM	
66	3	
67	F+	M^+
68	2	
69	GTO	
70	1	
71	6	

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Base conversion (Number in base b to number in base 10)	PROGRAM NO.	A-12

FORMULA

This program consists of two programs.

1. To change the integer part of a number in base b to a number in base 10.

$$I_{10} = i_n i_{n-1} \cdots\cdots i_2 i_1 = i_n b^{n-1} + i_{n-1} b^{n-2} + \cdots\cdots + i_2 b + i_1$$

$$= b(\cdots\cdots(b(b(i_n b + i_{n-1}) + i_{n-2}) + \cdots\cdots) + i_2) + i_1$$

2. To change the fraction part of a number in base b to a number in base 10.

$$F_{10} = f_1 f_2 \cdots\cdots f_m = f_1 b^{-1} + f_2 b^{-2} + \cdots\cdots + f_m b^{-m}$$

By combining these two programs, any number in base b can be converted to a number in base 10.

EXAMPLES

<Input>	<Output>
$10101_{(2)}$	$21.00000_{(10)}$
$0.10101_{(2)}$	$0.65625_{(10)}$

OPERATION

Integer part	Fraction part
1. [GTO] [0] [0]	1. [GTO] [2] [0]
2. Input of i_n	2. Input of f_m
3. [R/S]	3. [R/S]
4. Input of i_{n-1}	4. Input of f_{m-1}
5. Repeat steps 3 and 4. After entry of all data	5. Repeat steps 3 and 4. After entry of all data
6. [=] Display of I_{10}	6. [R/S] Display of F_{10}

NOTES

1. Before the operation, store b into memory M_0.

DATA MEMORY

M_0	b
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	×	
1	RM	
2	0	
3	+	
4	R/S	Input of $i_{n-1} \cdots i_1$ or display of I_{10}
5	=	
6	GTO	
7	0	
8	0	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20	÷	
21	RM	
22	0	
23	+	
24	R/S	Input of $f_{m-1} \cdots f_1$ or display of F_{10}
25	=	
26	GTO	
27	2	
28	0	
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	0

PROGRAM TITLE	Base conversion (Number in base 10 to number in base b)	PROGRAM NO.	A-13

FORMULA

Conversion from arbitrary decimal number N_{10} to b-ary number N_b ($2 \leqq b \leqq 100$) · Obtaining from lower integer digit to upper by repeat calculation, then fraction number is obtained from upper fraction digit to lower by repeat calculation.

EXAMPLES

1. 455.625 (Decimal) to hexadecimal notation

(input)	(output)
455.625	1C7. A

2. 0.7525 degree (Decimal) to sexagecimal degree

(input)	(output)
0.7525	45′ 09″

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of positive decimal number
4. [R/S]
5. Input of base mumber (b)
6. [R/S]
   Display of lowest integer digit number.
7. Obtain next integer digit number in order by repetition of step no.6.
8. [SKP]
9. [R/S]
   Display of lst fraction number
10. Obtain next fraction number by repetition of step no.9.

NOTES

1. Example of base number input
   - hexadecimal→16
   - sexagecimal→60
2. If the display becomes succession of zero by repeat operation of step number 6, operator can advance next step by pressing [SKP] key.
3. Result of each digit number will be displayed by using 2 digit display region: example, hexadecimal

display	
0~9	0~9
10	A
11	B
12	C
13	D
14	E
15	F

DATA MEMORY

M_0	base b
M_1	working
M_2	working
M_3	Decimal number
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of decimal number
1	SM	
2	3	
3	+	
4	EXP	
5	9	
6	−	
7	EXP	
8	9	
9	=	
10	SM	
11	1	
12	F−	M^-
13	3	
14	R/S	Input of base b
15	SM	
16	0	
17	RM	
18	1	
19	SM	
20	2	
21	÷	
22	RM	
23	0	
24	+	
25	EXP	
26	9	
27	−	
28	EXP	
29	9	
30	=	
31	SM	
32	1	
33	×	
34	RM	
35	0	
36	−	
37	RM	
38	2	
39	X⇆Y	
40	=	
41	R/S	Display of integer part
42	GTO	
43	1	
44	7	
45	R/S	
46	RM	
47	0	
48	F×	$M^\times$
49	3	
50	RM	
51	3	
52	+	
53	EXP	
54	9	
55	−	
56	EXP	
57	9	
58	=	
59	F−	M^-
60	3	
61	R/S	Display of fraction part
62	GTO	
63	4	
64	6	
65		
66		
67		
68		
69		
70		
71		

(B) Statistics and probabilities

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Arithmetic mean (Non distribution)	PROGRAM NO.	B-1

FORMULA

This program computes the arithmetic mean $\bar{x}$ for a set of given data $(x_1, x_2, \cdots\cdots, x_n)$

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where x_i : given data

n : number of given data

EXAMPLES

⟨Input⟩	⟨Output⟩
$x_1 = 9.140$	$\bar{x} = 9.165$
$x_2 = 9.145$	
$x_3 = 9.165$	
$x_4 = 9.185$	
$x_5 = 9.190$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of x_i
4. R/S
5. Repeat steps 3 and 4. After entry of all data
6. SKP
7. R/S

   Display of $\bar{x}$
8. Repeat steps 1 through 7.

NOTES

1. Every time data is input and R/S key is pressed, the number of data is displayed.

DATA MEMORY

M_0	Σx_i
M_1	n
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	C	
1	SM	
2	0	
3	SM	
4	1	
5	R/S	Input of x_i or SKP or display of $\bar{x}$
6	F+	M⁺
7	0	
8	1	
9	F+	M⁺
10	1	
11	RM	
12	1	
13	GTO	
14	0	
15	5	
16	R/S	
17	RM	
18	0	
19	÷	
20	RM	
21	1	
22	=	
23	GTO	
24	0	
25	5	
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		2

PROGRAM TITLE	Arithmetic mean (Frequency distribution)	PROGRAM NO.	B-2

FORMULA

This program calculates arithmetic mean $\bar{x}$ for a set of data which has frequency distribution.

Class value	x_1	x_2	x_3	………	………	x_i	………
frequency	f_1	f_2	f_3	………	………	f_i	………

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i \text{ (arithmetic mean)}$$

where $N = \sum_{i=1}^{n} f_i$

$x_i = x_i + (i-1)h \quad (i = 1.2. \cdots\cdots n)$

x_1 : initial class value

h : class interval

f_1 : frequency

EXAMPLES

⟨Input⟩		⟨Output⟩
h = 0.5	$f_1 = 3$	$\bar{x} = 3.50$
$x_1 = 3$	$f_2 = 6$	
	$f_3 = 8$	
	$f_4 = 5$	
	$f_5 = 2$	
	$f_6 = 1$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of h
4. R/S
5. Input of x_1
6. R/S
   Display of x_i
7. Input of f_i or SKP
8. Repeat steps 6 and 7 to f_n
9. R/S
   Display of $\bar{x}$
10. Repeat steps 3 through 9.

NOTES

1. SKP at 7 step operates to obtain $\bar{x}$ after an input of f_i

DATA MEMORY

M_0	h
M_1	Σf
M_2	Σfx
M_3	$x_1 + nh$
M_4	last input of f
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of h
1	SM	Display of $\bar{x}$
2	0	
3	R/S	Input of x_1
4	SM	
5	3	Display of x_i
6	R/S	Input of f_i or SKP
7	SM	
8	4	
9	F+	M+
10	1	
11	×	
12	RM	
13	3	
14	−	
15	F+	M+
16	2	
17	RM	
18	0	
19	F+	M+
20	3	
21	RM	
22	3	
23	GTO	
24	0	
25	6	
26	R/S	
27	RM	
28	2	
29	÷	
30	RM	
31	1	
32	=	
33	GTO	
34	0	
35	0	
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Geometric mean	PROGRAM NO.	B-3

FORMULA

The following formula is given to obtain geometric mean of n quantites ($\overline{x_g}$)

$$\overline{x_g} = \sqrt[n]{x_1 x_2 x_3 \cdots\cdots x_n} = \sqrt[n]{\prod_{i=1}^{n} x_i}$$

EXAMPLES

〈Input〉	〈Output〉
$x_1 = 3.4$	$\overline{x_g} = 6.61$
$x_2 = 5.1$	
$x_3 = 10.2$	
$x_4 = 10.8$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of x_i
4. R/S
   ⋮
   x_n
   R/S
5. SKP
6. R/S
   Display of $\overline{x_g}$

NOTES

1. Number of input data be obtained by pressing RM 1

DATA MEMORY

M_0	πx_i
M_1	n
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	1	
1	SM	
2	0	
3	R/S	Input of x_1
4	F×	$M^{\times}$
5	0	
6	1	
7	F+	M^{+}
8	1	
9	GTO	
10	0	
11	3	
12	R/S	SKP or R/S
13	RM	
14	0	
15	Y^x	
16	RM	
17	1	
18	1/X	
19	=	
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		6

PROGRAM TITLE	Mean, Variance, Standard Deviation	PROGRAM NO.	B-4

FORMULA

This program calculates the mean $\bar{x}$, the variance r and the standard deviation σ

$$\bar{x} = \sum_{i=1}^{n} x_i / n$$

$$r = \sum (x_i - \bar{x})^2 / n$$

$$\sigma = \sqrt{r}$$

EXAMPLES

⟨Input⟩	⟨Output⟩
$x_1 = 9.140$	$\bar{x} = 9.165000$
$x_2 = 9.145$	$r = 0.000413$
$x_3 = 9.165$	$\sigma = 0.020322$
$x_4 = 9.185$	
$x_5 = 9.190$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of x_i
4. R/S
5. Repeat steps 3 and 4.
6. After entry of all data
   SKP
7. R/S
   Display of σ
8. RM 4
   Display of $\bar{x}$
9. RM 5
   Display of r

NOTES

1. Clear M_1, M_2, and M_3 before the operation.

DATA MEMORY

M_0	
M_1	$\sum x$
M_2	$\sum x^2$
M_3	n
M_4	$\bar{x}$
M_5	r
M_6	σ
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of x_i
1	F+	M^+
2	1	
3	F$\sqrt{X}$	X^2
4	F+	M^+
5	2	
6	1	
7	F+	M^+
8	3	
9	GTO	
10	0	
11	0	
12	R/S	
13	RM	
14	1	
15	÷	
16	RM	
17	3	
18	=	
19	SM	
20	4	
21	F$\sqrt{X}$	X^2
22	×	
23	RM	
24	3	
25	−	
26	RM	
27	2	
28	÷	
29	RM	
30	3	
31	=	
32	+⇆−	
33	SM	
34	5	
35	$\sqrt{X}$	
36	SM	
37	6	
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Moving average (3-terms)	PROGRAM NO.	B-5

FORMULA

This program calculates the moving average of three terms for data $x_1, x_2 \cdots\cdots x_n$,

$$\overline{x_1} = (x_1 + x_2 + x_3)/3$$

$$\overline{x_2} = (x_2 + x_3 + x_4)/3$$

$$\vdots$$

$$\overline{x_i} = (x_i + x_{i+1} + x_{i+2})/3$$

EXAMPLES

⟨Input⟩		⟨Output⟩
$x_1 = 3.4$	$x_7 = 3.9$	$\overline{x_1} = 3.400$
$x_2 = 3.3$	$x_8 = 4.1$	$\overline{x_2} = 3.500$
$x_3 = 3.5$		$\overline{x_3} = 3.600$
$x_4 = 3.7$		$\overline{x_4} = 3.633$
$x_5 = 3.6$		$\overline{x_5} = 3.700$
$x_6 = 3.6$		$\overline{x_6} = 3.867$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of x_1
4. [R/S]
5. Input of x_2
6. [R/S]
7. Input of x_3
8. [R/S]
   Display of $\overline{x_1}$
9. Repeat steps 7 and 8.
   Display of $\overline{x_i}$

NOTES

DATA MEMORY

M_0	
M_1	x_i
M_2	x_{i+1}
M_3	x_{i+2}
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of x_1
1	SM	
2	1	
3	R/S	Input of x_2
4	SM	
5	2	
6	R/S	Input of x_3 or display of $\overline{x_1}$
7	SM	
8	3	
9	RM	
10	1	
11	+	
12	RM	
13	2	
14	SM	
15	1	
16	+	
17	RM	
18	3	
19	SM	
20	2	
21	÷	
22	3	
23	=	
24	GTO	
25	0	
26	6	
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		2

PROGRAM TITLE: Logarithmic curve fit

PROGRAM NO.: B-6

FORMULA

This program fits a logarithmic curve

$$y = a + b\,\ell n\,x$$

for the set of data $\{(x_i, y_i), i=1.2.\cdots\cdots n\}$

$$a = \frac{1}{n}(\Sigma y_i - b\Sigma \ell n x_i)$$

$$b = \frac{\Sigma y_i \ell n x_i - \frac{1}{n}\Sigma \ell n x_i \Sigma y_i}{\Sigma(\ell n x_i)^2 - \frac{1}{n}(\Sigma \ell n x_i)^2}$$

EXAMPLES

〈Input〉

x_i	y_i
3	1.5
4	9.3
6	23.4
10	45.8
12	60.1

〈Ontput〉

a = − 47.02

b = 41.39

OPERATION

1. GTO 0 0
2. R/S
3. Input of x_i.
4. R/S
5. Input of y_i.
6. R/S
7. Repeat steps 3 through 6.
8. After completion of all data entry
   SKP
9. SKP
10. R/S
    Display of a.
11. RM 7
    Display of b.

NOTES

Clear M_1 through M_6 before the operation.

DATA MEMORY

M_0	
M_1	$\ell n x_i$
M_2	$\Sigma \ell n x$
M_3	$\Sigma(\ell n x)^2$
M_4	n
M_5	Σy_i
M_6	$\Sigma y \ell n x$
M_7	b
M_8	a
M_9	$\frac{1}{n}$

STEP	PROGRAM	NOTE
0	R/S	Input of x
1	Fe^x	ℓn
2	SM	
3	1	
4	F+	M^+
5	2	
6	F√X	X^2
7	F+	M^+
8	3	
9	1	
10	F+	M^+
11	4	
12	R/S	Input of y
13	F+	M^+
14	5	
15	×	
16	RM	
17	1	
18	=	
19	F+	M^+
20	6	
21	GTO	
22	0	
23	0	
24	R/S	
25	RM	
26	4	
27	1/X	
28	SM	
29	9	
30	×	
31	RM	
32	2	
33	×	
34	RM	
35	5	
36	−	
37	RM	
38	6	
39	÷	
40	(5	
41	RM	
42	9	
43	×	
44	RM	
45	2	
46	F√X	X^2
47	−	
48	RM	
49	3	
50	5)	
51	=	
52	SM	
53	7	
54	×	
55	RM	
56	2	
57	−	
58	RM	
59	5	
60	÷	
61	RM	
62	4	
63	=	
64	+/−	
65	SM	
66	8	Display a
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Exponential curve fit.	PROGRAM NO.	B-7

FORMULA

This program calculates coefficients a and b for a exponential curve

$$y = a\, e^{bx}$$

$$b = \frac{\Sigma x_i \ell_n y_i - \frac{1}{n}(\Sigma x_i)(\Sigma \ell_n y_i)}{\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2}$$

$$a = \exp\left(\frac{\Sigma \ell_n y_i}{n} - b\frac{\Sigma x_i}{n}\right)$$

where (x_i, y_i) is set of data $(i = 1, 2, \ \ , n)$

$(\ell_n y = \ell_n a + bx)$

EXAMPLES

〈Input〉	〈Outpnt〉
$(x_1, y_1) = (1,1)$	a = 0.50000
$(x_2, y_2) = (2,2)$	b = 0.69315

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of y_i
4. [R/S]
5. Input of x_i
6. [R/S]
7. Repeat steps 3 through 6. After completion of all data entry.
8. [SKP]
9. [SKP]
10. [R/S]
    Display of a.

NOTES

① Clear M_0 through M_5 before the operation.

② b and a will be stored into M_6 and M_7 respectively.

DATA MEMORY

M_0	$\Sigma \ln y$
M_1	Σx
M_2	Σx^2
M_3	working
M_4	$\Sigma x \ln y$
M_5	$\Sigma 1$
M_6	b
M_7	a
M_8	
M_9	

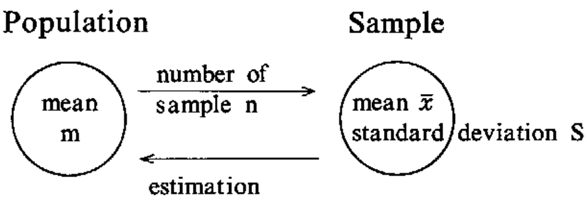
STEP	PROGRAM	NOTE
0	R/S	Input of y
1	F e^x	ℓ_n
2	F+	M+
3	0	
4	SM	
5	3	
6	R/S	Input of x
7	F+	M+
8	1	
9	F×	M+
10	3	
11	F√X	X^2
12	F+	M+
13	2	
14	RM	
15	3	
16	F+	M+
17	4	
18	1	
19	F+	M+
20	5	
21	GTO	
22	0	
23	0	
24	R/S	
25	RM	
26	1	
27	×	
28	RM	
29	0	
30	÷	
31	RM	
32	5	
33	−	
34	RM	
35	4	
36	÷	
37	(5	
38	RM	
39	1	
40	F√X	X^2
41	÷	
42	RM	
43	5	
44	−	
45	RM	
46	2	
47	5)	
48	=	
49	SM	
50	6	
51	×	
52	RM	
53	1	
54	−	
55	RM	
56	0	
57	÷	
58	RM	
59	5	
60	+/−	
61	=	
62	e^x	
63	SM	
64	7	Display of a
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE		PROGRAM NO.	
Estimation of population mean (95% confidence interval)			**B-8**

FORMULA



$$\underbrace{\bar{x} - \frac{2S}{\sqrt{n}}}_{\text{lower limit}} \leqq m \leqq \underbrace{\bar{x} + \frac{2S}{\sqrt{n}}}_{\text{upper limit}}$$

EXAMPLES

Estimate the mean height of schoolboys of N town

〈Input〉

number of sample

n = 100

standard deviation

S = 6.5cm

mean $\bar{x}$ = 158.5cm

〈Output〉

157.20 ≦ m ≦ 159.80

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. input of $\bar{x}$
4. [R/S]
5. Input of S
6. [R/S]
7. Input of n
8. [R/S]
   Display of lower limit
9. [R/S]
   Dispay of upper limit
10. Repeat steps 3 through 9

NOTES

DATA MEMORY

M_0	Upper limit
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of $\bar{x}$ or display of upper limit
1	SM	
2	0	
3	−	
4	〔5	
5	R/S	Input of S
6	÷	
7	R/S	Input of n
8	$\sqrt{X}$	
9	×	
10	2	
11	5〕	
12	F+	M^+
13	0	
14	=	
15	R/S	Display of lower limit
16	RM	
17	0	
18	GTO	
19	0	
20	0	
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		2

PROGRAM TITLE	Test of defect rate of population	PROGRAM NO.	B-9

FORMULA

The defect rate at the conventional process was P_0. When the new equipment was introduced to the process, number r out of number n were found defects.
This program tests the defect rate of population.
When $p < 0.5$ and $r = np > 3$, approximation method to the normal distribution is used.

defect rate of sample

$$P = \frac{r}{n}$$

Statistics $$U_0 = \frac{P - P_0}{\sqrt{P(1-P)/n}}$$

where
- P_0 : defect rate of population
- n : number of sample
- r : number of defects
- U_0 : statistics

EXAMPLES

〈Input〉	〈Output〉
r : 50	P = 0.25
n : 200	U_0 = 1.63
P_0 : 0.20	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of r
4. [R/S]
5. Input of n
6. [R/S]
   Display of P
7. Input of P_0
8. [R/S]
   Display of U_0
9. Repeat steps 3 through 8.

NOTES

DATA MEMORY

M_0	n
M_1	P
M_2	$P - P_0$
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of r or display of U_0
1	÷	
2	R/S	Input of n
3	SM	
4	0	
5	=	
6	SM	
7	1	
8	−	
9	R/S	Input of P_0 or display of P
10	=	
11	SM	
12	2	
13	1	
14	−	
15	RM	
16	1	
17	×	
18	RM	
19	1	
20	÷	
21	RM	
22	0	
23	=	
24	√X	
25	1/X	
26	×	
27	RM	
28	2	
29	=	
30	GTO	
31	0	
32	0	
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Interval estimation	PROGRAM NO.	B-10

FORMULA

The case of 95% confidence coefficient.

$m = np, \sigma = \sqrt{npq}, q = 1 - p$

where p; probability

m ; mean value of binomial distribution

σ ; standard deviation

Using binomial distribution

$$m - 2\sigma \leqq r \leqq m + 2\sigma$$

$$np - 2\sqrt{npq} \leqq r \leqq np + 2\sqrt{npq}$$

EXAMPLES

⟨Input⟩	⟨Output⟩
n = 100	upper limit = 74.54
P = 0.65	lower limit = 55.46

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of n
4. [R/S]
5. Input of P
6. [R/S]
   Display of upper limit
7. [R/S]
   Display of lower limit
8. Repeat steps 3 through 7.

NOTES

DATA MEMORY

M_0	P or $2\sqrt{npq}$
M_1	np
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of n or display of lower limit
1	×	
2	R/S	Input of P
3	SM	
4	0	
5	=	
6	SM	
7	1	
8	1	
9	−	
10	RM	
11	0	
12	×	
13	RM	
14	1	
15	×	
16	4	
17	=	
18	√X	
19	SM	
20	0	
21	+	
22	RM	
23	1	
24	=	
25	R/S	Display of upper limit
26	−	
27	(5	
28	RM	
29	1	
30	×	
31	2	
32	5)	
33	=	
34	+⇆−	
35	GTO	
36	0	
37	0	
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Covariance and correlation coefficient	PROGRAM NO.	B-11

FORMULA

For a set of given data points $\{(x_i, y_i),\ i = 1, 2, \cdots\cdots n\}$, the covariance and the correlation coefficient are defined as follows.

Covariance $S_{xy} = \frac{1}{n-1}(\Sigma x_i y_i - \frac{1}{n}\Sigma x_i \Sigma y_i)$

Correlation coefficient $r = \frac{S_{xy}}{S_x S_y}$ (※ $-1 \leqq r \leqq 1$)

where S_x and S_y are standard deviations

$$S_x = \sqrt{\frac{\Sigma x_i^2 - (\Sigma x_i)^2/n}{n-1}}$$

$$S_y = \sqrt{\frac{\Sigma y_i^2 - (\Sigma y_i)^2/n}{n-1}}$$

EXAMPLES

⟨Input⟩

	x_i	y_i
1	4	6
2	5	9
3	1	4
4	7	3
5	2	2

⟨Output⟩

$S_{xy} = 1.70$

$r = 0.26$

OPERATION

1. GTO 0 0
2. Input of x_i
3. ×
4. Input of y_i
5. R/S
6. Repeat steps 2 through 5
7. SKP (or GTO 2 4)
8. RM 3
9. R/S
10. RM 1
11. R/S
    Display of S_x
12. SM 6
13. RM 4
14. R/S
15. RM 2
16. R/S
17. SM 7
18. GTO 4 4
19. R/S
    Display of S_{xy}
20. R/S
    Display of r

NOTES

1. Clear all memories, before the operation.

DATA MEMORY

M_0	$\Sigma x_i y_i$
M_1	Σx_i
M_2	Σy_i
M_3	Σx_i^2
M_4	Σy_i^2
M_5	n
M_6	S_x
M_7	S_y
M_8	
M_9	

STEP	PROGRAM	NOTE
0	F+	M^+
1	2	
2	F√X	X^2
3	F+	M^+
4	4	
5	√X	
6	X⇆Y	
7	F+	M^+
8	1	
9	F√X	X^2
10	F+	M^+
11	3	
12	√X	
13	=	
14	F+	M^+
15	0	
16	1	
17	F+	M^+
18	5	
19	R/S	
20	GTO	
21	0	
22	0	
23	R/S	
24	−	
25	(5	
26	R/S	
27	F√X	X^2
28	÷	
29	RM	
30	5	
31	=	
32	÷	
33	(5	
34	RM	
35	5	
36	−	
37	1	
38	=	
39	√X	
40	GTO	
41	2	
42	3	
43	R/S	
44	RM	
45	0	
46	−	
47	(5	
48	RM	
49	1	
50	×	
51	RM	
52	2	
53	÷	
54	RM	
55	5	
56	=	
57	÷	
58	(5	
59	RM	
60	5	
61	−	
62	1	
63	=	
64	R/S	
65	÷	
66	RM	
67	6	
68	÷	
69	RM	
70	7	
71	=	

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		0

PROGRAM TITLE	Binominal coefficient $\binom{n}{r}$	PROGRAM NO.	B-12

FORMULA

$$\binom{n}{r} = {}_nC_r = \frac{{}_nP_r}{r!} = \frac{n(n-1)\cdots\cdots(n-r+1)}{r(r-1)\cdots\cdots\quad 2\times 1}$$

$$= \frac{n!}{(n-r)!\cdot r!}$$

EXAMPLES

⟨Input⟩	⟨Output⟩
r = 2	$_5C_2 = 10$
n = 5	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of r
4. [R/S]
5. Input of n
6. [R/S]

   Display of $_nC_r$

NOTES

DATA MEMORY

M_0	r
M_1	n_i, r_i
M_2	
M_3	$_nP_r$, r!
M_4	$_nP_r$, r!
M_5	$_nP_r$, $_nC_r$
M_6	fℓag
M_7	
M_8	
M_9	n−r+1, 2

STEP	PROGRAM	NOTE
0	1	
1	SM	
2	3	
3	SM	
4	6	
5	R/S	Input of r
6	SM	
7	0	
8	R/S	Input of n
9	SM	
10	1	
11	−	
12	RM	
13	0	
14	+	
15	1	
16	=	
17	SM	
18	9	
19	RM	
20	1	
21	F×	$M^{\times}$
22	3	
23	−	
24	1	
25	=	
26	SM	
27	1	
28	−	
29	RM	
30	9	
31	=	
32	SKIP	
33	GTO	
34	1	
35	9	
36	RM	
37	4	
38	SM	
39	5	
40	RM	
41	3	
42	SM	
43	4	
44	2	
45	SM	
46	9	
47	RM	
48	0	
49	SM	
50	1	
51	1	
52	SM	
53	3	
54	F−	M^{-}
55	6	
56	RM	
57	6	
58	SKIP	
59	GTO	
60	1	
61	9	
62	RM	
63	4	
64	F÷	$M^{\div}$
65	5	
66	RM	
67	5	
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Permutation ($_nP_r$)	PROGRAM NO.	B-13

FORMULA

Permutation

$$_nP_r = \frac{n!}{(n-r)!} = n(n-1)\cdots\cdots(n-r+1)$$

where

n, r are integers and $0 \leqq r \leqq n$

EXAMPLES

⟨Input⟩	⟨Output⟩
r = 2	$_nP_r$ = 20.00
n = 5	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of r
4. [R/S]
5. Input of n
6. [R/S]

   Display of $_nP_r$

NOTES

DATA MEMORY

M_0	r
M_1	$n-i$
M_2	
M_3	$_nP_r$
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	$n-r+1$

STEP	PROGRAM	NOTE
0	1	
1	SM	
2	3	
3	R/S	Input of r
4	SM	
5	0	
6	R/S	Input of n
7	SM	
8	1	
9	−	
10	RM	
11	0	
12	+	
13	1	
14	=	
15	SM	
16	9	
17	RM	
18	1	
19	F×	M×
20	3	
21	−	
22	1	
23	=	
24	SM	
25	1	
26	−	
27	RM	
28	9	
29	=	
30	SKIP	
31	GTO	
32	1	
33	7	
34	RM	
35	3	
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Chi-square evaluation	PROGRAM NO.	B-14

FORMULA

This program calculates the value of the χ^2 statistic for the goodness of fit test by the equation.

$$\chi^2 = \frac{(x_1 - m_1)^2}{m_1} + \frac{(x_2 - m_2)^2}{m_2} + \cdots\cdots + \frac{(x_k - m_k)^2}{m_k}$$

where x_i: observed frequency

m_i: expected frequency

The χ^2 statistics measures the closeness of the agreement between the observed frequencies and expected frequencies.

EXAMPLES

〈Input〉

$x_1 = 115$

$x_2 = 85$

$m_1 = 100$

$m_2 = 100$

〈Output〉

$\chi^2 = 4.50$

OPERATION

1. GTO 0 0
2. R/S
3. Input of x_i
4. R/S
5. Input of m_i
6. R/S
7. Repeat steps 3 through 6. After entry of all data.
8. SKP
9. SKP
10. R/S

Display of χ^2

NOTES

1. Clear M_2 before the operation.

DATA MEMORY

M_0	x_i
M_1	m_i
M_2	$\Sigma \frac{(x_i - m_i)^2}{m_i}$
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of x_i
1	SM	
2	0	
3	R/S	Input of m_i
4	SM	
5	1	
6	RM	
7	0	
8	−	
9	RM	
10	1	
11	=	
12	F√X	X^2
13	÷	
14	RM	
15	1	
16	=	
17	F+	M^+
18	2	
19	GTO	
20	0	
21	0	
22	R/S	
23	RM	
24	2	Display of χ^2
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Normal distribution	PROGRAM NO.	B-15

FORMULA

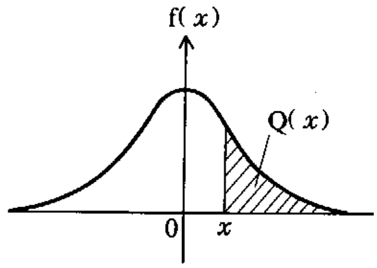
The density function for a standard normal distribution is

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

The upper tail area is

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-\frac{t^2}{2}} dt$$

where $0 \leqq x \leqq 3$



EXAMPLES

⟨Input⟩	⟨Output⟩
$x = 2.0$	$Q(2) = 0.0228$

OPERATION

1. GTO 0 0
2. R/S
3. Input of x
4. R/S

   Display of $Q(x)$

NOTES

Clear M_3 before the operation.

DATA MEMORY

M_0	xi
M_1	$e^{-\frac{xi^2}{2}}$
M_2	Δ
M_3	$\sum e^{-\frac{xi^2}{2}}$
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

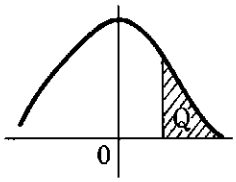
STEP	PROGRAM	NOTE
0	•	
1	1	
2	SM	
3	2	
4	R/S	Input of x
5	SM	
6	0	
7	F√X	X^2
8	÷	
9	2	
10	+⇆−	
11	=	
12	e^x	
13	SM	
14	1	
15	RM	
16	2	
17	F+	M^+
18	0	
19	RM	
20	0	
21	F√X	X^2
22	÷	
23	2	
24	+⇆−	
25	=	
26	e^x	
27	F+	M^+
28	3	
29	−	
30	RM	
31	1	
32	X⇆Y	
33	SM	
34	1	
35	÷	
36	2	
37	=	
38	F+	M^+
39	3	
40	3	
41	−	
42	RM	
43	0	
44	−	
45	SKP	
46	GTO	
47	1	
48	5	
49	π	
50	×	
51	2	
52	=	
53	√X	
54	÷	
55	RM	
56	3	
57	÷	
58	RM	
59	2	
60	=	
61	1/X	
62	+	
63	9	
64	7	
65	6	
66	1	
67	EXP	
68	7	
69	+⇆−	
70	=	
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Inverse normal integral	PROGRAM NO.	B-16

FORMULA



$$Q = \int_x^{\infty} \frac{e^{-\frac{t^2}{2}}}{\sqrt{2\pi}}\, dt \quad \left(\begin{matrix}\text{where} \\ Q = (0 < Q \leqq 0.5)\end{matrix}\right)$$

The approximate Value of x on above formula is calculated as follow.

$$X = t - \frac{C_0 + C_1 t + C_2}{1 + d_1 t + d_2 t^2 + d_3 t^3} + \varepsilon(Q)$$

now $|\varepsilon(Q)| < 4.5 \times 10^{-4}$

$$t = \sqrt{\mathrm{Ln}\frac{1}{Q^2}}$$

$C_0 = 2.515517$ $d_1 = 1.432788$

$C_1 = 0.802853$ $d_2 = 0.189269$

$C_2 = 0.010328$ $d_3 = 0.001308$

EXAMPLES

<Input>	<Output>
Q = 0.0013499	X = 3.00

OPERATION

1. GTO 0 0
2. R/S
3. Input of Q
4. R/S
   Display of X
5. Repeat steps 3 through 4

NOTES

Before operation, store $C_0 \sim C_2$, $d_1 \sim d_3$ into $M_0 \sim M_5$ respectively.

DATA MEMORY

M_0	$C_0 =$ 2.515517
M_1	$C_1 =$ 0.802853
M_2	$C_2 =$ 0.010328
M_3	$d_1 =$ 1.432788
M_4	$d_2 =$ 0.189269
M_5	$d_3 =$ 0.001308
M_6	t
M_7	t^2
M_8	t^3
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of Q or display of x
1	F√X	X^2
2	1/X	
3	Fe^x	L_n
4	√X	
5	SM	
6	6	
7	SM	
8	8	
9	F√X	X^2
10	SM	
11	7	
12	F×	$M^{\times}$
13	8	
14	RM	
15	6	
16	−	
17	(5	
18	RM	
19	0	
20	+	
21	(5	
22	RM	
23	1	
24	×	
25	RM	
26	6	
27	5)	
28	+	
29	(5	
30	RM	
31	2	
32	×	
33	RM	
34	7	
35	5)	
36	÷	
37	(5	
38	1	
39	+	
40	(5	
41	RM	
42	3	
43	×	
44	RM	
45	6	
46	5)	
47	+	
48	(5	
49	RM	
50	4	
51	×	
52	RM	
53	7	
54	5)	
55	+	
56	(5	
57	RM	
58	5	
59	×	
60	RM	
61	8	
62	5)	
63	5)	
64	5)	
65	=	Calculation of x
66	GTO	
67	0	
68	0	
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Random number generator	PROGRAM NO.	B-17

FORMULA

This program calculates uniformly distributed pseudo random numbers u_i in the range $0 \leqq u_i \leqq 1$.

$$u_i = \text{Fractional part of } (\pi + u_{i-1})^5$$

The user has to specify the starting value u_0 such that $0 \leqq u_0 \leqq 1$.

EXAMPLES

⟨Input⟩	⟨Output⟩
u_0 : 0.1200	$u_1 = 0.1039$
	$u_2 = 0.0677$
	$u_3 = 0.4677$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of u_0
4. [R/S]
   Display of u_i
5. Repeat step 4.

NOTES

1. Each operation of 4 displays $u_1, u_2, u_3 \cdots\cdots$ in order.
2. To generate new random numbers, repeat the operation 3 through 5.

DATA MEMORY

M_0	$(\pi+u_{i-1})^5$
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of u_0 or display of u_i
1	+	
2	π	
3	Y^x	
4	5	
5	=	
6	SM	
7	0	
8	+	
9	EXP	
10	9	
11	−	
12	EXP	
13	9	
14	−	
15	RM	
16	0	
17	X⇆Y	
18	=	
19	GTO	
20	0	
21	0	
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

(C) Surveying

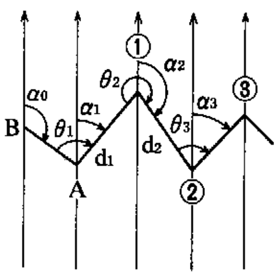
CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
O		3

PROGRAM TITLE	Open traverse	PROGRAM NO.	C-1

FORMULA

This program calculates the coordination $(x, y.)$ at point i from vectorial angles and distance.



α_0 vectorial angle for surveying line B−A

α_1 vectorial angle for surveying line A−①

$$\alpha_1 = \alpha_0 + \theta_1 - 180^\circ$$

α_i vectorial angle for surveying line (i−1)−i

$$\alpha_i = \alpha_{i-1} + \theta_i - 180^\circ$$

$$\left(\begin{array}{l}\text{when } \alpha_i < 0 \\ \alpha_i = \alpha_{i-1} + \theta_i + 180^\circ\end{array}\right)$$

The coordination at point i is obtained by using the coordination at point (i−1)

$x_i = x_{i-1} + d_i \cos \alpha_i$

$y_i = y_{i-1} + d_i \sin \alpha_i$

EXAMPLES

	⟨Input⟩	⟨Output⟩
$\alpha_0 = 81°27'00''$	$\theta_2 = 172°40'40''$	$\alpha_1 = 351.936°$
$= 81.4500°$	$= 172.6778$	$\fallingdotseq 351°56'10''$
$x_0 = 30.000$	$d_2 = 6.970$	$x_1 = 39.146$
$y_0 = 20.000$		$y_1 = 18.704$
$\theta_1 = 90°29'10''$		$\alpha_2 = 172.678$
$= 90.4861°$		$\fallingdotseq 172°40'40''$
$d_1 = 9.237$		$x_2 = 45.866$
		$y_2 = 16.855$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of α_0
4. [R/S]
5. Input of x_0
6. [R/S]
7. Input of y_0
8. [R/S]
9. Input of θ_i
10. [R/S]
    Display of α_i
11. Input of d_i
12. [R/S]
    Display of x_i
13. [R/S]
    Display of y_i
14. Repeat steps 8 through 13

NOTES

1. The operation 14 is for the next operation to get the coordination by using previously obtained data.
2. Start from step 1, to calculate different operation.
3. All angular intputs are in the form degrees.

DATA MEMORY

M0	α_0, α_i
M1	x_0, x_i
M2	y_0, y_i
M3	d_i
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of α_0
1	SM	
2	0	
3	R/S	Input of x_0
4	SM	
5	1	
6	R/S	Input of y_0
7	SM	
8	2	
9	R/S	Input of θ_i or display of y_i
10	+	
11	RM	
12	0	
13	−	
14	1	
15	8	
16	0	
17	=	
18	SKP	
19	GTO	
20	2	
21	7	
22	+	
23	3	
24	6	
25	0	
26	=	
27	SM	
28	0	
29	R/S	Input of d_i or display of α_i
30	SM	
31	3	
32	×	
33	RM	
34	0	
35	COS	
36	=	
37	F +	M+
38	1	
39	RM	
40	1	
41	R/S	Display of x_i
42	RM	
43	0	
44	SIN	
45	×	
46	RM	
47	3	
48	+	
49	RM	
50	2	
51	=	
52	GTO	
53	0	
54	7	
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

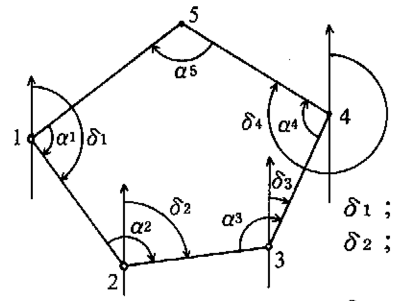
DEG	RAD	DPS
○		4

PROGRAM TITLE	Closed traverse	PROGRAM NO.	C-2

FORMULA

This program calculates the vectorial angle δ_i at point i. The angle is measured clockwise.

$$\delta_i = \delta_{i-1} + \alpha_i - 180°$$



δ_1 ; vectorial angle for surveying line 1 ~ 2

δ_2 ; vectorial angle for surveying line 2 ~ 3

$$\delta_2 = \delta_1 + \alpha_2 - 180°$$

δ_3 ; vectorial angle for surveying line 3 ~ 4

$$\delta_3 = \delta_2 + \alpha_3 - 180°$$

δ_4 ; vectorial angle for surveying line 4 ~ 5

$$\delta_4 = \delta_3 + \alpha_4 - 180°$$

When $\delta_n + \alpha_{n+1}$ is under 180° in each formula, add 180° to each formula.

EXAMPLES

<Input>			<Output>	
δ_1	81° 27′ 00″	81.45°	δ_2 351.9361	351° 56′ 10″
α_2	90° 29′ 10″	90.4861°	δ_3 344.6139	344° 36′ 50″
α_3	172° 40′ 40″	172.6778°	δ_4 262.2695	262° 16′ 10″
α_4	97° 39′ 20″	97.6556°	δ_5 191.8528	191° 51′ 10″
α_5	109° 35′ 00″	109.5833°		

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of δ_1
4. [R/S]
5. Input of α_i
6. [R/S]
   Display of δ_i
7. Repeat steps 4 and 5

NOTES

1. All angular inputs and outputs are in the form degrees.
2. Data in the form D.M.S must be converted to the degrees with the different program

DATA MEMORY

M0	
M1	
M2	
M3	
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of δ_1
1	+	
2	R/S	Input of α_i
3	−	
4	1	
5	8	
6	0	
7	=	
8	SKP	
9	GTO	
10	1	
11	7	
12	+	
13	3	
14	6	
15	0	
16	=	
17	GTO	
18	0	
19	1	
20	R/S	Display of δ_i
21	C	
22	GTO	
23	0	
24	0	
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

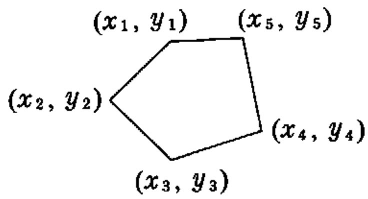
DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Area of polygon	PROGRAM NO.	C-3

FORMULA

This program calculates the area S of polygon which vertexes are given as a set of coordinate $\{(x_i, y_i), i=1, 2 \cdots\cdots n\}$

$$2S = \left| \sum_{i=1}^{n} (x_1 - x_i)(y_{i+1} - y_{i-1}) \right|$$



where $y_{n+1} = y_1$, $y_0 = y_n$

EXAMPLES

<Input>	<Output>
$(x_1, y_1) = (0,0)$	$S = 13.50$
$(x_2, y_2) = (3,0)$	
$(x_3, y_3) = (4,3)$	
$(x_4, y_4) = (2,5)$	
$(x_5, y_5) = (0,2)$	

OPERATION

1. [GTO] [0] [1]
2. [R/S]
3. Input of x_1
4. [R/S]
5. Input of y_1
6. [R/S]
7. Input of x_2
8. [R/S]
9. Input of y_2
10. [R/S]
11. Input of x_3
12. [R/S]
13. Input of y_3
14. [R/S]
15. Repeat steps 11 through 14 after completion of data entry
16. [R/S]
17. [R/S]
18. [SKP]
19. [R/S]
    Display of S

NOTES

DATA MEMORY

M_0	$\sum_{i=1}^{n}(\ )(\ )$
M_1	x_1
M_2	y_1
M_3	y_{i-1}
M_4	$x_1 - x_{i-2}$
M_5	$x_1 - x_{i-1}$
M_6	x_{i-2}
M_7	$x_1 - x_i$
M_8	
M_9	

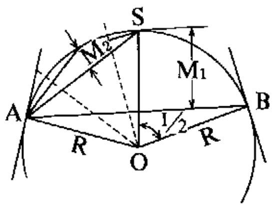
STEP	PROGRAM	NOTE
0	R/S	
1	C	
2	SM	
3	0	
4	SM	
5	4	
6	R/S	Input of x_1
7	SM	
8	1	
9	R/S	Input of y_1
10	SM	
11	2	
12	SM	
13	5	
14	R/S	Input of x_i
15	GTO	
16	2	
17	2	
18	R/S	
19	GTO	
20	5	
21	6	
22	+⇆−	
23	+	
24	RM	
25	1	
26	=	
27	SM	
28	7	
29	RM	
30	2	
31	R/S	Input of y_i
32	SM	
33	6	
34	−	
35	RM	
36	3	
37	×	
38	RM	
39	4	
40	=	
41	F+	M+
42	0	
43	RM	
44	5	
45	SM	
46	3	
47	RM	
48	7	
49	SM	
50	4	
51	RM	
52	6	
53	GTO	
54	1	
55	2	
56	RM	
57	0	
58	÷	
59	2	
60	=	
61	SKP	
62	+⇆−	
63	+⇆−	
64	GTO	
65	0	
66	0	
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		3

PROGRAM TITLE	Simple curve setting by middle ordinates	PROGRAM NO.	C-4

FORMULA



$$M_1 = R\left(1-\cos\frac{I}{2}\right) \doteqdot \frac{C_1^2}{8R}$$

$$M_2 = R\left(1-\cos\frac{I}{4}\right) \doteqdot \frac{C_2^2}{8R}$$

$$M_n = R\left(1-\cos\frac{I}{2^n}\right)$$

where

$C_1 = AB \quad C_2 = AS$

M_1 : middle ordinate of chord AB

M_2 : middle ordinate of chord AS

M_n : middle ordinate of chord AS_n

I : intersection angle between two angles

R : Radius of a circle

EXAMPLES

⟨Input⟩	⟨Output⟩
R = 400m	M_1 = 180.196m
I = 113.33°(113°20′)	M_2 = 47.919m
n = 1~6	M_3 = 12.169m
	M_4 = 3.053m
	M_5 = 0.764m
	M_6 = 0.191m

OPERATION

1. GTO 0 0
2. R/S
3. Input of R
4. R/S
5. Input of I
6. R/S
7. Input of n
8. R/S
9. Display of M_n
10. Repeat steps 3 through 9.

NOTES

○ Angular input I is in the form of degree.

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

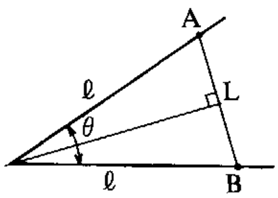
STEP	PROGRAM	NOTE
0	R/S	Input of R or display of M_n
1	×	
2	(5	
3	1	
4	−	
5	(5	
6	R/S	Input of I
7	÷	
8	(5	
9	2	
10	Y^x	
11	R/S	Input of n
12	5)	
13	5)	
14	COS	
15	5)	
16	=	
17	GTO	
18	0	
19	0	
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		2

PROGRAM TITLE	Calculation of the excluded length and area by corner cutting	PROGRAM NO.	C-5

FORMULA



This program calculates the excluded length and area by corner cutting with a corner cutting length and an excluded angle.

$$\ell = \frac{L}{2} \times \operatorname{cosec}\frac{\theta}{2}$$

$$S = \left(\frac{L}{2}\right)^2 \times \cot\frac{\theta}{2}$$

where L : an excluded length
θ : an excluded angle
ℓ : an excluded length by corner cutting
S : an excluded area by corner cutting

EXAMPLES

〈Input〉	〈Output〉
L = 100m	ℓ = 193.19 (m)
θ = 30°	S = 9330.13 (m^2)

OPERATION

1. GTO 0 0
2. Input of L
3. R/S
4. Input of θ
5. R/S
   Display of ℓ
6. R/S
   Display of S

NOTES

DATA MEMORY

M_0	$\frac{L}{2}$, $\left(\frac{L}{2}\right)^2$
M_1	$\frac{\theta}{2}$
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of L or display of S
1	÷	
2	2	
3	=	
4	SM	
5	0	
6	R/S	Input of θ
7	÷	
8	2	
9	=	
10	SM	
11	1	
12	SIN	
13	1/X	
14	×	
15	RM	
16	0	
17	F×	$M^\times$
18	0	
19	=	
20	R/S	Display of ℓ
21	RM	
22	0	
23	÷	
24	RM	
25	1	
26	TAN	
27	=	
28	GTO	
29	0	
30	0	
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		4

PROGRAM TITLE	Calculation of the corner cutting of the chord and circle (Inside the circle)	PROGRAM NO.	C-6

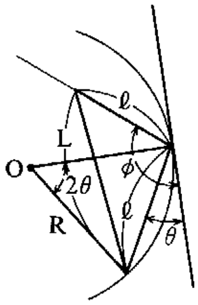
FORMULA

L ; corner cutting length

ℓ ; an excluded length by corner cutting

R ; Radius of a circle

ϕ ; intersection angle between a tangent and a chord



$$\ell = 2R \sin\theta$$

$$\theta = 2\sin^{-1}\frac{\tan\frac{\phi}{2} \pm \sqrt{\tan^2\frac{\phi}{2} - M\sec\frac{\phi}{2}}}{2}$$

where $M = \frac{L}{2R}$

EXAMPLES

〈Input〉	〈Output〉
R = 650 (m)	θ_1 = 108.9739°
L = 10 (m)	ℓ_1 = 1229.3665 (m)
ϕ = 78.5°	θ_2 = 0.3496°
	ℓ_2 = 7.9322 (m)

OPERATION

1. GTO 0 0
2. R/S
3. Input of L
4. R/S
5. Input of R
6. R/S
7. Input of ϕ
8. R/S
   Display of θ_1
9. R/S
   Display of ℓ_1
10. R/S
    Display of θ_2
11. R/S
    Display of ℓ_2
12. SKP
13. R/S
14. Repeat steps 3 through 13

NOTES

DATA MEMORY

M_0	2·R
M_1	$\phi/2$
M_2	$\tan\frac{\phi}{2}$
M_3	$\sqrt{\tan^2\frac{\phi}{2} - M\sec\frac{\phi}{2}}$
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of L
1	÷	
2	(	
3	2	
4	×	
5	R/S	Input of R
6	)	
7	SM	
8	0	
9	÷	
10	(	
11	R/S	Input of ϕ
12	÷	
13	2	
14	)	
15	SM	
16	1	
17	COS	
18	=	
19	+⇆−	
20	+	
21	RM	
22	1	
23	TAN	
24	SM	
25	2	
26	F√X	X^2
27	=	
28	√X	
29	SM	
30	3	
31	+	
32	RM	
33	2	
34	÷	
35	2	
36	×	
37	F SIN	SIN^{-1}
38	2	
39	=	
40	R/S	Display of θ_1 or θ_2
41	SIN	
42	×	
43	RM	
44	0	
45	=	
46	R/S	Display of ℓ_1 or ℓ_2
47	RM	
48	3	
49	+⇆−	
50	GTO	
51	3	
52	1	
53	R/S	
54	GTO	
55	0	
56	0	
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		4

PROGRAM TITLE	Stadia survey	PROGRAM NO.	C-7

FORMULA

This program calculates the horizontal distance and vertical distance between survey station and observed point.

The length of leveling rod (rod intercept) is measured in between stadia hairs and vertical angle.

Stadia constant is given as follows.

$$K = 100$$
$$C = 0$$

horizontal distance $D = KS\cos^2\alpha + C\cos\alpha = 100S\cos^2\alpha$

vertical distance $H = KS\cos\alpha\cdot\sin\alpha + C\sin\alpha$

$= 100S\cos\alpha\cdot\sin\alpha.$

Provided α = vertical angle

S = rod intercept

EXAMPLES

⟨Input⟩	⟨Output⟩
$\alpha = 41°26'$	$D = 485.7576$
$S = 8.642$	$H = 428.7555$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of $\alpha°$
4. [R/S]
5. Input of α'
6. [R/S]
7. Input of S
8. [R/S]

   Display of D
9. [R/S]

   Display of H
10. Repeat steps 3 through 9.

NOTES

1. Input angles are in the form of degrees and minutes.

DATA MEMORY

M0	α
M1	$100S\cdot\cos\alpha$
M2	
M3	
M4	
M5	
M6	
M7	
M8	
M9	

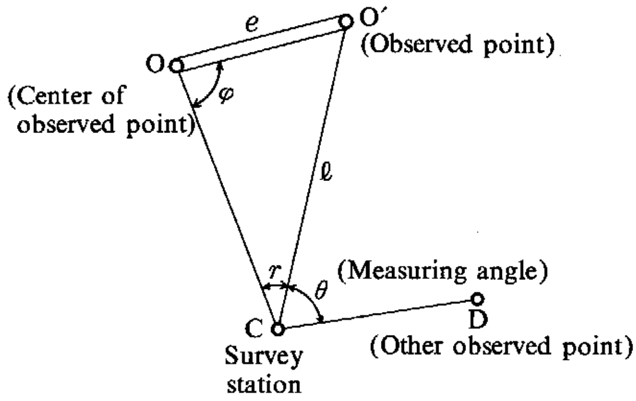
STEP	PROGRAM	NOTE
0	R/S	Input of $\alpha°$ or display of H
1	+	
2	(5	
3	R/S	Input of α
4	÷	
5	6	
6	0	
7	=	
8	SM	
9	0	
10	COS	
11	×	
12	R/S	Input of S
13	×	
14	1	
15	0	
16	0	
17	×	
18	SM	
19	1	
20	RM	
21	0	
22	COS	
23	=	
24	R/S	Display of D
25	RM	
26	0	
27	SIN	
28	×	
29	RM	
30	1	
31	=	
32	GTO	
33	0	
34	0	
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
O		5

PROGRAM TITLE	Reduction to center (Eccentric observed point)	PROGRAM NO.	C-8

FORMULA



$$\frac{\sin r}{e} = \frac{\sin \varphi}{\ell}$$

$$r = \sin^{-1}\frac{e}{\ell}\sin\varphi$$

e : eccentric distance (from O to O′)

φ: eccentric angle measured from center

ℓ : distance between survey station and observed point.

CO = CO′

EXAMPLES

〈Input〉	〈Output〉
e = 0.10 (m)	r = 0.00143°
ℓ = 2000 (m)	
φ = 150°	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of e
4. [R/S]
5. Input of ℓ
6. [R/S]
7. Input of φ
8. [R/S]
   Display of r
9. Repeat steps 3 through 8.

NOTES

DATA MEMORY

M0	
M1	
M2	
M3	
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of e or display of r
1	÷	
2	R/S	Input of ℓ
3	×	
4	R/S	Input of φ
5	SIN	
6	=	
7	F SIN	SIN^{-1}
8	GTO	
9	0	
10	0	
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

(D) Electrical engineering

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

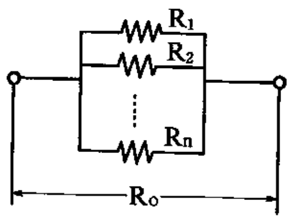
PROGRAM TITLE	C, R Circuit	PROGRAM NO.	D-1

FORMULA

- For parallel resistors

  Total Resistance

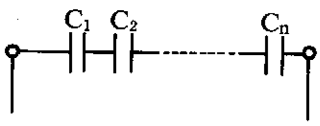
$$R_o = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots\cdots + \frac{1}{R_n}}$$



- For series capacitors

  Total capacitor

$$C_o = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \cdots\cdots + \frac{1}{C_n}}$$



EXAMPLES

⟨Input⟩	⟨Output⟩
$R_1 = 10$	$R_o = 5.45$
$R_2 = 20$	
$R_3 = 30$	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of R or C
4. [R/S]
5. Repeat steps 3 and 4.
6. [SKP]
7. [R/S]

   Display of R_o or C_o

NOTES

1. The intermediate result can be obtained during the operation 5 by doing operation 6 and 7 and can be go back to 5.
2. For the other problems, start from 1.

DATA MEMORY

M_0	$\frac{1}{R_0}$ or $\frac{1}{C_0}$
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	C	
1	SM	
2	0	
3	R/S	{ Input of R or C,
4	1/X	display of R_0 or C_0, [SKP]
5	F+	M+
6	0	
7	GTO	
8	0	
9	3	
10	R/S	
11	RM	
12	0	
13	1/X	
14	GTO	
15	0	
16	3	
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
O		6

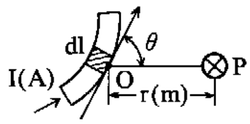
PROGRAM TITLE	Biot-savart's law	PROGRAM NO.	D-2

FORMULA

This program calculates the intensity of magnetic field δH at point P which is r(m) far from point O.

δH is generated when the current I(A) flows through the small part dl (m) of conductor at point O.

$$\delta H = \frac{I \cdot dl}{4\pi r^2} \sin\theta \,(AT/m)$$



where θ is the angle between the tangent of dl and the line O·P

EXAMPLES

<Input>	<Output>
I = 7 (A)	$\delta H = 0.007878$
dl = 0.005 (m)	
r = 0. 5 (m)	
$\theta = 45°$	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of θ
4. [R/S]
5. Input of I
6. [R/S]
7. Input of dl.
8. [R/S]
9. Input of r
   Display of δH
10. Repeat steps 3 through 9.

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of θ or display of δH
1	SIN	
2	×	
3	R/S	Input of I
4	×	
5	R/S	Input of $d\ell$
6	÷	
7	R/S	Input of r
8	F√X	X^2
9	÷	
10	4	
11	÷	
12	π	
13	=	
14	GTO	
15	0	
16	0	
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

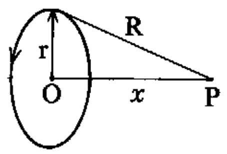
DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Intensity of magnetic flux at the center axis for circular coil	PROGRAM NO.	D-3

FORMULA

Intensity of magnetic field H is calculated with the following formula.

$$H = \frac{N I r^2}{2(r^2 + x^2)^{\frac{3}{2}}} \quad (AT/m)$$



where H : intensity of magnetic field at P

I : current

N : number of turns

x : distance between point O and P

r : radius

EXAMPLES

〈Input〉

r = 0.5

x = 1.0

N = 100

I = 10

〈Output〉

H = 89.443

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of r
4. [R/S]
5. Input of x
6. [R/S]
7. Input of N
8. [R/S]
9. Input of I
10. [R/S]

Display of H

NOTES

DATA MEMORY

M_0	r^2
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of r or display of H
1	F√X	X^2
2	SM	
3	0	
4	+	
5	R/S	Input of x
6	F√X	X^2
7	Y^x	
8	1	
9	•	
10	5	
11	×	
12	2	
13	÷	
14	[5	
15	R/S	Input of N
16	×	
17	R/S	Input of I
18	×	
19	RM	
20	0	
21	5]	
22	X⇄Y	
23	=	
24	GTO	
25	0	
26	0	
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	LRC series resonant circuit	PROGRAM NO.	D-4

FORMULA

The resonant frequency f_0, frequency band width B and circuit Q for a LRC series resonant circuit is calculated with the following formulas;

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_1 = \frac{1}{4\pi}\left[-\frac{R}{L} + \sqrt{(\frac{R}{L})^2 + 4\omega_0^2}\right]$$

$$f_2 = \frac{1}{4\pi}\left[\frac{R}{L} + \sqrt{(\frac{R}{L})^2 + 4\omega_0^2}\right]$$

$$B = f_2 - f_1$$

$$Q = \frac{f_0}{f_2 - f_1} \quad \text{where} \quad \omega_0 = 2\pi f_0$$

EXAMPLES

<Input>	<Output>
$L = 2mH = 2\times10^{-3}H$	$f_0 = 159154.94Hz$
$C = 500pF = 5\times10^{-10}F$	$B = 7957.7467Hz$
$R = 100\Omega$	$Q = 20.0000$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of L
4. [R/S]
5. Input of C
6. [R/S]
   Display of f_0
7. Input of R
8. [R/S]
9. [R/S]
10. [R/S]
11. [SKP]
12. [R/S]
    Display of B
13. [SKP]
14. [R/S]
    Display of Q

NOTES

DATA MEMORY

M_0	L
M_1	f_0
M_2	R/L
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of L or display of Q
1	SM	
2	0	
3	×	
4	R/S	Input of C
5	=	
6	√X	
7	×	
8	2	
9	×	
10	π	
11	=	
12	1/X	
13	SM	
14	1	
15	(5	
16	R/S	Input of R or [SKP]
17	÷	
18	RM	
19	0	
20	=	
21	SM	
22	2	
23	+	
24	R/S	R/S
25	(5	
26	(5	
27	2	
28	×	
29	π	
30	×	
31	RM	
32	1	
33	+	
34	F√X	X^2
35	×	
36	4	
37	5)	
38	+	
39	(5	
40	RM	
41	2	
42	F√X	X^2
43	5)	
44	5)	
45	√X	
46	÷	
47	4	
48	÷	
49	π	
50	5)	
51	−	
52	R/S	[R/S] or [SKP]
53	(5	
54	RM	
55	2	
56	+⇆−	
57	+	
58	GTO	
59	1	
60	6	
61	R/S	[R/S]
62	÷	
63	RM	
64	1	
65	X⇆Y	
66	=	
67	GTO	
68	0	
69	0	
70		
71		

CZ-0911PG PROGRAM LIBRARY

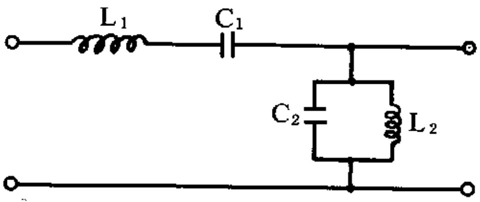
DEG	RAD	DPS
Arbitrary		8

PROGRAM TITLE	Circuit design for constant K band pass filter	PROGRAM NO.	D-5

FORMULA

This program determines L_1, C_1 and L_2, C_2 for the constant K filter circuit shown below. The frequency band width B, center frequency f_0 and nominal impedance K are given.

$$L_1 = \frac{K}{2\pi B},\ C_1 = \frac{2\pi B}{K\omega_0^2},\ L_2 = \frac{2\pi KB}{\omega_0^2},\ C_2 = \frac{1}{2\pi KB}$$



where $\omega_0 = 2\pi f_0$

EXAMPLES

⟨Input⟩	⟨Output⟩
$f_0 = 50000$ (Hz)	$L_1 = 6.3661977 \times 10^{-3}$ (H)
$B = 15000$ (Hz)	$C_1 = 1.5915494 \times 10^{-9}$ (F)
$K = 600$ (Ω)	$L_2 = 5.7295780 \times 10^{-4}$ (H)
	$C_2 = 1.7683883 \times 10^{-8}$ (F)

OPERATION

R

1. [GTO] [0] [0]
2. [R/S]
3. Input of f_0
4. [R/S]
5. Input of B
6. [R/S]
7. Input of K
8. [R/S]
   Display of L_1
9. [R/S]
   Display of C_1
10. [R/S]
    Display of L_2
11. [R/S]
    Display of C_2

NOTES

DATA MEMORY

M_0	K
M_1	$2\pi B$
M_2	ω_0^2
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of f_0
1	×	
2	2	
3	×	
4	π	
5	=	
6	F√X	X^2
7	SM	
8	2	
9	R/S	Input of B
10	×	
11	2	
12	×	
13	π	
14	=	
15	SM	
16	1	
17	÷	
18	R/S	Input of K
19	SM	
20	0	
21	X⇆Y	
22	=	
23	R/S	Display of L_1
24	RM	
25	1	
26	÷	
27	RM	
28	0	
29	÷	
30	RM	
31	2	
32	=	
33	R/S	Display of C_1
34	RM	
35	1	
36	×	
37	RM	
38	0	
39	÷	
40	RM	
41	2	
42	=	
43	R/S	Display of L_2
44	RM	
45	1	
46	×	
47	RM	
48	0	
49	=	
50	1/X	
51	R/S	Display of C_2
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

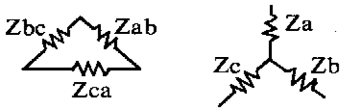
DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Δ↔Y Conversion	PROGRAM NO.	D-6

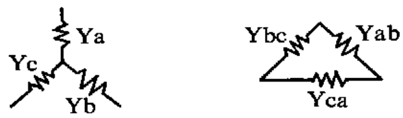
FORMULA

This program calculates impedances for Y-connection converted from Δ-connection and admittances for Δ-connection converted from Y.

Δ→Yconversion



Y→Δ conversion



$$Za = \frac{Zab \cdot Zca}{Zab + Zbc + Zca}$$

$$Zb = \frac{Zbc \cdot Zab}{Zab + Zbc + Zca}$$

$$Zc = \frac{Zbc \cdot Zca}{Zab + Zbc + Zca}$$

$$Yab = \frac{Ya \cdot Yb}{Ya + Yb + Yc}$$

$$Ybc = \frac{Yb \cdot Yc}{Ya + Yb + Yc}$$

$$Yca = \frac{Yc \cdot Ya}{Ya + Yb + Yc}$$

where Z : impedance
Y : admittance

EXAMPLES

	⟨Input⟩	⟨Output⟩
Δ→Y	Zab=100Ω	Za=44.44Ω
	Zbc=150Ω	Zb=33.33Ω
	Zca=200Ω	Zc=66.67Ω
Y→Δ	Ya=10℧	Yab=5.00℧
	Yb=20℧	Ybc=3.33℧
	Yc=30℧	Yca=10.00℧

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of Zab or Ya
4. [R/S]
5. Input of Zbc or Yb
6. [R/S]
7. Input of Zca or Yc
8. [R/S]
   Display of Za or Yca
9. [R/S]
   Display of Zb or Yab
10. [R/S]
    Display of Zc or Ybc
11. Repeat steps 3 through 10

NOTES

DATA MEMORY

M0	Zab or Ya
M1	Zbc or Yb
M2	Zca or Yc
M3	Zab+Zbc+Zca or Ya+Yb+Yc
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of Zab or Ya
1	SM	Display of Zc or Ybc
2	0	
3	+	
4	R/S	Input of Zbc or Yb
5	SM	
6	1	
7	+	
8	R/S	Input of Zca or Yc
9	SM	
10	2	
11	=	
12	SM	
13	3	
14	RM	
15	0	
16	×	
17	RM	
18	2	
19	÷	
20	RM	
21	3	
22	=	
23	R/S	Display of Zbc or Yca
24	RM	
25	0	
26	×	
27	RM	
28	1	
29	÷	
30	RM	
31	3	
32	=	
33	R/S	Display of Zba or Yab
34	RM	
35	1	
36	×	
37	RM	
38	2	
39	÷	
40	RM	
41	3	
42	GTO	
43	0	
44	0	
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

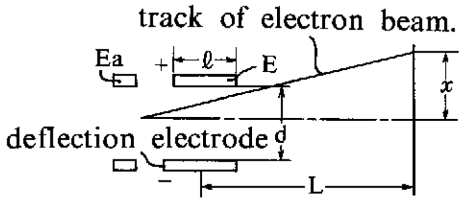
PROGRAM TITLE	Electrostatic deflection for cathode ray tube.	PROGRAM NO.	D-7

FORMULA

This program is applicable for electrostatic deflection. The sensitivity of electrostatic deflection Se and the deflection distance x is calculated as follows.

$$Se = \frac{L \cdot \ell}{2d \cdot Ea} \text{ (cm/V)}$$

$$x = \frac{E \cdot L \cdot \ell}{2d \cdot Ea} = SeE \text{ (cm)}$$



where:
- L : distance between the center of deflecting plate and fluorescence screen (cm)
- ℓ : length of deflecting plate (cm)
- d : gap between deflecting plate
- Ea : second anode voltage (accelarating voltage) (V)
- E : deflecting plate voltage (V)

EXAMPLES

⟨Input⟩	⟨Output⟩
L = 20cm	Se = 0.0067 (cm/V)
ℓ = 2cm	x = 8.0000 (cm)
d = 1cm	
Ea = 3000V	
E = 1200V	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of L
4. [R/S]
5. Input of ℓ
6. [R/S]
7. Input of d
8. [R/S]
9. Input of Ea
10. [R/S]
    Display of Se
11. Input of E
12. [R/S]
    Display of x
13. Repeat steps 3 through 12.

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of L or display of x
1	×	
2	R/S	Input of ℓ
3	÷	
4	2	
5	÷	
6	R/S	Input of d
7	÷	
8	R/S	Input of Ea
9	×	Calculation of Se
10	R/S	Input of E or display of Se
11	=	Calculation of x
12	GTO	
13	0	
14	0	
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		3

PROGRAM TITLE	Intensity of illumination (Point source of light)	PROGRAM NO.	D-8

FORMULA

Normal illumination $E_n = \frac{I}{R^2}\ (\ell x)$

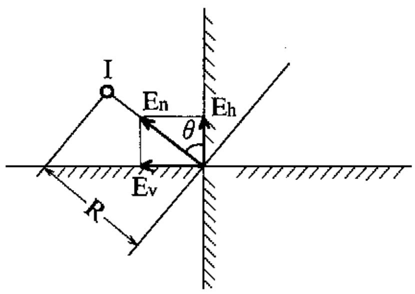
Horizontal illumination $E_h = E_n \cos\theta = \frac{I}{R^2}\cos\theta\ (\ell x)$

Vertical illumination $E_v = E_n \cos(90° - \theta) = E_n \sin\theta = \frac{I}{R^2}\sin\theta\ (\ell x)$

where i : luminous intensity of point source of light (cd)
R : distance from point source of light (m)
θ : angle of incidence

EXAMPLES

<Input>	<Output>
I = 100 (cd)	E_n = 25.000 (ℓx)
R = 2 (m)	E_h = 21.651 (ℓx)
θ = 30°	E_v = 12.500 (ℓx)



OPERATION

1. GTO 0 0
2. R/S
3. Input of I
4. R/S
5. Input of R
6. R/S
   Display of E_n
7. Input of θ
8. R/S
   Display of E_h
9. R/S
   Display of E_v
10. Repeat steps 3 through 9.

NOTES

DATA MEMORY

M_0	I/R^2
M_1	θ
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of I or display of Ev
1	÷	
2	R/S	Input of R
3	F $\sqrt{X}$	X^2
4	=	
5	SM	
6	0	
7	×	
8	R/S	Input of θ or display of En
9	SM	
10	1	
11	COS	
12	=	
13	R/S	Display of Eh
14	RM	
15	0	
16	×	
17	RM	
18	1	
19	SIN	
20	=	
21	GTO	
22	0	
23	0	
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

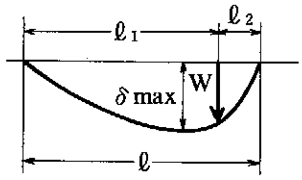
(E) Architecture

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE		PROGRAM NO.
	Maximum flexure of beam (Both end fixed)	E-1

FORMULA



$$\delta \max = \frac{W \cdot \ell_2 \cdot \sqrt{(\ell^2 - \ell_2^2)^3}}{9 \cdot \sqrt{3} \cdot E \cdot I \cdot \ell}$$

(※ $\ell_1 > \ell_2$)

where W : load

ℓ, ℓ_1, ℓ_2 : distance

E : modulus of longitudinal elasticity

I : geometrical moment of inertia

EXAMPLES

〈Input〉

$E = 2.1 \times 10^6$ (kg/mm²) $\ell = 1 \times 10^3$ (mm)

$I = 1.5 \times 10^4$ (mm⁴) $\ell_2 = 2 \times 10^2$ (mm)

$W = 2.5 \times 10^2$ (kg)

〈Output〉

$\delta \max = 0.0958$ (mm)

OPERATION

1. GTO 0 0
2. R/S
3. Input of E
4. R/S
5. Input of I
6. R/S
7. Input of W
8. R/S
9. Input of ℓ
10. R/S
11. Input of ℓ_2
12. R/S
    Display of δmax
13. Repeat steps 6 through 12.

NOTES

1. Before the operation, store E and I into memory M_0 and M_1 respectively.
2. At repeat calculation, if E and I are equal to the former E and I, go to operation 13.
3. At repeat calculation, if E or I is not equal to the former E or I, start from operation 1.

DATA MEMORY

M_0	E
M_1	I
M_2	ℓ
M_3	ℓ_2
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of E
1	SM	
2	0	
3	R/S	Input of I
4	SM	
5	1	
6	R/S	Input of W or display of δmax
7	×	
8	(5	
9	R/S	Input of ℓ
10	SM	
11	2	
12	F$\sqrt{X}$	X²
13	−	
14	R/S	Input of ℓ_2
15	SM	
16	3	
17	F$\sqrt{X}$	X²
18	Yˣ	
19	3	
20	5)	
21	$\sqrt{X}$	
22	×	
23	RM	
24	3	
25	÷	
26	9	
27	÷	
28	3	
29	$\sqrt{X}$	
30	÷	
31	RM	
32	0	
33	÷	
34	RM	
35	1	
36	÷	
37	RM	
38	2	
39	=	
40	GTO	
41	0	
42	6	
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM · LIBRARY

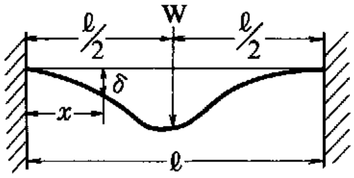
DEG	RAD	DPS
Arbitrary		2

PROGRAM TITLE	PROGRAM NO.
Flexure of fixed beam **(Rectangular section)**	**E-2**

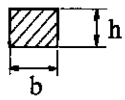
FORMULA

This program is for computing the flexure of fixed beam which has rectangular section.

Flexure at distance x $\quad \delta = \dfrac{W}{4Ebh^3}(3\ell x^2 - 4x^3)$



where
W : load
E : modulus of longitudinal elasticity
ℓ, h, b : distance
x : distance



EXAMPLES

〈Input〉		〈Output〉
W = 130	(kg)	δ = 2.86 −03
E = 21,000	(kg/mm^2)	
b = 10	(mm)	
h = 20	(mm)	
ℓ = 150	(mm)	
x = 20	(mm)	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of ℓ
4. [R/S]
5. Input of x
6. [R/S]
7. Input of h
8. [R/S]
9. Input of W
10. [R/S]
11. Input of E
12. [R/S]
13. Input of b
    Display of δ
14. Repeat steps 3 through 13.

NOTES

DATA MEMORY

M0	x
M1	$3\ell x^2$
M2	$4x^3$
M3	h^3
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of ℓ or display of δ
1	×	
2	3	
3	×	
4	R/S	Input of x
5	SM	
6	0	
7	F√X	X²
8	=	
9	SM	
10	1	
11	RM	
12	0	
13	Yˣ	
14	3	
15	×	
16	4	
17	=	
18	SM	
19	2	
20	R/S	Input of h
21	Yˣ	
22	3	
23	=	
24	SM	
25	3	
26	R/S	Input of W
27	÷	
28	(5	
29	4	
30	×	
31	R/S	Input of E
32	×	
33	R/S	Input of b
34	×	
35	RM	
36	3	
37	5)	
38	×	
39	(5	
40	RM	
41	1	
42	−	
43	RM	
44	2	
45	5)	
46	=	
47	GTO	
48	0	
49	0	
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

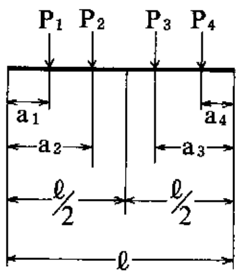
DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Flexure of Grain Garter	PROGRAM NO.	E-3

FORMULA

This program calculates the flexure of the beam which has four loads P_1, P_2, P_3 and P_4 at corresponding points a_1, a_2, a_3 and a_4.

$$\sigma = \frac{P_1 a_1}{12EJ}\left(\frac{3}{4}\ell^2 - a_1^2\right) + \frac{P_2 a_2}{12EJ}\left(\frac{3}{4}\ell^2 - a_2^2\right) + \frac{P_3 a_3}{12EJ}\left(\frac{3}{4}\ell^2 - a_3^2\right) + \frac{P_4 a_4}{12EJ}\left(\frac{3}{4}\ell^2 - a_4^2\right)$$



where J : geometrical moment of inertia

ℓ : length of beam

E : 2.1×10^3 t/cm²

EXAMPLES

〈Input〉

$J = 1530000$ (cm⁴)

$\ell = 3000$ (cm)

$(P_1, a_1) = (7.9, 670)$
$(P_2, a_2) = (8.2, 960)$
$(P_3, a_3) = (14.8, 850)$
$(P_4, a_4) = (18.5, 430)$ (t/cm², cm)

〈Output〉

$\sigma = 5.3762$

OPERATION

1. GTO 0 0
2. R/S
3. Input of J
4. R/S
5. Input of ℓ
6. R/S
7. Input of P
8. R/S
9. Input of a
10. R/S
11. Repeat steps 7 through 10 three times, then σ is displayed.

NOTES

DATA MEMORY

M0	counter
M1	12EJ
M2	$\frac{3}{4}\ell^2$
M3	a
M4	σ
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of J or display of σ
1	×	
2	2	
3	•	
4	1	
5	EXP	
6	3	
7	×	
8	1	
9	2	
10	=	
11	SM	
12	1	
13	3	
14	×	
15	R/S	Input of ℓ
16	F√X	X²
17	÷	
18	4	
19	=	
20	SM	
21	2	
22	C	
23	SM	
24	4	
25	4	
26	+⇄−	
27	SM	
28	0	
29	R/S	Input of P
30	×	
31	R/S	Input of a
32	SM	
33	3	
34	÷	
35	RM	
36	1	
37	×	
38	[(	
39	RM	
40	2	
41	−	
42	RM	
43	3	
44	F√X	X²
45	)]	
46	=	
47	F+	M⁺
48	4	
49	1	
50	F+	M⁺
51	0	
52	RM	
53	0	
54	SKP	
55	GTO	
56	6	
57	1	
58	GTO	
59	2	
60	9	
61	RM	
62	4	
63	GTO	
64	0	
65	0	
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	. 4

PROGRAM TITLE	Planning of slab (Cantileve beam)	PROGRAM NO.	E-4

FORMULA

Calculation of bending moment (M), demanded quantity of reinforcement (at), space of reinforcement ($9\phi, 9\phi \cdot 13\phi, 13\phi$) and burden (Q) in the process of slab calculation.

$$M = P \cdot \ell + W \cdot \ell \cdot \frac{\ell}{2} \text{(kg-m)}$$

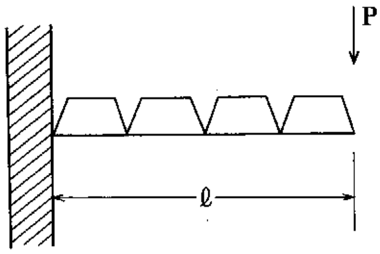
$$Q = W \cdot \ell + P \text{(kg)}$$

$$at = \frac{100M}{1.4 \times d} (\text{cm}^2)$$

$$9\phi = \frac{64}{at} \text{(cm)}$$

$$9\phi \cdot 13\phi = \frac{98.5}{at} \text{(cm)}$$

$$13\phi = \frac{133}{at} \text{(cm)}$$



EXAMPLES

⟨Input⟩	⟨Output⟩
$\ell = 1.3$	M = 0.4914
W = 0.52	Q = 0.7160
P = 0.04	at = 2.1938
d = 16	9ϕ = 29.1738
	$9\phi \cdot 13\phi$ = 44.9003
	13ϕ = 60.6268

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of W
4. [R/S]
5. Input of ℓ
6. [R/S]
7. Input of P
8. [R/S]
   Display of Q
9. [R/S]
   Display of M
10. [R/S]
11. Input of d
12. [R/S]
    Display of at
13. [R/S]
    Display of 9ϕ
14. [R/S]
    Display of $9\phi \cdot 13\phi$
15. [R/S]
    Display of 13ϕ
16. Repeat steps 3 through 15.

NOTES

DATA MEMORY

M_0	W
M_1	ℓ
M_2	P
M_3	at
M_4	$W \cdot \ell$
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of W or display of 13ϕ
1	SM	
2	0	
3	×	
4	R/S	Input of ℓ
5	SM	
6	1	
7	+	
8	SM	
9	4	
10	R/S	Input of P
11	SM	
12	2	
13	=	
14	R/S	Display of Q
15	RM	
16	1	
17	÷	
18	2	
19	×	
20	RM	
21	4	
22	+	
23	(5	
24	RM	
25	1	
26	×	
27	RM	
28	2	
29	=	
30	R/S	Display of M
31	×	
32	EXP	
33	2	
34	÷	
35	(5	
36	1	
37	•	
38	4	
39	×	
40	R/S	Input of d
41	=	
42	R/S	Display of at
43	SM	
44	3	
45	6	
46	4	
47	÷	
48	RM	
49	3	
50	=	
51	R/S	Display of 9ϕ
52	9	
53	8	
54	•	
55	5	
56	÷	
57	RM	
58	3	
59	=	
60	R/S	Display of $9\phi \cdot 13\phi$
61	1	
62	3	
63	3	
64	÷	
65	RM	
66	3	
67	−	
68	GTO	
69	0	
70	0	
71		

(F) Civil engineering

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Rectangular orifice	PROGRAM NO.	F-1

FORMULA

This program calculates the flux at rectangle orifice.

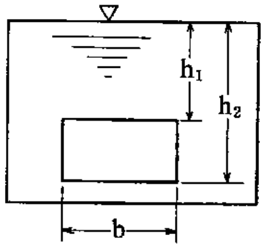
When approaching velocity is not at orifice.

$$Q=\frac{2}{3}C\cdot b\sqrt{2g}\,(h_2^{\frac{3}{2}}-h_1^{\frac{3}{2}})$$

when

$C = 0.62$

$$Q = 1.83\,b\,(h_2^{\frac{3}{2}}-h_1^{\frac{3}{2}})$$



EXAMPLES

⟨Input⟩	⟨Output⟩
$h_2 = 1.5$	$Q = 1.0005$
$h_1 = 1.1$	
$b = 0.8$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of h_2
4. R/S
5. Input of h_1
6. R/S
7. Input of b
8. R/S

   Display of Q

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of h_2 or display of Q
1	Y^x	
2	1	
3	•	
4	5	
5	=	
6	−	
7	(5	
8	R/S	Input of h_1
9	Y^x	
10	1	
11	•	
12	5	
13	5)	
14	=	
15	×	
16	R/S	Input of b
17	×	
18	1	
19	•	
20	8	
21	3	
22	=	
23	GTO	
24	0	
25	0	
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

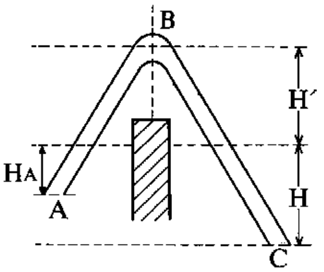
PROGRAM TITLE	Siphon (Flow rate, quantity of flow)	PROGRAM NO.	F-2

FORMULA

In tube flow rate

$$V=\sqrt{\frac{2gH}{1+f_e+f_b+\lambda\frac{\ell_1+\ell_2}{D}}}$$

max. quantity of flow $Q=\frac{\pi D^2}{4}V$



where

f_e, f_b : loss coefficient

λ : resistive coefficient

D : inner diameter of tube

ℓ_1: distance between A and B

ℓ_2: distance between B and C

EXAMPLES

〈Input〉		〈Output〉
$\ell_1 = 5$	$f_b = 0.4$	V = 6.6058 (m/s)
$\ell_2 = 10$	$f_e = 0.5$	Q = 1.2970 (m^3/s)
D = 0.5	H = 6	
λ = 0.0265	g = 9.8	

OPERATION

1. GTO 0 0
2. R/S
3. Input of f_e
4. R/S
5. Input of f_b
6. R/S
7. Input of ℓ_1
8. R/S
9. Input of ℓ_2
10. R/S
11. Input of D
12. R/S
13. Input of λ
14. R/S
15. Input of g
16. R/S
17. Input of H
18. R/S
    Display of V
19. R/S
    Display of Q
20. Repeat steps 3 through 19.

NOTES

DATA MEMORY

M_0	D
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of f_e or display of Q
1	+	
2	R/S	Input of f_b
3	+	
4	1	
5	+	
6	(5	
7	R/S	Input of ℓ_1
8	÷	
9	R/S	Input of ℓ_2
10	÷	
11	R/S	Input of D
12	SM	
13	0	
14	×	
15	R/S	Input of λ
16	5)	
17	÷	
18	(5	
19	2	
20	×	
21	R/S	Input of g
22	×	
23	R/S	Input of H
24	5)	
25	X⇆Y	
26	=	
27	√X	
28	R/S	Display of V
29	×	
30	π	
31	×	
32	RM	
33	0	
34	F√X	X^2
35	=	
36	÷	
37	4	
38	=	
39	GTO	
40	0	
41	0	
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

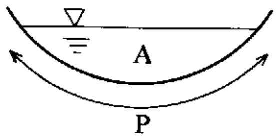
PROGRAM TITLE	Velocity formula	PROGRAM NO.	F-3

FORMULA

$$V = \frac{N \cdot R}{\sqrt{R} + D}$$

$$N = \left(23 + \frac{1}{n} + \frac{0.00155}{I}\right) \cdot \sqrt{I}$$

$$D = \left(23 + \frac{0.00155}{I}\right) \cdot n$$



$R = \frac{A}{P}$; hydraulic mean depth

A ; sectional area

P ; wetted perimeter

I ; surface slope

n ; coefficient of roughness

EXAMPLES

〈Input〉	〈Output〉
A = 38	V = 1.68513
P = 10	
I = 0.001	
n = 0.05	

OPERATION

1. GTO 0 0
2. R/S
3. Input of A
4. R/S
5. Input of P
6. R/S
7. Input of I
8. R/S
9. Input of n
10. R/S
    Display of V
11. Repeat steps 3 through 10.

NOTES

DATA MEMORY

M_0	R
M_1	I
M_2	$23 + \frac{0.001555}{I}$
M_3	n
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of A or display of V
1	÷	
2	R/S	Input of P
3	×	
4	SM	
5	0	
6	(	
7	R/S	Input of I
8	SM	
9	1	
10	√X	
11	×	
12	(	
13	•	
14	0	
15	0	
16	1	
17	5	
18	5	
19	÷	
20	RM	
21	1	
22	+	
23	2	
24	3	
25	+	
26	SM	
27	2	
28	R/S	Input of n
29	SM	
30	3	
31	1/X	
32	)	
33	)	
34	÷	
35	(	
36	RM	
37	2	
38	×	
39	RM	
40	3	
41	+	Calculation of D
42	RM	
43	0	
44	√X	
45	)	
46	=	Calculation of V
47	GTO	
48	0	
49	0	
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

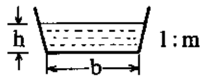
CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Mean quantity of flow/flow rate (Manning's formula)	PROGRAM NO.	F-4

FORMULA

This program calculates the mean quantity of flow and the flow velocity for open channel. The following manning's formula is used for this program.



mean quantity of flow Q ; $Q = A \cdot V$

flow velocity V ; $V = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}}$

sectional area of channel A ; $A = bh + mh^2$

wetted perimeter S ; $S = b + 2h\sqrt{1+m^2}$

hydraulic mean depth R ; $R = \frac{A}{S}$

where; n : roughness factor b : bottom width
m : normal gradient h : hydraulic depth
I : bottom gradient

EXAMPLES

<Input>	<Output>
m = 1.20	V = 1.563
h = 1.50	Q = 11.256
b = 3.00	
n = 0.015	
I = 0.0006	

OPERATION

1. GTO 0 0
2. R/S
3. Input of m
4. R/S
5. Input of h
6. R/S
7. Input of b
8. R/S
9. Input of n
10. R/S
11. Input of I
12. R/S
    Display of V
13. R/S
    Display of Q
14. Repeat steps 3 through 13

NOTES

1. Operation 14 is for the next problem.
2. To get A, S and R, user must recall M_0, M_1 and M_2 respectively aftar result of Q

DATA MEMORY

M_0	A
M_1	S
M_2	h or R
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of m or display of Q
1	SM	
2	0	
3	F√X	X²
4	+	
5	1	
6	=	
7	√X	
8	×	
9	2	
10	=	
11	SM	
12	1	
13	R/S	Input of h
14	SM	
15	2	
16	F×	M×
17	1	
18	F√X	X²
19	F×	M×
20	0	
21	RM	
22	2	
23	×	
24	R/S	Input of b
25	F+	M+
26	1	
27	=	
28	F+	M+
29	0	
30	RM	
31	0	
32	÷	
33	RM	
34	1	
35	=	
36	SM	
37	2	
38	Yˣ	
39	(	
40	2	
41	÷	
42	3	
43	)	
44	÷	
45	R/S	Input of n
46	×	
47	R/S	Input of I
48	√X	
49	=	
50	R/S	Display of V
51	×	
52	RM	
53	0	
54	=	
55	GTO	
56	0	
57	0	
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
O		5

PROGRAM TITLE	Calculating of stability of upright earth slope	PROGRAM NO.	F-5

FORMULA

This program calculates the critical height of upright earth slope when it has slide rupture.

Critical height Hc is given with the Coulomb's equation

$$H_c = \frac{4C}{r} \tan\left(45^\circ + \frac{\phi}{2}\right)$$

where H_c ; critical height

C ; cohesion

r ; weight per unit volume of soil

ϕ ; Internal friction angle of soil

EXAMPLES

⟨Input⟩	⟨Output⟩
$\phi = 30^\circ$	$H_c = 1.73205$
$C = 2$	
$r = 8$	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of ϕ
4. [R/S]
5. Input of C
6. [R/S]
7. Input of r
8. [R/S]
   Display of Hc
9. Repeat steps 3 through 8

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of ϕ or display of Hc
1	÷	
2	2	
3	+	
4	4	
5	5	
6	=	
7	TAN	
8	×	
9	4	
10	×	
11	R/S	Input of C
12	÷	
13	R/S	Input of r
14	=	
15	GTO	
16	0	
17	0	
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		6

PROGRAM TITLE	Coulomb's coefficient of active earth pressure	PROGRAM NO.	F-6

FORMULA

This program calculates Coulomb's coefficient of active earth with the following formula.

$$K_a = \frac{\sin^2(\theta-\phi)}{\sin^2\theta\ \sin(\theta+\delta)} \left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-i)}{\sin(\theta+\delta)\sin(\theta-i)}}\right)^{-2}$$

where

θ ; angle of inclination of back of the wall

ϕ ; internal friction angle of soil

i ; angle of inclination of ground surface

δ ; friction angle between soil and wall.

EXAMPLES

⟨Input⟩	⟨Output⟩
$\theta = 110°$	$K_a = 0.581549$
$\phi = 30°$	
$i = 10°$	
$\delta = 25°$	

OPERATION

1. GTO 0 1
2. Input of ϕ
3. R/S
4. Input of δ
5. R/S
6. Input of i
7. R/S
8. Input of θ
9. R/S

   Display of K_a

NOTES

DATA MEMORY

M_0	ϕ
M_1	δ, $\sin(\theta+\delta)$
M_2	i
M_3	θ
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of ϕ
1	SM	
2	0	
3	+	
4	R/S	Input of δ
5	SM	
6	1	
7	=	
8	SIN	
9	×	
10	(5	
11	RM	
12	0	
13	−	
14	R/S	Input of i
15	SM	
16	2	
17	5)	
18	SIN	
19	÷	
20	(5	
21	R/S	Input of θ
22	SM	
23	3	
24	+	
25	RM	
26	1	
27	5)	
28	SIN	
29	SM	
30	1	
31	÷	
32	(5	
33	RM	
34	3	
35	−	
36	RM	
37	2	
38	5)	
39	SIN	
40	=	
41	√X	
42	+	
43	1	
44	Y^x	
45	2	
46	+⇆−	
47	=	
48	×	
49	(5	
50	RM	
51	3	
52	−	
53	RM	
54	0	
55	5)	
56	SIN	
57	F√X	X^2
58	÷	
59	RM	
60	3	
61	SIN	
62	F√X	X^2
63	÷	
64	RM	
65	1	
66	=	
67	GTO	
68	0	
69	0	
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		4

PROGRAM TITLE	Rankine's active earth pressure	PROGRAM NO.	F-7

FORMULA

This program calculates the Rankine's active earth pressure with following formula.

$$P_a = \frac{1}{2} \gamma H^2 K_a$$

$$K_a = \cos\beta \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

where

P_a ; active earth pressure (t/m)

K_a ; coefficient of active earth pressure

H ; height of the wall at right angles (m)

γ ; weight per unit volume of soil (t/m³)

β ; angle of inclination of the ground surface

ϕ ; internal friction angle of soil

EXAMPLES

⟨Input⟩	⟨Output⟩
H = 6 m	K_a = 0.3495
γ = 1.6 t/m³	P_a = 10.0662 t/m
β = 10°	
ϕ = 30°	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of H
4. [R/S]
5. Input of γ
6. [R/S]
7. Input of β
8. [R/S]
9. Input of ϕ
10. [R/S]
11. Display of K_a
12. [R/S]
13. Display of P_a
14. Repeat steps 3 through 13.

NOTES

DATA MEMORY

M_0	$\cos\beta$
M_1	$\sqrt{\cos^2\beta - \cos^2\phi}$
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of H or display of P_a
1	F√X	X²
2	×	
3	R/S	Input of r
4	÷	
5	2	
6	×	
7	(5	
8	(5	
9	R/S	Input of β
10	COS	
11	SM	
12	0	
13	F√X	X²
14	−	
15	R/S	Input of ϕ
16	COS	
17	F√X	X²
18	5)	
19	√X	
20	SM	
21	1	
22	+⇄−	
23	+	
24	RM	
25	0	
26	÷	
27	(5	
28	RM	
29	0	
30	+	
31	RM	
32	1	
33	5)	
34	×	
35	RM	
36	0	
37	5)	
38	R/S	Display of K_a
39	=	
40	GTO	
41	0	
42	0	
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Stress of reinforced concrete beam	PROGRAM NO.	F-8

FORMULA

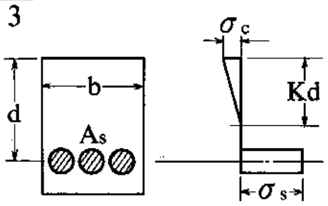
This program calculates the steel ratio P, the allowable compressive stress σ_c and the tensile stress σ_s for reinforced beam.

$$P = A_s/bd$$
$$\sigma_c = 2M/Kjbd^2$$
$$\sigma_s = M/Pjbd^2$$

where

$$K = \sqrt{2nP + (nP)^2} - nP$$
$$j = 1 - \frac{K}{3}$$

M ; bending moment
b ; width of rectangular section
d ; effective height
A_s ; total cross-sectional area of reinforcements
n ; ratio of elastic modulus between reinforcement and concrete



EXAMPLES

⟨Input⟩	⟨Output⟩
M = 300,000	P = 0.0083
b = 60	σ_c = 32.7195
d = 30	σ_s = 766.3975
A_s = 15	

OPERATION

1. [GTO] [0] [1]
2. Input of M
3. [R/S]
4. Input of b
5. [R/S]
6. Input of d
7. [R/S]
8. Input of A_s
9. [R/S]
   Display of P
10. [R/S]
    Display of σ_c
11. [R/S]
    Display of σ_s

NOTES

DATA MEMORY

M_0	M, M/jbd
M_1	bd^2, jbd^2
M_2	P
M_3	nP, K
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of M
1	SM	
2	0	
3	R/S	Input of b
4	×	
5	R/S	Input of d
6	SM	
7	1	
8	×	
9	F×	$M^×$
10	1	
11	1/X	
12	R/S	Input of A_s
13	=	
14	SM	
15	2	
16	R/S	
17	×	
18	1	
19	5	
20	×	
21	SM	
22	3	
23	2	
24	+	
25	RM	
26	3	
27	F√X	X^2
28	=	
29	√X	
30	−	
31	RM	
32	3	
33	÷	
34	SM	
35	3	
36	3	
37	+/−	
38	+	
39	1	
40	=	
41	F×	$M^×$
42	1	
43	RM	
44	0	
45	÷	
46	RM	
47	1	
48	÷	
49	SM	
50	0	
51	RM	
52	3	
53	×	
54	2	
55	=	
56	R/S	
57	SM	
58	RM	
59	0	
60	÷	
61	RM	
62	2	
63	=	
64	GTO	
65	0	
66	0	
67		
68		
69		
70		
71		

(G) Mechanical engineering

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		4

PROGRAM TITLE	Intermeshing rate of standard gear	PROGRAM NO.	G-1

FORMULA

Intermeshing rate

$$\varepsilon = \varepsilon_1(Z_1) + \varepsilon_2(Z_2)$$

$$\varepsilon_n = \frac{\sqrt{(Z_n+2)^2 - Z_n^2 \cos^2 \alpha_0} - Z_n \sin \alpha_0}{2\pi \cos \alpha_0}$$

where ; α_0 ; pressure angle

Z_n ; number of teeth

EXAMPLES

⟨Input⟩	⟨Output⟩
$\alpha_0 = 20°$	$\varepsilon = 1.6626$
$Z_1 = 25$	
$Z_2 = 40$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of α_0
4. R/S
5. Input of Z_1
6. R/S
   Display of ε_1
7. R/S
8. Input of Z_2
9. R/S
   Display of ε
10. Repeat steps 1 through 9.

NOTES

DATA MEMORY

M_0	α_0
M_1	$\cos \alpha_0$
M_2	Z_n
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of α_0
1	SM	
2	0	
3	COS	
4	SM	
5	1	
6	C	
7	[(	
8	[(	
9	R/S	Input of Z_n
10	SM	
11	2	
12	+	
13	2	
14	Y^x	
15	2	
16	−	
17	[(	
18	RM	
19	2	
20	F$\sqrt{X}$	X^2
21	×	
22	RM	
23	1	
24	F$\sqrt{X}$	X^2
25	)]	
26	)]	
27	$\sqrt{X}$	
28	−	
29	[(	
30	RM	
31	0	
32	SIN	
33	×	
34	RM	
35	2	
36	)]	
37	÷	
38	2	
39	÷	
40	π	
41	÷	
42	RM	
43	1	
44	)]	
45	+	
46	R/S	Display of ε_1 or ε
47	GTO	
48	0	
49	7	
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
O		4

PROGRAM TITLE	Diameter of base circle of helical gear	PROGRAM NO.	G-2

FORMULA

This program calculates the diameter of the base circle of a helical gear.

$$\text{Diameter } D = \frac{m \cdot Z}{\sqrt{\cos^2 \alpha + \tan^2 \beta}}$$

where; m = module
Z = number of cogs
α = twisting angle on pitch circle
β = right angled pressure angle of cogs

EXAMPLES

<input>	<output>
$m = 46$	$D = 1627.1385$
$Z = 30$	
$\alpha = 40°$	
$\beta = 20°$	

OPERATION

1. GTO 0 0
2. R/S
3. Input of m
4. R/S
5. Input of Z
6. R/S
7. Input of α
8. R/S
9. Input of β
10. R/S
    Display of D
11. Repeat steps 3 through 10

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of m or display of D
1	×	
2	R/S	Input of Z
3	÷	
4	(5	
5	R/S	Input of α
6	COS	
7	F $\sqrt{X}$	X^2
8	+	
9	R/S	Input of β
10	TAN	
11	F $\sqrt{X}$	X^2
12	5)	
13	$\sqrt{X}$	
14	=	Calculation of D
15	GTO	
16	0	
17	0	
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

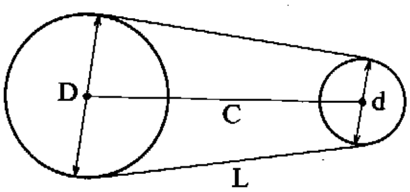
DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Length of belt	PROGRAM NO.	G-3

FORMULA

Length of the belt is calculated with the following formula.

$$L=\left(\frac{D+d}{2}\right)\pi+2C+\frac{(D-d)^2}{4C}$$



D: diameter of large pulley
d : diameter of small pulley
C : distance between centers
L : length of belt

EXAMPLES

⟨Input⟩	⟨Output⟩
D: 450	L = 1586.1039
d : 120	
C: 300	

OPERATION

1. GTO 0 0
2. R/S
3. Input of D
4. R/S
5. Input of d
6. R/S
7. Input of C
8. R/S
   Display of L
9. Repeat steps 3 through 8

NOTES

DATA MEMORY

M_0	D
M_1	d
M_2	C
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of D or display of L
1	SM	
2	0	
3	+	
4	R/S	Input of d
5	SM	
6	1	
7	÷	
8	2	
9	×	
10	π	
11	+	
12	(5	
13	2	
14	×	
15	R/S	Input of C
16	SM	
17	2	
18	5)	
19	+	
20	(5	
21	(5	
22	RM	
23	0	
24	−	
25	RM	
26	1	
27	5)	
28	F√X	X²
29	÷	
30	(5	
31	4	
32	×	
33	RM	
34	2	
35	5)	
36	5)	
37	=	
38	GTO	
39	0	
40	0	
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Thermal Loss	PROGRAM NO.	G-4

FORMULA

This program calculates thermal loss of airconditioning system and surface temperature of the cover

$$Q = \frac{2\pi(t_1 - t_2)}{\dfrac{\ln\frac{d_2}{d_1}}{\lambda_1} + \dfrac{\ln\frac{d_3}{d_2}}{\lambda_2} + \cdots + \dfrac{\ln\frac{d_n}{d_{n-1}}}{\lambda_{n-1}}}$$

T : surface temperature of the cover.

E : surface radiant heat.

$$T = \frac{Q}{\pi d_n E} + t_2$$

where
- Q : thermal loss
- t_1 : temperature of thermal source
- t_2 : ambient temperature
- $d_1, d_2 \cdots\cdots d_n$: radius of covers
- $\lambda_1, \lambda_2 \cdots\cdots \lambda_n$: coefficient of heattransfer of cover material.

EXAMPLES

<Input>

$d_1 = 0.5$ $\lambda_1 = 0.4$
$d_2 = 0.2$ $\lambda_2 = 0.55$
$d_3 = 0.4$ $\lambda_3 = 0.35$
$d_4 = 0.3$ $\lambda_4 = 0.2$
$d_5 = 0.6$ $t_1 = 95$
$E = 7$ $t_2 = 10$

<Output>

$Q = 331.037$
$T = 35.089$

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of d_{n-1}
4. [R/S]
5. Input of d_n
6. [R/S]
7. Input of λ
8. [R/S] or [SKP]
9. Repeat steps 5 through 8.
10. [R/S]
11. Input of t_1
12. [R/S]
13. Input of t_2
14. [R/S]
    Display of Q
15. Input of E
16. [R/S]
    Display of T
17. [R/S]
18. Repeat steps 3 through 16.

NOTES

1. Operation 9 is necessary only when [R/S] at 8 is pressed.

DATA MEMORY

M_0	working
M_1	d_n
M_2	t_2
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	C	
1	SM	
2	0	
3	R/S	Input of d_{n-1}
4	SM	
5	1	
6	RM	
7	1	
8	÷	
9	R/S	Input of d_n
10	SM	
11	1	
12	X⇆Y	
13	=	
14	Fe^x	L_n
15	÷	
16	R/S	Input of λ_{n-1} or SKP
17	=	
18	F+	M^+
19	0	
20	GTO	
21	0	
22	6	
23	R/S	
24	+	
25	RM	
26	0	
27	÷	
28	(5	
29	R/S	Input of t_1
30	−	
31	R/S	Input of t_2
32	SM	
33	2	
34	×	
35	π	
36	×	
37	2	
38	5)	
39	X⇆Y	
40	÷	
41	R/S	Display of Q or input of E
42	π	
43	÷	
44	RM	
45	1	
46	+	
47	RM	
48	2	
49	=	
50	R/	Display of T
51	GTO	
52	0	
53	0	
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Heat-Conduction between two plates	PROGRAM NO.	G-5

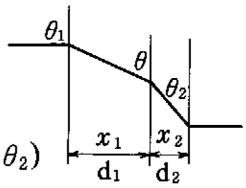
FORMULA

This program calculates the boundary surface temperature of piled two plates and conductive quantity of heat.

conductive quantity of heat $Q = x_1 \dfrac{\theta_1 - \theta}{d_1} = x_2 \dfrac{\theta - \theta_2}{d_2}$

temperature of boundary surface $\theta = \dfrac{\theta_1 \dfrac{x_1}{d_1} + \theta_2 \dfrac{x_2}{d_2}}{\dfrac{x_1}{d_1} + \dfrac{x_2}{d_2}}$

$$Q = \frac{\dfrac{x_1}{d_1} \cdot \dfrac{x_2}{d_2}}{\dfrac{x_1}{d_1} + \dfrac{x_2}{d_2}} (\theta_1 - \theta_2)$$



where x_1, x_2 : heat conductivities
θ_1, θ_2 : surface temperatures $(\theta_1 > \theta_2)$
d_1, d_2 : thickness of plates

EXAMPLES

⟨input⟩	⟨output⟩
$x_1 = 0.027$ (cal.cm/°C)	$\theta = 53.06931$
$x_2 = 0.002$ (cal.cm/°C)	$Q = 0.18713$
$d_1 = 1.0$ (cm)	
$d_2 = 0.3$ (cm)	
$\theta_1 = 60$ (°C)	
$\theta_2 = 25$ (°C)	

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of x_1
4. [R/S]
5. Input of d_1
6. [R/S]
7. Input of θ_1
8. [R/S]
9. Input of x_2
10. [R/S]
11. Input of d_2
12. [R/S]
13. Input of θ_2
14. [R/S]
    Display of θ
15. [R/S]
    Display of Q
16. Repeat steps 3 through 15.

NOTES

DATA MEMORY

M_0	$\frac{x_1}{d_1}$
M_1	θ_1
M_2	$\frac{x_2}{d_2}$
M_3	θ_2
M_4	$\frac{x_1}{d_1}+\frac{x_2}{d_2}$
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of x_1 or display of Q
1	÷	
2	R/S	Input of d_1
3	=	
4	SM	
5	0	
6	×	
7	R/S	Input of θ_1
8	SM	
9	1	
10	+	
11	(5	
12	(5	
13	R/S	Input of x_2
14	÷	
15	R/S	Input of d_2
16	5)	
17	SM	
18	2	
19	×	
20	R/S	Input of θ_2
21	SM	
22	3	
23	5)	
24	÷	
25	(5	
26	RM	
27	0	
28	+	
29	RM	
30	2	
31	5)	
32	SM	
33	4	
34	=	
35	R/S	Display of θ
36	RM	
37	0	
38	×	
39	RM	
40	2	
41	÷	
42	RM	
43	4	
44	×	
45	(5	
46	RM	
47	1	
48	−	
49	RM	
50	3	
51	5)	
52	=	
53	GTO	
54	0	
55	0	
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
○		5

PROGRAM TITLE	Involute function	PROGRAM NO.	G-6

FORMULA

Involute function is

$$\text{INV}\ \phi = \tan\phi - \phi$$

This program calculates the angle ϕ with the given INV ϕ.
The operation is done with Newton's method as following.

$$f(\phi) = \tan\phi - \phi - \text{INV}\ \phi = 0$$

EXAMPLES

⟨Input⟩	⟨Output⟩
INV ϕ = 0.0324	ϕ = 25.62109 (degree)

OPERATION

1. [GTO] [0] [0]
2. [R/S]
   Display of ϕ

NOTES

Before the operation, store the following data into M_0, M_1, M_2 and M_5.

$M_0 = 10^{-5}$
$M_1 = 1.5$
$M_2 = 10^{-6}$
$M_5 = \text{INV}\ \phi$

DATA MEMORY

M_0	10^{-5}
M_1	ϕ_i
M_2	10^{-6}
M_3	δ_i
M_4	$f(\phi)$
M_5	INV ϕ
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	1	
2	−	
3	X⇆Y	
4	TAN	
5	+	
6	RM	
7	5	
8	=	
9	×	
10	RM	
11	2	
12	+⇆−	
13	SM	
14	2	
15	SKP	
16	GTO	
17	3	
18	6	
19	X⇆Y	
20	SM	
21	4	
22	RM	
23	1	
24	X⇆Y	
25	RM	
26	0	
27	+	
28	SM	
29	3	
30	RM	
31	1	
32	=	
33	GTO	
34	0	
35	2	
36	RM	
37	4	
38	1/X	
39	−	
40	1	
41	=	
42	1/X	
43	×	
44	RM	
45	3	
46	=	
47	F−	M^-
48	1	
49	F $\sqrt{X}$	X^2
50	$\sqrt{X}$	
51	−	
52	RM	
53	2	
54	=	
55	SKP	
56	GTO	
57	0	
58	0	
59	RM	
60	1	
61	÷	
62	π	
63	×	
64	1	
65	8	
66	0	
67	=	
68	R/S	Display of ϕ
69		
70		
71		

(H) General business

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Loan calculation (1)	PROGRAM NO.	H-1

FORMULA

$$BAL_k = \frac{1}{(1+i)^{-k}}\left(PMT\,\frac{(1+i)^{-k}-1}{i} + PV\right)$$

BAL_k = balance of principal after k times of payment
PV = initial loan amount
PMT = periodic payment amount
i = periodic interest rate

$$BAL_j = \frac{PVi-PMT}{i} \times (1+i)^j + \frac{PMT}{i}$$

BAL_j = balance of principal after j times of payment

$$INT_{j\text{-}k} = \frac{PVi-PMT}{i} \times \left\{ (1+i)^{k-j+1} - 1 \right\} (1+i)^{j-1} + (k-j+1)\,PMT$$

$INT_{j\text{-}k}$ = accumulated interest, payment J through K.

EXAMPLES

〈Input〉

PV = $ 15,000
i = 0.0075 (0.75%/month)
j = 12 months = 1 year
j = 120 months = 10 years
PMT = $ 150
For 1 year from first j = 1 k = 12
For 10 years from first j = 1 k = 120

〈Output〉

Balance
(after 1 year)
$ 14,530.97
(after 10 years)
$ 7,743.21
Accumulated interest
$ 1,330.97 (1 year)
$ 10,743.21 (10 years)

OPERATION

① Compute the balance
1. GTO 0 0
2. R/S
3. Input of j
4. R/S
5. SKP
6. R/S
7. Display of BAL_j
8. Repeat steps 1 through 7

② Compute accumulated interest
1. GTO 0 0
2. R/S
3. Input of j
4. R/S
5. Input of k
6. R/S
7. Display of $INT_{j\text{-}k}$
8. Repeat steps 1 through 7

NOTES

① Before operation, Store PMT, PV, i, 1+i into M_1, M_2, M_3, M_4 respectively.
② This program is applicable to any loan calculation which is repaid with payment of equally spaced period.
③ The periodic interest rate i must be entered as decimal fraction. (For instant 7% = 0.07)

DATA MEMORY

M_0	j
M_1	PMT
M_2	PV
M_3	i
M_4	1+i
M_5	$\frac{PVi-PMT}{i}$
M_6	k−j+1
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of j
1	SM	
2	0	
3	RM	
4	2	
5	×	
6	RM	
7	3	
8	−	
9	RM	
10	1	
11	÷	
12	RM	
13	3	
14	=	
15	SM	
16	5	
17	R/S	Input of SKP or k
18	+	
19	1	
20	−	
21	RM	
22	0	
23	=	
24	SM	
25	6	
26	Y^x	
27	RM	
28	4	
29	X⇆Y	
30	−	
31	1	
32	×	
33	RM	
34	5	
35	×	
36	(5	
37	RM	
38	0	
39	−	
40	1	
41	Y^x	
42	RM	
43	4	
44	X⇆Y	
45	5)	
46	+	
47	(5	
48	RM	
49	6	
50	×	
51	RM	
52	1	
53	=	
54	R/S	Display of $INT_{j\text{-}k}$
55	×	
56	(5	
57	RM	
58	4	
59	Y^x	
60	RM	
61	0	
62	5)	
63	+	
64	(5	
65	RM	
66	1	
67	÷	
68	RM	
69	3	
70	=	
71	R/S	Display of BAL_j

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Loan calculation (2)	PROGRAM NO.	H-2

FORMULA

This program calculates payment, present value, and term.

Payment $PMT = PV\left(\frac{i}{1-(1+i)^{-n}}\right)$ (monthly)

Present value $PV = PMT\left(\frac{1-(1+i)^{-n}}{i}\right)$

Term $n = -\frac{Ln(1-i\cdot PV/PMT)}{Ln(1+i)}$

(※ i = interest)

EXAMPLES

⟨Input⟩	⟨Output⟩
i = 0.75%, n = 240 months, PV = $ 3,000	PMT = $ 26.99
i = 0.75%, n = 240 months, PMT = $ 60	PV = $ 6,669.00
i = 0.75%, PMT = $ 300, PV = $ 16,000	n = 68.37

OPERATION

Calculation of PMT
1. [GTO] [0] [0]
2. [R/S]
3. Input of 1
4. [R/S]
   Display of PMT

Calculation of PV
1. [GTO] [0] [0]
2. [R/S]
3. Input of 2
4. [R/S]
   Display of PV

Calculation of n
1. [GTO] [0] [0]
2. [R/S]
3. Input of 0
4. [R/S]
   Display of n

NOTES

1. Calculation of PMT
   Before operation, store the value of n, PV, i, i+1 into M_0, M_2, M_3, M_4 respectively.
2. Calculation of PV
   Before operation, store the value of n, PMT, i, i+1 into M_0, M_1, M_3, M_4.
3. Calculation of n
   Before operation, store the value of PMT, PV, i, i+1 into M_1, M_2, M_3, M_4.
   However the value of i must not be percent, it means for instance 0.75% should be entered 0.0075.
4. On calculation of n, when 1−iPV/PMT<0, the result will be error.

DATA MEMORY

M_0	n
M_1	PMT
M_2	PV
M_3	i
M_4	i+1
M_5	working
M_6	working
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of [0], [1] or [2]
1	−	
2	1	
3	=	
4	SKP	
5	GTO	
6	2	
7	8	
8	RM	
9	3	
10	×	
11	RM	
12	2	
13	÷	
14	RM	
15	1	
16	−	
17	1	
18	=	
19	+⇆−	
20	Fe^x	Ln
21	÷	
22	RM	
23	4	
24	Fe^x	Ln
25	=	
26	+⇆−	
27	R/S	Display of n
28	SM	
29	6	
30	RM	
31	4	
32	Y^x	
33	RM	
34	0	
35	+⇆−	
36	−	
37	1	
38	÷	
39	RM	
40	3	
41	=	
42	+⇆−	
43	SM	
44	5	
45	RM	
46	6	
47	−	
48	1	
49	=	
50	SKP	
51	GTO	
52	6	
53	1	
54	RM	
55	2	
56	÷	
57	RM	
58	5	
59	=	
60	R/S	Display of PMT
61	RM	
62	1	
63	×	
64	RM	
65	5	
66	=	
67	R/S	Display of PV
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Loan calculation (3)	PROGRAM NO.	H-3

FORMULA

$$i_{k+1} = i_k - \frac{f(i_k)}{f'(i_k)}$$

$$f(i) = \frac{1-(1+i)^{-n}}{i} - \frac{PV}{PMT}$$

$$f'(i) = \frac{(1+i)^{-n}\left\{\frac{n\cdot i}{1+i}+1\right\}-1}{i^2}$$

$$\left[\text{where} \quad i_0 = \frac{PMT}{PV} - \frac{PV}{n^2\,PMT}\right]$$

EXAMPLES

⟨Input⟩	⟨Output⟩
PV = \$ 4,300	i = 0.00795
PMT = \$ 45	
n = 180 (months)	

OPERATION

1. GTO 0 0
2. R/S
3. Input of i_0
4. R/S

   Display of i_k

NOTES

1. ε is the converging minimum unit, generally $\varepsilon = 10^{-8}$
2. In advance of operation, store the input data n, $\frac{PV}{PMT}$, ε into storage register M_0, M_1, M_2 respectively.

DATA MEMORY

M_0	n
M_1	$\frac{PV}{PMT}$
M_2	ε
M_3	working
M_4	working
M_5	working
M_6	working
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of i_0
1	SM	
2	3	
3	+	
4	1	
5	=	
6	SM	
7	4	
8	Y^x	
9	RM	
10	0	
11	+⇆−	
12	=	
13	SM	
14	6	
15	−	
16	1	
17	÷	
18	RM	
19	3	
20	+	
21	RM	
22	1	
23	=	
24	SM	
25	5	
26	F $\sqrt{X}$	X^2
27	−	
28	RM	
29	2	
30	=	
31	SKP	
32	GTO	
33	3	
34	8	
35	RM	
36	3	
37	R/S	Display of i
38	RM	
39	0	
40	×	
41	RM	
42	3	
43	÷	
44	RM	
45	4	
46	+	
47	1	
48	×	
49	RM	
50	6	
51	−	
52	1	
53	÷	
54	RM	
55	3	
56	F $\sqrt{X}$	X^2
57	÷	
58	RM	
59	5	
60	X⇆Y	
61	+	
62	RM	
63	3	
64	=	
65	GTO	
66	0	
67	1	
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Compound interest	PROGRAM NO.	H-4

FORMULA

○ Term $n = \frac{Ln(FV/PV)}{Ln(1+i)}$

○ Interest rate of each period

$$i = \left[\left(\frac{FV}{PV}\right)^{\frac{1}{n}} - 1\right] \times 100\ (\%)$$

○ Present value $PV = FV(1+i)^{-n}$

○ Future value $FV = PV(1+i)^{n}$

○ Total amount of interest

$$I = PV[(1+i)^n - 1]$$

EXAMPLES

	‹Input›				‹Output›
	M_0 (n)	M_1(i+1)	M_2 (PV)	M_3 (FV)	
A	−(?)	1.06	$ 330	$ 650	n = 11.63
B	5×2=10	−(?)	$ 3,000	$ 5,000	i = 5.24 %
C	5×2=10	1.04	−(?)	$ 3,300	PV = 2229.36 $
D	12×2=24	1.007	$ 3,300	−(?)	FV = 3901.41 $
E	4×2=8	1.0125	$ 300	−(?)	I = 31.35 $

OPERATION

A. Calculation of n
1. GTO 0 0
2. R/S
   Displayof n

B. Calculation of i
1. GTO 1 3
2. R/S
   Display of i

C. Calculation of PV
1. GTO 3 0
2. R/S
   Display of PV

D. Calculation of FV
1. GTO 4 2
2. R/S
   Display of FV

E. Calculation of I
1. GTO 5 2
2. R/S
   Display of I

NOTES

In advance of operation, store the input data to the data storage respectively.

DATA MEMORY

M_0	n
M_1	i+1
M_2	PV
M_3	FV
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	3	
2	÷	
3	RM	
4	2	
5	=	
6	Fe^x	Ln
7	÷	
8	RM	
9	1	
10	Fe^x	Ln
11	=	
12	R/S	Display of n
13	RM	
14	3	
15	÷	
16	RM	
17	2	
18	Y^x	
19	RM	
20	0	
21	1/X	
22	−	
23	1	
24	×	
25	1	
26	0	
27	0	
28	=	
29	R/S	Display of i
30	RM	
31	3	
32	÷	
33	[5	
34	RM	
35	1	
36	Y^x	
37	RM	
38	0	
39	5]	
40	=	
41	R/S	Display of PV
42	RM	
43	1	
44	Y^x	
45	RM	
46	0	
47	×	
48	RM	
49	2	
50	=	
51	R/S	Display of FV
52	RM	
53	1	
54	Y^x	
55	RM	
56	0	
57	−	
58	1	
59	×	
60	RM	
61	2	
62	=	
63	R/S	Display of I
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		2

PROGRAM TITLE	Periodic savings (Payment, present value, number of periods)	PROGRAM NO.	H-5

FORMULA

This program calculates payment (PMT), future value (FV), or number of time periods (n) for a schedule of periodic payment into a saving account.

The interest rate (i) is given

$$n = \frac{\mathrm{Ln}\left[\frac{FV\cdot i}{PMT}+(1+i)\right]}{\mathrm{Ln}\,(1+i)} - 1$$

$$PMT = \frac{FV\cdot i}{(1+i)^{n+1}-(1+i)}$$

$$FV = \frac{PMT}{i}\left[(1+i)^{n+1}-(1+i)\right]$$

EXAMPLES

⟨Input⟩	⟨Output⟩
PMT = 200 ($) FV = 10,000 ($) i = 0.005	n = 44.54
FV = 20,000 ($) i = 0.04 n = 6	PMT = 2899.27 ($)
PMT = 300 ($) i = 0.005 n = 36	FV = 11859.83 ($)

OPERATION

(A) Solution of n

1. [GTO] [0] [0]
2. [R/S]
3. [0]
4. [R/S]

Display of n

(B) Solution of PMT

1. [GTO] [0] [0]
2. [R/S]
3. [1]
4. [R/S]

Display of PMT

(C) Solution of FV

1. [GTO] [0] [0]
2. [R/S]
3. [2]
4. [R/S]

Display of FV

NOTES

1. In the case of solution for n, before the operation, store PMT, FV, i and i+1 into M_1, M_2, M_3 and M_4 respectively.
2. In the case of solution for PMT, before the operation, store n, FV, i and i+1 into M_0, M_2, M_3 and M_4. respectively.
3. In the case of solution for FV, before the operation, store n, PMT, i and i+1 into M_0, M_1, M_3 and M_4 respectively.

DATA MEMORY

M_0	n
M_1	PMT
M_2	FV
M_3	i
M_4	i+1
M_5	working
M_6	working
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of [0], [1] or [2]
1	−	
2	1	
3	=	
4	SKP	
5	GTO	
6	2	
7	9	
8	RM	
9	2	
10	×	
11	RM	
12	3	
13	÷	
14	RM	
15	1	
16	+	
17	RM	
18	4	
19	=	
20	Fe^x	Ln
21	÷	
22	RM	
23	4	
24	Fe^x	Ln
25	−	
26	1	
27	=	
28	R/S	Display of n
29	SM	
30	6	
31	RM	
32	0	
33	+	
34	1	
35	Y^x	
36	RM	
37	4	
38	X⇆Y	
39	−	
40	RM	
41	4	
42	÷	
43	RM	
44	3	
45	=	
46	SM	
47	5	
48	RM	
49	6	
50	−	
51	1	
52	=	
53	SKP	
54	GTO	
55	6	
56	4	
57	RM	
58	2	
59	÷	
60	RM	
61	5	
62	=	
63	R/S	Display of PMT
64	RM	
65	1	
66	×	
67	RM	
68	5	
69	=	
70	R/S	Display of FV
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		0

PROGRAM TITLE	Discount cash flow (Net present, internal rate of return)	PROGRAM NO.	H-6

FORMULA

Net present value at period K

$$NPV_K = -V_0 + \sum_{j=1}^{K} \frac{C_j}{(1+i)^j}$$

where

V_0; initial investment

$C_1 C_2 \cdots\cdots C_j$; periodic cash flows

i; cost of the capital (discount rate)

NPV_K; net present value at period K

EXAMPLES

<Input>		<Output>
$V_0 = 15000$ \$		$NPV_1 = -12273$ \$
$i = 0.1$/year		$NPV_2 = -10099$ \$
year	cash flow	$NPV_3 = -6343$ \$
1	$C_1 = 3000$ \$	$NPV_4 = -2545$ \$
2	$C_2 = 2630$ \$	$NPV_5 = 262$ \$
3	$C_3 = 5000$ \$	Since NPV_5 is positive. The cash
4	$C_4 = 5560$ \$	flow is profitable to the extent that
5	$C_5 = 4520$ \$	the cost of capital is 10%.

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of V_0
4. [R/S]
5. Input of i
6. [R/S]
7. Input of C_1
8. [R/S]
   Display of NPV_1
9. Repeat the operation 6 through 8 to obtain NPV_j at C_j.
10. Repeat steps 1 through 9

NOTES

DATA MEMORY

M_0	NPV_j
M_1	$1+i$
M_2	C_j
M_3	counter
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	C	
1	SM	
2	0	
3	SM	
4	3	
5	R/S	Input of V_0
6	F−	M^-
7	0	
8	R/S	Input of i
9	+	
10	1	
11	=	
12	SM	
13	1	
14	R/S	Input of C_j
15	SM	
16	2	
17	1	
18	F+	M^+
19	3	
20	RM	
21	1	
22	Y^x	
23	RM	
24	3	
25	=	
26	÷	
27	RM	
28	2	
29	X⇆Y	
30	=	
31	F+	M^+
32	0	
33	RM	
34	0	
35	R/S	Display of NPV_j
36	GTO	
37	1	
38	4	
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	0

PROGRAM TITLE	Calculation of salary	PROGRAM NO.	H-7

FORMULA

1. Amount of payment = basic salary + allowance for (family + commute + late work).
2. Social insurance = (the welfare annuity + health + unemployment).
3. The object value for taxable article = amount of payment − commute allowance − social insurance.
4. Subtraction value = income tax + social insurance + etc. (loan).
5. Acceptance value = amount of payment − subtraction value.

Commute allowance = taxable allowance + non-taxable allowance = A.

A ≦ \$ 14 …… non-taxable

A > \$ 14 …… \$ (A − 14) is taxable

$$\text{Allowance of late work} = \frac{\text{basic salary}}{170} \times 1.4 \times \text{hour (s)}.$$

Unemployment insurance = amont of payment × 0.0055.

EXAMPLES

〈Input〉		〈Output〉	
Late work times	= 30 (hours)	Allowance of late work	= \$ 124
Basic salary	= \$ 500 (monthly)	Amount of payment	= \$ 701
Commute allow.	= \$ 27	Unemployment insurance	= \$ 4
Family allow.	= \$ 50	Social insurance	= \$ 29
Welfare annuity insur.	= \$ 11	Object value for taxable articles	= \$ 658
Health insurane	= \$ 14	Amount of subtraction	= \$ 91
Income tax	= \$ 9	Acceptance value	= \$ 610
Other subtractions	= \$ 53		

OPERATION

1. [GTO] [0] [0]
2. [R/S]
3. Input of late work hours
4. [R/S]
5. Input of 1.4 (premium)
6. [R/S]
7. Input of basic salary
8. [R/S]
9. Input of 170 (work time/month)
10. [R/S]
    Display of late work allowance
11. Input of commute allowance
12. [R/S]
13. Input of family allowance
14. [R/S]
    Display of amount of payment
15. Input of 0.0055 (rate of unemployment insurance)
16. [R/S]
    Display of value of unemployment insurance.
17. Input of value of welfare annuity insurance.
18. [R/S]
19. Input of value of health insurance.
20. [R/S]
    Display of the value of social insurance.
21. [R/S]
22. Input of limited value on commute allowance. (14)
23. [R/S]
    Display of object value for taxable article.
24. Input of income tax.
25. [R/S]
26. Input of any subtraction (loan).
27. [R/S]
    Display of total subtraction value.
28. [R/S]
    Display of acceptance value.

DATA MEMORY

M_0	Basic salary
M_1	Commute allowance
M_2	Amount of payment
M_3	Social insurance
M_4	Limited value of non-taxable on commute allowance
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Display of acceptance value
1	×	or input of late work hours
2	R/S	Input of 1.4
3	×	
4	R/S	Input of basic salary
5	SM	
6	0	
7	÷	
8	R/S	Input of 170
9	+	
10	R/S	Allowance of late work or
11	SM	input of commute allowance
12	1	
13	+	
14	R/S	Family allowance
15	+	
16	RM	
17	0	
18	×	
19	SM	
20	2	
21	R/S	Display of amount of
22	+	payment or input of 0.0055
23	R/S	Display of unemployment
24	+	insurance
25	R/S	
26	=	
27	SM	
28	3	
29	R/S	Display of social insurance
30	RM	
31	1	
32	−	
33	R/S	Input of 14
34	SM	
35	4	
36	=	
37	SKP	
38	GTO	
39	4	
40	6	
41	RM	
42	1	
43	GTO	
44	4	
45	8	
46	RM	
47	4	
48	+	
49	RM	
50	3	
51	−	
52	RM	
53	2	
54	X⇄Y	
55	=	
56	R/S	Display of the object value for taxable article or input of income tax
57	+	
58	RM	
59	3	
60	+	
61	R/S	Input of any subtraction
62	=	
63	R/S	Subtraction value
64	−	
65	RM	
66	2	
67	X⇄Y	
68	=	Acceptance value
69	GTO	
70	0	
71	0	

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Determination of economical lot size (1)	PROGRAM NO.	H-8

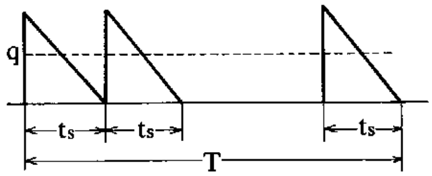
FORMULA

This program calculates optimum lot size q_0, optimum interval between orders t_{s_0} and optimum total expense T_{C_0}. During the certain period T, the constant number of products R will be ordered at the same interval and the stock will never run out.

$$q_0 = \sqrt{\frac{2RC_s}{TC_1}}$$

$$t_{s_0} = \sqrt{\frac{2TC_s}{RC_1}}$$

$$T_{C_0} = \sqrt{2RTC_1C_s}$$



where C_1 : maintenance expense of stock per unit time for the constant number of products.

C_s: preparation expense for one lot.

EXAMPLES

⟨Input⟩	⟨Output⟩
T = 12 (month)	q_0 = 3420.5263 (unit)
R = 24000 (unit)	t_{s_0} = 1.7103 (month)
C_1 = 0.0004 ($/month)	T_{C_0} = 16.4185 ($)
C_s = 1.17 ($/lot)	

OPERATION

1. GTO 0 0
2. R/S
3. Input of R
4. R/S
5. Input of Cs
6. R/S
7. Input of T
8. R/S
9. Input of C_1
10. R/S
    Display of q_0
11. R/S
    Display of t_{s_0}
12. R/S
    Display of T_{C_0}
13. Repeat steps 3 through 12.

NOTES

DATA MEMORY

M_0	R
M_1	C_s
M_2	T
M_3	C_1
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of R or display of T_{C_0}
1	SM	
2	0	
3	×	
4	2	
5	×	
6	R/S	Input of Cs
7	SM	
8	1	
9	÷	
10	(5	
11	R/S	Input of T
12	SM	
13	2	
14	×	
15	R/S	Input of C_1
16	SM	
17	3	
18	5)	
19	=	
20	√X	
21	R/S	Display of q_0
22	2	
23	×	
24	RM	
25	1	
26	×	
27	RM	
28	2	
29	÷	
30	(5	
31	RM	
32	0	
33	×	
34	RM	
35	3	
36	5)	
37	=	
38	√X	
39	R/S	Display of t_{s_0}
40	2	
41	×	
42	RM	
43	0	
44	×	
45	RM	
46	1	
47	×	
48	RM	
49	2	
50	×	
51	RM	
52	3	
53	=	
54	√X	
55	GTO	
56	0	
57	0	
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	3

PROGRAM TITLE	Determination of economical lot size (2)	PROGRAM NO.	H-9

FORMULA

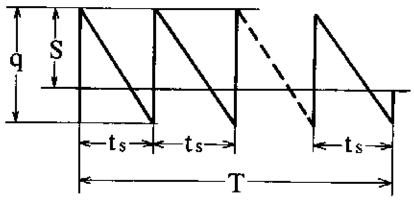
This program will determine the optimum lot size q_0, optimum interval between orders t_{s_0}, optimum stock level S_0 and optimum total expense T_{C_0}, The out of stock will occur and its loss will be in proportion to shortage and time.

$$q_0 = \sqrt{\frac{2RC_s}{TC_1}} \cdot \sqrt{\frac{C_1+C_2}{C_2}}$$

$$S_0 = \sqrt{\frac{2RC_s}{TC_1}} \cdot \sqrt{\frac{C_2}{C_1+C_2}}$$

$$t_{s_0} = \sqrt{\frac{2TC_s}{RC_1}} \cdot \sqrt{\frac{C_1+C_2}{C_2}}$$

$$T_{C_0} = \sqrt{2RTC_1C_s} \cdot \sqrt{\frac{C_2}{C_1+C_2}}$$



where C_2 : shortage loss per unit time for the constant number of products.
S_0 : initial stock level of each period.

EXAMPLES

⟨Input⟩		⟨Output⟩	
$C_1 = 0.0004$	(\$/month)	$q_0 = 4189.272$	(unit)
$C_2 = 0.0008$	(\$/month)	$S_0 = 2792.848$	(unit)
$R = 24000$	(unit)	$t_{s_0} = 2.095$	(month)
$T = 12$	(month)	$T_{C_0} = 13.406$	(\$)
$C_s = 1.17$	(\$/lot)		

OPERATION

1. GTO 0 0
2. R/S
3. Input of C_1
4. R/S
5. Input of C_2
6. R/S
7. Input of C_s
8. R/S
9. Input of R
10. R/S
11. Input of T
12. R/S
 Display of T_{C_0}
13. R/S
14. R/S
 Display of S_0
15. R/S
16. SKP
17. R/S
 Display of q_0
18. R/S
19. SKP
20. R/S
 Display of t_{s_0}
21. SKP
22. R/S
23. Repeat steps 3 through 22.

NOTES

DATA MEMORY

M_0	R
M_1	T
M_2	C_1
M_3	$2C_s$
M_4	C_2
M_5	$\frac{R}{T}$
M_6	$\frac{C_1+C_2}{C_2}$
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of C_1
1	SM	
2	2	
3	+	
4	R/S	Input of C_2
5	SM	
6	4	
7	÷	
8	RM	
9	4	
10	=	
11	SM	
12	6	
13	R/S	Input of C_s
14	×	
15	2	
16	×	
17	SM	
18	3	
19	R/S	Input of R
20	SM	
21	0	
22	×	
23	R/S	Input of T
24	SM	
25	1	
26	×	
27	RM	
28	2	
29	=	
30	√X	
31	×	
32	RM	
33	6	
34	1/X	
35	√X	
36	=	
37	R/S	Display of T_{C_0} or S_0
38	RM	
39	0	
40	÷	
41	RM	
42	1	
43	×	
44	SM	
45	5	
46	RM	
47	3	
48	÷	
49	RM	
50	2	
51	=	
52	√X	
53	R/S	
54	GTO	
55	3	
56	1	
57	R/S	
58	×	
59	RM	
60	6	
61	√X	
62	=	
63	R/S	Display of q_0 or t_{s_0}
64	RM	
65	5	
66	1/X	
67	×	
68	GTO	
69	4	
70	5	
71	R/S	

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
Arbitrary		0

PROGRAM TITLE	Calendar (Days between two dates)	PROGRAM NO.	H-10

FORMULA

This program will compute the days between such two dates as m_1(month) d_1 (day) y_1 (year) and m_2 d_2 y_2.

The number N is assigned for this date such that

$$N(m, d, y) = [y' \times 365.25] + [30.59m' - 0.2] + d$$

Provided $y' = \begin{cases} y \ (m \geqq 3) \\ y-1 \ (m=1,2) \end{cases}$ $m' = \begin{cases} m \ (m \geqq 3) \\ m+12 \ (m=1,2) \end{cases}$

[ ] : Represent the integer function.

Then $N(m_2\ d_2\ y_2) - N(m_1\ d_1\ y_1)$ is calculated to get the days between two dates.

EXAMPLES

<Input>	<Output>
$y_1 = 1941$	1346 days
$m_1 = 12$	
$u_1 = 8$	
$y_2 = 1945$	
$m_2 = 8$	
$d_2 = 15$	

OPERATION

1. GTO 0 0
2. R/S
   Display of N_1
3. R/S
   Term from N_1 to N_2

NOTES

① This program is applicable for the date between March 1, 1900 to February 28, 2100.

② After the operation, the contents of M_1 and M_2 will be changed from the initial value.

③ Before the operation.
Store m, d, and y, into M_1 M_2 and M_3 respectively.

④ Before the operation 3, Store m_1 d_2 and y_2 into M_1 M_2 and M_3 respectively.

DATA MEMORY

M_0	working
M_1	y
M_2	m
M_3	d
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	C	
1	SM	
2	0	
3	RM	
4	2	
5	−	
6	3	
7	=	
8	SKP	
9	GTO	
10	1	
11	9	
12	1	
13	F−	M^-
14	1	
15	1	
16	2	
17	F+	M^+
18	2	
19	RM	
20	1	
21	×	
22	3	
23	6	
24	5	
25	•	
26	2	
27	5	
28	+	
29	EXP	
30	9	
31	−	
32	EXP	
33	9	
34	=	
35	F+	M^-
36	0	
37	3	
38	0	
39	•	
40	5	
41	9	
42	×	
43	RM	
44	2	
45	−	
46	•	
47	2	
48	+	
49	EXP	
50	9	
51	−	
52	EXP	
53	9	
54	+	
55	RM	
56	3	
57	=	
58	F+	M^+
59	0	
60	RM	
61	0	
62	R/S	Display of N
63	1	
64	+⇆−	
65	F×	$M^\times$
66	0	
67	GTO	
68	0	
69	3	
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	0

PROGRAM TITLE	Calendar (Day of the week)	PROGRAM NO.	H-11

FORMULA

This program will compute the day of the week from the given date such as m(month) d(day) y(year).

Number N is assigned for this date such that

$$N = [y' \times 5 \div 4] + [2.59 \times m' + 0.8] + d$$

Provided $y' = \begin{cases} y\,(m \geqq 3) \\ y-1\,(m=1,2) \end{cases}$ and $m' = \begin{cases} m\,(m \geqq 3) \\ m+12\,(m=1,2) \end{cases}$

[ ] : represents the integer function

Then N is divided by 7 and the following remainder represents the day of the week.

remainder:
- 0 = Sunday
- 1 = Monday
- 2 = Tuesday
- ⋮
- 6 = Saturday

EXAMPLES

<Input>	<Output>
January 14, 1976	3 (Wednesday)
January 1, 1977	6 (Saturday)

OPERATION

1. [GTO] [0] [0]
2. [R/S]
   Display the day of the week (0~6)
3. y, m, d, should previously be entered into M_1, M_2 and M_3 respectively after second operation, then repeat to calculate 2).

NOTES

① Before the operation, Store y, m, d, into M_1, M_2, M_3 respectively.

② This program is applicable for the period of March 1, 1900 to February 28, 2100.

③ When $m < 3$, remained content of M_1 and M_2 will be different from the initial value.

DATA MEMORY

M_0	working
M_1	y
M_2	m
M_3	d
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	RM	
1	2	
2	−	
3	3	
4	=	
5	SKP	
6	GTO	
7	1	
8	6	
9	1	
10	F−	M^-
11	1	
12	1	
13	2	
14	F+	M^+
15	2	
16	RM	
17	1	
18	×	
19	5	
20	÷	
21	4	
22	+	
23	EXP	
24	9	
25	−	
26	EXP	
27	9	
28	+	
29	[5	
30	RM	
31	2	
32	×	
33	2	
34	•	
35	5	
36	9	
37	+	
38	•	
39	8	
40	+	
41	EXP	
42	9	
43	−	
44	EXP	
45	9	
46	5]	
47	+	
48	RM	
49	3	
50	=	
51	SM	
52	0	
53	+⇆−	
54	÷	
55	7	
56	+	
57	EXP	
58	9	
59	−	
60	EXP	
61	9	
62	×	
63	7	
64	+	
65	RM	
66	0	
67	=	
68	R/S	Display the day of the week
69	GTO	
70	0	
71	0	

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Calculation of biorhythm	PROGRAM NO.	H-12

FORMULA

This program derives dangerous days of biorhythm from calculation of cross points of P, S and I curves.

Consideration of the leap year is not necessary because of a year is treated 365.25 days in this program.

After calculating the days between birthday and today, the days from today to the day when the sign of the SIN curve changes is derived from the cycle of the P, S and I curve respectively.

where y ; this year
y′; the year of the birthday
d ; days from birthday

EXAMPLES

When a man who was born on February 24, 1945 wants to know his biorhythm in future on March 10, 1976, calculate d= only 14 days from birthday to March 10 in spite of leap month of February.

〈Input〉	〈Output〉
y ; 1976	The dangerous day on P curve is 3 days after from today (3/13)
y′; 1945	On S curve is 4 days after (3/14)
d ; +14	On I curve is 16 days after (3/26)

OPERATION

1. GTO 0 0
2. R/S
3. Input of y
4. R/S
5. Input of y′
6. R/S
7. Input of d
8. R/S
   Display of the dangerous day on P curve.
9. R/S
   Display of the dangerous day on S curve.
10. R/S
   Display of the dangerous day on I curve.

Repeat 1 through 10 after reset the memories

NOTES

1. Before operation, store under mentioned numbers into $M_0 \sim M_3$.
2. When the number of "d" is stored, store + number when birthday is already passed and store store − number when birthday is coming.
3. M_1, M_2 must be reset after RUN execution.
4. February must be calculated for 28 days.

DATA MEMORY

M_0	365.25
M_1	23
M_2	−1
M_3	2π
M_4	$(y-y')\times M_0+d$
M_5	working
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of y
1	−	
2	R/S	Input of y′
3	×	
4	RM	
5	0	
6	+	
7	R/S	Input of d
8	=	
9	SM	
10	4	
11	×	
12	RM	
13	3	
14	÷	
15	RM	
16	1	
17	−	
18	SIN	
19	X⇆Y	
20	RM	
21	2	
22	SKP	
23	GTO	
24	3	
25	5	
26	X⇆Y	
27	SM	
28	5	
29	1	
30	F+	M+
31	2	
32	GTO	
33	5	
34	9	
35	X⇆Y	
36	×	
37	RM	
38	5	
39	=	
40	SKP	
41	GTO	
42	5	
43	9	
44	RM	
45	2	
46	R/S	Display of dangerous day
47	5	
48	F+	M+
49	1	
50	1	
51	+⇆−	
52	SM	
53	2	
54	RM	
55	4	
56	GTO	
57	1	
58	1	
59	1	
60	F+	M+
61	2	
62	RM	
63	2	
64	+	
65	RM	
66	4	
67	=	
68	GTO	
69	1	
70	1	
71		

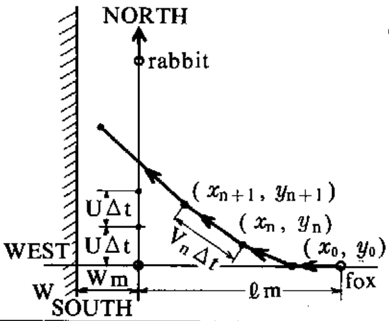
CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	2

PROGRAM TITLE	Game calculation (A fox who pursue a rabbit)	PROGRAM NO.	H-13

FORMULA

A fox who is ℓm distant at east, finds a rabbit running Um/sec rate wm far from the wall lying straightly from south to north. Then the fox starts after the rabbit and changes the speed for each limited Δt seconds. If the fox runs over the wall, it loses this game. But the fox wins if it stops the place between the wall and a line where the rabbit running, because it can catch the rabbit to pursue straightly.
Fox's speed is given by key pressing in each steps.



EAST

calculation formula;

$$\begin{cases} x_{n+1} = x_n - \Delta t \cdot V_n \cos \alpha \\ y_{n+1} = y_n + \Delta t \cdot V_n \sin \alpha \end{cases}$$

$$\alpha = \tan^{-1} \frac{n \cdot \Delta t \cdot U - y_n}{x_n}$$

V_n is fox's speed given by key operation.

where; The coordinate where the fox finds the rabbit is (x_0, y_0), (x_1, y_1), ……

EXAMPLES

<Input> when W = 2m, ℓ = 300m, U = 5m/sec, Δt = 5 seconds, V_0 = 20m/sec (x_1 = 200m), V_1 = 15m/sec (x_2 = 125.58m), V_2 = 20m/sec (x_3 = 30.45m), V_3 = 10m/sec

<Output> 99999999 fox's defeat (x_4 = −2.44)

<Input> when ℓ = 500m, W = 2m, U = 5m/sec, Δt = 5 seconds, V_0 = 15m/sec (x_1 = 425m), V_1 = 15m/sec (x_2 = 350.13m), V_2 = 20m/sec (x_3 = 250.97m), V_3 = 20m/sec (x_4 = 153.51m), V_4 = 20m/sec (x_5 = 60.43m), V_5 = 10m/sec (x_6 = 21.51m), V_6 = 10m/sec

<Output> 11111111 fox's win (x_7 = −1.14)

OPERATION

1. GTO 0 0
2. R/S
3. Input of V_n
4. R/S
   Display of x_n
5. Repeat steps 3 through 4
   Display of 99999999 or 11111111

NOTES

1. Store ℓ, 0, U, Δt, 0, W into $M_0, M_1, M_2, M_3, M_4, M_5$, before operation.
2. Display of 1111 1111 means the fox's win. Display of 9999 9999 means the fox's defeat.

DATA MEMORY

M_0	x_n
M_1	y_n
M_2	U (m/sec)
M_3	Δt (sec)
M_4	n
M_5	W (m)
M_6	working
M_7	working
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of V_n or display of x_n
1	×	
2	RM	
3	3	
4	=	
5	SM	
6	7	
7	RM	
8	4	
9	×	
10	RM	
11	3	
12	×	
13	RM	
14	2	
15	−	
16	RM	
17	1	
18	÷	
19	RM	
20	0	
21	=	
22	F TAN	TAN^{-1}
23	SM	
24	6	
25	SIN	
26	×	
27	RM	
28	7	
29	=	
30	F+	M^+
31	1	
32	1	
33	F+	M^+
34	4	
35	RM	
36	6	
37	COS	
38	×	
39	RM	
40	7	
41	=	
42	F−	M^-
43	0	
44	RM	
45	0	
46	SKP	
47	GTO	
48	0	
49	0	
50	+	
51	RM	
52	5	
53	=	
54	SKP	
55	GTO	
56	6	
57	4	
58	EXP	
59	8	
60	−	
61	1	
62	=	
63	R/S	99999999
64	EXP	fox's defeat
65	8	
66	÷	
67	9	
68	=	
69	R/S	11111111
70		fox's win
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	0

PROGRAM TITLE	Conjectural game	PROGRAM NO.	H-14

FORMULA

- Make conjecture a 2 digit of number by calculator.
- Operator must give a correct reply for the display following rule.
  - A. input [0]······The case of completely different number.
  - B. input [1]······The case that coincidence are observed at different digit position of single digit number.
  - C. input [2]······The case that coincidence are observed at same digit position of single digit number.
  - D. input [3]······The case that the answer is obtained.
- Limitation of the game; Upper digit number should be smaller than lower digit.

EXAMPLES

Imagine 47 (problem)

〈Input〉	〈Output〉
	12
0	34
1	45
2	46
2	47 ······ Answer
3	12 ※ start of next game.

OPERATION

1. Imagine 2 digit of number.
2. [GTO] [0] [0]
3. [R/S]
   Display 12.
4. Input of [0], [1], [2] or [3].
5. [R/S]
   Display of 2 digit number.
6. Repeat 4 and 5 if the displayed number is not the answer at step no. 5.
7. 12 will be displayed at step no. 5 if [3] is activated at step no. 4.

NOTES

1. Operation number 7, for the start of next game.

DATA MEMORY

M0	working
M1	working
M2	
M3	
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	1	
1	SM	
2	1	
3	2	
4	SM	
5	0	
6	RM	
7	1	
8	×	
9	1	
10	0	
11	+	
12	RM	
13	0	
14	=	
15	R/S	Display and input of 0, 1, 2 or 3
16	−	
17	1	
18	=	
19	SKP	
20	GTO	
21	3	
22	1	
23	2	
24	F+	M+
25	0	
26	F+	M+
27	1	
28	GTO	
29	0	
30	6	
31	−	
32	1	
33	=	
34	SKP	
35	GTO	
36	5	
37	4	
38	2	
39	F+	M+
40	1	
41	RM	
42	0	
43	X⇆Y	
44	RM	
45	1	
46	SM	
47	0	
48	X⇆Y	
49	SM	
50	1	
51	GTO	
52	0	
53	6	
54	−	
55	1	
56	=	
57	SKP	
58	GTO	
59	0	
60	0	
61	1	
62	F+	M+
63	1	
64	GTO	
65	0	
66	6	
67		
68		
69		
70		
71		

(I) Unit conversion

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	4

PROGRAM TITLE	Angle conversion (Degree, radian)	PROGRAM NO.	I-1

FORMULA

$$\pi \text{ radian} = 180 \text{ degree} = 200 \text{ gradient}$$

$$1 \text{ degree} = \frac{\pi}{180} \text{ radian} = \frac{10}{9} \text{ gradient}$$

$$1 \text{ radian} = \frac{180}{\pi} \text{ degree} = \frac{200}{\pi} \text{ gradient}$$

$$1 \text{ gradient} = \frac{9}{10} \text{ degree} = \frac{\pi}{200} \text{ radian}$$

EXAMPLES

	⟨Input⟩	⟨Output⟩
degree→ radian	90 degree	1.5708 radian
radian→ gradient	5 radian	318.3099 gradient
gradient→ degree	−150 gradient	−166.6667 degree

OPERATION

1. Depending on the conversion following key operation must be done.
   A. degree→ radian [GTO] [0] [0]
   B. radian→ degree [GTO] [1] [0]
   C. degree→ gradient [GTO] [2] [0]
   D. gradient→ degree [GTO] [3] [0]
   E. radian→ gradient [GTO] [4] [0]
   F. gradient→ radian [GTO] [5] [0]
2. [R/S]
3. Input the data to be converted.
4. [R/S]
   Display answer
5. Repeat steps 3 and 4.

NOTES

1. Before the operation, store $\frac{\pi}{180}$, 0.9 and $\frac{\pi}{200}$ into M_0, M_1 and M_2 respectively.
2. Operation 5 is for same type of conversion
3. For the different type of conversion go to operation 1.

DATA MEMORY

M_0	$\frac{\pi}{180}$
M_1	0.9
M_2	$\frac{\pi}{200}$
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of degree or display of radian
1	×	
2	RM	
3	0	
4	=	
5	GTO	
6	0	
7	0	
8		
9		
10	R/S	Input of radian or display of degree
11	÷	
12	RM	
13	0	
14	=	
15	GTO	
16	1	
17	0	
18		
19		
20	R/S	Input of degree or display of gradient
21	÷	
22	RM	
23	1	
24	=	
25	GTO	
26	2	
27	0	
28		
29		
30	R/S	Input of gradient or display of degree
31	×	
32	RM	
33	1	
34	=	
35	GTO	
36	3	
37	0	
38		
39		
40	R/S	Input of radian or display of gradient
41	÷	
42	RM	
43	2	
44	=	
45	GTO	
46	4	
47	0	
48		
49		
50	R/S	Input of gradient or display of radian
51	×	
52	RM	
53	2	
54	=	
55	GTO	
56	5	
57	0	
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	1

PROGRAM TITLE	Unit conversion (°C °F °K) (On temperature)	PROGRAM NO.	I-2

FORMULA

This program convert individual unit of temperature.

$$°F = \frac{9}{5} \times °C + 32$$

$$°C = \frac{5}{9}(°F - 32)$$

$$°K = 273.2 + °C$$

$$°K = 255.4 + \frac{5}{9} \times °F$$

$$°C = °K - 273.2$$

$$°F = \frac{9}{5}(°K - 255.4)$$

EXAMPLES

〈Input〉	〈Output〉
0°C	32.0°F
104°F	40.0°C
0°C	273.2°K
273.2°K	0.0°C
32°F	273.2°K
273.2°K	32.0°F

OPERATION

① °C→°F
1. [GTO] [0] [0]
2. [R/S]
3. Input of °C
4. [R/S]
   Display °F

② °F→°C
1. [GTO] [1] [2]
2. [R/S]
3. Input of °F
4. [R/S]
   Display of °C

③ °C→°K
1. [GTO] [2] [5]
2. [R/S]
3. Input of °C
4. [R/S]
   Display of °K

④ °K→°C
1. [GTO] [3] [3]
2. [R/S]
3. Input of °K
4. [R/S]
   Display of °C

⑤ °F→°K
1. [GTO] [4] [1]
2. [R/S]
3. Input of °F
4. [R/S]
   Display of °K

⑥ °K→°F
1. [GTO] [5] [6]
2. [R/S]
3. Input of °K
4. [R/S]
   Display of °F

NOTES

1. Before operation.

   Store $\frac{9}{5} = 1.8$ into M_0.

2. Then store 273.2 into M_1.

DATA MEMORY

M_0	1.8
M_1	273.2
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	Input of °C or display of °F
1	×	
2	RM	
3	0	
4	=	
5	+	
6	3	
7	2	
8	=	
9	GTO	
10	0	
11	0	
12	R/S	Input of °F or display of °C
13	−	
14	3	
15	2	
16	=	
17	×	
18	RM	
19	0	
20	1/X	
21	=	
22	GTO	
23	1	
24	2	
25	R/S	Input of °C or display of °K
26	+	
27	RM	
28	1	
29	=	
30	GTO	
31	2	
32	5	
33	R/S	Input of °K or display of °C
34	−	
35	RM	
36	1	
37	=	
38	GTO	
39	3	
40	3	
41	R/S	Input of °F or display of °C
42	×	
43	RM	
44	0	
45	1/X	
46	+	
47	2	
48	5	
49	5	
50	•	
51	4	
52	=	
53	GTO	
54	4	
55	1	
56	R/S	Input of °K or display of °F
57	−	
58	2	
59	5	
60	5	
61	•	
62	4	
63	=	
64	×	
65	RM	
66	0	
67	=	
68	GTO	
69	5	
70	6	
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Unit conversion (On weight) (pounds, ounces, grams)	PROGRAM NO.	I-3

FORMULA

$$1\ [\text{pound}] = 16\ [\text{ounce}]$$

$$1\ [\text{gram}] = \frac{1}{453.6}\ [\text{pound}]$$

$$= \frac{1}{28.35}\ [\text{ounce}]$$

EXAMPLES

Conversion	⟨Input⟩	⟨Output⟩
pound → ounce	2.8	44.80000
ounce → pound	18.5	1.15625
pound → gram	2.2	997.92000
gram → pound	1080.0	2.38095
ounce → gram	13.2	374.22000
gram → ounce	1080.0	38.09524

OPERATION

1) pound → ounce
1. [GTO] [0] [0]
2. [R/S]
3. Input of pound
4. [R/S]
Display of ounce

2) ounce → pound
1. [GTO] [0] [8]
2. [R/S]
3. Input of ounce
4. [R/S]
Display of pound

3) pound → gram
1. [GTO] [1] [7]
2. [R/S]
3. Input of pound
4. [R/S]
Display of gram

4) gram → pound
1. [GTO] [2] [8]
2. [R/S]
3. Input of gram
4. [R/S]
Display of pound

5) ounce → gram
1. [GTO] [4] [0]
2. [R/S]
3. Input of ounce
4. [R/S]
Display of gram

6) gram → ounce
1. [GTO] [5] [1]
2. [R/S]
3. Input of gram
4. [R/S]
Display of ounce

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0	R/S	
1	×	
2	1	
3	6	pound → ounce
4	=	
5	GTO	
6	0	
7	0	
8	R/S	
9	×	
10	1	
11	6	
12	1/X	ounce → pound
13	=	
14	GTO	
15	0	
16	8	
17	R/S	
18	×	
19	4	
20	5	
21	3	
22	•	pound → gram
23	6	
24	=	
25	GTO	
26	1	
27	7	
28	R/S	
29	×	
30	4	
31	5	
32	3	
33	•	gram → pound
34	6	
35	1/X	
36	=	
37	GTO	
38	2	
39	8	
40	R/S	
41	×	
42	2	
43	8	
44	•	
45	3	ounce → gram
46	5	
47	=	
48	GTO	
49	4	
50	0	
51	R/S	
52	×	
53	2	
54	8	
55	•	
56	3	gram → ounce
57	5	
58	1/X	
59	=	
60	GTO	
61	5	
62	1	
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG RAD	DPS
Arbitrary	5

PROGRAM TITLE	Unit conversion (In volume) (gallons(U.S)→liters, $cm^3 \rightarrow in^3$)	PROGRAM NO.	I-4

FORMULA

1 〔liter〕= 0.26417 〔gallon〕(U.S)

1 〔gallon〕(U.S) = 3.78543 〔liter〕

1 〔cm^3〕= 0.06102 〔in^3〕

1 〔in^3〕= 16.3871 〔cm^3〕

EXAMPLES

〈Input〉	〈Output〉
1.2 〔liter〕	0.317 〔gallon〕(U.S)
7 〔gallon〕(U.S)	26.49801 〔liter〕
123 〔cm^3〕	7.50546 〔in^3〕
13 〔in^3〕	213.0323 〔cm^3〕

OPERATION

1) liter→gallon (U.S)
   1. GTO 0 0
   2. R/S
   3. Input of liter
   4. R/S
      Display of gallon (U.S)
2) gallon (U.S)→liter
   1. GTO 1 2
   2. R/S
   3. Input of gallon (U.S)
   4. R/S
   5. Display of liter
3) $cm^3 \rightarrow in^3$
   1. GTO 2 5
   2. R/S
   3. Input of cm^3
   4. R/S
   5. Display of in^3
4) $in^3 \rightarrow cm^3$
   1. GTO 3 7
   2. R/S
   3. Input of in^3
   4. R/S
   5. Display of cm^3

NOTES

DATA MEMORY

M0	
M1	
M2	
M3	
M4	
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Input of liter or display of gallon
1	×	
2	•	
3	2	
4	6	
5	4	
6	1	
7	7	
8	=	
9	GTO	
10	0	
11	0	
12	R/S	Input of gallon or display of liter
13	×	
14	3	
15	•	
16	7	
17	8	
18	5	
19	4	
20	3	
21	=	
22	GTO	
23	1	
24	2	
25	R/S	Input of cm^3 or display of in^3
26	×	
27	•	
28	0	
29	6	
30	1	
31	0	
32	2	
33	=	
34	GTO	
35	2	
36	5	
37	R/S	Input of in^3 or display of cm^3
38	×	
39	1	
40	6	
41	•	
42	3	
43	8	
44	7	
45	1	
46	=	
47	GTO	
48	3	
49	7	
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS
ARB		O

PROGRAM TITLE	PROGRAM NO.
dBA Fall-off over varying distances	

FORMULA

Inverse Square Law

$$\text{dBA decay} = \left(10 \log_{10} \frac{1}{4\pi r^2}\right) \rightarrow F$$

Know dBA & dist ↓ a, b,   feed in new distance ↓

F_1 F_2

$F_2 - F_1 = F_3$

f = decay due to ground absorbtion.

EXAMPLES

OPERATION

Feed in Inputs off
– known Sound level and distance from source

~~R/S~~ GTO 00
R/S – Known Dist
R/S " S.L.
R/S Ground absorption factor (dbA/100m)
↓
Feed in desired dist.
R/S
↓
Display S.L at that dist from source.

NOTES

Grass 3dB(A)/100m.
Trees 5dB(A)/100m.

DATA MEMORY

M0	Init Dist
M1	" dBA
M2	decay factor
M3	F_1
M4	New dist
M5	
M6	
M7	
M8	
M9	

STEP	PROGRAM	NOTE
0	R/S	Known dist
1	SM 0	
2	0	
3	R/S	Known SL
4	SM	
5	1	
6	R/S	Decay factor
7	SM	
8	2	
9	RM	Known dist
10	0	
11	x^2	
12	×	
13	π	
14	×	
15	4	2 for hemi
16	=	
17	1/x	
18	Log	
19	×	
20	1	
21	0	
22	=	
23	SM	
24	3	
25	R/S	New dist
26	SM	
27	4	
28	x^2	
29	×	
30	π	
31	×	
32	4	2 for hem.
33	=	
34	1/x	
35	Log	
36	×	
37	1	
38	0	
39	–	
40	RM	
41	3	
42	+	
43	RM	
44	1	
45	=	
46	SM	
47	5	
48	RM	
49	4	
50	–	
51	RM	
52	0	
53	×	
54	[	
55	RM	
56	2	
57	÷	
58	1	
59	0	
60	0	
61	]	
62	=	
63	–	
64	RM	
65	5	
66	x↔y	
67	=	
68	GTO	
69	2	
70	5	
71		

CZ-0911PG PROGRAM LIBRARY

DEG	RAD	DPS

PROGRAM TITLE		PROGRAM NO.	

FORMULA

EXAMPLES

OPERATION

NOTES

DATA MEMORY

M_0	
M_1	
M_2	
M_3	
M_4	
M_5	
M_6	
M_7	
M_8	
M_9	

STEP	PROGRAM	NOTE
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		

SANYO
SANYO ELECTRIC TRADING CO.,LTD.
OSAKA, JAPAN

Printed in Japan