PROGRAM LIBRARY

FX-601P
FX-602P

CASIO

PROGRAM LIBRARY

FX-601P/FX-602P

CASIO

This program library gives sample programs used in the CASIO FX-601P and FX-602P. Programs are divided according to each category. Some of them can be performed only on the FX-602P because of the step numbers or memory capacity considerations.

For each program, one program example is given on a double-spread of left and right pages (it may continue to the following pages). The left-hand pages are for the program name, formula and example (test data), key operation and respective display. The right-hand pages are for the contents of the programming, contents in memories, notes and remarks.

To perform programmed calculations, it is first necessary to correctly write (store) the program shown on the right-hand page into the calculator.

To write a program, put the calculator in the WRT mode (press [MODE] [3] [INV] [MAC] [MODE] [·] [2] [0] [MODE] [2] as shown in the preparation line). If the program area for write-in is empty, [MODE] [3] [INV] [MAC] (This operation clears all the program area) can be omitted. Further, if the memory number has already been preset, [MODE] [·] [2] [0] (This operation sets the calculator at 22 memories and 512 program steps) can also be omitted.

* For the 601P, [MODE] [·] [2] [0] is not necessary because of no function of memory/program split settings.

Following completion of the above preparations, key in the program instructions for each line, reading from left to right. The punctuation symbols (,) are simply to separate neighboring steps and should not be keyed in.

The Step column at the right edge of the Program column shows the number of steps displayed during the WRT mode. This number will be the same as the number of punctuation symbols. The total number of the steps used in the program (including P No. setting) are shown at the end of the Step column.

After writing in each line of program, check the step number both in the Step column and in the display of the calculator. This will allow early detection of errors.

* For the FX-601P, substitute single-digit numerical keys (1 to 9) for 00 to 09 following INV AR or the memory keys (X⇌M, Min, MR, M−, and M+). However, number of steps will not be changed.

When program writing is completed, now you can start execution of the program.

Put the calculator in the RUN mode ([MODE] [1]) and perform Key Operation as shown on the bottom of the left-hand page. When using the sample data given, the correct sample answer must be displayed. This allows you to confirm that the program is properly written in. Then, go on to perform the actual desired calculations.

When the key Operation column is blank and there is an entry in the Display column, this indicates an automatic change in the display (pause display or alphabetical characters of 12 or more) continuing from the display of the previous operation.

Library programs may not suit your specific purposes but these programs are designed to be used as a guide in building programs exactly suited to performing the calculations you need. The description of the program and the use of registers and remarks will facilitate modification.

PLEASE NOTE

The programs in this library book are provided to be used freely; no licence or permission for use is required.

CASIO, however, disclaims all responsibility for any losses or missed profits incurred through use of these programs.

The program library is subject to addition and improvement without prior notice.

Mathematics

Electrical engineering

Mechanics

Physics/chemistry

Statistics

Medicine

Banking

Navigation

Game

Music

CASIO PROGRAM SHEET

Program for	No.	
Prime Factor Analysis	Mathematics–1	

Description

• Input the program written in the next page.

Prime factors of arbitrary positive integers are selected.

For $1<m<10^{10}$
prime numbers are selected starting with the smallest.
When "END" is displayed, the program ends.

<Approach>
m is divided by 2 and d = 3, 5, 7, 9, 11, 13 . . . . (all odd numbers) in that sequence, and divisibility is determined. Where d is a prime number, $m_i=m_{i-1}/d$ is assumed, and division is repeated until $\sqrt{m_i}+1 \leq d$.

Example

<Ex. 1>
119=7 x 17

<Ex. 2>
1234567890 = 2x3x3x5x3607x3803

<Ex. 3>
987654321 = 3x3x17x17x379721

<Ex. 4>
2512549139 = 4283 x 586633

Step	Data input operation	Read-out	Remark
	MODE 1		
1	119 PO	START×7	Smallest prime number
2	EXE	START×7×17	Next prime number
3	EXE	RT×7×17×END	End indicator
4	1234567890 PO	START×2	
5	EXE	START×2×3	
6	EXE	START×2×3×3	
7	EXE	ART×2×3×3×5	
8	EXE	×3×3×5×3607	After approx. 3 min. 50 sec.
9	EXE	5×3607×3803	
10	EXE	07×3803×END	

Step	Data input operation	Read-out	Remark
11	987654321 PO	START×3	
12	EXE	START×3×3	
13	EXE	TART×3×3×17	
14	EXE	T×3×3×17×17	
15	EXE	7×17×379721	After approx. 40 sec.
16	EXE	×379721×END	
17	2512549139 PO	START×4283	After approx. 4 min. 40 sec.
18	EXE	4283×586633	
19	EXE	×586633×END	
20			
21			

Program for

Prime Factor Analysis

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	PO Min 01 AC INV "AL S T A R T INV AL" GOTO 2		10
2	LBL 1 MR 01 ÷ 2 INV "AL INV ; × INV # INV AL" HLT =		21
3	Min 01 − 1 = INV X=0 GOTO 0		27
4	LBL 2 MR 01 ÷ 2 . = INV FRAC INV X=0 GOTO 1		35
5	LBL 3 3 Min 02		38
6	LBL 4 MR 01 INV √ Min F 1 M+ F		44
7	LBL 5 MR 01 ÷ MR 02 INV X≧F GOTO 7 =		51
8	INV FRAC INV X=0 GOTO 8		54
9	LBL 6 2 M+ 02 GOTO 5		58
10	LBL 8 MR 01 ÷ MR 02 × MR 02 − MR 01 =		67
11	INV X=0 GOTO 9 GoTo 6		70
12	LBL 9 MR 01 ÷ MR 02 INV "AL INV ; × INV # INV AL" HLT		80
13	= Min 01 GOTO 4		83
14	LBL 7 MR 01 INV "AL INV ; × INV # INV AL" HLT		91
15	LBL 0 INV "AL INV ; × E N D INV AL"		99
16			
17		Total 100	
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	mi
02	d
03	
04	
05	
06	
07	
08	
09	
F	$\sqrt{m}+1$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

When division is completed in lines 7~8, the resulting numerical values are again checked in lines 10~11, and confirmation made that these are indeed prime numbers. This eliminates errors due to computer rounding of numbers.

Ex.) 2512549139 ÷ 2141 = 1173539.9995 . . .

↓

rounded to 1173540

CASIO PROGRAM SHEET

Program for	No.	
Greatest Common Measure	Mathematics–2	

Description

• Input the program written in the next page.

Euclidean general division is used to determine the greatest common measure of two integers a and b.

For |a|, |b| $< 10^9$, positive values are taken as $<10^{10}$.

<Approach>

$n_0 = \max(|a|, |b|)$

$n_1 = \min(|a|, |b|)$

$$n_k = n_{k-2} - \left[\frac{n_{k-2}}{n_{k-1}}\right] n_{k-1}$$

$k = 2, 3 \ldots\ldots\ldots\ldots$

If $n_k = 0$, then the greatest common measure (c) will be n_{k-1}.

Example

	Example 1	Example 2	Example 3
IF	a = 238	a = 23345	a = 522952
	b = 374	b = 9135	b = 3208137866
THEN	c = 34	c = 1015	c = 998

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1		
2	PO	INPUT〈a〉	
3	238 EXE	INPUT〈b〉	
4	374 EXE	〈c〉= 34	
5	Example 2		
6	PO	INPUT〈a〉	
7	23345 EXE	INPUT〈b〉	
8	9135 EXE	〈c〉= 1015	
9			
10			

Step	Data input operation	Read-out	Remark
11	Example 3		
12	PO	INPUT〈a〉	
13	522952 EXE	INPUT〈b〉	
14	3208137866 EXE	〈c〉= 998	
15			
16			
17			
18			
19			
20			
21			

Program for

Greatest Common Measure

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0		
2	AC INV "AL I N P U T INV SPACE INV < INV a	Input a	10
3	INV > INV AL" HLT INV ABS Min 01 Min F		16
4	AC INV "AL I N P U T INV SPACE INV < INV b	Input b	26
5	INV > INV AL" HLT INV ABS Min 02		31
6	INV X≧F X ↔M 01 Min 02	|a|, |b| compared	34
7	LBL 1 MR 01 ÷ MR 02 = INV INT × MR 02 − MR 01 =	n_k	45
8	+/− INV X=0 GOTO 2	n_k=0?	48
9	X↔M 02 Min 01 GOTO 1		51
10	LBL 2 MR 02 INV "AL INV < INV C INV > = INV # INV #		60
11	INV # INV # INV # INV # INV # INV AL"		66
12			
13		Total 67	
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	a n_0
02	b n_1
03	$n_0 \left\lfloor \frac{n_0}{n_1} \right\rfloor n_1$
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.
Decimal ↔ Base-n Conversion (n=2~9)	Mathematics–3

Description

• Input the program written in the next page.

This program converts decimal notation to base-n, and base-n to decimal. n is taken as 2~9. Both input and answer are limited to positive integers of no more than 10 digits.

Example

Example 1

Decimal 11 is expressed in binary notation as 1011
Decimal 1000 is expressed in binary notation as 1111101000

Example 2

Binary 1011 is expressed in decimal notation as 11
Binary 11111 is expressed in decimal notation as..... 31

Example 3

Base-5 3214241 is expressed in decimal notation as 54321

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1 P1	〈10→n〉→n ?	
2	2 EXE	INPUT〈x〉	
3	11 EXE	1011	
4	EXE	INPUT〈x〉	
5	1000 EXE	1111101000	
6			
7	Example 3 P1	〈10→n〉→n ?	
8	EXE	〈n→10〉→n ?	
9	5 EXE	INPUT〈x〉	
10	3214241 EXE	54321	

Step	Data input operation	Read-out	Remark
11	Example 2 P1	〈10→n〉→n ?	
12	EXE	〈n→10〉→n ?	
13	2 EXE	INPUT〈x〉	
14	1011 EXE	11	
15	EXE	INPUT〈x〉	
16	11111 EXE	31	
17			
18			
19			
20			
21			

Program for

Decimal ↔ Base-n Conversion (n=2~9)

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2	(Decimal → base-n)	
1	P1 AC INV "AL INV < 1 O INV → INV n INV > INV SPACE		9
2	INV → INV SPACE INV n INV ? INV AL" HLT INV x=0 GOTO 1		17
3	Min F Min 01 1 O Min 02 GSB P2		23
4	LBL 1 INV "AL INV < INV n INV → 1 O INV > INV SPACE	(Base-n→decimal)	32
5	INV → INV SPACE INV n INV ? INV AL" HLT Min 02 1 O		41
6	Min 01 AC Min F GSB P2		45
7			
8	P2		
9	LBL 1 AC INV "AL I N P U T INV SPACE INV < INV x		11
10	INV > INV AL" HLT Min 03 O Min 00 Min 04		18
11	LBL 2 MR 03 ÷ MR 01 = INV INT Min 05 INV x=0 GOTO 3		27
12	MR 03 − MR 05 × MR 01 = GSB P3 MR 05 Min 03		36
13	INV ISZ GOTO 2		38
14	LBL 3 MR 03 GSB P3 AC INV x=F GOTO 4 INV "AL INV < 1 O		48
15	INV → INV AR 01 INV > INV AL" INV PAUSE MR 04 HLT		55
16	GOTO 1		56
17	LBL 4 INV "AL INV < INV AR 02 INV → 1 O INV > INV AL"		65
18	INV PAUSE MR 04 HLT GOTO 1		69
19			
20	P3 × MR 02 INV x^y MR 00 = M+ 04		6
21			
22		Total 123	
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	Digit count
01	n 10
02	10 n
03	Multiplicand or dividend
04	Answer
05	Integer portion of quotient
06	
07	
08	
09	
F	Determination of [10→n] [n→10]
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

For P1 with display ⟨10→n⟩→n?, when converting decimal to base-n notation n is input. For base-n decimal conversion, the EXE key is pressed, ⟨n→10⟩→n? is displayed, and n is put.
For output display, preceding the answer the type of conversion (⟨10→n⟩ or ⟨n→10⟩) is indicated with a temporary display, the answer is output, and the program goes to HLT.

CASIO PROGRAM SHEET

Program for	No.	
Calculation of Remainder	Mathematics—4	

Description

• Input the program written in the next page.

This program determines the quotient (integer portion of the answer) and the remainder which result from division.

Example

100 ÷ 7 = 14 remainder 2
250 ÷ 11 = 22 remainder 8

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	100 ÷			12			
2	7 PO	14	Quotient	13			
3	EXE	···2	Remainder	14			
4	250 ÷			15			
5	11 PO	22	Quotient	16			
6	EXE	···8	Remainder	17			
7				18			
8				19			
9				20			
10				21			

Program for **Calculation of Remainder**

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	
1	P0 Min 01 INV X↔Y Min 02 = INV 1/x INV INT HLT × MR 01		9	01	
2	= M− 02 MR 02 INV "AL • • • INV # INV AL"		18	02	
3				03	
4		Total 19		04	
5				05	
6				06	
7				07	
8				08	
9				09	
10				F	
11				10	
12				11	
13				12	
14				13	
15				14	
16				15	
17				16	
18				17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

CASIO PROGRAM SHEET

Program for	No.	
Polynomial Calculations	Mathematics–5	

Description

• Input the program written in the next page.

This program finds $f_{(x)} = a_n x^n + a_{n-1} x^{n-1} + \cdots\cdots + a_1 x + a_0$ when x is a real number. However, for $a_0 \sim a_n$ some real number x are negative, so that x^y cannot be used. The $f_{(x)}$ formula is therefore transformed in the following way and calculations are made.

$f_{(x)} = \{(((a_n \times x) + a_{n-1}) \times x + a_{n-2}) \times x + \cdots\cdots + a_1\} \times x + a_0$

Example

$f(x) = 13x^7 - 9x^6 + 12x^4 - 4x^3 + 3x + 5$
$f(4) = 178961$
$f(2.5) = 6156.054687$
$f(19) = 1.119845616^{10}$

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	4 EXE	f(4)=178961	
1	PO	(n) ?		12	EXE	(x) ?	
2	7 EXE	(a7) ?		13	2.5 EXE	f(2.5)=6156	
3	13 EXE	(a6) ?		14		6156.054688	
4	9 +/- EXE	(a5) ?		15	EXE	(x) ?	
5	EXE	(a4) ?		16	19 EXE	f(19)=1.119	
6	12 EXE	(a3) ?		17		9845616E10	
7	4 +/- EXE	(a2) ?		18	=	1.119845616^{10}	
8	EXE	(a1) ?		19			
9	3 EXE	(a0) ?		20			
10	5 EXE	(x) ?		21			

Program for **Polynomial Calculations**

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00	
1	PO INV MAC INV "AL INV (INV n INV) INV ? INV AL" HLT		8	01	
2	Min 00 Min F 1 M+ F		12	02	
3	LBL 1 AC INV "AL INV (INV a INV AR 00 INV) INV ?		20	03	
4	INV AL" HLT INV IND Min 00 INV DSZ GOTO 1		26	04	
5	MR F Min 00 1 M+ 00		30	05	
6	AC INV "AL INV (INV a O INV) INV ? INV AL" HLT		39	06	
7	INV IND Min 00 AC		42	07	
8	LBL 2 INV "AL INV (INV x INV) INV ? INV AL" HLT INV "AL		51	08	
9	INV f INV (INV # INV) INV AL" INV IND Min F		58	09	
10	MR F Min 00 1 M− 00 AC		63	F	
11	LBL 3 INV IND MR 00 = × INV IND MR F + INV DSZ GOTO 3		73	10	
12	MR F Min 00 1 M+ 00 O + INV IND MR 00 =		82	11	
13	INV "AL INV ; = INV # INV AL" HLT GOTO 2		89	12	
14		Total 90		13	
15				14	
16				15	
17				16	
18				17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

With FX-601P, the above program can calculate degree (n) as far as 7.
For FX-602P, calculations may be made through 69. However, for 18 and above, the operation should be executed after performing A = n + 2 (18 ≦ n ≦ 69) MODE • Value of A .

CASIO PROGRAM SHEET

Program for	No.	
Permutations and Combinations	Mathematics–6-1	

Description

• Input the program written in the next page.

- Permutations (P0 Program)
  From each different n, the number of single-series permutations formed by the removal of each r is
  $nPr = \frac{n!}{(n-r)!}$ $(n \geq r)$.
- Circular Permutations (P1 Program)
  The number of methods of placing each different n in a ring is $(n-1)!$ $(n \leq 70)$.
- Repeated Permutations (P2 Program)
  From each different n, with repeated removal of the same number permitted, the number of permutations formed by the removal of each r is n^r ($n < r$ is permitted).
- Permutations is which the Same Numbers Occur (P3 Program)
  Where within each n is found identical unit P, identical unit q differing from p, identical unit r differing from the two previous . . . . then the number of permutations which can be made from all n is $\frac{n!}{p!\,q!\,r!\ldots}$ $(p+q+r+\ldots = n)$.
- Combinations (P4 Program)
  From each different n, the number of combinations yielded for each r is
  $nCr = \frac{nPr}{r!}$ (with $nCn = 1$ and $nC_1 = n$).
- Repeated Combinations (P5 Program)
  From each different n, with repeated removal of the same number permitted, the number of combinations formed by the removal of each r is
  $nHr = {}_{n+r-1}Cr$.

Example

1. Find ${}_7P_5$ and ${}_7P_6$.
2. Find circular permutations for 6 and 7.
3. Determine a method of ranking 3 units of A, 2 units of B, and 1 unit of C in a single row.
4. Find ${}_{18}C_4$ and ${}_{18}C_7$.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1 P0	n = 0 ?	
2	7 EXE	r = 0 ?	
3	5 EXE	7P5=2520	
4	EXE	n=7 ?	
5	EXE	r=5 ?	
6	6 EXE	7P6=5040	
7	Example 2 P1	n ?	
8	6 EXE	(6-1) ! =120	
9	EXE	n ?	
10	7 EXE	(7-1) ! =720	
11	Example 3 P3	0	
12	3 EXE	〈n=3〉=1	
13	2 EXE	〈n=5〉=1 0	
14	1 EXE	〈n=6〉=6 0	
15	Example 4 P4	n= 0 ?	
16	18 EXE	r= 0 ?	
17	4 EXE	18C4=3060	
18	EXE	n=18 ?	
19	EXE	r=4 ?	
20	7 EXE	18C7=31824	
21			

Program for

Permutations and Combinations

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2	Permutation		00
1	P0 INV MAC ▶		1	01
2	LBL 1 ▶ GSB INV P8 ▶ INV x=0 ▶ GOTO 3 ▶ MR 09 ▶ Min 00 ▶ Min 01 ▶		8	02
3	GSB INV P9 ▶ INV x=0 ▶ GOTO 2 ▶ GOTO 4 ▶		12	03
4	LBL 2 ▶ MR 01 ▶ INV x! ▶ GOTO 4 ▶		16	04
5	LBL 3 ▶ 1 ▶		18	05
6	LBL 4 ▶ INV "AL ▶ INV AR 09 ▶ P ▶ INV AR 02 ▶ = ▶ INV # ▶ INV AL" ▶ HLT ▶		27	06
7	GOTO 1 ▶		28	07
8				08
9	P1	Circular permutation		09
10	LBL 1 ▶ INV "AL ▶ INV n ▶ INV ? ▶ INV AL" ▶ HLT ▶ INV "AL ▶ INV (▶ INV # ▶		9	F
11	− ▶ 1 ▶ INV) ▶ INV ! ▶ = ▶ INV AL" ▶ − ▶ 1 ▶ = ▶ INV x! ▶		19	10
12	INV "AL ▶ INV ; ▶ INV # ▶ INV AL" ▶ HLT ▶ GOTO 1 ▶		25	11
13				12
14	P2 INV "AL ▶ INV n ▶ INV ? ▶ INV AL" ▶ HLT ▶ Min 01 ▶ 0 ▶	Repeated permutation	7	13
15	LBL 1 ▶ INV "AL ▶ INV r ▶ INV ? ▶ INV AL" ▶ HLT ▶ Min 02 ▶ MR 01 ▶ INV x^y ▶		16	14
16	MR 02 ▶ = ▶ INV "AL ▶ INV AR 01 ▶ E ▶ INV SPACE ▶ INV AR 02 ▶ = ▶		24	15
17	INV # ▶ INV AL" ▶ HLT ▶ GOTO 1 ▶		28	16
18				17
19	P3 INV MAC ▶ 1 ▶ Min 02 ▶ 0 ▶	Same . . . permutation	4	18
20	LBL 1 ▶ HLT ▶ Min 00 ▶ M+ 01 ▶ INV x! ▶ × ▶ MR 02 ▶ = ▶ Min 02 ▶ MR 01 ▶		14	19
21	INV x! ▶ ÷ ▶ MR 02 ▶ = ▶ INV "AL ▶ INV < ▶ INV n ▶ = ▶ INV AR 01 ▶		23	1F
22	INV > ▶ = ▶ INV # ▶ INV AL" ▶ GOTO 1 ▶		28	20
23				21
24	P4 INV MAC ▶	Combination	1	22
25	LBL 1 ▶ GSB INV P8 ▶ MR 09 ▶ Min 00 ▶ Min 01 ▶ GSB INV P9 ▶ INV x=0 ▶		8	23
26	GOTO 2 ▶ ÷ ▶ MR 02 ▶ INV x! ▶ = ▶ GOTO 3 ▶		14	24
27	LBL 2 ▶ 1 ▶		16	25
28	LBL 3 ▶ INV "AL ▶ INV AR 09 ▶ C ▶ INV AR 02 ▶ = ▶ INV # ▶ INV AL" ▶ HLT ▶		25	26
29	GoTo 1 ▶		26	27
30				28
31	Continued to next page			29
32				2F
33				
34				
35				
36				
37				

Note

Since the FX-601P does not have a sufficient number of steps for this program, select the arbitrary programs from among P0~P5 whose total number of steps will be within 128. Programs P8 and P9 are used as subroutines of P0, P4 and P5.

CASIO PROGRAM SHEET

Program for	No.	
Permutations and Combinations	Mathematics–6-2	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Permutations and Combinations

	Program	Remark	Step	Contents in memories
				00
1	INV P5	Repeated combination		01
2	LBL 1 | GSB INV P8 | MR 09 | + | MR 02 | − | 1 | = | Min 00 | Min 01 |		10	02
3	GSB INV P9 | INV x=0 | GOTO 2 | ÷ | MR 02 | INV x! | = | GOTO 3 |		18	03
4	LBL 2 | 1 |		20	04
5	LBL 3 | INV "AL | INV AR 09 | H | INV AR 02 | = | INV # | INV AL" | HLT |		29	05
6	GOTO 1 |		30	06
7				07
8	INV P8 MR 09 | INV "AL | INV n | = | INV # | INV ? | INV AL" | HLT |	Subroutine	8	08
9	Min 09 |		9	09
10	MR 02 | INV "AL | INV r | = | INV # | INV ? | INV AL" | HLT |		17	F
11	Min 02 |		18	10
12				11
13	INV P9 MR 01 | − | MR 02 | = | Min F | O | INV x=F | GOTO 3 |	Subroutine	8	12
14	LBL 1 | INV DSZ | MR 00 | INV x=F | GOTO 2 | × | MR 01 | = | Min 01 |		17	13
15	GOTO 1 |		18	14
16	LBL 2 | MR 01 |		20	15
17	LBL 3 |		21	16
18				17
19		Total 212		18
20				19
21				1F
22				20
23				21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	Complex arithmetics	No.	Mathematics– 7

Description

• Input the program written in the next page.

$z_1 = x_1 + iy_1$ ..... $r_1 = \sqrt{x_1^2 + y_1^2}$, $\theta_1 = \tan^{-1}\frac{y_1}{x_1}$

$z_2 = x_2 + iy_2$ ..... $r_2 = \sqrt{x_2^2 + y_2^2}$, $\theta_2 = \tan^{-1}\frac{y_2}{x_2}$

1. Sum and difference → [P0]

$z_1 + z_2 = (x_1 + x_2) + i(y_1 + y_2)$

$z_1 - z_2 = (x_1 - x_2) + i(y_1 - y_2)$

2. Product → [P1]

$z_1 \times z_2 \times \ldots \times z_n = R \cdot e^{i\theta} = (R \times \cos\theta) + i(R \times \sin\theta)$ $\left[\begin{array}{l} R = r_1 \times r_2 \times \ldots \times r_n \\ \theta = \theta_1 + \theta_2 + \ldots + \theta_n \end{array}\right]$

Input z_1 through z_n. Then operate [GoTo] [1]

to obtain x and y.

3. Quotient → [P2]

$$\frac{z_1}{z_2} = \frac{r_1}{r_2} \cdot e^{i(\theta_1 - \theta_2)} = \left\{\frac{r_1}{r_2} \times \cos(\theta_1 - \theta_2)\right\} + i\left\{\frac{r_1}{r_2} \times \sin(\theta_1 - \theta_2)\right\}$$

4. n-th power → [P3]

$z^n = r^n \cdot e^{in\theta} = (r^n \times \cos n\theta) + i(r^n \times \sin n\theta)$

5. n-th root → [P4]

$\sqrt[n]{z} = \sqrt[n]{r} \cdot e^{iA} = (\sqrt[n]{r} \times \cos A) + i(\sqrt[n]{r} \times \sin A)$

$$[A = \frac{\theta}{n} + \frac{360}{n}K \ (K = 0, 1, 2, \ldots\ldots, n-1)]$$

There are as many solution as "n" (k = 0, 1, ..., $n-1$)

Example

$z_1 = 2 + \sqrt{3}i$
$z_2 = 4 - i$
→

$z_1 + z_2 = 6 + 0.732i$
$z_1 - z_2 = -2 + 2.732i$
$z_1 \times z_2 = 9.732 + 4.928i$

$(z_1)^5 = -118 - 53.693i$
$(z_1)^{1/2} = -1.524 - 0.568i$
$1.524 + 0.568i$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P0	0	
2	(x1) 2 EXE	0	
3	(y1) 3 INV √ EXE	0	
4	(x2) 4 EXE	0	
5	(y2) 1 +/- EXE	6	(x)
6	EXE	0.732050808	(y)
7	EXE	−2	(x)
8	EXE	2.732050808	(y)
9	P1	0	
10	2 EXE 3 INV √ EXE	0	

Step	Data input operation	Read-out	Remark
11	4 EXE 1 +/- EXE	9.732050807	(x)
12	EXE	4.92820323	(y)
13	(n) 5 P3	0	
14	2 EXE 3 INV √ EXE	−117.999999	
15	EXE	−53.6935751	(y)
16	(n) 2 P4	0	
17	2 EXE 3 INV √ EXE	−1.52409831	(x)
18	EXE	−0.56822148	(y)
19	EXE	1.52409831	(x)
20	EXE	0.568221484	(y)
21			

Program for

Complex arithmetics

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 AC		1
2	INV MAC HLT X↔M 01 HLT X↔M 02 HLT X↔M 03 HLT X↔M 04		10
3	MR 01 + MR 03 M- 01 = HLT MR 02 + MR 04 M- 02 = HLT		22
4	MR 01 HLT MR 02		25
5			
6	P1 AC		1
7	GSB INV P8 GSB INV P7 0 GSB INV P8 INV X↔Y M+ 02		7
8	INV X↔Y × MR 01 = GSB INV P9		12
9			
10	P2 AC		1
11	GSB INV P8 GSB INV P7 0 GSB INV P8 INV X↔Y M- 02		7
12	INV X↔Y ÷ MR 01 INV X↔Y = GSB INV P9		13
13			
14	P3 Min 00 AC GSB INV P8 GSB INV P7 MR 02 × MR 00 = Min 02		9
15	MR 01 INV x^y MR 00 = GSB INV P9		14
16			
17	P4 Min 00 MODE 4 AC GSB INV P8 GSB INV P7 MR 01 INV $x^{1/y}$ MR 00 =		9
18	Min 01 MR 02 ÷ MR 00 = Min 02 3 6 0 ÷ MR 00 = Min 03		22
19	LBL 1 MR 03 M+ 02 MR 01 GSB INV P9 HLT INV DSZ GOTO 1		30
20			
21	INV P7 Min 01 INV X↔Y Min 02		3
22			
23	INV P8 HLT INV R↔P 0 HLT =		5
24			
25	INV P9 INV P↔R MR 02 = HLT INV X↔Y		5
26			
27		Total 115	
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	n
01	x_1 r
02	y_1 θ
03	x_2 360/n
04	y_2
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

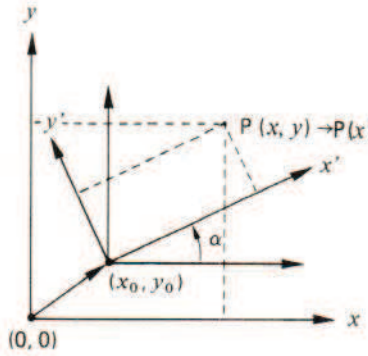
Note

CASIO PROGRAM SHEET

Program for	Transformation of coordinates	No.	Mathematics-8

Description

• Input the program written in the next page.



$$P(x, y) \rightarrow P(x', y')$$

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

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

Example

P (5, 5)→(x_0, y_0) = (3, 2)/ $\alpha = 20°$

what is P (x', y') ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	x = 0 ?		12			
2	5 EXE	y = 0 ?		13			
3	5 EXE	x 0 = 0 ?		14			
4	3 EXE	y 0 = 0 ?		15			
5	2 EXE	a = ?		16			
6	20 EXE	x, = 2.905445		17			
7		2.905445672		18			
8	EXE	y, = 2.135037		19			
9		2.135037576		20			
10				21			

Program for

Transformation of coordinates

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC		1
2	LBL 1 MR 01 INV "AL" INV x = INV # INV ? INV AL" HLT		10
3	Min 01		11
4	MR 02 INV "AL" INV y = INV # INV ? INV AL" HLT		19
5	Min 02		20
6	MR 03 INV "AL" INV x_0 = INV # INV ? INV AL" HLT		29
7	Min 03		30
8	MR 04 INV "AL" INV y $_0$ = INV # INV ? INV AL" HLT		39
9	Min 04		40
10	MR 05 INV "AL" INV a = INV # INV ? INV AL" HLT		48
11	Min 05		49
12	MR 01 − MR 03 = Min 06 MR 02 − MR 04 =		58
13	Min 07 MR 06 × MR 05 cos + MR 07 × MR 05 sin		68
14	= INV "AL" INV x INV , = INV # INV AL" HLT		76
15	MR 07 × MR 05 cos − MR 06 × MR 05 sin =		86
16	INV "AL" INV y INV , = INV # INV AL" HLT GOTO 1		94
17			
18		Total 95	
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	x
02	y
03	x_0
04	y_0
05	a
06	$x - x_0$
07	$y - y_0$
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
4-by-4 determinant	Mathematics– 9	FX-602P

Description

• Input the program written in the next page.

$$A = \begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{vmatrix}$$

$$= (a_{11}a_{22} - a_{12}a_{21})(a_{33}a_{44} - a_{34}a_{43}) + (a_{13}a_{21} - a_{11}a_{23})(a_{32}a_{44} - a_{34}a_{42})$$
$$+ (a_{11}a_{24} - a_{14}a_{21})(a_{32}a_{43} - a_{33}a_{42}) + (a_{12}a_{23} - a_{13}a_{22})(a_{31}a_{44} - a_{34}a_{41})$$
$$+ (a_{14}a_{22} - a_{12}a_{24})(a_{31}a_{43} - a_{33}a_{41}) + (a_{13}a_{24} - a_{14}a_{23})(a_{31}a_{42} - a_{32}a_{41})$$

Example

$$A = \begin{vmatrix} 2 & 0 & 1 & 3 \\ -1 & 2 & -1 & 1 \\ 0 & 1 & 0 & -2 \\ 1 & -3 & 2 & 1 \end{vmatrix} = 13$$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	a11 ?	
2	2 EXE	a21 ?	
3	1 +/- EXE	a31 ?	
4	0 EXE	a41 ?	
5	1 EXE	a12 ?	
6	0 EXE	a22 ?	
7	2 EXE	a32 ?	
8	1 EXE	a42 ?	
9	3 +/- EXE	a13 ?	
10	1 EXE	a23 ?	

Step	Data input operation	Read-out	Remark
11	1 +/- EXE	a33 ?	
12	0 EXE	a43 ?	
13	2 EXE	a14 ?	
14	3 EXE	a24 ?	
15	1 EXE	a34 ?	
16	2 +/- EXE	a44 ?	
17	1 EXE	A=13	
18			
19			
20			
21			

Program for
4-by-4 determinant

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC		1
2	LBL 1 1 M+ F		4
3	LBL 2 1 0 M+ F INV ISZ INV "AL INV a INV AR F INV ?		13
4	INV AL" HLT INV IND Min 00 4 0 INV X≥F GOTO 2 GOTO 3		22
5	LBL 3 4 0 M- F 4 INV X=F GOTO 4 GOTO 1		30
6	LBL 4 0 Min 19		33
7	MR 16 × MR 11 − MR 12 × MR 15 = Min 17		42
8	MR 06 × MR 01 − MR 02 × MR 05 = Min 18		51
9	GSB P1		52
10	MR 08 × MR 15 − MR 16 × MR 07 = Min 17		61
11	MR 10 × MR 01 − MR 02 × MR 09 = Min 18		70
12	GSB P1		71
13	MR 16 × MR 03 − MR 04 × MR 15 = Min 17		80
14	MR 10 × MR 05 − MR 06 × MR 09 = Min 18		89
15	GSB P1		90
16	MR 12 × MR 07 − MR 08 × MR 11 = Min 17		99
17	MR 14 × MR 01 − MR 02 × MR 13 = Min 18		108
18	GSB P1		109
19	MR 04 × MR 11 − MR 12 × MR 03 = Min 17		118
20	MR 14 × MR 05 − MR 06 × MR 13 = Min 18		127
21	GSB P1		128
22	MR 08 × MR 03 − MR 04 × MR 07 = Min 17		137
23	MR 14 × MR 09 − MR 10 × MR 13 = Min 18		146
24	GSB P1		147
25	INV "AL A = INV AR 19 INV AL"		152
26			
27	P1 MR 17 × MR 18 = M+ 19		5
28			
29		Total 159	
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	a_{11}
02	a_{21}
03	a_{31}
04	a_{41}
05	a_{12}
06	a_{22}
07	a_{32}
08	a_{42}
09	a_{13}
F	
10	a_{23}
11	a_{33}
12	a_{34}
13	a_{14}
14	a_{24}
15	a_{34}
16	a_{44}
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
3 variable linear equations	Mathematics- 1 0	FX-602P

Description

• Input the program written in the next page.

$$a_1x + b_1y + c_1z = d_1 \quad \text{(1)}$$

$$a_2x + b_2y + c_2z = d_2 \quad \text{(2)}$$

$$a_3x + b_3y + c_3z = d_3 \quad \text{(3)}$$

$$x = \frac{\begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}} \qquad y = \frac{\begin{vmatrix} a_1 & d_1 & c_1 \\ a_2 & d_2 & c_2 \\ a_3 & d_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}} \qquad z = \frac{d_1 - a_1x - b_1y}{c_1}$$

Example

$$x + y + z = 6$$
$$2x + 2y + z = 9$$
$$-x + y + z = 4$$

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	1 EXE	c3 ?	
1	PO	a1 ?		12	EXE	d3 ?	
2	1 EXE	b1 ?		13	4 EXE	x= 1	
3	EXE	c1 ?		14	EXE	y= 2	
4	EXE	d1 ?		15	EXE	z= 3	
5	6 EXE	a2 ?		16			
6	2 EXE	b2 ?		17			
7	EXE	c2 ?		18			
8	1 EXE	d2 ?		19			
9	9 EXE	a3 ?		20			
10	1 +/- EXE	b3 ?		21			

Program for

3 variable linear equations

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV MAC 1 2 Min 00 AC		5
2	LBL 1 1 M+ F		8
3	INV "AL" INV a INV AR F INV ? INV AL" HLT INV IND		15
4	Min 00 INV DSZ		17
5	INV "AL" INV b INV AR F INV ? INV AL" HLT INV IND		24
6	Min 00 INV DSZ		26
7	INV "AL" INV c INV AR F INV ? INV AL" HLT INV IND		33
8	Min 00 INV DSZ		35
9	INV "AL" INV d INV AR F INV ? INV AL" HLT INV IND		42
10	Min 00 INV DSZ GOTO 1		45
11	1 3 Min 13 GSB P2 4 Min 17 1 GSB INV P5 GSB P2		54
12	1 Min 17 3 GSB INV P5 3 Min 17 4 GSB INV P5		62
13	GSB P2 MR 15 ÷ MR 14 = Min 17 INV "AL" INV x =		71
14	INV # INV AL" HLT		74
15	MR 16 ÷ MR 14 = Min 18 INV "AL" INV y = INV #		83
16	INV AL" HLT		85
17	((MR 11 − MR 17 × MR 12 − MR 18 × MR 09		95
18	)) ÷ MR 10 = INV "AL" INV z = INV # INV AL"		104
19			
20	P1 MR 12 × MR 07 × MR 02 + MR 11 × MR 06		9
21	× MR 04 + MR 10 × MR 08 × MR 03 − ((MR 10		20
22	× MR 07 × MR 04 + MR 06 × MR 03 × MR 12 +		31
23	MR 02 × MR 11 × MR 08)) = INV IND Min 13		40
24			
25	P2 1 M+ 13 GSB P1		3
26			
27	P3 INV IND MR 17 Min F INV IND MR 18 INV IND Min 17		7
28	MR F INV IND Min 18		10
29			
30	P4		
31	LBL 1 4 M+ 17 M+ 18 GSB P3 INV DSZ GOTO 1		7
32			
33	INV P5 Min 18 2 Min 00 GSB P3 GSB P4		5
34			
35		Total 175	
36			
37			

	Contents in memories
00	
01	d_3
02	c_3
03	b_3
04	a_3
05	d_2
06	c_2
07	b_2
08	a_2
09	d_1
F	
10	c_1
11	b_1
12	a_1
13	
14	
15	
16	
17	x
18	y
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

The root of z is obtained from equation (1). If $c_1 = 0$, exchange equation (1) with (2) so that the divider be not zero.

$$\begin{cases} a_1x + b_1y = d_1 \ldots\ldots (1) \\ a_2x + b_2y + c_2z = d_2 \ldots\ldots (2) \\ a_3x + b_3y + c_3z = d_3 \ldots\ldots (3) \end{cases}$$

$$\begin{cases} a_2x + b_2y + c_2z = d_2 \ldots\ldots (1) \\ a_1x + b_1y = d_1 \ldots\ldots (2) \\ a_3x + b_3y + c_3z = d_3 \ldots\ldots (3) \end{cases}$$

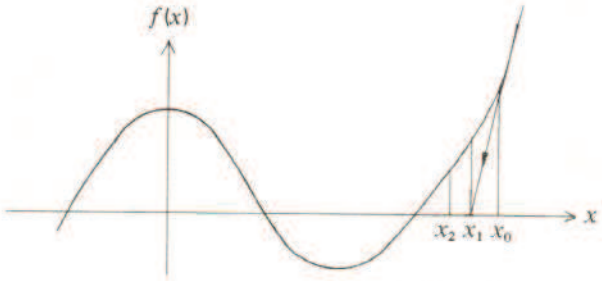
Input data a_1 through d_3 are stored in registers M01 through M12.

CASIO PROGRAM SHEET

Program for	Solving a cubic equation by the Newton method	No.	Mathematics–11

Description

• Input the program written in the next page.



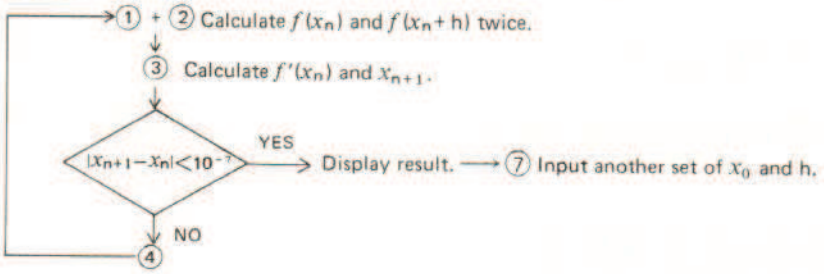
$$f(x) = ax^3 + bx^2 + cx + d$$

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

$$f'(x) = \frac{f(x+h) - f(x)}{h}$$

x_n will be taken as an approximate solution if $|x_{n+1} - x_n| < \epsilon_0$.

< Flowchart >



Example

$f(x) = x^3 + x^2 - x - 1$

$x_0 = 0$, $\epsilon_0 = 1 \times 10^{-7}$, h = 0.01

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	a ?		12			
2	1 EXE	b ?		13			
3	1 EXE	c ?		14			
4	1 +/− EXE	d ?		15			
5	1 +/− EXE	E0 ?		16			
6	1 EXP 7 +/− EXE	x0 ?		17			
7	2 EXE	h ?		18			
8	0.01 EXE	x=1.0000000		19			
9		=1.00000002		20			
10				21			

Program for

Solving a cubic equation by the Newton method

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV "AL" INV a INV ? INV AL" HLT Min 01		6
2	INV "AL" INV b INV ? INV AL" HLT Min 02		12
3	INV "AL" INV c INV ? INV AL" HLT Min 03		18
4	INV "AL" INV d INV ? INV AL" HLT Min 04		24
5	INV "AL" E 0 INV ? INV AL" HLT Min F		31
6	LBL 1 INV "AL" INV x 0 INV ? INV AL" HLT Min 05		39
7	INV "AL" INV h INV ? INV AL" HLT Min 06		45
8	LBL 2 MR 05 Min 07 2 Min 00		50
9	LBL 3 MR 01 × MR 05 INV x^2 × MR 05 + MR 02 ×		60
10	MR 05 INV x^2 + MR 03 × MR 05 + MR 04 =		69
11	Min 09 MR 06 M+ 05		72
12	INV DSZ GOTO 4		74
13	GOTO 5		75
14	LBL 4 MR 09 Min 08 GOTO 3		79
15	LBL 5 ((MR 09 − MR 08)) ÷ MR 06 = Min 09		89
16	MR 07 − MR 08 ÷ MR 09 = Min 08 − MR 07		98
17	= INV ABS INV $x \geqq$ F GOTO 6 GOTO 7		103
18	LBL 6 MR 08 Min 05 GOTO 2		107
19	LBL 7 INV "AL" INV x = INV AR 07 INV AL"		113
20			
21		Total 114	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	a
02	b
03	c
04	d
05	$x_0 \rightarrow x_n + h$
06	h
07	$x_0 \rightarrow x_n$
08	$f(x_n) \rightarrow x_{n+1}$
09	$f(x_n + h) \rightarrow f'(x_n)$
F	ε_0
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

If "−" remains displayed perpetually the approximation does not converge because start point x_0 is wrong. Depress AC, change the value of x_0 and repeat operation from step 1.

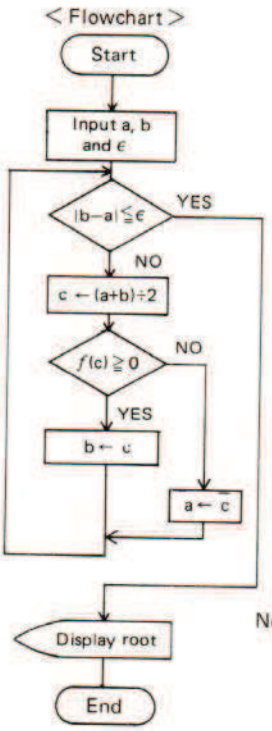
CASIO PROGRAM SHEET

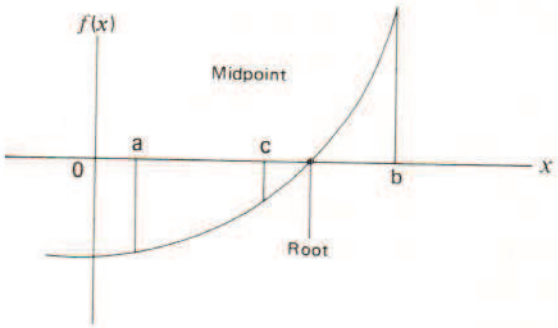
Program for	No.	
Solving an equation by the midpoint method	Mathematics–12	

Description

• Input the program written in the next page.

Let $f(x)$ be continuous in [a, b], $f(a) < 0$ and $f(b) > 0$.
Then there is a solution of $f(x) = 0$ in [a, b].





Example

$f(x) = x^3 + x^2 - x - 1$

a = 0, b = 2 ($f(0) < 0$, $f(2) > 0$)

ϵ = 0.00001 (ϵ: accuracy)

Obtain an approximate solution of $f(x) = 0$

Note: Input $f(x)$ as subroutine P1.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	a ?		12			
2	0 EXE	b ?		13			
3	2 EXE	E ?		14			
4	0.00001 EXE	x=0.9999923		15			
5		=0.99999237		16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Solving an equation by the midpoint method

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV "AL INV a INV ? INV AL" HLT Min 01		6
2	INV "AL INV b INV ? INV AL" HLT Min 02		12
3	INV "AL E INV ? INV AL" HLT Min F		18
4	LBL 1 MR 02 − MR 01 = INV ABS INV X≧F GOTO 2 GOTO 4		27
5	LBL 2 ((MR 01 + MR 02)) ÷ 2 = Min 03 GSB P1		38
6	INV X≧0 GOTO 3 MR 03 Min 01 GOTO 1		43
7	LBL 3 MR 03 Min 02 GOTO 1		47
8	LBL 4 INV "AL INV x = INV AR 03 INV AL"		53
9			
10	P1 MR 03 × MR 03 × MR 03 + MR 03 × MR 03 −		10
11	MR 03 − 1 =		14
12		Total 69	
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			

	Contents in memories
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

When writing the subroutine of $f(x)$, do not use x^y if $f(x) = 0$ has a negative root.

CASIO PROGRAM SHEET

Program for	Definite integral by the Simpson's rule	No.	Mathematics- 13

Description

• Input the program written in the next page.

$$I = \int_a^b f(x)dx = \frac{h}{3}\left\{ y_0 + 4(y_1 + y_3 + \ldots + y_{2m-1}) + 2(y_2 + y_4 + \cdots y_{2m-2}) + y_{2m} \right\}$$

$$h = \frac{b-a}{2m}$$

The right-hand side of the above equation can be transformed as follows.

$$I = \frac{h}{3}\left\{ y_0 + \sum_{i=1}^{m} (4y_{2i-1} + 2y_{2i}) - y_{2m} \right\}$$

Let $f(x) = \dfrac{1}{x^2+1}$

Example 1

$a = 0$, b = 1, $2m = 10$

$$I = \int_0^1 \frac{1}{x^2+1}\,dx = 0.785398152$$

Example 2

$a = 2$, b = 5, $2m = 20$

$$I = \int_2^5 \frac{1}{x^2+1}\,dx = 0.266252676$$

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	Example 1 PO	a ?		12			
2	0 EXE	b ?		13			
3	1 EXE	2m ?		14			
4	10 EXE	I =0.7853981		15			
5		0.785398153		16			
6	Example 2 PO	a ?		17			
7	2 EXE	b ?		18			
8	5 EXE	2m ?		19			
9	20 EXE	I =0.2662526		20			
10		0.266252676		21			

Program for

Definite integral by the Simpson's rule

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0		
2	LBL 1 | INV "AL | INV a | INV ? | INV AL" | HLT | Min 01 |		7
3	INV "AL | INV b | INV ? | INV AL" | HLT | Min 02 |		13
4	INV "AL | 2 | INV m | INV ? | INV AL" | HLT | Min 03 |		20
5	MR 01 | Min 07 | GSB P1 | Min 09 |		24
6	((| MR 02 | − | MR 01 |)) | ÷ | MR 03 | = | Min 04 |		33
7	MR 03 | ÷ | 2 | = | Min 00 |		38
8	LBL 2 MR 04 | M+ 07 | GSB P1 | × | 4 | = | M+ 09 |		46
9	MR 04 | M+ 07 | GSB P1 | × | 2 | = | M+ 09 |		53
10	INV DSZ | GOTO 2 |		55
11	MR 02 | Min 07 | GSB P1 | M− 09 |		59
12	MR 04 | × | MR 09 | ÷ | 3 | = |		65
13	INV "AL | I | = | INV # | INV AL" |		70
14			
15	P1 MR 07 | INV x^2 | + | 1 | = | INV $1/x$ |		6
16			
17		Total 78	
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	m (Number of repetitions)
01	a
02	b
03	2m
04	$h = \frac{b-a}{2m}$
05	
06	
07	x
08	
09	I
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	Solving ordinary differential equation of the first order by the Runge-Kutta method	No.	Mathematics-14

Description

• Input the program written in the next page.

Solve $\frac{dy}{dx} = f(x, y)$

under the initial condition of $x = x_0$ and $y = y_0$.

Let h be the length of a step on the x-axis.

$$x_{n+1} = x_n + h \qquad (n = 0, 1, 2 \cdots\cdots)$$

$$k_1 = h \cdot f(x_n, y_n)$$

$$k_2 = h \cdot f\left(x_n + \frac{h}{2}, y_n + \frac{k_1}{2}\right)$$

$$k_3 = h \cdot f\left(x_n + \frac{h}{2}, y_n + \frac{k_2}{2}\right)$$

$$k_4 = h \cdot f(x_n + h, y_n + k_3)$$

$$y_{n+1} = y_n + \frac{k_1 + 2k_2 + 2k_3 + k_4}{6}$$

Example

Let us solve $\frac{dy}{dx} = \frac{3y}{1+x}$

under the initial condition of $x_0 = 0$ and $y_0 = 1$ with $h = 0.1$.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	EXE	y3=2.196942	
1	PO	x 0 ?		12		2.196942675	
2	0 EXE	y 0 ?		13	⋮	⋮	
3	1 EXE	h ?		14	⋮	⋮	
4	0.1 EXE	x1=0.1		15			
5	EXE	y1=1.330983		16			
6		1.330983302		17			
7	EXE	x2=0.2		18			
8	EXE	y2=1.727964		19			
9		1.727964302		20			
10	EXE	x3=0.3		21			

Program for Solving ordinary differential equation of the first order by the Runge-Kutta method

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC		1
2	INV "AL INV x O INV ? INV AL" HLT Min 01		8
3	INV "AL INV Y O INV ? INV AL" HLT Min 02		15
4	INV "AL INV h INV ? INV AL" HLT Min 03 ÷ 2 =		24
5	Min 00		25
6	LBL 1 1 M+ F MR 01 Min 04 MR 02 Min 05 GSB P1 Min 06		34
7	MR 01 + MR 00 = Min 04 MR 02 + MR 06 ÷ 2		44
8	= Min 05 GSB P1 Min 07 ÷ 2 + MR 02 = Min 05		54
9	GSB P1 Min 08 + MR 02 = Min 05 MR 01 + MR 03		63
10	= Min 04 GSB P1 Min 09 MR 01 + MR 03 = Min 01		72
11	INV "AL INV x INV AR F = INV # INV AL" HLT		79
12	MR 02 + ((MR 06 + 2 × MR 07 + 2 ×		90
13	MR 08 + MR 09)) ÷ 6 = Min 02		98
14	INV "AL INV Y INV AR F = INV # INV AL" HLT GOTO 1		106
15			
16	P1 3 × MR 05 ÷ ((1 + MR 04)) × MR 03 =		12
17			
18		Total 120	
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories

00	$\frac{h}{2}$
01	$x_0 \rightarrow x_{n+1}$
02	$y_0 \rightarrow y_{n+1}$
03	h
04	x_n
05	y_n
06	k_1
07	k_2
08	k_3
09	k_4
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Write the value of $f(x, y)$ in P1 with x in memory cell 4 and y in memory cell 5.

CASIO PROGRAM SHEET

Program for	Bessel function of the first kind and n-th order	No.	Mathematics- 15

Description

• Input the program written in the next page.

$$J_n(x) = \sum_{k=0}^{\infty} (-1)^k \frac{1}{\Gamma(k+1)\,\Gamma(k+n+1)} \left(\frac{x}{2}\right)^{2k+n}$$

$$= \left(\frac{x}{2}\right)^n \sum_{k=0}^{\infty} \frac{\left(-\frac{x^2}{4}\right)^k}{k!\,(k+n)!}$$

Example 1

Calculate J_3 (2.5).

Example 2

Calculate J_5 (1.1)

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	x ?		12			
2	2.5 EXE	n ?		13			
3	3 EXE	J3(2.5)=0.2		14			
4		=0.21660039		15			
5	EXE	x ?		16			
6	1.1 EXE	n ?		17			
7	5 EXE	J5(1.1)=3.9		18			
8		8709883E-04		19			
9	=	3.98709883-04		20			
10				21			

Program for

Bessel function of the first kind and n-th order

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0		
2	LBL 1 ‖ INV MAC ‖ INV "AL ‖ INV x ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 07 ‖ ÷ ‖ 2 ‖		10
3	= ‖ Min 01 ‖ INV x^2 ‖ Min 03 ‖ 0 ‖		15
4	INV "AL ‖ INV n ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 02 ‖ Min 06 ‖ INV $x!$ ‖		23
5	Min 09 ‖ INV $1/x$ ‖ Min 00 ‖		26
6	LBL 2 ‖ 1 ‖ M+ 04 ‖ M+ 05 ‖ M+ 06 ‖		31
7	MR 09 ‖ × ‖ MR 06 ‖ × ‖ MR 05 ‖ = ‖ Min 09 ‖		38
8	MR 04 ‖ ÷ ‖ 2 ‖ = ‖ INV FRAC ‖ INV x=0 ‖ GOTO 3 ‖		45
9	GOTO 4 ‖		46
10	LBL 3 ‖ GSB P1 ‖ M+ 00 ‖ GOTO 5 ‖		50
11	LBL 4 ‖ GSB P1 ‖ M− 00 ‖		53
12	LBL 5 ‖ MR 00 ‖ INV x=F ‖ GOTO 6 ‖		57
13	Min F ‖ GOTO 2 ‖		59
14	LBL 6 ‖ MR 01 ‖ INV x^y ‖ MR 02 ‖ × ‖ MR 00 ‖ = ‖		66
15	INV "AL ‖ J ‖ INV AR 02 ‖ INV (‖ INV AR 07 ‖ INV) ‖ = ‖		73
16	INV # ‖ INV AL" ‖ HLT ‖ GOTO 1 ‖		77
17			
18	P1 MR 03 ‖ INV x^y ‖ MR 04 ‖ ÷ ‖ MR 09 ‖ = ‖		6
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	S_n
01	$\frac{x}{2}$
02	n
03	$\frac{x^2}{4}$
04	k count
05	k !
06	(k+n) !
07	x
08	
09	k ! (k+n) !
F	$S_n = S_{n+1}$ is examined.
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

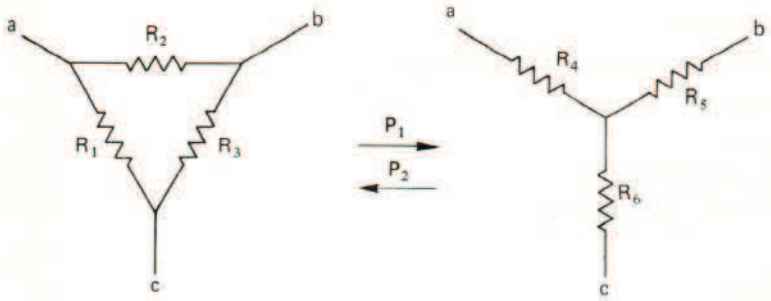
$J_n(x)$ is effective for small, positive x.

CASIO PROGRAM SHEET

Program for	No.
Δ ↔ Y conversion	Electrical engineering-1

Description

• Input the program written in the next page.



1) Δ → Y

$$R_4 = \frac{R_1 \cdot R_2}{R_1 + R_2 + R_3}$$

$$R_5 = \frac{R_2 \cdot R_3}{R_1 + R_2 + R_3}$$

$$R_6 = \frac{R_3 \cdot R_1}{R_1 + R_2 + R_3}$$

2) Y → Δ

$$R_1 = \frac{R_4R_5 + R_5R_6 + R_6R_4}{R_5}$$

$$R_2 = \frac{R_4R_5 + R_5R_6 + R_6R_4}{R_6}$$

$$R_3 = \frac{R_4R_5 + R_5R_6 + R_6R_4}{R_4}$$

Example

$R_1 = 12\ (\Omega)$
$R_2 = 47\ (\Omega)$
$R_3 = 82\ (\Omega)$

$R_4 = 100\ (\Omega)$
$R_5 = 150\ (\Omega)$
$R_6 = 220\ (\Omega)$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P1	INPUT R1?	Δ→Y
2	12 EXE	INPUT R2?	
3	47 EXE	INPUT R3?	
4	82 EXE	ANS R4	
5		4	
6	EXE	ANS R5	
7		27.33333333	
8	EXE	ANS R6	
9		6.978723404	
10			

Step	Data input operation	Read-out	Remark
11	P2	INPUT R4?	Y→Δ
12	100 EXE	INPUT R5?	
13	150 EXE	INPUT R6?	
14	220 EXE	ANS R1	
15		466.6666667	
16	EXE	ANS R2	
17		318.1818182	
18	EXE	ANS R3	
19		700	
20			
21			

Program for Δ ↔ Y Conversion

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P1	Δ→Y	
2	LBL 1 | 1 | Min00 | GSB P3 | HLT |		5
3	GSB INV P5 | GSB P3 | HLT | GSB INV P5 | GSB P3 | HLT |		11
4	GSB INV P5 | MR 01 | + | MR 02 | + | MR 03 | = | Min 07 |	$R_1+R_2+R_3$	19
5	GSB P4 | MR 01 | × | MR 02 | ÷ | MR 07 | = | HLT |	R_4	27
6	GSB P4 | MR 02 | × | MR 03 | ÷ | MR 07 | = | HLT |	R_5	35
7	GSB P4 | MR 03 | × | MR 01 | ÷ | MR 07 | = | HLT | GoTo 1 |	R_6	44
8			
9	P2	Y→Δ	
10	LBL 1 | 4 | Min00 | GSB P3 | HLT |		5
11	GSB INV P5 | GSB P3 | HLT | GSB INV P5 | GSB P3 | HLT |		11
12	GSB INV P5 | 1 | Min00 | MR 04 | × | MR 05 | + | MR 05 | × |		20
13	MR 06 | + | MR 06 | × | MR 04 | = | Min 08 |	$R_4R_5+R_5R_6+R_6R_4$	27
14	GSB P4 | MR 08 | ÷ | MR 05 | = | HLT |	R_1	33
15	GSB P4 | MR 08 | ÷ | MR 06 | = | HLT |	R_2	39
16	GSB P4 | MR 08 | ÷ | MR 04 | = | HLT | GoTo 1 |	R_3	46
17			
18	P3 INV "AL | I | N | P | U | T | INV SPACE | R | INV AR 00 | INV SPACE |	Input display	10
19	INV ? | INV AL" |		12
20			
21	P4 INV "AL | A | N | S | INV SPACE | R | INV AR 00 | INV AL" |	Output display	8
22	INV PAUSE | INV ISZ |		10
23			
24	INV P5 INV IND | Min 00 | INV ISZ |		3
25			
26		Total 120	
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For Rn display
01	R_1
02	R_2
03	R_3
04	R_4
05	R_5
06	R_6
07	$R_1+R_2+R_3$
08	$R_4R_5+R_5R_6+R_6R_4$
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Input display:
"INPUT Rn ?" is displayed.

Output display:
The answer will be displayed after the pause display of "ANS Rn".

CASIO PROGRAM SHEET

Program for	Impedance of series and parallel circuits	No.	Electrical engineering–2	

Description

• Input the program written in the next page.

1. Series → P0

$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right) = x + jy$$

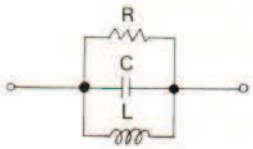
$$|Z| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$\theta = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right)$$

R [Ω]
C [μF]
L [mH]
f [Hz]

where $\omega = 2\pi f$

2. Parallel → P5



$$Z = \frac{1}{\frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)}$$

$$= \frac{\frac{1}{R} - j\left(\omega C - \frac{1}{\omega L}\right)}{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2} = x + jy$$

$$|Z| = \frac{1}{\sqrt{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2}}$$

$$\theta = \tan^{-1} R\left(\frac{1}{\omega L} - \omega C\right)$$

Example

1. Series
R = 10 (Ω)
C = 5 (μF)
L = 20 (mH)
f = 60 (Hz)

2. Parallel
R = 47 (Ω)
C = 1 (μF)
L = 30 (mH)
f = 50 (Hz)

3. What is the impedance of circuit if the components given in Example 2 are connected in series ?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	(R) 10 P1	10	R
2	(C) 5 P2	5.$^{-06}$	C
3	(L) 20 P3	0.02	L
4	(f) 60 P4	376.9911184	$2\pi f$
5	P0	10	Series x
6	EXE	−522.976654	y
7	EXE	523.0722524	Z
8	EXE	−88.9045629	Phase θ
9	(R) 47 P1	47	R
10	(C) 1 P2	1.$^{-06}$	C
11	(L) 30 P3	0.03	L
12	(f) 50 P4	314.1592654	$2\pi f$
13	INV P5	1.827252841	Parallel x
14	EXE	9.085264477	y
15	EXE	9.267193942	Z
16	EXE	78.6282295	Phase θ
17	P0	47	Series x
18	EXE	−3173.67408	y
19	EXE	3174.022083	Z
20	EXE	−89.1515496	Phase θ
21			

Program for

Impedance of series and parallel circuits

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV "AL| S |INV e |INV r |INV i |INV e |INV S |INV AL"|	Series	8
2	INV PAUSE | MR 01 | Min 06 |		11
3	MR 05 | × | MR 03 | − | MR 05 | INV 1/x | ÷ | MR 02 |		19
4	GSB INV P6 |		20
5			
6	INV P5 INV "AL| P | INV a | INV r | INV a | INV l | INV l | INV e |	Parallel	8
7	INV l | INV AL"| MR 05 | × | MR 02 | − | MR 05 | INV 1/x | ÷ |		17
8	MR 03 | = | Min 08 |		20
9	INV x^2 | + | MR 01 | INV 1/x | INV x^2 | = | Min 09 |		27
10	× | MR 01 | = | INV 1/x | Min 06 |		32
11	MR 08 | +/− | ÷ | MR 09 | GSB INV P6 |		37
12			
13	INV P6 = | Min 07 | INV "AL| INV x | INV AL"| INV PAUSE | MR 06 | HLT |	Answer output	8
14	INV R→P | INV "AL| INV y | INV AL"| INV PAUSE | MR 07 | HLT |		15
15	INV "AL| Z | INV AL"| INV PAUSE | = | HLT |		21
16	INV "AL| P | INV h | INV a | INV s | INV e | INV AL"|		28
17	INV PAUSE | INV X↔Y |		30
18			
19	P1 INV "AL| R | INV AL"| INV PAUSE | Min 01 |		5
20			
21	P2 INV "AL| C | INV AL"| INV PAUSE | EXP | 6 | +/− | Min 02 |		8
22		Data input	
23	P3 INV "AL| L | INV AL"| INV PAUSE | EXP | 3 | +/− | Min 03 |		8
24			
25	P4 INV "AL| 2 | INV π | INV f | INV AL"| INV PAUSE | Min 04 |		7
26	× | 2 | × | INV π | = | Min 05 |		13
27			
28		Total 128	
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Remark
00	
01	R
02	C
03	L
04	f
05	$\omega = 2\pi f$
06	x
07	y
08	$\omega c - \frac{1}{\omega L}$
09	$(\omega c - \frac{1}{\omega L})^2 + \frac{1}{R^2}$
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

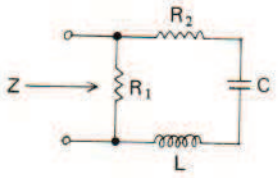
- R, C, L and $2\pi f$ will be displayed after each data is input.
- Each answer will be displayed after the pause display of X, Y, Z and phase.

CASIO PROGRAM SHEET

Program for	Impedance of series resonance circuit	No.	Electrical engineering—3	

Description

• Input the program written in the next page.



Resonance frequency $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

$$\frac{1}{Z} = \frac{1}{R_1} + \frac{1}{R_2 + j(\omega L - \frac{1}{\omega C})} \qquad \omega = 2\pi f$$

$$Z = \frac{R_1 R_2 (R_1 + R_2) + R_1 (\omega L - \frac{1}{\omega C})^2 + j R_1^2 (\omega L - \frac{1}{\omega C})}{(R_1 + R_2)^2 + (\omega L - \frac{1}{\omega C})^2} = x + jy$$

$$|Z| = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$

R = [Ω]
C = [μF]
L = [*m*H]
f = [Hz]

Example

R_1 = 20 (Ω)
R_2 = 15 (Ω)
C = 0.5 (μF)
L = 20 (*m*H)
f = 60 (Hz)

Calculate f_0 of this resonance cirucit.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	EXE	Z	
1	PO	R1		12		19.9996437	
2	20 EXE	R2		13	EXE	Phase	
3	15 EXE	C		14		−0.21630234	(θ)
4	0.5 EXE	L		15			
5	20 EXE	f0=1592		16			
6		*f*		17			
7	60 EXE	*x*		18			
8		19.99950118		19			
9	EXE	*y*		20			
10		−0.07550223		21			

Program for

Impedance of series resonance circuit

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV "AL" R 1 INV AL" HLT Min 01		6
2	INV "AL" R 2 INV AL" HLT Min 02		12
3	INV "AL" C INV AL" HLT EXP 6 +/- Min 03		20
4	INV "AL" L INV AL" HLT EXP 3 +/- Min 04		28
5	× MR03 = INV √ × 2 × INV π = INV 1/x		38
6	INV RND 4 Min F		40
7	INV "AL" INV f 0 = INV # INV AL" INV PAUSE	f_0	47
8	INV "AL" INV f INV AL" HLT × 2 × INV π = Min 05		57
9	× MR04 − MR 05 INV 1/x ÷ MR03 = Min 06		66
10	MR 01 + MR02 = Min 07 INV x^2 + MR06 INV x^2		75
11	= Min 00		77
12	MR 01 × ((MR02 × MR07 + MR06 INV x^2))		87
13	÷ MR00 =		90
14	INV "AL" INV x INV AL" INV PAUSE Min 08 HLT	x	96
15	INV R→P ((MR 01 INV x^2 × MR06 ÷ MR00))		105
16	INV "AL" INV y INV AL" INV PAUSE Min 09 HLT	y	111
17	INV "AL" Z INV AL" INV PAUSE = HLT	z	117
18	INV "AL" P INV h INV a INV s INV e INV AL"	θ	124
19	INV PAUSE INV X↔Y		126
20			
21		Total 127	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	$(R_1+R_2)^2+(\omega L-\frac{1}{\omega C})^2$
01	R_1
02	R_2
03	C
04	L
05	$\omega=2\pi f$
06	$\omega L-\frac{1}{\omega C}$
07	R_1+R_2
08	x
09	y
F	f_0
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

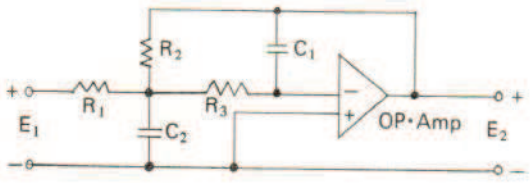
When inputting data by "User's function" mode, refer to Electrical engineering-2 "Impedance of series and parallel circuits".

CASIO PROGRAM SHEET

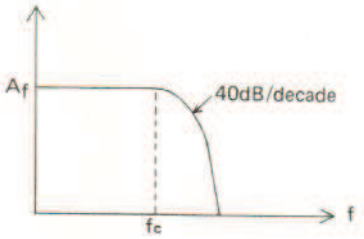
Program for	Design of an active low-pass filter	No.	Electrical engineering—4	

Description

• Input the program written in the next page.



$$\frac{E_2}{E_1} = \frac{-H\omega_0^2}{S^2 + \alpha\omega_0 S + \omega_0^2}$$



$H = A_f$

$\omega_0 = 2\pi f_0 \qquad \alpha = \sqrt{2}$

$$R_1 = \frac{\sqrt{2}}{2 \times A_f \times 2\pi f_c \times C_1}$$

$R_2 = A_f R_1$

$$R_3 = \frac{R_2}{A_f + 1}$$

$C_2 = 2(A_f + 1)\, C_1$

R [Ω] $\qquad$ f_c [Hz]

C [μF]

A_f [in times]

Example

Calculate the values of R_1, R_2, R_3 and C_2 to make up a low-pass filter with f_c = 200 Hz, A_f = 10 times and C_1 = 5μF.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11		110	
1	PO	fc(Hz)?		12			
2	200 EXE	Af?		13			
3	10 EXE	C1(μF)?		14			
4	5 EXE	ANS R1(Ohm)		15			
5		11.25395396		16			
6	EXE	ANS R2(Ohm)		17			
7		112.5395396		18			
8	EXE	ANS R3(Ohm)		19			
9		10.23086723		20			
10	EXE	ANS C2(μF)		21			

Program for

Design of an active low-pass filter

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 1 ‖ INV "AL ‖ INV f ‖ INV C ‖ INV (‖ H ‖ INV Z ‖ INV) ‖ INV SPACE ‖		9
3	INV ? ‖ INV AL" ‖ HLT ‖ Min 01 ‖		13
4	INV "AL ‖ A ‖ INV f ‖ INV SPACE ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 02 ‖	Data input	21
5	INV "AL ‖ C ‖ 1 ‖ INV (‖ INV μ ‖ F ‖ INV) ‖ INV SPACE ‖ INV ? ‖		30
6	INV AL" ‖ HLT ‖ EXP ‖ 6 ‖ +/− ‖ Min 03 ‖		36
7	1 ‖ Min 00 ‖ GSB P1 ‖ INV PAUSE ‖		40
8	2 ‖ × ‖ INV π ‖ × ‖ MR 01 ‖ = ‖ Min 04 ‖	$2\pi fc$	47
9	2 ‖ INV $\sqrt{\ }$ ‖ × ‖ MR 02 ‖ × ‖ MR 04 ‖ × ‖ MR 03 ‖ = ‖ INV $1/x$ ‖	R_1	57
10	HLT ‖		58
11	GSB P1 ‖ INV PAUSE ‖ × ‖ MR 02 ‖ = ‖ HLT ‖	R_2	64
12	GSB P1 ‖ INV PAUSE ‖ ÷ ‖ ((‖ MR 02 ‖ + ‖ 1 ‖)) ‖ = ‖ HLT ‖	R_3	74
13	INV "AL ‖ A ‖ N ‖ S ‖ INV SPACE ‖ C ‖ 2 ‖ INV (‖ INV μ ‖ F ‖	C_2	84
14	INV) ‖ INV AL" ‖ INV PAUSE ‖ 2 ‖ × ‖ ((‖ MR 02 ‖ + ‖ 1 ‖)) ‖		94
15	× ‖ MR 03 ‖ × ‖ 1 ‖ EXP ‖ 6 ‖ = ‖ HLT ‖ GoTo 1 ‖		103
16			
17	P1 INV "AL ‖ A ‖ N ‖ S ‖ INV SPACE ‖ R ‖ INV AR 00 ‖ INV (‖ O ‖	ANS Rn display	9
18	INV h ‖ INV m ‖ INV) ‖ INV AL" ‖ INV ISZ ‖		14
19			
20		Total 119	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For Rn display
01	f_c
02	A_f
03	C_1
04	$2\pi f_c$
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

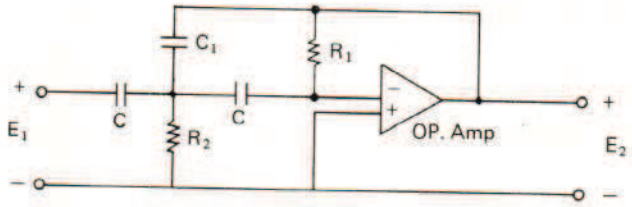
Each answer will be displayed after the pause display of output designation.

CASIO PROGRAM SHEET

Program for	Design of an active high-pass filter	No. Electrical engineering -5	

Description

• Input the program written in the next page.



$$\frac{E_2}{E_1} = \frac{-H_0 S^2}{S^2 + \alpha\omega_0 S + \omega_0{}^2}$$

$$H_0 = \frac{C}{C_1}$$

$\alpha = 2S$: Peak coefficient

S: Damping coefficient

$$R_1 = \frac{2H_0 + 1}{\alpha 2\pi f_c C}$$

$$R_2 = \frac{\alpha}{2\pi f_c C\,(2 + \frac{1}{H_0})}$$

$$C_1 = \frac{C}{H_0}$$

f_c [Hz]

H_0 [in times]

C [μF]

Example

f_c = 100 [Hz]

H_0 = 10 [in times]

C = 5 [μF]

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	fc(Hz)?		12			
2	100 EXE	H0?		13			
3	10 EXE	C(μF)?		14			
4	5 EXE	a?		15			
5	1 EXE	ANS R1(Ohm)		16			
6		6684.50761		17			
7	EXE	ANS R2(Ohm)		18			
8		151.5761363		19			
9	EXE	ANS C1(μF)		20			
10		5.$^{-07}$		21			

Program for

Design of an active high-pass filter

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 1 | INV "AL | INV f | INV C | INV (| H | INV Z | INV) | INV SPACE |		9
3	INV ? | INV AL" | HLT | Min 01 |		13
4	INV "AL | H | O | INV SPACE | INV ? | INV AL" | HLT | Min 02 |	Data input	21
5	INV "AL | C | INV (| INV μ | F | INV) | INV SPACE | INV ? |		29
6	INV AL" | HLT | EXP | 6 | +/- | Min 03 |		35
7	INV "AL | INV a | INV SPACE | INV ? | INV AL" | HLT | Min 04 |		42
8	1 | Min 00 | GSB P1 | INV PAUSE |		46
9	MR 01 | × | 2 | × | INV π | = | Min 01 |	$2\pi fc$	53
10	((| 2 | × | MR 02 | + | 1 |)) | ÷ | MR 04 | ÷ | MR 01 |	R1	64
11	÷ | MR 03 | = | HLT |		68
12	GSB P1 | INV PAUSE | MR 04 | ÷ | MR 01 | ÷ | MR 03 | ÷ |((|	R2	77
13	2 | + | MR 02 | INV 1/x |)) | = | HLT |		84
14	INV "AL | A | N | S | INV SPACE | C | 1 | INV (| INV μ | F |	C	94
15	INV) | INV AL" | INV PAUSE |		97
16	MR 03 | ÷ | MR 02 | = | HLT | GoTo 1 |		103
17			
18	P1 INV "AL | A | N | S | INV SPACE | R | INV AR 00 | INV (| O |		9
19	INV h | INV m | INV) | INV AL" | INV ISZ |		14
20			
21		Total 119	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For Rn display
01	$2\pi fc$
02	Ho
03	C
04	a
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

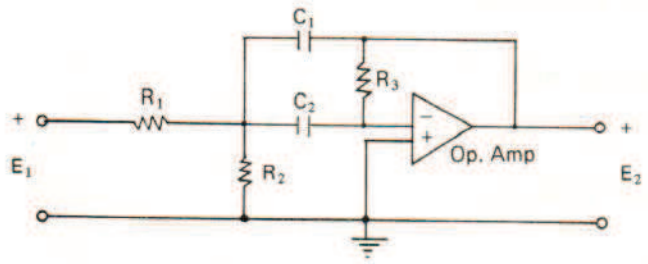
When the peak coefficient "a" is at position 0.1, "Ho" must be selected to be 10 or less.

CASIO PROGRAM SHEET

Program for	Design of an active band-pass filter	No.	Electrical engineering · 6	

Description

• Input the program written in the next page.



f_0 : Center frequency of pass band
Q : Resonance sharpness
A_0 : Loop gain

$$R_1 = \frac{Q}{|A_0|\omega_0 C_1} \qquad R_2 = \frac{1}{Q(C_1 + C_2)\omega_0 - \frac{1}{R_1}}$$

$$R_3 = \frac{Q}{\omega_0}\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$$

Example

f_0 = 5000 [Hz]
A_0 = 80
Q = 1200
C_1 = 0.001 [μF]
C_2 = 0.005 [μF]

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11		45836623.6	
1	PO	f0		12			
2	5000 EXE	A0		13			
3	80 EXE	Q		14			
4	1200 EXE	C1		15			
5	0.001 EXE	C2		16			
6	0.005 EXE	ANS R1(Ohm)		17			
7		477464.8292		18			
8	EXE	ANS R2(Ohm)		19			
9		4.421011576		20			
10	EXE	ANS R3(Ohm)		21			

Program for

Design of an active band-pass filter

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 1 | INV "AL | INV f | O | INV AL" | HLT | Min 01 |	Data input	7
3	INV "AL | A | O | INV AL" | HLT | Min 02 |		13
4	INV "AL | Q | INV AL" | HLT | Min 03 |		18
5	INV "AL | C | 1 | INV AL" | HLT | EXP | 6 | +/- | Min 04 |		27
6	INV "AL | C | 2 | INV AL" | HLT | EXP | 6 | +/- | Min 05 |		36
7	MR 01 | × | 2 | × | INV π | = | Min 01 |	$2\pi f_0$	43
8	MR 02 | ÷ | 2 | = | INV √ | Min F |		49
9	MR 03 | INV x≧F | GoTo 2 | GoTo 3 |		53
10	LBL 2 | 1 | Min 00 | GSB P1 | MR 03 | ÷ | MR 02 | ÷ | MR 01 |	R_1	62
11	÷ | MR 04 | = | Min 06 | HLT |		67
12	GSB P1 | MR 03 | × | MR 01 | × | ((| MR 04 | + | MR 05 |)) |	R_2	77
13	− | MR 06 | INV 1/x | = | INV 1/x | HLT |		83
14	GSB P1 | MR 03 | ÷ | MR 01 | × | ((| MR 04 | INV 1/x | + |	R_3	92
15	MR 05 | INV 1/x |)) | = | HLT | GoTo 1 |		98
16	LBL 3 | INV "AL | T | INV r | INV y | INV SPACE | INV a | INV g | INV a |		107
17	INV i | INV n | INV ! | INV AL" |		111
18			
19	P1 INV "AL | A | N | S | INV SPACE | R | INV AR 00 | INV ((| O |		9
20	INV h | INV m | INV) | INV AL" | INV PAUSE | INV ISZ |		15
21			
22		Total 128	
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For Rn display
01	$\omega_0 = 2\pi f_0$
02	A_0
03	Q
04	C_1
05	C_2
06	R_1
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

If $Q < \sqrt{\frac{|A_0|}{2}}$, calculation will not be made and "Try again!" displayed.

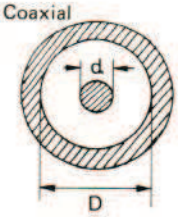
CASIO PROGRAM SHEET

Program for	Impedance of transmission line	No.	Electrical engineering - 7

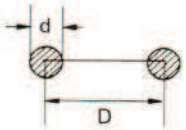
Description

• Input the program written in the next page.

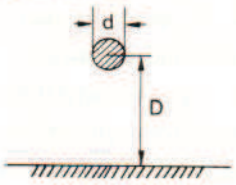
① Coaxial



② Two-wire



③ Grounded



$$Z_1 = \frac{K}{\sqrt{\varepsilon\gamma}} \log \frac{D}{d}$$

$$Z_2 = \frac{2K}{\sqrt{\varepsilon\gamma}} \log \left(\frac{D}{d} + \sqrt{(\frac{D}{d})^2 - 1} \right)$$

$$Z_3 = \frac{K}{\sqrt{\varepsilon\gamma}} \log \left(\frac{4D}{d} \right)$$

$$K = \frac{\sqrt{\mu_0}}{2\pi\sqrt{\varepsilon_0 \log e}} = 138.059824$$

$\varepsilon\gamma$: Dielectric constant

Example 1

D = 20mm
d = 10mm
$\varepsilon\gamma$ = 1.7

Example 2

D = 40mm
d = 5mm
$\varepsilon\gamma$ = 1

Example 3

D = 50mm
d = 7mm
$\varepsilon\gamma$ = 1.35

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P1	D(mm)?	Coaxial
2	20 EXE	d(mm)?	
3	10 EXE	Er?	
4	1.7 EXE	ANS Z1(Ohm)	
5		31.87517862	
6	P2	D(mm)?	Two-wire
7	40 EXE	d(mm)?	
8	5 EXE	Er?	
9	1 EXE	ANS Z2(Ohm)	
10		332.0099903	
11	P3	D(mm)?	Grounded
12	50 EXE	d(mm)?	
13	7 EXE	Er?	
14	1.35 EXE	ANS Z3(Ohm)	
15		172.9981701	
16			
17			
18			
19			
20			
21			

Program for

Impedance of transmission line

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV "AL| D| INV (| INV m | INV m | INV)| INV SPACE| INV ? |		8
2	INV AL"| HLT | Min 01 |		11
3	INV "AL| INV d | INV (| INV m | INV m | INV)| INV SPACE |		18
4	INV ? | INV AL"| HLT | Min 02 |		22
5	INV "AL| EXP | INV r | INV SPACE | INV ? | INV AL"|	Data input	28
6	HLT | INV √ | Min 03 |		31
7	MR01 | ÷ | MR02 | = | Min 05 |		36
8	1 | 3 | 8 | • | 0 | 5 | 9 | 8 | 2 | 4 | Min 04 |		47
9			
10	P1	Coaxial	
11	LBL 1 | GSB P0 | 1 | GSB P4 |		4
12	MR05 | log | × | MR04 | ÷ | MR03 | = | HLT | GoTo1 |		13
13			
14	P2	Two-wire	
15	LBL 1 | GSB P0 | 2 | GSB P4 |		4
16	MR05 | INV x^2 | − | 1 | = | INV √ | + | MR05 | = |		13
17	log | × | 2 | × | MR04 | ÷ | MR03 | = | HLT | GoTo1 |		23
18			
19	P3	Grounded	
20	LBL 1 | GSB P0 | 3 | GSB P4 |		4
21	MR05 | × | 4 | = | log | × | MR04 | ÷ | MR03 | = |		14
22	HLT | GoTo1 |		16
23			
24	P4 Min 00 | INV "AL| A | N | S | INV SPACE | Z | INV AR 00 | INV (|		9
25	0 | INV h | INV m | INV) | INV AL"| INV PAUSE |		15
26			
27		Total 119	
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For Z_n (Ohm) display
01	D
02	d
03	$\sqrt{\varepsilon_r}$
04	K
05	$\frac{D}{d}$
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

- D and d should be given in the same unit (such as mm, cm, or inches).
- For Two-wire, input so that $D \geqq d$.
- For Coaxial, if $D < d$, the answer will be negative.

CASIO PROGRAM SHEET

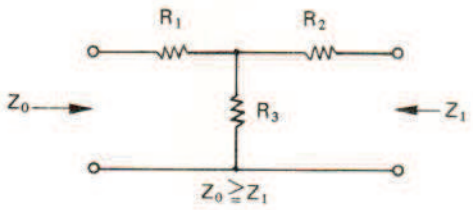
Program for	T - and π-attenuators	No.	Electrical engineering - 8

Description

• Input the program written in the next page.

We design attenuators which match line impedances on each end and divide watt to 1/N.

① T-type ---------- P1

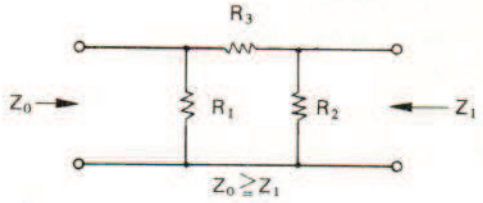


$$R_1 = Z_0\left[\frac{N+1}{N-1}\right] - R_3$$

$$R_2 = Z_1\left[\frac{N+1}{N-1}\right] - R_3$$

$$R_3 = \frac{2}{N-1}\sqrt{NZ_0Z_1}$$

② π-type ---------- P2



$$\frac{1}{R_1} = \frac{1}{Z_0}\left[\frac{N+1}{N-1}\right] - \frac{1}{R_3}$$

$$\frac{1}{R_2} = \frac{1}{Z_1}\left[\frac{N+1}{N-1}\right] - \frac{1}{R_3}$$

$$\frac{1}{R_3} = \frac{2}{N-1}\sqrt{\frac{N}{Z_0Z_1}}$$

Example 1

$Z_0 = 200$
$Z_1 = 100$
$N = 50$

Example 2

$Z_0 = 100$
$Z_1 = 50$
$N = 100$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P1	T type	
2		Z0?	
3	200 EXE	Z1?	
4	100 EXE	N?	
5	50 EXE	ANS R1(Ohm)	
6		167.3469389	
7	EXE	ANS R2(Ohm)	
8		63.26530617	
9	EXE	ANS R3(Ohm)	
10		40.81632653	

Step	Data input operation	Read-out	Remark
11	P2	π type	
12		Z0?	
13	100 EXE	Z1?	
14	50 EXE	N?	
15	100 EXE	ANS R1(Ohm)	
16		136.1466105	
17	EXE	ANS R2(Ohm)	
18		56.98965818	
19	EXE	ANS R3(Ohm)	
20		350.0178567	
21			

Program for

T- and π-attenuators

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV "AL" INV ; INV SPACE INV t INV y INV p INV e		7
2	INV AL" INV PAUSE	Data input	9
3	INV "AL" Z O INV SPACE INV ? INV AL" HLT Min 01		17
4	INV "AL" Z 1 INV SPACE INV ? INV AL" HLT Min 02		25
5	INV "AL" N INV SPACE INV ? INV AL" HLT Min 03		32
6	1 Min 00		34
7			
8	P1	T-type	
9	LBL 1 INV "AL" T INV AL" GSB P0 GSB P3 GSB P4 HLT		8
10	GSB P4 HLT		10
11	GSB INV P5 MR04 HLT GoTo1		14
12			
13	P2	π-type	
14	LBL 1 INV "AL" INV π INV AL" GSB P0 MR 01 INV 1/x Min 01		8
15	MR02 INV 1/x Min 02 GSB P3 GSB P4 INV 1/x HLT		15
16	GSB P4 INV 1/x HLT		18
17	GSB INV P5 MR04 INV 1/x HLT GoTo1		23
18			
19	P3 MR03 × MR 01 × MR02 = INV √		7
20	× 2 ÷ ((MR03 − 1)) Min 05 = Min 04		18
21	((MR03 + 1)) ÷ MR05 = Min 05		27
22			
23	P4 GSB INV P5		1
24	INV IND MR00 × MR05 − MR04 = INV ISZ		9
25			
26	INV P5 INV "AL" A N S INV SPACE R INV AR 00 INV (O		9
27	INV h INV m INV) INV AL" INV PAUSE		14
28			
29		Total 127	
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND
01	Z_0 or $\frac{1}{Z_0}$
02	Z_1 or $\frac{1}{Z_1}$
03	N
04	R_3 or $\frac{1}{R_3}$
05	$N+1/N-1$
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

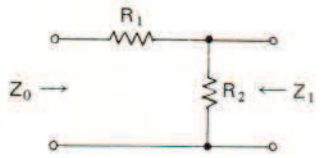
- Input so that $Zo \geqq Z_1$.
- N must be a positive number other than N = 1.

CASIO PROGRAM SHEET

Program for	Minimum loss matching	No.	Electrical engineering–9	

Description

• Input the program written in the next page.



We calculate R_1 and R_2 which match Z_0 and Z_1 with loss minimized.

$[Z_0 > Z_1]$

$$R_1 = Z_0 \sqrt{1 - \frac{Z_1}{Z_0}}$$

$$R_2 = \frac{Z_1}{\sqrt{1 - \frac{Z_1}{Z_0}}}$$

$$\text{Minimum loss } L_{MIN} = 20 \log \left(\sqrt{\frac{Z_0}{Z_1}} + \sqrt{\frac{Z_0}{Z_1} - 1} \right) \text{ [dB]}$$

Example

Calculate the values of R_1, R_2 and L_{MIN} for Z_0 = 500 ohms and Z_1 = 200 ohms.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	INPUT Z0?		12			
2	500 EXE	INPUT Z1?		13			
3	200 EXE	ANS R1(Ohm)		14			
4		387.2983346		15			
5	EXE	ANS R2(Ohm)		16			
6		258.1988898		17			
7	EXE	Lmin(dB)		18			
8		8.961393328		19			
9				20			
10				21			

Program for

Minimum loss matching

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0		
2	LBL 1 | AC | Min 00 |		3
3	GSB P1 | GSB P1 | ÷ | MR 01 | = | Min 03 |		9
4	1 | − | MR 03 | = | INV √ | Min 04 |		15
5	1 | Min 00 |		17
6	GSB P2 | MR 04 | × | MR 01 | = | HLT |	R_1	23
7	GSB P2 | MR 02 | ÷ | MR 04 | = | HLT |	R_2	29
8	INV "AL | L | INV m | INV i | INV n | INV (| INV d | B |		37
9	INV) | INV AL" | INV PAUSE |		40
10	MR 03 | INV 1/x | − | 1 | = | INV √ |		46
11	+ | MR 03 | INV 1/x | INV √ | = | log |		52
12	× | 2 | O | = | HLT | GoTo 1 |	L_{MIN}	58
13			
14	P1 INV "AL | I | N | P | U | T | INV SPACE | Z | INV AR 00 | INV SPACE |	Data input	10
15	INV ? | INV AL" | HLT | INV ISZ | INV IND | Min 00 |		16
16			
17	P2 INV "AL | A | N | S | INV SPACE | R | INV AR 00 | INV (| O |		9
18	INV h | INV m | INV) | INV AL" | INV PAUSE | INV ISZ |		15
19			
20		Total 92	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND
01	Z_0
02	Z_1
03	Z_1 / Z_0
04	$\sqrt{1 - Z_1/Z_0}$
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

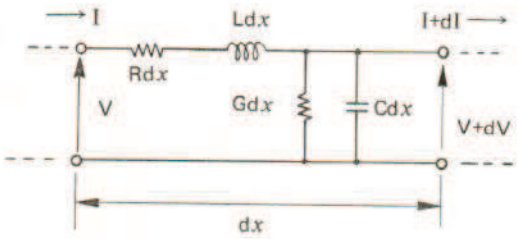
Input so that $Z_0 > Z_1$

CASIO PROGRAM SHEET

Program for	No.	
Distributed constant circuit	Electrical engineering-10	FX-602P

Description

• Input the program written in the next page.



Secondary constants
- R: Resistance per unit length between two conductors [Ω/km]
- L: Inductance per unit length between two conductors [mH/km]
- G: Leakage conductance per unit length between two conductors [μ℧/km]
- C: Capacitance per unit length between two conductors [μF/km]

Characteristic impedance Z_0

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

$$|Z_0| = \left(\frac{\sqrt{R^2+\omega^2L^2}}{\sqrt{G^2+\omega^2C^2}}\right)^{\frac{1}{2}} \quad [\Omega]$$

$$\phi = \phi_1 - \phi_2 \quad [\circ]$$

$$\phi_1 = \tan^{-1}\frac{\omega L}{R}$$

$$\phi_2 = \tan^{-1}\frac{\omega C}{G}$$

Propagation constant γ

$$\gamma = \alpha + j\beta$$

Attenuation constant α

$$\alpha = \left(\sqrt{R^2+\omega^2L^2}\cdot\sqrt{G^2+\omega^2C^2}\right)^{\frac{1}{2}}\cos\left(\frac{\phi_1+\phi_2}{2}\right)$$

[Np/km]

Phase constant β

$$\beta = \left(\sqrt{R^2+\omega^2L^2}\cdot\sqrt{G^2+\omega^2C^2}\right)^{\frac{1}{2}}\sin\left(\frac{\phi_1+\phi_2}{2}\right)$$

[rad/km]

Example

R = 167 [Ω/km]
L = 0.49 [mH/km]
G = 1.66 [μ℧/km]
C = 0.05 [μF/km]
f = 1000 [Hz] or 60 [Hz]

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	INPUT !	
2		R(Ohm/km)	
3	167 EXE	L(mH/km)	
4	0.49 EXE	G(μMho/km)	
5	1.66 EXE	C(μF/km)	
6	0.05 EXE	f(Hz)	
7	1000 EXE	729.1504749	ANSWERS 20(Ohm)(|Zo|)
8	EXE	−44.3205436	Phase(φ)
9	EXE	0.160910291	Alpha(α)
10	EXE	0.163040249	Beta (β)
11	EXE	INPUT !	
12		f(Hz)	
13	60 EXE	2970.76983	ANSWERS 20(Ohm)(|Zo|)
14	EXE	−42.4519059	Phase(φ)
15	EXE	0.041435485	Alpha(α)
16	EXE	0.037988965	Beta (β)
17			
18			
19			
20			
21			

Program for

Distributed constant circuit

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 5 6 MODE 2			00
1	P0 GSB P3 | INV "AL| R | INV (| O | INV h | INV m | INV / |		8	01 R
2	INV k | INV m | INV) | INV AL" | HLT | Min 01 |		14	02 L
3	INV "AL| L | INV (| INV m | H | INV / | INV k | INV m |		22	03 G
4	INV) | INV AL" | HLT | EXP | 3 | +/- | Min 02 |		29	04 C
5	INV "AL| G | INV (| INV μ | M | INV h | INV 0 | INV / |	Data input	37	05 $\omega=2\pi f$
6	INV k | INV m | INV) | INV AL" | HLT | ÷ | 6 | INV 10^x | = |		46	06 $\sqrt{R^2+\omega^2L^2}$
7	Min 03 |		47	07 $\sqrt{G^2+\omega^2C^2}$
8	INV "AL| C | INV (| INV μ | F | INV / | INV k | INV m |		55	08 ϕ_1
9	INV) | INV AL" | HLT | EXP | 6 | +/- | Min 04 | MODE 4 |		63	09 ϕ_2
10	LBL 1 | INV "AL| INV f | INV (| H | INV Z | INV) | INV AL" | HLT |		72	F
11	× | 2 | × | INV π | = | Min 05 |	$2\pi f$	78	10
12	INV "AL| A | N | S | W | E | R | S | INV AL" |		87	11
13	MR 01 | INV x^2 | + | MR 05 | INV x^2 | × | MR 02 |	$\sqrt{R^2+\omega^2L^2}$	94	12
14	INV x^2 | = | INV $\sqrt{}$ | Min 06 |		98	13
15	MR 03 | INV x^2 | + | MR 05 | INV x^2 | × | MR 04 |	$\sqrt{G^2+\omega^2C^2}$	105	14
16	INV x^2 | = | INV $\sqrt{}$ | Min 07 |		109	15
17	MR 05 | × | MR 02 | ÷ | MR 01 | = | INV $\tan^{-1}$ |	ϕ_1	116	16
18	Min 08 |		117	17
19	MR 03 | INV $x=0$ | GoTo 2 | GoTo 3 |	$G=0$?	121	18
20	LBL 2 | 9 | O | Min 09 | GoTo 4 |		126	19
21	LBL 3 | MR 05 | × | MR 04 | ÷ | MR 03 | = | INV $\tan^{-1}$ |	ϕ_2	134	1F
22	Min 09 |		135	20
23	LBL 4 | INV "AL| Z | O | INV (| O | INV h | INV m | INV) | INV AL" |	Z	145	21
24	INV PAUSE | MR 06 | ÷ | MR 07 | = | INV $\sqrt{}$ | HLT |		152	22
25	INV "AL| P | INV h | INV a | INV s | INV e | INV AL" | INV PAUSE |	ϕ	160	23
26	((| MR 08 | − | MR 09 |)) | ÷ | 2 | = | HLT |		169	24
27	INV "AL| A | INV I | INV p | INV h | INV a | INV AL" | INV PAUSE |	α	177	25
28	GSB P1 | cos | GSB P2 | HLT |		181	26
29	INV "AL| B | INV e | INV t | INV a | INV AL" | INV PAUSE |	β	188	27
30	GSB P1 | sin | GSB P2 | HLT |		192	28
31	GSB P3 | GoTo 1 |		194	29
32				2F
33	P1 ((| MR 08 | + | MR 09 |)) | ÷ | 2 | = |		8	
34				
35	P2 × | ((| MR 06 | × | MR 07 |)) | INV $\sqrt{}$ | = |		8	
36				
37	P3 INV "AL| I | N | P | U | T | INV SPACE | INV ! | INV AL" | INV PAUSE |	Total 224	10	

Note

- Input frequency in the unit of Hz.
- Input R, L, G, C and f. |Zo|, ϕ, α and β will be displayed.
  Repeat this procedure if necessary.
- Leakage conductance G may be neglected (input 0).

Memory split setting MODE • 5 6

CASIO PROGRAM SHEET

Program for	Transistor amplifier	No. Electrical engineering– 11-1	FX-602P

Description

• Input the program written in the next page.

① Conversion of h-parameters for grounded-base, grounded-emitter and grounded-collector circuits.

$\Delta = h_{11}h_{22} - h_{12}h_{21}$

$h_{11} = \frac{e_1}{i_1}$; Input impedance with output terminals shorted [kΩ]

$h_{12} = \frac{e_1}{e_2}$; Voltage feedback ratio with input terminals open

$h_{21} = \frac{i_2}{i_1}$; Current amplification factor with output terminals shorted

$h_{22} = \frac{i_2}{e_2}$; Output admittance with input terminals open [μ℧]

	Grounded base [hb]		Grounded emitter [he]		Grounded collector [hc]	
P1 hb	h_{11b}	h_{12b}	$\frac{h_{11b}}{1+h_{21b}}$	$\frac{\Delta b - h_{12b}}{1+h_{21b}}$	$\frac{h_{11b}}{1+h_{21b}}$	1
	h_{21b}	h_{22b}	$\frac{-h_{21b}}{1+h_{21b}}$	$\frac{h_{22b}}{1+h_{21b}}$	$\frac{-1}{1+h_{21b}}$	$\frac{h_{22b}}{1+h_{21b}}$
P2 he	$\frac{h_{11e}}{1+h_{21e}}$	$\frac{\Delta e - h_{12e}}{1+h_{21e}}$	h_{11e}	h_{12e}	h_{11e}	$1-h_{12e}$
	$\frac{-h_{21e}}{1+h_{21e}}$	$\frac{h_{22e}}{1+h_{21e}}$	h_{21e}	h_{22e}	$-(1+h_{21e})$	h_{22e}
P3 hc	$\frac{h_{11c}}{-h_{21c}}$	$\frac{\Delta c + h_{21c}}{-h_{21c}}$	h_{11c}	$1-h_{12c}$	h_{11c}	h_{12c}
	$\frac{1+h_{21c}}{-h_{21c}}$	$\frac{h_{22c}}{-h_{21c}}$	$-(1+h_{21c})$	h_{22c}	h_{21c}	h_{22c}
	GoTo 1		GoTo 2		GoTo 3	

P1 Input hb-parameters and depress GoTo 2 . he-parameters will be obtained.
Depress GoTo 3 and hc-parameter will be obtained.

P2 Input he-parameters and depress GoTo 1 . hb-parameters will be obtained.
Depress GoTo 3 and hc-parameters will be obtained.

P3 Input hc-parameters and depress GoTo 1 . hb-parameters will be obtained.
Depress GoTo 2 and he-parameters will be obtained.

Example Calculate he- and hc-parameters for a grounded base circuit. Units of input data:

$h_{11b} = 0.03$ [kΩ] $h_{12b} = 0.6 \times 10^{-3}$ h_{11} [kΩ]

$h_{21b} = -0.99$ $h_{22b} = 0.5$ [μ℧] h_{22} [μ℧]

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	GoTo 3	3	h11(KOhm)
1	P1	h11(KOhm)?		12	EXE	1	h12
2	0.03 EXE	h12?		13	EXE	−100	h21
3	0.6 EXP 3 +/− EXE	h21?		14	EXE	50	h22(μMho)
4	0.99 +/− EXE	h22(μMho)?		15			
5	0.5 EXE	123 : hbhehc		16			
6	GoTo 2	3	h11(KOhm)	17			
7	EXE	$9.^{-04}$	h12	18			
8	EXE	99	h21	19			
9	EXE	50	h22(μMho)	20			
10	EXE	123 : hbhehc		21			

Program for

Transistor amplifier

	Program	Remark	Step
	[MODE] [3] [INV] [MAC] [MODE] [•] [2] [0] [MODE] [2]		
1	P0 INV "AL| INV h | 1 | 1 | INV (| K | O | INV h | INV m|		9
2	INV) | INV SPACE | INV ? | INV AL"| HLT | EXP | 3 | Min 01 |	Input h_{11}	17
3	INV "AL| INV h | 1 | 2 | INV SPACE | INV ? | INV AL"|		24
4	HLT | Min 02 |	Input h_{12}	26
5	INV "AL| INV h | 2 | 1 | INV SPACE | INV ? | INV AL"|		33
6	HLT | Min 03 |	Input h_{21}	35
7	INV "AL| INV h | 2 | 2 | INV (| INV μ | M | INV h | INV O |		44
8	INV) | INV SPACE | INV ? | INV AL"| HLT | EXP | 6 | +/- | Min 04 |	Input h_{22}	53
9	× | MR 01 | − | MR 02 | × | MR 03 | = |	Δh	60
10	Min 05 | 1 | + | MR 03 | = | Min 06 |	$1+h_{21}$	66
11			
12	P1	hb-Conversion	
13	LBL 1 | INV "AL| INV h | INV b | INV SPACE | INV → | INV SPACE | INV h |		8
14	INV e | INV , | INV h | INV c | INV AL"| INV PAUSE | GSB P0 |		15
15	LBL O | GSB INV P5 | HLT | GoTo 1 |		19
16	LBL 2 | 1 | GSB INV P6 | GoTo O |	(h_e)	23
17	LBL 3 | 2 | GSB INV P6 | GoTo O |	(h_e)	27
18			
19	P2	he-Conversion	
20	LBL 2 | INV "AL| INV h | INV e | INV SPACE | INV → | INV SPACE | INV h |		8
21	INV b | INV , | INV h | INV c | INV AL"| INV PAUSE | GSB P0 |		15
22	LBL O | GSB INV P5 | HLT | GoTo 2 |		19
23	LBL 1 | 1 | GSB INV P6 | GoTo O |	(h_b)	23
24	LBL 3 | 3 | GSB INV P6 | GoTo O |	(h_c)	27
25			
26			
27	Continued to next page		
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND GoToO
01	h_{11}
02	h_{12}
03	h_{21}
04	h_{22}
05	Δh
06	$1+h_{21}$
07	
08	
09	
F	Denominator
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Memory split setting [MODE] [•] [2] [0]

CASIO PROGRAM SHEET

Program for	Transistor amplifier	No.	Electrical engineering– 11-2	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Transistor amplifier

	Program	Remark	Step
1	P3	hc-Conversion	
2	LBL 3 | INV "AL | INV h | INV C | INV SPACE | INV → | INV SPACE | INV h |		8
3	INV b | INV ' | INV h | INV e | INV AL" | INV PAUSE | GSB P0 |		15
4	LBL 0 | GSB INV P5 | HLT | GoTo 3 |		19
5	LBL 1 | 4 | GSB INV P6 | GoTo 0 |	(h_b)	23
6	LBL 2 | 3 | GSB INV P6 | GoTo 0 |	(h_e)	27
7			
8	INV P6 GSB INV P9 | Min 00 | INV IND | GoTo 0 |	h-Parameter Conversion	4
9	LBL 1 | MR 06 | GSB INV P8 | GSB INV P7 | +/- | + | MR 05 | = |		12
10	GSB INV P7 | +/- | GoTo 9 |		15
11	LBL 2 | MR 06 | GSB INV P8 | GSB INV P7 | MR 06 | GSB INV P7 |		21
12	1 | +/- | GoTo 9 |		24
13	LBL 3 | 1 | GSB INV P8 | GSB INV P7 | +/- | + | 1 | = | GSB INV P7 |		33
14	MR 06 | +/- | GoTo 9 |		36
15	LBL 4 | MR 03 | +/- | GSB INV P8 | GSB INV P7 | + | MR 03 | = |		44
16	GSB INV P7 | MR 06 | GSB INV P7 |		47
17	LBL 9 | GSB INV P7 | GSB INV P7 |		50
18			
19	INV P7 INV IND | GoTo 0 |	Answer Output	2
20	LBL 1 | INV "AL | INV h | 1 | 1 | INV (| K | 0 | INV h | INV m |		12
21	INV) | INV AL" | INV PAUSE | ÷ | 3 | INV 10^x | GoTo 5 |		19
22	LBL 2 | INV "AL | INV h | 1 | 2 | INV AL" | INV PAUSE | GoTo 5 |		27
23	LBL 3 | INV "AL | INV h | 2 | 1 | INV AL" | INV PAUSE | GoTo 5 |		35
24	LBL 4 | INV "AL | INV h | 2 | 2 | INV (| INV μ | M | INV h | INV O |		45
25	INV) | INV AL" | INV PAUSE | × | 6 | INV 10^x |		51
26	LBL 5 | ÷ | MR F | = | HLT | INV ISZ | INV IND | MR 00 |		59
27			
28	INV P8 Min F | 1 | Min 00 | MR 01 |		4
29			
30			
31	Continued to next page		
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND GoTo 0
01	h_{11}
02	h_{12}
03	h_{21}
04	h_{22}
05	Δh
06	$1+h_{21}$
07	
08	
09	
F	Denominator
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
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2F	

Note

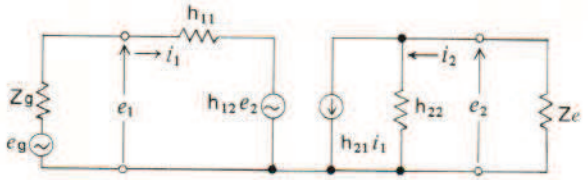
CASIO PROGRAM SHEET

Program for	No.
Transistor amplifier	Electrical engineering 11-3

Description

• Input the program written in the next page.

② Calculation of characteristic values for each type of circuit using an equivalent circuit P4



Input impedance $Z_i = \frac{e_1}{i_1} = h_{11} - \frac{h_{12}h_{21}}{h_{22} + \frac{1}{Z_e}}$ [kΩ]

Output impedance $Z_o = \frac{e_2}{i_2} = \frac{h_{11} + Z_g}{\Delta h + h_{22}Z_g}$ [kΩ]

Voltage amplification factor $A_v = \frac{e_2}{e_1} = \frac{-h_{21}Z_e}{h_{11} + \Delta h Z_e}$

Current amplification factor $A_i = \frac{i_2}{i_1} = \frac{-h_{21}}{Z_e(h_{22} + \frac{1}{Z_e})}$

Power gain $G = A_v \cdot A_i = \frac{h_{21}^2}{(h_{11} + Z_e\Delta h)(h_{22} + \frac{1}{Z_e})}$

Example

Calculate Z_i, Z_o, A_v, A_i and G for a grounded-base circuit whose data are:
$h_{11b} = 0.03$ (kΩ), $h_{12b} = 0.6\times10^{-3}$, $h_{21b} = -0.99$, $h_{22b} = 0.5$ (μ℧),
$Z_g = 1$ (kΩ) and $Z_e = 10$ (kΩ).
(Input Z_g and Z_e in kilohms)

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
/	MODE 1			11	EXE	270.2199725	G
1	P4	h11(KOhm)?		12			
2	0.03 EXE	h12?		13			
3	0.6 EXP 3 +/- EXE	h21?		14			
4	0.99 +/- EXE	h22(μMho)?		15			
5	0.5 EXE	Zg(KOhm)?		16			
6	1 EXE	Ze(KOhm)?		17			
7	10 EXE	0.035910447	Z_i(KOhm)	18			
8	EXE	928.7646528	Z_o(KOhm)	19			
9	EXE	274.3142145	A_v	20			
10	EXE	0.985074626	A_i	21			

Program for **Transistor amplifier**

	Program	Remark	Step
1	INV P5 INV "AL| 1 |2|3| INV : | INV h | INV b | INV h | INV e |		9
2	INV h | INV c | INV AL"|		12
3			
4	INV P9 INV "AL| INV ✳ | A | N | S | W | E | R | S | INV ✳ | INV AL"|		11
5	INV PAUSE|		12
6			
7	P4		
8	LBL O | INV "AL| INV h | INV b | INV SPACE | INV → | INV SPACE | Z | INV , |		9
9	A | INV , | G | INV AL"| INV PAUSE | GSB P0 |		15
10	INV "AL| Z | INV g | INV (| K | O | INV h | INV m | INV) |		24
11	INV SPACE | INV ? | INV AL"| HLT | EXP | 3 | Min 07 |		31
12	INV "AL| Z | INV e | INV (| K | O | INV h | INV m | INV) |		40
13	INV SPACE | INV ? | INV AL"| HLT | EXP | 3 | Min 08 |		47
14	LBL 9 | GSB INV P9 | INV "AL| Z | INV i | INV (| K | O | INV h | INV m |	Z_i	57
15	INV) | INV AL"| INV PAUSE | MR 01 | − | MR 02 | × |		64
16	MR 03 | ÷ | ((| MR 04 | + | MR 08 | INV 1/x |)) |		72
17	= | ÷ | 3 | INV 10^x | = | HLT |		78
18	INV "AL| Z | INV O | INV (| K | O | INV h | INV m | INV) |	Z_o	87
19	INV AL"| INV PAUSE | ((| MR 01 | + | MR 07 |)) | ÷ |		95
20	((| MR 05 | + | MR 04 | × | MR 07 |)) | ÷ |		103
21	3 | INV 10^x | = | HLT |		107
22	INV "AL| A | INV V | INV AL"| INV PAUSE | MR 03 | × |	A_v	114
23	MR 08 | ÷ | ((| MR 01 | + | MR 05 | × |		121
24	MR 08 |)) | = | +/− | Min 09 | HLT |		127
25	INV "AL| A | INV i | INV AL"| INV PAUSE | MR 03 | ÷ |	A_i	134
26	MR 08 | ÷ | ((| MR 04 | + | MR 08 | INV 1/x |)) |		142
27	= | +/− | HLT |		145
28	INV "AL| G | INV AL"| INV PAUSE | × | MR 09 | = | HLT | GoTo O |	G	154
29			
30		Total 448	
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	h_{11}
02	h_{12}
03	h_{21}
04	h_{22}
05	Δh
06	$1+h_{21}$
07	Z_g
08	Z_e
09	A_v
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
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1F	
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2F	

Note

CASIO PROGRAM SHEET

Program for	Four-terminal parameter conversion (Z,Y,G,H,F)	No. Electrical engineering -12-1	FX-602P

Description

• Input the program written in the next page.

	P0 Z	P1 Y	P2 G	P3 H	P4 F	
[Z]	$\begin{matrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{matrix}$	$\begin{matrix} \frac{y_{22}}{\Delta y} & \frac{-y_{12}}{\Delta y} \\ \frac{-y_{21}}{\Delta y} & \frac{y_{11}}{\Delta y} \end{matrix}$ ①	$\begin{matrix} \frac{1}{g_{11}} & \frac{-g_{12}}{g_{11}} \\ \frac{g_{21}}{g_{11}} & \frac{\Delta g}{g_{11}} \end{matrix}$ ②	$\begin{matrix} \frac{\Delta h}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{matrix}$ ③	$\begin{matrix} \frac{A}{C} & \frac{\Delta}{C} \\ \frac{1}{C} & \frac{D}{C} \end{matrix}$ ④	GoTo 0 → Z-parameter
[Y]	$\begin{matrix} \frac{z_{22}}{\Delta z} & \frac{-z_{12}}{\Delta z} \\ \frac{-z_{21}}{\Delta z} & \frac{z_{11}}{\Delta z} \end{matrix}$ ①	$\begin{matrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{matrix}$	$\begin{matrix} \frac{\Delta g}{g_{12}} & \frac{g_{12}}{g_{22}} \\ \frac{-g_{21}}{g_{22}} & \frac{1}{g_{22}} \end{matrix}$ ③	$\begin{matrix} \frac{1}{h_{11}} & \frac{-h_{12}}{h_{11}} \\ \frac{h_{21}}{h_{11}} & \frac{\Delta h}{h_{11}} \end{matrix}$ ②	$\begin{matrix} \frac{D}{B} & -\frac{\Delta}{B} \\ \frac{1}{B} & \frac{A}{B} \end{matrix}$	GoTo 1 → Y-parameter
[G]	$\begin{matrix} \frac{1}{z_{11}} & \frac{-z_{12}}{z_{11}} \\ \frac{z_{21}}{z_{11}} & \frac{\Delta z}{z_{11}} \end{matrix}$ ②	$\begin{matrix} \frac{\Delta y}{y_{22}} & \frac{y_{12}}{y_{22}} \\ \frac{-y_{21}}{y_{22}} & \frac{1}{y_{22}} \end{matrix}$ ③	$\begin{matrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{matrix}$	$\begin{matrix} \frac{h_{22}}{\Delta h} & \frac{-h_{12}}{\Delta h} \\ \frac{-h_{21}}{\Delta h} & \frac{h_{11}}{\Delta h} \end{matrix}$ ①	$\begin{matrix} \frac{C}{A} & -\frac{\Delta}{A} \\ \frac{1}{A} & \frac{B}{A} \end{matrix}$	GoTo 2 → G-parameter
[H]	$\begin{matrix} \frac{\Delta z}{z_{22}} & \frac{z_{12}}{z_{22}} \\ \frac{-z_{21}}{z_{22}} & \frac{1}{z_{22}} \end{matrix}$ ③	$\begin{matrix} \frac{1}{y_{11}} & \frac{-y_{12}}{y_{11}} \\ \frac{y_{21}}{y_{11}} & \frac{\Delta y}{y_{11}} \end{matrix}$ ②	$\begin{matrix} \frac{g_{22}}{\Delta g} & \frac{-g_{12}}{\Delta g} \\ \frac{-g_{21}}{\Delta g} & \frac{g_{11}}{\Delta g} \end{matrix}$ ①	$\begin{matrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{matrix}$	$\begin{matrix} \frac{B}{D} & \frac{\Delta}{D} \\ \frac{1}{D} & \frac{C}{D} \end{matrix}$	GoTo 3 → H-parameter
[F]	$\begin{matrix} \frac{z_{11}}{z_{21}} & \frac{\Delta z}{z_{21}} \\ \frac{1}{z_{21}} & \frac{z_{22}}{z_{21}} \end{matrix}$ ④	$\begin{matrix} \frac{-y_{22}}{y_{21}} & \frac{-1}{y_{21}} \\ \frac{-\Delta y}{y_{21}} & \frac{-y_{11}}{y_{21}} \end{matrix}$	$\begin{matrix} \frac{1}{g_{21}} & \frac{g_{22}}{g_{21}} \\ \frac{g_{11}}{g_{21}} & \frac{\Delta g}{g_{21}} \end{matrix}$	$\begin{matrix} \frac{-\Delta h}{h_{21}} & \frac{-h_{11}}{h_{21}} \\ \frac{-h_{22}}{h_{21}} & \frac{-1}{h_{21}} \end{matrix}$	$\begin{matrix} A & B \\ C & D \end{matrix}$	GoTo 4 → F-parameter

$\Delta z = z_{11}z_{22} - z_{12}z_{21}$ $\Delta y = y_{11}y_{22} - y_{12}y_{21}$ $\Delta g = g_{11}g_{22} - g_{12}g_{21}$ $\Delta h = h_{11}h_{22} - h_{12}h_{21}$ $\Delta = AD - BC$

Calculation ① → LBL 5, P5
Calculation ② → LBL 1, P5
Calculation ③ → LBL 4, P5
Calculation ④ → LBL 3, P5

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Four-terminal parameter conversion (Z,Y,G,H,F)

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0	Z-Conversion	
2	LBL0 | GSB INV P7 | INV "AL | INV ; | Z | INV AL" | INV PAUSE | GSB INV P9 |		8
3	LBL9 | GSB INV P6 | HLT | GoTo0 |		12
4	LBL1 | INV "AL | Z | INV SPACE | INV → | INV SPACE | Y | INV AL" | INV PAUSE |		21
5	5 | GSB INV P5 | GoTo9 |		24
6	LBL2 | INV "AL | | INV SPACE | INV → | INV SPACE | G | INV AL" | INV PAUSE |		33
7	1 | GSB INV P5 | GoTo9 |		36
8	LBL3 | INV "AL | Z | INV SPACE | INV → | INV SPACE | H | INV AL" | INV PAUSE |		45
9	4 | GSB INV P5 | GoTo9 |		48
10	LBL4 | INV "AL | Z | INV SPACE | INV → | INV SPACE | F | INV AL" | INV PAUSE |		57
11	3 | GSB INV P5 | GoTo9 |		60
12			
13	P1	Y-Conversion	
14	LBL1 | GSB INV P7 | INV "AL | INV ; | Y | INV AL" | INV PAUSE | GSB INV P9 |		8
15	LBL9 | GSB INV P6 | HLT | GoTo1 |		12
16	LBL0 | INV "AL | Y | INV SPACE | INV → | INV SPACE | Z | INV AL" | INV PAUSE |		21
17	5 | GSB INV P5 | GoTo9 |		24
18	LBL2 | INV "AL | Y | INV SPACE | INV → | INV SPACE | G | INV AL" | INV PAUSE |		33
19	4 | GSB INV P5 | GoTo9 |		36
20	LBL3 | INV "AL | Y | INV SPACE | INV → | INV SPACE | H | INV AL" | INV PAUSE |		45
21	1 | GSB INV P5 | GoTo9 |		48
22	LBL4 | INV "AL | Y | INV SPACE | INV → | INV SPACE | F | INV AL" | INV PAUSE |	Y → F Calculation	57
23	3 | Min 00 | MR04 | +/- | GSB INV P8 | 1 | +/- |		64
24	GSB INV P8 | MR 05 | +/- | GSB INV P8 | MR 01 | +/- |		70
25	GSB INV P8 | GoTo9 |		72
26			
27			
28	Continued to next page		
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32			
33			
34			
35			
36			
37			

Note

	Contents in memories
00	For IND
01	x_{11}
02	x_{12}
03	x_{21}
04	x_{22}
05	Δ_i
06	
07	
08	
09	For data protection
F	For display
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
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24	
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26	
27	
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29	
2F	

CASIO PROGRAM SHEET

Program for	Four-terminal parameter conversion (Z,Y,G,H,F)	No. Electrical engineering	12-2

Description

• Input the program written in the next page.

1. Z-conversion, (P0 , Input data)

   GoTo 1 → Y, GoTo 2 → G, GoTo 3 → H, GoTo 4 → F

2. Y-conversion (P1 , Input data)

   GoTo 0 → Z, GoTo 2 → G, GoTo 3 → H, GoTo 4 → F

3. G-conversion (P2 , Input data)

   GoTo 0 → Z, GoTo 1 → Y, GoTo 3 → H, GoTo 4 → F

4. H-conversion (P3 , Input data)

   GoTo 0 → Z, GoTo 1 → Y, GoTo 2 → G, GoTo 4 → F

5. F-conversion (P4 , Input data)

   GoTo 0 → Z, GoTo 1 → Y, GoTo 2 → G, GoTo 3 → H

Example

$$H = \begin{bmatrix} 0.5 & 0 \\ -1 & 1 \end{bmatrix} \rightarrow [Y]\ ? \quad [G]\ ? \quad [F]\ ?$$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P3	⟨11⟩?	
2	⟨h_{11}⟩ 0.5 EXE	⟨12⟩?	
3	⟨h_{12}⟩ 0 EXE	⟨21⟩?	
4	⟨h_{21}⟩ 1 +/- EXE	⟨22⟩?	
5	⟨h_{22}⟩ 1 EXE	01234 : ZYGHF	GOTO destination
6	GoTo 1	2	Y_{11}
7	EXE	0	Y_{12}
8	EXE	−2	Y_{21}
9	EXE	1	Y_{22}
10	EXE	01234 : ZYGHF	

Step	Data input operation	Read-out	Remark
11	GoTo 2	2	G_{11}
12	EXE	0	G_{12}
13	EXE	2	G_{21}
14	EXE	1	G_{22}
15	EXE	01234 : ZYGHF	
16	GoTo 4	0.5	A
17	EXE	0.5	B
18	EXE	1	C
19	EXE	1	D
20			
21			

Program for

Four-terminal parameter conversion (Z,Y,G,H,F)

	Program	Remark	Step
1	P2	G-Conversion	
2	LBL 2 | GSB INV P7 | INV "AL | INV ; | G | INV AL" | INV PAUSE | GSB INV P9 |		8
3	LBL 9 | GSB INV P6 | HLT | GoTo 2 |		12
4	LBL O | INV "AL | G | INV SPACE | INV → | INV SPACE | Z | INV AL" | INV PAUSE |		21
5	1 | GSB INV P5 | GoTo 9 |		24
6	LBL 1 | INV "AL | G | INV SPACE | INV → | INV SPACE | Y | INV AL" | INV PAUSE |		33
7	4 | GSB INV P5 | GoTo 9 |		36
8	LBL 3 | INV "AL | G | INV SPACE | INV → | INV SPACE | H | INV AL" | INV PAUSE |		45
9	5 | GSB INV P5 | GoTo 9 |		48
10	LBL 4 | INV "AL | G | INV SPACE | INV → | INV SPACE | F | INV AL" | INV PAUSE |	G → F Calculation	57
11	3 | Min 00 | 1 | GSB INV P8 | MR 04 | GSB INV P8 |		63
12	MR 01 | GSB INV P8 | MR 05 | GSB INV P8 | GoTo 9 |		68
13			
14	P3	H-Conversion	
15	LBL 3 | GSB INV P7 | INV "AL | INV ; | H | INV AL" | INV PAUSE | GSB INV P9 |		8
16	LBL 9 | GSB INV P6 | HLT | GoTo 3 |		12
17	LBL O | INV "AL | H | INV SPACE | INV → | INV SPACE | Z | INV AL" | INV PAUSE |		21
18	4 | GSB INV P5 | GoTo 9 |		24
19	LBL 1 | INV "AL | H | INV SPACE | INV → | INV SPACE | Y | INV AL" | INV PAUSE |		33
20	1 | GSB INV P5 | GoTo 9 |		36
21	LBL 2 | INV "AL | H | INV SPACE | INV → | INV SPACE | G | INV AL" | INV PAUSE |		45
22	5 | GSB INV P5 | GoTo 9 |		48
23	LBL 4 | INV "AL | H | INV SPACE | INV → | INV SPACE | F | INV AL" | INV PAUSE |	H → F Calculation	57
24	3 | Min 00 | MR 05 | +/- | GSB INV P8 | MR 01 | +/- |		64
25	GSB INV P8 | MR 04 | +/- | GSB INV P8 | 1 | +/- | GSB INV P8 |		71
26	GoTo 9 |		72
27			
28			
29	Continued to next page		
30			
31			
32			
33			
34			
35			
36			
37			

Note

	Contents in memories
00	For IND
01	x_{11}
02	x_{12}
03	x_{21}
04	x_{22}
05	Δ_i
06	
07	
08	
09	For data protection
F	For display
10	
11	
12	
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1F	
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CASIO PROGRAM SHEET

Program for	No.	
Four-terminal parameter conversion (Z,Y,G,H,F)	Electrical engineering 12-3	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Four-terminal parameter conversion (Z,Y,G,H,F)

	Program	Remark	Step
1	P4	F-Conversion	
2	LBL 4 | GSB INV P7 | INV "AL | INV ; | F | INV AL" | INV PAUSE | GSB INV P9 |		8
3	LBL 9 | GSB INV P6 | HLT | GoTo 4 |		12
4	LBL O | INV "AL | F | INV SPACE | INV → | INV SPACE | Z | INV AL" | INV PAUSE |		21
5	3 | GSB INV P5 | GoTo 9 |		24
6	LBL 1 | INV "AL | F | INV SPACE | INV → | INV SPACE | Y | INV AL" | INV PAUSE |	F → Y calculation	33
7	2 | Min 00 | MR 04 | GSB INV P8 | MR 05 | +/- |		39
8	GSB INV P8 | 1 | +/- | GSB INV P8 | MR 01 | GSB INV P8 |		45
9	GoTo 9 |		46
10	LBL 2 | INV "AL | F | INV SPACE | INV → | INV SPACE | G | INV AL" | INV PAUSE |	F → G calculation	55
11	1 | Min 00 | MR 03 | GSB INV P8 | MR 05 | +/- |		61
12	GSB INV P8 | 1 | GSB INV P8 | MR 02 | GSB INV P8 | GoTo 9 |		67
13	LBL 3 | INV "AL | F | INV SPACE | INV → | INV SPACE | H | INV AL" | INV PAUSE |	F → H calculation	76
14	4 | Min 00 | MR 02 | GSB INV P8 | MR 05 |		81
15	GSB INV P8 | 1 | +/- | GSB INV P8 | MR 03 | GSB INV P8 |		87
16	GoTo 9 |		88
17			
18	INV P5 Min 00 | INV IND | GoTo O |	Conversion calculations	3
19	LBL 5 | MR 04 | GSB INV P8 | MR 02 | +/- | GSB INV P8 |	Calculation ①	9
20	MR 03 | +/- | GSB INV P8 | MR 01 | GoTo 9 |		14
21	LBL 1 | 1 | GSB INV P8 | MR 02 | +/- | GSB INV P8 | MR 03 |	Calculation ②	21
22	GSB INV P8 | MR 05 | GoTo 9 |		24
23	LBL 4 | MR 05 | GSB INV P8 | MR 02 | GSB INV P8 | MR 03 |	Calculation ③	30
24	+/- | GSB INV P8 | 1 | GoTo 9 |		34
25	LBL 3 | MR 01 | GSB INV P8 | MR 05 | GSB INV P8 | 1 |	Calculation ④	40
26	GSB INV P8 | MR 04 |		42
27	LBL 9 | GSB INV P8 |		44
28			
29			
30	Continued to next page		
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND
01	x_{11}
02	x_{12}
03	x_{21}
04	x_{22}
05	Δ_i
06	
07	
08	
09	For data protection
F	For display
10	
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Note

CASIO PROGRAM SHEET

Program for	No.	
Four-terminal parameter conversion (Z,Y,G,H,F)	Electrical engineering 12-4	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Four-terminal parameter conversion (Z,Y,G,H,F)

	Program	Remark	Step
1	INV P6 1 | 0 | Min F | AC |	GOTO destination display	4
2	INV "AL | 0 | 1 | 2 | 3 | 4 | INV : | Z | Y | G | H | F |		16
3	INV AL" |		17
4			
5	INV P7 INV "AL | I | N | P | U | T | INV SPACE | INV AL" |		8
6			
7	INV P8 Min 09 | 1 | 2 | INV x=F | GoTo 1 | 1 | GoTo 2 |	Output display	7
8	LBL 1 | 9 |		9
9	LBL 2 | M+ F | MR 09 | INV "AL | INV < | INV AR F | INV > |		16
10	INV AL" | INV PAUSE | ÷ | INV IND | MR 00 | = | HLT |		23
11			
12	INV P9 INV "AL | INV < | 1 | 1 | INV > | INV SPACE | INV ? | INV AL" |	Data input	8
13	HLT | Min 01 |		10
14	INV "AL | INV < | 1 | 2 | INV > | INV SPACE | INV ? | INV AL" |		18
15	HLT | Min 02 |		20
16	INV "AL | INV < | 2 | 1 | INV > | INV SPACE | INV ? | INV AL" |		28
17	HLT | Min 03 |		30
18	INV "AL | INV < | 2 | 2 | INV > | INV SPACE | INV ? | INV AL" |		38
19	HLT | Min 04 | × | MR 01 | − | MR 02 | × |		45
20	MR 03 | = | Min 05 |		48
21			
22		Total 510	
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	For IND
01	x_{11}
02	x_{12}
03	x_{21}
04	x_{22}
05	Δ_i
06	
07	
08	
09	For data protection
F	For display
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

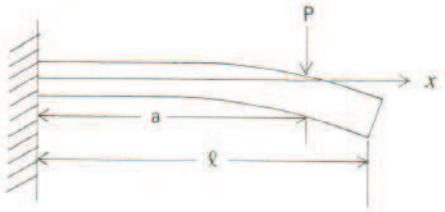
Note

CASIO PROGRAM SHEET

Program for	No.	
Cantilever under concentrated load	Mechanics–1	

Description

* Input the program written in the next page.



E : Young's modulus [kg/mm²]
I : Geometrical moment of inertia [mm⁴]
a : Distance of concentrated load from support [mm]
P : Load [kg]

Deflection y [mm], Angle of deflection S [°], Bending moment M [kg·mm]

① $\ell > x > a$

$$y = \frac{Pa^3}{6EI} - \frac{Pa^2}{2EI}x$$

$$S = \tan^{-1}\left[-\frac{Pa^2}{2EI}\right]$$

M = 0 (shearing load Ws = 0)

② $x \leqq a$

$$y = \frac{P}{6EI}x^3 - \frac{Pa}{2EI}x^2$$

$$S = \tan^{-1}\left\{\frac{Px}{2EI}(x-2a)\right\}$$

M = P $(x - a)$

(shearing load Ws = P)

Example

E = 4,000 (kg/mm²)
I = 5 (mm⁴)
a = 30 (mm)
P = 2 (kg)

What are deflection, angle of deflection, bending moment and shearing load at x = 25mm and x = 32mm ?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	0	
2	(E) 4000 EXE	4000	
3	(I) 5 EXE	5	
4	(a) 30 EXE	30	
5	(p) 2 EXE	0	
6	(x) 25 EXE	y=	
7		−0.67708333	
8	EXE	s=	
9		−2.50509286	
10	EXE	M=	

Step	Data input operation	Read-out	Remark
11		−10	
12	(x) 32 EXE	y=	
13		−0.98999999	
14	EXE	s=	
15		−2.57657183	
16	EXE	M=	
17		0	
18			
19			
20			
21			

Program for

Cantilever under concentrated load

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 HLT | Min01 | HLT | Min02 | HLT | Min03 | Min F | HLT | Min04 |		9
2	÷ | 2 | ÷ | MR 01 | ÷ | MR02 | = | Min06 | ÷ | 3 | = |		20
3	Min07 | 0 | MODE 4 |		23
4	LBL 1 | HLT | Min05 | INV $x \geqq$ F | GOTO 2 | GOTO 3 |		29
5	LBL 2 | MR 07 | × | MR 03 | INV x^y | 3 | − | MR06 | × | MR 03 |		39
6	INV x^2 | × | MR 05 | GSB P1 |		43
7	MR06 | × | MR 03 | INV x^2 | = | +/− | GSB P2 |		50
8	0 | GSB P3 | GOTO 1 |		53
9	LBL 3 | MR 07 | × | MR05 | INV x^y | 3 | − | MR06 | × | MR 03 |		63
10	× | MR 05 | INV x^2 | = | GSB P1 |		68
11	MR06 | × | MR 05 | × | (| MR05 | − | 2 | × | MR03 |) |		79
12	= | GSB P2 |		81
13	MR04 | × | (| MR05 | − | MR03 |) | GSB P3 | GOTO 1 |		90
14			
15	P1 INV "AL | INV y | = | INV AL" | INV PAUSE | INV PAUSE | = | HLT |		8
16			
17	P2 INV "AL | INV s | = | INV AL" | INV PAUSE | INV PAUSE | INV $\tan^{-1}$ | HLT |		8
18			
19	P3 INV "AL | M | = | INV AL" | INV PAUSE | INV PAUSE | = | HLT |		8
20			
21		Total 118	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	E
02	I
03	a
04	p
05	x
06	P / 2 EI
07	P / 6 EI
08	
09	
F	a
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

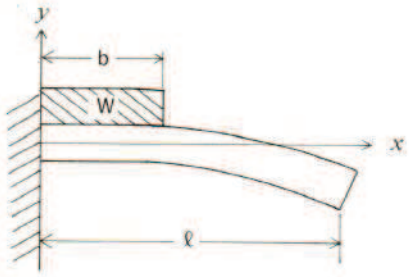
Following E, I, a and P, input x ($< \ell$, in mm) which is the distance between the support and a point of interest. Then the values of y, S and M will be displayed. Input other values of x as necessary.

CASIO PROGRAM SHEET

Program for	No.	
Cantilever under distributed load	Mechanics–2	

Description

• Input the program written in the next page.



E : Young's modulus [kg/mm^2]
I : Geometrical moment of inertia [mm^4]
b : Length of distributed load [mm]
W : Distributed load [kg/mm]
x : Distance of a point of interest from the support [mm]

Deflection y [mm], Angle of deflection S [°], Bending moment M [kg·mm], Shearing load Ws [kg]

① $\ell > x > b$

$$y = \frac{Wb^4}{24EI} - \frac{Wb^3}{6EI}x$$

$$S = \tan^{-1}\left[-\frac{Wb^3}{6EI}\right]$$

$$M = 0$$

$$Ws = 0$$

② $x \leqq b$

$$y = -\frac{Wx^4}{24EI} + \frac{Wb}{6EI}x^3 - \frac{Wb^2}{4EI}x^2$$

$$S = \tan^{-1}\left[-\frac{Wx^3}{6EI} + \frac{Wb}{2EI}x^2 - \frac{Wb^2}{2EI}x\right]$$

$$M = -W\left[\frac{x^2}{2} - bx + \frac{b^2}{2}\right]$$

$$Ws = W(b - x)$$

Example

E = 4,000 (kg/mm^2)
I = 5 (mm^4)
b = 40 (mm)
W = 0.02 (kg/mm)

What are deflection, angle of deflection, bending moment and shearing load at x = 30mm and x = 50mm ?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO		
2	(E) 4000 EXE	4000	
3	(I) 5 EXE	5	
4	(b) 40 EXE	40	
5	(W) 0.02 EXE	0	
6	(x) 30 EXE	−0.21375	
7	EXE	−0.60158357	
8	EXE	−1	
9	EXE	0.2	
10	(x) 50 EXE	−0.42666666	

Step	Data input operation	Read-out	Remark
11	EXE	−0.6111318	
12	EXE	0	
13	EXE	0	
14			
15			
16			
17			
18			
19			
20			
21			

Program for **Cantilever under distributed load**

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 HLT Min01 HLT Min02 HLT Min03 Min F HLT Min04		9
2	÷ 6 ÷ MR01 ÷ MR02 = +/− Min06 0 MODE 4		20
3	LBL 1 HLT Min05 INV x≧F GOTO 2 GOTO 3		26
4	LBL 2 MR06 × MR03 INV x^y 3 = Min07 × ((MR05		37
5	− MR03 ÷ 4)) = HLT		44
6	MR07 INV $\tan^{-1}$ HLT		47
7	0 HLT 0 GOTO 1		51
8	LBL 3 MR05 INV x^2 Min08 MR03 × MR05 = Min09		60
9	MR03 INV x^2 Min00 MR06 × MR05 = Min07		68
10	× MR05 × ((MR08 ÷ 4 − MR09 + 3 ×		80
11	MR00 ÷ 2)) = HLT		86
12	MR07 × ((MR08 − 3 × MR09 + 3 ×		97
13	MR00)) = INV $\tan^{-1}$ HLT		102
14	MR04 +/− × ((MR08 ÷ 2 − MR09 + MR00		113
15	÷ 2)) = HLT MR04 × ((MR03 − MR05))		125
16	= GOTO 1		127
17			
18		Total 128	
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	b^2
01	E
02	I
03	b
04	W
05	x
06	$-W / 6EI$
07	
08	x^2
09	bx
F	b
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

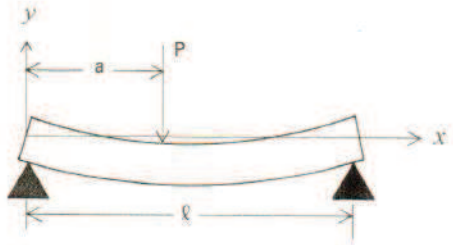
Following E, I, b and W, input x ($< \ell$) and y, S, M and Ws will be displayed. This can be repeated.

CASIO PROGRAM SHEET

Program for	Simple beam under concentrated load	No.	Mechanics–3

Description

• Input the program written in the next page.



E : Young's modulus [kg/mm^2]
I : Geometrical moment of inertia [mm^4]
ℓ : Overall length of beam [mm]
a : Distance of concentrated load from the support [mm]
P : Concentrated load [kg]

① $x \leqq a$

Deflection $y = \dfrac{P(\ell - a)x}{6EI\ell}\left\{x^2 + (\ell - a)^2 - \ell^2\right\}$ [mm]

Angle of deflection $S = \tan^{-1}\left[\dfrac{P(\ell - a)}{6EI\ell}\left\{3x^2 + (\ell - a)^2 - \ell^2\right\}\right]$ [°]

Bending moment $M = \dfrac{P(\ell - a)x}{\ell}$ [kg·mm]

Shearing load $Ws = \dfrac{P(\ell - a)}{\ell}$ [kg]

② $a < x < \ell$:

Replace $(\ell - a)$ with $-a$ and x with $(x - \ell)$ in the above equations.

Example

E = 4,000 (kg/mm^2)
I = 5 (mm^4)
ℓ = 40(mm)
a = 30(mm)
P = 2 (kg)

What are deflection, angle of deflection, bending moment and shearing load at x = 10 mm and x = 35 mm ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
/	MODE 1			11	EXE	M=	
1	PO	0		12		5	
2	(E) 4000 EXE	4000		13	EXE	Ws=	
3	(I) 5 EXE	5		14		0.5	
4	(ℓ) 40 EXE	40		15	(x) 35 EXE	y=	
5	(a) 30 EXE	30		16		−0.0421875	
6	(p) 2 EXE	2		17	EXE	s=	
7	(x) 10 EXE	y=		18		0.44761417	
8		−0.05833333		19		Repeat these steps.	
9	EXE	s=		20			
10		−0.28647651		21			

Program for

Simple beam under concentrated load

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 HLT Min01 HLT Min02 HLT Min03 HLT Min F HLT		9
2	Min04 MODE 4		11
3	LBL 1 HLT Min05 INV $x \geqq F$ GOTO 2 GOTO 3		17
4	LBL 2 MR F +/− Min08 MR05 − MR03 = GSB P1 GOTO 1		27
5	LBL 3 MR03 − MR F = Min08 MR05 GSB P1 GOTO 1		36
6			
7	P1 Min09 MR04 × MR08 ÷ MR03 = Min06 ÷ 6		10
8	÷ MR01 ÷ MR02 = Min07 × MR09 ×		19
9	(GSB P2 GSB P3		22
10	MR07 × (1 3 × GSB P2 = GSB P4		30
11	MR06 × MR09 GSB INV P5		34
12	MR06 GSB INV P6		36
13			
14	P2 MR09 INV x^2 + MR08 INV x^2 − MR03 INV x^2)		9
15			
16	P3 INV "AL INV y = INV AL" INV PAUSE INV PAUSE = HLT		8
17	P4 INV "AL INV s = INV AL" INV PAUSE INV PAUSE INV $\tan^{-1}$ HLT		8
18	INV P5 INV "AL M = INV AL" INV PAUSE INV PAUSE = HLT		8
19	INV P6 INV "AL W INV s = INV AL" INV PAUSE INV PAUSE =		8
20			
21		Total 120	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	E
02	I
03	l
04	P
05	x
06	$P(l-a)/l$ or $-Pa/l$
07	
08	$l-a$ or $-a$
09	x or $x-l$
F	a
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

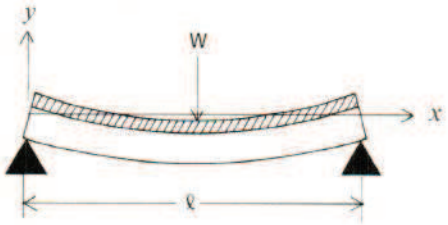
Input x following E, I, ℓ, a and P. Then y, S, M and Ws will be displayed. This can be repeated.

CASIO PROGRAM SHEET

Program for	No.
Simple beam under distributed load	Mechanics–4

Description

• Input the program written in the next page.



E : Young's modulus [kg/mm^2]
I : Geometrical moment of intertia [mm^4]
ℓ : Overall length of beam [mm]
W : Distributed load [kg/mm]

Deflection $y = -\frac{Wx}{24EI}\left\{\ell^3 + x^2(x - 2\ell)\right\}$ [mm]

Angle of deflection $S = \tan^{-1}\left[-\frac{W}{24EI}\left\{\ell^3 + x^2(4x - 6\ell)\right\}\right]$ [°]

Bending moment $M = -\frac{Wx}{2}(x - \ell)$ [kg·mm]

Shearing load $Ws = W\left(\frac{\ell}{2} - x\right)$ [kg]

Example

E = 4,000 (kg/mm^2)
I = 5 (mm^4)
ℓ = 40 (mm)
W = 0.05 (kg/mm)

What are deflection, angle of deflection, bending moment and shearing load at x = 10 mm and x = 25 mm ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11		7.5	
1	PO	0		12	EXE	Ws=	
2	(E) 4000 EXE	4000		13		0.5	
3	(I) 5 EXE	5		14	(x) 25 EXE	y=	
4	(ℓ) 40 EXE	40		15		−0.07714843	
5	(W) 0.05 EXE	0.05		16	EXE	s=	
6	(x) 10 EXE	y=		17		0.140255013	
7		−0.059375		18	EXE	M=	
8	EXE	s=		19		9.375	
9		−0.26260381		20		Repeat these steps.	
10	EXE	M=		21			

Program for

Simple beam under distributed load

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 HLT Min01 HLT Min02 HLT Min03 HLT Min04 MODE 4		9
2	LBL 1 HLT Min05 MR04 ÷ 2 4 ÷ MR01 ÷ MR02 =		21
3	+/− Min06		23
4	MR03 INV x^y 3 = Min07		28
5	MR05 × GSB P1 − 2 × MR03))) INV "AL		38
6	INV y = INV AL" INV PAUSE INV PAUSE = HLT		45
7	GSB P1 × 4 − 6 × MR03))) = INV"AL		56
8	INV s = INV AL" INV PAUSE INV PAUSE INV $\tan^{-1}$ HLT		63
9	MR04 × MR05 ÷ 2 × ((MR05 − MR03))		74
10	INV"AL M = INV AL" INV PAUSE INV PAUSE = +/− HLT		83
11	MR04 × ((MR03 ÷ 2 − MR05))		92
12	INV "AL W INV s = INVAL" INV PAUSE INV PAUSE = GOTO 1		101
13			
14	P1 MR06 × ((MR07 + MR05 INV x^2 × ((MR05		10
15			
16		Total 113	
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	E
02	I
03	l
04	W
05	x
06	$-W/24EI$
07	l^3
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

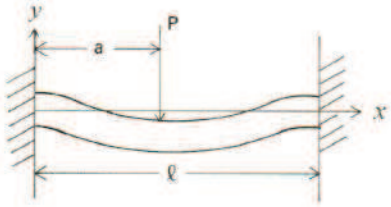
Note

CASIO PROGRAM SHEET

Program for	No.	
Beam fixed at both ends under concentrated load	Mechanics–5	

Description

• Input the program written in the next page.



E : Young's modulus [kg/mm²]

I : Geometrical moment of inertia [mm⁴]

a : Distance of concentrated load from a support [mm]

P : Concentrated load [kg]

① $x \leqq a$

Deflection $y = \dfrac{P(\ell-a)^2x^2}{6EI\ell^3}\left\{x(\ell+2a)-3a\ell\right\}$ [mm]

Angle of deflection $S = \tan^{-1}\left[\dfrac{P(\ell-a)^2x}{2EI\ell^3}\left\{x(\ell+2a)-2a\ell\right\}\right]$ [°]

Bending moment $M = \dfrac{P(\ell-a)^2}{\ell^3}\left\{x(\ell+2a)-a\ell\right\}$ [kg·mm]

Shearing load $Ws = \dfrac{P(\ell-a)^2}{\ell^3}(\ell+2a)$ [kg]

② $a < x < \ell$

Replace a with $(\ell - a)$ and x with $(\ell - x)$ in the above equations.

Example

E = 4,000 (kg/mm²)
I = 5 (mm⁴)
ℓ = 40 (mm)
a = 10 (mm)
P = 5 (kg)

What are deflection, angle of deflection, bending moment and shearing load at x = 20mm and x = 5mm ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
/	MODE 1			11	(x) 5 EXE	−0.01318359	
1	PO	0		12	EXE	−0.25178647	
2	(E) 4000 EXE	4000		13	EXE	−7.03125	
3	(I) 5 EXE	0		14	EXE	4.21875	
4	(ℓ) 40 EXE	40		15			
5	(a) 10 EXE	10		16			
6	(p) 5 EXE	0		17			
7	(x) 20 EXE	−0.04166666		18			
8	EXE	−0.08952458		19			
9	EXE	6.25		20			
10	EXE	0.78125		21			

Program for Beam fixed at both ends under concentrated load

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 HLT ×HLT =Min01 0 HLT Min02 HLT MinF HLT		11
2	÷MR02 INV x^y 3 =Min03 0 MODE 4		19
3	LBL 1 HLT Min04 INV $x \geqq$ F GOTO 2 MR F Min08 MR04 Min09		28
4	GSB P1 GOTO 1		30
5	LBL 2 MR02 − MR F =Min08 MR02 − MR04 =		40
6	Min09 GSB P1 GOTO 1		43
7			
8	P1 MR09 × (MR02 + 2 × MR08) = Min 04		11
9	MR02 × MR08 =Min 05 MR03 × (MR02 −		21
10	MR08) INV x^2 =Min06 ÷ 2 ÷ MR 01 ×		31
11	MR09 =Min07 ÷ 3 × MR09		38
12	GSB P2 3 × GSB P3 HLT		43
13	MR07 GSB P2 2 × GSB P3 INV $\tan^{-1}$ HLT		50
14	MR06 GSB P2 GSB P3 HLT		54
15	MR06 × MR04 ÷ MR09 =		60
16			
17	P2 × (MR04 −		4
18			
19	P3 MR05) =		3
20			
21		Total 114	
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	$E \times I$
02	l
03	P / l^3
04	
05	al or $l(l-a)$
06	$\frac{P(l-a)^3}{\beta}$ or $\frac{Pa^2}{\beta}$
07	$\frac{P(l-a)^2x}{2EI\beta}$ or $\frac{Pa^2(l-x)}{2EI\beta}$
08	a or $l-a$
09	x or $l-x$
F	a
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

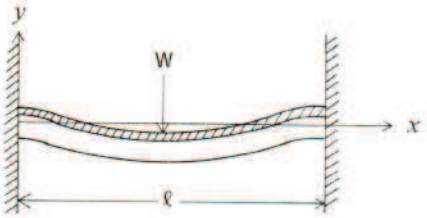
Note

CASIO PROGRAM SHEET

Program for	No.	
Beam fixed at both ends under distributed load	Mechanics–6	

Description

• Input the program written in the next page.



E : Young's modulus [kg/mm²]
I : Geometrical moment of inertia [mm⁴]
ℓ : Overall length of beam [mm]
W : Distributed load [kg/mm]

Deflection $y = \frac{Wx^2}{24EI}\left\{x(2\ell - x) - \ell^2\right\}$ [mm]

Angle of deflection $S = \tan^{-1}\left[\frac{Wx}{12EI}\left\{x(3\ell - 2x) - \ell^2\right\}\right]$ [°]

Bending moment $M = \frac{W}{12}\left\{6x(\ell - x) - \ell^2\right\}$ [kg·mm]

Shearing load $Ws = -\frac{W}{2}(2x - \ell)$ [kg]

Example

E = 4,000 (kg/mm²)
I = 5 (mm⁴)
ℓ = 40 (mm)
W = 0.05 (kg/mm)

What are deflection, angle of deflection, bending moment, and shearing load at x = 10mm and x = 25mm ?

Step	Data input operation	Read-out	Remark
/	MODE 1		
1	PO	0	
2	(E) 4000 EXE	4000	
3	(I) 5 EXE	5	
4	(ℓ) 40 EXE	40	
5	(W) 0.05 EXE	0	
6	(x) 10 EXE	y=	
7		−9.37499999⁻⁰³	
8	EXE	s=	
9		−0.07161968	
10	EXE	M=	
11		0.833333333	
12	EXE	Ws=	
13		0.5	
14	(x) 25 EXE	y=	
15		−0.01464843	
16	EXE	s=	
17		0.044762318	
18	EXE	M=	
19		2.708333333	
20		Repeat these steps.	
21			

Program for **Beam fixed at both ends under distributed load**

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	
1	P0 HLT Min01 HLT Min02 HLT Min03 HLT ÷ 2 = Min04		11	01	E
2	0		12	02	I
3	LBL 1 HLT Min05 × MR04 ÷ 6 ÷ MR01 ÷ MR02 =		24	03	l
4	Min06 MR03 INV x^2 Min07 MR06 ÷ 2 × MR05		33	04	W ⁄ 2
5	× ((MR05 × ((2 × MR03 − MR05)) −		45	05	x
6	MR07))		47	06	Wx ⁄ 12EI
7	INV "AL INV y = INVAL" INV PAUSE INV PAUSE = HLT		55	07	l^2
8	MR06 × ((MR05 × ((3 × MR03 − 2 ×		67	08	
9	MR05)) − MR07)) = MODE 4		74	09	
10	INV "AL INV s = INVAL" INV PAUSE INV PAUSE INV $\tan^{-1}$ HLT		82	F	
11	MR04 ÷ 6 × ((6 × MR05 × ((MR03 −		94	10	
12	MR05)) − MR07))		99	11	
13	INV "AL M = INVAL" INV PAUSE INV PAUSE = HLT		107	12	
14	MR04 +/− × ((2 × MR05 − MR03))		117	13	
15	INV "AL W INV s = INVAL" INV PAUSE INV PAUSE =		125	14	
16	GOTO 1		126	15	
17				16	
18		Total 127		17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

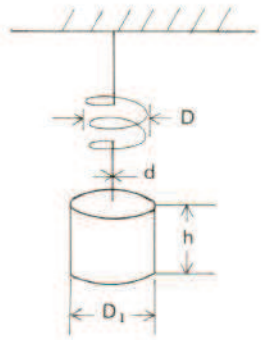
Input x following E, I, ℓ and W. The values of y, S, M and Ws will be displayed.
Repeat inputting x as many times as necessary.

CASIO PROGRAM SHEET

Program for	No.	
Free vibration	Mechanics–7	

Description

• Input the program written in the next page.



Weight of load $W = \frac{\pi}{4} D_1^2 hb$

Mass of load $m = \frac{W}{980}$

Spring constant $K = \frac{Gd^4}{8ND^3}$

Natural vibration frequency

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

d, D, D_1, h (cm) b (kg/cm^3)

N : Number of effective coils

G : Shearing modulus (kg/cm^2)

Example

d = 0.5 (cm)
D = 4 (cm)
N = 10
G = 750,000 (kg/cm^2)
D_1 = 25 (cm)
h = 7 (cm)
b = 0.0077 (kg/cm^3)

What is the natural frequency (f) ?
If d is 0.4 and N is 20 with the other data unchanged, what become f ?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P1	d= ?	
2	0.5 EXE	0.5	
3	P2	D = ?	
4	4 EXE	4	
5	P3	N = ?	
6	10 EXE	10	
7	P4	G = ?	
8	750000 EXE	750000	
9	INV P5	D1= ?	
10	25 EXE	h= ?	

Step	Data input operation	Read-out	Remark
11	7 EXE	b= ?	
12	0.0077 EXE	7.7^{-03}	
13	PO	f=	
14		2.930822368	
15	P1	d= ?	
16	0.4 EXE	0.4	
17	P3	N = ?	
18	20 EXE	20	
19	PO	f=	
20		1.326338797	
21			

Program for

Free vibration

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	
1	P1 INV"AL" INV d = INV? INVAL" HLT Min01		7	01	d
2				02	D
3	P2 INV"AL" D = INV? INVAL" HLT Min02		7	03	N
4				04	G
5	P3 INV"AL" N = INV? INVAL" HLT Min03		7	05	D_1
6				06	h
7	P4 INV"AL" G = INV? INVAL" HLT Min04		7	07	b
8				08	K
9	INVP5 INV"AL" D 1 = INV? INVAL" HLT Min05		8	09	m
10	INV"AL" INV h = INV? INVAL" HLT Min06		15	F	
11	INV"AL" INV b = INV? INVAL" HLT Min07		22	10	
12				11	
13	P0 MR04 × MR01 INV x^y 4 ÷ 8 ÷ MR03 ÷		10	12	
14	MR02 INV x^y 3 = Min08		15	13	
15	INV π × MR05 INV x^2 × MR06 × MR07 ÷ 4 ÷		26	14	
16	9 8 0 = Min09		31	15	
17	MR08 ÷ MR09 = INV $\sqrt{\ }$ ÷ 2 ÷ INV π		40	16	
18	INV"AL" INV f = INVAL" INV PAUSE INV PAUSE =		47	17	
19				18	
20		Total 103		19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

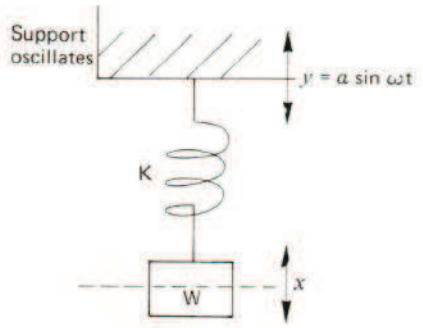
Note

CASIO PROGRAM SHEET

Program for	No.	
Forced vibration	Mechanics-8	

Description

• Input the program written in the next page.



$$x = -\frac{a\omega\,\omega_n}{\omega_n{}^2 - \omega^2}\sin\omega_n t + \frac{a\omega_n{}^2}{\omega_n{}^2 - \omega^2}\sin\omega t$$

$$\omega_n = \sqrt{\frac{K \times 980}{W}}$$

K [kg/cm]
W [kg]

$t = t + \Delta t$

dt : Time interval

Example

K = 50 (kg/cm)
W = 20 (kg)
a = 2 (cm)
ω = 5π [vad/sec]
to = 0.5 (sec)
dt = 0.02 (sec)

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	K ?	
2	50 EXE	W ?	
3	20 EXE	a ?	
4	2 EXE	w ?	
5	5 × π = EXE	to ?	
6	0.5 EXE	dt ?	
7	0.02 EXE	t=0	
8		x=	
9		0	
10	EXE	t=0.02	

Step	Data input operation	Read-out	Remark
11		x=	
12		0.097218863	
13	EXE	t=0.04	
14		x=	
15		0.659686562	
16	EXE	t=0.06	
17		x=	
18		1.678617445	
19		Repeat these steps.	
20			
21			

Program for

Forced vibration

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC MODE 5 INV "AL" K INV ? INV AL" HLT Min01		8
2	INV "AL" w INV ? INV AL" HLT Min02		14
3	INV "AL" INV a INV ? INV AL" HLT Min03		20
4	INV "AL" INV w INV ? INV AL" HLT Min04		26
5	INV "AL" INV t 0 INV ? INV AL" HLT Min F		33
6	INV "AL" INV d INV t INV ? INV AL" HLT Min05		40
7	MR 01 × 9 8 0 ÷ MR02 = INV √ Min06		50
8	× MR03 ÷ ((MR06 INV x^2 − MR04 INV x^2))		60
9	× × MR04 = Min08 MR06 = Min09 AC		69
10	LBL 1 MR07 × MR04 GSB P1 MR09 = Min00 MR07 ×		79
11	MR06 GSB P1 MR08 = M− 00		84
12	MR07 INV $x \geqq$ F GOTO 2 GSB P2 HLT MR05 M+ 07 GOTO 1		92
13	LBL 2 GSB P2		94
14			
15	P1 = ÷ 2 ÷ INV π = INV FRAC × 2 × INV π = sin ×		14
16			
17	P2 INV "AL" INV t = INV # INV AL" INV PAUSE INV PAUSE		7
18	INV "AL" INV x = INV AL" INV PAUSE INV PAUSE MR00		14
19			
20		Total 125	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	x
01	K
02	W
03	a
04	w
05	dt
06	w_n
07	Variable t
08	$aww_n / w_n^2 - w^2$
09	$aw_n^2 / w_n^2 - w^2$
F	to
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

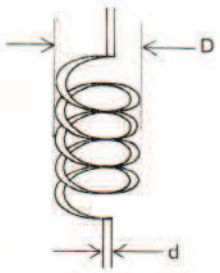
P1 is incorporated to prevent an error when calculating sin of angles greater than 8 rad.
The constant function is used in the program.

CASIO PROGRAM SHEET

Program for	No.	
Design of coil spring	Mechanics– 9	

Description

• Input the program written in the next page.



d : Wire diameter [mm]
D : Mean coil diameter [mm]
Na: Number of effective coils
G : Shearing modulus [kg/mm^2]
y : Deflection [mm]
P : Load [kg]
K : Spring constant [kg/mm]

$$P = Ky = \frac{Gd^4}{8NaD^3}\, y$$

① Input d → P1
② Input D → P2
③ Input Na → P3
④ Input G → P4
⑤ Input y → P5
⑥ Input P → P6

① Calculate K and P → P0
② Calculate d → P7
③ Calculate D → P8
④ Calculate Na → P9

Example

1. d = 0.5 (mm)
   D = 5 (mm)
   Na = 10
   G = 4,000 (kg/mm^2)
   y = 10 (mm)
   What are K and P ?

2. D = 5 (mm)
   Na = 10
   G = 4,000 (kg/mm^2)
   y = 10 (mm)
   P = 0.25 (kg)
   What is d ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	INV P7	d=	
1	(d) 0.5 P1	0.5		12		0.5	
2	(D) 5 P2	5		13			
3	(Na) 10 P3	10		14			
4	(G) 4000 P4	4000		15			
5	(y) 10 INV P5	10		16			
6	P0	K=		17			
7		0.025		18			
8	EXE	P=		19			
9		0.25		20			
10	(P) 0.25 INV P6	0.25		21			

Program for

Design of coil spring

	Program	Remark	Step	Contents in memories	
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	
1	P1 Min01		1	01	d
2				02	D
3	P2 Min02		1	03	Na
4				04	G
5	P3 Min03		1	05	y
6				06	P
7	P4 Min04		1	07	
8				08	
9	INVP5 Min05		1	09	
10				F	
11	INVP6 Min06		1	10	
12				11	
13	P0 MR 01 INV x^y 4 × MR04 ÷ 8 ÷ MR02		9	12	
14	INV x^y 3 ÷ MR03		13	13	
15	INV "AL K = INV AL" INV PAUSE INV PAUSE = HLT		21	14	
16	× MR05		23	15	
17	INV "AL P = INVAL" INV PAUSE INV PAUSE = HLT		31	16	
18				17	
19	INVP7 8 × MR02 INV x^y 3 × MR03 × MR06		9	18	
20	÷ MR04 ÷ MR05 = INV $x^{1/y}$ 4		16	19	
21	INV "AL INV d = INV AL" INV PAUSE INV PAUSE = HLT		24	1F	
22				20	
23	INVP8 MR 01 INV x^y 4 × MR04 × MR05 ÷ 8 ÷		10	21	
24	MR03 ÷ MR06 = INV $x^{1/y}$ 3		16	22	
25	INV "AL D = INV AL" INV PAUSE INV PAUSE = HLT		24	23	
26				24	
27	INVP9 MR 01 INV x^y 4 × MR04 × MR05 ÷ 8 ÷		10	25	
28	MR02 INV x^y 3 ÷ MR06		15	26	
29	INV "AL N INV a = INV AL" INV PAUSE INV PAUSE = HLT		24	27	
30				28	
31		Total 119		29	
32				2F	
33					
34					
35					
36					
37					

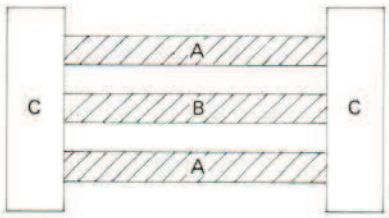
Note

CASIO PROGRAM SHEET

Program for	Thermal stress	No.	Mechanics-10	

Description

• Input the program written in the next page.



L_1 : Linear expansion coefficient of A
L_2 : Linear expansion coefficient of B
E_1 : Elastic constant of A
E_2 : Elastic constant of B
A_1 : Cross section of A
A_2 : Cross section of B

Temperature T

S_1 : Thermal stress developing in A

$$S_1 = -\frac{E_1 E_2 A_2 (L_1 - L_2) T}{E_1 A_1 + E_2 A_2}$$

S_2 : Thermal stress developing in B

$$S_2 = \frac{E_1 E_2 A_1 (L_1 - L_2) T}{E_1 A_1 + E_2 A_2}$$

Example

$L_1 = 1.15 \times 10^{-5}$ $\quad T = 100$
$L_2 = 1.65 \times 10^{-5}$
$E_1 = 2.1 \times 10^{6}$
$E_2 = 1.25 \times 10^{6}$
$A_1 = \pi$
$A_2 = 0.84\pi$

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11		−416.666666	
1	PO	L1=?		12			
2	1.15 EXP 5 +/− EXE	L2=?		13			
3	1.65 EXP 5 +/− EXE	E1=?		14			
4	2.1 EXP 6 EXE	E2=?		15			
5	1.25 EXP 6 EXE	A1=?		16			
6	π EXE	A2=?		17			
7	0.84 × π = EXE	T=?		18			
8	100 EXE	S1=		19			
9		349.9999999		20			
10	EXE	S2=		21			

Program for

Thermal stress

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 1 | INV "AL" | L | 1 | = | INV ? | INV AL" | HLT | Min01 |		9
3	INV "AL" | L | 2 | = | INV ? | INV AL" | HLT | Min02 |		17
4	INV "AL" | E | 1 | = | INV ? | INV AL" | HLT | Min03 |		25
5	INV "AL" | E | 2 | = | INV ? | INV AL" | HLT | Min04 |		33
6	INV "AL" | A | 1 | = | INV ? | INV AL" | HLT | Min05 |		41
7	INV "AL" | A | 2 | = | INV ? | INV AL" | HLT | Min06 |		49
8	INV "AL" | T | = | INV ? | INV AL" | HLT | Min07 |		56
9	((| MR03 | × | MR04 | × | ((| MR01 | − | MR02 |)) |		66
10	× | MR07 |)) | ÷ | ((| MR03 | × | MR05 | + | MR04 | × |		77
11	MR06 |)) | = | Min08 | × | MR06 | +/− |		84
12	INV "AL" | S | 1 | = | INV AL" | INV PAUSE | INV PAUSE | = | HLT |		93
13	MR08 | × | MR05 |		96
14	INV "AL" | S | 2 | = | INV AL" | INV PAUSE | INV PAUSE | = | HLT | GOTO 1 |		106
15			
16		Total 107	
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	L 1
02	L 2
03	E 1
04	E 2
05	A 1
06	A 2
07	T
08	$\frac{E1 \cdot E2 (L1 - L2) T}{E1 \cdot A1 + E2 \cdot A2}$
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

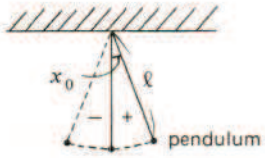
Note

CASIO PROGRAM SHEET

Program for	No.	
Simple pendulum	Physics/chemistry-1	

Description

• Input the program written in the next page.



Period $T = 2\pi\sqrt{\frac{\ell}{g}}$ (sec.)

ℓ: Length of pendulum (cm)

g: 980 (cm/sec.)

$x = x_0 \times \cos(360\frac{t}{T})$

Example

Let ℓ = 100 cm, x_0 = 15° and t (int) = 0.2 sec.

What is the value of x at each time slot.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
/	MODE 1			11		0.4	
1	PO	ℓ = ?		12		$x2$=	
2	(ℓ) 100 EXE	$x0$ = ?		13		4.698535051	
3	(x_0) 15 EXE	T=		14			
4		2.007089923		15		Repeat these steps.	
5	EXE	$t(int)$= ?		16			
6	($t(int)$) 0.2 EXE	$t1$=		17			
7		0.2		18			
8		$x1$=		19			
9		12.15479382		20			
10	EXE	$t2$=		21			

Program for

Simple pendulum

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 O Min 07 INV "AL INV ℓ = INV ? INV AL" HLT Min 01	Input ℓ	9
2	INV "AL INV x_0 O = INV ? INV AL" HLT Min 02	Input x_0	17
3	MR 01 ÷ 9 8 O = INV √ × 2 × INV π = Min 03		30
4	INV "AL T = INV AL" INV PAUSE INV PAUSE MR 03		37
5	HLT	Output T	38
6	INV "AL INV t INV (INV i INV n INV t INV) =		46
7	INV ? INV AL" HLT Min 04 MODE 4 1 Min 08	Input t(int)	53
8	LBL 1 INV "AL INV t INV AR 08 = INV AL" INV PAUSE		60
9	INV PAUSE MR 04 M+ 07 MR 07 INV PAUSE	Output ti	65
10	INV "AL INV x INV AR 08 = INV AL" INV PAUSE		71
11	INV PAUSE MR 02 × ((((MR 07 ÷ MR 03))		80
12	INV FRAC × 3 6 O)) cos = HLT	Output xi	89
13	1 M+ 08 GoTo 1		92
14		Total 93	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	ℓ
02	x_0
03	T
04	$t(int)$
05	
06	
07	ti
08	Subscript i of ti and xi
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

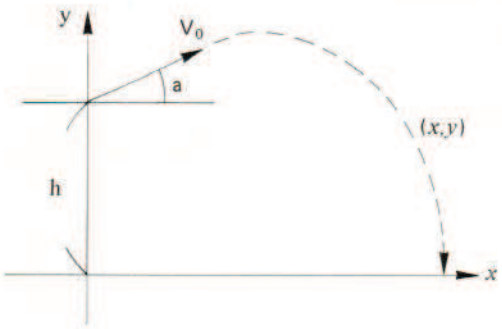
When ℓ and x_0 have been input, T is displayed.
After time interval t (int) is input, ti and xi
will be displayed repeatedly.

CASIO PROGRAM SHEET

Program for	No.	
Parabolic movement	Physics/chemistry-2	

Description

• Input the program written in the next page.



$x = (V_0 \cos a)t$

$y = (V_0 \sin a)t - \frac{1}{2}gt^2 + h$

$g = 9.8\ [m/s^2]$

V_0 [m/s]

a [°]

Δt [sec.]

h [m]

Example

Initial velocity V_0 = 130 (m/s)

Initial angle a = 25 (°)

Height h = 0 (m)

Δt = 0.5 (sec.)

Plot the trace of movement in intervals of Δt.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	EXE	$t=$	
1	PO	V0= ?		12		1	
2	130 EXE	a= ?		13	EXE	$x=$	
3	25 EXE	h= ?		14		117.8200123	
4	0 EXE	dt = ?		15	EXE	$y=$	
5	0.5 EXE	t=		16		50.04037403	
6		0.5		17			
7	EXE	$x=$		18			
8		58.91000616		19			
9	EXE	$y=$		20			
10		26.24518701		21			

Program for

Parabolic movement

	Program	Remark	Step	Contents in memories	
	MODE 3 INV MAC MODE • 20 MODE 2			00	
1	P0 MODE 4		1	01	V_0
2	INV "AL" V O = INV ? INV AL" HLT Min 01	Input V_0	9	02	α
3	INV "AL" INV a = INV ? INV AL" HLT Min 02	Input a	16	03	h
4	INV "AL" INV h = INV ? INV AL" HLT Min 03	Input h	23	04	Δt
5	INV "AL" INV d INV t = INV ? INV AL" HLT Min 04		31	05	Variable t
6	Min 05	Input Δt	32	06	
7	LBL 1 INV "AL" INV t = INV AL" GSB P1 MR 05 HLT	Output t	40	07	
8	INV "AL" INV x = INV AL" GSB P1 MR 01 × MR 02 cos		49	08	
9	× MR 05 = HLT	Output x	53	09	
10	INV "AL" INV y = INV AL" GSB P1 MR 01 × MR 02 sin		62	F	
11	× MR 05 − 4 • 9 × MR 05 INV x^2 + MR 03		73	10	
12	= HLT	Output y	75	11	
13	MR 04 M+ 05 GoTo 1		78	12	
14				13	
15	P1 INV PAUSE INV PAUSE		2	14	
16				15	
17		Total 82		16	
18				17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

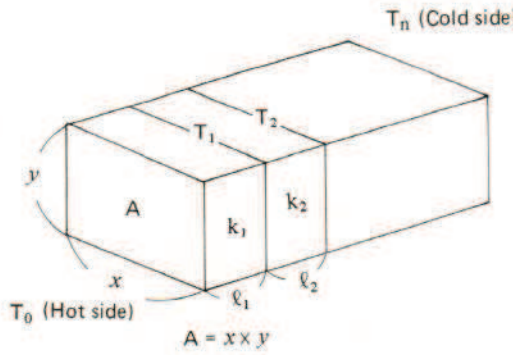
Note

CASIO PROGRAM SHEET

Program for	No.	
Thermal conduction through layers	Physics/chemistry-3	

Description

• Input the program written in the next page.



Heat loss

$$q = \frac{T_0 - T_n}{\frac{\ell_1}{k_1 A} + \frac{\ell_2}{k_2 A} + \cdots + \frac{\ell n}{KnA}} \quad [Kcal/h]$$

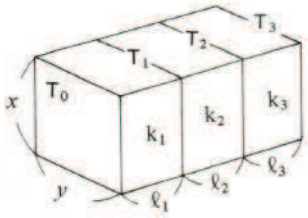
k : Thermal conductivity [Kcal/m·h·deg]

$$T_1 = T_0 - \frac{q\ell_1}{k_1 A}$$

$$T_2 = T_1 - \frac{q\ell_2}{k_2 A}$$

$$T_n = T_{n-1} - \frac{q\ell_n}{k_n A}$$

Example



x = 1 [m] , y = 1 [m] ,

ℓ_1 = 0.25[m] k_1 = 1.2 [Kcal/m·h·deg]

ℓ_2 = 0.12[m] k_2 = 0.25 [Kcal/m·h·deg]

ℓ_3 = 0.15[m] k_3 = 0.75 [Kcal/m·h·deg]

Let T_0 = 900°C and T_3 = 100°C.

Calculate T_1 and T_2.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	900 EXE	INPUT Tn	
1	PO	INPUT x		12	100 EXE	q =	
2	1 EXE	INPUT y		13		900.5628518	
3	1 EXE	INPUT ℓ1		14	EXE	T1=	
4	0.25 EXE	INPUT k1		15		712.3827392	
5	1.2 EXE	INPUT ℓ2		16	EXE	T2=	
6	0.12 EXE	INPUT k2		17		280.1125703	
7	0.25 EXE	INPUT ℓ3		18	EXE	T3=	
8	0.15 EXE	INPUT k3		19		99.99999994	
9	0.75 EXE	INPUT ℓ4		20		Repeat from step 2.	
10	GoTo 1	INPUT T0		21			

Program for

Thermal conduction through layers

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 2 | INV MAC | GSB P1 | INV "AL | INV ; | INV x | INV AL" | HLT | Min 01 |	Input x	9
3	GSB P1 | INV "AL | INV ; | INV y | INV AL" | HLT | × | MR 01 | = |	Input y	18
4	Min 09 |	$x \times y = A$	19
5	LBL 3 | INV ISZ |		21
6	GSB P1 | INV "AL | INV ; | INV I | INV AR 00 | INV AL" | HLT | Min 07 |	Input ℓi	29
7	GSB P1 | INV "AL | INV ; | INV k | INV AR 00 | INV AL" | HLT | Min 08 |	Input ki	37
8	MR 07 | ÷ | MR 08 | ÷ | MR 09 | = | INV IND | Min 00 | M+ F |		46
9	6 | − | MR 00 | = | INV x=0 | GoTo 1 | GoTo 3 |	Input 6th layer?	53
10	LBL 1 | GSB P1 | INV "AL | INV ; | T | O | INV AL" | HLT | Min 07 |	Input T_o	62
11	GSB P1 | INV "AL | INV ; | T | INV n | INV AL" | HLT | Min 08 |	Input Tn	70
12	INV "AL | INV q | = | INV AL" | GSB P2 | ((| MR 07 | − | MR 08 |		79
13	)) | ÷ | MR F | = | Min 09 | HLT |	Output q	85
14	MR 00 | = | Min F | O | Min 00 |	M0 clear	90
15	LBL 4 | INV ISZ | MR 00 | INV x=F | GoTo 2 |	n-th layer?	95
16	INV "AL | T | INV AR 00 | = | INV AL" | GSB P2 | MR 07 | − | MR 09 |		104
17	× | INV IND | MR 00 | = | Min 07 | HLT | GoTo 4 |	Output Ti	111
18			
19	P1 INV "AL | I | N | P | U | T | INV SPACE | INV AL" |		8
20			
21	P2 INV PAUSE | INV PAUSE |		2
22		Total 124	
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	Number of layers
01	$x \rightarrow \ell_1 / K_1 A$
02	$\ell_2 / K_2 A$
03	$\ell_3 / K_3 A$
04	$\ell_4 / K_4 A$
05	$\ell_5 / K_5 A$
06	$\ell_6 / K_6 A$
07	$\ell_i \rightarrow T_o$
08	$K_i \rightarrow T_n$
09	$A \rightarrow q$
F	$\Sigma(\ell_i / K_i A)$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Up to six layers are permitted. Input ℓ and k of each layer.

Operate GoTo 1 . And input T_0 and T_n.

If the number of layers is six, GoTo 1 is not necessary. Input T_0 and T_n immediately.

(Six layers are set on the ninth line of the program. By changing this value, input becomes possible up to any arbitrary number of layers.)

CASIO PROGRAM SHEET

Program for	No.	
First- and second-order reaction speeds	Physics/chemistry-4	

Description

• Input the program written in the next page.

(1) First-order reaction → P1

$$K_i = \frac{1}{t_i} \ell_n \frac{a}{mi}$$

$$t^{\frac{1}{2}} = \frac{\ell_n 2}{\overline{K}}$$

$$\overline{K} = \frac{\Sigma K_i}{n}$$

K : Velocity constant
a : Initial concentration
m_i : Concentration after t_i
t_i : Time in minutes
$t^{\frac{1}{2}}$: Half life

(2) Second-order reaction → P2

(A) $a \neq b$

$$K_i = \frac{1}{t_i(a-b)} \ell_n \frac{b(a-x)}{a(b-x)}$$

$$= \frac{1}{t_i(a-b)} \ell_n \frac{bm_i}{a(b-a+m_i)} \quad [^{mol}/_{\ell \cdot t}]$$

(B) $a = b$

$$K_i = \frac{x}{t_i\, a(a-x)} = \frac{a - m_i}{t_i a\, m_i}$$

a, b: Initial concentration
x: Variation of concentration after t_i

Example

Minute	0	10	20	30	50
Current concentration	34.75	28.45	23.35	15.85	13.05

Obtain first-order reaction K_i, n, $\overline{K}$ and $t^{\frac{1}{2}}$ based on the above table.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P1	a ?	
2	34.75 EXE	$m1$?	
3	28.45 EXE	$t1$?	
4	10 EXE	K 1 =	
5		0.020003141	
6	EXE	$m2$?	
7	23.35 EXE	$t2$?	
8	20 EXE	K 2 =	
9		0.019879129	
10	⋮	⋮	

Step	Data input operation	Read-out	Remark
11	Input all data	After K_4 displayed	
12	EXE	4	(n)
13	EXE	0.021409275	$(\overline{K})$
14	EXE	32.3760224	$(t_{\frac{1}{2}})$
15			
16			
17			
18			
19			
20			
21			

Program for

First- and second-order reaction speeds

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P1 INV MAC ‖ GSB P3 ‖	Input a	2
2	LBL 1 ‖ INV ISZ ‖ GSB P4 ‖ GSB INV P5 ‖	Input m_i, t_i	6
3	MR 01 ‖ ÷ ‖ MR 03 ‖ = ‖ ln ‖ ÷ ‖ MR 04 ‖ = ‖ M+ 06 ‖ HLT ‖	Output K_i	16
4	MR 00 ‖ − ‖ 4 ‖ = ‖ INV X=0 ‖ GoTo 2 ‖ GoTo 1 ‖	4th element of data?	23
5	LBL 2 ‖ M+ 00 ‖ MR 00 ‖ HLT ‖	Output n	27
6	MR 06 ‖ ÷ ‖ MR 00 ‖ = ‖ HLT ‖	Output ΣK_i	32
7	INV 1/x ‖ × ‖ 2 ‖ ln ‖ = ‖ HLT ‖	Output $t_{\frac{1}{2}}$	38
8			
9	P2 INV MAC ‖ GSB P3 ‖	Input a	2
10	INV "AL ‖ INV b ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 02 ‖	Input b	8
11	LBL 1 ‖ INV ISZ ‖ GSB P4 ‖	Input m_i, t_i	11
12	MR 01 ‖ − ‖ MR 02 ‖ = ‖ INV X=0 ‖ GoTo 2 ‖	a=b?	17
13	GSB INV P5 ‖ MR 02 ‖ × ‖ MR 03 ‖ ÷ ‖ MR 01 ‖ ÷ ‖ ((‖ MR 02 ‖		26
14	− ‖ MR 01 ‖ + ‖ MR 03 ‖)) ‖ = ‖ ln ‖ ÷ ‖ MR 04 ‖ ÷ ‖ ((‖		37
15	MR 01 ‖ − ‖ MR 02 ‖)) ‖ = ‖ HLT ‖ GoTo 1 ‖	Output K_i	44
16	LBL 2 ‖ GSB INV P5 ‖ ((‖ MR 01 ‖ − ‖ MR 03 ‖)) ‖ ÷ ‖ MR 04 ‖ ÷ ‖		54
17	MR 01 ‖ ÷ ‖ MR 03 ‖ = ‖ HLT ‖ GoTo 1 ‖	Output K_i	60
18			
19	P3 INV "AL ‖ INV a ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 01 ‖	Input a	6
20			
21	P4 INV "AL ‖ INV m ‖ INV AR 00 ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 03 ‖	Input m_i	7
22	INV "AL ‖ INV t ‖ INV AR 00 ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 04 ‖	Input t_i	14
23			
24	INV P5 INV "AL ‖ K ‖ INV AR 00 ‖ INV AL" ‖ INV PAUSE ‖	K_i display	5
25			
26		Total 128	
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	n
01	a
02	b
03	m_i
04	t_i
05	
06	ΣK_i
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

P2 Operation:
P2 a EXE b EXE
m_i EXE t_1 EXE → K_1
EXE m_2 EXE t_2 EXE → K_2
and repeated in the following.

The number of data (4) in the sample problem is set on the 4th line in the program.
Note that, since the number of program steps has been held less than 128, output comments n, $\bar{K}$, $t_{\frac{1}{2}}$ are not displayed.

CASIO PROGRAM SHEET

Program for	No.	
Equation of state of ideal gas	Physics/chemistry-5	

Description

• Input the program written in the next page.

$PV = nRT$
$= nR\,(273+t)$

P : Pressure (atm)
V : Volume (ℓ)
n : Number of moles

R : Gas constant 0.082 ($\ell \cdot atm / deg \cdot mol$)
T : Absolute temperature (°K)
t : Temperature (°C)

[P1] – Program for unknown pressure (P)

[P2] – Program for unknown volume (V)

[P3] – Program for unknown number of moles (n)

[P4] – Program for unknown temperature (t)

Input data in the order of P, V, n and T except the unknown.

Example

(1) Calculate the number of moles when P = 780 (mmHg), V = 0.7(ℓ) and t = 30(°C). (Use program [P3].)

(2) Calculate the temperature (°C) when P = 1 (atm), V = 30(ℓ) and n = 1.5 (Moles). (Use program [P4].)

Step	Data input operation	Read-out	Remark
	MODE 1		
1	0.082 Min 0 5		
2	273 Min 0 6		
3	P3	P = ?	
4	780 ÷ 760 = EXE	V = ?	
5	0.7 EXE	t = ?	
6	30 EXE	n = ?	
7	EXE	0.028914958	
8			
9			
10			

Step	Data input operation	Read-out	Remark
11	P4	P = ?	
12	1 EXE	V = ?	
13	30 EXE	n = ?	
14	1.5 EXE	t = ?	
15	EXE	−29.0975609	
16			
17			
18			
19			
20			
21			

Program for

Equation of state of ideal gas

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P1 GSB INV P7 ‖ GSB INV P8 ‖ GSB INV P9 ‖	Input V,n,t	3	01 P
2	GSB INV P6 ‖	Output P	4	02 V
3	GSB P0 ‖ MR 02 ‖ = ‖		7	03 n
4				04 t
5	P2 GSB INV P6 ‖ GSB INV P8 ‖ GSB INV P9 ‖	Input P,n,t	3	05 0.082
6	GSB INV P7 ‖	Output V	4	06 273
7	GSB P0 ‖ MR 01 ‖ = ‖		7	07
8				08
9	P3 GSB INV P6 ‖ GSB INV P7 ‖ GSB INV P9 ‖	Input P,V,t	3	09
10	GSB INV P8 ‖	Output n	4	F
11	GSB INV P5 ‖ ((‖ MR 04 ‖ + ‖ MR 06 ‖)) ‖ = ‖		11	10
12				11
13	P4 GSB INV P6 ‖ GSB INV P7 ‖ GSB INV P8 ‖	Input P,V,n	3	12
14	GSB INV P9 ‖	Output t	4	13
15	GSB INV P5 ‖ MR 03 ‖ = ‖ − ‖ MR 06 ‖ = ‖		10	14
16				15
17	INV P6 INV "AL ‖ P ‖ = ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 01 ‖	Input P	7	16
18				17
19	INV P7 INV "AL ‖ V ‖ = ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 02 ‖	Input V	7	18
20				19
21	INV P8 INV "AL ‖ INV n ‖ = ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 03 ‖	Input n	7	1F
22				20
23	INV P9 INV "AL ‖ INV ‖ = ‖ INV ? ‖ INV AL" ‖ HLT ‖ Min 04 ‖	Input t	7	21
24				22
25	P0 MR 03 ‖ × ‖ MR 05 ‖ × ‖ ((‖ MR 04 ‖ + ‖ MR 06 ‖)) ‖ ÷ ‖		10	23
26				24
27	INV P5 MR 01 ‖ × ‖ MR 02 ‖ ÷ ‖ MR 05 ‖ ÷ ‖		6	25
28				26
29		Total 89		27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

Before execution, input 0.082, and 273 into M5 and M6 respectively.

Units of data

P (atm) . . . . . 1 atm = 760mmHg

V (ℓ)

n (Moles)

t (°C)

CASIO PROGRAM SHEET

Program for	No.	
Geometrical and harmonic means	Statistics-1	

Description

• Input the program written in the next page.

① Geometrical mean $Gm = (X_1 \cdot X_2 \cdot \cdots \cdot X_n)^{\frac{1}{n}}$ → [P1]

② Harmonic mean $Hm = \dfrac{n}{\frac{1}{X_1} + \frac{1}{X_2} + \cdots + \frac{1}{X_n}}$ → [P2]

Example

What is the geometrical mean (Gm) of 2, 3.5, 6.1, 1.2 and 3.9?
What is the harmonic mean (Hm) of 2, 3.5, 6.1, 1.2 and 3.9?

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	(Gm) [P1]	X(1)	
2	2 [EXE]	X(2)	
3	3.5 [EXE]	X(3)	
4	6.1 [EXE]	X(4)	
5	1.2 [EXE]	X(5)	
6	3.9 [EXE]	X(6)	
7	[GoTo] [1]	Gm = 2.884926	
8		2.884926451	(Gm)
9			
10			

Step	Data input operation	Read-out	Remark
11	(Hm) [P2]	X(1)	
12	2 [EXE]	X(2)	
13	3.5 [EXE]	X(3)	
14	6.1 [EXE]	X(4)	
15	1.2 [EXE]	X(5)	
16	3.9 [EXE]	X(6)	
17	[GoTo] [1]	Hm = 2.451710	
18		2.451710736	(Hm)
19			
20			
21			

Program for

Geometrical and harmonic means

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P1 INV MAC 1 Min 00 Min 01		4
2	LBL 3 INV "AL x INV(INV AR 00 INV) INVAL" HLT ×		13
3	MR 01 = Min 01 INV ISZ GOTO 3		18
4	LBL 1 MR 01 INV $x^{\frac{1}{y}}$ ((MR 00 − 1)) = INV "AL G		29
5	INV m = INV # INV AL"		33
6			
7	P2 INV MAC 1 Min 00		3
8	LBL 3 INV "AL x INV(INV AR 00 INV) INV AL" HLT INV $1/x$		12
9	M+ 01 INV ISZ GoTo 3		15
10	LBL 1 ((MR 00 − 1)) ÷ MR 01 = INV "AL H INV m		27
11	= INV # INV AL"		30
12			
13		Total 65	
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Depress GoTo and 1 after data input.
And Gm and Hm will be displayed.

CASIO PROGRAM SHEET

Program for	No.	
6-month moving average	Statistics-2	

Description

• Input the program written in the next page.

$$Y_0 = \frac{y_1 + y_2 + y_3 + y_4 + y_5 + y_6}{6}$$

$$Y_1 = \frac{y_2 + y_3 + y_4 + y_5 + y_6 + y_7}{6}$$

$$\vdots$$

$$Y_n = \frac{y_{n+1} + y_{n+2} + \cdots\cdots\cdots + y_{n+6}}{6}$$

Example

Month	y_1 1	y_2 2	y_3 3	y_4 4	y_5 5	y_6 6	y_7 7	y_8 8
Data	469	642	1034	587	386	417	529	648

Calculate 6-month moving averages Y_0, Y_1 and Y_2.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	y_1	
2	469 EXE	y_2	
3	642 EXE	y_3	
4	1034 EXE	y_4	
5	587 EXE	y_5	
6	386 EXE	y_6	
7	417 EXE	$Y_0 = 589.1666$	
8		589.1666667	
9	(y_7) 529 EXE	$Y_1 = 599.1666$	
10		599.1666667	
11	(y_8) 648 EXE	$Y_2 = 600.1666$	
12		600.1666667	
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for

6-month moving average

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV MAC 6 Min 00 Min F 1 Min 09		6
2	LBL 1 INV "AL INV Y INV AR 09 INV AL" HLT		12
3	INV IND Min 00 M+ 07 1 M+ 09 INV DSZ GoTo 1		19
4	7 M- 09		21
5	LBL 2 MR 07 ÷ 6 = Min 08 MR 06 M- 07 5 Min 00		31
6	LBL 3 INV IND MR 00 INV IND Min F 1 M- F		38
7	INV DSZ GoTo 3		40
8	6 Min F MR 08 INV "AL Y INV AR 09 = INV #		48
9	INV AL" HLT Min 01 M+ 07 1 M+ 09 GoTo 2		55
10			
11		Total 56	
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			

	Contents in memories
00	For DSZ
01	y_6
02	y_5
03	y_4
04	y_3
05	y_2
06	y_1
07	6-month sum
08	6-month average
09	For output
F	To exchange contents of registers
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
n-month moving average ($n \leqq 77$)	Statistics-3	FX-602P

Description

• Input the program written in the next page.

$$Y_0 = \frac{y_1 + y_2 + y_3 + \cdots + y_n}{n}$$

$$\vdots$$

$$Y_n = \frac{y_{n+1} + y_{n+2} + \cdots + y_{n+n}}{n} \quad (n \leqq 77)$$

Example

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	559	571	721	806	722	957	768	626	758	620	503	852	819	911	759

Calculate 12-month moving averages Y_0, Y_1, Y_2 and Y_3.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	n= ?	
2	12 EXE	y_1	
3	559 EXE	y_2	
4	571 EXE	y_3	
5	721 EXE	y_4	
6	806 EXE	y_5	
7	722 EXE	y_6	
8	⋮	⋮	
9	⋮	⋮	
10	⋮	⋮	

Step	Data input operation	Read-out	Remark
11	(y_{12}) 852 EXE	Y=705.25	(Y_0)
12	(y_{13}) 819 EXE	Y=726.9166	
13		726.9166667	(Y_1)
14	(y_{14}) 911 EXE	Y=755.25	(Y_2)
15	⋮	⋮	
16	⋮	⋮	
17	⋮	⋮	
18			
19			
20			
21			

Program for

n-month moving average ($n \leqq 77$)

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 5 MODE 2		
1	P0 INV MAC ¡ INV "AL ¡ INVn ¡ = ¡ INV ? ¡ INV AL" ¡ HLT ¡ Min 00 ¡		8
2	Min 1F ¡		9
3	LBL 1 ¡ MR 1F ¡ − ¡ MR 00 ¡ + ¡ 1 ¡ = ¡ INV "AL ¡ INV Y ¡ INV # ¡		19
4	INV AL" ¡ HLT ¡ INV IND ¡ Min 00 ¡ M+ F ¡ INV DSZ ¡ GoTo 1 ¡		26
5	LBL 2 ¡ MR 1F ¡ Min 00 ¡		29
6	LBL 3 ¡ MR F ¡ ÷ ¡ MR 1F ¡ = ¡ INV "AL ¡ Y ¡ = ¡ INV # ¡ INV AL" ¡ HLT ¡		40
7	M+ F ¡ INV IND ¡ X↔M 00 ¡ M− F ¡ INV DSZ ¡ GoTo 3 ¡ GoTo 2 ¡		47
8			
9		Total 48	
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			

	Contents in memories
00	For DSZ
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	n-month sum
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	n
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Under the condition of $20 \leqq n \leqq 77$, it is necessary to expand memory capacity which should be n + 1.

For example:
Operation of MODE • 2 5 is necessary for processing 24-month moving averages.

CASIO PROGRAM SHEET

Program for	No.	
Correlation coefficient	Statistics-4	

Description

• Input the program written in the next page.

Correlation coefficient $r = \dfrac{n\Sigma xy - \Sigma x \cdot \Sigma y}{\sqrt{\{n\Sigma x^2 - (\Sigma x)^2\}\{n\Sigma y^2 - (\Sigma y)^2\}}}$

Decision coefficient r^2

Example

No.	x	y
1	8.8	94
2	4.3	66
3	1.3	40
4	1.5	30
5	7.2	52
6	3.5	66
7	4.5	44
8	6.6	68
9	2.0	35
10	2.9	35
11	3.4	50
12	2.8	62
13	6.2	55
14	4.9	66
15	4.2	56

Calculate correlation coefficient and decision coefficient for x and y given above.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	x_1	
2	8.8 EXE	y_1	
3	94 EXE	x_2	
4	4.3 EXE	y_2	
5	66 EXE	x_3	
6	1.3 EXE	y_3	
7	40 EXE	x_4	
8			
9			
10			

Step	Data input operation	Read-out	Remark
11	After all data input P1	r=0.7400959	
12		0.740095957	
13	EXE	r_2=0.547742	
14		0.547742026	
15			
16			
17			
18			
19			
20			
21			

Program for

Correlation coefficient

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	For data unit display
1	P0 INV MAC		1	01	
2	LBL 1 INV ISZ MR 00 INV "AL" INV x INV # INV AL" HLT x_D		10	02	
3	× MR 00 INV "AL" INV y INV # INV AL" HLT		17	03	y
4	M+ 06 Min 03 = M+ 04 MR 03 INV x^2 M+ 05 GoTo 1		25	04	Σxy
5				05	Σy^2
6	P1 MR 09 × MR 04 − MR 08 × MR 06 = ÷ ((((		11	06	Σy
7	MR 09 × MR 07 − MR 08 INV x^2)) × ((MR 09		21	07	Σx^2
8	× MR 05 − MR 06 INV x^2)))) INV √ =		30	08	Σx
9	INV "AL" INV r = INV # INV AL" HLT		36	09	n
10	INV x^2 INV "AL" INV r 2 = INV # INV AL"		43	F	
11				10	
12		Total 70		11	
13				12	
14				13	
15				14	
16				15	
17				16	
18				17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

CASIO PROGRAM SHEET

Program for	No.	
Spearman's coefficient of rank correlation	Statistics-5	

Description

• Input the program written in the next page.

$$r = 1 - \frac{6\Sigma(A-B)^2}{n^3 - n}$$

Example

No.	A	B
1	5	6
2	4	7
3	3	3
4	7	5
5	2	1
6	1	2
7	6	4

Calculate rank correlation coefficient for the above.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	A_1		12			
2	5 EXE	B_1		13			
3	6 EXE	A_2		14			
4	⋮	⋮		15			
5	⋮	⋮		16			
6	4 EXE	A_8		17			
7				18			
8	After all data input P1	r = 0.6428571		19			
9		0.642857142		20			
10				21			

Program for

Spearman's coefficient of rank correlation

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV MAC ▌		1
2	LBL 1 ▌ INV ISZ ▌ MR 00 ▌ INV "AL ▌ A ▌ INV # ▌ INV AL" ▌ HLT ▌ − ▌		10
3	MR 00 ▌ INV "AL ▌ B ▌ INV # ▌ INV AL" ▌ HLT ▌ = ▌ INV x^2 ▌		18
4	M+ 01 ▌ GoTo 1 ▌		20
5			
6	P1 INV DSZ ▌ 1 ▌ − ▌ 6 ▌ × ▌ MR 01 ▌ ÷ ▌ ((▌ MR 00 ▌ INV x^y ▌ 3 ▌		11
7	− ▌ MR 00 ▌)) ▌ = ▌ INV "AL ▌ INV r ▌ = ▌ INV # ▌ INV AL" ▌		20
8			
9		Total 42	
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			

	Contents in memories
00	n count
01	$\Sigma(A-B)^2$
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.
Regression analysis (linear, exponential, logarithmic, power)	Statistics-6

Description

• Input the program written in the next page.

Regression	Linear	Exponential	Logarithmic	Power
Program	[1] [PO]	[2] [PO]	[3] [PO]	[4] [PO]
Formula	$y = a + bx$	$y = a \cdot e^{bx}$ $(\ln y = \ln a + bx)$	$y = a + b\ln x$	$y = a \cdot x^b$ $(\ln y = \ln a + b\ln x)$

Coefficient $A = \frac{1}{n}(\Sigma Y - b\Sigma X)$

Coefficient $b = \frac{\Sigma XY - \frac{1}{n}\Sigma X \cdot \Sigma Y}{\Sigma X^2 - \frac{1}{n}(\Sigma X)^2}$

$= \frac{\Sigma XY - \bar{X} \cdot \Sigma Y}{\Sigma X^2 - \bar{X} \cdot \Sigma X}$

Determinating coefficient $r^2 = \frac{A \cdot \Sigma Y + b\Sigma XY - \frac{1}{n}(\Sigma Y)^2}{\Sigma Y^2 - \frac{1}{n}(\Sigma Y)^2}$

* X, Y and A of each regression are as follows:

	Linear	Exponential	Logarithmic	Power
X	x_i	x_i	$\ln x_i$	$\ln x_i$
Y	y_i	$\ln y_i$	y_i	$\ln y_i$
A	a	ln a	a	ln a

Example

Exponential regression

	1	2	3	4
x_i	1.4	1.9	2.6	3.4
y_i	2.9	2.2	1.6	0.9

$x = 4.2$ . . . . . What is $\hat{y}$?

$x = 5.1$ . . . . . What is $\hat{y}$?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	2 PO	x1	
2	1.4 EXE	y1	
3	2.9 EXE	x2	
4	1.9 EXE	y2	
5	2.2 EXE	x3	
6	2.6 EXE	y3	
7	1.6 EXE	x4	
8	3.4 EXE	y4	
9	0.9 EXE	x5	
10			

Step	Data input operation	Read-out	Remark
11	After all data input P1	a=6.6291891	
12		=6.62918912	
13	EXE	b=−0.575066	
14		−0.57506653	
15	EXE	r_2=0.989782	
16		0.989782455	
17	(x) 4.2 EXE	y=0.5922674	
18		0.592267465	
19	(x) 5.1 EXE	y=0.3529754	
20		=0.35297543	
21			

Program for

Regression analysis (linear, exponential, logarithmic, power)

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P0 INV MAC Min 01 Min 02 4 M+ 02		5	01
2	LBL 0 INV ISZ MR 00 INV "AL INV × INV # INV AL" HLT		13	02
3	INV IND GoTo 1		15	03
4	LBL 4		16	04
5	LBL 3 ln		18	05
6	LBL 2		19	06
7	LBL 1 x_D × MR 00 INV "AL INV Y INV # INV AL" HLT		28	07
8	INV IND GoTo 2		30	08
9	LBL 8		31	09
10	LBL 6 ln		33	F
11	LBL 7		34	10
12	LBL 5 M+ 05 Min 03 = M+ 06 MR 03 INV x^2 M+ 04 GoTo 0		43	11
13				12
14	P1 1 Min 00 MR 06 − INV $\bar{x}$ × MR 05 = ÷ ((		10	13
15	MR 07 − INV $\bar{x}$ × MR 08)) = Min F		18	14
16	MR 05 ÷ MR 09 − MR F × INV $\bar{x}$ = Min 03		27	15
17	INV IND GoTo 2		29	16
18	LBL 0 INV "AL INV a = INV # INV AL" HLT MR 03 × MR 05 +		40	17
19	MR F INV "AL INV b = INV # INV AL" HLT × MR 06		49	18
20	− MR 05 INV x^2 ÷ MR 09 = ÷ ((MR 04 −		59	19
21	MR 05 INV x^2 ÷ MR 09)) = INV "AL INV r 2 =		69	1F
22	INV # INV AL" HLT INV IND GoTo 1		74	20
23	LBL 9 INV "AL INV Y = INV # INV AL" HLT INV IND GoTo 1		83	21
24	LBL 4		84	22
25	LBL 3 ln		86	23
26	LBL 2		87	24
27	LBL 1 × MR F + MR 03 = INV IND GoTo 2		95	25
28	LBL 8		96	26
29	LBL 6 INV e^x		98	27
30	LBL 7		99	28
31	LBL 5 INV DSZ GoTo 9 GoTo 0		103	29
32				2F
33		Total 148		
34				
35				
36				
37				

Note

When using FX-601P, prepare the program omitting INV "AL ~ INV AL" before each HLT.

* In this case, alphabet will not be displayed preceding each input and output.

CASIO PROGRAM SHEET

Program for	No.	
Quadratic regression analysis	Statistics-7	

Description

• Input the program written in the next page.

$$y = ax^2 + bx + c$$

$$a = \frac{S_{(x^2\ y)}\, S_{(x\ x)} - S_{(x\ y)}\, S_{(x\ x^2)}}{S_{(x\ x)}\, S_{(x^2\ x^2)} - \left\{S_{(x\ x^2)}\right\}^2}$$

$$b = \frac{S_{(x\ y)}\, S_{(x^2\ x^2)} - S_{(x^2\ y)}\, S_{(x\ x^2)}}{S_{(x\ x)}\, S_{(x^2\ x^2)} - \left\{S_{(x\ x^2)}\right\}^2}$$

$$c = \frac{\Sigma y_i}{n} - b\frac{\Sigma x_i}{n} - a\frac{\Sigma x_i^2}{n}$$

$$S_{(x\ x)} = \Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}$$

$$S_{(x\ y)} = \Sigma x_i y_i - \frac{\Sigma x_i \cdot \Sigma y_i}{n}$$

$$S_{(x\ x^2)} = \Sigma x_i^3 - \frac{\Sigma x_i \cdot \Sigma x_i^2}{n}$$

$$S_{(x^2\ y)} = \Sigma x_i^2 y_i - \frac{\Sigma x_i^2 \cdot \Sigma y_i}{n}$$

$$S_{(x^2\ x^2)} = \Sigma x_i^4 - \frac{(\Sigma x_i^2)^2}{n}$$

Example

	1	2	3	4	5
x_i	1	5	8	11	15
y_i	21	30	41	54	70

Analyse the quadratic regression for the above data, and estimate y when $x = 18$ and $x = 22$.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	x1	
2	1 EXE	y1	
3	21 EXE	x2	
4	5 EXE	y2	
5	30 EXE	x3	
6	8 EXE	y3	
7	41 EXE	x4	
8	⋮	⋮	
9			
10			

Step	Data input operation	Read-out	Remark
11	After all data input P1	a=0.0896691	
12		=0.08966913	(a)
13	EXE	b=2.1428801	
14		2.142880117	(b)
15	EXE	c=18.237810	
16		18.23781088	(c)
17	(x) 18 EXE	y=85.862451	
18		=85.8624513	(y)
19	(x) 22 EXE	y=108.78103	
20		108.7810327	(y)
21			

Program for

Quadratic regression analysis

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC		1
2	LBL 1 INV ISZ MR 00 INV "AL INV x INV # INV AL" HLT x_D		10
3	× × = = M+ 06 = M+ 05		17
4	MR 00 INV "AL INV y INV # INV AL" HLT M+ 04 =		25
5	M+ 03 = M+ 02 AC GoTo 1		30
6			
7	P1 INV $\bar{x}$ × × MR 04 = M− 03		6
8	MR 07 = M− 06		9
9	MR 07 ÷ MR 09 × × MR 04 = M− 02		17
10	MR 07 = M− 05		20
11	MR 07 − INV $\bar{x}$ × MR 08 = Min 00 × MR 05 −		30
12	MR 06 INV x^2 = ÷ ÷ ((MR 02 × MR 00 −		40
13	MR 03 × MR 06)) = Min 01 INV "AL INV a =		49
14	INV # INV AL" HLT		52
15	((MR 03 × MR 05 − MR 02 × MR 06)) =		62
16	Min 00 INV "AL INV b = INV # INV AL" HLT		69
17	MR 04 ÷ MR 09 − MR 00 × INV $\bar{x}$ − MR 01 ×		79
18	MR 07 ÷ MR 09 = Min F INV "AL INV C = INV #		88
19	INV AL"		89
20	LBL 1 HLT Min 09 INV x^2 × MR 01 + MR 09 × MR 00 +		100
21	MR F = INV "AL INV y = INV # INV AL" GoTo 1		108
22			
23		Total 140	
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Note

When using FX-601P, prepare the program omitting INV "AL ~ INV AL" before each HLT.
* In this case, alphabet will not be displayed preceding each input and output.

	Contents in memories	
00	Number of terms	$S(x, x)$
01		a
02	$\Sigma x_i^2 y_i$	$S(x^2, y)$
03	$\Sigma x_i y_i$	$S(x, y)$
04	Σy_i	
05	Σx_i^4	$S(x^2, x^2)$
06	Σx_i^3	$S(x, x^2)$
07	Σx_i^2	
08	Σx_i	
09	n	x
F		c
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
1F		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
2F		

CASIO PROGRAM SHEET

Program for	No.	
Binomial and Poisson distributions	Statistics-8	

Description

① Binomial distribution → [P1].

$$P_X = \frac{n!}{X!\,(n-X)!} \times p^X \times (1-P)^{n-X}$$

n: Number of samples, X: Number of defectives, P: Fraction defective

Probability that there are defectives as many as X.

② Poisson distribution → [P2]

$$P_X = e^{-m} \cdot \frac{m^X}{X!}$$

Example 1

When percent defective is 15 and there are 30 samples,
what is the probability of detecting one detective? → [P1]

Example 2

When m = 2 and X = 5, what is P_X ? → [P2]

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	[MODE] [1]			11	[P2]	m	
1	[P1]	n		12	2 [EXE]	X	
2	30 [EXE]	X		13	5 [EXE]	$P_X = 0.036089$	
3	1 [EXE]	P_X		14		0.036089408	
4	0.15 [EXE]	$P_X = 0.040398$		15			
5		0.040398139		16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Binomial and Poisson distributions

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P1 INV "AL| INV n | INV AL" | HLT | Min 01 | INV "AL| INV × | INV AL" |		8
2	HLT | Min 02 | INV "AL| P | INV x | INV AL" | HLT | Min 03 |		16
3	MR 01 | − | MR 02 | = | Min 04 |		21
4	MR 01 | INV $x!$ | ÷ | MR 02 | INV $x!$ | ÷ | MR 04 | INV $x!$ | × |		30
5	MR 03 | INV x^y | MR 02 | × | (| 1 | − | MR 03 |) | INV x^y |		40
6	MR 04 | = | INV "AL| P | INV x | = | INV # | INV AL" |		48
7			
8	P2 INV "AL| INV m | INV AL" | HLT | Min 01 | INV "AL| INV x | INV AL" |		8
9	HLT | Min 02 |		10
10	MR 01 | +/− | INV e^x | × | MR 01 | INV x^y | MR 02 | ÷ | MR 02 |		19
11	INV $x!$ | = | INV "AL| P | INV x | = | INV # | INV AL" |		27
12			
13		Total 77	
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	n, m
02	x, x
03	P
04	n−x,
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

P1: $n \leqq 69$
P2: $x \leqq 69$

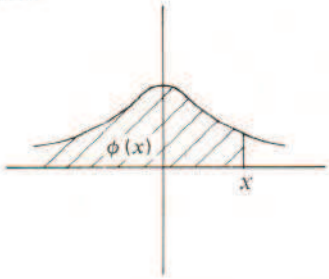
CASIO PROGRAM SHEET

Program for	No.	
Normal distribution	Statistics-9	

Description

• Input the program written in the next page.

You can obtain normal distribution function $\phi(x)$ (by Hastings' best approximation).



$$\phi(x) = \int_{-\infty}^{t} \phi_t \, dx$$

$$\phi_t = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

Put $t = \dfrac{1}{1 + Px}$

$$\phi(x) \fallingdotseq 1 - \phi_t (C_1 t + C_2 t^2 + C_3 t^3 + C_4 t^4 + C_5 t^5)$$

$P = 0.2316419$ $\quad C_3 = 1.78147937$

$C_1 = 0.31938153$ $\quad C_4 = -1.821255978$

$C_2 = -0.356563782$ $\quad C_5 = 1.330274429$

Example

Calculate the values of $\phi(x)$ at $x = 1.18$ and $x = 0.7$.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	(x) 1.18 PO	0.880999696	ϕ(x)	12			
2	(x) 0.7 PO	0.758036136	ϕ(x)	13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Normal distribution

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1			
2	P0 Min 01 × • 2 3 1 6 4 1 9 + 1 =		13
3	INV $1/x$ Min 02 ((2 × INV π)) INV $\sqrt{}$ INV $1/x$ ×		23
4	((MR 01 INV x^2 ÷ 2 +/-)) INV e^x = Min 03		33
5	1 − MR 03 × ((• 3 1 9 3 8 1 5 3		47
6	× MR 02 − • 3 5 6 5 6 3 7 8 2 ×		61
7	MR 02 INV x^2 + 1 • 7 8 1 4 7 9 3 7		74
8	× MR 02 INV x^y 3 − 1 • 8 2 1 2 5 5		87
9	9 7 8 × MR 02 INV x^y 4 + 1 • 3 3 0		100
10	2 7 4 4 2 9 × MR 02 INV x^y 5)) =		112
11			
12		Total 113	
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			

	Contents in memories
00	
01	x
02	t
03	ϕt
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
x^2 distribution	Statistics-10	

Description

x^2 distribution probability density function.

$$f(x) = \frac{x^{\frac{\nu}{2}-1}}{2^{\frac{\nu}{2}}\Gamma(\frac{\nu}{2})e^{\frac{\nu}{2}}}$$

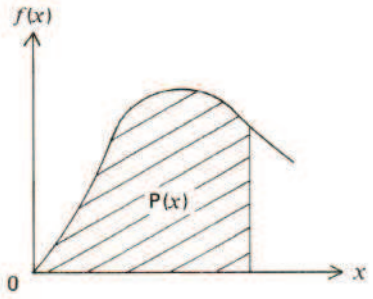
$x \geqq 0$, ν is the degree of freedom

ν : even $\quad \Gamma(\frac{\nu}{2}) = (\frac{\nu}{2}-1)!$

ν : odd $\quad \Gamma(\frac{\nu}{2}) = (\frac{\nu}{2}-1)(\frac{\nu}{2}-2)\cdots\cdots(\frac{1}{2})\cdot\sqrt{\pi}$

x^2 distribution

$$P(x) = \int_0^x f(t)dt = \frac{2x}{\nu} f(x)\left[1 + \sum_{k=1}^{\infty} \frac{x^k}{(\nu+2)(\nu+4)\cdots\cdots(\nu+2k)}\right]$$



* Calculation terminates when two successive partial sums are equal.

$$S_n = \sum_{k=1}^{n} \frac{x^k}{(\nu+2)\cdots\cdots(\nu+2k)}$$

Example

Calculate the values of $f(x)$ and $P(x)$ at $x = 8.1$ and $\nu = 4$.

手順	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
/	MODE 1			11			
1	PO	x		12			
2	8.1 EXE	v		13			
3	4 EXE	$f_{(8.1)} = 0.03$		14			
4		0.035280308		15			
5	EXE	$P_{(8.1)} = 0.91$		16			
6		0.912017008		17			
7	It takes about 12 seconds.			18			
8				19			
9				20			
10				21			

Program for

x^2 distribution

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1			
2	P0 INV MAC ┘		1
3	INV "AL ┘ INV χ ┘ INV AL" ┘ HLT ┘ Min 01 ┘ INV "AL ┘ INV ν ┘ INV AL" ┘		9
4	HLT ┘ Min 02 ┘ Min 08 ┘ • ┘ 5 ┘ Min F ┘		15
5	MR 02 ┘ ÷ ┘ 2 ┘ = ┘ Min 03 ┘ − ┘ 1 ┘ = ┘ Min 04 ┘ MR 01 ┘ ÷ ┘		26
6	2 ┘ = ┘ Min 05 ┘ MR 01 ┘ INV x^y ┘ MR 04 ┘ ÷ ┘ 2 ┘ INV x^y ┘		35
7	MR 03 ┘ ÷ ┘ MR 05 ┘ INV e^x ┘ = ┘ Min 06 ┘ MR 03 ┘ INV FRAC ┘		43
8	INV χ=0 ┘ GoTo 2 ┘		45
9	MR 04 ┘ Min 03 ┘ GoTo 5 ┘		48
10	LBL 2 ┘ MR 06 ┘ ÷ ┘ MR 04 ┘ INV $x!$ ┘ = ┘ Min 06 ┘ INV "AL ┘ INV f ┘		57
11	INV(┘ INV AR 01 ┘ INV) ┘ = ┘ INV # ┘ INV AL" ┘ HLT ┘ GoTo 7 ┘		65
12	LBL 4 ┘ 1 ┘ M− 04 ┘ MR 03 ┘ × ┘ MR 04 ┘ = ┘ Min 03 ┘ MR 04 ┘		74
13	LBL 5 ┘ INV χ=F ┘ GOTO 6 ┘		77
14	GOTO 4 ┘		78
15	LBL 6 ┘ MR 06 ┘ ÷ ┘ MR 03 ┘ ÷ ┘ INV π ┘ INV $\sqrt{}$ ┘ = ┘ Min 06 ┘ INV "AL ┘		88
16	INV f ┘ INV(┘ INV AR 01 ┘ INV) ┘ = ┘ INV # ┘ INV AL" ┘ HLT ┘		96
17	LBL 7 ┘ 1 ┘ Min 09 ┘ 0 ┘ Min F ┘		101
18	LBL 8 ┘ 1 ┘ M+ 07 ┘ 2 ┘ M+ 08 ┘ MR 08 ┘ × ┘ MR 09 ┘ = ┘ Min 09 ┘		111
19	MR 01 ┘ INV x^y ┘ MR 07 ┘ ÷ ┘ MR 09 ┘ = ┘ M+ 00 ┘		118
20	MR 00 ┘ INV χ=F ┘ GoTo 9 ┘		121
21	Min F ┘ GOTO 8 ┘		123
22	LBL 9 ┘ + ┘ 1 ┘ = ┘ × ┘ 2 ┘ × ┘ MR 01 ┘ ÷ ┘ MR 02 ┘ × ┘ MR 06 ┘ = ┘		136
23	INV "AL ┘ P ┘ INV (┘ INV AR 01 ┘ INV) ┘ = ┘ INV # ┘ INV AL" ┘		144
24			
25		Total 145	
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	$\sum_{k=1}^{88} \rightarrow P(x)$
01	x
02	ν
03	$\frac{\nu}{2}$
04	$\frac{\nu}{2}-1$
05	$\frac{x}{2}$
06	f(x)
07	k
08	$\nu+2$
09	$\nu+2k$
F	$\frac{1}{2} \rightarrow \sum^{88}$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Error will be displayed when $\nu > 141$.
When using FX-601P, prepare the program omitting INV "AL ┘ ~ ┘ INV AL" before each HLT.
* In this case, alphabet will not be displayed preceding each input and output.

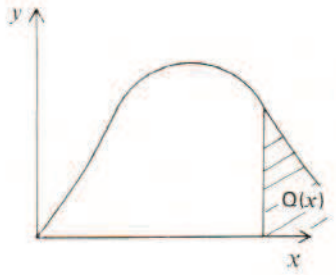
CASIO PROGRAM SHEET

Program for	No.	
F-distribution	Statistics-11	FX-602P

Description

• Input the program written in the next page.

$$Q(x) = \int_x^{\infty} \frac{\Gamma(\frac{\nu_1+\nu_2}{2})\, y^{\frac{\nu_1}{2}-1} (\frac{\nu_1}{\nu_2})^{\frac{\nu_1}{2}}}{\Gamma(\frac{\nu_1}{2})\Gamma(\frac{\nu_2}{2})(1+\frac{\nu_1}{\nu_2}y)^{\frac{\nu_1+\nu_2}{2}}}\, dy$$



ν_1 and ν_2 are the degree of freedom.
Either ν_1 or ν_2 is even. If both are even, take the smaller one.

① ν_1 : even

$$Q(x) = t^{\frac{\nu_2}{2}} \left[1 + \frac{\nu_2}{2}(1-t) + \frac{\nu_2(\nu_2+2)}{2\cdot 4}(1-t)^2 + \cdots\cdots + \frac{\nu_2(\nu_2+2)\ldots(\nu_2+\nu_1-4)}{2\cdot 4\ldots\ldots(\nu_1-2)}(1-t)^{\frac{\nu_1-2}{2}}\right]$$

② ν_2 : even

$$Q(x) = 1 - (1-t)^{\frac{\nu_1}{2}} \left[1 + \frac{\nu_1}{2}t + \frac{\nu_1(\nu_1+2)}{2\cdot 4}t^2 + \cdots\cdots + \frac{\nu_1(\nu_1+2)\ldots(\nu_1+\nu_2-4)}{2\cdot 4\ldots\ldots(\nu_2-2)}t^{\frac{\nu_2-2}{2}}\right]$$

$$t = \frac{\nu_2}{\nu_2 + \nu_1 x}$$

Example

Calculate $Q(x)$ for $x = 2.71$, $\nu_1 = 6$ and $\nu_2 = 7$.
Calculate $Q(x)$ for $x = 4.12$, $\nu_1 = 4$ and $\nu_2 = 10$.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	x		12			
2	2.71 EXE	v_1		13			
3	6 EXE	v_2		14			
4	7 EXE	$Q_{(X)} = 0.1090$		15			
5		0.109077599		16			
6	PO	x		17			
7	4.12 EXE	v_1		18			
8	4 EXE	v_2		19			
9	10 EXE	$Q_{(X)} = 0.0315$		20			
10		0.031582043		21			

Program for

F-distribution

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1			
2	P0 INV MAC INV "AL INV x INV AL" HLT Min 01 INV "AL INV v		8
3	1 INV AL" HLT Min 02 INV "AL INV v 2 INV AL" HLT		17
4	Min 03 ÷ ((MR 03 + MR 01 × MR 02)) =		27
5	Min 06 1 Min 00 Min 09 Min F		32
6	MR 03 ÷ 2 = Min 05 MR 02 ÷ 2 = INV FRAC		42
7	INV x=0 GOTO 1		44
8	MR 05 INV FRAC INV x=0 GOTO 5		48
9	0 GOTO 9		50
10	LBL 1 MR 05 INV FRAC INV x=0 GOTO 2		55
11	GOTO 4		56
12	LBL 2 MR 02 − MR 03 = INV $x \geqq 0$ GOTO 5		63
13	LBL 4 0 Min 01 Min 05 MR 03 Min 04 1 − MR 06 =		73
14	Min 07 ((MR 02 − 2)) ÷ 2 = INV x=F GOTO 7		84
15	Min F GOTO 6		86
16	LBL 5 1 Min 01 0 Min 05 MR 02 Min 04 MR 06 Min 07		95
17	((MR 03 − 2)) ÷ 2 = INV x=F GOTO 7 Min F		106
18	LBL 6 1 M+ 08 MR 08 INV x=F GOTO 7		112
19	2 M+ 05 MR 09 × MR 04 ÷ MR 05 × MR 07 =		122
20	Min 09 M+ 00 2 M+ 04 GOTO 6		127
21	LBL 7 MR 09 × MR 04 ÷ ((MR 05 + 2)) × MR 07		139
22	= M+ 00 MR 01 INV x=0 GOTO 8		144
23	1 − MR 06 = Min 07 1 − MR 00 × MR 07		154
24	INV x^y ((MR 02 ÷ 2)) = GOTO 9		162
25	LBL 8 MR 00 × MR 06 INV x^y ((MR 03 ÷ 2)) =		173
26	LBL 9 INV "AL Q INV (INV x INV) = INV # INV AL"		182
27			
28		Total 183	
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	$Q(x)$
01	x
02	ν_1
03	ν_2
04	Numerator
05	$\frac{\nu_1}{2}$ → Denominator
06	t
07	t or 1 − t
08	Count
09	Terms of Q(x)
F	$1 \rightarrow \frac{\nu_1^2}{2}$ or $\frac{\nu_2^2}{2}$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

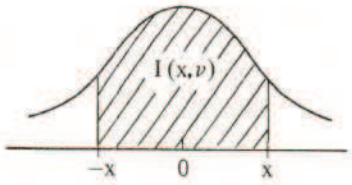
CASIO PROGRAM SHEET

Program for	No.
t-distribution	Statistics-12

Description

• Input the program written in the next page.

$$I(x,\nu) = \int_{-x}^{x} \frac{\Gamma\left(\frac{\nu+1}{2}\right)\left(1+\frac{y^2}{\nu}\right)^{-\frac{\nu+1}{2}}}{\sqrt{\pi\nu}\ \Gamma\left(\frac{\nu}{2}\right)}\,dy$$



$x > 0$, ν : Degree of freedom

① ν : even

$$I(x,\nu) = \sin\theta\left\{1+\frac{1}{2}\cos^2\theta+\frac{1\cdot3}{2\cdot4}\cos^4\theta+\cdots\cdots+\frac{1\cdot3\cdot5\cdots(\nu-3)}{2\cdot4\cdot6\cdots(\nu-2)}\cos^{\nu-2}\theta\right\}$$

② ν : odd

$$I(x,\nu) = \frac{2\theta}{\pi} \quad : \nu = 1$$

$$\text{or } \frac{2\theta}{\pi}+\frac{2}{\pi}\cos\theta\left[\sin\theta\left\{1+\frac{2}{3}\cos^2\theta+\cdots\cdots\cdots+\frac{2\cdot4\cdots(\nu-3)}{1\cdot3\cdots(\nu-2)}\cos^{\nu-3}\theta\right\}\right] \quad : \nu > 1$$

$$\theta = \tan^{-1}\left(\frac{x}{\sqrt{\nu}}\right)$$

Example

Obtain I, when x = 2.13 and ν = 10.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	x		12			
2	2.13 EXE	v		13			
3	10 EXE	I=0.9409787		14			
4		0.940978732		15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

t-distribution

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1			
2	P0 MODE 5 | INV MAC | INV "AL | INV x | INV AL" | HLT | Min 01 |		7
3	INV "AL | INV $\sqrt{}$ | INV AL" | HLT | Min 02 |		12
4	1 | Min F | Min 09 | Min 00 |		16
5	MR 01 | ÷ | MR 02 | INV $\sqrt{}$ | = | INV $\tan^{-1}$ | Min 01 | cos | INV x^2 |		25
6	Min 06 | MR 02 | ÷ | 2 | = | INV FRAC | INV x=0 | GoTo 2 |		33
7	2 | × | MR 01 | ÷ | INV π | = | Min 03 | MR 02 | INV x=F |		42
8	GoTo 6 |		43
9	MR 02 | − | 1 | = | Min F | 3 | Min 07 |		50
10	LBL 8 | 2 | M+ 08 | MR 08 | INV x=F | GoTo 9 |		56
11	MR 09 | × | MR 08 | ÷ | MR 07 | × | MR 06 | = | Min 09 |		65
12	M+ 00 | 2 | M+ 07 | GOTO 8 |		69
13	LBL 2 | MR 02 | Min F | 1 | Min 07 |		74
14	LBL 3 | 2 | M+ 08 | MR 08 | INV x=F | GOTO 4 |		80
15	MR 09 | × | MR 07 | ÷ | MR 08 | × | MR 06 | = | Min 09 |		89
16	M+ 00 | 2 | M+ 07 | GOTO 3 |		93
17	LBL 4 | MR 01 | sin | × | MR 00 | = | GOTO O |		100
18	LBL 6 | MR 03 | GOTO O |		103
19	LBL 9 | 2 | ÷ | INV π | × | MR 01 | cos | × | MR 01 | sin | × | MR 00 |		115
20	+ | MR 03 | = |		118
21	LBL O | INV "AL | I | = | INV # | INV AL" |		124
22			
23		Total 125	
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	Sum
01	$x \rightarrow \theta$
02	ν
03	$\frac{2\theta}{\pi}$
04	
05	
06	$\cos^2\theta$
07	Numerator calculation
08	Denominator calculation
09	n-th term
F	$1 \rightarrow \nu$ or $\nu - 1$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
F-test	Statistics-13	

Description

• Input the program written in the next page.

We test null hypothesis Ho; $\sigma_1^2 = \sigma_2^2$ for population variance σ^2 of two normal populations $N(\mu_1, \sigma_1^2)$ and $N(\mu_2, \sigma_2^2)$.

$$x = \{x_1, x_2, \cdots\cdots, x_{n1}\}$$

$$y = \{y_1, y_2, \cdots\cdots, y_{n2}\}$$

Unbiased variance of x $\quad F_1 = (\sigma_{n1-1})^2$

Unbiased variance of y $\quad F_2 = (\sigma_{n2-1})^2$

Unbiased variance ratio

Ho is rejected if $F_0 = \dfrac{F_1}{F_2} > F_{\phi_2}^{\phi_1}\left(\dfrac{\epsilon}{2}\right)$

Ho is accepted if $F_0 = \dfrac{F_1}{F_2} < F_{\phi_2}^{\phi_1}\left(\dfrac{\epsilon}{2}\right)$

where $\phi_1 = n_1 - 1$, $\phi_2 = n_2 - 1$, $F_{\phi_2}^{\phi_1}(x)$ is F-distribution, and ϵ the level of significance.

Example

A	15.2	10.4	12.3	14.5	18.6	16.3	14.3	13.6
B	18.6	19.3	16.3	19.4	16.0			

Is $\sigma_A^2 = \sigma_B^2$ in this case ?

⇩

$\sigma_A^2 = \sigma_B^2$ where $F_4^7(0.025) \fallingdotseq 9.07$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P0	x_1	
2	15.2 EXE	x_2	
3	10.4 EXE	x_3	
4	⋮	⋮	
5	13.6 EXE	x_9	
6			
7	P1	y_1	
8	18.6 EXE	y_2	
9	19.3 EXE	y_3	
10	⋮	⋮	

Step	Data input operation	Read-out	Remark
11	(y_5) · 16.0 EXE	y_6	
12			
13	P2	$p_1 = 7$	(ϕ_1)
14	EXE	$p_2 = 4$	(ϕ_2)
15	EXE	$F_0 = 2.258793$	
16		2.258793838	(F_0)
17			
18			
19			
20			
21			

Program for

F-test

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1				01
2	PO INV MAC		1	02
3	LBL 1 INV ISZ MR 00 INV "AL INV $\bar{x}$ INV # INV AL" HLT $x\hat{D}$		10	03
4	GOTO 1		11	04
5				05
6	P1 MR 00 Min 01 INV $\hat{\sigma}_{n-1}$ INV x^2 Min 02 INV SAC 0 Min 00		8	06
7	LBL 1 INV ISZ MR 00 INV "AL INV Y INV # INV AL" HLT $x\hat{D}$		17	07
8	GOTO 1		18	08
9				09
10	P2 2 M- 01 MR 01 INV "AL INV P 1 = INV # INV AL"		9	F
11	HLT 2 M- 00 MR 00 INV "AL INV P 2 = INV #		18	10
12	INV AL" HLT		20	11
13	MR 02 ÷ INV $\hat{\sigma}_{n-1}$ INV x^2 = INV "AL F INV 0 =		29	12
14	INV # INV AL"		31	13
15				14
16		Total 63		15
17				16
18				17
19				18
20				19
21				1F
22				20
23				21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	No.	
t-test	Statistics-14	

Description

• Input the program written in the next page.

① Test for mean μ → P0

We test null hypothesis Ho; $\mu_1 = \mu_2$ for population mean μ of two normal populations N $(\mu_1, {\sigma_1}^2)$ and N $(\mu_2, {\sigma_2}^2)$.
(Population variances ${\sigma_1}^2$ and ${\sigma_2}^2$ are unknown.)

x	x_1	x_2	·····	x_n
y	y_1	y_2	·····	y_n

$$D_i = x_i - y_i \qquad \bar{D} = \frac{1}{n}\sum_{i=1}^{n} D_i$$

$$\sigma_D = \sqrt{\frac{\Sigma D_i^2 - \frac{1}{n}(\Sigma D_i)^2}{n}}$$

$$t = \frac{\bar{D}}{\frac{\sigma_D}{\sqrt{n-1}}}$$

Let the level of significance be ϵ and t-distribution of degree of freedom ϕ be to (x).

Ho is accepted when $-t\phi(\frac{\epsilon}{2}) < t < t\phi(\frac{\epsilon}{2})$.

Ho is rejected otherwise.

where $\phi = n - 1$

② Test for difference d of means → P2

We test null hypothesis Ho; $\mu_1 - \mu_2 = d$ for the difference of means of two normal populations.

$$x = \{x_1, x_2 \cdots\cdots, x_{n1}\} \quad , \bar{x} = \frac{1}{n_1}\sum_{i=1}^{n_1} x_i$$

$$y = \{y_1, y_2 \cdots\cdots, y_{n2}\} \quad , \bar{y} = \frac{1}{n_2}\sum_{i=1}^{n_2} y_i$$

$$t = \frac{\bar{x} - \bar{y} - d}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\sqrt{\frac{\Sigma x_i^2 - n_1\bar{x}^2 + \Sigma y_i^2 - n_2\bar{y}^2}{n_1 + n_2 - 2}}}$$

For $t\phi(\frac{\epsilon}{2})$ of $\phi = n_1 + n_2 - 2$
Ho is accepted when $-t\phi(\frac{\epsilon}{2}) < t < t\phi(\frac{\epsilon}{2})$.

Ho is rejected otherwise.

Example 1

	1	2	3	4	5	6	7	8	9	10
A	43	41	41	48	44	45	40	45	46	41
B	41	40	37	48	42	42	41	42	47	43

Will results of measurement vary with A and B ?

→ $t \fallingdotseq 1.7$ $\quad t_9(0.025) = 2.262$ ($\epsilon = 5\%$)

$\mu_1 = \mu_2$ is accepted from $-t\phi(\frac{\epsilon}{2}) < t < t\phi(\frac{\epsilon}{2})$

Example 2

A;	15.2	10.4	12.3	14.5	18.6	16.3
	14.3	13.6				
B;	18.6	19.3	16.3	19.4	16.0	

Are A and B different ? → $\mu_1 = \mu_2$ (d=0)

$\mu_1 = \mu_2$ is rejected from
$t < -t_{11}(0.025) \fallingdotseq -2.201$

Step	Data input operation	Read-out	Remark
	MODE 1		
1	P0	x_1	
2	43 EXE	y_1	
3	41 EXE	x_2	
4	41 EXE	y_2	
5	⋮	⋮	
6	43 EXE	x_{11}	
7			
8	P1	p=9	(ϕ)
9	EXE	t=1.7179113	
10		1.717911381	(t)

Step	Data input operation	Read-out	Remark
11	P2	x_1	
12	15.2 EXE	x_2	
13	⋮	⋮	
14	13.6 EXE	x_9	
15	P3	y_1	
16	18.6 EXE	y_2	
17	⋮	⋮	
18	16.0 EXE	y_6	
19	(d) 0 P4	p=11	(ϕ)
20	EXE	t=−2.791214	
21		−2.79121444	(t)

Program for

t-test

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 INV MAC ┘		1
2	LBL 1 ┘MR 09┘+┘1 ┘=┘INV "AL┘INV x ┘INV ♯ ┘INV AL"┘HLT ┘		11
3	Min 01┘MR 09┘+┘1 ┘=┘INV "AL┘INV Y ┘INV ♯ ┘INV AL"┘		20
4	HLT ┘Min 02┘MR 01┘−┘MR 02┘=┘xD┘ GOTO 1 ┘		28
5			
6	P1 MR 09┘−┘1 ┘=┘INV "AL┘INV P ┘=┘INV ♯ ┘INV AL"┘HLT ┘		10
7	INV √┘×┘INV $\bar{x}$ ┘÷┘INV σn┘=┘INV "AL┘INV t ┘=┘		19
8	INV ♯ ┘INV AL"┘		21
9			
10	P2 INV MAC┘		1
11	LBL 1 ┘MR 09┘+┘1 ┘=┘INV "AL┘INV x ┘INV ♯ ┘INV AL"┘HLT ┘xD┘		12
12	GOTO 1 ┘		13
13			
14	P3 MR 09┘Min 01┘MR 07┘Min 02┘INV $\bar{x}$ ┘Min 03┘INV SAC ┘		7
15	LBL 1 ┘MR 09┘+┘1 ┘=┘INV "AL┘INV Y ┘INV ♯ ┘INV AL"┘HLT ┘xD┘		18
16	GOTO 1 ┘		19
17			
18	P4 Min 04┘MR 01┘+┘MR 09┘−┘2 ┘=┘Min 05┘		8
19	INV "AL┘INV P ┘=┘INV ♯ ┘INV AL"┘HLT ┘		14
20	(┘MR 03┘−┘INV $\bar{x}$ ┘−┘MR 04┘)┘÷┘(┘MR 01┘		24
21	INV 1/x┘+┘MR 09┘INV 1/x┘)┘INV √┘÷┘(┘(┘MR 02┘		34
22	−┘MR 01┘×┘MR 03┘INV x^2┘+┘MR 07┘−┘MR 09┘×┘		44
23	INV $\bar{x}$ ┘INV x^2┘)┘÷┘MR 05┘)┘INV √┘=┘		52
24	INV "AL┘INV t ┘=┘INV ♯ ┘INV AL"┘		57
25			
26		Total 143	
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories	
00		
01	x'	n_1
02	y'	Σx_i^2
03		$\bar{x}$
04		d
05		n_1+n_2-2
06		
07	ΣD_i^2	Σy_i^2
08	ΣD_i	Σy_i
09	n	n_2
F		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
1F		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
2F		

Note

When using FX-601P, prepare the program omitting INV "AL┘ ~ ┘ INV AL" before each HLT.

* In this case, alphabet will not be displayed preceding each input and output.

CASIO PROGRAM SHEET

Program for	No.	
2-by-2 contingency table	Statistics-15	

Description

• Input the program written in the next page.

	B_1	B_2	Total
A_1	a	b	a + b = g
A_2	c	d	c + d = h
Total	a + c = e	b + d = f	a + b + c + d = n

$$x_0^2 = \frac{(ad - bc)^2 n}{e\ f\ g\ h}$$

We consider A and B are dependent if x_0^2 is greater than 3.84 (risk : 5%).

Yeat's correction $x_s^2 = \dfrac{n\left\{|ad - bc| - \frac{1}{2}n\right\}^2}{e\ f\ g\ h}$

Example

	B_1	B_2
A_1	2422	439
A_2	2892	447

Calculate x_0^2 and x_s^2 of the above contingency table.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	a		12			
2	2422 EXE	b		13			
3	439 EXE	c		14			
4	2892 EXE	d		15			
5	447 EXE	$X_0 = 4.818054$		16			
6		4.818054007	(X_0^2)	17			
7	EXE	$X_S = 4.659596$		18			
8		$= 4.65959646$	(X_S^2)	19			
9				20			
10				21			

Program for

2-by-2 contingency table

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV "AL" INV a INV AL" HLT Min 01 INV "AL" INV b INV AL"		8
2	HLT Min 02 INV "AL" INV c INV AL" HLT Min 03 INV "AL"		16
3	INV d INV AL" HLT Min 04		20
4	MR 01 Min 05 MR 03 M+ 05		24
5	MR 02 Min 06 MR 04 M+ 06		28
6	MR 01 Min 07 MR 02 M+ 07		32
7	MR 03 Min 08 MR 04 M+ 08		36
8	MR 05 Min 09 MR 06 M+ 09		40
9	GSB P1 GSB P2 INV "AL" X INV O = INV # INV AL" HLT		49
10	GSB P1 INV ABS − MR 09 ÷ 2 = GSB P2 INV "AL" X		59
11	INV s = INV # INV AL"		63
12			
13	P1 MR 01 × MR 04 − MR 02 × MR 03 =		8
14			
15	P2 INV x^2 × MR 09 ÷ MR 05 ÷ MR 06 ÷ MR 07 ÷		10
16	MR 08 =		12
17			
18		Total 86	
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	a
02	b
03	c
04	d
05	e
06	f
07	g
08	h
09	n
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
m-by-n contingency table	Statistics-16	FX-602P

Description

• Input the program written in the next page.

Calculate an arbitrary contingency table as far as 5 by 5.

	1	2	..... j	n	Total
A_1	x_{11}	x_{12}	..... x_{1j}	x_{1n}	N_{A1}
A_2	x_{21}	x_{22}	..... x_{2j}	x_{2n}	N_{A2}
A_3	x_{31}	x_{32}	..... x_{3j}	x_{3n}	N_{A3}
⋮	⋮	⋮	⋮	⋮	⋮
A_i	x_{i1}	x_{i2}	..... x_{ij}	x_{in}	N_{Ai}
⋮	⋮	⋮	⋮	⋮	⋮
A_m	x_{m1}	x_{m2}	..... x_{mj}	x_{mn}	N_{Am}
Total	N_1	N_2	..... N_j	N_n	N

$$x^2 = \frac{N}{N_{A1}} \sum_{j=1}^{n} \frac{x_{1j}^2}{N_j} + \frac{N}{N_{A2}} \sum_{j=1}^{n} \frac{x_{2j}^2}{N_j} + \cdots\cdots + \frac{N}{N_{Am}} \sum_{j=1}^{n} \frac{x_{mj}^2}{N_j} - N$$

$$= \sum_{i=1}^{m} \frac{N}{N_{Ai}} \sum_{j=1}^{n} \frac{x_{ij}^2}{N_j} - N$$

Example

	1	2	3	4
A_1	4	5	1	7
A_2	2	9	3	4
A_3	1	7	5	6

Calculate x^2 of the above 3-by-4 contingency table.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	m	
2	3 EXE	n	
3	4 EXE	x1,1	
4	4 EXE	x2,1	
5	2 EXE	x3,1	
6	⋮	⋮	
7	4 EXE	x3,4	
8	6 EXE	X=6.6108177	(X^2)
9			
10			

Step	Data input operation	Read-out	Remark
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for

m-by-n contingency table

	Program	Remark	Step
	MODE 3 INV MAC MODE • 6 1 MODE 2		
1	P0 INV MAC ‖		1
2	INV "AL ‖ INV m ‖ INV AL" ‖ HLT ‖ Min F ‖ Min 02 ‖		7
3	INV "AL ‖ INV n ‖ INV AL" ‖ HLT ‖ Min 01 ‖ 2 ‖ Min 00 ‖		14
4	1 ‖ Min 58 ‖ Min 59 ‖		19
5	LBL 2 ‖ INV "AL ‖ INV x ‖ INV AR 58 ‖ INV , ‖ INV AR 59 ‖ INV AL" ‖ HLT ‖ Min 03 ‖		30
6	M+ 1F ‖ 3 ‖ M+ 02 ‖ MR 03 ‖ INV x^2 ‖ INV IND ‖ Min 02 ‖		37
7	3 ‖ 6 ‖ M+ 02 ‖ MR 03 ‖ INV IND ‖ M+ 02 ‖ 3 ‖ 9 ‖ M− 02 ‖		46
8	1 ‖ M+ 58 ‖ INV IND ‖ INV DSZ ‖ GOTO 2 ‖		52
9	INV DSZ ‖ INV IND ‖ INV DSZ ‖ GOTO 3 ‖		56
10	GOTO 4 ‖		57
11	LBL 3 ‖ GSB P1 ‖ MR F ‖ Min 02 ‖ 0 ‖ Min 1F ‖ 1 ‖ Min 58 ‖ M+ 59 ‖		68
12	GOTO 2 ‖		69
13	LBL 4 ‖ GSB P1 ‖ 1 ‖ 7 ‖ Min 00 ‖ 5 ‖ 7 ‖ Min 58 ‖ MR 57 ‖ Min 1F ‖		81
14	LBL 6 ‖ 1 ‖ M− 58 ‖ INV IND ‖ MR 58 ‖ M+ 1F ‖ INV DSZ ‖ GOTO 6 ‖		91
15	2 ‖ Min 00 ‖ MR F ‖ Min 02 ‖ 0 ‖ Min 60 ‖		98
16	LBL 5 ‖ 3 ‖ 9 ‖ M+ 02 ‖ MR 02 ‖ − ‖ 1 ‖ 8 ‖ = ‖ Min 01 ‖		108
17	INV IND ‖ MR 01 ‖ ÷ ‖ INV IND ‖ MR 02 ‖ = ‖ M+ 60 ‖		116
18	3 ‖ 9 ‖ M− 02 ‖ INV IND ‖ INV DSZ ‖ GOTO 5 ‖		122
19	MR 60 ‖ − ‖ 1 ‖ = ‖ × ‖ MR 1F ‖ = ‖		130
20	INV "AL ‖ X ‖ = ‖ INV # ‖ INV AL" ‖		135
21			
22	P1 2 ‖ Min 00 ‖ MR F ‖ Min 02 ‖		4
23	LBL 1 ‖ MR 02 ‖ + ‖ 2 ‖ 1 ‖ = ‖ Min 60 ‖		12
24	3 ‖ M+ 02 ‖ INV IND ‖ MR 02 ‖ ÷ ‖ MR 1F ‖ = ‖ INV IND ‖ M+ 60 ‖		22
25	3 ‖ M− 02 ‖ INV IND ‖ INV DSZ ‖ GOTO 1 ‖		27
26			
27		Total 164	
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

It is necessary to expand the memory capacity to 61 by operating MODE • 6 1 before programming.

CASIO PROGRAM SHEET

Program for	No.	
Analysis of variance with one-way layout	Statistics-17	FX-602P

Description

• Input the program written in the next page.

i \ j	1	2	3	4	.... n
1	4	8	2	10	
2	6	9	8	–	
3	14	11	–	–	
⋮ m					

Groups

Sum of i-th group $S_i = \sum_{j=1}^{n} x_{ij}$

Correction term $M = \dfrac{(\sum_{i=1}^{m} S_i)^2}{\sum_{i=1}^{m} n_i}$

Total variation $S_T = \sum_{i=1}^{m} \sum_{j=1}^{n} x_{ij}^2 - M$

Variation of i-th group $S_p = \sum_{i=1}^{m} \dfrac{S_i^2}{n_i} - M$

Error variation $S_E = S_T - S_p$

Degree of freedom $df_1 = m - 1$, $df_2 = \sum_{i=1}^{m} n_i - m$

Unbiased variance $MS_T = \dfrac{S_p}{df_1}$, $MS_E = \dfrac{S_E}{df_2}$

Unbiased variance ratio $F = \dfrac{MS_T}{MS_E}$

* An empty column indicates that input is 0.

If 0 is an actual data, "INV x = 0" and "GOTO 6" in line 3 and all of line 17 must be removed.

Example

Make analysis of variance for the data given above.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	m	
2	(m) 3 EXE	n	
3	(n) 4 EXE	x	
4	(x_{11}) 4 EXE	x	
5	(x_{12}) 8 EXE	x	
6	(x_{13}) 2 EXE	x	
7	⋮	⋮	
8	(x_{33}) 0 EXE	x	
9	(x_{34}) 0 EXE	ST=106	
10	EXE	SP=56.83333	
11		=56.8333333	
12	EXE	SE=49.16666	
13		=49.1666667	
14	EXE	MST=28.4166	
15		28.41666665	
16	EXE	MSE=8.19444	
17		=8.19444445	
18	EXE	F=3.4677966	
19		3.467796606	
20			
21			

Program for

Analysis of a variance with one-way layout

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P0 INV MAC ‖		1	01
2	INV "AL ‖ INV m ‖ INV AL" ‖ HLT ‖ Min 01 ‖ Min 08 ‖		7	02
3	INV "AL ‖ INV n ‖ INV AL" ‖ HLT ‖ Min 02 ‖ Min 09 ‖ 2 ‖ Min 00 ‖		15	03
4	LBL 2 ‖ INV "AL ‖ INV x ‖ INV AL" ‖ HLT ‖ INV x=0 ‖ GOTO 6 ‖		22	04
5	M+ 03 ‖ INV x^2 ‖ M+ 04 ‖		25	05
6	LBL 3 ‖ INV IND ‖ INV DSZ ‖ GOTO 2 ‖		29	06
7	INV DSZ ‖ INV IND ‖ INV DSZ ‖ GOTO 4 ‖		33	07
8	GSB P1 ‖ MR 08 ‖ × ‖ MR 09 ‖ − ‖ MR 07 ‖ = ‖ Min 07 ‖		41	08
9	MR 05 ‖ INV x^2 ‖ ÷ ‖ MR 07 ‖ = ‖ Min 01 ‖		47	09
10	MR 04 ‖ − ‖ MR 01 ‖ = ‖ Min 02 ‖ INV "AL ‖ S ‖ T ‖ = ‖ INV # ‖		57	F
11	INV AL" ‖ HLT ‖		59	10
12	MR 06 ‖ − ‖ MR 01 ‖ = ‖ Min 03 ‖ INV "AL ‖ S ‖ P ‖ = ‖ INV # ‖		69	11
13	INV AL" ‖ HLT ‖		71	12
14	MR 02 ‖ − ‖ MR 03 ‖ = ‖ Min 04 ‖ INV "AL ‖ S ‖ E ‖ = ‖ INV # ‖		81	13
15	INV AL" ‖ HLT ‖		83	14
16	MR 03 ‖ ÷ ‖ (‖ MR 08 ‖ − ‖ 1 ‖) ‖ = ‖ Min 05 ‖ INV "AL ‖		93	15
17	M ‖ S ‖ T ‖ = ‖ INV # ‖ INV AL" ‖ HLT ‖		100	16
18	MR 04 ‖ ÷ ‖ (‖ MR 07 ‖ − ‖ MR 08 ‖) ‖ = ‖ Min 06 ‖ INV "AL ‖		110	17
19	M ‖ S ‖ E ‖ = ‖ INV # ‖ INV AL" ‖ HLT ‖		117	18
20	MR 05 ‖ ÷ ‖ MR 06 ‖ = ‖ INV "AL ‖ F ‖ = ‖ INV # ‖ INV AL" ‖ HLT ‖		127	19
21	LBL 4 ‖ GSB P1 ‖ 2 ‖ Min 00 ‖ MR 09 ‖ Min 02 ‖ 0 ‖ Min 03 ‖ Min F ‖		136	1F
22	GOTO 2 ‖		137	20
23	LBL 6 ‖ 1 ‖ M+ F ‖ 0 ‖ GOTO 3 ‖		142	21
24				22
25	P1 MR 03 ‖ M+ 05 ‖ INV x^2 ‖ ÷ ‖ (‖ MR 09 ‖ − ‖ MR F ‖) ‖ = ‖		10	23
26	M+ 06 ‖ MR F ‖ M+ 07 ‖		13	24
27				25
28		Total 157		26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

Input 0 (zero) when there is no data ("−").

When "0" is an actual data, calculations must be made with a program from which the 5th line (INV x = 0, GOTO 6) and the 24th line (LBL 6, 1, M+ F, 0, GOTO 3) have been deleted.

When using FX-601P, prepare the program omitting INV "AL ‖ ~ ‖ INV AL" before each HLT.

* In this case, alphabet will not be displayed preceding each input and output.

CASIO PROGRAM SHEET

Program for	No.	
Analysis of variance with two-way layout	Statistics-18	FX-602P

Description

• Input the program written in the next page.

	B_1	B_2	..... B_j	B_n	Total	Average
A_1	X_{11}	X_{12}	X_{1j}	X_{1n}	S_{1b}	$\overline{X_{1b}}$
A_2	X_{21}	X_{22}	X_{2j}	X_{2n}	S_{2b}	$\overline{X_{2b}}$
A_i	X_{i1}	X_{i2}	X_{ij}	X_{in}	S_{ib}	$\overline{X_{ib}}$
A_m	X_{m1}	X_{m2}	X_{mj}	X_{mn}	S_{mb}	$\overline{X_{mb}}$
Total	S_{a1}	S_{a2}	S_{aj}	S_{an}	S_{ab}	
Average	$\overline{X_{a1}}$	$\overline{X_{a2}}$	$\overline{X_{aj}}$	$\overline{X_{an}}$		$\overline{X_{ab}}$

Sum over Ai $\quad S_{ib} = \sum_{j=1}^{n} x_{ij}$

Correction term $\quad M = \dfrac{\left(\sum_{i=1}^{n} S_{ib}\right)^2}{mn} = \dfrac{(S_{ab})^2}{mn}$

Total variation $\quad S_T = \sum_{i=1}^{m}\sum_{j=1}^{n} X_{ij}^2 - M$

A-variation $\quad S_A = \dfrac{\sum_{i=1}^{m} S_{ib}^2}{n} - M$

B-variation $\quad S_B = \dfrac{\sum_{j=1}^{n} S_{aj}^2}{m} - M$

Error variation $\quad S_E = S_T - S_A - S_B$

Degree of freedom

$df_T = mn - 1$

$df_A = m - 1$

$df_B = n - 1$

$df_E = (m - 1)(n - 1)$

Unbiased variance of A-variation $\quad V_A = \dfrac{S_A}{df_A}$

Unbiased variance ratio $\quad F_A = \dfrac{V_A}{V_E}$

Unbiased variance of B-variation $\quad V_B = \dfrac{S_B}{df_B}$

Unbiased variance ratio $\quad F_B = \dfrac{V_B}{V_E}$

Unbiased variance of error $\quad V_E = \dfrac{S_E}{df_E}$

Example

	B_1	B_2	B_3	B_4
A_1	15	23	6	19
A_2	12	48	31	7
A_3	11	17	25	14

m: Number of lines
n: Number of columns
($n \leq 12$; m is unlimited.)

Step	Data input operation	Read-out	Remark
	MODE 1		
1	PO	m	
2	3 EXE	n	
3	4 EXE	x1,1	
4	15 EXE	x1,2	
5	23 EXE	x1,3	
6	⋮	⋮	
7	14 EXE	ST=1508	
8	EXE	SA=183.5	
9	EXE	SB=545.3333	
10		545.3333333	
11	EXE	SE=779.1666	
12		779.1666667	
13	EXE	VA=91.75	
14	EXE	VB=181.7777	
15		181.7777778	
16	EXE	VE=129.8611	
17		129.8611111	
18	EXE	FA=0.706524	
19		0.706524064	
20	EXE	FB=1.399786	
21		1.399786097	

Program for

Analysis of variance with two-way layout

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 5 5 MODE 2			00
1	P0 INV MAC		1	01
2	INV "AL INV m INV AL" HLT Min 01 Min F		7	02
3	INV "AL INV n INV AL" HLT Min 02 Min 1F 2 Min 00		15	03
4	1 Min 2 F‖ Min 3 F‖		20	04
5	LBL 1 INV "AL INV x INV AR 2 F‖ INV , INV AR 3 F‖ INV AL" HLT		30	05
6	Min 03 M+ 04 INV x^2 M+ 06 7 M+ 02		36	06
7	MR 03 INV IND M+ 02 7 M− 02 1 M+ 3 F‖		44	07
8	INV IND INV DSZ GOTO 1		47	08
9	INV DSZ INV IND INV DSZ GOTO 2 GOTO 3		52	09
10	LBL 2 MR 04 M+ 05 INV x^2 M+ 07 2 Min 00 MR 1F Min 02		61	F
11	0 Min 04 1 M+ 2 F‖ Min 3 F‖ Goto 1		69	10
12	LBL 3 2 Min 00 MR 1F Min 02 0 Min 03		76	11
13	LBL 4 7 M+ 02 INV IND MR 02 INV x^2 M+ 03 7 M− 02		85	12
14	INV IND INV DSZ GOTO 4		88	13
15	MR 04 M+ 05 INV x^2 M+ 07		92	14
16	MR 05 INV x^2 ÷ MR F ÷ MR 1F = Min 01		100	15
17	MR 06 − MR 01 = Min 02 INV "AL S T = INV #		110	16
18	INV AL" HLT		112	17
19	MR 07 ÷ MR 1F − MR 01 = Min 04 INV "AL S A		122	18
20	= INV # INV AL" HLT		126	19
21	MR 03 ÷ MR F − MR 01 = Min 05 INV "AL S B		136	1F
22	= INV # INV AL" HLT		140	20
23	MR 02 − MR 04 − MR 05 = Min 06 INV "AL S E		150	21
24	= INV # INV AL" HLT		154	22
25	MR 04 ÷ ((MR F − 1)) = Min 07 INV "AL V		165	23
26	A = INV # INV AL" HLT		170	24
27	MR 05 ÷ ((MR 1F − 1)) = Min 08 INV "AL V		181	25
28	B = INV # INV AL" HLT		186	26
29	MR 06 ÷ ((MR F − 1)) ÷ ((MR 1F − 1		198	27
30	)) = Min 09 INV "AL V E = INV # INV AL" HLT		208	28
31	MR 07 ÷ MR 09 = INV "AL F A = INV # INV AL"		218	29
32	HLT		219	2F
33	MR 08 ÷ MR 09 = INV "AL F B = INV # INV AL"		229	
34				
35		Total 230		
36				
37				

Note

It is necessary to expand the memory capacity to 55 by operating MODE • 5 5 before programming.

CASIO PROGRAM SHEET

Program for	No.	
Multiple correlation coefficient	Statistics-19	FX-602P

Description

• Input the program written in the next page.

	x_1	x_2	y
1	x_{11}	x_{21}	y_1
2	x_{12}	x_{22}	y_2
⋮	⋮	⋮	⋮
n	x_{1n}	x_{2n}	y_n

Multiple correlation coefficient between (x_1, x_2) and y.

$$\rho y x_1 x_2 = \sqrt{1 - \frac{R}{R_{yy}}}$$

$$R = \begin{vmatrix} 1 & \gamma x_1 x_2 & \gamma x_1 y \\ \gamma x_2 x_1 & 1 & \gamma x_2 y \\ \gamma y x_1 & \gamma y x_2 & 1 \end{vmatrix} = 1 + 2\gamma x_1 x_2\, \gamma x_1 y\, \gamma x_2 y - (\gamma x_1 x_2{}^2 + \gamma x_1 y^2 + \gamma x_2 y^2)$$

$$R_{yy} = \begin{vmatrix} 1 & \gamma x_1 x_2 \\ \gamma x_2 x_1 & 1 \end{vmatrix} = 1 - \gamma x_1 x_2{}^2$$

Correlation coefficient for x_1 and x_2.

$$\gamma x_1 x_2 = \frac{n\Sigma x_1 x_2 - \Sigma x_1 \Sigma x_2}{\sqrt{\{n\Sigma x_1^2 - (\Sigma x_1)^2\}\{n\Sigma x_2^2 - (\Sigma x_2)^2\}}} = \gamma x_2 x_1$$

Correlation coefficient for x_1 and y.

$$\gamma x_1 y = \frac{n\Sigma x_1 y - \Sigma x_1 \Sigma y}{\sqrt{\{n\Sigma x_1{}^2 - (\Sigma x_1)^2\}\{n\Sigma y^2 - (\Sigma y)^2\}}} = \gamma y x_1$$

Correlation coefficient for x_2 and y.

$$\gamma x_2 y = \frac{n\Sigma x_2 y - \Sigma x_2 \Sigma y}{\sqrt{\{n\Sigma x_2{}^2 - (\Sigma x_2)^2\}\{n\Sigma y^2 - (\Sigma y)^2\}}} = \gamma y x_2$$

Example

	1	2	3	4	5	6	7	8	9	10
x_1	2.8	2.9	3.2	3.4	3.5	3.7	3.8	3.9	4.1	4.1
x_2	12.2	10.3	12.7	10.1	8.6	11.0	9.5	8.6	9.7	11.5
y	42	45	42	51	55	47	65	70	62	68

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	P0	x1,1		12			
2	2.8 EXE	x2,1		13			
3	12.2 EXE	y1		14			
4	42 EXE	x1,2		15			
5	2.9 EXE	x2,2		16			
6	10.3 EXE	y2		17			
7	⋮	⋮		18			
8	68 EXE	x1,11		19			
9	After all data input P1	P=0.8956596		20			
10		0.895659679		21			

Program for

Multiple correlation coefficient

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV MAC 1 Min 17 Min 18		4
2	LBL 1 INV "AL INV x INV AR 17 INV , INV AR 18 INV AL" HLT		12
3	Min 01 M+ 04 INV x^2 M+ 03 1 M+ 17		18
4	INV "AL INV x INV AR 17 INV , INV AR 18 INV AL" HLT		25
5	Min 02 M+ 06 INV x^2 M+ 05		29
6	INV "AL INV y INV AR 18 INV AL" HLT $x\mathrm{D}$ × × MR 01		38
7	= M+ 11 MR 02 = M+ 12		43
8	MR 01 × MR 02 = M+ 13 1 Min 17 M+ 18 GOTO 1		52
9			
10	P1 MR 13 Min 10 MR 04 Min 01 MR 06 Min 02 MR 03		7
11	Min F MR 05 Min 00 GSB P2 Min 14		12
12	MR 11 Min 10 MR 08 Min 02 MR 07 Min 00 GSB P2		19
13	Min 15 MR 12 Min 10 MR 06 Min 01 MR 05 Min F		26
14	GSB P2 Min 16		28
15	1 − (1 + 2 × MR 14 × MR 15 × MR 16		40
16	− MR 14 INV x^2 − MR 15 INV x^2 − MR 16 INV x^2		49
17	) ÷ ((1 − MR 14 INV x^2)) = INV √		59
18	INV "AL P = INV # INV AL"		64
19			
20	P2 ((MR 09 × MR 10 − MR 01 × MR 02)) ÷ ((		11
21	((MR 09 × MR F − MR 01 INV x^2)) × ((		21
22	MR 09 × MR 00 − MR 02 INV x^2))) INV √ =		31
23			
24		Total 150	
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Note

	Contents in memories	
00		ΣY^2
01	x_1	ΣX
02	x_2	ΣY
03	Σx_1^2	
04	Σx_1	
05	Σx_2^2	
06	Σx_2	
07	Σy^2	
08	Σy	
09	n	
F		ΣX^2
10		ΣXY
11	$\Sigma x_1 y$	
12	$\Sigma x_2 y$	
13	$\Sigma x_1 x_2$	
14	$r x_1 x_2$	
15	$r x_1 y$	
16	$r x_2 y$	
17	For displaying number of terms.	
18	— 〃 —	
19		
1F		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
2F		

CASIO PROGRAM SHEET

Program for	No.
Removal of urea	Medicine–1

Description

• Input the program written in the next page.

Urine generation rate $Vt = \frac{V\ [m\ell]}{t\ [min]}$

(The factor of correction Vt* by the body surface area (BSA) of a client is $\frac{1.73}{BSA}$ Vt)

① When $Vt > 2$: Maximum removal Cm [mℓ/min] and percentage mean normal <Cm>

$$Cm = \frac{UVt}{B}$$

$$<Cm> = 1.33\ Cm$$

② When $Vt \leqq 2$: Standard removal Cs [mℓ/min] and percentage mean normal <Cs>

$$Cs = \frac{U\sqrt{Vt}}{B}$$

$$<Cs> = 1.85\ Cs$$

U : Urea concentration in urine
B : Urea concentration in blood
) In any but the same unit

Example 1

Vt = 1.8 mℓ/min
U = 912 mg/100mℓ
B = 25 mg/100mℓ

Calculate Cs and <Cs> of a person whose data are given above.

Example 2

Vt = 2.5 mℓ/min
U = 823 mg/100mℓ
B = 22 mg/100mℓ
BSA = 2.11m²

Calculate Cm and <Cm> for a person whose data are given above.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11	2.5 EXE	INPUT U	
1	P0	INPUT Vt		12	823 EXE	INPUT B	
2	Example 1 1.8 EXE	INPUT U		13	22 EXE	INPUT	
3	912 EXE	INPUT B		14		BSA or 0	
4	25 EXE	INPUT		15	2.11 EXE	Vt *=	
5		BSA or 0		16		2.049763033	
6	0 EXE	Cs=		17	EXE	Cm=	
7		48.94305587		18		76.67977164	
8	EXE	⟨Cs⟩=		19	EXE	⟨Cm⟩=	
9		90.54465337		20		101.9840963	
10	Example 2 EXE	INPUT Vt		21	EXE	INPUT Vt	Repeat from step 2

Program for

Removal of urea

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 0 GSB P2 INV "AL INV ; V INV t INV AL" HLT Min F		9
3	GSB P2 INV "AL INV ; U INV AL" HLT Min 02		16
4	GSB P2 INV "AL INV ; B INV AL" HLT Min 03		23
5	GSB P2 INV PAUSE INV "AL B S A INV SPACE INV o		31
6	INV r INV SPACE 0 INV AL" HLT Min 04		37
7	INV x-0 GoTo 1		39
8	INV "AL V INV t INV ✳ = INV AL" INV PAUSE		46
9	1 • 1 7 3 ÷ MR 04 × MR F = Min F HLT	Vt* calculation	57
10	LBL 1 2 INV $x \geqq$ F GoTo 2		61
11	INV "AL C INV m = INV AL" INV PAUSE GSB P1	Cm Calculation	68
12	INV "AL INV < C INV m INV > = INV AL" INV PAUSE		76
13	1 • 1 3 3 = HLT GoTo 0	<Cm> Calculation	83
14	LBL 2 INV "AL C INV s = INV AL" INV PAUSE		90
15	MR F INV √‾ Min F GSB P1	Cs Calculation	94
16	INV "AL INV < C INV s INV > = INV AL" INV PAUSE		102
17	1 • 1 8 5 = HLT GoTo 0	<Cs> Calculation	109
18			
19			
20			
21	P1 MR 02 × MR F ÷ MR 03 = HLT ×		8
22			
23	P2 INV "AL I N P U T INV SPACE INV AL"		8
24			
25		Total 128	
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	
02	U
03	B
04	BSA or 0
05	
06	
07	
08	
09	
F	$Vt, Vt^*, \sqrt{Vt}$ or $\sqrt{Vt}^*$
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

The presence or absence of BSA corrections is determined automatically by whether 0 is input or not in steps 6 and 15 on the left page.

CASIO PROGRAM SHEET

Program for	No.	
Surface area of a human body	Medicine–2	

Description

• Input the program written in the next page.

DuBois's formula

$$BSA\ (D) = h^{0.725}\ (cm) \times W^{0.425}\ (kg) \times 71.84 \times 10^{-4}\ [m^2]$$

Boyde's formula (The DuBois's formula will produce large error for a child when BSA is smaller than 0.6 m^2.)

$$BSA\ (B) = h^{0.3}\ (cm) \times W^{(0.7285 - 0.0188 \log W)}\ (g) \times 3.207 \times 10^{-4}\ [m^2]$$

* For this program, height is input in centimeters and weight in kilograms.
When BSA < 0.6, BSA is computed automatically using Boyde's formula.
To find for reference the BSA computed through Boyde's formula, press [GoTo] [1] .

Example

Calculate the surface area of a person who measures 171.9 cm high and weights 61.8 kg.

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	[PO]	INPUT h→cm	
2	171.9 [EXE]	INPUT W→kg	
3	61.8 [EXE]	BSA(D) =	
4		1.730260272	
5			
6	[GoTo] [1]	BSA(B) =	
7		1.71945059	
8	[EXE]	INPUT h→cm	Repeat from step 2
9			
10			

Step	Data input operation	Read-out	Remark
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for

Surface area of a human body

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 3, GSB P1, INV "AL, INV ;, INV h, INV →, INV C,		7
3	INV m, INV AL", HLT, Min 01,		11
4	GSB P1, INV "AL, INV ;, W, INV →, INV k, INV g,		18
5	INV AL", HLT, Min 02,		21
6	×, 3, INV 10^x, =, Min 03, •, 6, Min F,		29
7	7, 1, •, 8, 4, EXP, 4, +/−, ×, MR 01, INV x^y,		40
8	•, 7, 2, 5, ×, MR 02, INV x^y, •, 4, 2, 5,	BSA(D)	51
9	=, Min 04,	Calculation	53
10	INV $x \geq F$, GoTo 2,		55
11	GoTo 1,		56
12	LBL 2, INV "AL, B, S, A, INV (, D, INV), =, INV AL", INV PAUSE,		67
13	MR 04, HLT, GoTo 3,		70
14	LBL 1, INV "AL, B, S, A, INV (, B, INV), =, INV AL", INV PAUSE,		81
15	•, 7, 2, 8, 5, −, •, 0, 1, 8, 8, ×, MR 03,		94
16	log, =, Min 05, 3, •, 2, 0, 7, EXP, 4, +/−, ×	BSA(B)	106
17	MR 03, INV x^y, MR 05, ×, MR 01, INV x^y, •, 3, =,	Calculation	115
18	HLT, GoTo 3,		117
19			
20			
21	P1 INV "AL, I, N, P, U, T, INV SPACE, INV AL",		8
22			
23		Total 127	
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	h
02	W(kg)
03	1000W(g)
04	BSA(D)
05	0.7285-0.0188log Wg
06	
07	
08	
09	
F	0.6
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.
Indication of red corpuscle	Medicine–3

Description

• Input the program written in the next page.

- Red cell count : C [10^6/mm^3]
- Hematocrit : Hct [%]
- Hemoglobin in 100 mℓ of blood : Hb [g/100mℓ]

1. Mean corpuscular volume : Vm

$$Vm = \frac{Hct \times 10}{C} \quad [micron^3 = \mu^3 = (10^{-6})^3 m^3]$$

2. Part of hemoglobin in a blood cell

$$Hm = \frac{Hb \times 10}{C} \quad [10^{-12} g = pico\ g]$$

3. Mean quantity of hemoglobin in 100 mℓ of blood

$$Hbm = \frac{Hb \times 100}{Hct} \quad [g/100m\ell]$$

Example

Calculate Vm, Hm and Hbm for a person whose data are 2.03 x 10^6 /mm^3 for red cell count, 22.3% for Hct and 14.5g/100mℓ for Hb.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	INPUT C		12			
2	2.03 EXE	INPUT Hct		13			
3	22.3 EXE	INPUT Hb		14			
4	14.5 EXE	Vm=		15			
5		109.8522167		16			
6	EXE	Hm=		17			
7		71.42857143		18			
8	EXE	Hbm=		19			
9		65.02242152		20			
10	EXE	INPUT C	Repeat from step 2	21			

Program for

Indication of red corpuscle

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00	
1	P0			01	C
2	LBL 1 GSB P1 INV "AL INV ; C INV AL" HLT Min 01		8	02	Hct
3	GSB P1 INV "AL INV ; H INV c INV t INV AL"		15	03	Hb
4	HLT Min 02		17	04	
5	GSB P1 INV "AL INV ; H INV b INV AL" HLT Min 03		25	05	
6	INV "AL V INV m = INV AL" INV PAUSE		31	06	
7	MR 02 × 1 0 ÷ MR 01 = HLT	V_m Calculation	39	07	
8	INV "AL H INV m = INV AL" INV PAUSE		45	08	
9	÷ MR 02 × MR 03 = HLT	Hm Calculation	51	09	
10	INV "AL H INV b INV m = INV AL" INV PAUSE		58	F	
11	MR 03 × 1 0 0 ÷ MR 02 = HLT	Hbm Calculation	67	10	
12	GoTo 1		68	11	
13				12	
14				13	
15	P1 INV "AL I N P U T INV SPACE INV AL"		8	14	
16				15	
17				16	
18		Total 78		17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

When the number of INV PAUSE is increased in the 31st, 45th, and 58th steps, the time for display of V_m=, H_m=, and H_{bm}= is extended.

CASIO PROGRAM SHEET

Program for	No.	
Acidity of blood	Medicine–4	

Description

• Input the program written in the next page.

○ Bodily temperature : T [°C]

○ CO_2 partial pressure : P* [mmHg]

P* partial pressure at 37°C

$$P^*(37^\circ C) = P^*(T)\ 10^{0.019(37-T)}$$

○ pH

pH at 37°C

$$pH(37^\circ C) = pH(T) - 0.0146(37-T)$$

○ Hemoglobin concentration : H [$g/100m\ell$]

1. Hydrogencarbonate ion concentration
   $[HCO_3^-]$ [$m\,mol/\ell$]
   $[HCO_3^-] = 0.0307 \cdot P^* \cdot 10^{(pH-6.11)}$

2. Base Excess : BE [mEq/ℓ]
   $BE = (1 - 0.0143H)\{[Hco_3^-] - (9.5+1.63H)(7.4-pH)-24\}$

3. Ions of dissociated CO_2 (Plasma) I [$mmol/\ell$]
   $I = 0.0307 \cdot P^*[1+10^{(pH-6.11)}]$
   ↑ Solubility of CO_2

Example

T = 40°C
P* (40°) = 53 mmHg
pH (40°) = 7.32
H = 16 $g/100m\ell$

Calculate P* (37°C), pH (37°C), $[HCO_3^-]$, BE and I of a person whose data are given above.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	PO	T ?		12			
2	40 EXE	P* ?		13			
3	53 EXE	PH ?		14			
4	7.32 EXE	H ?		15			
5	16 EXE	46.48104352	P*(37°C)	16			
6	EXE	7.3638	PH(37°C)	17			
7	EXE	25.59848393	$[HCO_3^-]$	18			
8	EXE	0.239448294	BE	19			
9	EXE	27.02545197	I	20			
10	EXE	T ?	Repeat from step 2	21			

Program for

Acidity of blood

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0		
2	LBL 1 INV "AL T INV ? INV AL" HLT Min 01		7
3	INV "AL P INV ✳ INV ? INV AL" HLT Min 02		14
4	INV "AL P H INV ? INV AL" HLT Min 03		21
5	INV "AL H INV ? INV AL" HLT Min 04		27
6	3 7 − MR 01 = Min 01 × • 0 1 9	P*(37°C) calculation	38
7	= INV 10^x × MR 02 = Min 02 HLT		45
8	MR 03 − • 0 1 4 6 × MR 01 = Min 03 HLT	PH(37°C) Calculation	57
9	− 6 • 1 1 = Min 05	PH−6.11	64
10	• 0 3 0 7 × MR 02 = Min 06	0.0307 P*	73
11	× MR 05 INV 10^x = HLT	$[HCO_3^-]$	78
12	− ((9 • 5 + 1 • 6 3 × MR 04))		91
13	× ((7 • 4 − MR 03)) − 2 4 =	BE Calculation	103
14	× ((1 − • 0 1 4 3 × MR 04)) = HLT		117
15	1 + MR 05 INV 10^x = × MR 06 = HLT	I Calculation	126
16	GoTo 1		127
17			
18		Total 128	
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	T → 37 − T
02	P*
03	PH
04	H
05	PH−6.11
06	0.0307 P*
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
Saturated and normal oxygen contents of blood	Medicine–5	FX-602P

Description

• Input the program written in the next page.

- Bodily temperature : T [°C]
- CO_2 partial pressure : P* [mmHg]
- pH

P* and pH at 37°C

$P^*(37^\circ) = P^*(T) \cdot 10^{0.019(37-T)}$

$pH(37^\circ) = pH(T) - 0.0146(37 - T)$

These can be calculated by the "acidity of blood" program.

- O_2 partial pressure : P [mmHg]
- Hemoglobin concentration : H [g/100mℓ]
- Effective P : VP [mmHg]

$$VP = P \cdot 10^{[0.024(37-T) + 0.48(pH - 7.4) + 0.06 \log \frac{40}{P^*}]}$$

(PH : PH(37°), P* : P*(37°))

Saturated oxygen content S [%]

$$S = \frac{(VP)^4 - 15(VP)^3 + 2045(VP)^2 + 2000(VP)}{(VP)^4 - 15(VP)^3 + 2400(VP)^2 - 31100(VP) + 2400000} \times 100$$

Oxygen content C [Vol%]

$$C = 1.34 \cdot \frac{S}{100} \cdot H + 0.0031 \cdot VP$$

Example

T = 40°C, P* (40°) = 51mmHg, pH (40°) = 7.31

P (40°) = 75mmHg, H = 16 g/100mℓ

Calculate S and C of a person whose data are given above.

Step	Data input operation	Read-out	Remark
/	MODE 1		
1	PO	INPUT T	
2	40 EXE	INPUT P*	
3	51 EXE	INPUT PH	
4	7.31 EXE	INPUT P	
5	75 EXE	INPUT H	
6	16 EXE	S=	
7		91.03490889	
8	EXE	C=	
9		19.70380885	
10	EXE	INPUT T	Repeat from step 2

Step	Data input operation	Read-out	Remark
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for

Saturated and normal oxygen contents of blood

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00	
1	P0			01	$T \rightarrow 37-T$
2	LBL 1 GSB P1 INV "AL INV ; T INV AL" HLT Min 01		8	02	P^*
3	GSB P1 INV "AL INV ; P INV ✳ INV AL" HLT Min 02		16	03	PH
4	GSB P1 INV "AL INV ; P H INV AL" HLT Min 03		24	04	P
5	GSB P1 INV "AL INV ; P INV AL" HLT Min 04		31	05	H
6	GSB P1 INV "AL INV ; H INV AL" HLT Min 05		38	06	VP
7	INV "AL S = INV AL" INV PAUSE		43	07	$(VP)^4-15(VP)^3$
8	3 7 − MR 01 = Min 01 × • 0 1 9 =	P* (37°) Calculation	55	08	$\frac{S}{100}$
9	INV 10^x × MR 02 = Min 02		60	09	
10	MR 03 − • 0 1 4 6 × MR 01 = Min 03	PH (37°) Calculation	71	F	
11	• 0 2 4 × MR 01 + • 4 8 ×		82	10	
12	((MR 03 − 7 • 4)) + ((4 0 ÷ MR 02	VP Calculation	95	11	
13	)) log × • 0 6 = INV 10^x × MR 04 = Min 06		107	12	
14	INV x^y 4 − 1 5 × MR 06 INV x^y 3 =		117	13	
15	Min 07 + 2 0 4 5 × MR 06 INV x^2 +		127	14	
16	2 EXP 3 × MR 06 = ÷ ((MR 07 + 2		138	15	
17	4 0 0 × MR 06 INV x^2 − 3 1 1 0 0	S Calculation	150	16	
18	× MR 06 + 2 4 EXP 5)) = Min 08 × 2		162	17	
19	INV 10^x = HLT		165	18	
20	INV "AL C = INV AL" INV PAUSE		170	19	
21	1 • 3 4 × MR 08 × MR 05 + • 0 0		182	1F	
22	3 1 × MR 06 = HLT	C Calculation	188	20	
23	GoTo 1		189	21	
24				22	
25				23	
26	P1 INV "AL I N P U T INV SPACE INV AL"		8	24	
27				25	
28		Total 199		26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

The value of S will be rather inaccurate for hemoglobin of babies aged less than six months and abnormal hemoglobin of adults and in some extra-ordinary blood conditions.

Pay attention to S and C if the dissociation curve of O_2 is improper.

This is not physiological P. Correct values of T and pH must be used but effect of P* to the result is small.

CASIO PROGRAM SHEET

Program for	Calculation for loan-repayment I (equally divided monthly repayment)	No.	Banking–1

Description

• Input the program written in the next page.

$$P = PV\frac{i}{1-(1+i)^{-n}} \rightarrow [P5]$$

$$PV = P\frac{1-(1+i)^{-n}}{i} \rightarrow [P6]$$

$$n = -\frac{l_n(1-\frac{i\cdot PV}{P})}{l_n(1+i)} \rightarrow [P7]$$

P : Amount of monthly repayment · · [P0]

PV: Amount of loan · · · · · · · · · · · · [P1]

i : Monthly interest (input data is annual interest) · · · · · · · · · · · · [P3]

n : Number of times of repayment · · [P2]

The amount of repayment will be calculated in units of 1,000 Yen by counting 500 Yen or more as 1,000 Yen and disregarding the rest.

Example 1: We borrow 3 million Yen at an annual interest of 7.65% for 10 years. What is the amount of monthly repayment ?

Example 2: What is the amount of monthly repayment under the same loan conditions as Example 1 but that the annual interest is 5.05% ?

Example 3: With a monthly repayment of ¥45,000, annual interest of 7.5%, and term of loan of 15 years, how much money can be borrowed?

Example 4: For a loan of ¥6,000,000 at annual interest of 5.5% and monthly payments of ¥84,000, how many months (years) will it take to repay the loan in full?

Example 5: As a check on the calculations for Example 4, will it be possible to repay the ¥6,000,000 in 87 months?

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	Example 1		
2	(PV) 300 [P1]	3000000	
3	(i) 7.65 [P3]	i=0.6375	Monthly interest
4	(n) 10 [P2]	n=120	No. of repayment
5	[INV] [P5]	P=36000	(P)
6	Example 2		
7	(i) 5.05 [P3]	i=0.4208333	Monthly interest
8	[INV] [P5]	P=32000	(P)
9	Example 3		
10	(P) 45000 [P0]	P=45000	
11	(n) 15 [P2]	n=180	No. of repayment
12	(i) 7.5 [P3]	i=0.625	Monthly interest
13	[INV] [P6]	PV=4854304	(PV)
14	Example 4		
15	(PV) 600 [P1]	6000000	
16	(i) 5.5 [P3]	i=0.4583333	Monthly interest
17	(P) 84000 [P0]	P=84000	
18	[INV] [P7]	M=87	Months
19	[EXE]	Y=7.25	Years
20	Example 5 (Subsequently) [INV] [P6]	PV=6015557	(PV)
21			

Program for **Calculation for loan-repayment I (equally divided monthly repayment)**

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P1 EXP, 4, Min 01,		3
2			
3	P2 ×, 1, 2, =, Min 02, INV "AL, INV n, =, INV #, INV AL",		10
4			
5	P3 ÷, 1, 2, 0, 0, ×, Min 03, 2, INV 10^x, =, INV "AL,		11
6	INV i, =, INV #, INV AL",		15
7			
8	P0 Min 00, INV "AL, P, =, INV #, INV AL",		6
9			
10	INV P5 GSB P4, ×, MR 01, =, Min 00, ÷, 3, INV 10^x, +, •, 5,		11
11	=, INV INT, ×, 3, INV 10^x, =, INV "AL, P, =, INV #,		21
12	INV AL",		22
13			
14	INV P6 GSB P4, INV $1/x$, ×, MR 00, GSB INV P9, Min 01, INV "AL, P,		8
15	V, =, INV #, INV AL",		12
16			
17	INV P7 1, −, MR 03, ×, MR 01, ÷, MR 00, =, ln, ÷,		10
18	GSB INV P8, ln, +/−, GSB INV P9, Min 02, INV "AL, M, =,		18
19	INV #, INV AL", HLT, ÷, 1, 2, =, INV "AL, Y, =, INV #,		29
20	INV AL",		30
21			
22	P4 MR 03, ÷, ((, 1, −, GSB INV P8, INV x^y, MR 02, +/−, =,		10
23			
24			
25	INV P9 =, Min 05, +, •, 5, =, INV INT,		7
26			
27	INV P8 ((, 1, +, MR 03,)),		5
28			
29		Total 130	
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	P
01	PV
02	n
03	i
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

P0 = Amount of repayment
P1 = Amount of loan
P2 = Term of loan
P3 = Rate of interest

When pressed after INV, each answer can be determined.

MR 0 0 allows a check of amount of repayment before fractions are processed.

MR 0 1 allows a check of amount of loan before fractions are processed.

When using FX-601P, prepare the program omitting INV "AL, ~, INV AL".

*In this case, alphabet will not be displayed preceeding each input and output.

CASIO PROGRAM SHEET

Program for	Calculation for loan-repayment II (Interest on equally divided monthly repayment)	No.	Banking–2

Description

• Input the program written in the next page.

This program determines interest i from $PV = P\dfrac{1-(1+i)^{-n}}{i}$

(Method) Newton's approximate expressions are used.

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

$$f_{(ik)} = PV - \frac{P}{i}\left\{1-(1+i)^{-n}\right\}$$

$$f'_{(ik)} = PV - \frac{P}{i}\left\{n(1+i)^{-n-1} - \frac{1-(1+i)^{-n}}{i}\right\}$$

[Preliminary values] $i_{(0)} = \dfrac{P}{PV} - \dfrac{PV}{n^2P}$ Considered as convergence where $|i_{(k+1)} - i_k| \leqq 10^{-8}$

[P0] – Amount of monthly repayment (P)
[P1] – Amount of loan (PV)
[P2] – Number of months (n)
[P3] – Monthly interest (i%)

Example 1: ¥3,000,000 was borrowed, and returned over a period of 15 years with monthly repayments of ¥28,000. What was the interest rate (in %)?

Example 2: Recalculate Example 1 for a period of 200 months.

Example 3: ¥54,000,000 was borrowed, and returned over 150 months at monthly repayments of ¥490,000. What was the interest rate?

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	Example 1		
2	(PV) 300 [P1]	3000000	
3	(n) 15 [×] 12 [=] [P2]	$n=180$	
4	28000 [P0]	P=28000	
5	[INV] [P8]	i(M) =0.6342	
6		0.634252938	Monthly interest rate(%)
7	[EXE]	i(Y) =7.6110	
8		=7.61103526	Annual interest rate (%)
9	Example 2		
10	(n) 200 [P2]	$n=200$	
11	[INV] [P8]	i(M) =0.7037	
12		0.703781306	Monthly interest rate(%)
13	[EXE]	i(Y) =8.4453	
14		8.445375683	Annual interest rate (%)
15	Example 3 (PV) 5400 [P1]	54000000	
16	(P) 490000 [P0]	P=490000	
17	(n) 150 [P2]	$n=150$	
18	[INV] [P8]	i(M) =0.4323	
19		=0.43230279	Monthly interest rate(%)
20	[EXE]	i(Y) =5.1876	
21		5.187633487	Annual interest rate (%)

Program for **Calculation for loan-repayment II (Interest on equally divided monthly repayment)**

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P1 EXP, 4, Min 01,		3
2			
3	P0 Min 00, INV "AL, P, =, INV #, INV AL",		6
4			
5	P2 Min 02, INV "AL, INV n, =, INV #, INV AL",		6
6			
7	INV P8 8, +/-, INV 10^x, Min F,		4
8	MR 00, ÷, MR 01, −, MR 01, ÷, MR 02, INV x^2, ÷,		13
9	MR 00, =, Min 04,		16
10	LBL 1, MR 04, Min 05, −, ((, MR 01, −, ((, MR 00, ÷, MR 05,		27
11	)), Min 06, ×, ((, 1, −, ((, ((, 1, +, MR 05,)),		39
12	Min 07, INV x^y, MR 02, +/-,)), Min 08,)), Min 09,)), ÷,		49
13	((, MR 01, −, MR 06, ×, ((, MR 02, ×, MR 08, ÷,		59
14	MR 07, −, MR 09, ÷, MR 05,)),)), =, Min 04, −,		69
15	MR 05, =, INV ABS, INV $x \geq t$, GoTo 1,		74
16	MR 04, Min 03, ×, 2, INV 10^x, =, INV "AL, INV i, INV (		83
17	M, INV), =, INV #, INV AL", HLT, ×, 1, 2, =, INV "AL,		94
18	INV i, INV (, Y, INV), =, INV #, INV AL",		101
19			
20		Total 120	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	P
01	PV
02	n
03	i
04	$i_{(k+1)}$
05	i_k
06	P/i
07	$1+i_k$
08	$(1+i_k)^{-n}$
09	$1-(1+i^k)^{-n}$
F	1×10^{-8}
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
Calculation for loan-repayment III (equally divided monthly repayment plus extra at bonus times twice a year).	Banking–3	

Description

• Input the program written in the next page.

$$P = \frac{i(1+i)^{n-1}}{(1+i)^{n}-1}\left\{ PV\left(1+\frac{d}{30}i\right) - \frac{Q}{(1+i)^{e+n-6}} \cdot \frac{(1+i)^{n}-1}{(1+i)^{6}-1} \right\}$$

PV : Amount of loan ····· P1
i : Monthly interest ····· P3
n : Number of times of monthly repayment ····· P2
Q : Extra repayment at bonus time ····· P0
e : Number of months from the first repayment month to the bonus month ····· P4
d : Number of days from the day of loan to the first repayment day ····· P6

The amount of repayment, P, will be rounded up to units of 100 yen.

Example 1

Amount of loan : 8 million yen
Annual interest : 6.7%
Number of years of repayment : 10 years
Extra repayment at bonus time : 200,000 Yen
e : 3 months
d : 15 days

Example 2

What is the amount of monthly repayment under the same loan conditions as Example 1 but that the amount of bonus-time extra repayment is 500,000 Yen ?

Step	Data input operation	Read-out	Remark
	MODE 1		
1	(PV) 800 P1	8000000	
2	(Annual interest) 6.7 P3	i=0.5583333	Monthly interest
3	(Years) 10 P2	n=120	No. of repayment
4	(Q) 20 P0	200000	
5	(e) 3 P4	e= 3	
6	(d) 15 INV P6	d=15	
7	INV P5	P=58200	Amount of repayment
8			
9			
10			

Step	Data input operation	Read-out	Remark
11	(Q) 50 P0	500000	
12	INV P5	P=8400	Amount of repayment
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for
Calculation for loan-repayment III (equally divided monthly repayment plus extra at bonus times twice a year).

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 EXP, 4, Min 00,		3
2			
3	P1 EXP, 4, Min 01,		3
4			
5	P2 ×, 1, 2, =, Min 02, INV "AL, INV n, =, INV ♯, INV AL",		10
6			
7	P3 ÷, 1, 2, 0, 0, ×, Min 03, 2, INV 10^x, =,		11
8	INV RND FIX 7, INV "AL, INV i, =, INV ♯, INV AL",		17
9			
10	P4 Min 04, INV "AL, INV e, =, INV ♯, INV AL",		6
11			
12	INV P6 Min 05, INV "AL, INV d, =, INV ♯, INV AL",		6
13			
14	INV P5 1, +, MR 03, =, Min 07, MR 04, +, MR 02, −, 6, =,		11
15	Min 08, MR 03, ×, MR 07, INV x^y, ((, MR 02, −, 1,)),		21
16	÷, ((, MR 07, INV x^y, MR 02, −, 1,)), Min 09, ×, ((		32
17	MR 01, ×, ((, 1, +, MR 05, ×, MR 03, ÷, 3, 0,)),		44
18	−, MR 00, ×, MR 09, ÷, MR 07, INV x^y, MR 08, ÷, ((		54
19	MR 07, INV 10^x, 6, −, 1,)),)), ÷, 2, INV x^y, =,		65
20	Min 06, INV FRAC, INV x=0, GoTo 1, 1, M+06,		71
21	LBL 1, MR 06, INV INT, ×, 2, INV 10^x, =, INV "AL, P, =, INV ♯,		82
22	INV AL",		83
23			
24		Total 135	
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	Q
01	PV
02	n
03	i
04	e
05	d
06	For round-up
07	$1+i$
08	$e+n-6$
09	$(1+i)^n-1$
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

P0 = Amount of repayment
P1 = Amount of loan
P2 = Term of loan
P3 = Rate of interest
} When pressed after INV, each answer can be determined.

MR 0 0 allows a check of amount of repayment before fractions are processed.

MR 0 1 allows a check of amount of loan before fractions are processed.

When using FX-601P, prepare the program omitting INV "AL, ~, INV AL".
*In this case, alphabet will not be displayed preceeding each input and output.

CASIO PROGRAM SHEET

Program for	No.	
Calculation for installment plan	Banking–4	

Description

• Input the program written in the next page.

$$P = (PT - R) \times \frac{i}{1 - \frac{1}{(1+i)^n}}$$

The installment will be rounded up to units of 100 yen.

P : Installment
PT : List price
R : Down payment
n : Number of times for paying installment
i : Monthly interest (%)

Example 1

We buy a good priced at 478,000 yen by such an installment plan that installment will be paid at a monthly interest of 1.02% for 24 months adding to the down payment of 178,000 yen.
What is the amount of monthly installment ?

Example 2

We buy a good priced at 350,000 yen according to the same installment conditions as Example 1 but that the down payment is 100,000 yen.
What is the amount of monthly installment ?

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	Example 1 478000 P1	PT=478000		12			
2	178000 P2	R=178000		13			
3	24 P3	n=24		14			
4	1.02 P4	i(M)=0.0102		15			
5	P0	P=14200	Amount of repayment	16			
6	Example 2 350000 P1	PT=350000		17			
7	100000 P2	R=100000		18			
8	P0	P=11800	Amount of repayment	19			
9				20			
10				21			

Program for

Calculation for installment plan

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P1 Min 01 ▸ INV "AL ▸ P ▸ T ▸ = ▸ INV # ▸ INV AL" ▸		7
2			
3	P2 Min 02 ▸ INV "AL ▸ R ▸ = ▸ INV # ▸ INV AL" ▸		6
4			
5	P3 Min 03 ▸ INV "AL ▸ INV n ▸ = ▸ INV # ▸ INV AL" ▸		6
6			
7	P4 ÷ ▸ 2 ▸ INV 10^x ▸ Min F ▸ = ▸ Min 04 ▸ INV "AL ▸ INV i ▸ INV (▸		9
8	M ▸ INV) ▸ = ▸ INV # ▸ INV AL" ▸		14
9			
10	P0 ((▸ MR 01 ▸ − ▸ MR 02 ▸)) ▸ × ▸ MR 04 ▸ ÷ ▸ ((▸ 1 ▸ − ▸ ((▸		12
11	((▸ 1 ▸ + ▸ MR 04 ▸)) ▸ INV x^y ▸ MR 03 ▸)) ▸ INV $1/x$ ▸)) ▸ ÷ ▸		23
12	MR F ▸ = ▸ Min 06 ▸ INV INT ▸ Min 05 ▸ MR 06 ▸ INV FRAC ▸ INV $x=0$ ▸		31
13	GoTo 1 ▸ 1 ▸ M+ 05 ▸		34
14	LBL 1 ▸ MR 05 ▸ × ▸ MR F ▸ = ▸ INV "AL ▸ P ▸ = ▸ INV # ▸ INV AL" ▸		44
15			
16		Total 82	
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	PT
02	R
03	n
04	i
05	P
06	For round-up
07	
08	
09	
F	100 (constant)
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

To use annual interest instead of monthly one, change subroutine P4 as follows.

÷, 2, INV10^x, Min F, ÷, 1, 2, =, Min 04,

At the end of processing, all numerical values less than 10-yen units are rounded up. For 10-yen units to be rounded up only for a numerical value other than 0, make the 12th line and following MR F, +, ·, 9, =, INV INT, X, MR F, =, Min 05,

CASIO PROGRAM SHEET

Program for	No.	
Calculation of compound annual interest	Banking–5	

Description

• Input the program written in the next page.

1. Calculation of present value of compound interest annuity

   A. End-of-term payment → P3 (formula) $P = R\dfrac{1-\frac{1}{(1+i)^n}}{i}$

   B. Beginning-of-term payment → P4 (formula) $P = R(1+i)\dfrac{1-\frac{1}{(1+i)^n}}{i}$

2. Calculation of full-term value of compound interest annuity

   A. End-of-term payment → P5 (formula) $S = R\dfrac{(1+i)^n-1}{i}$

   B. Beginning-of-term payment → P6 (formula) $S = R(1+i)\dfrac{(1+i)^n-1}{i}$

3. Calculation of accumulated funds → P5 (formula) $FV = PMT\dfrac{(1+i)^n-1}{i}$

P: Present value of annuity
R: Amount of annuity P0
n: Period P2
PMT: Amount accumulated P0
S: Full-term value of annuity
i: Interest P1
FV: Full-term value of compound interest

The answer is rounded off (under 0.5 cut off, 0.5 and above rounded up) to the nearest yen.

Example:

In order to provide a yearly annuity of ¥350,000 for the next 10 years, how much present value is required? Assume yearly interest of 5.5%, and determine the amounts required for end-of-term and first-of-term payments respectively.
How much present value is required to provide the same annuity for 20 years?
How much to provide an annuity of ¥1,000,000 for 20 years?

Step	Data input operation		Read-out	Remark
		MODE 1		
1	(R)	350000 P0	R=350000	
2	(*i*)	5.5 P1	*i*=0.055	
3	(*n*)	10 P2	*n*=10	
4		P3	P=2638169	End-of-term payment
5		P4	P=2783268	Beginning-of-term payment
6	(*n*)	20 P2	*n*=20	
7		P3	P=4182634	End-of-term payment
8		P4	P=4412679	Beginning-of-term payment
9	(R)	1000000 P0	R=1000000	
10		P3	P=11950382	End-of-term payment
11		P4	P=12607654	Beginning-of-term payment
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

Program for

Calculation of compound annual interest

	Program	Remark	Step
	MODE 3 INV MAC MODE • 2 0 MODE 2		
1	P0 Min 00 ▸ INV "AL ▸ R ▸ = ▸ INV # ▸ INV AL" ▸		6
2			
3	P1 ÷ ▸ 2 ▸ INV 10^x ▸ = ▸ Min 01 ▸ GSB INV P9 ▸ MR 01 ▸ INV AL" ▸		8
4	INV i ▸ = ▸ INV # ▸ INV AL" ▸		12
5			
6	P2 Min 02 ▸ GSB INV P9 ▸ MR 02 ▸ INV "AL ▸ INV n ▸ = ▸ INV # ▸		7
7	INV AL" ▸		8
8			
9	INV P9 ((▸ 1 ▸ + ▸ MR 01 ▸)) ▸ Min 03 ▸ INV x^y ▸ MR 02 ▸ = ▸ Min 04 ▸		10
10	((▸ 1 ▸ − ▸ MR 04 ▸ INV $1/x$ ▸)) ▸ ÷ ▸ MR 01 ▸ = ▸ Min 05 ▸		20
11	((▸ MR 04 ▸ − ▸ 1 ▸)) ▸ ÷ ▸ MR 01 ▸ = ▸ Min 06 ▸		29
12			
13	P3 MR 00 ▸ × ▸ MR 05 ▸ GSB INV P8 ▸ INV "AL ▸ P ▸ = ▸ INV # ▸		8
14	INV AL" ▸		9
15			
16	P4 MR 00 ▸ × ▸ MR 03 ▸ × ▸ MR 05 ▸ GSB INV P8 ▸ INV "AL ▸ P ▸ = ▸		9
17	INV # ▸ INV AL" ▸		11
18			
19	INV P5 MR 00 ▸ × ▸ MR 06 ▸ GSB INV P8 ▸ INV "AL ▸ S ▸ = ▸ INV # ▸		8
20	INV AL" ▸		9
21			
22	INV P6 MR 00 ▸ × ▸ MR 03 ▸ × ▸ MR 06 ▸ GSB INV P8 ▸ INV "AL ▸ S ▸ = ▸		9
23	INV # ▸ INV AL" ▸		11
24			
25	INV P8 + ▸ • ▸ 5 ▸ = ▸ INV INT ▸		5
26			
27		Total 109	
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	R(PMT)
01	i
02	n
03	$1+i$
04	$(1+i)^n$
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

Interest is given as annual interest, in % units.

CASIO PROGRAM SHEET

Program for	Calculation for discounting commercial bills (by annual interest basis.)	No.	Banking–6	

Description

• Input the program written in the next page.

$$a_1 \times \frac{b_1}{100} \times c_1 \div 365 = d_1$$

$$\vdots$$

$$a_n \times \frac{b_n}{100} \times c_n \div 365 = d_n$$

Σa_n Σd_n

$\Sigma a_n - \Sigma d_n - e = f$

The discount charge and commission will be rounded off to units of yen.

a : Value of bill

b : Annual interest (%)

c : Number of days

d : Discount charge

e : Commission

Σa_n: Total value of bills

Σd_n: Total interest

f : Net money receivable

Example

	a (Yen)	b (%)	c (Days)	d (Yen)
1	1,258,250	8.00	56	15,443
2	3,697,120	8.75	115	101,924
3	876,321	7.50	83	14,945
Σan	5,831,691		Σdn	132,312
			e	750
			f	5,698,629

Step	Data input operation	Remark	Remark
	MODE 1		
1	PO	$a\,1$	
2	(a_1) 1258250 EXE	$b\,1$	
3	(b_1) 8 EXE	$c\,1$	
4	(c_1) 56 EXE	$d\,1 = 15443$	
5	(a_2) 3697120 EXE	$b\,2$	
6	(b_2) 8.75 EXE	$c\,2$	
7	(c_2) 115 EXE	$d\,2 = 101924$	
8	(a_3) 876321 EXE	$b\,3$	
9	(b_3) 7.5 EXE	$c\,3$	
10	(c_3) 83 EXE	$d\,3 = 14945$	

Step	Data input operation	Read-out	Remark
11	P1	$\Sigma a3 = 5831691$	
12	EXE	$\Sigma d3 = 132312$	
13	(e) 750 EXE	$f = 5698629$	
14			
15			
16			
17			
18			
19			
20			
21			

Program for **Calculation for discounting commercial bills (by annual interest basis.)**

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 INV MAC,		1
2	INV ISZ, INV "AL, INV a, 1, INV AL",		6
3	LBL 1, HLT, Min 01, M+ 02, INV "AL, INV b, INV AR 00, INV AL", HLT,		15
4	Min 03, INV "AL, INV c, INV AR 00, INV AL", HLT, × , MR 01,		23
5	× , MR 03, ÷ , 3, 6, 5, 0, 0, = , INV INT, M+ 04,		34
6	INV "AL, INV d, INV AR 00, = , INV #, INV AL", INV ISZ,		41
7	GoTo 1,		42
8			
9	P1 INV DSZ, MR 02, INV "AL INV Σ, INV a, INV AR 00, =,		7
10	INV #, INV "AL, HLT, − , MR 04, INV "AL, INV Σ, INV d,		15
11	INV AR 00, = , INV #, INV AL", HLT, − , MR 04, = , INV "AL,		24
12	INV f, = , INV #, INV AL",		28
13			
14		Total 72	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	a
02	Σan
03	b
04	Σdn
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	Calculating for depreciation	No.	Banking–7

Description

• Input the program written in the next page.

P; Purchase cost

r; Residual value (%)

R; Rate of depreciation

n; Service life

m; Settlement of accounts in times per year

Q; Amount of depreciation

① Fixed instalment method → P1

$R = \frac{1}{n}$ (Round off at the fourth decimal place)

When m = 2, R = ½n. Round up the fourth decimal digit.

$Q = P(1 - \frac{r}{100}) \times R$

② Fixed percentage method → P2

$R = 1 - r^{\frac{1}{nm}}$

$Q = P \times R$

Book value S = P – Q

Total depreciation T

Ex. 1. Calculate Q by the fixed instalment method when P = 1,000,000 Yen, r = 10%, n = 6, and m = 1.

Ex. 2. Tabulate depreciation value by the fixed percentage method when P = 1,000,000 Yen, r = 10%, n = 3, and m = 2.

Settlement of accounts	Depreciation value Q	Book value S
1st	319000	681000
2nd	217239	463761
3rd	147939	315822
4th	100747	215075
5th	68608	146467
6th	46722	99745
Total	900255	

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1 P1	P	
2	1000000 EXE	r	
3	10 EXE	n	
4	6 EXE	m	
5	1 EXE	Q=149400	
6	Example 2 P2	P	
7	1000000 EXE	r	
8	10 EXE	n	
9	3 EXE	m	
10	2 EXE	Q1=319000	
11	EXE	S1=681000	
12	EXE	Q2=217239	
13		⋮	
14	EXE	S6=99745	
15	EXE	T=900255	
16			
17			
18			
19			
20			
21			

Program for

Calculating for depreciation

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P1 GSB P3		1	01
2	Min F MR 03 INV $\frac{1}{x}$ × 3 INV 10^x GSB P0		8	02
3	1 INV $x=$ GoTo 1		11	03
4	MR 05 ÷ 2 × 3 INV 10^x + • 5 GSB P0		21	04
5	LBL 1 MR 01 × ((1 − MR 02)) × MR 05 =		32	05
6	INV "AL Q = INV # INV AL"		37	06
7				07
8	P2 GSB P3 × MR 03 = Min 00		5	08
9	1 − MR 02 INV $x\sqrt{}$ MR 00 = INV RND 3 Min 05		13	09
10	LBL 1 1 M+ 06 MR 01 × MR 05 = INV INT Min 07 M+ 08		23	F
11	INV "AL Q INV AR 06 = INV # INV AL" HLT		30	10
12	MR 01 − MR 07 = Min 01 INV "AL S INV AR 06 =		39	11
13	INV # INV AL" HLT INV DSZ GoTo 1		44	12
14	MR 08 INV "AL T = INV # INV AL"		50	13
15				14
16	P0 = INV INT ÷ 3 INV 10^x = Min 05		7	15
17				16
18	P3 INV MAC		1	17
19	INV "AL P INV AL" HLT Min 01 INV "AL INV r INV AL" HLT		10	18
20	÷ 2 INV 10^x = Min 02 INV "AL INV n INV AL" HLT		19	19
21	Min 03 INV "AL INV m INV AL" HLT Min 04		25	1F
22				20
23		Total 123		21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	Calculation of aggregate classification and prorating	No.	Banking–8

Description

• Input the program written in the next page.

Item	Amount	%
1		
2		
3		
:		
:		
N		
Total		

Perform aggregate classification after inputting data of all bills, and determine amount and percentage of each amount.
The percentage will be obtained to the second decimal place by rounding off the third decimal.

Example

Code	Amount
3	2,870
2	1,960
5	3,850
7	2,690
9	1,890
5	1,250
8	3,300
7	1,960
1	2,500
2	2,310
6	3,190
5	4,370
3	5,360
1	2,220
8	3,880
2	1,450
4	6,120
9	3,600
9	2,000
1	3,100
3	1,850

➡

Code	Amount	%
1	7,820	12.67
2	5,720	9.27
3	10,080	16.33
4	6,120	9.92
5	9,470	15.34
6	3,190	5.17
7	4,650	7.53
8	7,180	11.63
9	7,490	12.14
Total	61,720	100

At data input → [P0]
At aggregate data output → [P1]

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	[P0]	No. ?	Repeat these steps
2	3 [EXE]	No.3→DATA ?	
3	2870 [EXE]	No. ?	
4	2 [EXE]	No.2→DATA ?	
5	1960 [EXE]	No. ?	
6	⋮	⋮	
7	After all data input [P1]	T=61720	(Total)
8	[EXE]	No.1=7820	Total for Code 1
9	[EXE]	P=12.67	% for Code 1
10	[EXE]	No.2=5720	Total for Code 2
11	[EXE]	P=9.27	% for Code 2
12		⋮	
13	[EXE]	P=12.14	% for Code 9
14	[EXE]	TP=100	(Total %)
15			
16			
17			
18			
19			
20			
21			

Program for: Calculation of aggregate classification and prorating

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 7 0 MODE 2			00
1	P0 INV MAC		1	01
2	LBL 1 INV "AL N INV o • INV ? INV AL" HLT Min 00 INV $x \geq f$		11	02
3	Min F INV "AL N INV o • INV AR 00 INV → D A		20	03
4	T A INV ? INV AL" HLT INV IND M+ 00 GoTo 1		28	04
5				05
6	P1 MR F Min 00 AC		3	06
7	LBL 1 + INV IND MR 00 INV DSZ		8	07
8	GoTo 1 = INV "AL T = INV # INV AL" HLT INV ISZ		17	08
9	÷ 4 INV 10^x = X-M 01 GSB P4 INV ISZ		24	09
10	X-M 02 GSB P4 M+ 02 2 Min 00 INV $x=f$ GoTo 3		31	F
11	LBL 2 INV ISZ INV IND MR 00 GSB P4 M+ 02		37	10
12	MR 00 INV $x=f$ GoTo 3 GoTo 2		41	11
13	LBL 3 MR 02 INV "AL T P = INV # INV AL"		49	12
14				13
15	P4 INV "AL N INV o • INV AR 00 = INV # INV AL" HLT		9	14
16	÷ MR 01 + • 5 = INV INT ÷ 2 INV 10^x =		20	15
17	INV "AL P = INV # INV AL" HLT		26	16
18				17
19		Total 106		18
20				19
21				1F
22				20
23				21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

Max. 9 classifications for FX-601P
Max. 69 classifications for FX-602P
Note: When using FX-602P with max. 69 classifications, operate MODE • 7 0 before inputting data.

CASIO PROGRAM SHEET

Program for	No.	
Horizontal/vertical aggregate calculations	Banking–9	FX-602P

Description

• Input the program written in the next page.

	x_1	x_2	x_3	x_4	···	···	···	x_n	Total
y_1									
y_2									
y_3									
⋮									
⋮									
⋮									
y_m									
Total									

y_m terms are arbitrary.

x_n terms are 73 terms or less.

Example

	x_1	x_2	x_3	x_4	x_5	Total
y_1	23	26	2	50	32	133
y_2	19	46	11	19	10	105
y_3	79	54	22	30	86	271
y_4	35	11	15	12	5	78
y_5	19	11	39	20	21	110
y_6	77	71	58	92	26	324
y_7	23	50	36	47	41	197
y_8	2	39	24	9	16	90
y_9	17	38	50	37	53	195
Total	294	346	257	316	290	1503

Step	Data input operation	Read-out	Remark
	MODE 1		
1	(n) 5 PO	$y1-x1$?	Input (y_1, x_1)
2	23 EXE	$y1-x2$?	Input (y_1, x_2)
3	26 EXE	$y1-x3$?	
4	2 EXE	$y1-x4$?	
5	50 EXE	$y1-x5$?	
6	32 EXE	$y1=133$	Horizontal total value of y_1
7	EXE	$y2-x1$?	
8	19 EXE	$y2-x2$?	
9	⋮	⋮	
10	Repeat these steps.		

Step	Data input operation	Read-out	Remark
11	After inputting all the data P1	$x1=294$	Vertical total of x_1
12	EXE	$x2=346$	Vertical total of x_2
13	EXE	$x3=257$	
14	EXE	$x4=316$	
15	EXE	$x5=290$	
16	EXE	$\Sigma x=1503$	Total
17			
18			
19			
20			
21			

Program for

Horizontal/vertical aggregate calculations

	Program	Remark	Step
	MODE 3 INV MAC MODE • 74 MODE 2		
1	P0 INV MAC ; Min F ; GoTo 2 ;		3
2	LBL 1 ; INV "AL ; INV y ; INV AR 1F ; − ; INV x ; INV AR 2F ; INV ? ;		12
3	INV AL" ; HLT ; INV IND ; M+ 00 ; M+ 3F ; 1 ; M+ 2F ;		21
4	INV DSZ ; GoTo 1 ;		23
5	INV "AL ; INV y ; INV AR 1F ; = ; INV AR 3F ; INV AL" ; HLT ;		31
6	LBL 2 ; 1 ; M+ 1F ; Min 2F ; 0 ; Min 3F ; MR F ; Min 00 ; GoTo 1 ;		42
7			
8	P1 MR F ; Min 00 ; 0 ; Min 1F ; Min 2F ;		6
9	LBL 1 ; 1 ; M+ 1F ; INV IND ; MR 00 ; M+ 2F ;		13
10	INV "AL ; INV x ; INV AR 1F ; = ; INV # ; INV AL" ; HLT ;		20
11	INV DSZ ; GoTo 1 ;		22
12	MR 2F ; INV "AL ; INV Σ ; INV x ; = ; INV # ; INV AL" ;		30
13			
14		Total 74	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

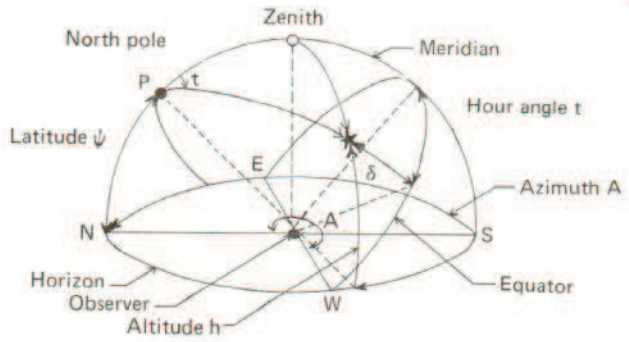
Before executing this program, be sure to expand the memory by operating MODE • 7 4 .

CASIO PROGRAM SHEET

Program for	No.	
Astronomical observation	Navigation–1	

Description

• Input the program written in the next page.



We use the first equatorial system.

- Latitude of observer ψ; $+90^\circ \sim -90^\circ$ (Identify south latitude by a minus sign.)
- Declination δ; $+90^\circ \sim -90^\circ$ (Identify south of the equator by a minus sign.)
- Hour angle t; Measure hour angle from the intersection of the equator and meridian in the direction of the diurnal motion of the celestial sphere.
- Altitude h; Angle between the horizon and a star. Identify the lower half of the celestial sphere by a minus sign.
- Azimuth A; Measure from north toward east along the horizon.

ψ, δ, t – A decimal number (degree, minute, second)

↓

h, A

$$h = \sin^{-1}[\sin\psi\sin\delta + \cos\psi\cos\delta\cos t]$$

$$a = \cos^{-1}\left[\frac{\sin\delta - \sin\psi\sin h}{\cos\psi\cos h}\right]$$

$$A = \begin{cases} 360 - a & ; \sin t \geqq 0 \\ a & ; \sin t < 0 \end{cases}$$

Example 1

Calculate h and A of the star whose declination is 12°14'54" and hour angle 25°39'21" at 41°21'34" N Lat.

Example 2

Calcualte δ and t of a star whose altitude is 61° and azimuth 246° at 41°21'34" N Lat.

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1 PO	P ?	
2	(ψ) 41.2134 EXE	D/h ?	
3	(δ) 12.1454 EXE	t/A ?	
4	(t) 25.3921 EXE	h/D=53°15' 3	
5		53°15'37.8"	(h)
6	EXE	A/t=225°1'5	
7		225°1'5.07"	(A)
8			
9			
10			

Step	Data input operation	Read-out	Remark
11	Example 2 PO	P ?	
12	(ψ) 41.2134 EXE	D/h ?	
13	(h) 61 EXE	t/A ?	
14	(A) 246 EXE	h/D=25°27'4	
15		25°27'46.1"	(δ)
16	EXE	A/t=29°22'3	
17		t=29°22'35"	(t)
18			
19			
20			
21			

Program for

Astronomical observation

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00	
1	P0 MODE 4,		1	01	ψ
2	INV "AL, P, INV ?, INV AL", HLT,		6	02	δ
3	GSB INV P9, Min 01,		8	03	t
4	INV "AL, D, INV /, INV h, INV ?, INV AL", HLT, GSB INV P9, Min 02,		17	04	h
5	INV "AL, INV t, INV /, A, INV ?, INV AL", HLT, GSB INV P9, Min 03,		26	05	a
6	MR 01, sin, ×, MR 02, sin, +, MR 01, cos, ×, MR 02, cos,		37	06	
7	×, MR 03, cos, =, INV $\sin^{-1}$, Min 04, INV $\rightleftharpoons$,		44	07	
8	INV "AL, INV h, INV /, D, =, INV #, INV AL", HLT,		52	08	
9	((, MR 02, sin, −, MR 01, sin, ×, MR 04, sin,)), ÷,		63	09	For subroutine
10	MR 01, cos, ÷, MR04, cos, =, INV $\cos^{-1}$, Min 05,		71	F	
11	MR 03, sin, INV $x \geq 0$, GoTo 3, MR 05, GoTo 4,		77	10	
12	LBL 3, 3, 6, 0, −, MR 05, =,		84	11	
13	LBL 4, INV $\rightleftharpoons$, INV "AL, A, INV/, INV t, =, INV #, INV AL",		93	12	
14				13	
15	INV P9 Min 09, INV INT, +, ((, MR 09, INV FRAC, ×, 2, INV 10^x,)),		10	14	
16	Min 09, INV INT, ÷, 6, 0, +, MR 09, INV FRAC, ÷, 3, 6,		21	15	
17	=,		22	16	
18				17	
19		Total 117		18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

φ (Psi) is displayed as P.
δ (Delta) is displayed as D.
For (φ,h,A) → (δ,t), (δ,t) is determined by inputting h to δ and A to t.

Use the decimal-like representation for the input format of angle, i.e. 12.3456 for 12°34'56".

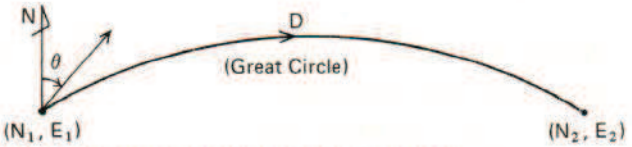
CASIO PROGRAM SHEET

Program for	No.	
Great circle navigation	Navigation–2	

Description

• Input the program written in the next page.

When the terrestrial latitudes and longitudes of two points are given, this program allows to calculate the shortest distance between the two points and the azimuth (from north toward east) at the start point.



D: Distance between two points (in nautical miles)
1 nautical mile = 1.852 km

θ_i: Azimuth at the start point (The azimuth will change with sailing.)

$$D = 60\cos^{-1}\{\sin N_1 \sin N_2 + \cos N_1 \cos N_2 \cos(E_2 - E_1)\}$$

$$\theta_i = \cos^{-1}\left\{\frac{\sin N_2 - \sin N_1 \cos\left(\frac{D}{60}\right)}{\sin\left(\frac{D}{60}\right)\cos N_1}\right\}$$

$$\theta = \begin{cases} \theta_i & ; \sin(E_2 - E_1) \geqq 0 \\ 360 - \theta_i & ; \sin(E_2 - E_1) < 0 \end{cases}$$

* North latitude and east longitude should be expressed by positive numbers, and south latitude and west longitude by negative numbers. However, Lat. 90°N (north pole) and Lat. 90°S (south pole) can not be input.

Example

(Lat. 33°53'30"S, Long. 18°23'10"E) ⟶ (Lat. 40°27'10"N, Long. 73°49'40"W)

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	P0	N1 ?		12			
2	33.533 +/- EXE	E1 ?		13			
3	18.231 EXE	N2 ?		14			
4	40.271 EXE	E2 ?		15			
5	73.494 +/- EXE	D=6763.0925		16			
6		6763.092552	(D)	17			
7	EXE	T=304°28'46		18			
8		=304°28'46"	(θ)	19			
9				20			
10				21			

Program for

Great circle navigation

	Program	Remark	Step		Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00	
1	P0 MODE 4,		1	01	N_1
2	INV "AL, N, 1, INV ?, INV AL", HLT, GSB INV P9, Min 01,		9	02	E_1
3	INV "AL, E, 1, INV ?, INV AL", HLT, GSB INV P9, Min 02,		17	03	N_2
4	INV "AL, N, 2, INV ?, INV AL", HLT, GSB INV P9, Min 03,		25	04	E_2
5	INV "AL, E, 2, INV ?, INV AL", HLT, GSB INV P9, Min 04,		33	05	E_2-E_1
6	−, MR 02, =, Min 05,		37	06	$D/60$
7	MR 01, sin, ×, MR 03, sin, +, MR 01, cos, ×, MR 03, cos,		48	07	D
8	×, MR 05, cos, =, INV $\cos^{-1}$, Min 06, ×, 6, 0, =, Min 07,		59	08	θ_i
9	INV "AL, D, =, INV #, INV AL", HLT,		65	09	For subroutine
10	((, MR 03, sin, −, MR 01, sin, ×, MR 06, cos,)), ÷,		76	F	
11	MR 06, sin, ÷, MR 01, cos, =, INV $\cos^{-1}$, Min 08,		84	10	
12	MR 05, sin, INV $x \geq 0$, GoTo 1, 3, 6, 0, −,		92	11	
13	LBL 1, MR 08, =, INV $\overline{...}$, INV "AL, T, =, INV #, INV AL",		101	12	
14				13	
15	INV P9 Min 09, INV INT, +, ((, MR 09, INV FRAC, ×, 2, INV 10^x,)),		10	14	
16	Min 09, INV INT, ÷, 6, 0, +, MR 09, INV FRAC, ÷, 3, 6,		21	15	
17	=,		22	16	
18		Total 125		17	
19				18	
20				19	
21				1F	
22				20	
23				21	
24				22	
25				23	
26				24	
27				25	
28				26	
29				27	
30				28	
31				29	
32				2F	
33					
34					
35					
36					
37					

Note

θ (Theta) is displayed as T.

- Accuracy deteriorates for D which is smaller than 1 nautical mile.
- Use the decimal-like representation for the input format of angle, i.e. 12.3456 for 12°34'56".

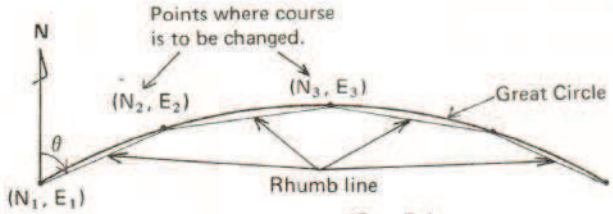
CASIO PROGRAM SHEET

Program for	No.	
Rhumb line navigation	Navigation–3	

Description

• Input the program written in the next page.

This program can be used to work out the distance and direction of each segment of rhumb line when course must be changed midway.



$$\theta = \tan^{-1} \frac{\pi (E_1 - E_2)}{180 \{ \ln \tan (N_2/2 + 45) - \ln \tan (N_1/2 + 45) \}} \quad [^\circ]$$

$$D = 60 \frac{N_2 - N_1}{\cos\theta} \text{ [nautical miles]}$$

* North latitude and east longitude should be expressed by positive numbers, and south latitude and west longitude by negative numbers. However, Lat. 90°N (north pole) and Lat. 90°S (south pole) can not be input. When two points are at the same latitude, calculation will result in an error. In this case, use the program for great circle navigation.

Example 1

Lat. 37°36'40"N
Long. 130°20'35"W
↓
Lat. 42°11'30"N
Long. 143°24'12"E

Example 2

Lat. 4°15'45"S
Long. 160°12'38"E
↓
Lat. 3°30'14"N
Long. 160°24'36"W

Step	Data input operation	Read-out	Remark
	MODE 1		
1	Example 1 PO	N1 ?	
2	37.364 EXE	E1 ?	
3	130.2035 +/- EXE	N2 ?	
4	42.113 EXE	E2 ?	
5	143.2412 EXE	D=3977.1355	
6		=3977.13558	(D)
7	EXE	T=273°57'44	
8		=273°57'44"	(θ)
9			
10			

Step	Data input operation	Read-out	Remark
11	Example 2 PO	N1 ?	
12	4.1545 +/- EXE	E1 ?	
13	160.1238 EXE	N2 ?	
14	3.3014 EXE	E2 ?	
15	160.2436 +/- EXE	D=2406.4525	
16		2406.452566	(D)
17	EXE	T=78°50'5.1	
18		78°50'5.15"	(θ)
19			
20			
21			

Program for

Rhumb line navigation

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 MODE 4, INV MAC,		2
2	INV "AL, N, 1, INV ?, INV AL", HLT, GSB INV P9, X-M 01,		10
3	INV "AL, E, 1, INV ?, INV AL", HLT, GSB INV P9, X-M 02,		18
4	INV "AL, N, 2, INV ?, INV AL", HLT, GSB INV P9, X-M 03,		26
5	INV "AL, E, 2, INV ?, INV AL", HLT, GSB INV P9, M- 02,		34
6	1, 8, 0, Min F, MR 02, INV ABS, INV x≥r, GSB INV P6,		42
7	×, INV π, ÷, MR F, ÷, ((, ((, MR 03, GSB INV P8,		51
8	−, ((, MR 01, GSB INV P8,)), =, INV tan⁻¹, Min 05, MR 01,		60
9	M- 03, MR 02, sin, INV sin⁻¹, INV x≥0, GoTo 2,		66
10	LBL 1, MR 03, INV x≥0, GoTo 4,		70
11	MR 05, ±, GSB INV P7, GoTo 4,		74
12	LBL 2, INV x=0, GoTo 1,		77
13	MR 03, INV x≥0, GoTo 3,		80
14	MR 05, GSB INV P7, GoTo 4,		83
15	LBL 3, MR 05, GSB INV P6,		86
16	LBL 4, 6, 0, ×, MR 03, ÷, MR 05, cos, =,		95
17	INV "AL, D, =, INV ♯, INV AL", HLT,		101
18	MR 05, INV D.MS, INV "AL, T, =, INV ♯, INV AL",		108
19			
20	INV P6 GSB INV P7, M+ 05, MR 05,		3
21			
22	INV P7 ±, Min 05, MR F, M+ 05,		4
23			
24	INV P8 ÷, 2, +, 4, 5,)), tan, ln,		8
25			
26	INV P9 Min 09, INV INT, +, ((, MR 09, INV FRAC, ×, 2, INV 10^x,)),		10
27	Min 09, INV INT, ÷, 6, 0, +, MR 09, INV FRAC, ÷, 3, 6,		21
28	=,		22
29			
30		Total 150	
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	N_1
02	$E_1 - E_2$
03	$N_2 \rightarrow N_2 - N_1$
04	
05	θ
06	
07	
08	
09	Conversion of angle
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

θ (Theta) is displayed as T.

- Since $\tan^{-1} x$ is $-90° < \theta < 90°$, corrections are made from positions of (N_1, E_1) and (N_2, E_2) so as to be $0 \leq \theta < 360°$.
- Accuracy deteriorates for a very short route, and azimuths near the due east (90°) and due west (270°).
- Use the decimal-like representation for the input format of angle, i.e. 12.3456 for 12°34'56".

When using FX-601P, prepare the program omitting INV "AL, ~, INV AL" before each HLT.

CASIO PROGRAM SHEET

Program for	No.
Secret number game	Game—1

Description

• Input the program written in the next page.

The calculator holds a secret number whose value is anywhere between 0 and 50. You have to guess that number by using messages as crossreferences. As you enter a guess (input a number) the calculator gives you a clue as to the general area of the secret number.

Example

Let the secret number be 25.

1st message

0<0>50. (The secret number is between 0 and 50.)

Lower limit
Upper limit

If you input 35

2nd message

0<0>35. (The secret number is between 0 and 35.)

If you input 15

3rd message

15<0>35. (The secret number is between 15 and 35.)

If you input 25

4th message

HIT

Subsequenty

3. (The secret number is hit at the third trial.)

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	Pol	GAME START		12			
2		0〈X〉50		13			
3	35	35		14			
4		0〈X〉35		15			
5	15	15		16			
6		15〈X〉35		17			
7	25	HIT		18			
8		3		19			
9				20			
10				21			

Program for

Secret number game

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P0 INV "AL, G, A, M, E, INV SPACE, S, T, A, R, T, INV AL",		12	01
2	INV PAUSE, INV MAC, AC, 5, 0, Min 08, Min 02, INV RAN#, INV RAN#,		21	02
3	×, 2, INV 10^x, =, INV INT, Min 06, −, MR 08, =, INV $x \geq 0$,		31	03
4	GoTo 1, GoTo 2,		33	04
5	LBL 1, Min 06,		35	05
6	LBL 2, Min F, INV "AL, INV AR 01, INV SPACE, INV <, INV SPACE, X,		43	06
7	INV SPACE, INV >, INV SPACE, INV AR 02, INV AL", INV PAUSE, INV $x=f$,		50	07
8	GoTo 2,		51	08
9	Min 08, 1, M+ 09, MR 08, −, MR 06, =, INV $x=0$, GoTo 4,		60	09
10	INV $x \geq 0$, GoTo 3, MR 08, Min 01, GoTo 2,		65	F
11	LBL 3, MR 08, Min 02, GoTo 2,		69	10
12	LBL 4, INV "AL, H, I, T, INV AL", INV PAUSE, MR 09,		77	11
13				12
14		Total 78		13
15				14
16				15
17				16
18				17
19				18
20				19
21				1F
22				20
23				21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	No.	
Gopher game	Game–2	

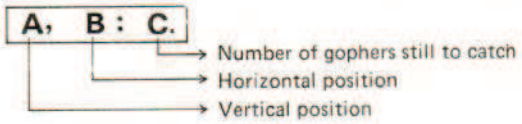
Description

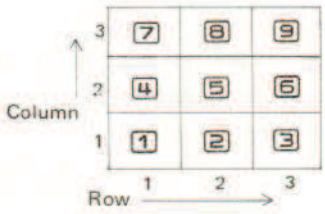
• Input the program written in the next page.

The idea is to rid an area of gophers (represented by numbered squares) by eliminating each one as it appears. The game tests your wits and reflexes. Numbers come onto the display to show the position of the hidden gopher and you must press the correct key within one second to score a hit.
There are three similar games, explained below.

1. [P0] program

Message



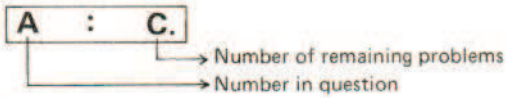


Example

Let's say a " 1, 2:9 " is displayed. This means the 1st column and 2nd row and there are 9 gophers to go. This means pressing the number 2 within a second will catch one gopher. If the input is not made fast enough, the chance is lost. When the series of squares has been completed the display shows your number of catches.

2. [P1] program

Message



In this game, divide the displayed number (A) by four and input the residual.
If "6:8" is displayed for example, depress key [2].

3. [P2] program

This is the same as the [P1] program but that the number (A) may have two digits.

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	[P0]	1 ,1:10	Displayed for about 1 second.
2	(Respond within 1 second) [1]	1	
3		2 ,3:9	Displayed for about 1 second.
4	(Respond within 1 second) [6]	6	
5			
6		3 ,1:1	Displayed for about 1 second.
7	(Respond within 1 second [7]	7	
8		8	Number of correct answers
9			
10			

Step	Data input operation	Read-out	Remark
11	[P1]	7:10	Displayed for about 1 second.
12	(Input the answer) [3]	3	
13			
14		2: 1	Displayed for about 1 second.
15	(Input the answer) [2]	2	
16		10	Number of correct answers
17			
18			
19			
20			
21			

Program for

Gopher game

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	INV P9 INV RAN# × MR 08 = INV INT		5	01
2				02
3	INV P7			03
4	LBL 1 − 4 = INV x≥f GoTo 1		6	04
5				05
6	INV P6 INV MAC 1 0 Min 00 Min 08		5	06
7				07
8	INV P5			08
9	LBL 1 GSB INV P9 Min 01 ÷ 4 = INV FRAC × 4 = INV INT		11	09
10	Min 02		12	F
11	9 = INV "AL INV AR 01 INV SPACE INV : INV AR 00		19	10
12	INV AL" INV PAUSE M− 02 MR 02 INV x=0 GoTo 3		25	11
13	LBL 2 INV DSZ GoTo 1 GoTo 4		29	12
14	LBL 3 1 M+ 09 GoTo 2		33	13
15	LBL 4 MR 09		35	14
16				15
17	P0 GSB INV P6 4 Min F		3	16
18	LBL 1 GSB INV P9 INV x≥f GSB INV P7 INV x=0 GoTo 1 Min 01		10	17
19	LBL 2 GSB INV P9 INV x≥f GSB INV P7 INV x=0 GoTo 2 Min 02		17	18
20	AC INV "AL INV AR 01 INV ' INV AR 02 INV SPACE INV :		24	19
21	INV AR 00 INV AL" INV PAUSE Min 07		28	1F
22	LBL 3 ((MR 01 − 1)) × 3 + MR 02 − MR 07 =		41	20
23	INV x=0 GoTo 6		43	21
24	LBL 5 INV DSZ GoTo 1 GoTo 7		47	22
25	LBL 6 1 M+ 09 GoTo 5		51	23
26	LBL 7 MR 09		53	24
27				25
28	P1 GSB INV P6 GSB INV P5		2	26
29				27
30	P2 GSB INV P6 1 0 0 Min 08 GSB INV P5		6	28
31				29
32		Total 119		2F
33				
34				
35				
36				
37				

Note

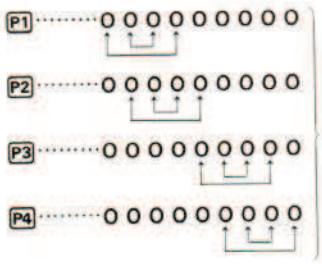
CASIO PROGRAM SHEET

Program for	No.
Shuffle-number game	Game–3

Description

• Input the program written in the next page.

The objective is to place the shuffled number in ascending order with the least number of steps. The digits from 1 to 9 will appear in shuffled form, you must rearrange them in proper order by depressing the right keys to make the changes as shown below. There are nine degrees of difficulty and a code should be selected first (1 = easiest, 9 = hardest) and [P0] pressed. The shuffled numbers will then be displayed and can be rearranged by use of the [P1] to [P4] keys which make the following movements:



Digits will be interchanged as shown at left depending on the key depressed.

Complete the game with the least number of key presses.

Variations: 1. Follow the reverse sequence if you can remember it.

2. See if you can input the initial number directly.

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	(Level code) 2 [P0]	LEVEL 2	
2		451236789	
3	[P2]	432156789	
4	[P1]	123456789	
5			
6	(Level code) 3 [P0]	LEVEL 3	
7		345129876	
8	[P4]	345126789	
9	[P1]	154326789	
10	[P2]	123456789	

Step	Data input operation	Read-out	Remark
11	To retry with 451287639.		
12	4 [Min] [0] [1]		
13	5 [Min] [0] [2]		
14			
15			
16	9 [Min] [0] [9]		
17	[INV] [P5]	451287639	
18	[P3]	451236789	
19	[P2]	432156789	
20	[P1]	123456789	
21			

Program for

Shuffle-number game

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 2 0 MODE 2			00
1	INV P5 9, Min 00, AC,		3	01
2	LBL 1, +, INV IND, MR 00, ×, MR 00, +/-, INV 10^x, =, INV DSZ,		13	02
3	GoTo 1, ×, 9, INV 10^x, =,		18	03
4				04
5	INV P6 MR 01, X-M 04, Min 01, MR 02, X-M 03, Min 02,		6	05
6				06
7	INV P7 MR 02, X-M 05, Min 02, MR 03, X-M 04, Min 03,		6	07
8				08
9	INV P8 MR 05, X-M 08, Min 05, MR 06, X-M 07, Min 06,		6	09
10				F
11	INV P9 MR 06, X-M 09, Min 06, MR 07, X-M 08, Min 07,		6	10
12				11
13	P1 GSB INV P6, GSB INV P5,		2	12
14				13
15	P2 GSB INV P7, GSB INV P5,		2	14
16				15
17	P3 GSB INV P8, GSB INV P5,		2	16
18				17
19	P4 GSB INV P9, GSB INV P5,		2	18
20				19
21	P0 Min F, INV "AL, L, E, V, E, L, INV SPACE, INV #, INV AL", AC,		11	1F
22	9, Min 00,		13	20
23	LBL 1, MR 00, INV IND, Min 00, INV DSZ, GoTo 1, MR F, Min 00, 0,		22	21
24	LBL 3, Min F,		24	22
25	LBL 4, INV RAN#, INV RAN#, ×, 1, 0, =, INV INT, INV x=f, GoTo 4,		34	23
26	X-M F, 6, X-M F, INV x≥f, GoTo 2,		39	24
27	+, 4, =, INV x≥f, GoTo 2, +, 3, =,		47	25
28	LBL 2, X-M 00, INV X-Y, INV IND, GSB 0, INV X-Y, X-M 00, INV DSZ,		55	26
29	GoTo 3, GSB INV P5, Min F,		58	27
30				28
31		Total 118		29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	Hit-and-blow game	No.	Game-4	

Description

• Input the program written in the next page.

Guess a 4-digit number

Operation:

1) Let the calculator hold a four-digit number by the following operation.
Key operation: [MODE], [1] (The calculator is now in the RUN mode), [INV], [P9] (A four-digit random number consisting of different digits is generated and held by the calculator.)

2) Guess the number the calculator holds by inputting a four-digit number.
Key operation: □, □, □, □, [P0] (□: numeric key).

3) The calculator judges whether you are right or not.

Example:

Let us assume the calculator holds "1234".
If your guess is "5432" (key operation: [5], [4], [3], [2], [P0]), the calculator displays:

```
1° 2' 1"
```

(1 hit and 2 blows)

- Means first trial
- Number of right digits but in wrong positions (called "blows", "4" and "2" in this case)
- Number of right digits in right positions (called "hits", "3" in this case)

Referring to the message displayed, you make a guess several times until the right number is reached.
When your guess "hits" the secret number (key operation: [1], [2], [3], [4], [P0]), the calculator displays:

```
4° 0' n"
```

(You have succeeded at the *n*-th trial.)

Now the game ends.
To restart the game with a new secret number, depress [INV] and [P9].

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1	P4	? : ? : ? : ?		12			
2	5432 P0	1° 2' 1"	1 hit & 2 blows	13			
3	8901 P0	0° 1' 2"	1 blow	14			
4	5231 P0	2° 1' 3"	2 hits & 1 blow	15			
5	7241 P0	1° 2' 4"	1 hit & 2 blows	16			
6	1236 P0	3° 0' 5"	3 hits	17			
7	1234 P0	4° 0' 6"	success at the 6th trial	18			
8				19			
9				20			
10				21			

Program for

Hit-and-blow game

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	INV P5 × 1 0 =		4	01
2				02
3	P4 INV MAC 1 Min 00		3	03
4	LBL 1 INV RAN# INV RAN# GSB INV P5 INV INT Min F INV IND Min 00		11	04
5	MR 00 Min 05		13	05
6	LBL 2 1 M− 05 MR 05 INV x=0 GoTo 3		19	06
7	INV IND MR 05 INV x=F GoTo 1 GoTo 2		24	07
8	LBL 3 4 Min F MR 00 INV x=F GoTo 4 INV ISZ GoTo 1		32	08
9	LBL 4 INV IND MR 00 × ((MR 00 − 1)) INV 10^x +		43	09
10	INV DSZ GoTo 4 X-M 08 AC INV "AL INV ? INV : INV ?		51	F
11	INV : INV ? INV : INV ? INV AL"		56	10
12				11
13	P0 Min 07 3 6 0 0 INV $\frac{1}{x}$ M+ 09 MR 07 ÷ 4		10	12
14	Min 07 INV 10^x = Min 06 0 Min 05		16	13
15	LBL 1 4 Min 00 MR 06 GSB INV P5 Min 06 INV INT Min F		24	14
16	M− 06		25	15
17	LBL 2 INV IND MR 00 INV x=F GoTo 4 INV DSZ GoTo 2		32	16
18	LBL 3 1 M− 07 MR 07 INV x=0 GoTo 6 GoTo 1		39	17
19	LBL 4 MR 07 − MR 00 = INV x=0 GoTo 5		46	18
20	6 0 INV $\frac{1}{x}$ M+ 05 GoTo 3		51	19
21	LBL 5 1 M+ 05 GoTo 3		55	1F
22	LBL 6 MR 09 M+ 05 MR 05 INV ⇆		60	20
23				21
24		Total 123		22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	No.	
Last-stone game I	Game-5	

Description

• Input the program written in the next page.

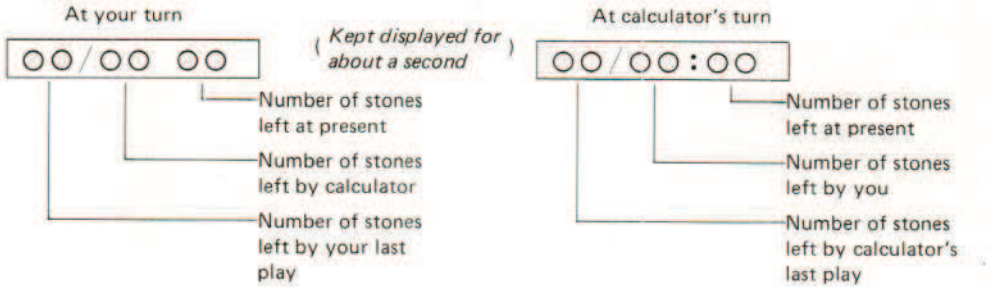
You and the calculator take turns in taking stones. The winner is the side which leaves the last stone for the opponent to take.

Rules:

You must always take at least one stone and not more than three stones.

1. Depress [P0] and calculator will tell you how many stones are to be played between 4 and 59.
2. You have a choice of tactics.
   a) To let the calculator play first, press [P4], if not, you play first.
   b) To take one stone . . . . . press [P1]
   c) To take two stones. . . . . press [P2]
   d) To take three stones . . . . . press [P3]
3. You have a choice of tactics b, c or d each time it is your turn.
4. The calculator also has the same choice of tactics.

Conents of display:



Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	[MODE] [1]			11		9/ 6: 5	
1	[P0]	0/ 0:23		12	Take a stone [P1]	6/ 5: 4	Displayed for about a second
2	Take a stone [P1]	0/23:22	Displayed for about a second	13		5/ 4: 1	
3		23/22:21		14	Take a stone [P1]	LOSE	You lost
4	Take three stones [P3]	22/21:18	Displayed for about a second	15			
5		21/18:17		16		WIN	* In case of you won
6	Take three stones [P3]	18/17:14	Displayed for about a second	17			
7		17/14:13		18			
8	Take three stones [P3]	14/13:10	Displayed for about a second	19			
9		14/10: 9		20			
10	Take three stones [P3]	10/ 9: 6	Displayed for about a second	21			

Program for

Last-stone game I

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	INV P5 INV "AL, INV AR 03, INV /, INV AR 02, INV :, INV AR 01,		6	01
2	INV AL",		7	02
3				03
4	INV P6 Min F, MR 02, Min 03, MR 01, Min 02, X-M F, INV $x \geq f$,		7	04
5	GoTo 1, M- 01, GSB INV P5, INV PAUSE, GSB P4, GoTo 2,		13	05
6	LBL 1, INV "AL, L, O, S, E, INV AL",		20	06
7	LBL 2,		21	07
8				08
9	P0			09
10	LBL 1, INV RAN#, INV RAN#, × , 2, INV 10^x, +, 4, =, INV INT, Min 01,		11	F
11	6, 0, Min F, MR 01, INV $x \geq f$, GoTo 1, 0, Min 02, Min 03,		20	10
12	GSB INV P5,		21	11
13				12
14	P1 1, GSB INV P6,		2	13
15				14
16	P2 2, GSB INV P6,		2	15
17				16
18	P3 3, GSB INV P6,		2	17
19				18
20	P4 MR 02, Min 03, MR 01, Min 02, ÷, 4, =, Min 04, INV INT,		9	19
21	Min 05, Min F, 4, INV $x \geq f$, GoTo 1,		14	1F
22	LBL 2, INV RAN#, INV RAN#, × , 1, 0, +, 1, =, INV INT, Min F,		25	20
23	LBL 3, 3, INV $x \geq f$, GoTo 4, M- F, GoTo 3,		31	21
24	LBL 1, MR 05, M- 04, MR 04, × , 4, =, INV $x=0$, 4, −, 1, =,		43	22
25	Min F, +, MR 05, =, INV $x=0$, GoTo 5, MR F, INV $x=0$,		51	23
26	GoTo 2,		52	24
27	LBL 4, MR F, M- 01, GSB INV P5, GoTo 6,		57	25
28	LBL 5, INV "AL, W, I, N, INV AL",		63	26
29	LBL 6,		64	27
30				28
31		Total 126		29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	No.	
Last-stone game II	Game-6-1	FX-602P

Description

• Input the program written in the next page.

- You and the calculator take turns in taking stones. The winner is the side which leaves the last stone for the opponent to take.
- Depress [P0] and the calculator will tell you how many stones are to be played.
- [P0] program

You have the following choices at the first turn.

(1) To subtract n_1 from the left number ..... Depress n_1 [P1].

(2) To subtract n_2 from the middle one ..... Depress n_2 [P2].

(3) To subtract n_3 from the right one ..... Depress n_3 [P3].

(4) To let the calculator play first ..... Depress [P4].

- Depress [P4] following one of [P1] to [P3] at your subsequent turn.

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	[P0]	6 * 14 * 12	
2	Number of stones taken 5 [P1]	1 * 14 * 12	
3	To let the calculator play [P4]	1 * 13 * 12	
4	Number of stones taken 6 [P2]	1 * 7 * 12	
5	To let the calculator play [P4]	1 * 7 * 6	
6	Number of stones taken 3 [P3]	1 * 7 * 3	
7	To let the calculator play [P4]	1 * 2 * 3	
8	Number of stones taken 2 [P2]	1 * 0 * 3	
9	To let the calculator play [P4]	1 * 0 * 0	
10	Number of stones taken 1 [P1]	END	Calculator won.

Step	Data input operation	Read-out	Remark
11	[P0]	7 * 13 * 15	
12	To let the calculator play [P4]	2 * 13 * 15	
13	Number of stones taken 13 [P2]	2 * 0 * 15	
14	To let the calculator play [P4]	2 * 0 * 2	
15	Number of stones taken 1 [P1]	1 * 0 * 2	
16	To let the calculator play [P4]	1 * 0 * 0	
17	Number of stones taken 1 [P1]	END	Calculator won.
18			
19			
20			
21			

Program for

Last-stone game II

	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	INV P5 MR 01 ‖ INV x≥0 ‖ GoTo 1 ‖ GoTo 2 ‖		4	01
2	LBL 1 ‖ + ‖ MR 02 ‖ INV x≥0 ‖ GoTo 3 ‖ GoTo 2 ‖		10	02
3	LBL 3 ‖ + ‖ MR 03 ‖ INV x≥0 ‖ GoTo 4 ‖ GoTo 2 ‖		16	03
4	LBL 4 ‖ = ‖ INV x=0 ‖ GoTo 2 ‖ INV "AL ‖ INV AR 01 ‖ INV ✳ ‖ INV AR 02 ‖		24	04
5	INV ✳ ‖ INV AR 03 ‖ INV AL" ‖ GoTo 5 ‖		28	05
6	LBL 2 ‖ INV "AL ‖ E ‖ N ‖ D ‖ INV AL" ‖		34	06
7	LBL 5 ‖		35	07
8				08
9	INV P6 0 ‖ Min 08 ‖ 8 ‖ Min F ‖ 3 ‖ Min 00 ‖		6	09
10	LBL 1 ‖ INV IND ‖ MR 00 ‖ INV x≥F ‖ GoTo 2 ‖ GoTo 3 ‖		12	F
11	LBL 2 ‖ MR 00 ‖ + ‖ 3 ‖ = ‖ Min 12 ‖ 8 ‖ INV IND ‖ M− 00 ‖ 1 ‖ M+ 08 ‖		23	10
12	LBL 3 ‖ INV DSZ ‖ GoTo 1 ‖		26	11
13				12
14	INV P7 3 ‖ Min 00 ‖		2	13
15	LBL 1 ‖ INV IND ‖ MR 00 ‖ INV IND ‖ M+ 00 ‖ INV DSZ ‖ GoTo 1 ‖		9	14
16				15
17	INV P8 0 ‖ Min 00 ‖ 2 ‖ Min F ‖		4	16
18	MR 04 ‖ INV x≥F ‖ 5 ‖ M+ 00 ‖		8	17
19	MR 05 ‖ INV x≥F ‖ 5 ‖ M+ 00 ‖		12	18
20	MR 06 ‖ INV x≥F ‖ 5 ‖ M+ 00 ‖		16	19
21	INV IND ‖ MR 12 ‖ INV x≥F ‖ 5 ‖ M− 00 ‖ 3 ‖ Min F ‖		23	1F
22	MR 00 ‖ INV x≥F ‖ GoTo 3 ‖ INV IND ‖ GoTo 0 ‖		28	20
23	LBL 1 ‖ INV IND ‖ MR 12 ‖ Min 07 ‖ GoTo 3 ‖		33	21
24	LBL 0 ‖		34	22
25	LBL 2 ‖ INV IND ‖ MR 12 ‖ − ‖ 1 ‖ = ‖ INV x=0 ‖ 1 ‖ Min 07 ‖		43	23
26	LBL 3 ‖ MR 07 ‖		45	24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Program for	No.	
Last-stone game II	Game–6-2	FX-602P

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Last-stone game II

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	P0 AC ¡ 3 ¡ Min 00 ¡ INV RAN# ¡ INV RAN# ¡		5
2	LBL 1 ¡ × ¡ 1 ¡ 0 ¡ + ¡ 6 ¡ = ¡ Min 04 ¡ INV INT ¡ INV IND ¡ Min 00 ¡		16
3	MR 04 ¡ INV FRAC ¡ INV DSZ ¡ GoTo 1 ¡ GSB INV P5 ¡		21
4			
5	P1 M− 01 ¡ GSB INV P5 ¡		2
6			
7	P2 M− 02 ¡ GSB INV P5 ¡		2
8			
9	P3 M− 03 ¡ GSB INV P5 ¡		2
10			
11	P4 MR 01 ¡ Min 04 ¡ MR 02 ¡ Min 05 ¡ MR 03 ¡ Min 06 ¡ 0 ¡ Min 07 ¡		8
12	Min 13 ¡ 8 ¡ Min 11 ¡ Min 09 ¡		12
13	LBL 5 ¡ GSB INV P6 ¡ INV IND ¡ GoTo 8 ¡		16
14	LBL 3 ¡ MR 11 ¡ M+ 07 ¡		19
15	LBL 0 ¡		20
16	LBL 2 ¡ 2 ¡ M− 09 ¡ MR 09 ¡ INV x=0 ¡ GoTo 6 ¡		26
17	GSB INV P7 ¡ MR 11 ¡ ÷ ¡ 2 ¡ = ¡ Min 11 ¡ GoTo 5 ¡		33
18	LBL 1 ¡ MR 13 ¡ INV x=0 ¡ GoTo 7 ¡		37
19	Min F ¡ MR 12 ¡ INV x=F ¡ GoTo 3 ¡		41
20	MR 11 ¡ M− 07 ¡ GoTo 2 ¡		44
21	LBL 7 ¡ MR 12 ¡ Min 13 ¡ GoTo 3 ¡		48
22	LBL 6 ¡ MR 07 ¡ INV x=0 ¡ 1 ¡ Min 07 ¡ MR 13 ¡ INV x=0 ¡ GoTo 9 ¡ Min 12 ¡		57
23	LBL 9 ¡ GSB INV P8 ¡ INV IND ¡ M− 12 ¡		61
24	MR 04 ¡ Min 01 ¡ MR 05 ¡ Min 02 ¡ MR 06 ¡ Min 03 ¡ GSB INV P5 ¡		68
25			
26		Total 219	
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

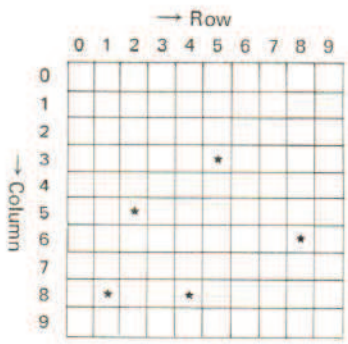
Note

CASIO PROGRAM SHEET

Program for	No.	
Search-bug game	Game—7-1	FX-602P

Description

• Input the program written in the next page.



Five bugs hide in 100 boxes arranged in a square as shown at left. You try to catch them with a net.
Place your net on a box by designating its column and row positions. Then the calculator displays a message. Referring to the message, guess where the bugs hide, the bug will move away to a neighboring box. It may flee to a far box if it stays at the edge of the square when the net is placed close.

Contents of message:
[P4] mwm ····· 5 bugs hide
Search Bugs ····· preparation completed

[P0]
Right → n:m ..... captured
Wrong → n:m ..... missed
Ri/Wr → n:m ..... captured on the line but missed on the column
Wr/Ri → n:m ..... captured on the column but missed on the line

n: Number of trials
m: Number of uncaptured bugs

Step	Data input operation	Read-out	Remark
	[MODE] [1]		
1	[P4]	mwm	
2		Search Bugs	
3	(5th line/ 4th column) 5·4 [P0]	Wrong→ 5 : 1	
4	(6th line/ 4th column) 6·4 [P0]	Ri/Wr→ 5 : 2	
5	(7th line/ 3rd column) 7·3 [P0]	Right→ 4 : 3	
6		⋮	
7		⋮	
8			
9			
10			

Step	Data input operation	Read-out	Remark
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Program for

Search-bug game

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1	INV P7 INV RAN#, × , MR 1F, = , INV INT,		5
2			
3	INV P8 MR 07, − , 1, = , INV x-0, GoTo 1, INV "AL, R, INV i,		9
4	INV / , W, INV r, INV →, INV AR 08, INV :, INV AR 09,		16
5	INV AL", GoTo 2,		18
6	LBL 1, INV "AL, W, INV r, INV /, R, INV i, INV →, INV AR 08,		27
7	INV :, INV AR 09, INV AL",		30
8	LBL 2,		31
9			
10	P0 Min 06, 5, Min 00, 1, M+ 09, 0, Min 07,		7
11	LBL 2, MR 1F, Min F, INV IND, MR 00, INV $x \geq$ F, GoTo 8, INV INT, − ,		16
12	MR 06, INV INT, = , INV ABS, Min F, MR 06, INV FRAC, − ,		24
13	INV IND, MR 00, INV FRAC, = ,		28
14	INV ABS, M+ F, 0, INV x-F, GoTo 3, 1, INV x-F, GoTo 6,		36
15	• , 1, INV x-F, GoTo 6,		40
16	LBL 8, INV DSZ, GoTo 2, GoTo 4,		44
17	LBL 6, MR F, Min 07, GSB INV P7, ÷ , 2, = , INV FRAC, INV x-0,		53
18	GoTo 7, 1,		55
19	LBL 7, Min 06, GSB INV P7, ÷ , 2, = , INV FRAC, INV x-0, • , 1,		65
20	INV IND, GoTo 6,		67
21	LBL 0, INV IND, M+ 00, INV IND, M+ 00,		72
22	LBL 1, INV IND, M− 00, MR 1F, Min F, INV IND, MR 00, INV $x \geq$ F, 1,		81
23	0, INV IND, M− 00, INV IND, MR 00, INV ABS, INV IND, Min 00,		89
24	GSB INV P8, GoTo 5,		91
25	LBL 3, MR 1F, INV IND, M+ 00, 1, M− 08, INV "AL, R, INV i,		100
26	INV g, INV h, INV t, INV →, INV AR 08, INV :,		106
27	INV AR 09, INV AL", GoTo 5,		109
28	LBL 4, INV "AL, W, INV r, INV o, INV n, INV g, INV →,		117
29	INV AR 08, INV :, INV AR 09, INV AL",		121
30	LBL 5,		122
31			
32			
33			
34			
35			
36			
37			

	Contents in memories
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	
Search-bug game	Game—7-2	FX-602P

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

Search-bug game

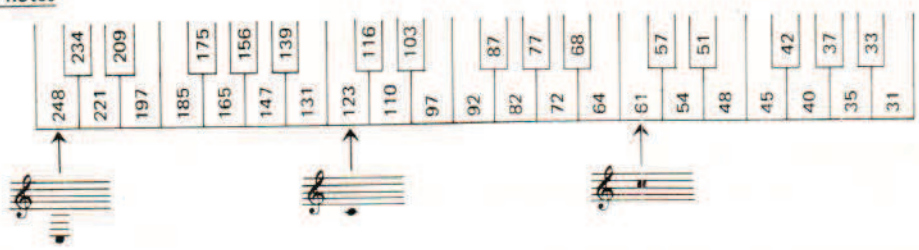
	Program	Remark	Step	Contents in memories
	MODE 3 INV MAC MODE • 20 MODE 2			00
1	P4 INV MAC, 1, Min 00, 1, 0, Min 1 F,		6	01
2	LBL 1, INV "AL, INV m, INV AL", MR 00, Min 06, GSB INV P7, INV IND,		14	02
3	Min 00, GSB INV P7, ÷, MR 1 F, =, INV "AL, INV m,		21	03
4	INV w, INV AL", INV IND, M+ 00, INV IND, MR 00, Min F,		28	04
5	INV "AL, INV m, INV w, INV m, INV AL",		33	05
6	LBL 2, 1, M− 06, MR 06, INV x=0, GoTo 3, INV IND, MR 06, INV x=F,		42	06
7	GoTo 1, GoTo 2,		44	07
8	LBL 3, MR 00, Min F, 5, INV x=F, GoTo 4, INV ISZ, GoTo 1,		52	08
9	LBL 4, 5, Min08, INV "AL, S, INV e, INV a, INV r, INV c,		61	09
10	INV h, INV SPACE, B, INV u, INV g, INV s, INV AL",		68	F
11				10
12		Total 230		11
13				12
14				13
15				14
16				15
17				16
18				17
19				18
20				19
21				1F
22				20
23				21
24				22
25				23
26				24
27				25
28				26
29				27
30				28
31				29
32				2F
33				
34				
35				
36				
37				

Note

CASIO PROGRAM SHEET

Ogonek	No. Music– 1

Codes of notes



Duration

- Place the music overlay sheet on the calculator's keyboard. Duration of notes and rests are indicated on the sheet.
- Use the ➖ key for a dotted note.

Example: ♩. : [♩][0][2][➖][♪][0][2]

Rests	Input operation
𝅘𝅥𝅯	[♪][𝄽]
𝅘𝅥	[♩][𝄽]
𝄽	[𝅗𝅥][𝄽]
𝄻	[𝅝][𝄽]
𝄺	[𝅝][𝄽]

Tempo

Content of memory cell F	Tempo	Content of memory cell F	Tempo
0	♩ ≒ 40	5	♩ ≒ 240
1	♩ ≒ 80	6	♩ ≒ 280
2	♩ ≒ 120	7	♩ ≒ 320
3	♩ ≒ 160	8	♩ ≒ 360
4	♩ ≒ 200	9	♩ ≒ 400

Slur and tie

(1) Slur: Use the ➕ key.

Example:

[♩][0][3][➕][♩][0][5][➕][♩][0][7]

(2) Tie: Use the ➖ key.

Example:

[♩][0][5][➖][♩][0][5]

Preparation

(1) Input the following program and data to the calculator.
(2) Set the FA-1's mode switches at MUSIC and SAVE/LOAD.
(3) Connect the white MIC plug to the cassette tape recorder's microphone jack. (It is not necessary to connect the EAR plug.)
(4) Load the cassette tape to the tape recorder and start recording.
(5) Depress [MODE][1] (the calculator enters RUN mode) and [PO].
* You can listen to the tune through the earphone while it is being recorded by connecting the earphone to the tape recorder's earphone jack. When using a tape recorder with mic-mixing feature, you can listen to the tune from speaker.
(6) "0." on display shows that the recording is completed. You can enjoy music by playing back.

Note data (Contents in memories)					
00	la	147	10	fa	45
01	si	131	11	sol	40
02	do	123	12	la	35
03	mi	97	13	si	31
04	sol♯	77	14	do	29
05	la	72	15		
06	si	64	16		
07	do	61	17		
08	re	54	18		
09	mi	48	19		
Tempo data					
F	3				

Ogonek

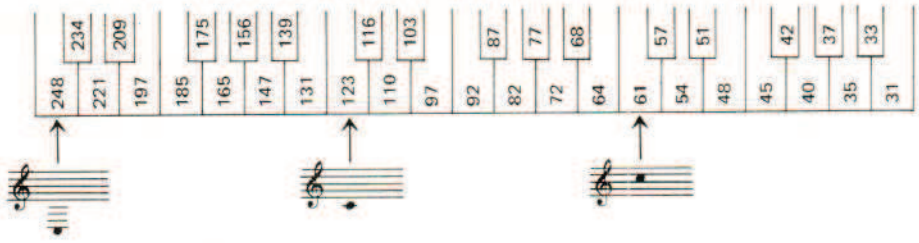
Program

	Step	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	INV P9	00	03	05	07	09	03	08	07	09	03	04	08	08	03	04	06	08	03	06	07	08	03	06
2		24 07	25 05																					
3																								
4	P0	1 GSB INV P9	2 02	3 03	4 05	5 07	6 05	7 03	8 02	9 00	10 03		11 09	12 10	13 11	14 04	15 10	16 09	17 11	18 03	19 06	20 10	21 10	22 05	23 08	24 05
5		25 10	26 05		27 10	28 11	29 12	30 05	31 11	32 12	33 09	34 03	35 04	36 06	37 09	38 08	39 06	40 04	41 00	42 07		43 14	44 14	45 14	46 07	47 13
6		48 12	49 14	50 07	51 09	52 13	53 10	54 05	55 08	56 05	57 10	58 05		59 10	60 11	61 12	62 05	63 11	64 12	65 09	66 04	67 07	68 09	69 01	70 04	71 06
7		72 09	73 GSB INV P9	74 07	75 09	76 07	77 05	78 12	79 AC															
8																							Total	106
9																								
10																								
11																								
12																								
13																								
14																								
15																								

CASIO PROGRAM SHEET

Für Elise	No. Music–2	FX-602P

Codes of notes



Duration

- Place the music overlay sheet on the calculator's keyboard. Duration of notes and rests are indicated on the sheet.
- Use the [−] key for a dotted note.

Example: ♩. : [♩][0][2][−][♪][0][2] .

Rests	Input operation
𝅘𝅥𝅯	[♪][I]
𝅘𝅥𝅮	[♪][I]
𝄽	[♩][I]
𝅗𝅥	[𝅗𝅥][I]
𝅝	[○][I]

Tempo

Content of memory cell F	Tempo	Content of memory cell F	Tempo
0	♩ ≒ 40	5	♩ ≒ 240
1	♩ ≒ 80	6	♩ ≒ 280
2	♩ ≒ 120	7	♩ ≒ 320
3	♩ ≒ 160	8	♩ ≒ 360
4	♩ ≒ 200	9	♩ ≒ 400

Slur and tie

(1) Slur: Use the [+] key.

Example:

[♩][0][3][+][♩][0][5][+][♩][0][7]

(2) Tie: Use the [−] key.

Example:

[♩][0][5][−][♩][0][5]

Preparation

(1) Input the following program and data to the calculator.
(2) Set the FA-1's mode switches at MUSIC and SAVE/LOAD.
(3) Connect the white MIC plug to the cassette tape recorder's microphone jack. (It is not necessary to connect the EAR plug.)
(4) Load the cassette tape to the tape recorder and start recording.
(5) Depress [MODE][1] (the calculator enters RUN mode) and [PO].
* You can listen to the tune through the earphone while it is being recorded by connecting the earphone to the tape recorder's earphone jack. When using a tape recorder with mic-mixing feature, you can listen to the tune from speaker.
(6) "0." on display shows that the recording is completed. You can enjoy music by playing back.

Note data (Contents in memories)					
00	do	123	10	fa	45
01	re	110	11	sol	40
02	mi	97	12	la	35
03	fa	92	13	si	31
04	sol	82	14	do	29
05	la	72	15	mi	23
06	si	64	16	sol#	77
07	do	61	17	si^{b}	68
08	re	54	18	re#	51
09	mi	48	19	si^{b}	33
Tempo data					
F		4 – 5			

Für Elise

Program

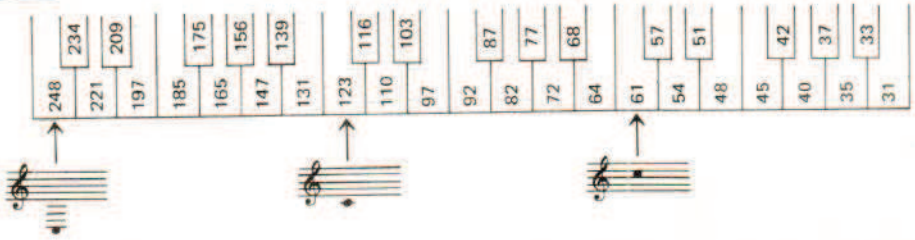
	Step	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	INV P9	♪ 09	♪ 18	♪ 09	♪ 18	♪ 09	♪ 06	♪ 08	♪ 07	♩ 05	𝄽	♪ 00	♪ 02	♪ 05	♩ 06	𝄽
2																
3	INV P8	1 GSB INV P9	2 ♪ 02	3 ♪ 16	4 ♪ 06	5 ♩ 07	6 𝄽	7 ♪ 02	8 GSB INV P9	9 ♪ 01	10 ♪ 07	11 ♪ 06				
4																
5	INV P7	1 ♩ 09	2 —	3 ♪ 09	4 ♪ 04	5 ♪ 10	6 ♪ 09	7 ♩ 08	8 —	9 ♪ 08	10 ♪ 03	11 ♪ 09	12 ♪ 08	13 ♩ 07	14 —	15 ♪ 07
		16 ♪ 02	17 ♪ 08	18 ♪ 07	19 ♪ 06	20 ♪ 02	21 ♪ 09	22 ♪ 02	23 ♪ 09	24 ♪ 02	25 ♪ 09					
6		26 ♪ 09	27 ♪ 15	28 ♪ 18	29 ♪ 09	30 ♪ 18	31 ♪ 09	32 ♪ 18	33 ♪ 09	34 ♪ 18	35 GSB INV P9	36 ♪ 02	37 ♪ 16	38 ♪ 06	39 ♩ 07	40 𝄽
		41 ♪ 02	42 GSB INV P9	43 ♪ 01	44 ♪ 07	45 ♪ 06										
7																
8	P0	1 GSB INV P8	2 ♩ 05	3 —	4 ♪ 05	5 ♪ 𝄽	6 GSB INV P8	7 ♩ 05	8 ♪ 𝄽	9 ♪ 06	10 ♪ 07	11 ♪ 08	12 GSB INV P7	13 ♩ 05	14 ♪ 𝄽	15 ♪ 06
		16 ♪ 07	17 ♪ 08	18 GSB INV P7	19 ♩ 05	20 ♪ 𝄽	21 ♪ 07	22 ♪ 07	23 ♪ 07	24 ♩ 07	25 ♩ 10					
9		26 —	27 ♪ 10	28 ♪ 09	29 ♩ 09	30 ♩ 08	31 ♪ 19	32 —	33 ♪ 19	34 ♪ 12	35 ♪ 12	36 ♪ 11	37 ♪ 10	38 ♪ 09	39 ♪ 08	40 ♪ 07
		41 ♩ 17	42 ♩ 05	43 ♪ 05	44 ♪ 04	45 ♪ 05	46 ♪ 17	47 ♩ 07	48 ♪ 08	49 ♪ 18	50 ♩ 09					
10		51 —	52 ♪ 09	53 ♪ 09	54 ♪ 10	55 ♪ 05	56 ♩ 07	57 ♪ 08	58 —	59 ♪ 08	60 ♪ 06	61 ♪ 07	62 ♪ 11	63 ♪ 04	64 ♪ 11	65 ♪ 05
		66 ♪ 11	67 ♪ 06	68 ♪ 11	69 ♪ 07	70 ♪ 11	71 ♪ 08	72 ♪ 11	73 ♪ 09	74 ♪ 11	75 ♪ 14					
11		76 ♪ 13	77 ♪ 12	78 ♪ 11	79 ♪ 10	80 ♪ 09	81 ♪ 08	82 ♪ 11	83 ♪ 10	84 ♪ 08	85 ♪ 07	86 ♪ 11	87 ♪ 04	88 ♪ 11	89 ♪ 05	90 ♪ 11
		91 ♪ 06	92 ♪ 11	93 ♪ 07	94 ♪ 11	95 ♪ 08	96 ♪ 11	97 ♪ 09	98 ♪ 11	99 ♪ 14	100 ♪ 13					
12		101 ♪ 12	102 ♪ 11	103 ♪ 10	104 ♪ 09	105 ♪ 08	106 ♪ 11	107 ♪ 10	108 ♪ 08	109 ♪ 09	110 ♪ 10	111 ♪ 09	112 ♪ 18	113 ♪ 09	114 ♪ 06	115 ♪ 09
		116 ♪ 18	117 ♪ 09	118 ♪ 06	119 ♪ 09	120 ♪ 18	121 ♩ 09	122 —	123 ♪ 09	124 ♪ 06	125 ♪ 09					
13		126 ♪ 18	127 ♩ 09	128 —	129 ♪ 09	130 ♪ 06	131 ♪ 09	132 ♪ 18	133 ♪ 09	134 ♪ 18	135 ♪ 09	136 ♪ 18	137 GSB INV P8	138 ♩ 05	139 ♪ 𝄽	140 ♪ 06
		141 ♪ 07	142 ♪ 08	143 GSB INV P7	144 𝅝 05	145 AC										
14																
15																

Total 220

CASIO PROGRAM SHEET

Romance de amor	No. Music–3-1	FX-602P

Codes of notes



Duration

- Place the music overlay sheet on the calculator's keyboard. Duration of notes and rests are indicated on the sheet.
- Use the [−] key for a dotted note.

rest.

Example: ♩. : [♩][0][2][−][♪][0][2]

Rests	Input operation
𝅘𝅥𝅯	[♪][1]
𝅘𝅥𝅰	[♪][1]
𝅗𝅥	[♩][1]
𝄼	[♩][1]
𝄻	[○][1]

Tempo

Content of memory cell F	Tempo	Content of memory cell F	Tempo
0	♩ ≒ 40	5	♩ ≒ 240
1	♩ ≒ 80	6	♩ ≒ 280
2	♩ ≒ 120	7	♩ ≒ 320
3	♩ ≒ 160	8	♩ ≒ 360
4	♩ ≒ 200	9	♩ ≒ 400

Slur and tie

(1) Slur: Use the [+] key.

Example: [♩][0][3][+][♩][0][5][+][♩][0][7]

(2) Tie: Use the [−] key.

Example: [♩][0][5][−][♩][0][5]

Preparation

(1) Input the following program and data to the calculator.
(2) Set the FA-1's mode switches at MUSIC and SAVE/LOAD.
(3) Connect the white MIC plug to the cassette tape recorder's microphone jack. (It is not necessary to connect the EAR plug.)
(4) Load the cassette tape to the tape recorder and start recording.
(5) Depress [WOK][1] (the calculator enters RUN mode) and [PO].
* You can listen to the tune through the earphone while it is being recorded by connecting the earphone to the tape recorder's earphone jack. When using a tape recorder with mic-mixing feature, you can listen to the tune from speaker.
(6) "0." on display shows that the recording is completed. You can enjoy music by playing back.

Note data (Contents in memories)					
00	la	35	10	si	131
01	fa	92	11	fa#	87
02	fa*	80	12	sol#	77
03	la	72	13	do	123
04	si	64	14	re	110
05	do	61	15	do#	57
06	re	54	16	mi	97
07	mi	48	17	do#	116
08	fa	45	18	fa#	42
09	sol	40	19	sol#	37
Tempo data					
F		4–5			

Romance de amor

Program

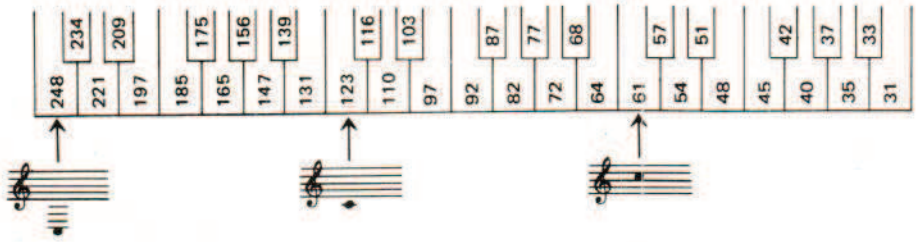
	Step	1	2
1	P1	♪ 16	♪ 13
2	P2	♪ 03	♪ 01
3	P3	♪ 04	♪ 12
4	P4	♪ 16	♪ 14
5	INV P5	♪ 16	♪ 17
6	INV P6	♪ 14	♪ 10
7	INV P7	♪ 15	♪ 03
8	INV P8	♪ 03	♪ 11
9	INV P9	♪ 12	♪ 14
10			
11			
12			
13			
14			
15			

Continued to next page

CASIO PROGRAM SHEET

Romance de amor	No. Music – 3-2	FX-602P

Codes of notes



Duration

- Place the music overlay sheet on the calculator's keyboard. Duration of notes and rests are indicated on the sheet.
- Use the [−] key for a dotted note.

Example: ♩. : [♩][0][2][−][♪][0][2]

Rests	Input operation
𝅘𝅥𝅯	[♪][1]
𝅘𝅥𝅯	[♪][1]
𝅘𝅥	[♩][1]
𝅗𝅥	[♩][1]
𝅝	[○][1]

Tempo

Content of memory cell F	Tempo	Content of memory cell F	Tempo
0	♩ ≒ 40	5	♩ ≒ 240
1	♩ ≒ 80	6	♩ ≒ 280
2	♩ ≒ 120	7	♩ ≒ 320
3	♩ ≒ 160	8	♩ ≒ 360
4	♩ ≒ 200	9	♩ ≒ 400

Slur and tie

(1) Slur: Use the [+] key.

Example: [♩][0][3][+][♩][0][5][+][♩][0][7]

(2) Tie: Use the [−] key.

Example: [♩][0][5][−][♩][0][5]

Preparation

(1) Input the following program and data to the calculator.
(2) Set the FA-1's mode switches at MUSIC and SAVE/LOAD.
(3) Connect the white MIC plug to the cassette tape recorder's microphone jack. (It is not necessary to connect the EAR plug.)
(4) Load the cassette tape to the tape recorder and start recording.
(5) Depress [MODE][1] (the calculator enters RUN mode) and [Pσ].
* You can listen to the tune through the earphone while it is being recorded by connecting the earphone to the tape recorder's earphone jack. When using a tape recorder with mic-mixing feature, you can listen to the tune from speaker.
(6) "0." on display shows that the recording is completed. You can enjoy music by playing back.

Note data (Contents in memories)					
00	la	35	10	si	131
01	fa	92	11	fa#	87
02	fa*	80	12	sol#	77
03	la	72	13	do	123
04	si	64	14	re	110
05	do	61	15	do#	57
06	re	54	16	mi	97
07	mi	48	17	do#	116
08	fa	45	18	fa#	42
09	sol	40	19	sol#	37
Tempo data					
F		4 – 5			

Romance de amor

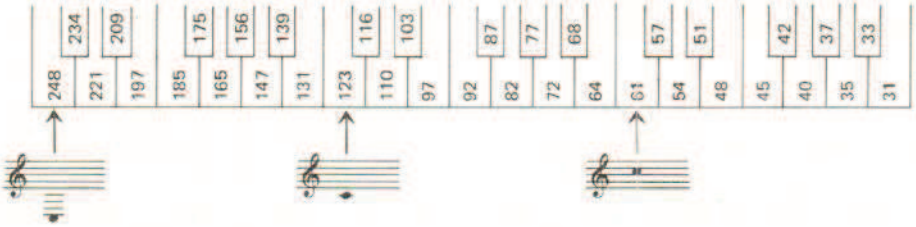
Program

	Step	1	2	3	4	5	6	7	8	9	10	11	12		13	14	15	16	17	18	19	20	21	22	23	24
1	P0	♪ 07	GSB P1	♪ 07	GSB P1	♪ 07	GSB P1	♪ 07	GSB P1	♪ 06	GSB P1	♪ 05	GSB P1		♪ 05	GSB P1	♪ 04	GSB P1	♪ 03	GSB P1	♪ 03	GSB P1	♪ 05	GSB P1	♪ 07	GSB P1
2		25 ♪ 00	26 GSB P1	27 ♪ 00	28 GSB P1	29 ♪ 00	30 GSB P1	31 ♪ 00	32 GSB P1	33 ♪ 09	34 GSB P1	35 ♪ 08	36 GSB P1		37 ♪ 08	38 GSB P2	39 ♪ 07	40 GSB P2	41 ♪ 06	42 GSB P2	43 ♪ 06	44 GSB P2	45 ♪ 07	46 GSB P2	47 ♪ 08	48 GSB P2
3		49 ♪ 07	50 GSB P3	51 ♪ 08	52 GSB P3	53 ♪ 07	54 GSB P3	55 ♪ 19	56 GSB P3	57 ♪ 08	58 GSB P3	59 ♪ 07	60 GSB P3		61 ♪ 07	62 GSB P1	63 ♪ 06	64 GSB P1	65 ♪ 05	66 GSB P1	67 ♪ 05	68 GSB P1	69 ♪ 04	70 GSB P1	71 ♪ 03	72 GSB P1
4		73 ♪ 04	74 GSB P4	75 ♪ 04	76 GSB P4	77 ♪ 04	78 GSB P4	79 ♪ 04	80 GSB P4	81 ♪ 05	82 GSB P4	83 ♪ 04	84 GSB P4		85 ♪ 03	86 GSB P1	87 ♪ 03	88 GSB P1	89 ♪ 03	90 GSB P1	91 𝅗𝅥 03	92 —	93 ♪ 03		94 ♪ 15	95 GSB INV P5
5		96 ♪ 15	97 GSB INV P5	98 ♪ 15	99 GSB INV P5	100 ♪ 15	101 GSB INV P5	102 ♪ 04	103 GSB INV P5	104 ♪ 03	105 GSB INV P5		106 ♪ 03	107 GSB INV P6	108 ♪ 12	109 GSB INV P6	110 ♪ 12	111 GSB INV P6	112 ♪ 12	113 GSB INV P6	114 ♪ 02	115 GSB INV P6	116 ♪ 12	117 GSB INV P6		118 ♪ 18
6		119 GSB P3	120 ♪ 18	121 GSB P3	122 ♪ 18	123 GSB P3	124 ♪ 18	125 GSB P3	126 ♪ 19	127 GSB P3	128 ♪ 18	129 GSB P3		130 ♪ 18	131 GSB INV P7	132 ♪ 07	133 GSB INV P7	134 ♪ 07	135 GSB INV P7	136 ♪ 07	137 GSB INV P7	138 ♪ 18	139 GSB INV P7	140 ♪ 19	141 GSB INV P7	
7		142 ♪ 00	143 GSB INV P7	144 ♪ 00	145 GSB INV P7	146 ♪ 00	147 GSB INV P7	148 ♪ 00	149 GSB INV P7	150 ♪ 19	151 GSB INV P7	152 ♪ 09	153 GSB INV P7		154 ♪ 18	155 GSB INV P8	156 ♪ 18	157 GSB INV P8	158 ♪ 18	159 GSB INV P8	160 ♪ 18	161 GSB INV P8	162 ♪ 07	163 GSB INV P8	164 ♪ 06	165 GSB INV P8
8		166 ♪ 15	167 GSB INV P9	168 ♪ 15	169 GSB INV P9	170 ♪ 15	171 GSB INV P9	172 ♪ 15	173 GSB INV P9	174 ♪ 06	175 GSB INV P9	176 ♪ 04	177 GSB INV P9		178 ♪ 03	179 GSB INV P5	180 ♪ 03	181 GSB INV P5	182 ♪ 03	183 GSB INV P5	184 𝅗𝅥 03	185 —	186 ♪ 03	187 AC		
9																									Total 215	
10																										
11																										
12																										
13																										
14																										
15																										

CASIO PROGRAM SHEET

Tarantella napoletana	No. Music–4	FX-602P

Codes of notes



Duration

- Place the music overlay sheet on the calculator's keyboard. Duration of notes and rests are indicated on the sheet.
- Use the [−] key for a dotted note.

Example: ♩. : [♩][0][2][−][♪][0][2]

Rests	Input operation
𝄽	[♪][I]
𝄾	[♪][I]
𝄽	[♩][I]
𝄼	[♩][I]
𝄻	[○][I]

Tempo

Content of memory cell F	Tempo	Content of memory cell F	Tempo
0	♩ ≒ 40	5	♩ ≒ 240
1	♩ ≒ 80	6	♩ ≒ 280
2	♩ ≒ 120	7	♩ ≒ 320
3	♩ ≒ 160	8	♩ ≒ 360
4	♩ ≒ 200	9	♩ ≒ 400

Slur and tie

(1) Slur: Use the [+] key.

Example: [♩][0][3][+][♩][0][5][+][♩][0][7]

(2) Tie: Use the [−] key.

Example: [♩][0][5][−][♩][0][5]

Preparation

(1) Input the following program and data to the calculator.
(2) Set the FA-1's mode switches at MUSIC and SAVE/LOAD.
(3) Connect the white MIC plug to the cassette tape recorder's microphone jack. (It is not necessary to connect the EAR plug.)
(4) Load the cassette tape to the tape recorder and start recording.
(5) Depress [MODE] [1] (the calculator enters RUN mode) and [P0].
* You can listen to the tune through the earphone while it is being recorded by connecting the earphone to the tape recorder's earphone jack. When using a tape recorder with mic-mixing feature, you can listen to the tune from speaker.
(6) "0." on display shows that the recording is completed. You can enjoy music by playing back.

Note data (Contents in memories)					
00	la	147	10	la^{b}	156
01	si^{b}	139	11	mi	97
02	do	123	12	sol	82
03	re^{b}	116			
04	mi^{b}	103			
05	fa	92			
06	sol^{b}	87			
07	la^{b}	77			
08	si	68			
09	do	61			
Tempo data					
F		5 – 6			

Program

	Step	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
1	INV P9	♩ 05	♪ 05	♩ 08	–	♪ 08	♩ 05	–	♪ 05	♩ 05	♪ 05	♩ 06	♪ 06	♪ 06	♪ 07	♪ 06	♩ 05	–	♪ 05	♪ 05	♪ 06	♪ 05	♩ 05	♪ 04	♪ 04	♪ 05
2		26 ♪ 04	27 ♩ 04	28 ♪ 03	29 ♪ 03	30 ♪ 04	31 ♪ 03	32 ♩ 03	33 ♪ 02	34 ♪ 02	35 ♪ 03	36 ♪ 02	37 ♩ 01	38 –	39 ♪ 01	40 ♩ 08	41 ♪ 08	42 ♩ 05	43 ♪ 05	44 ♩ 08	45 –	46 ♪ 08	47 ♩ 05	48 –	49 ♪ 05	50 ♩ 05
3		51 ♪ 05	52 ♩ 06	53 ♪ 06	54 ♪ 06	55 ♪ 07	56 ♪ 06	57 ♩ 05	58 –	59 ♪ 05	60 ♪ 05	61 ♪ 06	62 ♪ 05	63 ♩ 05	64 ♪ 04	65 ♪ 04	66 ♪ 05	67 ♪ 04	68 ♩ 04	69 ♪ 03	70 ♪ 03	71 ♪ 04	72 ♪ 03			
4																										
5	INV P8	1 ♪ 03	2 ♪ 02	3 ♪ 03	4 ♪ 04	5 ♪ 03	6 ♪ 04	7 ♪ 03	8 ♪ 02	9 ♪ 03	10 ♪ 04	11 ♪ 03	12 ♪ 02	13 ♪ 03	14 ♪ 02	15 ♪ 01	16 ♪ 00	17 ♪ 01	18 ♪ 02	19 ♩ 01	20 –	21 ♪ 01	22 ♩ 01	23 ♪ 02	24 ♪ 03	25 ♪ 02
6		26 ♪ 03	27 ♪ 04	28 ♪ 03	29 ♪ 04	30 ♪ 05	31 ♪ 04	32 ♪ 05	33 ♪ 06	34 ♪ 05	35 ♪ 04															
7																										
8	INV P7	1 ♪ 03	2 ♪ 02	3 ♪ 03	4 ♪ 05	5 ♪ 11	6 ♪ 05	7 ♩ 07	8 ♪ 07	9 ♪ 07	10 ♪ 08	11 ♪ 07	12 ♩ 07	13 ♪ 06	14 ♪ 06	15 ♪ 07	16 ♪ 06	17 ♩ 06	18 ♪ 05	19 ♪ 10	20 ♪ 01	21 ♪ 02	22 ♪ 03	23 ♪ 02	24 ♪ 03	25 ♪ 05
9		26 ♪ 11	27 ♪ 05	28 ♩ 07	29 ♪ 07	30 ♪ 07	31 ♪ 12	32 ♪ 07																		
10																										
11	P0	1 ♩ 08	2 ♪ 08	3 GSB INV P9	4 ♩ 03	5 ♪ 02	6 ♪ 02	7 ♪ 03	8 ♪ 02	9 ♩ 01	10 –	11 ♪ 01	12 ♩ 01	13 ♪ 02	14 GSB INV P8	15 ♪ 03	16 ♪ 02	17 ♪ 01	18 ♪ 00	19 ♪ 01	20 ♪ 02	21 ♩ 01	22 –	23 ♪ 01	24 ♩ 01	25 ♪ 02
12		26 GSB INV P8	27 ♪ 03	28 ♪ 02	29 ♪ 01	30 ♪ 00	31 ♪ 01	32 ♪ 02	33 ♩ 01	34 –	35 ♪ 01	36 ♩ 08	37 ♪ 08	38 GSB INV P9	39 ♩ 03	40 ♪ 02	41 ♪ 02	42 ♪ 03	43 ♪ 02	44 ♩ 01	45 –	46 ♪ 01	47 ♪ 10	48 ♪ 01	49 ♪ 02	50 GSB INV P7
13		51 ♪ 09	52 ♪ 08	53 ♪ 07	54 ♪ 06	55 ♪ 05	56 ♪ 04	57 ♩ 03	58 –	59 ♪ 03	60 ♪ 10	61 ♪ 01	62 ♪ 02	63 GSB INV P7	64 ♪ 09	65 ♪ 08	66 ♪ 07	67 ♪ 06	68 ♪ 05	69 ♪ 04	70 ♩ 03	71 –	72 ♪ 03	73 AC		
14																								Total		216
15																										

CASIO PROGRAM SHEET

Program for	No.	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
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21			
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23			
24			
25			
26			
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30			
31			
32			
33			
34			
35			
36			
37			

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
1F	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
2F	

Note

CASIO PROGRAM SHEET

Program for	No.	

Description

• Input the program written in the next page.

Step	Data input operation	Read-out	Remark	Step	Data input operation	Read-out	Remark
	MODE 1			11			
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			

Program for

	Program	Remark	Step
	MODE 3 INV MAC MODE • 20 MODE 2		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
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31			
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35			
36			
37			

Note

Contents in memories	
00	
01	
02	
03	
04	
05	
06	
07	
08	
09	
F	
10	
11	
12	
13	
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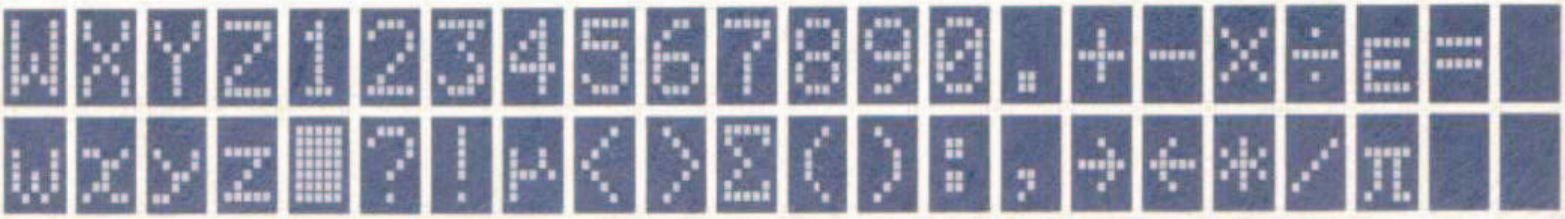
27	
28	
29	
2F	



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