HEWLETT hp PACKARD

HP-65

MATH PAC 2

CONTENTS

INTRODUCTION

Programs for your HP-65 Math Pac 2 have been selected from the areas of number theory, complex analysis, numerical analysis and miscellaneous higher functions.

Each program includes a general description, formulas used in the program solution, numerical examples, and user instructions. Program listings and register allocations are given in the back of the Pac.

Some related individual programs were combined on one card when it seemed they might be useful together. In this way more programs could be included in the Pac.

We hope you find the HP-65 Math Pac 2 a useful tool for your computational work, and welcome your comments, requests and suggestions–these are our most important source of future user-oriented programs.

FORMAT OF USER INSTRUCTIONS

The following is an example of a set of User Instructions.

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2	Clear registers		A	[ ]	
3	Perform 3–4 for i=1, ..., n	a_i	↑	[ ]	
4		b_i	B	[ ]	
5			C	[ ]	Answer
	(To run a new case, go to 2)		[ ]	[ ]	

To follow the instructions, start with line 1 and read from left to right, performing indicated operations as you proceed. Lines having no numbers contain special notes to the user and are inside parentheses in the INSTRUCTIONS column. The message "To run a new case, go to 2" following line 5 in the above example is a special note.

Lines are read in sequential order except where the INSTRUCTIONS column directs otherwise. For example, "go to 2" means to jump to line 2. Repeated processes–used in most cases for a long string of input/output data–are outlined with a bold border together with a "Perform" instruction. In the above example. "Perform 3–4 for i = 1, ..., n" means to execute the loop (line 3 and line 4) n times. The first time, the dummy variable i takes the value 1; the second time i takes the value 2; etc.

Normally, as in the above example, the first instruction is "Enter program" which means load the preprogrammed magnetic card (for instructions of loading a card, see "Entering A Program" on P. 7). Some instructions are self-contained and can be carried out by just reading the INSTRUCTIONS column alone, e.g., "Enter program". But some instructions depend on the information supplied by the DATA and/or KEYS columns. In line 2 of the example above, "Clear registers" appears in the INSTRUCTIONS column and **A** appears in the KEYS column, which means you have to clear the working registers by pressing the **A** key.

The DATA column specifies the input data to be supplied. Invalid arguments which result in division by zero, finding square root of a negative number, etc. will result in flashing zeros. Arguments out of the designated program range will result in incorrect answers or flashing zeros. When a computed value exceeds the calculator range, an overflow or underflow occurs and halts the program.

The KEYS column specifies the keys to be pressed. [↑] is the symbol used to denote the [ENTER↑] key. All other key designations are identical to those appearing on the HP-65. Ignore any blank positions in the KEYS column.

The DISPLAY column may show counters, intermediate or final results. In line 5 of the example, the answer will be displayed after pressing the C key.

ENTERING A PROGRAM

From the card case supplied with this application pac, select a program card.

Set W/PRGM-RUN switch to RUN.

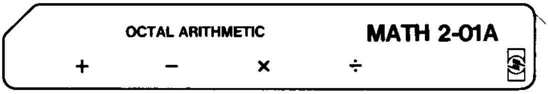
Turn the calculator ON. You should see 0.00

Gently insert the card (printed side up) in the right, lower slot as shown. When the card is part way in, the motor engages it and passes it out the left side of the calculator. Sometimes the motor engages but does not pull the card in. If this happens, push the card a little farther into the machine. Do not impede or force the card; let it move freely. (The display will flash if the card reads improperly. In this case, press [CLX] and reinsert the card.)

When the motor stops, remove the card from the left side of the calculator and insert it in the upper "window slot" on the right side of the calculator.

The program is now stored in the calculator. It remains stored until another program is entered or the calculator is turned off.

OCTAL ARITHMETIC



Given octal integers x, y, this program computes

$$y_8 \circ x_8$$

where operation ∘ can be +, –, x or ÷.

Examples:

1. $213_8 + 37507_8 = 37722_8$

2. $12_8 - 37_8 = -25_8$

3. $12345_8 \times 4567_8 = 61341563_8$

4. $16_8 \div 4_8 = 3.40_8$

Note: This program will accept non-octal input arguments containing the digits 8 or 9. A number such as 981_8 will be treated the same as 1201_8 ($8_8 = 10_8$, $9_8 = 11_8$).

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program			
2	Add	y	↑	
3		x	A	
4	Subtract	y	↑	
5		x	B	
6	Multiply	y	↑	
7		x	C	
8	Divide	y	↑	
9		x	D	

INTEGER BASE CONVERSION

This program can be used to convert an integer n in base B_1 to an equivalent integer in base B_2, where B_1, B_2 are integers such that $2 \leq B_i \leq 10$ $(i = 1, 2)$.

n is first converted to a decimal integer then the decimal integer is converted to an integer in base B_2.

Notes:

1. A non-integer entry is truncated to an integer which then is converted to its equivalent integer in the specified base.
2. This program will accept "invalid" input arguments; e.g., 981_8 will be treated the same as 1201_8 $(8_8 = 10_8, 9_8 = 11_8)$.

Examples:

1. $110_2 = 6_8$
2. $346_{10} = 2341_5$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		n	↑		
3		B_1	↑		
4		B_2	A		

BASE CONVERSION

BASE CONVERSION MATH 2-03A

This program converts a positive decimal number Q to its equivalent number R in base a ($Q_{10} \rightarrow R_a$), or converts a positive number R in base a to a decimal number Q ($R_a \rightarrow Q_{10}$).

The base a can be any integer such that $2 \leqslant a \leqslant 99$.

A number such as $4B6_{16}$ cannot be represented directly on the display because the display is strictly numeric. Therefore, some convention must be adopted to represent numbers R_a when $a > 10$. We use the convention of allocating two digit locations for each single character in R_a when $a > 10$.

For example, $4B6_{16}$ is represented as 041106_{16} by our convention (in hexadecimal system, A = 10, B = 11, C = 12, D = 13, E = 14, F = 15).
When displayed, this number may appear as 41106 or with an exponent

4.1106 04

which is interpreted as $4.B6 \times 16^2$.

The displayed exponent 4 is in base 10 and only serves to locate the decimal point (in the same manner as for decimal numbers).

When base $a > 10$ (as in the above example), divide the displayed exponent by 2 to get the true exponent of the number. When the displayed exponent is an odd integer, shift the decimal point of the displayed number one place (to the left or right) and adjust its exponent accordingly to make the true exponent an integer.

For example, the displayed number

1.112 –03

is interpreted as $B.C \times 16^{-2}$ or $0.BC \times 16^{-1}$.

Notes: 1. When the magnitude of the number is very large or very small, it takes a long time to execute this program. For integer (with base $a < 10$), use *Math 2–02A, Integer Base Conversion.*

2. This program will accept "invalid" input arguments; e.g., 981_8 will be treated the same as 1201_8 ($8_8 = 10_8$, $9_8 = 11_8$).

Examples:

1. $0.2937_{10} = 0.226277543_8$

   (Press DSP [•] [9] to see the number)

2. $1.23_{10} \times 10^{-12} = 1.5A36A_{16} \times 16^{-10}$

   (After pressing DSP [9], display shows 1.051003061–20)

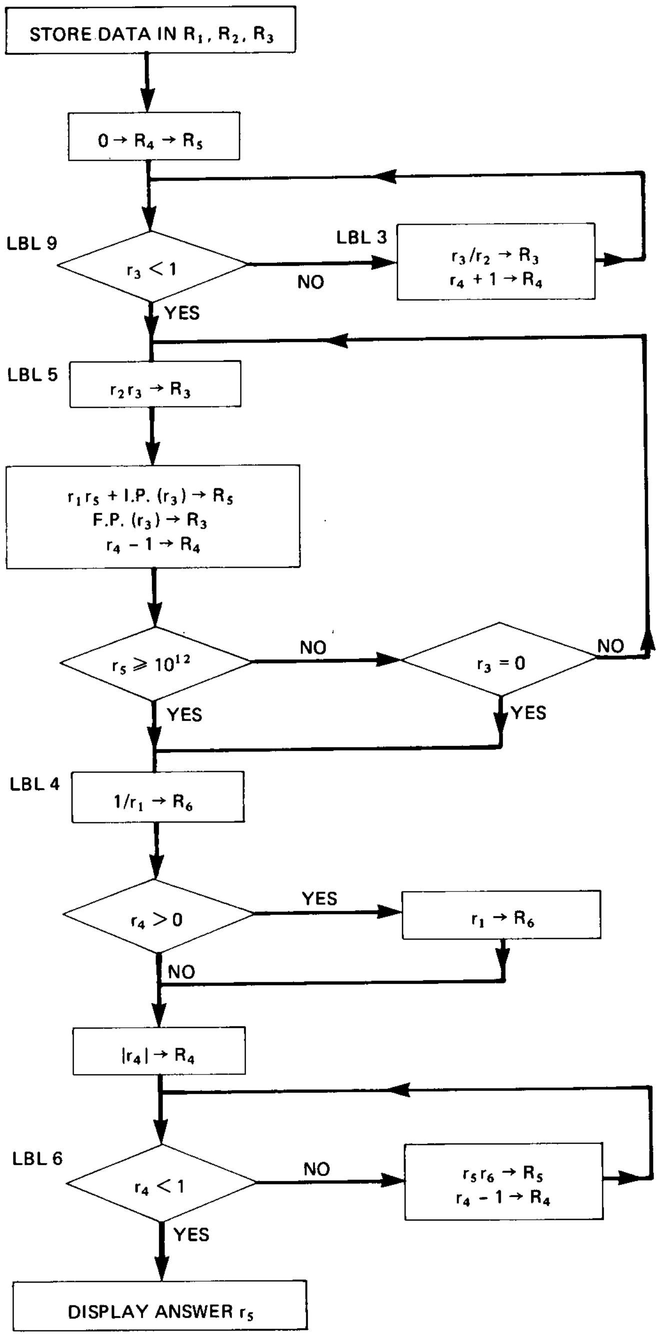
3. $7.200067_8 \times 8^{-10} = 6.752284070_{10} \times 10^{-9}$

   (Press 7.200067 [EEX] [CHS] 10 to enter the number $7.200067_8 \times 8^{-10}$ in the calculator.)

4. $D.2EE4_{16} \times 16^{12} = 3.7107314850_{10} \times 10^{15}$

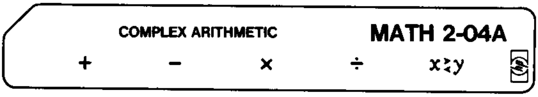
   (Press 13.02141404 [EEX] 24 to enter the number $D.2EE4_{16} \times \times 16^{12}$.)

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2	Convert $Q_{10} \rightarrow R_a$	Q	[↑]	[ ]	
3	If a≤10, c=10, if a>10, c=100	c	[↑]	[ ]	
4		a	[A]	[ ]	R
5	Convert $R_a \rightarrow Q_{10}$	R	[↑]	[ ]	
6		a	[↑]	[ ]	
7	If a≤10, c=10, if a>10, c=100	c	[A]	[ ]	Q



Note: I. P. = Integer Part
F. P. = Fractional Part

COMPLEX ARITHMETIC



1. $(x_1 + iy_1) + (x_2 + iy_2) = (x_1 + x_2) + i\,(y_1 + y_2)$

2. $(x_1 + iy_1) - (x_2 + iy_2) = (x_1 - x_2) + i\,(y_1 - y_2)$

3. $(x_1 + iy_1)(x_2 + iy_2) = r_1\, r_2\, e^{i(\theta_1 + \theta_2)}$

   where $x_1 + iy_1 = r_1\, e^{i\theta_1}$

   $x_2 + iy_2 = r_2\, e^{i\theta_2}$

4. $\dfrac{x_1 + iy_1}{x_2 + iy_2} = \dfrac{r_1}{r_2}\, e^{i(\theta_1 - \theta_2)}$, $x_2 + iy_2 \neq 0$

Notation: Let a + ib be the answer.

Examples:

1. $(3 + 4i) + (7.4 - 5.6i) = 10.40 - 1.60i$

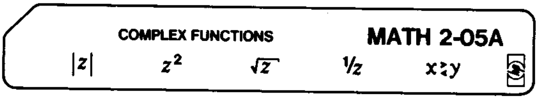
2. $(3 + 4i) - (7.4 - 5.6i) = -4.40 + 9.60i$

3. $(3.1 + 4.6i)(5 - 12i) = 70.70 - 14.20i$

4. $\frac{3 + 4i}{7 - 2i} = 0.25 + 0.64i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Add	y_1	↑		
3		x_1	↑		
4		y_2	↑		
5		x_2	A		a
6			E		b
7	Subtract	y_1	↑		
8		x_1	↑		
9		y_2	↑		
10		x_2	B		a
11			E		b
12	Multiply	y_1	↑		
13		x_1	↑		
14		y_2	↑		
15		x_2	C		a
16			E		b
17	Divide	y_1	↑		
18		x_1	↑		
19		y_2	↑		
20		x_2	D		a
21			E		b

COMPLEX FUNCTIONS |z|, z^2, $\sqrt{z}$, 1/z



Suppose z = x + iy, then

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

$$z^2 = (x^2 - y^2) + i\,(2xy)$$

$$\sqrt{z} = \begin{cases} \pm\sqrt{x}\,i & \text{if } y = 0 \text{ and } x < 0 \\ \pm\left[\sqrt{\dfrac{x+r}{2}} + i\,\dfrac{y}{2\sqrt{\dfrac{x+r}{2}}}\right] & \text{otherwise} \end{cases}$$

$$\frac{1}{z} = \frac{x}{r^2} - i\,\frac{y}{r^2} \qquad (z \neq 0)$$

where $r = \sqrt{x^2 + y^2}$

Notation: Let a + ib be the answer.

Examples:

1. $|3 + 4i| = 5.00$

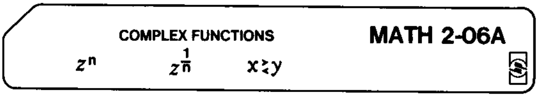
2. $(7 - 2i)^2 = 45.00 - 28.00i$

3. $\sqrt{7 + 6i} = \pm(2.85 + 1.05i)$

4. $\dfrac{1}{2 + 3i} = 0.15 - 0.23i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute $\|z\|$	y	↑		
3		x	A		$\|z\|$
4	Compute z^2	y	↑		
5		x	B		a
6			E		b
7	Compute $\sqrt{z}$	y	↑		
8		x	C		a
9			E		b
10	Compute $1/z$	y	↑		
11		x	D		a
12			E		b

COMPLEX FUNCTIONS z^n, $z^{1/n}$



Suppose $z = x + iy = re^{i\theta}$ then

$$z^n = r^n e^{i n\theta} = r^n (\cos n\theta + i \sin n\theta) = a + ib$$

$$z^{\frac{1}{n}} = r^{\frac{1}{n}} \left(\cos \frac{\theta + 360k}{n} + i \sin \frac{\theta + 360k}{n} \right) = x_k + iy_k$$

where θ is in degrees

n is a positive integer

and $k = 0, 1, ..., n - 1$.

Restriction: $z \neq 0$

Examples:

1. $(3 + 4.5i)^5 = 926.44 - 4533.47i$

2. 5 + 3i has three cube roots:

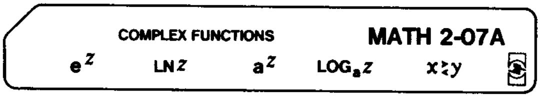
$x_0 + iy_0 = 1.77 + 0.32i$

$x_1 + iy_1 = -1.16 + 1.37i$

$x_2 + iy_2 = -0.61 - 1.69i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute z^n	y	↑		
3		x	↑		
4		n	A		a
5			C		b
6	Compute $z^{1/n}$	y	↑		
7		x	↑		
8		n	B		x_0
9			R/S		y_0
10	Perform 10-11 for k=1,2,...,n−1		R/S		x_k
11			R/S		y_k
	(Subroutine B sets machine in				
	DEG mode)				

COMPLEX FUNCTIONS e^z, $\ln z$, a^z, $\log_a z$



Suppose $z = x + iy = re^{i\theta}$, then

1. $e^z = e^x (\cos y + i \sin y)$, where y is in radians

2. $\ln z = \ln r + i\theta$, where $z \neq 0$

3. $a^z = e^{z \ln a}$, where $a > 0$

4. $\log_a z = \dfrac{\ln z}{\ln a}$, where $a > 0, z \neq 0$

Notation: Let u + iv be the answer.

Reference: Complex Analysis, L. V. Ahlfors, McGraw-Hill, 1966

Examples:

1. $e^{3+4i} = -13.13 - 15.20i$

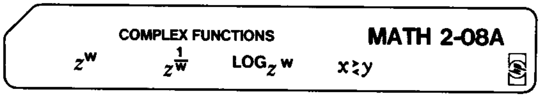
2. $\ln i = 1.57i$

3. $2^{3+4i} = -7.46 + 2.89i$

4. $\log_2(-7.46 + 2.89i) = 3.00 + 4.00i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute e^z	y	↑		
3		x	A		u
4			E		v
5	Compute ln z	y	↑		
6		x	B		u
7			E		v
8	Compute a^z	y	↑		
9		x	↑		
10		a	C		u
11			E		v
12	Compute $\log_a z$	y	↑		
13		x	↑		
14		a	D		u
15			E		v
	(Machine now is in RAD mode)				

COMPLEX FUNCTIONS z^w, $z^{1/w}$, $\log_z w$



Suppose $z = x + iy$, $w = u + iv$, then

1. $z^w = e^{w \ln z}$, where $z \neq 0$

2. $z^{\frac{1}{w}} = e^{\ln z/w}$, where $z \neq 0$, $w \neq 0$

3. $\log_z w = \dfrac{\ln w}{\ln z}$, where $z \neq 0$, $w \neq 0$

Notation: Let $a + ib$ be the answer.

Examples:

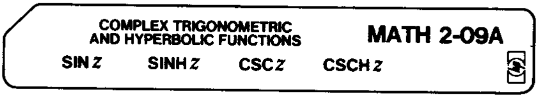
1. $(1 + i)^{(2-i)} = 1.49 + 4.13i$

2. $(1.49 + 4.13i)^{\frac{1}{2-i}} = 1.00 + 1.00i$

3. $\log_{(1+i)} (1.49 + 4.13i) = 2.00 - 1.00i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute z^w	v	↑		
3		u	↑		
4		y	↑		
5		x	A		a
6			D		b
7	Compute $z^{1/w}$	v	↑		
8		u	↑		
9		y	↑		
10		x	B		a
11			D		b
12	Compute $\log_z w$	v	↑		
13		u	↑		
14		y	↑		
15		x	C		a
16			D		b
	(Machine now is in RAD mode)				

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS sin z, sinh z, csc z, csch z



Suppose z = x + iy, then

1. sin z = sin x cosh y + i cos x sinh y

2. sinh z = –i sin i z

3. $\csc z = \dfrac{1}{\sin z}$

4. csch z = i csc i z

Restriction: z can not be a singular point of the function or flashing zeros will result.

Notes: 1. All angles are in radians.

2. Let a + ib be the answer.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. sin (2 + 3i) = 9.15 – 4.17i

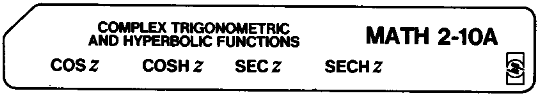
2. sinh (3 – 2i) = –4.17 – 9.15i

3 csc (2 + 3i) = 0.09 + 0.04i

4. csch (1 + 2i) = –0.22 – 0.64i

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute sin z	y	↑		
3		x	A		a
4			R/S		b
5	Compute sinh z	y	↑		
6		x	B		a
7			R/S		b
8	Compute csc z	y	↑		
9		x	C		a
10			R/S		b
11	Compute csch z	y	↑		
12		x	D		a
13			R/S		b
	(Machine now is in RAD mode)				

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS cos z, cosh z, sec z, sech z



Suppose z = x + iy, then

1. cos z = cos x cosh y – i sin x sinh y

2. cosh z = cos iz

3. $\sec z = \dfrac{1}{\cos z}$

4. sech z = sec iz

Restriction: z can not be a singular point of the function or flashing zeros will result.

Notes: 1. All angles are in radians.

2. Let a + ib be the answer.

Examples:

1. $\cos 2 = -0.42$

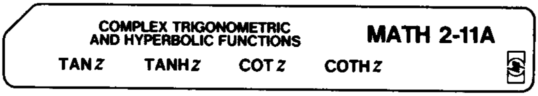
2. $\cosh(1 + 2i) = -0.64 + 1.07i$

3. $\sec(2 + 3i) = -0.04 + 0.09i$

4. $\operatorname{sech}(1 + 2i) = -0.41 - 0.69i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute cos z	y	↑		
3		x	A		a
4			R/S		b
5	Compute cosh z	y	↑		
6		x	B		a
7			R/S		b
8	Compute sec z	y	↑		
9		x	C		a
10			R/S		b
11	Compute sech z	y	↑		
12		x	D		a
13			R/S		b
	(Machine now is in RAD mode)				

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS tan z, tanh z, cot z, coth z



Suppose z = x + iy, then

1. $\tan z = \dfrac{\sin 2x + i \sinh 2y}{\cos 2x + \cosh 2y}$

2. $\tanh z = \dfrac{\sinh 2x + i \sin 2y}{\cosh 2x + \cos 2y}$

3. $\cot z = \dfrac{\sin 2x - i \sinh 2y}{\cosh 2y - \cos 2x}$

4. $\coth z = \dfrac{\sinh 2x - i \sin 2y}{\cosh 2x - \cos 2y}$

Restriction: z can not be a singular point of the function or flashing zeros will result.

Notes:
1. All angles are in radians.
2. Let a + ib be the answer.

Examples:

1. tan 4 = 1.16

2. tanh (1 + 2i) = 1.17 – 0.24i

3. cot (4 + 0.01i) = 0.86 – 0.02i

4. coth (1 + 2i) = 0.82 + 0.17i

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute tan z	y	↑		
3		x	A		a
4			R/S		b
5	Compute tanh z	y	↑		
6		x	B		a
7			R/S		b
8	Compute cot z	y	↑		
9		x	C		a
10			R/S		b
11	Compute coth z	y	↑		
12		x	D		a
13			R/S		b
	(Machine now is in RAD mode)				

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS
$\sin^{-1} z$, $\sinh^{-1} z$, $\csc^{-1} z$, $\operatorname{csch}^{-1} z$

Suppose $z = x + iy$, then

1. $\sin^{-1} z = k\pi + (-1)^k \sin^{-1}\beta + (-1)^k i \operatorname{sgn}(y) \ln[\alpha + (\alpha^2 - 1)^{1/2}]$

   where

$$\alpha = \frac{1}{2}\sqrt{(x+1)^2 + y^2} + \frac{1}{2}\sqrt{(x-1)^2 + y^2}$$

$$\beta = \frac{1}{2}\sqrt{(x+1)^2 + y^2} - \frac{1}{2}\sqrt{(x-1)^2 + y^2}$$

$$\operatorname{sgn}(y) = \begin{cases} 1 & \text{if } y \geq 0 \\ -1 & \text{if } y < 0 \end{cases}$$

k is an integer.

2. $\sinh^{-1} z = -i \sin^{-1} iz$

3. $\csc^{-1} z = \sin^{-1} \frac{1}{z} \qquad (z \neq 0)$

4. $\operatorname{csch}^{-1} z = i \csc^{-1} iz \qquad (z \neq 0)$

Notes:
1. All angles are in radians.
2. Inverse trigonometric and hyperbolic functions are multiple-valued functions. The programs will compute one answer only ($k = 0$).
3. Let $a + ib$ be the answer.

Examples:

1. $\sin^{-1}(5 + 8i) = 0.56 + 2.94i$

2. $\sinh^{-1}(3.14 + 10.3i) = 3.07 + 1.27i$

3. $\csc^{-1}(5 + 8i) = 0.06 - 0.09i$

4. $\operatorname{csch}^{-1}(3.14 + 10.3i) = 0.03 - 0.09i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute $\sin^{-1} z$	y	↑		
3		x	A		a
4			R/S		b
5	Compute $\sinh^{-1} z$	y	↑		
6		x	B		a
7			R/S		b
8	Compute $\csc^{-1} z$	y	↑		
9		x	C		a
10			R/S		b
11	Compute $\operatorname{csch}^{-1} z$	y	↑		
12		x	D		a
13			R/S		b
	(Machine now is in RAD mode)				

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS
$\cos^{-1} z$, $\cosh^{-1} z$, $\sec^{-1} z$, $\operatorname{sech}^{-1} z$

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS — MATH 2-13A

COS^{-1}z COSH^{-1}z SEC^{-1}z SECH^{-1}z

Suppose z = x + iy, then

1. $\cos^{-1} z = 2k\pi \pm \left\{\cos^{-1} \beta - i\, \operatorname{sgn}(y) \ln \left[\alpha + (\alpha^2 - 1)^{1/2}\right]\right\}$

   where

$$\alpha = \frac{1}{2}\sqrt{(x+1)^2 + y^2} + \frac{1}{2}\sqrt{(x-1)^2 + y^2}$$

$$\beta = \frac{1}{2}\sqrt{(x+1)^2 + y^2} - \frac{1}{2}\sqrt{(x-1)^2 + y^2}$$

$$\operatorname{sgn}(y) = \begin{cases} 1 & \text{if } y \geq 0 \\ -1 & \text{if } y < 0 \end{cases}$$

k is an integer.

2. $\cosh^{-1} z = i \cos^{-1} z$

3. $\sec^{-1} z = \cos^{-1} \frac{1}{z}$ $(z \neq 0)$

4. $\operatorname{sech}^{-1} z = i \sec^{-1} z$ $(z \neq 0)$

Notes:
1. All angles are in radians.
2. Inverse trigonometric and hyperbolic functions are multiple-valued functions. The program will compute one answer only (k = 0).
3. Let a + bi be the answer.

Examples:

1. $\cos^{-1}(0.9) = 0.45$

2. $\cosh^{-1}(5 + 8i) = 2.94 + 1.01i$

3. $\sec^{-1}(5) = 1.37$

4. $\text{sech}^{-1}(5 + 8i) = -0.09 + 1.51i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute $\cos^{-1} z$	y	↑		
3		x	A		a
4			R/S		b
5	Compute $\cosh^{-1} z$	y	↑		
6		x	B		a
7			R/S		b
8	Compute $\sec^{-1} z$	y	↑		
9		x	C		a
10			R/S		b
11	Compute $\text{sech}^{-1} z$	y	↑		
12		x	D		a
13			R/S		b
	(Machine now is in RAD mode)				

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS $\tan^{-1} z$, $\tanh^{-1} z$, $\cot^{-1} z$, $\coth^{-1} z$

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS				MATH 2-14A
$TAN^{-1}z$	$TANH^{-1}z$	$COT^{-1}z$	$COTH^{-1}z$	$x \rightleftarrows y$

Suppose $z = x + iy$

1. $$\tan^{-1} z = \frac{1}{2}\left[(2k+1)\pi - \tan^{-1}\frac{1+y}{x} - \tan^{-1}\frac{1-y}{x}\right] + \frac{i}{4}\ln\left[\frac{(1+y)^2 + x^2}{(1-y)^2 + x^2}\right] \qquad (z^2 \neq -1)$$

   where k is an integer.

2. $\tanh^{-1} z = -i \tan^{-1} iz \qquad (z^2 \neq 1)$

3. $\cot^{-1} z = \frac{\pi}{2} - \tan^{-1} z \qquad (z^2 \neq -1)$

4. $\coth^{-1} z = i \cot^{-1} iz \qquad (z^2 \neq 1)$

Notes:

1. All angles are in radians.
2. Inverse trigonometric and hyperbolic functions are multiple-valued functions. The program will compute one answer only ($k = 0$).
3. Let $a + ib$ be the answer.

Examples:

1. $\tan^{-1}(5) = 1.37$

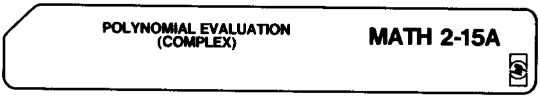
2. $\tanh^{-1}(8 - 5i) = 0.09 - 1.51i$

3. $\cot^{-1}(5 + 8i) = 0.06 - 0.09i$

4. $\coth^{-1}(-7i) = 0.14i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2	Compute $\tan^{-1} z$	y	[↑]	[ ]	
3		x	[A]	[ ]	a
4			[E]	[ ]	b
5	Compute $\tanh^{-1} z$	y	[↑]	[ ]	
6		x	[B]	[ ]	a
7			[E]	[ ]	b
8	Compute $\cot^{-1} z$	y	[↑]	[ ]	
9		x	[C]	[ ]	a
10			[E]	[ ]	b
11	Compute $\coth^{-1} z$	y	[↑]	[ ]	
12		x	[D]	[ ]	a
13			[E]	[ ]	b
	(Machine now is in RAD mode)		[ ]	[ ]	

POLYNOMIAL EVALUATION (COMPLEX)



Given a polynomial (with complex coefficients) of the form

$$f(z) = c_0 z^n + c_1 z^{n-1} + \ldots + c_{n-1} z + c_n$$

this program evaluates $f(z_0) = a + ib$ for any complex number z_0

where $c_k = a_k + ib_k \qquad k = 0, 1, 2, \ldots, n$

$z_0 = x_0 + iy_0$

Example:

$f(z) = (3 + 4i)\,z^4 + 18z^3 + (-2 + i)\,z^2 - 10z + (5 - 7i)$

For $z_0 = 2 + i$

$f(z_0) = -106.00 + 220.00i$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		b_0	↑		
3		a_0	↑		
4		y_0	↑		
5		x_0	A		
6	Perform 6–7 for k = 1, 2, ..., n – 1	b_k	↑		
7		a_k	B		
8		b_n	↑		
9		a_n	C		a
10			R/S		b

INTERSECTIONS OF A LINE AND A CONIC SECTION

The program finds the intersections (x_1, y_1), (x_2, y_2) of

$$\begin{cases} ax + by + c = 0 \\ Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0 \end{cases}$$

$$x_1 = -(by_1 + c)/a \quad (\text{if } a \neq 0)$$

$$y_1 = \frac{-\beta + \sqrt{\beta^2 - 4\alpha\gamma}}{2\alpha}$$

$$x_2 = -(by_2 + c)/a$$

$$y_2 = \frac{-\beta - \sqrt{\beta^2 - 4\alpha\gamma}}{2\alpha}$$

where

$$\alpha = \frac{Ab^2}{a^2} - \frac{Bb}{a} + C$$

$$\beta = \frac{2Abc}{a^2} - \frac{Bc}{a} - \frac{Db}{a} + E$$

$$\gamma = \frac{Ac^2}{a^2} - \frac{Dc}{a} + F$$

Notes:

1. This program also handles the case when $a = 0$ (and $b \neq 0$). It solves the problem by interchanging the roles of x and y.
2. If $Q = \beta^2 - 4\alpha\gamma < 0$ there are no real solutions; display will show all 9's.
3. If there is only one intersection, display will show flashing zeros. This program will not find the intersection in this case.

Examples:

1. $\begin{cases} 3x + 4y + 5 = 0 \\ 2x^2 - 3xy + y^2 + x + 10y + 7 = 0 \end{cases}$

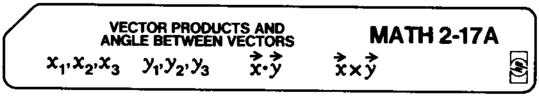
$\begin{cases} x_1 = -0.82 \\ y_1 = -0.64 \end{cases}$ $\begin{cases} x_2 = 1.00 \\ y_2 = -2.00 \end{cases}$

2. $\begin{cases} y - 1 = 0 \\ x^2 + y^2 = 4 \end{cases}$

$\begin{cases} x_1 = 1.73 \\ y_1 = 1.00 \end{cases}$ $\begin{cases} x_2 = -1.73 \\ y_2 = 1.00 \end{cases}$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2		a	↑		
3		b	↑		
4		c	A		
5		A	↑		
6		B	↑		
7		C	B		
8		D	↑		
9		E	↑		
10		F	R/S		
11	Enter program on card 2		A		x_1
12			R/S		y_1
13			R/S		x_2
14			R/S		y_2

VECTOR PRODUCTS AND ANGLE BETWEEN VECTORS



$\vec{x} = (x_1, x_2, x_3)$, $\vec{y} = (y_1, y_2, y_3)$ are two vectors in a 3-dimensional space.

dot product $\vec{x} \cdot \vec{y} = x_1 y_1 + x_2 y_2 + x_3 y_3$

cross product $\vec{z} = \vec{x} \times \vec{y} = (x_2 y_3 - x_3 y_2, x_3 y_1 - x_1 y_3, x_1 y_2 - x_2 y_1)$

$= (z_1, z_2, z_3)$

angle between $\vec{x}$ and $\vec{y}$

$$\theta \doteq \cos^{-1}\left(\frac{\vec{x} \cdot \vec{y}}{|\vec{x}|\,|\vec{y}|}\right)$$

where

$$|\vec{x}| = \sqrt{x_1^2 + x_2^2 + x_3^2}$$

$$|\vec{y}| = \sqrt{y_1^2 + y_2^2 + y_3^2}$$

Examples:

$\vec{x} = (2.34, 5.17, 7.43)$

$\vec{y} = (0.072, 0.231, 0.409)$

$\vec{x} \cdot \vec{y} = 4.40$

$\theta = 7.82° = 0.14$ radians $= 8.68$ grads

$|\vec{x}| = 9.35$

$|\vec{y}| = 0.48$

$\vec{x} \times \vec{y} = (0.40, -0.42, 0.17)$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		x_1	↑		
3		x_2	↑		
4		x_3	A		
5		y_1	↑		
6		y_2	↑		
7		y_3	B		
8	Compute $\vec{x} \cdot \vec{y}$ and θ		C		$\vec{x} \cdot \vec{y}$
9			R/S		θ
10			R/S		$\lvert\vec{x}\rvert$
11			R/S		$\lvert\vec{y}\rvert$
12	Compute $\vec{x} \times \vec{y}$		D		z_1
13			R/S		z_2
14			R/S		z_3

PARTIAL SUM AND PARTIAL PRODUCT

This program will evaluate sums or products of the form

$$\sum_{k=n}^{N} f(k, x) \quad \text{or} \quad \prod_{k=n}^{N} f(k, x)$$

and, in particular, sums or products of the form

$$\sum_{k=n}^{N} g(k) \quad \text{or} \quad \prod_{k=n}^{N} g(k)$$

Note: f(k, x) or g(k) must be programmed in the calculator by the user. Assuming the value in the X register to be k and the value in register R_1 to be x, 42 memory locations, the stack registers and registers R_4, R_5, R_6, R_7, R_9 are available for evaluating the function.

Examples:

1. $\sum_{k=1}^{10} x^k = 0.999023438$ for $x = 0.5$

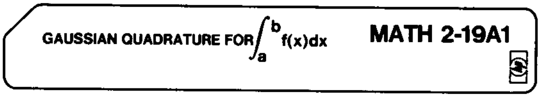
Keys for f(k, x): [RCL] [1] [g] [x⇄y] [g] [y^x]

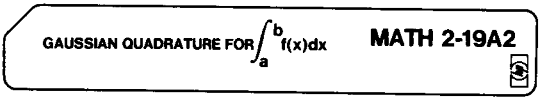
2. $\prod_{k=1}^{10} k = 10! = 3628800.00$

Keys for g(k): none

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2			GTO	C	
3	Switch to PRGM mode				
4	Enter f(k, x) or g(k)		RTN		
5	Switch to RUN mode				
	(For partial product, go to 9)				
6	Compute partial sum	n	↑		
7		N	↑		
8	In the case of g(k), let x = 1.	x	A		Σ
9	Compute partial product	n	↑		
10		N	↑		
11		x	B		Π
	(For new values of n, N, x, go				
	to 6 or 9. For a new function,				
	go to 2)				

GAUSSIAN QUADRATURE FOR $\int_a^b f(x)\,dx$





The program computes the value

$$\int_a^b f(x)\,dx$$

for finite a, b and single-valued function f(x) by the six point Gauss-Legendre quadrature formula

$$\int_a^b f(x) \cong \frac{b-a}{2} \sum_{i=1}^{6} w_i\, f\left(\frac{z_i(b-a)+b+a}{2}\right)$$

where

$$\begin{aligned}
z_1 &= -z_2 = .2386191861\\
z_3 &= -z_4 = .6612093865\\
z_5 &= -z_6 = .9324695142\\
w_1 &= w_2 = .4679139346\\
w_3 &= w_4 = .360761573\\
w_5 &= w_6 = .1713244924
\end{aligned}$$

Note: f(x) must be programmed in the calculator by the user. Assuming the value in the X register to be x, 18 memory locations and the stack registers are available for f(x).

Reference: Applied Numerical Methods, Carnahan, Luther and Wilks, John Wiley and Sons, 1969

Examples:

1. $$\int_{1}^{10} \frac{dx}{x} \cong 2.30$$

Keys for f(x): [g] [1/x]

Correct answer is ln 10.

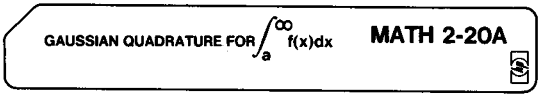
2. $$\int_{e}^{e^2} \frac{dx}{x(\ln x)^3} \cong 0.37$$

Keys for f(x): [↑] [f] [LN] 3 [g] [y^x] [×] [g] [1/x]

Correct answer is $\frac{3}{8}$.

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2			A		
3	Enter program on card 2				
4			GTO	A	
5	Switch to PRGM mode				
6	Enter f(x)				
7	Switch to RUN mode				
8		a	↑		
9		b	C		
	(For new values of a, b, go to 8.				
	For a new f(x), go to 3.)				

GAUSSIAN QUADRATURE FOR $\int_a^{\infty} f(x)\,dx$



This program computes the value

$$\int_a^{\infty} f(x)\,dx$$

for finite a and single-valued function f(x) by the six point Gauss-Legendre quadrature formula

$$\int_a^{\infty} f(x)\,dx \cong \frac{1}{2}\sum_{i=1}^{6} \frac{4w_i}{(1+z_i)^2}\, f\left(\frac{2}{1+z_i} + a - 1\right)$$

where
$z_1 = -z_2 = .2386191861$

$z_3 = -z_4 = .6612093865$

$z_5 = -z_6 = .9324695142$

$w_1 = w_2 = .4679139346$

$w_3 = w_4 = .360761573$

$w_5 = w_6 = .1713244924$

Note: f(x) must be programmed in by the user. Assuming the value in the X register to be x, 24 memory locations and the stack registers are available for f(x).

Reference: Applied Numerical Methods, Carnahan, Luther and Wilks, John Wiley and Sons, 1969

Examples:

1. $$\int_0^\infty e^{-x}\, x^{0.8}\, dx \cong 0.92$$

Keys for f(x): [CHS] [f⁻¹] [LN] [g] [LST X] [CHS] .8 [g] [yˣ] [×]

Correct answer is $\Gamma(1.8) = 0.931383771$

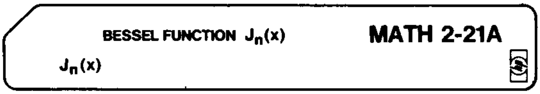
2. $$\int_0^\infty \frac{dx}{(x^2+1)(x^2+4)^2} \cong 0.05$$

Keys for f(x): [f⁻¹] [√x] 1 [+] [↑] [↑] 3 [+] [f⁻¹] [√x] [×] [g] [1/x]

Correct answer is $\frac{5\pi}{288}$.

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program *Math 2–19A1*		[ ] [ ]	
2			[A] [ ]	
3	Enter program *Math 2–20A*		[ ] [ ]	
4			[GTO] [A]	
5	Switch to PRGM mode		[ ] [ ]	
6	Enter f(x)		[ ] [ ]	
7	Switch to RUN mode		[ ] [ ]	
8		a	[C] [ ]	
	(For a new value of a, go to 8.		[ ] [ ]	
	For a new f(x), go to 3.)		[ ] [ ]	

BESSEL FUNCTION $J_n(x)$



This program computes the value of the Bessel function $J_n(x)$ by using a numerical method which makes use of the recurrence relation

$$J_{n-1}(x) = \frac{2n}{x} J_n(x) - J_{n+1}(x)$$

the summation relation

$$J_0(x) + 2 \sum_{i=1}^{\infty} J_{2i}(x) = 1$$

and the fact that

$$\lim_{n \to \infty} J_n(x) = 0$$

First let

$$m = \text{INT}\left\{ 1 + 3x^{\frac{1}{12}} + 9x^{\frac{1}{3}} + \max(n, x) \right\}$$

where INT means "integer part of".

Then set

$$T_m = a \qquad\qquad T_{m+1} = 0$$

where a is an arbitrary non-zero constant.

Then the series of terms, T_k, $0 \leq k \leq m$, is computed by successively applying the relation

$$T_{k-1}(x) = \frac{2k}{x} T_k(x) - T_{k+1}(x)$$

starting with k = m.

$J_n(x)$ is then found by dividing the term $T_n(x)$ by the normalizing constant

$$K = T_0(x) + 2 \sum_{i=1}^{p} T_{2i}(x)$$

where

$$p = \begin{cases} \dfrac{m}{2} & \text{if m is even} \\ \dfrac{m-1}{2} & \text{if m is odd} \end{cases}$$

Note that all the T_k are proportional to a, hence K and the result are independent of a.

Note: $J_0(x) = 1$ for $x \leq 10^{-6}$ but it is out of range for this program.

Examples:

1. $J_0(4.7) = -0.27$

2. $J_5(9.2) = -0.10$

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program		[ ] [ ]	
2		n	[↑] [ ]	
3		x	[A] [ ]	

KELVIN FUNCTIONS

KELVIN FUNCTIONS MATH 2-22A

$$\mathrm{ber}\,(x) = 1 - \frac{\left(\frac{1}{4}x^2\right)^2}{(2!)^2} + \frac{\left(\frac{1}{4}x^2\right)^4}{(4!)^2} - \cdots$$

$$\mathrm{bei}\,(x) = \frac{1}{4}x^2 - \frac{\left(\frac{1}{4}x^2\right)^3}{(3!)^2} + \frac{\left(\frac{1}{4}x^2\right)^5}{(5!)^2} - \cdots$$

This program computes successive partial sums of the series. The program stops and displays the last partial sum as the answer, when two consecutive partial sums are equal or more than 50 terms have been added.

Notes: 1. When x is too large, computing a new term of the series might cause an overflow, in that case, display shows all 9's and the program stops.

2. ber (–x) = ber (x), bei (–x) = bei (x)

Examples:

1. ber (4.4) = –3.93

2. bei (0.6) = 0.09

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	For ber (x)	0	↑		
3		x	A		
4	For bei (x)	1	↑		
5		x	A		

EULER Φ FUNCTION

Φ(n) is the number of integers not exceeding and relatively prime to n, where n is a non-negative integer.

Suppose

$$n = p_1^{m_1} p_2^{m_2} \ldots p_k^{m_k}$$

where p_i (i = 1, 2, ..., k) are distinct primes dividing n, then

$$\Phi(n) = n \prod_{i=1}^{k} \left(1 - \frac{1}{p_i}\right)$$

$$= \prod_{i=1}^{k} (p_i^{m_i} - p_i^{m_i - 1})$$

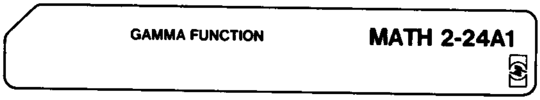
Examples:

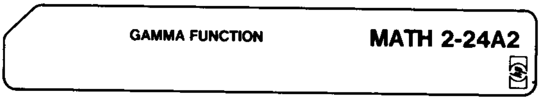
1. Φ (30) = 8.00

2. Φ (251) = 250.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		n	A		

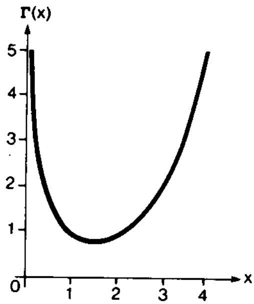
GAMMA FUNCTION





This program approximates the value of gamma function $\Gamma(x)$ for $1 \leq x < 70$.

$$\Gamma(x) = \int_0^\infty t^{x-1} e^{-t} dt$$



1. $\Gamma(x) = (x - 1)\, \Gamma(x - 1)$
2. For $1 \leq x \leq 2$, polynomial approximation can be used.

$$\Gamma(x) \cong 1 + b_1 (x - 1) + b_2 (x - 1)^2 + \ldots + b_8 (x - 1)^8$$

where $b_1 = -0.577191652$, $b_2 = 0.988205891$
$b_3 = -0.897056937$, $b_4 = 0.918206857$
$b_5 = -0.756704078$, $b_6 = 0.482199394$
$b_7 = -0.193527818$, $b_8 = 0.035868343$

Note: This program can be used to find the generalized factorial x! for $0 \leq x < 69$.

$$x! = \Gamma(x + 1)$$

Examples:

1. $\Gamma(5.25) = 35.21$
2. $7! = \Gamma(8) = 5040.00$
3. $2.34! = \Gamma(3.34) = 2.80$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program on card 1				
2			A		
3	Enter program on card 2				
4		x	A		
	(For a new value of x, go to 4.)				

INCOMPLETE GAMMA FUNCTION

INCOMPLETE GAMMA FUNCTION **MATH 2-25A**
γ (a, x)

$$\gamma(a, x) = \int_0^x e^{-t}\, t^{a-1}\, dt$$

$$= x^a e^{-x} \sum_{n=0}^{\infty} \frac{x^n}{a(a+1)\ldots(a+n)}$$

where $a > 0, x > 0$.

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.

Note: When x is too large, computing a new term of the series might cause an overflow. In that case, display shows all 9's and the program stops.

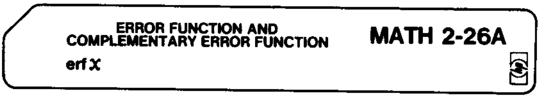
Examples:

1. $\gamma(1, 2) = 0.86$

2. $\gamma(1, 0.1) = 0.10$

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program		[ ] [ ]	
2		a	[↑] [ ]	
3		x	[A] [ ]	

ERROR FUNCTION AND COMPLEMENTARY ERROR FUNCTION



Error function $\text{erf}\, x = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt$

$$= \frac{2}{\sqrt{\pi}} e^{-x^2} \sum_{n=0}^{\infty} \frac{2^n}{1 \cdot 3 \cdot \ldots \cdot (2n+1)} x^{2n+1}$$

Complementary error function

$$\text{erfc}\, x = 1 - \text{erf}\, x$$

where $x > 0$

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.

Note: When x is too large, computing a new term of the series might cause an overflow. In that case, display shows all 9's and the program stops.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

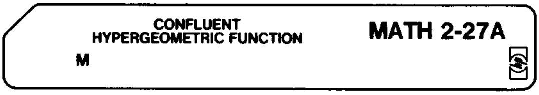
Example:

erf (1.34) = 0.94

erfc (1.34) = 0.06

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		x	A		erf
3			R/S		erfc

CONFLUENT HYPERGEOMETRIC FUNCTION



$$M(a, b, x) = 1 + \frac{a}{b} x + \frac{(a)_2}{(b)_2} \frac{x^2}{2!} + \ldots + \frac{(a)_n}{(b)_n} \frac{x^n}{n!} + \ldots$$

where $(a)_0 = 1$

$(a)_n = a(a + 1) \ldots (a + n - 1)$

$(b)_0 = 1$

$(b)_n = b(b + 1) \ldots (b + n - 1)$

$b \neq -m \ (m = 0, 1, 2, \ldots)$

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

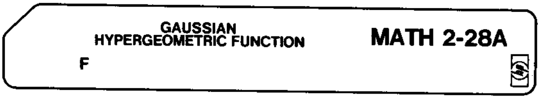
Examples:

1. M(0.6, 0.8, 0.1) = 1.08

2. M(–1, 1, 8) = –7.00

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		a	↑		
3		b	↑		
4		x	A		

GAUSSIAN HYPERGEOMETRIC FUNCTION



$$F(a, b; c; x) = F(b, a; c; x)$$

$$= \sum_{k=0}^{\infty} \frac{(a)_k (b)_k x^k}{(c)_k \, k!}$$

where $|x| < 1$.

The series is not defined if $c = -m$ ($m = 0, 1, 2, \ldots$) except when a or b is equal to $-l$ ($l = 0, 1, 2, \ldots$) with $l < m$.

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.

Notation: $(d)_0 = 1$

$$(d)_k = d\,(d+1)\,(d+2) \ldots (d+k-1)$$

where d = a, b, or c

Some special cases are:

1. $F\left(-n, n; \frac{1}{2}; x\right) = T_n(1-2x)$

2. $F(-n, n+1; 1; x) = P_n(1-2x)$

3. $F\left(-n, n+2\alpha; \alpha+\frac{1}{2}; x\right) = \frac{n!}{(2\alpha)_n} C_n^{(\alpha)}(1-2x)$

4. $F(-n, \alpha+1+\beta+n; \alpha+1; x) = \frac{n!}{(\alpha+1)_n} P_n^{(\alpha,\beta)}(1-2x)$

where T_n, P_n, $C_n^{(\alpha)}$, $P_n^{(\alpha,\beta)}$ denote Chebyshev, Legendre's, Gegenbauer's and Jacobi's polynomials respectively.

Note: Displayed flashing zeros indicate that

1. The series is undefined for the set of input arguments.

   or

2. The program has not found the sum of the series to desired accuracy after the first 400 terms have been added. This is likely to occur when $|x|$ is near 1 (the series converges slowly in that region).

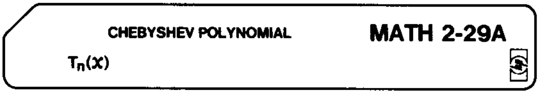
Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Example:

$F(1, 1; 2; 0.3) = 1.19$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		a	[↑]	[ ]	
3		b	[↑]	[ ]	
4		c	[↑]	[ ]	
5		x	[A]	[ ]	

CHEBYSHEV POLYNOMIAL



This program computes the value of the Chebyshev polynomial $T_n(x)$ by using the recurrence equation

$$T_{n+1}(x) = 2xT_n(x) - T_{n-1}(x)$$

where starting values are $T_0(x) = 1$, $T_1(x) = x$ and n is a non-negative integer.

Example:

$T_3\ (0.4) = -0.94$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		n	[↑]	[ ]	
3		x	[A]	[ ]	

LEGENDRE POLYNOMIAL

LEGENDRE POLYNOMIAL MATH 2-30A

$P_n(x)$

This program computes the value of the Legendre polynomial $P_n(x)$ by using the recurrence equation

$$P_{n+1}(x) = \frac{(2n+1)\,xP_n(x) - nP_{n-1}(x)}{n+1}$$

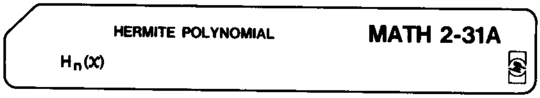
where starting values are $P_0(x) = 1$, $P_1(x) = x$ and n is a non-negative integer.

Example:

$P_{10}(0.98) = 0.16$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		n	↑		
3		x	A		

HERMITE POLYNOMIAL



This program computes the value of the Hermite polynomial $H_n(x)$ by using the recurrence equation

$$H_{n+1}(x) = 2x\, H_n(x) - 2n\, H_{n-1}(x)$$

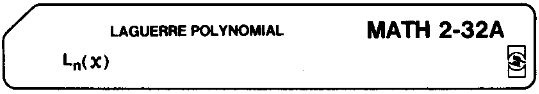
where the starting values are $H_0(x) = 1$, $H_1(x) = 2x$ and n is a non-negative integer.

Example:

$H_5(3) = 3816.00$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		n	↑		
3		x	A		

LAGUERRE POLYNOMIAL



This program computes the value of the Laguerre polynomial $L_n(x)$ by using the recurrence equation

$$L_{n+1}(x) = [(2n + 1 - x)\, L_n(x) - nL_{n-1}(x)] \;/\; (n + 1)$$

where the starting values are $L_0(x) = 1$, $L_1(x) = 1 - x$, and n is a non-negative integer.

Example:

$L_6(3) = -0.01$

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program		[ ] [ ]	
2		n	[↑] [ ]	
3		x	[A] [ ]	

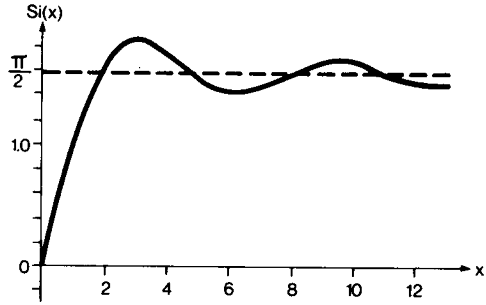
SINE INTEGRAL

Sine integral

$$\mathrm{Si}(x) = \int_0^x \frac{\sin t}{t}\, dt = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+1}}{(2n+1)(2n+1)!}$$

where x is real.

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.



Notes: 1. When x is too large, computing a new term of the series might cause an overflow. In that case, display shows all 9's and the program stops.

2. Si (–x) = –Si (x)

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. Si(0.69) = 0.67

2. Si(9.8) = 1.67

LINE	INSTRUCTIONS	DATA	KEYS	DISPLAY
1	Enter program			
2		x	A	

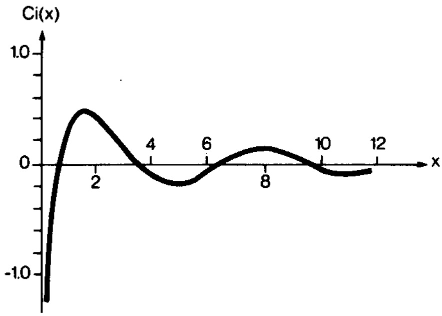
COSINE INTEGRAL

Cosine integral

$$Ci(x) = \gamma + \ln x + \int_0^x \frac{\cos t - 1}{t}\, dt = \gamma + \ln x + \sum_{n=1}^{\infty} \frac{(-1)^n x^{2n}}{2n\,(2n)!}$$

where $x > 0$, and $\gamma = 0.5772156649$ is the Euler's constant.

This program computes successive partial sums of the series. When two consecutive partial sums are equal, the value is used as the sum of the series.



Notes:

1. When x is too large, computing a new term of the series might cause an overflow. In that case, display shows all 9's and the program stops.
2. $Ci(-x) = Ci(x) - i\pi$ for $x > 0$.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. $Ci(1.38) = 0.46$
2. $Ci(5) = -0.19$

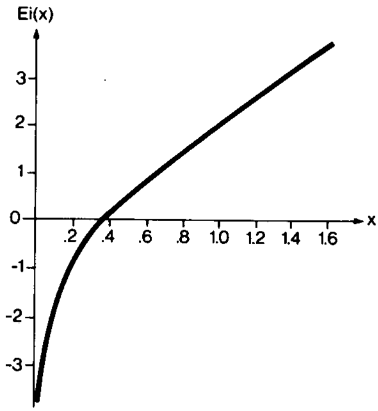
LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2		x	A		

EXPONENTIAL INTEGRAL

$$\mathrm{Ei}(x) = \int_{-\infty}^{x} \frac{e^t}{t}\, dt = \gamma + \ln x + \sum_{n=1}^{\infty} \frac{x^n}{n\, n!}$$

where $x > 0$ and $\gamma = 0.5772156649$ is Euler's constant.

This program computes successive partial sums of the series. When two consecutive partial sums are equal, the value is used as the sum of the series.



Note: When x is too large, computing a new term of the series might cause an overflow. In that case, display shows all 9's and the program stops.

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. Ei(1.59) = 3.57

2. Ei(0.61) = 0.80

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		x	[A]	[ ]	

FRESNEL INTEGRALS

Fresnel cosine integral

$$C(x) = \int_0^x \cos\left(\frac{\pi}{2} t^2\right) dt$$

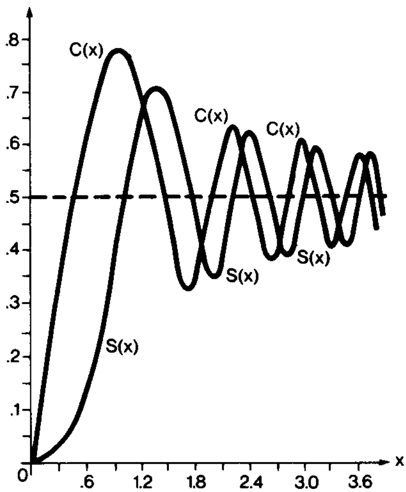
$$= \sum_{n=0}^{\infty} \frac{(-1)^n \left(\frac{\pi}{2}\right)^{2n}}{(2n)!\,(4n+1)} x^{4n+1}$$

Fresnel sine integral

$$S(x) = \int_0^x \sin\left(\frac{\pi}{2} t^2\right) dt$$

$$= \sum_{n=0}^{\infty} \frac{(-1)^n \left(\frac{\pi}{2}\right)^{2n+1}}{(2n+1)!\,(4n+3)} x^{4n+3}$$

This program computes successive partial sums of the series. The program stops when two consecutive partial sums are equal, and displays the last partial sum as the answer.



Notes: 1. This program requires $|x| < 3.6$ or flashing zeros will result. As $|x|$ varies from 0 to 3.6, the accuracy of the answer will decrease from 10 digits to 2 or 3 digits.

2. $\lim_{x \to \infty} C(x) = \lim_{x \to \infty} S(x) = \frac{1}{2}$

3. $C(-x) = -C(x),\ S(-x) = -S(x)$

Reference: Handbook of Mathematical Functions, Abramowitz and Stegun, National Bureau of Standards, 1968

Examples:

1. $C(0.42) = 0.42$

2. $S(-3) = -0.50$

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program				
2	Compute C(x)	x	A		
3	Compute S(x)	x	B		

COMPLETE ELLIPTIC INTEGRALS

The generalized complete elliptic integral of the second kind is defined as

$$\text{CEI}\,(k;\, A, B) = \int_0^{\pi/2} \frac{A + (B - A)\sin^2 t}{\sqrt{1 - k^2 \sin^2 t}}\, dt \qquad (0 \leq k < 1)$$

To evaluate the integral, let

$$u_0 = 1,\; v_0 = \sqrt{1 - k^2},\;\; a_0 = A,\; b_0 = B$$

be the starting values. Compute the sequences of numbers

$$u_{i+1} = u_i + v_i$$

$$v_{i+1} = 2\sqrt{u_i v_i}$$

$$a_{i+1} = a_i + \frac{b_i}{u_i}$$

$$b_{i+1} = 2\,(a_i v_i + b_i)$$

The process is stopped at the n^{th} step such that

$$u_{n-1}\,(1 - 10^{-9}) \leqslant v_{n-1}$$

Then the integral is computed by

$$\text{CEI}\,(k;\, A, B) = \frac{\pi}{4}\,\frac{a_{n+1}}{u_n}$$

Some important special cases are:

1. $A = 1, B = 1$
   Complete elliptic integral of the first kind

$$K(k) = \int_0^{\pi/2} \frac{dt}{\sqrt{1 - k^2 \sin^2 t}}$$

2. A = 1, B = 0

$$B(k) = \int_0^{\pi/2} \frac{1 - \sin^2 t}{\sqrt{1 - k^2 \sin^2 t}} dt$$

3. A = 0, B = 1

$$D(k) = \int_0^{\pi/2} \frac{\sin^2 t}{\sqrt{1 - k^2 \sin^2 t}} dt$$

Note: Special values are displayed for invalid arguments:

1. If $k^2 > 1$, display = 10^{99}
2. If $k^2 = 1$

$$\text{display} = \begin{cases} 10^{99} & \text{if } B > 0 \\ -10^{99} & \text{if } B < 0 \\ A & \text{if } B = 0 \end{cases}$$

References: 1. Numerical Calculation of Elliptic Integrals and Elliptic Functions, R. Bulirsch, Handbook Series Special Functions, Numerical Mathematik 7, 1965

2. Tables of Higher Functions, Jahnke-Emde-Losch, McGraw-Hill, 1960

Example:

CEI (0.5; 1, 1) = K (0.5) = 1.69

LINE	INSTRUCTIONS	DATA	KEYS		DISPLAY
1	Enter program		[ ]	[ ]	
2		k	[↑]	[ ]	
3		A	[↑]	[ ]	
4		B	[A]	[ ]	

PROGRAM LISTINGS

OCTAL ARITHMETIC

CODE	KEYS
23	LBL
11	A
15	E
61	+
22	GTO
09	9
23	LBL
12	B
15	E
51	–
22	GTO
09	9
23	LBL
13	C
15	E
71	x
23	LBL
09	9
31	f
00	→OCT
24	RTN
23	LBL
14	D
15	E
81	÷
33 03	STO 3
31	f
83	INT
31	f
00	→OCT
33 01	STO 1
01	1
00	0
33 08	STO 8
33 04	STO 4

CODE	KEYS
01	1
33 02	STO 2
44	CLX
33 05	STO 5
23	LBL
01	1
34 03	RCL 3
32	f^{-1}
83	INT
41	↑
44	CLX
35 23	g x=y
22	GTO
02	2
08	8
71	x
33 03	STO 3
31	f
83	INT
34 02	RCL 2
34 04	RCL 4
71	x
33 02	STO 2
81	÷
33	STO
61	+
05	5
35	g
83	DSZ
22	GTO
01	1
23	LBL
02	2
34 01	RCL 1
34 05	RCL 5

CODE	KEYS
61	+
24	RTN
23	LBL
15	E
32	f^{-1}
00	→OCT
35 07	g x⇄y
32	f^{-1}
00	→OCT
35 07	g x⇄y
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	10	R_7	
R_2	Used	R_5	Used	R_8	Used
R_3	Used	R_6		R_9	Used

INTEGER BASE CONVERSION

CODE	KEYS
23	LBL
11	A
33 03	STO 3
35 08	g R↓
33 02	STO 2
35 08	g R↓
71	x
00	0
33 01	STO 1
01	1
33 05	STO 5
83	•
01	1
33 04	STO 4
33 06	STO 6
23	LBL
01	1
35 00	g LST X
34 04	RCL 4
71	x
34 02	RCL 2
33	STO
71	x
05	5
35 08	g R↓
35	g
06	ABS
01	1
35 22	g x≤y
22	GTO
01	1
35 00	g LST X
23	LBL
02	2
34 04	RCL 4
81	÷
41	↑
31	f
83	INT
51	–
35 00	g LST X
34 05	RCL 5
34 02	RCL 2
81	÷
33 05	STO 5
71	x
33	STO
61	+
01	1
44	CLX
35 07	g x⇄y
35 21	g x≠y
22	GTO
02	2
33 02	STO 2
34 01	RCL 1
31	f
83	INT
23	LBL
03	3
41	↑
41	↑
34 03	RCL 3
81	÷
31	f
83	INT
33 05	STO 5
34 03	RCL 3
71	x
51	–
34 06	RCL 6
34 04	RCL 4
81	÷
33 06	STO 6
71	x
33	STO
61	+
02	2
00	0
34 05	RCL 5
35 21	g x≠y
22	GTO
03	3
34 02	RCL 2
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5	Used	R_8	
R_3	Used	R_6	Used	R_9	Used

BASE CONVERSION

CODE	KEYS
23	LBL
11	A
33 02	STO 2
35 08	g R↓
33 01	STO 1
35 08	g R↓
33 03	STO 3
00	0
33 04	STO 4
33 05	STO 5
34 03	RCL 3
23	LBL
09	9
01	1
35 22	g x≤y
22	GTO
03	3
23	LBL
05	5
34 02	RCL 2
34 03	RCL 3
71	x
33 03	STO 3
31	f
83	INT
34 05	RCL 5
34 01	RCL 1
71	x
61	+
33 05	STO 5
34 03	RCL 3
32	f^{-1}
83	INT
33 03	STO 3
01	1

CODE	KEYS
33	STO
51	–
04	4
34 05	RCL 5
43	EEX
01	1
02	2
35 22	g x≤y
22	GTO
04	4
00	0
34 03	RCL 3
35 21	g x≠y
22	GTO
05	5
23	LBL
04	4
34 01	RCL 1
35	g
04	$^1/x$
33 06	STO 6
00	0
34 04	RCL 4
35 24	g x>y
34 01	RCL 1
33 06	STO 6
34 04	RCL 4
35	g
06	ABS
33 04	STO 4
23	LBL
06	6
34 04	RCL 4
01	1
35 24	g x>y

CODE	KEYS
34 05	RCL 5
84	R/S
34 06	RCL 6
33	STO
71	x
05	5
01	1
33	STO
51	–
04	4
22	GTO
06	6
23	LBL
03	3
33	STO
61	+
04	4
44	CLX
34 02	RCL 2
81	÷
33 03	STO 3
22	GTO
09	9
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5	Used	R_8	
R_3	Used	R_6	Used	R_9	Used

COMPLEX ARITHMETIC

CODE	KEYS
23	LBL
11	A
35 07	g x⇄y
35 08	g R↓
61	+
35 08	g R↓
61	+
35 09	g R↑
24	RTN
23	LBL
12	B
35 07	g x⇄y
35 08	g R↓
51	−
35 08	g R↓
35 07	g x⇄y
51	−
35 09	g R↑
24	RTN
23	LBL
13	C
31	f
01	R→P
35 08	g R↓
35 08	g R↓
31	f
01	R→P
35 07	g x⇄y
35 08	g R↓
71	x
35 08	g R↓
61	+
35 09	g R↑
32	f^{-1}
01	R→P

CODE	KEYS
24	RTN
23	LBL
14	D
31	f
01	R→P
35 08	g R↓
35 08	g R↓
31	f
01	R→P
35 07	g x⇄y
35 08	g R↓
35 07	g x⇄y
81	÷
35 08	g R↓
51	−
35 09	g R↑
32	f^{-1}
01	R→P
24	RTN
23	LBL
15	E
35 07	g x⇄y
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	R_4	R_7
R_2	R_5	R_8
R_3	R_6	R_9 Used

COMPLEX FUNCTIONS |z|, z^2, $\sqrt{z}$, 1/z

CODE	KEYS
23	LBL
11	A
31	f
01	R→P
24	RTN
23	LBL
12	B
33 08	STO 8
35 07	g x⇄y
33 07	STO 7
71	x
02	2
71	x
34 08	RCL 8
32	f^{-1}
09	$\sqrt{x}$
34 07	RCL 7
32	f^{-1}
09	$\sqrt{x}$
51	–
24	RTN
23	LBL
13	C
33 08	STO 8
35 07	g x⇄y
33 07	STO 7
00	0
35 23	g x=y
22	GTO
01	1
23	LBL
03	3
35 08	g R↓
35 07	g x⇄y
31	f

CODE	KEYS
01	R→P
34 08	RCL 8
61	+
02	2
81	÷
31	f
09	$\sqrt{x}$
33 06	STO 6
02	2
71	x
34 07	RCL 7
35 07	g x⇄y
81	÷
34 06	RCL 6
24	RTN
23	LBL
14	D
33 08	STO 8
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y
33 07	STO 7
32	f^{-1}
09	$\sqrt{x}$
61	+
34 07	RCL 7
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 08	RCL 8
35 07	g x⇄y
81	÷
24	RTN
23	LBL

CODE	KEYS
01	1
34 08	RCL 8
35 22	g x≤y
22	GTO
02	2
31	f
09	$\sqrt{x}$
24	RTN
23	LBL
02	2
35	g
06	ABS
31	f
09	$\sqrt{x}$
35 07	g x⇄y
24	RTN
23	LBL
15	E
35 07	g x⇄y
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1		R_4		R_7	y
R_2		R_5		R_8	x
R_3		R_6	Used	R_9	Used

COMPLEX FUNCTIONS z^n, $z^{\frac{1}{n}}$

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	35 07	g x⇄y	35 01	g NOP
11	A	31	f	35 01	g NOP
35 08	g R↓	01	R→P	35 01	g NOP
31	f	35 07	g x⇄y	35 01	g NOP
01	R→P	34 07	RCL 7	35 01	g NOP
35 09	g R↑	61	+	35 01	g NOP
35	g	35 07	g x⇄y	35 01	g NOP
05	y^x	32	f^{-1}	35 01	g NOP
35 07	g x⇄y	01	R→P	35 01	g NOP
35 00	g LST X	35	g	35 01	g NOP
71	x	83	DSZ	35 01	g NOP
35 07	g x⇄y	22	GTO	35 01	g NOP
32	f^{-1}	01	1	35 01	g NOP
01	R→P	24	RTN	35 01	g NOP
24	RTN	23	LBL	35 01	g NOP
23	LBL	13	C	35 01	g NOP
12	B	35 07	g x⇄y	35 01	g NOP
35	g	24	RTN	35 01	g NOP
41	DEG	35 01	g NOP	35 01	g NOP
33 08	STO 8	35 01	g NOP	35 01	g NOP
35	g	35 01	g NOP	35 01	g NOP
04	$^1/x$	35 01	g NOP	35 01	g NOP
11	A	35 01	g NOP	35 01	g NOP
03	3	35 01	g NOP	35 01	g NOP
06	6	35 01	g NOP	35 01	g NOP
00	0	35 01	g NOP	35 01	g NOP
34 08	RCL 8	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
33 07	STO 7	35 01	g NOP	35 01	g NOP
35 08	g R↓	35 01	g NOP	35 01	g NOP
23	LBL	35 01	g NOP		
01	1	35 01	g NOP		
84	R/S	35 01	g NOP		
35 07	g x⇄y	35 01	g NOP		
84	R/S	35 01	g NOP		

R_1		R_4		R_7	Used
R_2		R_5		R_8	Counter
R_3		R_6		R_9	Used

COMPLEX FUNCTIONS e^z, ln z, a^z, $\log_a z$

CODE	KEYS
23	LBL
11	A
35	g
42	RAD
32	f^{-1}
07	LN
32	f^{-1}
01	R→P
24	RTN
23	LBL
12	B
35	g
42	RAD
31	f
01	R→P
31	f
07	LN
24	RTN
23	LBL
13	C
35	g
42	RAD
35 08	g R↓
33 01	STO 1
35 07	g x⇄y
35 09	g R↑
31	f
07	LN
71	x
35 00	g LST X
34 01	RCL 1
71	x
32	f^{-1}
07	LN
32	f^{-1}

CODE	KEYS
01	R→P
24	RTN
23	LBL
14	D
31	f
07	LN
33 01	STO 1
35 08	g R↓
35	g
42	RAD
31	f
01	R→P
31	f
07	LN
34 01	RCL 1
81	÷
35 07	g x⇄y
34 01	RCL 1
81	÷
35 07	g x⇄y
24	RTN
23	LBL
15	E
35 07	g x⇄y
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Used	R_4	R_7
R_2	R_5	R_8
R_3	R_6	R_9 Used

COMPLEX FUNCTIONS z^w, $z^{\frac{1}{w}}$, $\log_z w$

CODE	KEYS
23	LBL
11	A
35	g
42	RAD
31	f
01	R→P
31	f
07	LN
31	f
01	R→P
35 08	g R↓
35 08	g R↓
31	f
01	R→P
35 07	g x⇄y
35 08	g R↓
71	x
35 08	g R↓
61	+
35 09	g R↑
32	f^{-1}
01	R→P
32	f^{-1}
07	LN
32	f^{-1}
01	R→P
24	RTN
23	LBL
12	B
33 03	STO 3
35 08	g R↓
33 04	STO 4
35 08	g R↓
33 01	STO 1
32	f^{-1}

CODE	KEYS
09	$\sqrt{x}$
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 01	RCL 1
35 07	g x⇄y
81	÷
34 04	RCL 4
34 03	RCL 3
11	A
24	RTN
23	LBL
13	C
35	g
42	RAD
31	f
01	R→P
31	f
07	LN
31	f
01	R→P
35 08	g R↓
35 08	g R↓
31	f
01	R→P
31	f
07	LN
31	f

CODE	KEYS
01	R→P
35 07	g x⇄y
35 08	g R↓
35 07	g x⇄y
81	÷
35 08	g R↓
51	–
35 09	g R↑
32	f^{-1}
01	R→P
24	RTN
23	LBL
14	D
35 07	g x⇄y
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS sin z, sinh z, csc z, csch z

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35	g
42	RAD
31	f
04	SIN
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
07	LN
41	↑
35	g
04	1/x
61	+
02	2
81	÷
71	x
33 03	STO 3
34 01	RCL 1
31	f
05	COS
34 02	RCL 2
32	f^{-1}
07	LN
41	↑
35	g
04	1/x
51	–
02	2
81	÷
71	x
34 03	RCL 3
24	RTN
35 07	g x⇄y

CODE	KEYS
84	R/S
23	LBL
12	B
35 07	g x⇄y
42	CHS
11	A
42	CHS
35 07	g x⇄y
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
13	C
11	A
15	E
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
14	D
35 07	g x⇄y
42	CHS
11	A
15	E
35 07	g x⇄y
42	CHS
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
15	E
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y

CODE	KEYS
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 01	RCL 1
35 07	g x⇄y
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS cos z, cosh z, sec z, sech z

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35	g
42	RAD
31	f
05	COS
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
07	LN
41	↑
35	g
04	$^1/x$
61	+
02	2
81	÷
71	x
33 03	STO 3
34 01	RCL 1
31	f
04	SIN
34 02	RCL 2
32	f^{-1}
07	LN
41	↑
35	g
04	$^1/x$
51	–
02	2
81	÷
71	x
42	CHS
34 03	RCL 3
24	RTN

CODE	KEYS
35 07	g x⇄y
84	R/S
23	LBL
12	B
35 07	g x⇄y
42	CHS
11	A
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
13	C
11	A
15	E
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
14	D
35 07	g x⇄y
42	CHS
11	A
15	E
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
15	E
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$

CODE	KEYS
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 01	RCL 1
35 07	g x⇄y
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

COMPLEX TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS tan z, tanh z, cot z, coth z

CODE	KEYS
23	LBL
11	A
15	E
34 03	RCL 3
34 02	RCL 2
34 04	RCL 4
61	+
81	÷
34 01	RCL 1
23	LBL
01	1
35 00	g LST X
81	÷
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
12	B
35 07	g x⇄y
15	E
34 01	RCL 1
34 02	RCL 2
34 04	RCL 4
61	+
81	÷
34 03	RCL 3
22	GTO
01	1
23	LBL
13	C
15	E
34 03	RCL 3
34 04	RCL 4
34 02	RCL 2
51	–

CODE	KEYS
81	÷
42	CHS
34 01	RCL 1
22	GTO
01	1
23	LBL
14	D
35 07	g x⇄y
15	E
34 01	RCL 1
34 04	RCL 4
34 02	RCL 2
51	–
81	÷
42	CHS
34 03	RCL 3
22	GTO
01	1
23	LBL
15	E
35	g
42	RAD
02	2
71	x
31	f
04	SIN
33 01	STO 1
35 00	g LST X
31	f
05	COS
33 02	STO 2
35 08	g R↓
35 08	g R↓
02	2
71	x

CODE	KEYS
32	f^{-1}
07	LN
41	↑
35	g
04	1/x
33 04	STO 4
51	–
02	2
81	÷
33 03	STO 3
34 04	RCL 4
61	+
33 04	STO 4
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS

$\sin^{-1} z$, $\sinh^{-1} z$, $\csc^{-1} z$, $\text{csch}^{-1} z$

CODE	KEYS
35 07	g x⇄y
42	CHS
11	A
42	CHS
35 07	g x⇄y
84	R/S
35 07	g x⇄y
84	R/S
23	LBL
11	A
35	g
42	RAD
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
35 07	g x⇄y
01	1
61	+
31	f
01	R→P
33 03	STO 3
34 02	RCL 2
34 01	RCL 1
01	1
51	–
31	f
01	R→P
33 04	STO 4
34 03	RCL 3
61	+
02	2
81	÷
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$

CODE	KEYS
01	1
51	–
31	f
09	$\sqrt{x}$
34 01	RCL 1
61	+
31	f
07	LN
33 05	STO 5
34 02	RCL 2
01	1
61	+
01	1
35 24	g x>y
42	CHS
35 01	g NOP
34 05	RCL 5
71	x
34 03	RCL 3
34 04	RCL 4
51	–
02	2
81	÷
32	f^{-1}
04	SIN
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
13	C
15	E
11	A
24	RTN
35 07	g x⇄y
84	R/S

CODE	KEYS
23	LBL
14	D
35 07	g x⇄y
42	CHS
15	E
11	A
35 07	g x⇄y
42	CHS
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
15	E
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 01	RCL 1
35 07	g x⇄y
81	÷
24	RTN

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5	Used	R_8	
R_3	Used	R_6		R_9	Used

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS
$\cos^{-1} z$, $\cosh^{-1} z$, $\sec^{-1} z$, $\text{sech}^{-1} z$

CODE	KEYS
23	LBL
11	A
35	g
42	RAD
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
35 07	g x⇄y
01	1
61	+
31	f
01	R→P
33 03	STO 3
34 02	RCL 2
34 01	RCL 1
01	1
51	–
31	f
01	R→P
33 04	STO 4
34 03	RCL 3
61	+
02	2
81	÷
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$
01	1
51	–
31	f
09	$\sqrt{x}$
34 01	RCL 1
61	+
31	f
07	LN

CODE	KEYS
42	CHS
33 05	STO 5
34 02	RCL 2
01	1
61	+
01	1
35 24	g x>y
42	CHS
35 01	g NOP
34 05	RCL 5
71	x
34 03	RCL 3
34 04	RCL 4
51	–
02	2
81	÷
32	f^{-1}
05	COS
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
12	B
11	A
35 07	g x⇄y
42	CHS
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
13	C
15	E
11	A
24	RTN
35 07	g x⇄y

CODE	KEYS
84	R/S
23	LBL
14	D
15	E
11	A
35 07	g x⇄y
42	CHS
24	RTN
35 07	g x⇄y
84	R/S
23	LBL
15	E
33 01	STO 1
32	f^{-1}
09	$\sqrt{x}$
35 07	g x⇄y
33 02	STO 2
32	f^{-1}
09	$\sqrt{x}$
61	+
34 02	RCL 2
35 07	g x⇄y
81	÷
42	CHS
35 00	g LST X
34 01	RCL 1
35 07	g x⇄y
81	÷
24	RTN
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5	Used	R_8	
R_3	Used	R_6		R_9	Used

COMPLEX INVERSE TRIGONOMETRIC AND HYPERBOLIC FUNCTIONS

$\tan^{-1} z$, $\tanh^{-1} z$, $\cot^{-1} z$, $\coth^{-1} z$

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	12	B	35 07	g x⇄y
11	A	35 07	g x⇄y	24	RTN
35	g	42	CHS	35 01	g NOP
42	RAD	11	A	35 01	g NOP
33 01	STO 1	42	CHS	35 01	g NOP
35 07	g x⇄y	35 07	g x⇄y	35 01	g NOP
33 02	STO 2	24	RTN	35 01	g NOP
01	1	23	LBL	35 01	g NOP
61	+	13	C	35 01	g NOP
35 07	g x⇄y	11	A	35 01	g NOP
31	f	35	g	35 01	g NOP
01	R→P	02	π	35 01	g NOP
01	1	02	2	35 01	g NOP
34 02	RCL 2	81	÷	35 01	g NOP
51	–	35 07	g x⇄y	35 01	g NOP
34 01	RCL 1	51	–	35 01	g NOP
31	f	35 07	g x⇄y	35 01	g NOP
01	R→P	42	CHS	35 01	g NOP
35 07	g x⇄y	35 07	g x⇄y	35 01	g NOP
35 08	g R↓	24	RTN	35 01	g NOP
81	÷	23	LBL	35 01	g NOP
31	f	14	D	35 01	g NOP
07	LN	35 07	g x⇄y	35 01	g NOP
02	2	42	CHS	35 01	g NOP
81	÷	11	A	35 01	g NOP
35	g	35	g	35 01	g NOP
02	π	02	π	35 01	g NOP
35 08	g R↓	02	2	35 01	g NOP
35 08	g R↓	81	÷	35 01	g NOP
61	+	35 07	g x⇄y	35 01	g NOP
51	–	51	–		
02	2	35 07	g x⇄y		
81	÷	24	RTN		
24	RTN	23	LBL		
23	LBL	15	E		

R_1 Used	R_4	R_7
R_2 Used	R_5	R_8
R_3	R_6	R_9 Used

POLYNOMIAL EVALUATION (COMPLEX)

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
35 07	g x⇄y
15	E
24	RTN
23	LBL
12	B
14	D
34 02	RCL 2
34 01	RCL 1
15	E
24	RTN
23	LBL
13	C
14	D
84	R/S
35 07	g x⇄y
24	RTN
23	LBL
14	D
35 07	g x⇄y
35 08	g R↓
61	+
35 08	g R↓
61	+
35 09	g R↑
24	RTN
23	LBL
15	E
31	f
01	R→P
35 08	g R↓

CODE	KEYS
35 08	g R↓
31	f
01	R→P
35 07	g x⇄y
35 08	g R↓
71	x
35 08	g R↓
61	+
35 09	g R↑
32	f^{-1}
01	R→P
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x_0	R_4		R_7	
R_2	y_0	R_5		R_8	
R_3		R_6		R_9	Used

INTERSECTIONS OF A LINE AND A CONIC SECTION (CARD 1)

CODE	KEYS
23	LBL
11	A
32	f^{-1}
51	SF 1
33 06	STO 6
35 08	g R↓
33 02	STO 2
35 08	g R↓
33 03	STO 3
00	0
35 21	g x≠y
84	R/S
35 01	g NOP
31	f
51	SF 1
34 03	RCL 3
34 02	RCL 2
33 03	STO 3
35 07	g x⇄y
33 02	STO 2
84	R/S
23	LBL
12	B
33	STO
09	9
35 08	g R↓
33 04	STO 4
35 08	g R↓
33 01	STO 1
31	f
61	TF 1
13	C
35 01	g NOP
34 02	RCL 2
32	f^{-1}

CODE	KEYS
09	$\sqrt{x}$
71	x
34 03	RCL 3
32	f^{-1}
09	$\sqrt{x}$
81	÷
34 04	RCL 4
34 03	RCL 3
81	÷
34 02	RCL 2
71	x
51	–
34	RCL
09	9
61	+
41	↑
61	+
33 05	STO 5
34 01	RCL 1
02	2
71	x
34 02	RCL 2
71	x
34 03	RCL 3
81	÷
34 04	RCL 4
51	–
34 06	RCL 6
71	x
34 03	RCL 3
81	÷
33 07	STO 7
84	R/S
34 07	RCL 7
35 08	g R↓

CODE	KEYS
33	STO
09	9
35 08	g R↓
33 08	STO 8
35 08	g R↓
33 07	STO 7
32	f^{-1}
61	TF 1
34 02	RCL 2
84	R/S
33 08	STO 8
35 09	g R↑
33 07	STO 7
35 07	g x⇄y
35 08	g R↓
34 02	RCL 2
84	R/S
23	LBL
13	C
34	RCL
09	9
33 01	STO 1
35 07	g x⇄y
33	STO
09	9
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	A	R_4	B	R_7	D
R_2	b	R_5	2α	R_8	E
R_3	a	R_6	c	R_9	C, F

INTERSECTIONS OF A LINE AND A CONIC SECTION (CARD 2)

CODE	KEYS
23	LBL
11	A
71	x
34 03	RCL 3
81	÷
51	–
33	STO
61	+
08	8
34 01	RCL 1
34 06	RCL 6
32	f^{-1}
09	$\sqrt{x}$
71	x
34 03	RCL 3
32	f^{-1}
09	$\sqrt{x}$
81	÷
34 07	RCL 7
34 06	RCL 6
71	x
34 03	RCL 3
81	÷
51	–
34	RCL
09	9
61	+
33 01	STO 1
34 08	RCL 8
34 05	RCL 5
81	÷
42	CHS
41	↑
32	f^{-1}
09	$\sqrt{x}$

CODE	KEYS
34 01	RCL 1
41	↑
61	+
34 05	RCL 5
81	÷
51	–
00	0
35 24	g $x>y$
22	GTO
01	1
35 08	g R↓
31	f
09	$\sqrt{x}$
33 01	STO 1
61	+
33 04	STO 4
35 07	g x⇄y
34 01	RCL 1
51	–
33 07	STO 7
12	B
33 08	STO 8
34 04	RCL 4
12	B
31	f
61	TF 1
22	GTO
08	8
84	R/S
34 04	RCL 4
84	R/S
34 08	RCL 8
84	R/S
34 07	RCL 7
84	R/S

CODE	KEYS
23	LBL
08	8
34 04	RCL 4
84	R/S
35 07	g x⇄y
84	R/S
34 07	RCL 7
84	R/S
34 08	RCL 8
84	R/S
23	LBL
01	1
09	9
09	9
09	9
32	f^{-1}
07	LN
84	R/S
23	LBL
12	B
34 02	RCL 2
71	x
34 06	RCL 6
61	+
34 03	RCL 3
81	÷
42	CHS
24	RTN
35 01	g NOP
35 01	g NOP

R_1	A, γ, $\sqrt{Q}$	R_4	B, y_1	R_7	D, y_2
R_2	b	R_5	2α	R_8	E, B, x_2
R_3	a	R_6	C	R_9	C, F

VECTOR PRODUCTS AND ANGLE BETWEEN VECTORS

CODE	KEYS
23	LBL
11	A
33 03	STO 3
35 08	g R↓
33 02	STO 2
35 08	g R↓
33 01	STO 1
24	RTN
23	LBL
12	B
33 06	STO 6
35 08	g R↓
33 05	STO 5
35 08	g R↓
33 04	STO 4
24	RTN
23	LBL
13	C
34 01	RCL 1
34 04	RCL 4
71	x
34 02	RCL 2
34 05	RCL 5
71	x
61	+
34 03	RCL 3
34 06	RCL 6
71	x
61	+
84	R/S
34 01	RCL 1
15	E
34 02	RCL 2
15	E
61	+

CODE	KEYS
34 03	RCL 3
15	E
61	+
31	f
09	$\sqrt{x}$
33 07	STO 7
34 04	RCL 4
15	E
34 05	RCL 5
15	E
61	+
34 06	RCL 6
15	E
61	+
31	f
09	$\sqrt{x}$
33 08	STO 8
71	x
81	÷
32	f^{-1}
05	COS
84	R/S
34 07	RCL 7
84	R/S
34 08	RCL 8
24	RTN
23	LBL
14	D
34 02	RCL 2
34 06	RCL 6
71	x
34 03	RCL 3
34 05	RCL 5
71	x
51	–

CODE	KEYS
33 07	STO 7
34 01	RCL 1
34 05	RCL 5
71	x
34 02	RCL 2
34 04	RCL 4
71	x
51	–
34 03	RCL 3
34 04	RCL 4
71	x
34 01	RCL 1
34 06	RCL 6
71	x
51	–
34 07	RCL 7
84	R/S
35 08	g R↓
84	R/S
35 08	g R↓
24	RTN
23	LBL
15	E
32	f^{-1}
09	$\sqrt{x}$
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x_1	R_4	y_1	R_7	$\lvert\vec{x}\rvert$
R_2	x_2	R_5	y_2	R_8	$\lvert\vec{y}\rvert$
R_3	x_3	R_6	y_3	R_9	Used

PARTIAL SUM AND PARTIAL PRODUCT

CODE	KEYS
23	LBL
11	A
14	D
00	0
33 03	STO 3
34 02	RCL 2
23	LBL
01	1
13	C
34 03	RCL 3
61	+
33 03	STO 3
01	1
34 02	RCL 2
61	+
33 02	STO 2
35	g
83	DSZ
22	GTO
01	1
34 03	RCL 3
24	RTN
23	LBL
12	B
14	D
01	1
33 03	STO 3
34 02	RCL 2
23	LBL
02	2
13	C
34 03	RCL 3
71	x
33 03	STO 3
01	1

CODE	KEYS
34 02	RCL 2
61	+
33 02	STO 2
35	g
83	DSZ
22	GTO
02	2
34 03	RCL 3
24	RTN
23	LBL
14	D
33 01	STO 1
35 08	g R↓
35 07	g x⇄y
33 02	STO 2
51	−
01	1
61	+
33 08	STO 8
24	RTN
23	LBL
13	C
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x	R_4		R_7	
R_2	Used	R_5		R_8	Used
R_3	Σ, Π	R_6		R_9	

GAUSSIAN QUADRATURE FOR $\int_a^b f(x)\,dx$ (CARD 1)

CODE	KEYS
23	LBL
11	A
83	•
02	2
03	3
08	8
06	6
01	1
09	9
01	1
08	8
06	6
01	1
33 01	STO 1
83	•
06	6
06	6
01	1
02	2
00	0
09	9
03	3
08	8
06	6
05	5
33 02	STO 2
83	•
09	9
03	3
02	2
04	4
06	6
09	9
05	5
01	1

CODE	KEYS
04	4
02	2
33 03	STO 3
83	•
04	4
06	6
07	7
09	9
01	1
03	3
09	9
03	3
04	4
06	6
33 04	STO 4
83	•
03	3
06	6
00	0
07	7
06	6
01	1
05	5
07	7
03	3
33 05	STO 5
83	•
01	1
07	7
01	1
03	3
02	2
04	4
04	4
09	9

CODE	KEYS
02	2
04	4
33 06	STO 6
84	R/S
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	z_1	R_4	w_1	R_7	
R_2	z_3	R_5	w_3	R_8	
R_3	z_5	R_6	w_5	R_9	

GAUSSIAN QUADRATURE FOR $\int_a^b f(x)\,dx$ (CARD 2)

CODE	KEYS
33 08	STO 8
35 07	g x⇄y
61	+
33 07	STO 7
35 00	g LST X
34 08	RCL 8
35 07	g x⇄y
51	–
33 08	STO 8
00	0
33	STO
09	9
32	f^{-1}
51	SF1
23	LBL
01	1
12	B
34 01	RCL 1
34 02	RCL 2
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
34 04	RCL 4
34 05	RCL 5
33 04	STO 4
35 07	g x⇄y
33 05	STO 5
12	B
34 01	RCL 1
34 03	RCL 3
33 01	STO 1
35 07	g x⇄y
33 03	STO 3
34 04	RCL 4
34 06	RCL 6

CODE	KEYS
33 04	STO 4
35 07	g x⇄y
33 06	STO 6
12	B
31	f
61	TF1
22	GTO
02	2
34 01	RCL 1
42	CHS
33 01	STO 1
34 02	RCL 2
42	CHS
33 02	STO 2
34 03	RCL 3
42	CHS
33 03	STO 3
31	f
51	SF1
22	GTO
01	1
23	LBL
02	2
34	RCL
09	9
34 08	RCL 8
71	x
02	2
81	÷
84	R/S
23	LBL
12	B
34 01	RCL 1
34 08	RCL 8
71	x

CODE	KEYS
34 07	RCL 7
61	+
02	2
81	÷
23	LBL
11	A
34 04	RCL 4
71	x
33	STO
61	+
09	9
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	$z_1\,(z_2)$	R_4	w_1	R_7	a + b
R_2	$z_3\,(z_4)$	R_5	w_3	R_8	b, b – a
R_3	$z_5\,(z_6)$	R_6	w_5	R_9	Used

GAUSSIAN QUADRATURE FOR $\int_a^{\infty} f(x)\,dx$

CODE	KEYS
32	f^{-1}
51	SF 1
41	↑
01	1
51	–
33 07	STO 7
00	0
33 08	STO 8
23	LBL
01	1
12	B
34 01	RCL 1
34 02	RCL 2
33 01	STO 1
35 07	g x⇄y
33 02	STO 2
34 04	RCL 4
34 05	RCL 5
33 04	STO 4
35 07	g x⇄y
33 05	STO 5
12	B
34 01	RCL 1
34 03	RCL 3
33 01	STO 1
35 07	g x⇄y
33 03	STO 3
34 04	RCL 4
34 06	RCL 6
33 04	STO 4
35 07	g x⇄y
33 06	STO 6
12	B
34 08	RCL 8
02	2

CODE	KEYS
31	f
61	TF 1
81	÷
84	R/S
34 01	RCL 1
42	CHS
33 01	STO 1
34 02	RCL 2
42	CHS
33 02	STO 2
34 03	RCL 3
42	CHS
33 03	STO 3
31	f
51	SF 1
22	GTO
01	1
23	LBL
12	B
02	2
34 01	RCL 1
01	1
61	+
81	÷
33	STO
09	9
34 07	RCL 7
61	+
23	LBL
11	A
34	RCL
09	9
32	f^{-1}
09	$\sqrt{x}$
71	x

CODE	KEYS
34 04	RCL 4
71	x
33	STO
61	+
08	8
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	z_1 (z_2)	R_4	w_1	R_7	a – 1
R_2	z_3 (z_4)	R_5	w_3	R_8	Used
R_3	z_5 (z_6)	R_6	w_5	R_9	Used

BESSEL FUNCTION Jn(x)

CODE	KEYS
33 01	STO 1
43	EEX
42	CHS
09	9
09	9
33 06	STO 6
00	0
33 03	STO 3
33 04	STO 4
35 09	g R↑
33 05	STO 5
35 22	g x≤y
22	GTO
01	1
35	g
04	1/x
61	+
35	g
05	y^x
02	2
71	x
35 07	g x⇄y
35 22	g x≤y
44	CLX
84	R/S
23	LBL
01	1
34 01	RCL 1
06	6
35	g
04	1/x
35	g
05	y^x
41	↑
41	↑

CODE	KEYS
09	9
71	x
71	x
35 00	g LST X
31	f
09	$\sqrt{x}$
61	+
01	1
61	+
34 01	RCL 1
34 05	RCL 5
35 24	g x>y
35 01	g NOP
35 07	g x⇄y
35 08	g R↓
61	+
31	f
83	INT
23	LBL
03	3
33 08	STO 8
34 05	RCL 5
35 23	g x=y
34 06	RCL 6
33 07	STO 7
00	0
34 08	RCL 8
35 23	g x=y
34 07	RCL 7
22	GTO
02	2
81	÷
32	f^{-1}
83	INT
35 23	g x=y

CODE	KEYS
34 06	RCL 6
33	STO
61	+
04	4
34 03	RCL 3
34 08	RCL 8
02	2
34 01	RCL 1
81	÷
71	x
34 06	RCL 6
33 03	STO 3
71	x
35 07	g x⇄y
51	–
33 06	STO 6
34 08	RCL 8
01	1
51	–
22	GTO
03	3
23	LBL
02	2
34 04	RCL 4
02	2
71	x
34 06	RCL 6
61	+
81	÷
84	R/S

R_1	x	R_4	ΣT_{2i}	R_7	T_n
R_2		R_5	n	R_8	counter k
R_3	T_{k+1}	R_6	10^{-99}, T_k	R_9	Used

KELVIN FUNCTIONS

CODE	KEYS
23	LBL
11	A
41	↑
71	x
41	↑
71	x
33 03	STO 3
35 00	g LST X
04	4
81	÷
35 08	g R↓
44	CLX
33 02	STO 2
35 07	g x⇄y
33 01	STO 1
35 23	g x=y
01	1
35 08	g R↓
35 09	g R↑
33 05	STO 5
23	LBL
01	1
41	↑
33 04	STO 4
34 05	RCL 5
61	+
35 23	g x=y
24	RTN
24	RTN
43	EEX
02	2
34 02	RCL 2
02	2
61	+
33 02	STO 2

CODE	KEYS
35 24	g x>y
34 04	RCL 4
24	RTN
34 01	RCL 1
61	+
41	↑
71	x
35 00	g LST X
51	−
41	↑
71	x
08	8
00	0
71	x
05	5
42	CHS
34 03	RCL 3
71	x
35 07	g x⇄y
81	÷
34 05	RCL 5
71	x
33 05	STO 5
34 04	RCL 4
61	+
22	GTO
01	1
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	0 or 1	R_4	Used	R_7	
R_2	Used	R_5	Used	R_8	
R_3	x^4	R_6		R_9	Used

EULER Φ FUNCTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
01	1
33 02	STO 2
33 04	STO 4
02	2
33 03	STO 3
23	LBL
01	1
34 01	RCL 1
34 03	RCL 3
81	÷
34 03	RCL 3
35 24	g x>y
22	GTO
02	2
35 08	g R↓
31	f
83	INT
35 00	g LST X
35 24	g x>y
22	GTO
03	3
33 01	STO 1
34 04	RCL 4
34 03	RCL 3
33 04	STO 4
35 21	g x≠y
01	1
51	–
33	STO
71	x
02	2
22	GTO

CODE	KEYS
01	1
23	LBL
03	3
02	2
34 03	RCL 3
35 23	g x=y
44	CLX
01	1
61	+
33 03	STO 3
22	GTO
01	1
23	LBL
02	2
34 04	RCL 4
34 01	RCL 1
35 21	g x≠y
01	1
51	–
34 02	RCL 2
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

GAMMA FUNCTION (CARD 1)

CODE	KEYS
23	LBL
11	A
83	•
00	0
03	3
05	5
08	8
06	6
08	8
03	3
04	4
03	3
33 01	STO 1
83	•
01	1
09	9
03	3
05	5
02	2
07	7
08	8
01	1
08	8
42	CHS
33 02	STO 2
83	•
04	4
08	8
02	2
01	1
09	9
09	9
03	3
09	9
04	4

CODE	KEYS
33 03	STO 3
83	•
07	7
05	5
06	6
07	7
00	0
04	4
00	0
07	7
08	8
42	CHS
33 04	STO 4
83	•
09	9
01	1
08	8
02	2
00	0
06	6
08	8
05	5
07	7
33 05	STO 5
83	•
08	8
09	9
07	7
00	0
05	5
06	6
09	9
03	3
07	7
42	CHS

CODE	KEYS
33 06	STO 6
83	•
09	9
08	8
08	8
02	2
00	0
05	5
08	8
09	9
01	1
33 07	STO 7
83	•
05	5
07	7
07	7
01	1
09	9
01	1
06	6
05	5
02	2
42	CHS
33 08	STO 8
84	R/S
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	b_8	R_4	b_5	R_7	b_2
R_2	b_7	R_5	b_4	R_8	b_1
R_3	b_6	R_6	b_3	R_9	

GAMMA FUNCTION (CARD 2)

CODE	KEYS
23	LBL
11	A
41	↑
01	1
51	–
00	0
35 24	g x>y
00	0
81	÷
35 07	g x⇄y
01	1
33 08	STO 8
23	LBL
02	2
35 07	g x⇄y
35 24	g x>y
22	GTO
01	1
41	↑
41	↑
41	↑
34 01	RCL 1
71	x
34 02	RCL 2
61	+
71	x
34 03	RCL 3
61	+
71	x
34 04	RCL 4
61	+
71	x
34 05	RCL 5
61	+
71	x

CODE	KEYS
34 06	RCL 6
61	+
71	x
34 07	RCL 7
61	+
71	x
83	•
05	5
07	7
07	7
01	1
09	9
01	1
06	6
05	5
02	2
42	CHS
61	+
71	x
01	1
61	+
34 08	RCL 8
71	x
84	R/S
23	LBL
01	1
33	STO
71	x
08	8
35 07	g x⇄y
51	–
01	1
22	GTO
02	2
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	b_8	R_4	b_5	R_7	b_2
R_2	b_7	R_5	b_4	R_8	Used
R_3	b_6	R_6	b_3	R_9	Used

INCOMPLETE GAMMA FUNCTION

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	35 01	g NOP	35 01	g NOP
11	A	35 01	g NOP	35 01	g NOP
33 01	STO 1	35 01	g NOP	35 01	g NOP
35 07	g x⇄y	35 01	g NOP	35 01	g NOP
33 02	STO 2	35 01	g NOP	35 01	g NOP
35	g	35 01	g NOP	35 01	g NOP
05	y^x	35 01	g NOP	35 01	g NOP
34 02	RCL 2	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
33 03	STO 3	35 01	g NOP	35 01	g NOP
23	LBL	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
34 01	RCL 1	35 01	g NOP	35 01	g NOP
34 02	RCL 2	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP	35 01	g NOP
33 02	STO 2	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
34 03	RCL 3	35 01	g NOP	35 01	g NOP
71	x	35 01	g NOP	35 01	g NOP
33 03	STO 3	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP	35 01	g NOP
35 21	g x≠y	35 01	g NOP	35 01	g NOP
22	GTO	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
34 01	RCL 1	35 01	g NOP	35 01	g NOP
32	f^{-1}	35 01	g NOP	35 01	g NOP
07	LN	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
24	RTN	35 01	g NOP	35 01	g NOP
35 01	g NOP	35 01	g NOP		
35 01	g NOP	35 01	g NOP		
35 01	g NOP	35 01	g NOP		
35 01	g NOP	35 01	g NOP		
35 01	g NOP	35 01	g NOP		

R_1	x	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

ERROR FUNCTION AND COMPLEMENTARY ERROR FUNCTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
41	↑
71	x
02	2
71	x
33 02	STO 2
01	1
33 03	STO 3
34 01	RCL 1
23	LBL
01	1
34 02	RCL 2
34 03	RCL 3
02	2
61	+
33 03	STO 3
81	÷
34 01	RCL 1
71	x
33 01	STO 1
61	+
35 21	g x≠y
22	GTO
01	1
02	2
71	x
35	g
02	π
31	f
09	$\sqrt{x}$
34 02	RCL 2
02	2
81	÷

CODE	KEYS
32	f^{-1}
07	LN
71	x
81	÷
84	R/S
01	1
35 07	g x⇄y
51	–
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4		R_7	
R_2	$2x^2$	R_5		R_8	
R_3	Used	R_6		R_9	Used

CONFLUENT HYPERGEOMETRIC FUNCTION

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	35 01	g NOP	35 01	g NOP
11	A	35 01	g NOP	35 01	g NOP
33 01	STO 1	35 01	g NOP	35 01	g NOP
35 08	g R↓	35 01	g NOP	35 01	g NOP
33 02	STO 2	35 01	g NOP	35 01	g NOP
35 08	g R↓	35 01	g NOP	35 01	g NOP
33 03	STO 3	35 01	g NOP	35 01	g NOP
00	0	35 01	g NOP	35 01	g NOP
33 04	STO 4	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
33 05	STO 5	35 01	g NOP	35 01	g NOP
23	LBL	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
34 01	RCL 1	35 01	g NOP	35 01	g NOP
34 03	RCL 3	35 01	g NOP	35 01	g NOP
34 04	RCL 4	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP	35 01	g NOP
71	x	35 01	g NOP	35 01	g NOP
34 02	RCL 2	35 01	g NOP	35 01	g NOP
34 04	RCL 4	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
34 04	RCL 4	35 01	g NOP	35 01	g NOP
01	1	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP	35 01	g NOP
33 04	STO 4	35 01	g NOP	35 01	g NOP
81	÷	35 01	g NOP	35 01	g NOP
34 05	RCL 5	35 01	g NOP	35 01	g NOP
71	x	35 01	g NOP	35 01	g NOP
33 05	STO 5	35 01	g NOP	35 01	g NOP
61	+	35 01	g NOP		
35 21	g x≠y	35 01	g NOP		
22	GTO	35 01	g NOP		
01	1	35 01	g NOP		
24	RTN	35 01	g NOP		

R_1	x	R_4	Used	R_7	
R_2	b	R_5	Used	R_8	
R_3	a	R_6		R_9	Used

GAUSSIAN HYPERGEOMETRIC FUNCTION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
35 08	g R↓
33 02	STO 2
35 08	g R↓
33 03	STO 3
35 08	g R↓
33 04	STO 4
04	4
00	0
00	0
33 08	STO 8
00	0
33 05	STO 5
01	1
33 06	STO 6
23	LBL
01	1
34 01	RCL 1
34 05	RCL 5
34 04	RCL 4
61	+
71	x
34 05	RCL 5
34 03	RCL 3
61	+
71	x
34 02	RCL 2
34 05	RCL 5
61	+
81	÷
34 05	RCL 5
01	1
61	+

CODE	KEYS
33 05	STO 5
81	÷
34 06	RCL 6
71	x
33 06	STO 6
61	+
35 23	g x=y
24	RTN
35 01	g NOP
35	g
83	DSZ
22	GTO
01	1
00	0
81	÷
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x	R_4	a	R_7	
R_2	c	R_5	Used	R_8	Used
R_3	b	R_6	Used	R_9	Used

CHEBYSHEV POLYNOMIAL

CODE	KEYS
23	LBL
11	A
33 01	STO 1
02	2
33 02	STO 2
71	x
33 03	STO 3
44	CLX
35 07	g x⇄y
35 22	g x≤y
01	1
24	RTN
01	1
33 04	STO 4
35 23	g x=y
34 01	RCL 1
24	RTN
23	LBL
01	1
44	CLX
34 03	RCL 3
34 01	RCL 1
71	x
34 04	RCL 4
35 00	g LST X
33 04	STO 4
35 08	g R↓
51	−
33 01	STO 1
44	CLX
34 02	RCL 2
01	1
61	+
33 02	STO 2
35 22	g x≤y

CODE	KEYS
22	GTO
01	1
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	Used	R_5		R_8	
R_3	2x	R_6		R_9	Used

LEGENDRE POLYNOMIAL

CODE	KEYS
23	LBL
11	A
33 02	STO 2
33 05	STO 5
44	CLX
35 07	g x⇄y
33 01	STO 1
35 22	g x≤y
01	1
24	RTN
01	1
33 04	STO 4
35 07	g x⇄y
35 22	g x≤y
34 02	RCL 2
24	RTN
02	2
33 03	STO 3
23	LBL
01	1
34 05	RCL 5
34 02	RCL 2
71	x
41	↑
41	↑
34 04	RCL 4
51	–
61	+
35 00	g LST X
34 05	RCL 5
33 04	STO 4
44	CLX
34 03	RCL 3
81	÷
51	–

CODE	KEYS
33 05	STO 5
34 01	RCL 1
34 03	RCL 3
01	1
61	+
33 03	STO 3
35 22	g x≤y
22	GTO
01	1
34 05	RCL 5
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Used	R_7	
R_2	x	R_5	Used	R_8	
R_3	Used	R_6		R_9	Used

HERMITE POLYNOMIAL

CODE	KEYS
23	LBL
11	A
33 02	STO 2
02	2
71	x
33 04	STO 4
44	CLX
35 07	g x⇄y
35 22	g x≤y
01	1
24	RTN
01	1
33 01	STO 1
33 03	STO 3
35 07	g x⇄y
35 22	g x≤y
34 04	RCL 4
24	RTN
23	LBL
01	1
34 01	RCL 1
34 04	RCL 4
33 01	STO 1
34 02	RCL 2
71	x
35 07	g x⇄y
34 03	RCL 3
71	x
51	–
02	2
71	x
33 04	STO 4
44	CLX
34 03	RCL 3
01	1

CODE	KEYS
61	+
33 03	STO 3
35 07	g x⇄y
35 21	g x≠y
22	GTO
01	1
34 04	RCL 4
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	x	R_5		R_8	
R_3	Used	R_6		R_9	Used

LAGUERRE POLYNOMIAL

CODE	KEYS
23	LBL
11	A
41	↑
01	1
33 04	STO 4
61	+
33 02	STO 2
02	2
33 03	STO 3
35 07	g x⇄y
51	–
33 05	STO 5
44	CLX
35 07	g x⇄y
35 22	g x≤y
01	1
24	RTN
33 01	STO 1
01	1
35 07	g x⇄y
35 22	g x≤y
34 05	RCL 5
24	RTN
23	LBL
01	1
34 05	RCL 5
34 04	RCL 4
51	–
34 05	RCL 5
61	+
34 02	RCL 2
34 05	RCL 5
71	x
34 04	RCL 4
51	–

CODE	KEYS
34 03	RCL 3
81	÷
34 05	RCL 5
33 04	STO 4
35 08	g R↓
51	–
33 05	STO 5
34 01	RCL 1
34 03	RCL 3
01	1
61	+
33 03	STO 3
35 22	g x≤y
22	GTO
01	1
34 05	RCL 5
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	n	R_4	Used	R_7	
R_2	1 + x	R_5	Used	R_8	
R_3	Used	R_6		R_9	Used

SINE INTEGRAL

CODE	KEYS
23	LBL
11	A
33 03	STO 3
41	↑
71	x
42	CHS
33 01	STO 1
01	1
33 02	STO 2
34 03	RCL 3
23	LBL
01	1
34 01	RCL 1
34 02	RCL 2
01	1
61	+
81	÷
35 00	g LST X
01	1
61	+
33 02	STO 2
81	÷
34 03	RCL 3
71	x
33 03	STO 3
34 02	RCL 2
81	÷
61	+
35 21	g x≠y
22	GTO
01	1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	$-x^2$	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

COSINE INTEGRAL

CODE	KEYS
23	LBL
11	A
41	↑
71	x
42	CHS
33 01	STO 1
01	1
33 03	STO 3
00	0
33 02	STO 2
35 00	g LST X
31	f
07	LN
83	•
05	5
07	7
07	7
02	2
01	1
05	5
06	6
06	6
04	4
09	9
61	+
23	LBL
01	1
34 01	RCL 1
34 02	RCL 2
01	1
61	+
81	÷
35 00	g LST X
01	1
61	+

CODE	KEYS
33 02	STO 2
81	÷
34 03	RCL 3
71	x
33 03	STO 3
34 02	RCL 2
81	÷
61	+
35 21	g x≠y
22	GTO
01	1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 $-x^2$	R_4	R_7
R_2 Used	R_5	R_8
R_3 Used	R_6	R_9 Used

EXPONENTIAL INTEGRAL

CODE	KEYS
23	LBL
11	A
33 01	STO 1
01	1
33 03	STO 3
00	0
33 02	STO 2
34 01	RCL 1
31	f
07	LN
83	•
05	5
07	7
07	7
02	2
01	1
05	5
06	6
06	6
04	4
09	9
61	+
23	LBL
01	1
34 01	RCL 1
34 02	RCL 2
01	1
61	+
33 02	STO 2
81	÷
34 03	RCL 3
71	x
33 03	STO 3
34 02	RCL 2
81	÷

CODE	KEYS
61	+
35 21	g x≠y
22	GTO
01	1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	x	R_4		R_7	
R_2	Used	R_5		R_8	
R_3	Used	R_6		R_9	Used

FRESNEL INTEGRALS

CODE	KEYS
23	LBL
11	A
13	C
01	1
33 03	STO 3
34 01	RCL 1
23	LBL
01	1
34 02	RCL 2
34 03	RCL 3
04	4
61	+
33 03	STO 3
01	1
51	–
02	2
81	÷
33 04	STO 4
01	1
51	–
34 04	RCL 4
71	x
81	÷
34 01	RCL 1
71	x
33 01	STO 1
34 03	RCL 3
81	÷
61	+
35 21	g x≠y
22	GTO
01	1
24	RTN
23	LBL
12	B

CODE	KEYS
13	C
35 00	g LST X
34 01	RCL 1
71	x
33 01	STO 1
03	3
33 03	STO 3
81	÷
22	GTO
01	1
23	LBL
13	C
33 01	STO 1
35	g
06	ABS
03	3
83	•
06	6
35 22	g x≤y
00	0
81	÷
34 01	RCL 1
41	↑
71	x
35	g
02	π
02	2
81	÷
71	x
41	↑
71	x
42	CHS
33 02	STO 2
24	RTN
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Used	R_4	Used	R_7	
R_2	$-(\pi x^2/2)^2$	R_5		R_8	
R_3	Used	R_6		R_9	

COMPLETE ELLIPTIC INTEGRALS

CODE	KEYS
23	LBL
11	A
33 03	STO 3
35 07	g x⇄y
33 02	STO 2
61	+
33 01	STO 1
43	EEX
09	9
09	9
33 04	STO 4
01	1
33 05	STO 5
35 09	g R↑
41	↑
71	x
35 24	g x>y
35 09	g R↑
24	RTN
35 21	g x≠y
22	GTO
01	1
44	CLX
71	x
34 03	RCL 3
35 24	g x>y
35 09	g R↑
24	RTN
35 09	g R↑
42	CHS
35 08	g R↓
35 07	g x⇄y
35 24	g x>y
35 09	g R↑
24	RTN

CODE	KEYS
34 02	RCL 2
24	RTN
23	LBL
01	1
51	–
31	f
09	$\sqrt{x}$
33 04	STO 4
23	LBL
02	2
34 02	RCL 2
34 04	RCL 4
71	x
34 03	RCL 3
61	+
02	2
71	x
33 03	STO 3
34 05	RCL 5
33 06	STO 6
34 04	RCL 4
61	+
33 05	STO 5
81	÷
34 01	RCL 1
33 02	STO 2
61	+
33 01	STO 1
34 04	RCL 4
34 06	RCL 6
01	1
41	↑
43	EEX
42	CHS
09	9

CODE	KEYS
51	–
71	x
34 06	RCL 6
34 04	RCL 4
71	x
31	f
09	$\sqrt{x}$
02	2
71	x
33 04	STO 4
35 08	g R↓
35 24	g x>y
22	GTO
02	2
35	g
02	π
04	4
81	÷
34 01	RCL 1
71	x
34 05	RCL 5
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	a_{i+1}	R_4	10^{99}, v_i	R_7	
R_2	a_i	R_5	u_i	R_8	
R_3	b_i	R_6	u_{i-1}	R_9	Used

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