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HP 41 PROGRAM SUBMITTAL FORM

PROGRAMMFORMBLATT/DOCUMENTATION DU PROGRAMME/GENERALITÀ SUL PROGRAMMA

Program Title (Programmtitel / Titre du programme / Titolo del programma): SPLINE INTERPOLATION FOR DISCRET DATA

Category No. (Kategorie Nr. / Catégorie N / Categoria N°): 209

Name (Rubrik / Rubrique / Nome della categoria): Interpolation

No. of program lines (Anzahl Programmzeilen / Nombre de lignes de programme / N° di linee di programma): 995 incl. subroutines

No. of data registers (Anzahl des benötigten Datenspeicher / Nombre de registres de données / N° di registri utilizzati): 20 + 5N

Recommended HP 41 System configuration (Empfohlene System-Konfiguration / Configuration recommandée / Configurazione raccomandata):

Port # 1: Quad Memory
Port # 2:
Port # 3: Printer
Port # 4: Card Reader

This program requires the following programs as subroutines: (Dieses Programm benutzt folgende Programme als Unterprogramme / Ce programme utilise les programmes suivants comme sous programmes / Questo programma usa i seguenti programmi come subroutines)

Program Name: (Programm: / Nom du programme: / Programma:) SINP, SCOF, SCDS, SIGR

HP Applications ROM (HP Applikations ROM / ROM d'application HP / ROM di applicazione HP): PRPLOT, PRPLOTP

Program Abstract (Kurzbeschreibung / Resume / Breve descrizione del programma):

The spline function S(x) is a piecewise polynomial function of degree ≤ 3. S(x) and its derivatives of order 1 & 2 are continuous everywhere ("smoothness").
Calculation of S(x) with N≤ 34 data points (X_k, Y_k) k=1,2,...,N; $x_1<x_2<...<x_N$.
The function and the data points are ploted automatically, using different symbols for (x_k, y_k) and interpolated points. A curve discussion is made (maxima, minima and turning points are found) and the integral of the spline at any boundaries within the total interval is given.
Minimal number of program registers needed for execution: 125 (main program + largest subroutine).

Program Size 250 reg.

Name (Name / Nom / Nome): Meier B. U.

Address (Strasse / Adresse / Indirizzo): Altstetterstrasse 190

Country (Land / Pays / Paese): Switzerland

Postal Code (Postleitzahl / Code postal / C.A.P.): CH-8048

City (Ort / Localité / Città): Zürich

12-15-81

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Application, Equations, Variables
Anwendung, Gleichungen, Veränderliche
Application, Equations, Variables
Applicazione, Equazioni, Variabili

Given a strictly increasing sequence $X_1, X_2, \ldots$ An interpolating cubic spline $S(X)$ consists of sectional polynomials of degree ≤ 3

$$(1) \quad S(X) = \begin{cases} S_1(X) & \text{for } X_1 \leq X \leq X_2 \\ S_2(X) & \text{for } X_2 \leq X \leq X_3 \\ \vdots & \vdots \\ S_k(X) & \text{for } X_k \leq X \leq X_{k+1} \\ \vdots & \vdots \\ S_{N-1}(X) & \text{for } X_{N-1} \leq X \leq X_N \end{cases}$$

$S(X)$ is defined as a function having the following properties:

(a) $S(X_k) = Y_k \qquad k = 1, 2, \ldots, N$

(b) $S(X)$ and its derivatives of order 1 and 2 are continuous in the interval $[X_1, X_N]$.

(c) $S(X)$ is the "smoothest" of <u>all</u> functions with continuous derivatives up to order 2 in $[X_1, X_N]$ in the sense, that it minimizes

$$\int_{X_1}^{X_N} [F(X)]^2 \, dX$$

We set

$$(2) \quad S_k(X) = A_k(X-X_k)^3 + B_k(X-X_k)^2 + C_k(X-X_k) + D_k$$

using (a), (b) and (c) we obtain:

$$\left.\begin{aligned} &(3) \quad A_k = \frac{1}{6\Delta X_k}(S''_{k+1} - S''_k) \\ &(4) \quad B_k = \tfrac{1}{2} S''_k \\ &(5) \quad C_k = \frac{\Delta Y_k}{\Delta X_k} - \tfrac{1}{6}\Delta X_k(S''_{k+1} + 2S''_k) \\ &(6) \quad D_k = Y_k \\ &\text{where} \\ &\Delta X_k = X_{k+1} - X_k \quad \text{and} \quad \Delta Y_k = Y_{k+1} - Y_k \end{aligned}\right\} \; k = 1, \ldots, N-1$$

The interpolation problem is solved here for $S(X)$ with zero second derivative at the end points (natural spline):

$$(7) \quad \begin{aligned} S''(X_1) &= 0 \\ S''(X_N) &= 0 \end{aligned}$$

Note: The SCOF program page 21 is not limited to zero second derivative at the end points. Obtain it by adding the marked lines to the normal SCOF program page 14.

By using (b) and (7) we obtain a linear equation system for $S''_2, \ldots, S''_{N-1}$.

$$\begin{bmatrix} 2(\Delta X_1+\Delta X_2) & \Delta X_2 & & & & \\ \Delta X_2 & 2(\Delta X_2+\Delta X_3) & \Delta X_3 & & & \\ & \Delta X_3 & 2(\Delta X_3+\Delta X_4) & \Delta X_4 & & \\ & & \cdot & \cdot & \cdot & \cdot \\ & & & \Delta X_{N-2} & 2(\Delta X_{N-2}+\Delta X_{N-1}) & \end{bmatrix} \begin{bmatrix} S''_2 \\ S''_3 \\ S''_4 \\ \vdots \\ S''_{N-1} \end{bmatrix} = \tag{8}$$

$$\begin{bmatrix} 6\left(\frac{\Delta Y_2}{\Delta X_2} - \frac{\Delta Y_1}{\Delta X_1}\right) \\ 6\left(\frac{\Delta Y_3}{\Delta X_3} - \frac{\Delta Y_2}{\Delta X_2}\right) \\ 6\left(\frac{\Delta Y_4}{\Delta X_4} - \frac{\Delta Y_3}{\Delta X_3}\right) \\ \cdot \cdot \cdot \cdot \cdot \\ 6\left(\frac{\Delta Y_{N-1}}{\Delta X_{N-1}} - \frac{\Delta Y_{N-2}}{\Delta X_{N-2}}\right) \end{bmatrix}$$

To find the extremes of S(X) the following relationships are used:

(9) $S'_k = 3A_k(X-X_k)^2 + 2B_k(X-X_k) + C_k$

(10) $S''_k = 6A_k(X-X_k) + 2B_k$

(11) $S'_k = 0$ $\qquad X_{1,2} = -\frac{B_k}{3A_k} + \sqrt{\left(\frac{B_k}{3A_k}\right)^2 - C_k} + X_k$

(12) $S''_k = 0$ $\qquad X = -\frac{B_k}{3A_k} + X_k$

for integration:

(13) $I_k = \int_a^b S_k(X)\, dX = \left[\frac{A_k}{4} u^4 + \frac{B_k}{3} u^3 + \frac{C_k}{2} u^2 + D_k u\right]_{a-X_k}^{b-X_k}$

(14) $I = \sum I_k$ with respect to the boundaries

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PROGRAM DESCRIPTION I

PROGRAMMBESCHREIBUNG I
DESCRIPTION DU PROGRAMME I
DESCRIZIONE DEL PROGRAMMA I

Program Structure

Main program SPLINE:	Initialization; SIZE test, sets flags and data registers for subroutine entry; checks for existance of subroutines in program memory and calls subroutines; output of A_k, B_k, C_k, Y_k, X_k.
Global label SIPL:	Interpolation of X register value (eq. 2); changes plot-symbol for data points.
Subroutine SINP:	Input of data points; testing for increasing X-values; edit - and list option.
Subroutine SCOF:	Solving of equation system (8); determination of A_k, B_k, C_k according to eq. (3), (4), (5).
Subroutine SCDS:	Finds maxima, minima, turning points using eq. (9), (10), (11), (12); automatic scaling for PRPLOTP.
Subroutine SIGR:	Integration of S(X) in the interval [a,b], according to eq. (13),(14).

References:
Späth, Helmut; Spline-Algorithmen; Oldenbourg, München 1973
Pearson, Carl E., Handbook of Applied Mathematics, VNR 1974

Operating limits and Warnings
Grenzen und Einschränkungen
Limites et restrictions
Limiti operativi e avvertenze

The printplot may not contain all data points if $(X_{i+1} - X_i) \leq$ XINC, i= 1,..,N . Expand the plot, using XEQ J.

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.
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Dieses Programm wurde lediglich anhand des in der Programmbeschreibung II enthaltenen Zahlenbeispiels überprüft. Der Benutzer erhält und benutzt das Programmaterial auf eigenes Risiko hin; er hat es deshalb - gleichgültig, ob es bereits anderweitig präsentiert oder beschrieben wurde - selbst zu untersuchen.
WEDER HP NOCH DER EINSENDER DES PROGRAMMS ÜBERNEHMEN FÜR DAS PROGRAMMATERIAL EINE IRGENDWIE GEARTETE GEWÄHRLEISTUNG ODER HAFTUNG, INSBESONDERE NICHT FÜR SEINE VERKAUFLICHKEIT ODER SEINE VERWENDBARKEIT FÜR EINEN BESTIMMTEN ZWECK. HP UND DER EINSENDER HAFTEN AUCH NICHT FÜR INDIREKTE ODER FOLGESCHÄDEN.

Le present programme n'a été verifie qu'en ce qui concerne l'exemple numerique indiqué dans la description du programme II. L'utilisateur accepte et utilise le présent prog À SES PROPRES RISQUES et doit se fier uniquement à sa propre inspection dudit programme sans se referer à toute autre declaration et description.
HP ET LE FOURNISSEUR NE DONNENT AUCUNE GARANTIE, EXPRESSE OU IMPLICITE CONCERNANT LE PRESENT PROGRAMME, NOTAMMENT DE COMMERCIALISATION ET D'ADAPTATION À UN USAGE PARTICULIER. HP ET LE FOURNISSEUR N'ASSUMENT AUCUNE RESPONSABILITE EN CE QUI CONCERNE LES DOMMAGES INDIRECTS NES DE LA FOURNITURE, DE L'UTILISATION OU DU FONCTIONNEMENT DU PRESENT PROGRAMME.

Questo programma è stato verificato soltanto per quanto concerne l'esempio numerico indicato nella Descrizione del Programma II. L'utilizzatore accetta e utilizzerà il presente programma A SUO INTERO RISCHIO, fidandosi unicamente della propria verifica del programma e non basandosi su altre dichiarazioni o descrizioni.
NE LA SOCIETÀ NE L'AUTORE DANNO ALCUNA GARANZIA IMPLICITA O ESPLICITA CONCERNENTE IL PRESENTE PROGRAMMA, IN SPECIAL MODO RIGUARDO ALLA SUA COMMERCIALIZZAZIONE O ADATTABILITÀ AD UN USO PARTICOLARE. NÉ LA SOCIETÀ HP NÉ L'AUTORE ASSUMONO ALCUNA RESPONSABILITÀ PER DANNI IMMEDIATI O MEDIATI CAUSATI DALLA FORNITURA, UTILIZZAZIONE O FUNZIONAMENTO DEL PRESENTE PROGRAMMA.

PROGRAM DESCRIPTION II

PROGRAMMBESCHREIBUNG II
DESCRIPTION DU PROGRAMME II
DESCRIZIONE DEL PROGRAMMA II

Example
Beispiel
Exemple
Esempio

Determine

- maxima, minima, turning points
- the integral for a= 0, b= 12.0 and a= 1.1 , b= 4.3

of the spline function fitted to the following data points:

k	1	2	3	4	5	6	7	8	9	10
x_k	o	2.0	3.2	4.9	6.1	7.3	8.9	10.1	10.8	12.0
y_k	2.13	-1.09	-.99	0.54	1.85	2.56	1.60	1.2	1.2	1.2

Printplot the spline function and the data points,
list the spline coefficients,
find a root of the spline.

Sketch
Skizze
Croquis
Schizzo

02365C

PROGRAM DESCRIPTION III
PROGRAMMBESCHREIBUNG III
DESCRIPTION DU PROGRAMME III
DESCRIZIONE DEL PROGRAMMA III

	Data Input Dateneingabe Donnees Dati	Keystrokes Tasten Touches Tasti	Result Resultat Resultat Risultato	Comments Kommentare Commentaires Commenti
1		insert card		
		SPLINE	RDY 2 OF 5	(always load all tracks)
			etc.	
2		GTO..		
3		insert card		in your examples if
		SINP	RDY 2 OF 2	19 < N ≤ 34 continue at 10
4		GTO..		
5		insert card		
		SIGR	RDY 2 OF 3	
6		GTO..		
7		insert card		
		SCOF	RDY 2 OF 3	continue at 10 if 10 < N ≤ 19
8		GTO..		
9		insert card		
		SCDS	RDY 2 OF 3	
10		XEQ SPLINE	PAIRS,N= ?	
	10	R/S	SET SIZE 70	
		SIZE 070		
		R/S	PAIRS,N= ?	
11	10	R/S	X1↑Y1=?	
	0.000000	ENTER↑		
	2.130000	RUN		
			X2↑Y2=?	
	2.000000	ENTER↑		
	-1.090000	RUN		
			X3↑Y3=?	
	3.200000	ENTER↑		
	-.990000	RUN		
			X4↑Y4=?	
	4.900000	ENTER↑		
	.540000	RUN		
			X5↑Y5=?	
	6.100000	ENTER↑		
	1.850000	RUN		
			X6↑Y6=?	
	7.300000	ENTER↑		
	2.560000	RUN		
			X7↑Y7=?	
	.000000	ENTER↑		
	8.900000	RUN		input error
			X8↑Y8=?	
	10.100000	ENTER↑		
	1.200000	RUN		
			X9↑Y9=?	
	10.800000	ENTER↑		
	1.200000	RUN		
			X10↑Y10=?	
	12.000000	ENTER↑		
	1.200000	RUN	E, L ?	
12	E	R/S	PAIR NO ?	correct input for pair 7
	7	R/S	X7↑Y7=?	

	Data Input / Dateneingabe / Donnees / Dati	Keystrokes / Tasten / Touches / Tasti	Result / Resultat / Resultat / Risultato	Comments / Kommentare / Commentaires / Commenti
	8.9	ENTER		
	1.6	R/S	E, L ?	
		R/S		continue
			see fig. III/ 1	
13		CF 00		results in prompting for
		XEQ I	a↑b ?	boundaries in SIGR
	1.1	ENTER		
	4.3	R/S	INTEGRAL I :	
			INTERVAL	
			a= 1.1000	
			b= 4.3000	
			I= -2.6016	
14		XEQ e	see fig. III/ 2	
15		CF 01 *		to find a root of the spline
		CF 02		use SOLVE (math I) or solve
		XEQ SOLVE	FUNCTION NAME?	the cubic equation, using the
	SIPL	R/S		A_k, B_k, etc. or expand the
			GUESS 1=?	printplot using XEQ D and then
	0.7	R/S		XEQ E to check your approx.
			GUESS 2=?	
	1.4	R/S		
			ROOT IS BETWEEN	
			1.086287	
			AND 1.086207	
				* not necessary in this case but remember to always clear flags 1 and 2 before using SIPL as a function
16		GTO SPLINE		
		XEQ E	1.000000-09	check of the root found in SOLVE

TURNING POINT: K= 1
X= 0.000000
Y= 2.130000

MINIMA K= 2
X= 2.473446
Y= -1.228150

TURNING POINT: K= 4
X= 5.225947
Y= 0.904984

MAXIMA K= 5
X= 7.282875
Y= 2.560201

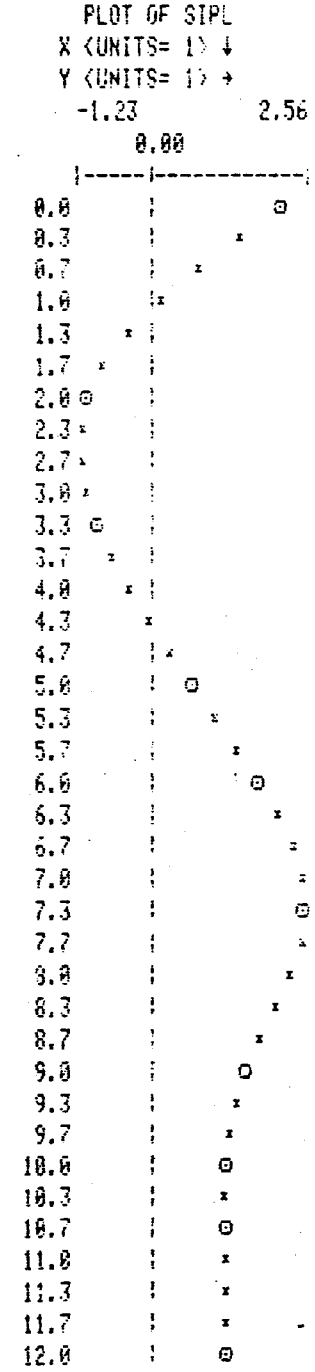
TURNING POINT: K= 6
X= 8.412277
Y= 1.962912

MINIMA K= 8
X= 10.376519
Y= 1.190887

TURNING POINT: K= 8
X= 10.691111
Y= 1.196969

MAXIMA K= 9
X= 11.307180
Y= 1.205894

TURNING POINT: K= 9
X= 12.000000
Y= 1.200000



INTEGRAL I:
INTERVAL
a= 0.0000
b= 12.0000
I= 10.2100

Fig. III/ 1

X1= 0.000000
Y1= 2.130000
C1= -2.107777
B1= 0.000000
A1= 0.124444

X2= 2.000000
Y2= -1.090000
C2= -0.614447
B2= 0.746665
A2= -0.137651

X3= 3.200000
Y3= -0.990000
C3= 0.582896
B3= 0.251121
A3= -0.037993

X4= 4.900000
Y4= 0.540000
C4= 1.107383
B4= 0.057355
A4= -0.058654

X5= 6.100000
Y5= 1.850000
C5= 0.991568
B5= -0.153891
A5= -0.149541

X6= 7.300000
Y6= 2.560000
C6= -0.023574
B6= -0.692150
A6= 0.207428

X7= 8.900000
Y7= 1.600000
C7= -0.645412
B7= 0.303502
A7= -0.036197

X8= 10.100000
Y8= 1.200000
C8= -0.073379
B8= 0.173192
A8= -0.097665

X9= 10.800000
Y9= 1.200000
C9= 0.025523
B9= -0.031904
A9= 0.008862

X10= 12.000000
Y10= 1.200000

Fig. III/ 2

USER INSTRUCTIONS I

PROGRAMMABLAUF I
INSTRUCTIONS D'EMPLOI I
NORME OPERATIVE I

Step Schritt Pas Passo	Instructions Operation Instructions Istruzioni	Variables Dateneingabe Données Dati	Function(s) Taste(n) Touche(s) Tasti	Result Resultat Résultat Risultato
1	Insert card SPLINE (5 TR)		CTO..	
2	Start program		XEQ SPLINE	PAIRS,N= ?
3	Enter number of data points	$3 \leq N \leq 34$	R/S	LOAD SINP *
4	Insert card SINP (2 TR)		R/S	X1↑Y1=?
5	Enter data, note that	Y1	ENTER	
	X1 < X2<...<XN	Y1	R/S	X2 Y2=?
6	Repeat 5 for k= 2, 3,...,N			E, L ?
7	- Edit:	E	R/S	PAIR NO ?
	enter number of data pair			
	to be changed,	k	R/S	Xk↑Yk=?
	continue at step 5			
	- List input	L	R/S	X1=...
	continue at step 7			Y1=...
				etc.
	- Continue execution		R/S	LOAD SCOF *
8	Insert card SCOF (3 TR)		R/S	LOAD SCDS *
9	Insert card SCDS (3 TR)		R/S	output of
				minima,
				maxima etc.
				printplot
				LOAD SIGR *
10	Insert card SIGR (3 TR)		R/S	INTEGRAL I:
				etc.
11	Options		CF 00 **	
	a) Interpolation of value in			
	the X- register	$X1 \leq X \leq XN$	XEQ E	S(X)
	b) Change input data		XEQ D	LOAD SINP *
	continue at step 7			
	c) Calculation of the integral			
	for boundaries a, b		XEQ I	a↑b=?
		$X1 \leq a \leq XN$	ENTER	
		$X1 \leq b \leq XN$	R/S	INTEGRAL I :
				etc.
	d) Output of spline coeff. and			
	Xk, Yk - input		XEQ e	X1=...
				Y1=....
				C1=...
				B1=...
				A1=... etc.
	e) Printplot cutout (calls		XEQ J	NAME?
	PRPLOT)	SIPL	R/S	etc.

*) Appears only if subroutine is not in program memory

**) CF 00 may be executed any time and results in additional prompting:
in routine SCDS: K ? B.EEE curve discussion only in sections B...E
in routine SIGR: see 11c.
in SPLINE: calls PRPLOT instead of PRPLOTP.

Error messages:

SEQ ERR : appears if the Xk-values are not strictly increasing, press R/S, continue at step 7

INP ERR : X < X1 or X > XN in routine SIPL

a TO BIG/SMALL: the definition range of a and b must be respected (11c)

PROGRAM LISTING

PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
01♦LBL "SPLINE"		initialization
02 SF 00		
03 CF 01		
04 CF 02		
05 CF 03		
06 CF 04		
07 SF 21		
08 CF 29		
09 CLRG		
10♦LBL 00		input of
11 "PAIRS, N=?"		number of
12 PROMPT		data points
13 STO Y		
14 5		
15 *		
16 19		
17 +		
18 SF 25		test
19 RCL IND X		SIZE setting
20 FS?C 25		
21 GTO 01		
22 1		
23 +		
24 "ZE "		
25 ARCL X		
26 ASTO X		
27 "SET SI"		
28 ARCL X		
29 CLX		
30 PROMPT		
31 GTO 00		
32♦LBL 01		
33 RDN		
34 RDN		
35 STO 19		
36♦LBL 02		
37 "SINP"		call input
38 XEQ 10		routine
39 "SCOF"		call routine
40 XEQ 10		for spline coeff.
41 FC? 55		
42 GTO 03		
43 20		
44 RCL 19		store YMIN
45 3		and YMAX
46 *		in R00 and
47 +		R01 for
48 ENTER↑		automatic
49 ENTER↑		scaling in
50 RCL 19		PRPLOT P
51 +		
52 1		
53 -		
54 RCL IND Y		

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
55 RCL IND Y		
56 X<Y?		
57 X<>Y		
58 STO 01		
59 X<>Y		
60 STO 00		
61♦LBL 03		
62 "SCDS"		call routine
63 XEQ 10		for curve
64 SF 21		discussion
65 FC? 55		
66 GTO I		
67 FC? 00		manual input
68 GTO J		for PRPLOT
69 RCL 00		if flag 00
70 STO 04		is clear, else
71 X>0?		automatic
72 GTO 04		input of
73 RCL 01		
74 X<=0?		
75 GTO 04		
76 CLX		
77 STO 04		AXIS
78♦LBL 04		
79 20		
80 RCL 19		
81 4		
82 *		
83 +		
84 RCL IND X		
85 STO 08		
86 STO 11		YMIN
87 X<>Y		
88 RCL 19		
89 +		
90 1		
91 -		
92 RCL IND X		
93 STO 09		
94 ST- 11		XMAX
95 RCL 11		
96 CHS		
97 RCL 19		
98 1		length of
99 -		printplot:
100 4		average: 3 inter-
101 *		polated points
102 50		between data
103 X<Y?		points. Max.
104 X<>Y		50 lines
105 RDN		
106 /		
107 STO 10		
108 "SIPL"		XINC

Please use paper glue to attach listings. Adhesive tape may affect print!
Bitte Listings mit Papierleim einkleben. Klebestreifen können Druck bleichen!
S.V.P. utilisez de la colle à papier pour fixer les listings. Les rubans adhésifs peuvent altérer l'impression!
Per favore usare la colla per fissare i listati. Il nastro adesivo può alterare la stampato!

PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
109	ASTO 11	NAME
110	SF 01	
111	CF 02	
112	XROM "PRPLOTP"	call PRPLOTP
113	♦LBL I	
114	"SIGR"	call routine
115	XEQ 10	for integration
116	RTN	STOP
117	♦LBL 10	
118	ASTO 15	check existance
119	♦LBL 11	of called
120	SF 25	routine in prog.
121	GTO IND 15	memory,
122	"LOAD "	PROMPT for
123	ARCL 15	loading if
124	AVIEW	not found.
125	RSUB	
126	GTO 11	
127	♦LBL D	
128	SF 02	change
129	GTO 02	input
130	♦LBL J	
131	SF 01	
132	CF 02	printplot
133	XROM "PRPLOT"	with manual
134	RTN	input.
135	♦LBL e	
136	RCL 19	
137	1 E3	output of
138	/	spline
139	1	coefficients
140	+	
141	STO 18	
142	RCL 19	setting of
143	1 E5	loop
144	/	parameters
145	RCL 19	
146	4	
147	*	
148	+	
149	19	
150	+	
151	LASTX	
152	1 E3	
153	/	
154	+	
155	STO 17	
156	♦LBL 08	
157	SF 01	
158	ISG 18	sets flag 01
159	CF 01	if loop is
160	DSE 18	executed last
161	X<> X	time
162	RCL 19	
163	.003	
164	*	
165	RCL 17	
166	FS?C 01	
167	+	
168	RCL 18	
169	INT	
170	+	
171	FIX 0	
172	CF 28	
173	CLA	
174	ARCL L	
175	"⊢= "	
176	ASTO 15	
177	" ABCYX"	
178	ASTO 16	
179	FIX 6	
180	SF 28	
181	♦LBL 09	
182	" "	
183	ARCL 16	
184	ASTO 16	
185	ASHF	
186	ARCL 15	
187	ARCL IND X	
188	AVIEW	
189	DSE X	
190	GTO 09	
191	ADV	
192	ISG 18	
193	GTO 08	
194	RTN	
195	♦LBL E	
196	CF 01	interpolate the
197	CF 02	value found in the
198	♦LBL "SIPL"	X register
199	STO 15	("Xinput")
200	STO 13	
201	19	
202	STO 14	
203	FS? 02	
204	GTO 12	skip search if
205	RCL 19	routine is called
206	4	2. time by PRPLOT
207	*	
208	+	
209	STO 18	
210	1	adress YN
211	+	
212	RDN	adress X1
213	RCL IND T	
214	X>Y?	
215	GTO 13	valid input:
216	RCL 19	X1 ≤ Xinput?

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PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line (Zeile, Ligne, Linea)	Keystrokes (Tastenfolge, Touches, Tasti)	Comments (Kommentar, Commentaires, Commenti)
217	1 E3	
218	/	
219	2	
220	+	
221	STO 17	loop index
222	♦LBL 12	
223	RCL 17	search interval that contains X input
224	RCL 18	
225	+	
226	RCL IND X	
227	RCL 15	
228	X<=Y?	
229	GTO 14	
230	ISG 17	
231	GTO 12	
232	♦LBL 13	
233	"INP ERR"	XN < Xinput
234	AVIEW	
235	RTN	
236	♦LBL 14	
237	RCL IND Z	
238	ST- 13	ΔX_{k+1}
239	CLX	
240	1	
241	ST- T	
242	ST- 17	
243	RCL IND T	
244	ST- 15	
245	FS? 01	ΔX_k
246	XEQ 16	PRPLOT
247	RCL 17	calling
248	ST+ 14	A_k
249	1.003	
250	STO 16	loop index
251	RCL IND 14	
252	♦LBL 15	
253	RCL 15	
254	*	Horner algorithm
255	RCL 19	
256	ST+ 14	
257	CLX	
258	RCL IND 14	
259	+	
260	ISG 16	
261	GTO 15	
262	FS? 01	
263	SF 02	skip searching after next call by PRPLOT
264	RTN	
265	♦LBL 16	
266	RCL 10	
267	2	
268	/	change plotsymbol if Xinput is closer to a data point
269	RCL 15	
270	X<Y?	
271	GTO 17	flag XINC/2
272	CLX	
273	RCL 13	
274	ABS	
275	X<Y?	
276	GTO 17	
277	CLX	
278	STO 03	
279	RTN	
280	♦LBL 17	plotsymbol for data points.
281	0	
282	ENTER↑	
283	28	
284	BLDSPEC	
285	34	
286	BLDSPEC	
287	34	
288	BLDSPEC	
289	42	
290	BLDSPEC	
291	34	
292	BLDSPEC	
293	34	
294	BLDSPEC	
295	28	
296	BLDSPEC	
297	STO 03	
298	.END.	

PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
	01♦LBL "SINP"	
	02 CF 03	
	03 CF 25	
	04 FS?C 02	
	05 GTO 03	
	06♦LBL 06	
	07 RCL 19	
	08 STO 12	
	09 1 E3	
	10 /	
	11 1	
	12 +	
	13 STO 15	loop index
	14♦LBL 01	
	15 19	
	16 +	
	17 RCL 12	
	18 3	
	19 *	
	20 +	
	21 STO 13	Yk address
	22 RCL 12	
	23 +	
	24 STO 14	Xk address
	25 FS?C 03	
	26 RTN	
	27♦LBL 02	
	28 FIX 0	input loop
	29 CF 28	
	30 "X"	
	31 ARCL 15	
	32 "⊢↑Y"	
	33 ARCL 15	
	34 "⊢=?"	
	35 FIX 6	
	36 SF 28	
	37 PROMPT	
	38 STO IND 13	
	39 RDN	
	40 STO IND 14	
	41 1	
	42 ST+ 13	
	43 ST+ 14	
	44 ISG 15	
	45 GTO 02	
	46♦LBL 03	
	47 SF 03	edit, list,
	48 XEQ 06	continue
	49 "E, L?"	option.
	50 AON	
	51 PROMPT	
	52 ASTO X	
	53 AOFF	
	54 "E"	

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
	55 ASTO Y	
	56 X=Y?	
	57 GTO 04	
	58 "L"	
	59 ASTO Y	
	60 X=Y?	
	61 GTO 05	
	62 RCL IND 14	
	63 GTO 11	
	64♦LBL 09	
	65 RCL IND 14	test for
	66 X<=Y?	increasing
	67 GTO 10	Xk-values
	68♦LBL 11	
	69 ISG 14	
	70 CLD	
	71 ISG 15	
	72 GTO 09	
	73 RTN	
	74♦LBL 10	
	75 "SEQ ERR"	
	76 AVIEW	
	77 GTO 03	
	78 RTN	
	79♦LBL 04	edit
	80 "PAIR NO.?"	routine
	81 PROMPT	
	82 INT	
	83 X<=0?	
	84 GTO 04	check
	85 RCL 12	input.
	86 X<Y?	
	87 GTO 04	
	88 X<>Y	
	89 ENTER↑	
	90 ENTER↑	
	91 1 E3	
	92 /	
	93 +	
	94 STO 15	
	95 GTO 01	
	96♦LBL 05	
	97 ADV	list
	98 SF 03	routine
	99 RCL IND 13	
	100 RCL IND 14	
	101 "X"	
	102♦LBL 08	
	103 FIX 0	
	104 CF 28	
	105 ARCL 15	
	106 "⊢= "	
	107 FIX 6	
	108 SF 28	

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PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
109	ARCL X	
110	AVIEW	
111	X<>Y	
112	"Y"	
113	FS?C 03	
114	GTO 08	
115	1	
116	ST+ 13	
117	ST+ 14	
118	ISG 15	
119	GTO 05	
120	GTO 03	
121	.END.	

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
01	♦LBL "SCOF"	
02	CF 25	
03	RCL 19	
04	1	
05	-	
06	1 E3	
07	/	
08	1	
09	+	
10	STO 18	Loop index
11	20	
12	RCL 19	solve equation system (8)
13	+	
14	0	
15	STO 20	
16	STO IND Y	
17	CLX	
18	RCL 19	(Gauss elimination)
19	3	
20	*	
21	+	
22	STO 16	Address pointer
23	STO IND Y	
24	♦LBL 02	
25	RCL 16	
26	RCL 16	
27	1	
28	+	
29	STO 16	ΔX_k
30	RCL IND X	
31	RCL IND Z	
32	-	
33	STO 13	
34	CLX	
35	RCL 19	
36	-	
37	X<>Y	
38	LASTX	
39	-	$R_2 = \frac{\Delta Y_k}{\Delta X_k}$
40	RCL IND Y	
41	RCL IND Y	
42	-	
43	RCL 13	
44	/	
45	STO 11	
46	RCL 18	
47	INT	
48	1	
49	-	
50	X=0?	
51	GTO 01	first loop → set reg at the end of the loop
52	RCL 14	
53	RCL 13	
54	+	

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PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
55	2	
56	*	
57	RCL IND 17	Z
58	RCL 14	
59	*	
60	-	
61	1/X	
62	STO 10	
63	RCL 13	
64	*	
65	19	
66	RCL 18	$G_k = Z \cdot \Delta X_k$
67	+	
68	X<>Y	
69	STO IND Y	
70	RCL 11	
71	RCL 12	
72	-	
73	6	$H = 6(R_2 - R_1)$
74	*	
75	STO 15	
76	RCL 17	
77	RCL 19	
78	+	
79	ENTER↑	$F_k = Z(H - \Delta X F_{k-1})$
80	ENTER↑	
81	1	
82	+	
83	RCL IND Y	
84	RCL 14	
85	*	
86	CHS	
87	RCL 15	
88	+	
89	RCL 10	
90	*	
91	STO IND Y	
92	♦LBL 01	
93	RCL 18	
94	19	
95	+	$\Delta X_k = \Delta X_{k-1}$
96	STO 17	
97	RCL 13	$R_1 = R_2$
98	STO 14	
99	RCL 11	
100	STO 12	
101	ISG 18	
102	GTO 02	
103	18	
104	RCL 19	
105	2	$S''_{N-1} = F_{N-1}$
106	*	
107	+	
108	ENTER↑	

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
109	ENTER↑	
110	RCL 19	
111	+	
112	RCL IND Y	
113	STO IND Y	
114	RCL 19	
115	3	
116	-	no eq. system
117	X<=0?	
118	GTO 05	
119	RCL 19	loop index
120	2	
121	-	
122	1 E3	
123	/	
124	2	
125	+	
126	STO 18	
127	♦LBL 03	
128	RCL 19	determine
129	RCL 18	$S'_2, \ldots, S_{N-1}$
130	INT	
131	-	out of $G_1, \ldots$
132	19	$F_1, \ldots$
133	+	
134	STO 14	
135	RCL 19	
136	+	
137	STO 15	
138	LASTX	
139	+	
140	STO 17	
141	1	
142	+	
143	RCL IND 15	
144	RCL IND Y	
145	RCL IND 14	
146	*	
147	-	
148	STO IND 17	
149	ISG 18	
150	GTO 03	
151	♦LBL 05	
152	RCL 19	Determine
153	1	A_k, B_k, C_k
154	-	
155	1 E3	
156	/	
157	1	
158	+	
159	STO 18	
160	♦LBL 04	loop index
161	19	
162	RCL 19	

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PROGRAM LISTING

PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
163	2	
164	*	
165	+	
166	RCL 18	
167	+	
168	STO 13	
169	RCL IND X	
170	STO 15	S_k'' address
171	CLX	
172	1	
173	+	
174	RCL IND X	
175	STO 14	S_{k+n}'' address
176	CLX	
177	RCL 19	
178	+	
179	ENTER↑	
180	ENTER↑	
181	1	
182	-	
183	RCL IND Y	
184	RCL IND Y	
185	-	
186	STO 16	ΔY_k
187	RDN	
188	X<>Y	
189	RCL 19	
190	+	
191	RCL IND X	
192	STO 17	
193	CLX	
194	1	
195	-	
196	RCL IND X	
197	ST- 17	
198	RCL 16	ΔX_k
199	RCL 17	
200	/	
201	RCL 15	
202	ENTER↑	
203	+	
204	RCL 14	C_k (5)
205	+	
206	RCL 17	
207	*	
208	6	
209	/	
210	-	
211	STO IND 13	
212	RCL 19	
213	ST- 13	
214	RCL 15	
215	2	
216	/	B_k (4)

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
217	STO IND 13	
218	RCL 19	
219	ST- 13	
220	RCL 14	
221	RCL 15	
222	-	A_k (3)
223	6	
224	/	
225	RCL 17	
226	/	
227	STO IND 13	
228	ISG 18	
229	GTO 04	
230	.END.	

PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
01	♦LBL "SCDS"	Initialization
02	CF 03	
03	CF 04	
04	CF 05	
05	CF 25	
06	RCL 19	
07	1	
08	-	
09	1 E3	
10	/	
11	1	
12	+	
13	"K? B.EEE"	
14	FC? 00	
15	PROMPT	
16	STO 11	
17	♦LBL 01	loop index
18	SF 06	
19	ISG 11	
20	CF 06	SF 06 if
21	DSE 11	last loop
22	X<> X	exec.
23	RCL 11	
24	19	coeff. for
25	+	eq. (9)
26	STO 10	
27	RCL 19	
28	4	
29	*	
30	+	
31	1	
32	STO 06	
33	+	
34	STO 09	
35	3	
36	RCL IND 10	
37	*	A_k
38	STO 05	
39	X=0?	
40	GTO 04	$A_k = 0$?
41	ST/ 06	(no root for
42	RCL 19	S_k)
43	ST+ 10	
44	CLX	
45	RCL IND 10	solve (11)
46	STO 04	
47	CHS	
48	ST* 06	
49	RCL 19	
50	ST+ 10	
51	RCL 06	
52	ENTER↑	
53	X↑2	
54	RCL IND 10	
55	RCL 05	
56	/	
57	-	
58	SF 25	
59	SQRT	
60	FC?C 25	
61	GTO 04	complex root
62	ST+ Y	
63	ST- Z	
64	CLX	
65	RCL 19	
66	ST+ X	
67	ST+ 10	
68	RDN	
69	X=Y?	
70	SF 05	
71	X<Y?	SQRT(0)=0
72	X<>Y	
73	STO 08	
74	X<>Y	
75	XEQ 11	
76	FS?C 04	
77	XEQ 14	
78	FS?C 05	
79	GTO 03	
80	RCL 08	
81	XEQ 11	
82	FS?C 04	
83	XEQ 14	
84	♦LBL 03	
85	RCL 06	
86	XEQ 11	
87	FC?C 04	
88	GTO 04	
89	"TURNING POINT:"	
90	RCL 06	
91	RCL IND 10	
92	+	
93	STO 07	
94	XEQ 17	
95	♦LBL 04	
96	ISG 11	
97	GTO 01	
98	RTN	
99	♦LBL 11	
100	X<0?	
101	RTN	root within
102	RCL IND 09	interval k !
103	RCL IND 10	
104	-	
105	X<>Y	
106	FS? 06	
107	GTO 12	
108	X<Y?	

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PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
109	SF 04	
110	RTN	
111	♦LBL 12	
112	X<=Y?	
113	SF 04	
114	RTN	
115	♦LBL 14	value of
116	STO 07	$S_k'(x)$
117	RCL IND 10	
118	ST+ 07	
119	X<>Y	
120	RCL 05	
121	*	
122	RCL 04	
123	+	
124	2	
125	*	
126	RND	
127	SF 12	
128	"MINIMA"	
129	X>0?	
130	GTO 17	
131	"MAXIMA"	
132	X<0?	
133	GTO 17	
134	CF 12	
135	"HOR. TURN. TANG"	
136	"⊢ENT:"	
137	SF 03	
138	♦LBL 17	
139	RCL 07	output
140	CF 01	
141	CF 02	
142	XEQ "SIPL"	
143	ADV	
144	FIX 0	
145	"⊢ K= "	
146	ARCL 11	
147	FIX 6	
148	AVIEW	
149	CF 12	
150	"X= "	
151	ARCL 07	
152	AVIEW	
153	"Y= "	
154	ARCL X	
155	AVIEW	
156	CLD	
157	FS?C 03	
158	RTN	
159	RCL 00	
160	X<>Y	printplot
161	X<Y?	scaling
162	STO 00	
163	RCL 01	
164	X<>Y	
165	X>Y?	
166	STO 01	
167	RTN	
168	.END.	

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
60		
65		
70		
75		
80		
85		
90		
95		
100		

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PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
01♦LBL "SIGR"		
02♦LBL 00		
03 CF 01		initiali -
04 CF 02		zation
05 CF 25		
06 CLX		
07 STO 12		I = 0
08 RCL 19		
09 1		
10 ST- Y		
11 X<>Y		
12 1 E3		
13 /		
14 +		
15 STO 18		
16 19		k - loop
17 5		
18 RCL 19		
19 *		
20 LASTX		
21 .01		
22 *		
23 +		
24 +		
25 1 E3		
26 /		
27 +		
28 STO 17		
29 RCL 19		loop index:
30 4		19.XN..N
31 *		
32 RCL 17		
33 +		
34 1		
35 +		
36 STO 16		
37 LASTX		X_k - address
38 +		
39 STO 15		
40 RCL 19		X_{k+1} - address
41 +		
42 2		
43 -		
44 RCL IND X		
45 STO 13		
46 RCL IND 16		X_N (b_{max})
47 STO 14		
48 FS? 00		X_1 (a_{min})
49 GTO 02		
50♦LBL 01		
51 X<>Y		input of
52 "a↑b?"		boundaries
53 PROMPT		
54 X<Y?		

Line / Zeile / Ligne / Linea	Key pressed / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
55 SF 01		boundaries
56 FS? 01		changed.
57 X<>Y		
58 STO 13		upper limit
59 X<>Y		
60 RCL 14		
61 X>Y?		
62 GTO 07		error
63 X<>Y		
64 STO 14		lower limit
65♦LBL 02		
66 RCL IND 15		find the
67 X<>Y		k - interval
68 X<=Y?		of lower
69 GTO 03		Limit
70 1		
71 ST+ 16		
72 ST+ 15		
73 RDN		
74 ISG 18		
75 GTO 02		
76♦LBL 07		
77 "a"		
78 FS?C 01		
79 "b"		
80 "⊢ TO SMALL"		
81 AVIEW		
82 GTO 01		
83♦LBL 03		
84 RCL IND 16		
85 -		
86 LASTX		set upper
87 CHS		and
88 RCL IND 15		lower
89 RCL 13		limit
90 X<=Y?		for det.
91 SF 02		of I_k
92 FS? 02		
93 X<>Y		
94 RDN		
95 +		
96 X<>Y		
97 2		
98 STO 07		Loop index
99 RDN		
100♦LBL 11		
101 X=0?		
102 GTO 13		
103♦LBL 10		
104 STO 11		
105 RCL 18		
106 INT		
107 RCL 17		
108 +		

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S.V.P. utilisez de la colle à papier pour fixer les listings. Les rubans adhésifs peuvent altérer l'impression!
Per favore usare la colla per fissare i listati. Il nastro adesivo può alterare la stampa!

PROGRAM LISTING
PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA

Line / Zeile / Ligne / Linea	Keystrokes / Tastenfolge / Touches / Tasti	Comments / Kommentar / Commentaires / Commenti
109	STO 10	
110	4	> I_k (13)
111	STO 09	
112	R↑	
113	0	
114	♦LBL 12	
115	RCL IND 10	
116	RCL 09	
117	INT	
118	/	
119	+	
120	RCL 11	
121	*	
122	ISG 10	
123	CLD	
124	DSE 09	
125	GTO 12	
126	♦LBL 13	
127	X<>Y	(same for
128	DSE 07	upper limit
129	GTO 11	
130	-	
131	ST+ 12	
132	FS?C 02	
133	GTO 04	last I_k
134	1	→ output
135	ST+ 16	
136	ST+ 15	
137	RCL IND 16	
138	ISG 18	
139	GTO 03	
140	"b"	
141	FS?C 01	
142	"a"	upper limit
143	"⊢ TO BIG"	to big
144	AVIEW	
145	GTO 00	
146	♦LBL 04	
147	RCL 12	output
148	FS?C 01	I
149	GTO 06	
150	♦LBL 05	
151	SF 12	change sign
152	ADV	of I
153	"INTEGRAL I:"	
154	AVIEW	
155	CF 12	
156	" INTERVAL"	
157	AVIEW	
158	" a= "	
159	ARCL 14	
160	AVIEW	
161	" b= "	
162	ARCL 13	
163	AVIEW	
164	"I= "	
165	ARCL 12	
166	AVIEW	
167	ADV	
168	RTN	
169	GTO 00	
170	♦LBL 06	change sign
171	RCL 14	of I
172	X<> 13	store
173	STO 14	boundaries
174	RDN	according
175	CHS	to
176	STO 12	input.
177	GTO 05	
178	.END.	

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01365C

Additional SCOF listing see note page 2.

PROGRAM LISTING

PROGRAMMAUFLISTUNG
LISTAGE DU PROGRAMME
LISTATO DI PROGRAMMA


```
01♦LBL "SCOF"
02 CF 25
03 CLX
04 "S2<X1>?"
05 PROMPT
06 20
07 RCL 19
08 ENTER↑
09 +
10 +
11 X<>Y
12 STO IND Y
13 CLX
14 "S2<XN>?"
15 PROMPT
16 19
17 RCL 19
18 3
19 *
20 +
21 X<>Y
22 STO IND Y
23 RCL 19
24 1
25 -
26 1 E3
27 /
28 I
29 +
30 STO 18
31 20
32 RCL 19
33 +
34 8
35 STO 20
36 STO IND Y
37 CLX
38 RCL 19
39 3
40 *
41 +
42 STO 16
43♦LBL 02
44 RCL 16
45 RCL 16
46 1
47 +
48 STO 16
49 RCL IND X
50 RCL IND Z
51 -
52 STO 13
53 CLX
54 RCL 19
55 -
56 X<>Y
57 LASTX
58 -
59 RCL IND Y
60 RCL IND Y
61 -
62 RCL 13
63 /
64 STO 11
65 RCL 18
66 INT
67 1
68 -
69 X=0?
70 GTO 01
71 RCL 14
72 RCL 13
73 +
74 2
75 *
76 RCL IND 17
77 RCL 14
78 *
79 -
80 1/X
81 STO 10
82 RCL 13
83 *
84 19
85 RCL 18
86 +
87 X<>Y
88 STO IND Y
89 RCL 11
90 RCL 12
91 -
92 6
93 *
94 STO 15
95 RCL 18
96 INT
97 ENTER↑
98 ENTER↑
99 2
100 -
101 X=0?
102 GTO 21
103 RDN
104 RCL 19
105 1
106 -
107 -
108 X=0?
109 GTO 22
110♦LBL 23
111 RCL 17
112 RCL 19
113 +
114 ENTER↑
115 ENTER↑
116 1
117 +
118 RCL IND Y
119 RCL 14
120 *
121 CHS
122 RCL 15
123 +
124 RCL 10
125 *
126 STO IND Y
127♦LBL 01
128 RCL 18
129 19
130 +
131 STO 17
132 RCL 13
133 STO 14
134 RCL 11
135 STO 12
136 GTO 24
137♦LBL 21
138 20
139 RCL 19
140 2
141 *
142 +
143 RCL IND X
144 RCL 14
145 *
146 CHS
147 RCL 15
148 +
149 STO 15
150 GTO 23
151♦LBL 22
152 19
153 RCL 19
154 3
155 *
156 +
157 RCL IND X
158 RCL 13
159 *
160 CHS
161 RCL 15
162 +
163 STO 15
164 GTO 23
165♦LBL 24
166 ISG 18
167 GTO 02
168 18
169 RCL 19
170 2
171 *
172 +
173 ENTER↑
174 ENTER↑
175 RCL 19
176 +
177 RCL IND Y
178 STO IND Y
179 RCL 19
180 3
181 -
182 X<=0?
183 GTO 05
184 RCL 19
185 2
186 -
187 1 E3
188 /
189 2
190 +
191 STO 18
192♦LBL 03
193 RCL 19
194 RCL 18
195 INT
196 -
197 19
198 +
199 STO 14
200 RCL 19
201 +
202 STO 15
203 LASTX
204 +
205 STO 17
206 1
207 +
208 RCL IND 15
209 RCL IND Y
210 RCL IND 14
211 *
212 -
213 STO IND 17
214 ISG 18
215 GTO 03
216♦LBL 05
217 RCL 19
218 1
219 -
220 1 E3
221 /
222 1
223 +
224 STO 18
225♦LBL 04
226 19
227 RCL 19
228 2
229 *
230 +
231 RCL 18
232 +
233 STO 13
234 RCL IND X
235 STO 15
236 CLX
237 1
238 +
239 RCL IND X
240 STO 14
241 CLX
242 RCL 19
243 +
244 ENTER↑
245 ENTER↑
246 1
247 -
248 RCL IND Y
249 RCL IND Y
250 -
251 STO 16
252 RDN
253 X<>Y
254 RCL 19
255 +
256 RCL IND X
257 STO 17
258 CLX
259 1
260 -
261 RCL IND Y
262 ST- 17
263 RCL 16
264 RCL 17
265 /
266 RCL 15
267 ENTER↑
268 +
269 RCL 14
270 +
271 RCL 17
272 *
273 6
274 /
275 -
276 STO IND 13
277 RCL 19
278 ST- 13
279 RCL 15
280 2
281 /
282 STO IND 13
283 RCL 19
284 ST- 13
285 RCL 14
286 RCL 15
287 -
288 6
289 /
290 RCL 17
291 /
292 STO IND 17
293 ISG 18
294 GTO 04
295 END
```

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Note: the CLRG line 09 in SPLINE is not necessairy using this routine instead of SCOF page 14.

REGISTERS, STATUS, FLAGS

REGISTERBELEGUNG, FLAGS, BETRIEBSARTEN
REGISTRES, INDICATEURS, MODES OPÉRATOIRES
REGISTRI, MODI OPERATIVI, FLAGS

Registers Datenspeicher/Registres de données/Registri

Example for N = 5

	code	
00	4, 6	temporary use by SIPL (code 1)
	4, 6	SINP (" 2)
	6	SCOF (" 3)
	6	SCDS (" 4)
	4, 6	SIGR (" 5)
05	4, 6	PRPLOT (" 6)
	4,5,6	
	4,5,6	
	4,5,6	
	4,5,6	
10	3,4,5,6	
	3,4,5,6	
	2,3, 5	
	1,2,3, 5	
	1,2,3, 5	
15	1,2,3, 5	
	1, 3, 5	
	1, 3, 5	
	1, 3, 5	
	N	
20	A1	
	A2	
	A3	
	A4	
25	B1	
	B2	
	B3	
	B4	
30	C1	
	C2	
	C3	
	C4	
35	Y1	
	Y2	
	Y3	
	Y4	
	Y5	
40	X1	
	X2	
	X3	
	Y4	
	X5	
45		

70	
75	
80	

Address calculation:

$A_k = 19 + k$

$B_k = 19 + N + k$

$C_k = 19 + 2N + k$

$Y_i = 19 + 3N + i$

$X_i = 19 + 4N + i$

$k = 1,2,..,N-1$
$i = 1,2,..,N$

Status Betriebsart/Modes opératoires, Modi operativi

Size 20+5N Total Reg. _____

						User Mode
Eng	☐	Fix	☒	Sci	☐	On ☒
Deg	☐	Rad	☐	Grad	☐	Off ☐

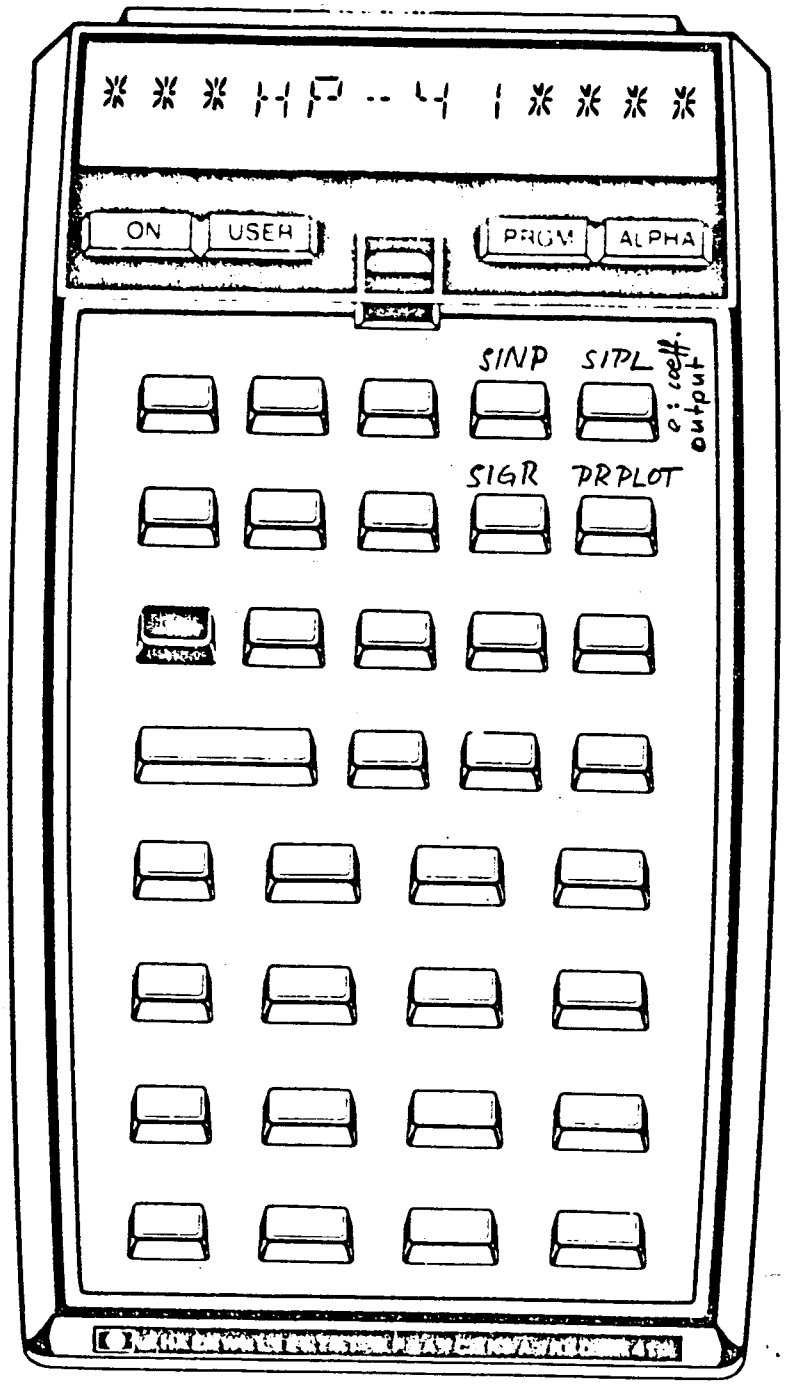
Flags

	Purpose (Bedeutung, Signification, Scopo) code	SET	CLEAR	
00	1		X	add. prompting
01	1,5 misc.			clear before
02	1,2,5 use			calling SIPL!
03	2,init.as subr.	X		
04	4, root found	X		
05	4, SQRT(D)=0	X		
06	4, last loop	X		
07	execution			
08				
09				
10				
11	Audio execute			
12				
13				
14				
15				
16				
17				
18				
19				
20				
21	Printer Enable			
22	Number Input			
23	Alpha Input			
24	Range Ignore			
25	Error Ignore			
26	Audio Enable			
27	User Mode			
28	Decimal Point			
29	Digit Grouping		X	

Assignments
Tastenbelegung/Assignations/Assegnamenti

Function (Funktion, Fonction, Funzione)	Key (Taste, Touche, Tasto)	Function (Funktion, Fonction, Funzione)	Key (Taste, Touche, Tasto)
	LBL		
SINP	D		
SIPL	E		
Coeff.output	e		
SIGR	I		
PRPLOT	J		

SYSTEM CONFIGURATION
CONFIGURAZIONE DEL SISTEMA

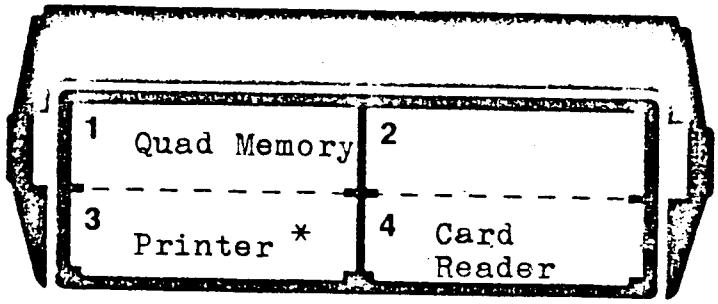


Assignments
Belegungen
Assignations
Assegnamenti

no global
lables assigned.

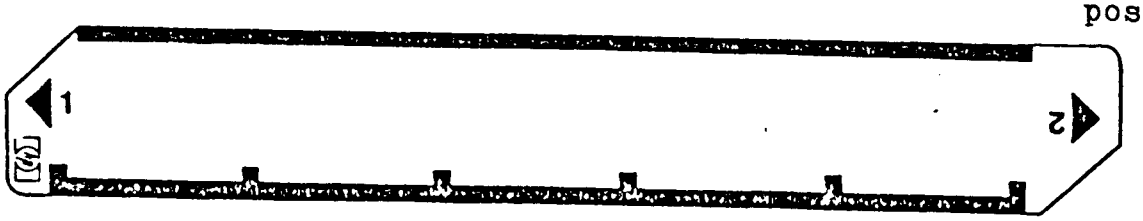
Assignment of
local alpha labels
subroutines in
program SPLINE.

Configuration
Belegung
Configuration
Configurazione



*) Program
execution
without
printer
possible

Magnetic card
Magnetkarte
Carte magnetique
Scheda magnetica



ROW 1 (1 : 3)

ROW 2 (3 : 10)

ROW 3 (11 : 13)

ROW 4 (13 : 21)

ROW 5 (21 : 27)

ROW 6 (27 : 33)

ROW 7 (34 : 39)

ROW 8 (39 : 43)

ROW 9 (44 : 54)

ROW 10 (54 : 62)

ROW 11 (62 : 67)

ROW 12 (68 : 76)

ROW 13 (77 : 86)

ROW 14 (87 : 96)

ROW 15 (97 : 107)

ROW 16 (108 : 112)

ROW 17 (113 : 118)

ROW 18 (118 : 123)

ROW 19 (123 : 130)

ROW 20 (130 : 137)

ROW 21 (137 : 144)

ROW 22 (145 : 153)

ROW 23 (154 : 161)

ROW 24 (161 : 167)

ROW 25 (168 : 175)

ROW 26 (175 : 178)

ROW 27 (179 : 186)

ROW 28 (186 : 193)

ROW 29 (194 : 198)

ROW 30 (198 : 205)

ROW 31 (206 : 215)

ROW 32 (216 : 223)

ROW 33 (224 : 231)

ROW 34 (232 : 237)

ROW 35 (237 : 244)

ROW 36 (245 : 249)

ROW 37 (249 : 256)

ROW 38 (257 : 263)

ROW 39 (264 : 273)

ROW 40 (274 : 283)

ROW 41 (283 : 289)

ROW 42 (290 : 296)

ROW 43 (296 : 298)

SPLINE INTERPOLATION FOR
DISCRET DATA SIGR
PROGRAM REGISTERS NEEDED: 45

USERS' LIBRARY
PROGRAM NUMBER: 01365C

ROW 1 (1 : 4)

ROW 2 (5 : 12)

ROW 3 (13 : 21)

ROW 4 (21 : 29)

ROW 5 (29 : 39)

ROW 6 (40 : 48)

ROW 7 (49 : 55)

ROW 8 (56 : 66)

ROW 9 (66 : 74)

ROW 10 (75 : 80)

ROW 11 (80 : 84)

ROW 12 (85 : 94)

ROW 13 (95 : 105)

ROW 14 (106 : 116)

ROW 15 (117 : 126)

ROW 16 (127 : 134)

ROW 17 (135 : 141)

ROW 18 (141 : 144)

ROW 19 (145 : 153)

ROW 20 (153 : 155)

ROW 21 (155 : 158)

ROW 22 (158 : 161)

ROW 23 (161 : 168)

ROW 24 (169 : 178)

ROW 25 (178 : 178)

SPLINE INTERPOLATION FOR
DISCRET DATA SINP
PROGRAM REGISTERS NEEDED: 32

USERS' LIBRARY
PROGRAM NUMBER: 01365C

ROW 1 (1 : 4)

ROW 2 (4 : 12)

ROW 3 (13 : 24)

ROW 4 (25 : 32)

ROW 5 (32 : 36)

ROW 6 (37 : 44)

ROW 7 (45 : 49)

ROW 8 (49 : 57)

ROW 9 (58 : 65)

ROW 10 (65 : 73)

ROW 11 (74 : 78)

ROW 12 (79 : 82)

ROW 13 (83 : 91)

ROW 14 (92 : 100)

ROW 15 (101 : 106)

ROW 16 (107 : 114)

ROW 17 (114 : 121)

ROW 18 (121 : 121)

SPLINE INTERPOLATION FOR
DISCRET DATA SCDS
PROGRAM REGISTERS NEEDED: 47

USERS' LIBRARY
PROGRAM NUMBER: 01365C

ROW 1 (1 : 4)

ROW 2 (4 : 12)

ROW 3 (13 : 16)

ROW 4 (17 : 24)

ROW 5 (24 : 35)

ROW 6 (36 : 43)

ROW 7 (44 : 52)

ROW 8 (53 : 61)

ROW 9 (62 : 69)

ROW 10 (70 : 77)

ROW 11 (77 : 83)

ROW 12 (83 : 89)

ROW 13 (89 : 90)

ROW 14 (91 : 98)

ROW 15 (99 : 107)

ROW 16 (108 : 117)

ROW 17 (118 : 128)

ROW 18 (128 : 131)

ROW 19 (131 : 135)

ROW 20 (135 : 135)

ROW 21 (136 : 140)

ROW 22 (141 : 145)

ROW 23 (145 : 150)

ROW 24 (150 : 156)

ROW 25 (157 : 168)

ROW 26 (168 : 168)

ROW 1 (1 : 4)

ROW 2 (5 : 12)

ROW 3 (13 : 22)

ROW 4 (22 : 30)

ROW 5 (30 : 40)

ROW 6 (40 : 50)

ROW 7 (51 : 61)

ROW 8 (62 : 71)

ROW 9 (72 : 82)

ROW 10 (83 : 93)

ROW 11 (93 : 102)

ROW 12 (102 : 111)

ROW 13 (112 : 119)

ROW 14 (120 : 128)

ROW 15 (129 : 138)

ROW 16 (139 : 147)

ROW 17 (148 : 155)

ROW 18 (155 : 164)

ROW 19 (165 : 174)

ROW 20 (175 : 184)

ROW 21 (185 : 193)

ROW 22 (194 : 202)

ROW 23 (203 : 212)

ROW 24 (213 : 221)

ROW 25 (222 : 230)

ROW 26 (230 : 230)