UNIVERSITY OF ILLINOIS

DIGITAL COMPUTER

LIBRARY ROUTINE L7 - 230

By Dave Muller

TITLE — Automatic Linear Equation Solver With Programmed Checks and Calculation of Residues **(SADOI Only)**

TYPE — Entire Program

ACCURACY — Depends upon the condition of the equations to be solved.

DURATION

(a) 15 seconds to input program

(b) .004k seconds to input coefficients, where k is the number of characters on the data tape

(c) $.0017\ n^3$ seconds to solve equations.

(d) $.017(p+3)n$ seconds to punch results, where p is the number of decimal digits punched for each result.

CAPACITY — 143 equations

METHOD OF USE — This program is an extension of the older routine L2 and is used in the same way as L2. It uses the drum whenever the number of equations exceeds 32, and is capable of solving as many as 143 equations.

Read the program into the memory in the usual way. When the program tape has been read, place the data tape in the reader and restart with the black switch. The results will be punched in a single column with a decimal point properly placed in each result.

PUNCHING OF DATA — To solve the set of equations

$$\sum_{j=0}^{n-1} a_{ij} x_j + a_{in} = 0$$

we proceed as follows:

(a) Scale the coefficients by rows and also possibly by columns (usually simply by moving the decimal point) so that each coefficient is less than 1/2. If the coefficients have been scaled by columns one must take account of this in interpreting the results.

(b) Punch each scaled coefficient as a sign followed by 12 or fewer decimal digits. The decimal point is assumed to follow the sign so that +.016 and -.204 should be punched as +016 and -204.

(c) Terminate each row $a_{io}, \ldots, a_{in}$ of coefficients by punching the character N.

(d) Follow the last N by a sexadecimal character p which determines the number of decimal digits to be printed in the results. The character p can assume the values 2, 3, ..., 9, K, S, N. Spaces (5 holes) may be punched at will in the data tape. A leader of non-sexadecimal (5th hole punched) characters should precede the first coefficient.

PROGRAMMED CHECKS

If the program stops on the instruction FF 026 the drum has failed during triangularization.

If the program stops on the instruction FF 027 the drum has failed during back substitution. Another attempt at back substitution may be made if this instruction is by-passed with the white switch.

If the program stops on the instruction FF 028 the wrong number of coefficients has been read from the data tape during the reading of the last equation.

If the program stops on the instruction FF 029 the solution of more than 143 equations is being attempted.

If the program stops on the instruction FF 02K before reading the coefficients the sum check on the master tape has failed, indicating that it was read incorrectly.

CALCULATION OF RESIDUES

After completing the solution of a set of equations the computer will stop on the instruction 24009. One may then read and solve another set of equations by throwing the black switch. Alternatively, after completing the solution of a set of equations one may calculate the residues by means of a program for this purpose which is attached to the end of the L-7 tape. This program may be read by throwing the white switch rather than the black switch. The tape of coefficients should be reread using the black switch and the residues

$$\delta_i = \sum_{j=0}^{n-1} a_{ij} x_j + a_{in} \quad ; \quad i = 0,1, \ldots, n-1$$

will be computed and printed.

If the residues are not small compared to the roots one may conclude that the calculation of the roots has been carried out inaccurately. On the other hand, the fact that the residues are small does not necessarily indicate that the roots are accurate since the equations may be poorly conditioned or they may have been ineptly scaled.

RT: 3/25/59
DATE December 28, 1956
CODED BY D.E. Muller
APPROVED BY D.E. Muller

lgr

LOCATION	ORDER	NOTES PAGE 1
	K	
	00 3K	
3	00 F	
	00 342F	r_0
4	00 F	
	00 9F	Location of L 6
5	00 F	
	00 227F	Location of master routine
6	00 F	
	00 171F	Location of P 16
7	00 F	
	00 270F	Location of N12
8	00 F	
	00 30S5	
	00 9K	
Modified Version of L 6		
Word in Present Routine		Word in L 6
3	26 S7	26 S7
	26 S5	L5 150L
66	32 63L	32 63L
	41 F	41 1S9
70	L4 F	L4 1S9
	40 F	40 1S9
115	50 F	50 S9
	26 87L	26 87L
120	26 28S5	50 147L
	7J S4	7J S4
129	L0 149L	L0 149L
	32 30S5	36 SK
138	85 11F	85 11F
	00 2560F	00 SS
139	N0 F	N0 1S9
	00 F	00 F
143	80 1F	80 1F
	L5 F	L5 1S9

LOCATION	ORDER	NOTES PAGE 2
145	86 11F	86 11F
	00 2560F	00 SS
151	S2 67L	S2 67L
	L5 F	L5 2S9
152	NO F	NO F
	40 F	40 2S9
161	75 F	75 F
	LO F	LO 1S9
(P16)	00 171K	Infraprint
(N12)	00 270K	Infraput
	00 227K	
0	L5 21S7	
	46 41L	Plant $r_0 + n + 1$
1	10 20F	
	42 41L	
2	L1 3F	
	36 7L	Test for first row
3	L5 41L	
	LO 142S4	
4	36 5L	
	FF 40F	
5	LO 134S4	Test number of coefficients
	32 4L	
6	L5 150S4	
	26 4S4	

LOCATION	ORDER	NOTES PAGE 3
7	L5 41L	
	LO 136S4	
8	LO 134S4	
	40 146S4	
9	LO 42L	
	32 10L	
10	FF 41F	
	L5 146S4	
11	L4 134S4	
	L4 134S4	
12	46 159S4	
	42 159S4	
13	L5 41L	
	40 142S4	
14	46 135S4	
	42 135S4	
15	LO 134S4	
	42 39L	
16	42 87S4	Test for more than 144 coefficients
	42 120S4	and plant addresses
17	LO 134S4	
	46 20S4	
18	L5 41L	
	L4 146S4	
19	46 115S4	
	L4 134S4	
20	42 66S4	
	46 70S4	
21	42 70S4	
	46 139S4	
22	42 143S4	
	42 161S4	
23	L4 134S4	
	42 133S4	
24	42 151S4	
	42 152S4	

LOCATION	ORDER	NOTES
25	42 150S4	
	L5 136S4	
26	42 33L	
	L5 40L	
27	46 34L	
	26 6L	
28	L5 34L	
	L4 40L	
29	46 34L	Change scale factor
	50 147S4	
30	22 120S4	
	81 7F	
31	00 17F	
	L4 34L	
32	46 34L	
	92 131F	
33	92 513F	Print results
	L5 F	
34	J4 F	
	50 34L	
35	26 S6	
	F5 33L	
36	42 33L	
	L0 39L	
37	32 32L	
	92 131F	
38	24 S4	
	26 327F	
39	12 513F	
	L5 F	
40	00 100F	
	00 F	Constants
41	LJ F	
	40 F	
42	00 144F	
	00 F	

LOCATION	ORDER	NOTES
	00 309K	
0	50 500F	
	50 L	Read a row of coefficients
1	26 270F	
	L5 17L	
2	40 4L	
	41 F	
3	2L 4L	
	S5 F	
4	50 F	
	74 500F	Compute a residue
5	L4 F	
	40 F	
6	L5 4L	
	L4 143F	
7	40 4L	
	L0 14L	
8	32 3L	
	92 131F	
9	92 513F	
	L5 F	
10	54 F	
	50 10L	
11	26 171F	Print a residue
	F5 15L	
12	40 15L	
	L0 16L	
13	36 L	
	24 28L	

LOCATION	ORDER	NOTES
14	J0 F	
	00 F	
15	00 F	
	00 2F	
16	80 F	Constants
	00 F	
17	50 S3	
	74 500F	
18	L5 144F	
	46 14L	
19	L5 168F	
	42 16L	
20	L5 261F	
	46 10L	
21	92 135F	
	92 259F	
22	92 258F	Prepare parameters and print RESIDUES
	92 194F	
23	92 706F	
	92 514F	
24	92 67F	
	92 450F	
25	92 194F	
	92 706F	
26	92 707F	
	92 131F	
27	19 37F	
	26 12L	
28	92 135F	
	92 259F	
29	92 258F	
	92 582F	
30	92 322F	Print ROOTS and return to L-7
	92 706F	

LOCATION	ORDER	NOTES
31	92 707F	
	92 131F	
32	26 9F	
	24 17L	
33	L3 F	
	34 28L	
34	FF 42F	
	26 28L	
35	S0 1408F	
	06 2319F	
	26 33L	
	26 1N	