TI PPC NOTES

NEWSLETTER OF THE TI PERSONAL PROGRAMMABLE CALCULATOR CLUB
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From the Editor:

Please note that the ZIP code in our address has changed. While the Post Office has indicated that they will continue to deliver mail which is addressed to the old ZIP code (34294) for some time, we might as well start using the new code now.

What will you find in this first issue of our twelfth year?

TI-59 owners will find a limited number of programs, but an extensive treatment on how to check out a used TI-59. The impetus for that discussion was my experience in trying to find good, used TI-59's for some of the members. The place where I earn a living participated in the TI Professional Productivity Program in which engineers and technicians were trained in the use of the TI-59, and on successfully completing the course were given a TI-59. There are hundreds of TI-59's at work, many of which are seldom being used. So I thought it would be easy to find two that would pass some extended testing. Not so! I had to test six to yield two. The problems ranged from failure of the ML-01 diagnostics after warmup to read/write failures diagnosed by the extended memory test, and one truly unique problem in which the sequence 1 5 EE 8 STO 03 3 7 EE 6 STO 04 would not place 37e06 in data register 04, but only if the calculator was mounted on a printer. So, if you haven't recently run a complete diagnostic on your TI-59, you probably should.

TI-74 owners will find a linear regression program that does not rely on a Library module and a program for curve fitting with orthogonal polynomials translated from a recent issue of BYTE.

TI-95 owners will find relatively extensive coverage of the MATH Library module, and a benchmark article by William Hawes describing how to access routines in a library module from a user program. His complex quadratic solution demonstrates the technique in a program.

In addition there is a demonstration of the solution of non-linear equations with a wide range of machines and routines including the fx-7000G and the non-linear systems routine in the TI-95 Math Library module. As usual there are also reviews of publications and offers to sell equipment and support material.

RCP

ERRATA AND COMMENTS

Errors with Linear Equation Solutions - Gene Friel provided the HP-41 solution which was listed for the 7 x 7 sub-Hilbert benchmark in V11N4P9. He now reports the answers when the solution vector is multiplied by the original matrix (our so-called "Walters" test). The values are at the right. The exact answers are each 1. The maximum error is 2.9E-6 and the rms error is 2.2E-6. Gene writes that he does not know why the HP-15 results are more accurate than those from an HP-41.

0.999997750
0.999997509
0.999998000
0.999998840
0.999997752
0.999997079
0.999998463

Polynomial Regression with Variance - V9N2P20 - Gene Friel also suggests that it may be appropriate to add the following sentence to step 12 on V9N2P22 which discusses the selection of the polynomial which is the best solution. "If ($\sigma_n^2 / \sigma_{n+1}^2$) is <= $F_{(1-\alpha)}$(N-n-1,N-n-2), the F-test value at a level of significance usually of α = 0.05 choose the lower degree polynomial."

TI-66 Code Table - Robert Prina reports that the table on V11N4P21/22 is incomplete. Codes 0B-0F, 1D-1F, 2E-2F, 3E-3F, 4A-4F, 5D-5F, 6E-6F and 7E-7F all display as **. Code 5B displays as EE and code 5C displays as =. Code 6C displays as CE and code 6D displays as CLR. Codes A0, A2, B0, F0, and F2 display as ST*. Code A4 displays as SM*, codes A5 and A6 display as GO*, and code A8 displays as RTN.

Disabling the Printer with the TI-95 - V11N4P7 noted that it would be nice to be able to disable the PC-324 while it is connected to the TI-95. Robert Prina provided the following routine which will do that:

```
I/O    F2(PRT)    F1(DEV)    XXX
```

where the XXX should be something other than 012. To enable the printer repeat the sequence with XXX = 012.

CC-40 For Sale - Write to Arthur O. Jacobsen, 56 Maguire Avenue, Avon, MA 02322.

TI-58 AND PC-100 FOR SALE - Write to Jim Carter, EduCALC, 27953 Cabot Road, Laguna Niguel, CA 92677. Any reasonable offer will be accepted.

A TI-66 AND PC-200 SALE - Charles Lehr sent a page from a catalog which lists a TI-66 and PC-200 at a special package price of only $59.95. The mail order telephone number is 212-260-4410.

BATTERY PACK REPAIR - Why should I be concerned with repair of the battery packs when I can still order replacement packs from Elek-Tek? One reason is cost. The latest Elek-Tek catalog lists the following prices:

BP-1A	Battery Pack for the TI-58C/59	$ 11.00
BP-7	Battery Pack for the TI-55/57/MBA	$ 9.50

Those prices are somewhat deceptive. The ordering information indicates that the shipping charge for battery packs is only fifty cents if ordered with other merchandise, but four dollars if ordered alone. Thus, the price for a BP-1A ordered alone becomes $15.00.

The first potential repair recognizes one of the predominant failure mechanisms of nickel-cadmium cells, the generation of "whiskers" which cause internal shorts. The cure is the momentary application of high current to burn away the whiskers. In V7N6P10 Maurice Swinnen described a "zapper" circuit which would remove the whiskers. If you would like a copy send a stamped and self addressed envelope, and enclose an additional stamp to cover copying costs.

If the "zapping" technique doesn't solve your battery pack problem, and you don't want to pay for a new pack, then replacement of the individual cells is another alternative. A battery pack comes from the manufacturer with the connection straps spot welded to the cells. I had difficulty removing the straps and soldering them to the electrodes of the replacement cells. Radio Shack's Replace-A-Cell at $3.99 plus tax (catalog no. 23-191) contains two replacement "AA" nickel-cadmium cells which have connection straps already welded to the electrodes. Soldering the straps to each other is a snap. Thus, for four dollars and very little effort you can easily repair a BP-7 which only uses two cells, and which has a battery pack case which snaps together. Reassembly will be easier if you save the sleeve which holds the two cells together. Slip it off end of the defective cells rather than cutting it, and slip it over the replacement cells.

Repair of a BP-1A is harder since the case is cemented together, and the cells are held together with plastic tape. I cut the holding bracket free with a knife. The Radio Shack batteries are slightly larger in diameter, so it is a tight fit. I welded the bracket in place when I was done by touching the joint with my soldering iron.

HISTORY OF A TI-59 REPAIR - March 31: I am trying to get my TI-58 working again. Can I get parts? If so, where? Does the Service Manual include the schematic? S.Z.

April 10: The Service Manual includes a schematic. For parts contact the Dealer Parts Facility (see V11N2P26). You can call 1-806-741-3090 for information. Have you tried 1-800-TI-CARES? P.O.H..

May 11: I called TI-CARES and was told I could trade my TI-58 for a TI-58C by sending my calculator in with $36.50 plus shipping and handling. Troubleshooting my TI-58 indicated that either IC TMC0582 or TMC0583 were bad. For $13.74 plus tax and shipping I was able to get both parts from TI. The calculator seems to be working. S.Z.

TESTING THE ARITHMETIC AND MEMORY OF A USED TI-59

V11N4P25 reported that Texas Instruments is no longer providing repair service for the TI-59. I expect that will generate additional demand for used TI-59's. An important issue for a purchaser of a used TI-59 is how to determine that the device is operating properly. The sequence that I suggest to check the arithmetic and memory is:

1. With the Master Library module in place press 2nd Pgm 0 1 SBR = . After about fifteen seconds the calculator should stop with a "1." in the display. A flashing display indicates failure.

2. With the calculator in the turn-on partitioning, load side 1 of the Calculator Diagnostic card. Press E. After about six seconds the calculator should stop with "-.8888888888" in the display. A flashing display indicates failure.

3. With the calculator installed on a printer load the extended calculator diagnostic program from page 5. Press A. A properly operating calculator will yield the printout at the upper right. The complete test requires about sixteen minutes. A sample printout for an improperly operating calculator appears at the lower right, where the extra notation below the ".8888888889 (?)" line indicates that the test of storing 8/9 to each register followed by summing -8/9 to each register did not yield the expected zero for registers 62, 63, 66, and 68.

```
   MEMORY TEST

            0.      (?)
  .1111111111      (?)
  .2222222222      (?)
  .3333333333      (?)
  .4444444444      (?)
  .5555555556      (?)
  .6666666667      (?)
  .7777777778      (?)
  .8888888889      (?)
```

```
   MEMORY TEST

            0.      (?)
  .1111111111      (?)
  .2222222222      (?)
  .3333333333      (?)
  .4444444444      (?)
  .5555555556      (?)
  .6666666667      (?)
  .7777777778      (?)
  .8888888889      (?)
 0.000000008        68
 0.000000008        66
 0.000000008        63
 0.000000008        62
```

4. Press 0 2nd Op 17 and see "959." in the display. Force a magnetic card with key code 41 (SST) at each step into all four banks. For example, to force the card into bank 3, enter -3 in the display and read the card. Press CLR RST SST. The calculator will run for about eight seconds and stop with a flashing "0." in the display. Press LRN and see "959 41" in the display. If the calculator stops before eight seconds, press LRN BST and note the step and the erroneous key code. Then press SST LRN CLR SST to continue the test.

5. Press 0 2nd Op 17 and see "959." in the display. Force side 2 of the Calculator Diagnostic card into all four banks. For example, to force the card into bank 4, enter -4 in the display and read the card. Press RST LRN and see 000 77 in the display. Press SST to verify that key code 77 is in every location. If the calculator is installed on a printer, you may obtain an alternate readout by pressing RST 2nd List and verifying that key code 77 is printed for each location.

6. Repeat step 1

Testing a Used TI-59 - (cont)

Extended Calculator Diagnostic Program

000	76	LBL	027	07	7	054	69	OP	081	29	CP	108	54	)	135	04	04
001	11	A	028	69	OP	055	06	06	082	67	EQ	109	85	+	136	32	X:T
002	69	OP	029	03	03	056	72	ST*	083	01	01	110	53	(	137	69	OP
003	00	00	030	69	OP	057	00	00	084	39	39	111	53	(	138	06	06
004	03	3	031	05	05	058	97	DSZ	085	32	X:T	112	53	(	139	97	DSZ
005	08	8	032	01	1	059	00	00	086	53	(	113	43	RCL	140	00	00
006	69	OP	033	00	0	060	00	00	087	53	(	114	00	00	141	00	00
007	01	01	034	69	OP	061	56	56	088	53	(	115	55	÷	142	79	79
008	01	1	035	17	17	062	32	X:T	089	43	RCL	116	01	1	143	01	1
009	07	7	036	29	CP	063	09	9	090	00	00	117	00	0	144	82	HIR
010	03	3	037	37	P/R	064	09	9	091	55	÷	118	54	)	145	37	37
011	00	0	038	47	CMS	065	42	STO	092	01	1	119	22	INV	146	32	X:T
012	03	3	039	32	X:T	066	00	00	093	00	0	120	59	INT	147	82	HIR
013	02	2	040	09	9	067	32	X:T	094	54	)	121	65	×	148	17	17
014	03	3	041	09	9	068	94	+/-	095	59	INT	122	01	1	149	55	÷
015	05	5	042	42	STO	069	74	SM*	096	85	+	123	00	0	150	09	9
016	04	4	043	00	00	070	00	00	097	01	1	124	54	)	151	95	=
017	05	5	044	98	ADV	071	97	DSZ	098	85	+	125	85	+	152	22	INV
018	69	OP	045	05	5	072	00	00	099	28	LOG	126	01	1	153	77	GE
019	02	02	046	05	5	073	00	00	100	59	INT	127	85	+	154	00	00
020	03	3	047	07	7	074	69	69	101	65	×	128	28	LOG	155	38	38
021	07	7	048	01	1	075	09	9	102	02	2	129	59	INT	156	06	6
022	01	1	049	05	5	076	09	9	103	54	)	130	65	×	157	69	OP
023	07	7	050	06	6	077	42	STO	104	65	×	131	02	2	158	17	17
024	03	3	051	69	OP	078	00	00	105	01	1	132	54	)	159	91	R/S
025	06	6	052	04	04	079	73	RC*	106	00	0	133	95	=			
026	03	3	053	32	X:T	080	00	00	107	00	0	134	69	OP			

Notes on the test sequence described on page 4:

1. Test the magnetic card writing capability using the method described under "Read/Write Test" on page VII-9 of Personal Programming.

2. You may use other modules than the Master Library for the calculator diagnostic. You may not use Business Decisions (BD), Math Utilities (MU), Electrical Engineering (EE) or RPN modules. V8N2P9 noted that those four modules only provides a module check, not a diagnostic.

3. You can make a card with all key code 41's in a similar manner to that by which you make key code 82 for HIR, that is, enter a series of RCL 41's, and go back and delete all the RCL's. You would have to enter 240 RCL 41 commands and delete 240 RCL commands. A more efficient way to make your own card is to use the keycode translation technique described in V5N4/5P18 and V5N6P4. Turn on the calculator and press LRN. See "000 00" in the display. Enter a short program with the following keystrokes:

2nd Pgm 0 2 SBR 2 3 9

The display will be "005 00". Press LRN RST R/S. The calculator will run for a short period of time and stop with a "0" in the display. Press GTO 000 and see "0.0000" in the display. (CAUTION: Do not use RST instead of GTO 000 - it won't give the same results.) Press LRN and see "000 00" in the display. Press the 1 key 240 times. See "240 00" in the display. Press the BST key several times and see that in this special mode pressing the 1 key caused key code 41 (SST) to appear in memory. Press LRN RST CLR INV 2nd FIX. Record a magnetic card for bank 1 which will contain all key code 41's.

4. If instead you would like me to provide a magnetic card with the extended diagnostic on one side and all key code 41's on the other, send one dollar and a stamped, self-addressed envelope.

Testing a Used TI-59 - (cont)

The proposed test sequence emphasizes examination of user memory since that is one area where problems seem to occur. In particular, I have helped troubleshoot several calculators where the user memory might be able to accept and retrieve a STO (code 42) command at a particular program location, but not be able to accept and retrieve a RCL (code 43) command at the same location. Some bit patterns could be stored and recalled corrrectly. Other bit patterns could not. Similar problems occur for user data.

Recognition of the sensitivity to bit patterns in memory led to the extended memory diagnostic program on page 5, which is a modification of a program which appears in TI's Service Manual for the TI-59. The TI program only checked the memory using all ones (1/9). My modification checks data registers 01 through 99 with all zeroes, all ones (1/9), all twos (2/9) etc., on to all eights (8/9). The lower printout on page 4 is for a calculator which would could operate properly with all zeroes through all sevens, but would fail with all eights. The problem with the four data registers (62, 63, 66 and 68) could be duplicated from the keyboard with the sequence

8 / 9 = STO XX +/- SUM XX RCL XX

A problem would also occur if all nines were used. The calculator always passed the calculator diagnostic card test (step 5 on page 4). It would usually fail the all 41's test (step 4 on page 4) with code 49 appearing at program steps 411, 427, 451 and 459, but the failure at step 411 was intermittent, particularly when the device was cold. You will recognize that those program steps correspond to the data registers which failed the extended memory test. This particular failure would yield other curious results. If I used the 8/9 test sequence from the keyboard for one of the four data registers the display would read 0.000000008, indicating that residual value in the data register was not zero. If I then pressed 1 STO XX RCL XX the display would read 1.000000008 !

Of course, the memory test program provides only a limited check of data register 00 and the program section (steps 000 through 159). The other memory test methods (steps 4 and 5 on page 4) permit examination of the entire memory, but for a more limited range of bit patterns. If you suspect a problem with data register 00 you can test it from the keyboard with 1/9, 2/9, etc., as in the sequence used above. If you suspect problems in program steps 000 through 159 that are not found with the all 41's or all 77's tests you can devise other tests with different codes. For example, enter all 44's in memory, either by repetitive entry of SUM 44 commands, or by using the translation technique in item 3 on page 5, but pressing the 4 key 240 times. After you have filled the memory with 44's press

5 Op 17 Cms 1 RST R/S

The calculator will run for about 30 seconds and stop with a flashing "1" in the display. Press CLR RCL 44 and see "280" in the display with a properly operating device. The defective device discussed above returned 276, which indicates four bad locations. Members are encouraged to submit other routines which are successful in finding defective memory operations.

Testing a Used TI-59 - (cont)

Another type of TI-59 malfunction is proper operation at turnon, but improper operation after the calculator has been running for several minutes. These malfunctions can be insidious and difficult to pinpoint--I worked with one device where the sine function became incorrect when the calculator was warm. For the values that I checked the output was approximately correct--the sine of 30 degrees was not 0.5 but a somewhat higher value, almost as if a series evaluation of the function had been prematurely terminated. The 2nd Pgm 01 SBR = diagnostic would indicate a problem, but only after the calculator had run for fifteen minutes or so. This need to examine the calculator operation when warm is why the proposed sequence performs the diagnostic at turn-on (step 1 on page 4), and then repeats the diagnostic after the memory checks are complete (step 6).

The value of these techniques in finding improperly operating TI-59's was demonstrated while trying to find a used calculator for one of our members. I tested three TI-59's. One had the problem illustrated at the bottom right of page 4. The other two would fail the 2nd Pgm 01 SBR = diagnostic, but only after they had warmed up. If you haven't run the test sequence on page 4 on your TI-59, you should. Again, members are invited to share their results.

MORE PERIPHERALS FOR THE TI-74? - P. Hanson. In early spring I was contacted by a telephone survey performed for TI. Purchasers of the TI-74 and TI-95 were being surveyed. The questions suggest that several new peripherals are being considered for those devices:

* An interface which would allow the connection of the AC-9201 to the TI-74 without the use of the PC-324.
* A Centronics interface for use with printers and plotters.
* An RS-232 interface.
* A combined Centronics and RS-232 interface.

One of the purposes of the survey was to determine what might be acceptable prices. The caller asked what I thought might be a price at which I would probably buy, and then asked the liklihood that I would buy at various other price ranges. Nothing in the catalogs yet. We will have to wait and see.

LABELON PAPER FOR THE PC-100 - V11N4P26 noted that the editor had received a roll of Labelon Thermal Calculator Paper Type CR-025 which provided a well-defined black on white printout, but had been unable to locate a source for additional paper. Robert Lucas sent copies of pages from the catalog of L. E. Muran Co., 45 Dunham Road, Billerica, MA 01821. A three roll pack of CR-025 paper is priced at $9.95. The telephone numbers for Muran are 617-667-4900 and 617-272-2208.

THE MATHEMATICS MODULE FOR THE TI-95 - P. Hanson. My Mathematics Library module for the TI-95 arrived last month. The module contains a variety of mathematical capabilities such as complex functions, cubic splines interpolation, the gamma function, matrix solutions, roots of a function, differential equation solutions, number theory, coordinate transformations, analytic geometry, and nonlinear systems solutions. As you might expect I immediately ran the 7x7 sub-Hilbert test. The results were very good:

Exact	Solution	Walters Test
56	55.9987716858	1.000000000
-1512	-1511.973655317	1.000000007
12600	12599.81818591	0.999999998
-46200	-46199.43180070	1.000000003
83160	83159.10965249	1.000000000
-72072	-72071.31726712	1.000000000
24024	24023.79603390	1.000000002
Max Error	2.19E-05	7.0E-9
RMS Error	1.42E-05	3.1E-9

where the numbers at the bottom of the second and third columns are the relative error, (answer-exact)/exact. These results are some of the best achieved to date with portable calculators and computers. The solution is slightly worse than that obtained with ML-02 plus double-divides in V9N6, but is slightly better for the Walters test.

Note that I have not demonstrated a call to the linear equation solution of the Mathematics Library module from a user program. That will have to come in a future issue. The documentation with the TI-95 Library modules provide no assistance for calling portions of the library module software from a user program. Fortunately, members such as Robert Prins of the Netherlands and William Hawes of Montreal, Quebec are starting to define methods for such calls. Their first results are presented elsewhere in this issue.

NEW HAND-HELDS - The competition for the market for hand-held progammable calculators and computers seems to be heating up. In addition to the TI-74 and TI-95 we have already discussed the Casio fx-7000G, the HP-18 and the HP-28. Now the latest Elek-Tek catalog shows two new entries in the race:

The Casio fx-8000G is a followon to the fx-7000G. The display capability is the same, there are more functions, and the memory has been expanded. Where the fx-7000G could support 422 program steps and 26 data registers, the fx-8000G can support 1446 steps and 26 data registers. The Elek-Tek price is $79.00 . For an additional $55.00 the user can obtain an FA-80 interface unit which provides a cassette interface and the Centronics printer interface.

The same catalog offers the Sharp EL-5200 scientific calculator which includes a graphics capability, a 4 line, 16 digit display versus the 8 line, 16 digit display on the Casio models. A matrix capability is available. The Elek-Tek price is $69.99 .

1987 FEDERAL INCOME TAX RETURN - V10N1P16 presented an income tax program by Hewlett Ladd which would accept schedules for either 1984 or 1985, and annotate the output to show which year was being used. The program used one magnetic card side for each of the four schedules per year. V10N4P3 presented the listing for the magnetic cards corresponding to the tax schedules for 1986. A set of magnetic cards has been generated for the 1987 schedules, based on the information in the 1987 Estimated Tax for Individuals, Form 1040-ES (OCR). There is no change required to the program from V10N1P16, nor to the constants in bank 2 from V10N4P3.

Joint		Head of Household		Married Filing Separate		Single	
60.7	00	61.7	00	62.7	00	63.7	00
0.	01	0.	01	0.	01	0.	01
3000.0033	02	2500.00275	02	1500.00165	02	1800.00198	02
28000.0408	03	23000.0335	03	14000.0204	03	16800.02448	03
45000.0884	04	38000.0755	04	22500.0442	04	27000.05304	04
90000.2459	05	80000.2225	05	45000.12295	05	54000.14754	05
1000000.	06	1000000.	06	1000000.	06	1000000.	06
1000000.	07	1000000.	07	1000000.	07	1000000.	07
1000000.	08	1000000.	08	1000000.	08	1000000.	08
1000000.	09	1000000.	09	1000000.	09	1000000.	09
1000000.	10	1000000.	10	1000000.	10	1000000.	10
1000000.	11	1000000.	11	1000000.	11	1000000.	11
1000000.	12	1000000.	12	1000000.	12	1000000.	12
1000000.	13	1000000.	13	1000000.	13	1000000.	13
1000000.	14	1000000.	14	1000000.	14	1000000.	14
0.	15	0.	15	0.	15	0.	15
0.11	16	0.11	16	0.11	16	0.11	16
0.15	17	0.15	17	0.15	17	0.15	17
0.28	18	0.28	18	0.28	18	0.28	18
0.35	19	0.35	19	0.35	19	0.35	19
0.385	20	0.385	20	0.385	20	0.385	20
0.	21	0.	21	0.	21	0.	21
0.	22	0.	22	0.	22	0.	22
0.	23	0.	23	0.	23	0.	23
0.	24	0.	24	0.	24	0.	24
0.	25	0.	25	0.	25	0.	25
0.	26	0.	26	0.	26	0.	26
0.	27	0.	27	0.	27	0.	27
0.	28	0.	28	0.	28	0.	28
0.	29	0.	29	0.	29	0.	29

Each of the four schedule cards contain the number 1,000,000 in data registers 06 through 14. Those entries are required if the previously published program is to be used is. If you are going to calculate the tax for incomes greater than one million dollars you wil have to increase all of those entries as needed.

A sample printout appears at the right. If you joined our club after 1985 and would like a copy of the program and instructions send a SASE with an extra stamp to cover copying expenses.

JOINT TABLE	1987
15000.00	T.I.
2130.00	TAX
15.00	TOP%
14.20	AV.%
SINGL TABLE	1987
15000.00	T.I.
2178.00	TAX
15.00	TOP%
14.52	AV.%

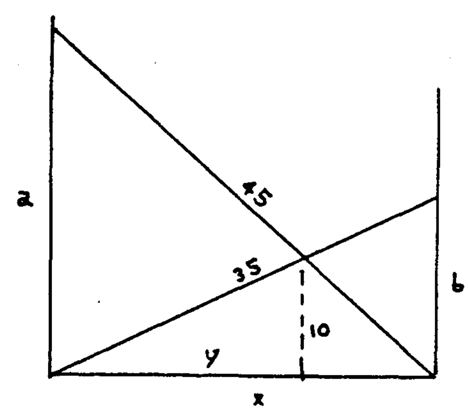
MORE ON A DISK DRIVE FOR THE TI-74 - I received a flyer on the Mechatronic Quickdisk-02 Drive from Technical Application Product Engineering, Ltd., 1439 Solano Place, Ontario, California 91764. Storage capacity is listed as 64K on each side. Operation is possible with either a power supply or AA batteries. No prices are given.

SOLVING LADDER PROBLEMS - P. Hanson. I have always been interested in the solution of the so-called "ladders in an alley" problems. My interest was rekindled by an article in a recent in-house Honeywell publication which reported the use a ladder problem to illustrate the problem-solving capability of Borland's "Eureka: The Solver" program.

There are two kinds of "ladders in the alley" problem. For both the ladders are set so that they touch the ground at one side of the alley and lean against the building on the other side of the alley. The lengths of the ladders are given. In the first problem the width of the alley is given, and the problem is to find the height at which the ladders cross. This is solvable in a straightforward manner as the intersection of two straight lines.

In the second "ladders in the alley" problem the height at which they cross is given. The problem is to find the width of the alley. The classical analysis eventually reduces the solution to a fourth degree polynomial in the square of the width. The capability of the "Eureka: The Solver" program to solve simultaaneous nonlinear equations avoids the necessity to reduce the problem to a polynomial in x. The Mathematics Library module for the TI-95 has a similar capability, so this ladder problem provides a good vehicle to demonstrate the use of that routine, and to demonstrate other methods of solution.

Consider the ladder problem illustrated at the right, where one ladder is 35 feet long, the other ladder is 45 feet long, and the ladders cross 10 feet above the ground. The heights at which the ladders touch the opposite walls are designated a and b, the width of the alley is x, and the distance from one side to a point directly below the point at which the ladders cross is y. Then, four equations in a, b, x, and y may be written as:



(1) $x^2 + a^2 = 45^2$

(2) $x^2 + b^2 = 35^2$

(3) $y/10 = x/b$

(4) $(x-y)/10 = x/a$

Solution with Nonlinear Systems Program in the TI-95 Math Module

1. Store the four functions as subroutines into program memory. The subroutines I used are at the right, where the relationships between data registers and variables in the equations are:

x	001	B
a	002	C
b	003	D
y	004	E

and I used the letter designations of the registers in the subroutines.

```
0000 LBL f1 ( RCL B x^2
0007 + RCL C x^2 -2025)
0017 RTN
0018 LBL f2 ( RCL B x^2
0025 + RCL D x^2 -1225)
0035 RTN
0036 LBL f3 ( RCL E /10-
0046 RCL B / RCL D ) RTN
0053 LBL f4 (( RCL B -
0061 RCL E )/10- RCL B /
0071 RCL C ) RTN
```

Solving Ladder Problems - (cont)

2. Select the Mathematics module and the Nonlinear Systems program. In response to the prompts enter n=4, err=0.000001, and #it=10. Press F4 (EOD) and enter initial estimates for the variables. I used x=10, a=20, b=20 and y=10 since I was running a comparison with the nonlinear equation in "Eureka: The Solver" and those values were used in the demonstration of that program. It took about 140 seconds to complete the solution, where x was x1 = 31.8174591. If a PC-324 is connected the printout at the right will be obtained.

```
NONLINEAR SYSTEM

n=            4.
err=   0.0000001
#it=         10.

xo(1)=          10.
xo(2)=          20.
xo(3)=          20.
xo(4)=          10.

x1=   31.8174591
x2=  31.82215104
x3=  14.58249967
x4=  21.81893352
```

Experimentation showed that the 0.000001 error could actually be achieved in 7 iterations, and that ten iterations are capable of yielding an error of 1e-11 for this problem and initial conditions in about 3 minutes 20 seconds.

I note in passing that the a portion of the instructions on page 13-2 of the Guidebook for The TI-95 Mathematics Library seem redundant. The fourth paragraph states:

> "The program prompts you for allowable error, maximum number of iterations, initial values for each variable, and an initial guess for the root of each variable."

where it is not clear that there is any difference between an "initial value" and an "initial guess".

Solution on the fx-7000G

The four equations in four unknowns above can be easily reduced to two equations in two unknowns by substituting equation (4) into equation (1) to remove a, and by substituting equation (3) into equation (2) to remove b. The resulting equations are:

(5) $y = x - 10x/\sqrt{(2025 - x^2)}$

(6) $y = 10x/\sqrt{(1225 - x^2)}$

Subtracting one of those equations from the other yields an new equation in x where the zero is the desired solution. That function can be solved with any "zeroes of a function" routine.

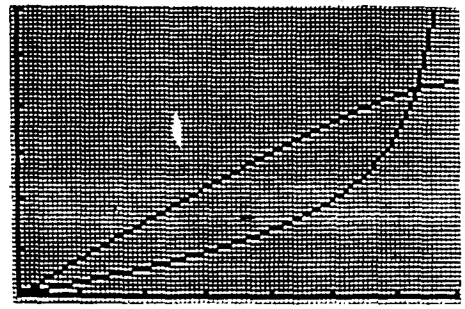
(7) $y = x - 10x(1/\sqrt{(2025 - x^2)} + 1/\sqrt{(1225 - x^2)})$

V11N3P10 illustrated the use of the Graph, Trace, Factor and Range functions of the fx-7000G to find the zero of a function. This example uses the Graph, Plot, Factor and Range functions to find the intersection of equations (5) and (6).

1. Enter the program at the right, say in the Program 3 location.

```
Graph Y=X-10X÷√(2025-X²)
Graph Y=10X÷√(1225-X²)
```

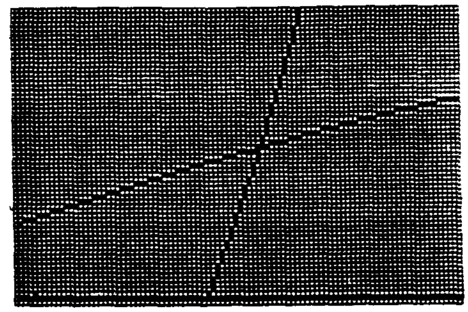
Solving Ladder Problems - (cont)



2. Press Range and enter the following values:

```
Xmin:0.        Ymin:0.
 max:35.        max:30
 scl:5.         scl:5.
```

3. Press Prog 3 EXE and a graph of the two functions will be generated in about ten seconds. See the upper graph at the right. The x coordinate of the intersection of the two curves is the solution.



4. Press SHIFT Plot 20,20 EXE and see a flashing cursor near the center of the screen. The legend X=20.10638298 will appear at the bottom of the screen. Use the cursor keys (the arrow keys) to move the cursor over the intersection. The legend at the bottom of the screen will read X=32.0212766. Press SHIFT X-Y and see Y=21.77419355.

5. Expand the graph in the neighborhood of the intersection by pressing SHIFT Factor 10 EXE Prog 3 EXE. The new graph should look like the lower figure at the right. Press SHIFT Plot EXE and see the flashing cursor near the intersection. Note that if you do not add coordinates to the Plot command you will get the previous coordinates for the cursor. Use the cursor keys to move the cursor over the intersection. Read X=31.83510639.

6. Repeat step 5 to achieve the desired resolution. In about three iterations you should be able to obtain an x value of 31.8174575 which is correct to the fifth decimal place.

Solution using Zeroes of a Function

Solutions using zeroes of a function routines with equation (7) can be obtained with the fx-7000G using the technique described on V11N3P10, with the TI-58/59 using ML-08, and with the TI-74 or TI-95 using either the bisection or Newton-Raphson methods from the Mathematics Library modules. I will begin with the TI-74.

```
1000 SUB FX(X,Y)
1001 Y=X*(1-10*(1/SQR(20
25-X*X)+1/SQR(1225-X*X))
)
1002 SUBEND
```

The bisection rootfinder program requires that the function be entered as a subprogram. The subprogram I used is illustrated at the right. For boundary values of A = 1 and B = 34.9, and Epsilon = 0.000001 the program calculates x = 31.81745886 in about 25 seconds. If the printer is used the printout at the right will occur. If you try to use A = 1 and B = 35 the program will stop with the error message "W26 at 1001 Division by Zero". If instead you try to use A = 1 and B = 36 the program will stop with the error message "E23 at 1001 Bad Argument". Both of those errors might be expected due to the SQR(1225 - x^2) in the denominator of the function.

```
ROOT FINDER-BISECTION

A=
 1
B=
 34.9
Epsilon=
 .000001

Root=
 31.81745886
```

Solving Ladder Problems - (cont)

The Newton-Raphson root finder in the TI-74 Mathematics Library requires that both the function and its derivative be entered as subprograms. The subprograms I used are illustrated at the right. Note that I did not use the equation which is the exact derivative of the function, but rather used an approximation by finding the slope in the neighborhood of x by numerically evaluating $(f(x + \Delta x) - f(x))/\Delta x$ where Δx was selected as 0.0001. For an initial guess of Xo = 29 and Epsilon = 0.000001 the program finds x = 31.8174591 in about 10 seconds. If the printer is used the printout at the right will occur. If you try to use an Xo less than 28.57 the program will stop with the error message "E23 at 1001 Bad Argument". You might think that situation could be relieved by defining a better derivative function. However, if you run the Newton root finder in the TI-95 Mathematic Library, where a user defined derivative is not required, you will experience a similar problem where an Xo less than 28.57 results in the error message "INVALID ARGUMENT".

```
1000 SUB FX(X,Y)
1001 Y=X*(1-10*(1/SQR(20
25-X*X)+1/SQR(1225-X*X))
)
1002 SUBEND
1003 SUB FD(X,Y)
1004 Y=X*(1-10*(1/SQR(20
25-X*X)+1/SQR(1225-X*X))
)
1005 A=X+.0001
1006 B=A*(1-10*(1/SQR(20
25-A*A)+1/SQR(1225-A*A))
)
1007 Y=(B-Y)/.0001
1008 SUBEND
```

```
ROOT FINDER-NEWTON

Xo=
 29
Epsilon=
 .000001
Root=
 31.8174591
```

In both the TI-74 and TI-95 an Xo between about 19.4 and 28.57 will stop the program. A Xo between 0 and 19.3 will find the root at zero. There is also an inconsistency in documentation for the program. Page 3-16 of the TI-74 Mathematics Library Guidebook indicates that approximations are used by the program to compute the derivative. The approximation formulas presented are similar in concept to the ones that I used. Now, if the program implements a derivative internally, then why must I enter a subprogram to compute the derivative? I thought that I might not need to have a subprogram FD, but when I try to run without one I get an error message "E13 Not Found". Can anyone explain?

The ML-08 program in TI-58/TI-59 Master Library uses the bisection method. With the function at the right, the initial limits at 1 and 34.9, and epsilon = 0.000001, ML-08 yields x = 31.81745911 in about ninety seconds. Users will find that ML-08 does not stop for invalid arguments; ather, the program continues on to a solution, but flashes the display to indicate that the solution may be in error, say because of a divide by zero, or taking the square root of a negative number. For initial limits of 1 and 35, the program yields a flashing display of 31.81745924.

000	76	LBL	022	10	10
001	16	A'	023	33	X²
002	53	(	024	54	)
003	42	STO	025	34	√X
004	10	10	026	85	+
005	65	×	027	01	1
006	53	(	028	55	÷
007	01	1	029	53	(
008	75	-	030	01	1
009	01	1	031	02	2
010	00	0	032	02	2
011	65	×	033	05	5
012	53	(	034	75	-
013	01	1	035	43	RCL
014	55	÷	036	10	10
015	53	(	037	33	X²
016	02	2	038	54	)
017	00	0	039	34	√X
018	02	2	040	54	)
019	05	5	041	54	)
020	75	-	042	54	)
021	43	RCL	043	92	RTN

Members are invited to submit other solutions for ladder problems.

REGRESSION WITH USER DEFINED FUNCTIONS

The program in V11N4P12 relied on the availability of a Mathematics Library module. Some members have requested an equivalent program which does not rely on a library module. The program below provides an equivalent capability, but:

* Input values are printed on the same line as the annotation.

* There is no check for ill-conditioning.

* The edit function is provided only after a solution is complete.

* In line 630 the formula for the mean was changed from S1/L to S1/K. The same change should be made in the program on V11N4P13.

A sample printout for the first problem in V11N4P12 appears at the right. This program should work equally well on the CC-40.

```
X1 =            -7
Y1 =           -81

X2 =            -4
Y2 =            27

X3 =             0
Y3 =             3

X4 =             2
Y4 =            27

X5 =             5
Y5 =           243

A1 =  18.61841343
A2 =  26.3477128
A3 =  2.460625362

d1 = -35.75506659
d2 =  74.40243196
d3 = -15.61841343
d4 = -54.15634047
d5 =  31.12738854

Mean = -2.08E-11

S.E. =  74.02670139
```

```
100 DIM A(8,8),B(8),F(8)
,X(50),Y(50)
105 INPUT "Use Printer <
Y/N>? ";A$
110 IF A$="Y"OR A$="y"TH
EN PN=1 ELSE 125
115 INPUT "Device Code ?
 ";P$
120 OPEN #1,P$,OUTPUT
125 PRINT "Are the funct
ions correct?":PAUSE 2
130 INPUT "Number of Dat
a Pairs? ";K
140 FOR I=1 TO K
150 A$="X"&STR$(I)&" = "
:INPUT A$;X(I)
160 IF PN<>0 THEN PRINT
#PN,A$,X(I)
170 A$="Y"&STR$(I)&" = "
:INPUT A$;Y(I)
180 IF PN<>0 THEN PRINT
#PN,A$,Y(I)
185 PRINT #PN:IF E$<>""T
HEN 700
190 NEXT I
200 INPUT "Order of the
solution? ";N
210 FOR I=1 TO N:FOR J=1
 TO N
220 A(I,J)=0:NEXT J
230 B(I)=0:F(I)=0:NEXT I
240 FOR L=1 TO K
250 GOSUB 800
300 FOR I=1 TO N:FOR J=1
 TO N
305 A(I,J)=A(I,J)+F(I)*F
(J):NEXT J
310 B(I)=B(I)+F(I)*Y(L):
NEXT I
315 NEXT L
320 FOR L=1 TO N
325 P=A(L,L)
330 FOR J=L TO N
335 A(L,J)=A(L,J)/P:NEXT
 J
340 B(L)=B(L)/P
345 FOR I=1 TO N
350 IF I=L THEN 375
355 G=A(I,L)
360 FOR J=L TO N
365 A(I,J)=A(I,J)-G*A(L,
J):NEXT J
370 B(I)=B(I)-G*B(L)
375 NEXT I
380 NEXT L
400 FOR I=1 TO N
410 X$="A"&STR$(I)&" = "
420 PRINT #PN,X$;B(I)
430 IF PN=0 THEN PAUSE
440 NEXT I
450 PRINT #PN
500 INPUT "Display Resid
uals <Y/N>? ";A$
510 S1=0:S2=0
520 FOR L=1 TO K
530 GOSUB 800
540 YF=0:FOR J=1 TO N
550 YF=YF+B(J)*F(J):NEXT
 J
560 D=Y(L)-YF
570 IF A$="N"OR A$="n"TH
EN 610
580 P$="d"&STR$(L)&" = "
590 PRINT #PN,P$;D
600 IF PN=0 THEN PAUSE
610 S1=S1+D:S2=S2+D*D:NE
XT L
620 PRINT #PN
630 PRINT #PN,"Mean = ";
S1/K
640 IF PN=0 THEN PAUSE
650 PRINT #PN
660 PRINT #PN,"S.E. = ";
SQR(S2/(K-N))
670 IF PN=0 THEN PAUSE
680 PRINT #PN
700 INPUT "Edit Input Da
ta <Y/N>? ";E$
710 IF E$="N"OR E$="n"TH
EN 780
720 INPUT "Which Data Pa
ir to Edit? ";I
730 IF I<1 OR I>K THEN 7
00
740 GOTO 150
780 INPUT "New Solution
<Y/N>? ";A$
790 IF A$="Y"OR A$="y"TH
EN 200
799 STOP
800 REM USER DEFINED FUN
CTIONS
810 F(1)=1
820 FOR W=2 TO N
830 F(W)=F(W-1)*X(L)
840 NEXT W
890 RETURN
```

TI PROGRAMMABLE CALCULATOR NEWS - This is a new publication by Texas Instruments which appears to be the free newsletter promised by material received with my TI-95. The eight page first issue provides coverage of the TI-74 and TI-95, but no coverage of any of the earlier devices such as the TI-59 or CC-40. There is no mention of the additional peripherals described in the survey telephone call that I received earlier this year (see page 7 of this issue).

There is one apparent mistake in the first issue. The first column of page 6 states that "In the calculator mode, the TI-74 offers 70 scientific functions, alphanumeric messages, and 13-digit accuracy which spans a numeric range of +/- 9.9999999999999E127. ...". I did copy the nines correctly. There were 14 in all, 13 to the right of the decimal point. More correct descriptions of the numerical accuracy of the TI-74 appear in the TI-74 Programming Reference Guide: "The TI-74 uses a minimum of 13 digits to perform calculations. ..." from page A-32, and "The TI-74 uses radix-100 format for internal calculations ... ... Another benefit of this technique is 13, and sometimes 14, digits of internal precision." A more complete discussion of radix-100 arithmetic appeared in pages F-1 and F-2 of the CC-40 User's Guide and in Laurance Leeds' treatise "Numeric Representation in the TI-99/4 and CC-40" in V9N5P6/7.

TI's Direct Marketing Program Manager has offered to provide copies of the first issue for our members. If they arrive in time a copy will have been included with this issue TI PPC Notes. If they do not, the copy will be included with the next issue. You can get on their mailing list by writing to Programmable Caclulator News, P. O. Box 53, Lubbock, TX 79408. Please mention TI PPC Notes.

TI-59 MATERIAL FOR SALE - Member J. M. Gallego still has magnetic cards and Solid State software modules for sale. His inventory in late May was:

- 15 Boxes of 40 Blank Magnetic Cards with Carrying Case.
- 7 Marine Navigation modules
- 7 Aviation modules.
- 7 Securities Analysis modules.
- 1 Surveying module.

He will sell the boxes of magnetic cards for six dollars ($6.00) each, and the Solid State Software modules for nine dollars ($9.00) each. Shipping is included in those prices. U.S. members should send money orders only, no checks, to:

Q. Jose M. Gallego
2302 'D' Avenue, Apt. 104
P.O. Box 2746
National City CA 92050

Note that the address is new. Members from other countries should write to make appropriate arrangements.

EXTENDED PRECISION MULTIPLICATION FOR THE TI-59 - Laurance Leeds

V11N4P20 presented an extended precision multiply program for the TI-59 by Robert Prins. I translated it to BASIC and found that the run time was longer than one of my own programs; for example, for a 120x120 digit problem, the BASIC version of the program from V11N4 required 41 seconds while my own program required only 14 seconds. This suggested that a faster extended precision multiply for the TI-59 would result if I translated my BASIC algorithm.

Program Listing:

000	91	R/S	040	22	INV	080	69	DP	120	00	00	160	91	R/S	200	00	0
001	25	CLR	041	44	SUM	081	31	31	121	69	DP	161	00	0	201	00	0
002	09	9	042	03	03	082	69	DP	122	20	20	162	00	0	202	00	0
003	42	STD	043	69	DP	083	32	32	123	69	DP	163	00	0	203	00	0
004	01	01	044	21	21	084	97	DSZ	124	25	25	164	00	0	204	00	0
005	03	3	045	97	DSZ	085	05	05	125	69	DP	165	00	0	205	00	0
006	00	0	046	04	04	086	00	00	126	27	27	166	00	0	206	00	0
007	42	STD	047	00	00	087	61	61	127	61	GTD	167	00	0	207	00	0
008	02	02	048	13	13	088	25	CLR	128	01	01	168	00	0	208	00	0
009	05	5	049	43	RCL	089	66	PAU	129	18	18	169	00	0	209	00	0
010	01	1	050	06	06	090	81	RST	130	76	LBL	170	00	0	210	00	0
011	42	STD	051	42	STD	091	76	LBL	131	14	D	171	00	0	211	00	0
012	03	03	052	01	01	092	11	A	132	05	5	172	00	0	212	00	0
013	73	RC*	053	42	STD	093	09	9	133	00	0	173	00	0	213	00	0
014	01	01	054	02	02	094	69	DP	134	42	STD	174	00	0	214	00	0
015	65	×	055	69	DP	095	17	17	135	03	03	175	00	0	215	76	LBL
016	73	RC*	056	32	32	096	47	CMS	136	43	RCL	176	00	0	216	13	C
017	02	02	057	43	RCL	097	09	9	137	50	50	177	00	0	217	43	RCL
018	95	=	058	08	08	098	42	STD	138	22	INV	178	00	0	218	04	04
019	74	SM*	059	42	STD	099	00	00	139	67	EQ	179	00	0	219	85	+
020	03	03	060	05	05	100	25	CLR	140	01	01	180	00	0	220	43	RCL
021	69	DP	061	73	RC*	101	91	R/S	141	46	46	181	00	0	221	05	05
022	22	22	062	01	01	102	72	ST*	142	69	DP	182	00	0	222	95	=
023	69	DP	063	55	÷	103	00	00	143	23	23	183	00	0	223	42	STD
024	23	23	064	01	1	104	69	DP	144	69	DP	184	00	0	224	08	08
025	97	DSZ	065	52	EE	105	20	20	145	30	30	185	00	0	225	42	STD
026	05	05	066	06	6	106	69	DP	146	22	INV	186	00	0	226	00	00
027	00	00	067	95	=	107	24	24	147	52	EE	187	00	0	227	85	+
028	13	13	068	75	-	108	61	GTD	148	73	RC*	188	00	0	228	04	4
029	03	3	069	59	INT	109	01	01	149	03	03	189	00	0	229	09	9
030	00	0	070	74	SM*	110	01	01	150	91	R/S	190	00	0	230	95	=
031	42	STD	071	02	02	111	76	LBL	151	69	DP	191	00	0	231	42	STD
032	02	02	072	95	=	112	12	B	152	23	23	192	00	0	232	06	06
033	43	RCL	073	65	×	113	03	3	153	97	DSZ	193	00	0	233	69	DP
034	07	07	074	01	1	114	00	0	154	00	00	194	00	0	234	38	38
035	42	STD	075	52	EE	115	42	STD	155	01	01	195	00	0	235	04	4
036	05	05	076	06	6	116	00	00	156	48	48	196	00	0	236	05	5
037	75	-	077	95	=	117	25	CLR	157	25	CLR	197	00	0	237	30	TAN
038	01	1	078	72	ST*	118	91	R/S	158	69	DP	198	00	0	238	33	X^2
039	95	=	079	01	01	119	72	ST*	159	99	99	199	00	0	239	86	STF

User Instructions:

1. Partition the factors into 6 digit words starting at the right. the first word of each factor may have less than 6 digits.

2. Press A to initialize for entry of the first factor. Enter each six digit word starting at the left, and press R/S.

3. Press B to initialize for entry of the second factor. Again, enter the six digit words starting at the left, and press R/S as each word is entered.

4. To solve press C. See a flashing "1." in the display. Press 7 and then EE to enter fast mode. When the solution is complete the calculator will stop with a zero in the display.

5. Press D to display the product in six digit words, starting at the left. Press R/S to display additional words. A flashing zero indicates the end.

Execution Time: For 72x72 digit problems the program in V11N4 required 2 minutes 15 seconds. This program required 1 minute 30 seconds. For 120x120 digit problems the program in V11N4 required 6 minutes. This program required 3 minutes 45 seconds.

<u>THE</u> <u>TI-95</u> <u>MTH</u> <u>LIBRARY</u> - William Hawes, Montreal, Quebec. I had only had the TI-95 and the Mathematics Library Module a couple days before I realized that accessing the MTH functions from a user program was not as easy as it should be. Page 8-34 of the TI-95 Programming Guide states that you can access a library routine, but neither the programming guide nor the guidebook for the module shows exactly how to do it. The problem is that neither labels nor absolute addresses of the various routines in the are given in the manuals. It turns out that labels wouldn't work as the library routines have been assembled with the ASM function and the labels have been replaced with absolute addresses.

So if absolute addresses are required the question is how to find them when they are not in the manuals. The answer is to put the calculator in the TRACE mode and then access segments of the routines to identify the DFA addresses. You can do it from the keyboard and display but it is much easier if you use a printer.

```
TRC
F2:PRL
DFA F1:X^2@76EC
DFA F2:Y^X@778F
DFA F3: ln@772E
DFA F4:log@7776
DFA F5:ESC@74FA
RTN
POWER/ROOT/LOG
```

Suppose that you want to find the entry address so that you can use the complex square routine from the complex functions program. Press

RUN F3(MTH) F1(PLX) F5(EOD) 2nd TRACE F2(PRL)

and you will obtain the printout at the upper right. The line which reads DFA F1:X^2@76EC shows that the complex square (x^2) routine will start at 76EC.

```
TRC
F1:INV X^2
TF 52
GTO 7713
```

Note that where a function is accessed as an inverse function, say the $\sqrt{x}$ function which is the inverse of the x^2 function, there is a separate address for the two functions. Merely setting the INV flag will not obtain the desired result. You have to find the entry addresses for the inverse functions one at a time. For $\sqrt{x}$ press

RUN F3(MTH) F1(PLX) F5(EOD) F2(PRL) 2nd TRACE INV F1(x)

and you will see the lower printout at the right, which shows that the entry address for the $\sqrt{x}$ function is 7713. The general rule is that to find the access address for a given routine, enter TRACE before entering the next higher routine, that is, the routine for which the routine you want is one of the options.

Once the addresses for the functions of interest have been obtained it is necessary to store these addresses in a data register and then access the routines indirectly via a SBR IND command. The addresses needed are in hexadecimal. So, to access the complex x^2 routine you might put HEX 76EC STO 004 DEC in your program to store the hexadecimal address for use by an indirect subroutine call. Later in the program put 'MTHPLX' to call the directory and file, store the real part in data register 000 and the imaginary part in data register 001, and add RUN 2nd SBL 2nd IND 004 which appears in the program as RUN SBR IND 004. At the end of the complex x^2 routine the real part of the solution will be in data register 000 and the imaginary part in data register 002. The complex quadratic program on the following pages provides additional illustrations of calling routines from a library module.

COMPLEX QUADRATIC SOLUTION ON THE TI-95 - W. Hawes

This program provides an excellent illustration of the calling of library programs from a user program. The program solves the quadratic

$$(aRe + aIm)x^2 + (bRe + bIM)x + (cRe + cIm) = 0$$

using the standard quadratic solution

$$x = (-b \pm \sqrt{b^2 - 4ac})/2a$$

where a, b, and c can be real or complex, and

$$x1 = Re1 + Im1 \quad \text{and} \quad x2 = Re2 + Im2$$

User Instructions:

1. Since the program calls the MATH library it is necessary that the program be in user memory, not in a 8K Memory Cartridge. The highest data register used is 061.

2. Select the CQD program and see CMPLX QUADRATIC in the display and aRe, bRe, cRe and EOD in the windows.

3. Enter the value for aRe and press F1. The value will be displayed and the window above F1 will change to aIm.

4. Enter the value for aIm and press F1. The value will be displayed and the window above F1 will return to aRe.

5. Repeat steps 4 and 5 for the other two coefficients using F2 and F3. Actually, you can enter the six values in any order you choose using the selections available from the windows.

6. Press F5(EOD). The value for Re1 will appear in the display after about 5 seconds, and the notation in the windows will change to permit readout of the remaining parts of the solution. Press F5(EOD) to set up for another problem.

Note 1: To solve a quadratic with real coefficients it is not necessary to enter zero for all the imaginary parts. Simply clear memory with 2nd CMS, enter the real parts, and solve.

Note 2: The input coefficeints are retained in data registers 031-033 and 051-053. The program can be rerun with the same coefficients with out reentering tne values. If a similar quadratic is to be solved some of the coefficients may not have to be reentered.

```
0000 `CMPLX QUADRATIC (`
0017 `CQD) V.C05 10 APR`
0034 ` 87 W HAWES`
0045 LBL S1 CE `CMPLX Q`
0056 `UADRATIC` DFN CLR
0066 DFN F1:aRe@AR
0073 DFN F2:bRe@BR
0080 DFN F3:cRe@CR
0087 DFN F5:EOD@C1 HLT
0095 LBL AR STO 031 CE
0102 `aRe=` COL 16
0108 MRG 031 PAU
0112 DFN F1:aIm@AI HLT
0120 LBL AI STO 051 CE
0127 `aIm=` COL 16
0133 MRG 051
0136 DFN F1:aRe@AR HLT
0144 LBL BR CE STO 032
0151 CE `bRe=` COL 16
0158 MRG 032 PAU
0162 DFN F2:bIm@BI HLT
0170 LBL BI STO 052 CE
0177 `bIm=` COL 16
0183 MRG 052
0186 DFN F2:bRe@BR HLT
0194 LBL CR STO 033 CE
0201 `cRe=` COL 16
0207 MRG 033 PAU
0211 DFN F3:cIm@CI HLT
0219 LBL CI STO 053 CE
0226 `cIm=` COL 16
0232 MRG 053
0235 DFN F3:cRe@CR HLT
0243 LBL C1 DFN CLR PAU
0249 CE `CQD RUN` PAU
0258 HEX 76EC STO 020 76
0268 3F STO 021 7713 -
0277 STO 022 766C
0284 STO 023 DEC RCL 031
0291 *2= STO 034 *2 +/-
0300 = STO 035 RCL 051 *
0308 2= STO 054 *2 +/- =
0317 STO 055 CE `MTHPLX`
0327 RCL 032 STO 000
0333 RCL 052 STO 001 RUN
0340 SBR IND 020 RCL 000
0347 STO 036 RCL 001
0353 STO 056 RCL 035
0359 STO 000 RCL 055
0365 STO 001 RCL 033
0371 STO 002 RCL 053
0377 STO 003 CE `MTHPLX`
0387 RUN SBR IND 021
0392 RCL 000 STO 037
0398 RCL 001 STO 057
0404 RCL 036 + RCL 037 =
0412 STO 038 STO 000
0418 RCL 056 + RCL 057 =
0426 STO 058 STO 001 CE
0433 `MTHPLX` RUN
0440 SBR IND 022 RCL 000
0447 STO 039 RCL 001
0453 STO 059 RCL 034
0459 STO 002 RCL 054
0465 STO 003 CE `MTHPLX`
```

Complex Quadratic Solution - (cont)

Sample Solution

For the quadratic $(3+4i)x^2 + (9-i)x + (6+2i) = 0$, the solution is:

Re1 = -.4610011126
Im1 = -.4186663432
Re2 = -.4589988874
Im2 = 1.978666343

Comments on Calling Routines from the Library:

Steps 0258-287 store the hex values for indirect access to the x^2 , * , x , and / functions of the Math Library module. Input values for the routines must be stored properly prior to the SBR IND call. See page A-2 of the library guide. Calls using the SBR IND occur at five places:

steps	function	address	register
0321-0343	x^2	76EC	020
0381-0391	*	763F	021
0433-0443	x	7713	022
0469-0479	/	766C	023
0507-0517	/	766C	023

```
0475 RUN SBR IND 023
0480 RCL 000 STO 040
0486 RCL 001 STO 060
0492 RCL 032 +/- STO 000
0499 RCL 052 +/- STO 001
0506 CE `MTHPLX` RUN
0514 SBR IND 023 RCL 000
0521 STO 041 RCL 001
0527 STO 061 RCL 041 +
0534 RCL 040 = STO 042
0541 RCL 061 + RCL 060 =
0549 STO 062 RCL 041 -
0556 RCL 040 = STO 043
0563 RCL 061 - RCL 060 =
0571 STO 063 CE
0575 DFN F1:Re1@R1
0582 DFN F2:Im1@I1
0589 DFN F3:Re2@R2
0596 DFN F4:Im2@I2
0603 DFN F5:EOD@ED
0610 LBL R1 CE `Re1`
0617 COL 16 MRG 042 HLT
0623 LBL I1 CE `Im1`
0630 COL 16 MRG 062 HLT
0636 LBL R2 CE `Re2`
0643 COL 16 MRG 043 HLT
0649 LBL I2 CE `Im2`
0656 COL 16 MRG 063 HLT
0662 LBL ED GTL S1
```

SELECTION OF DEGREES, RADIAN OR GRADS IN A TI-95 PROGRAM

Selection of the Deg, Rad or Grad modes in a TI-59 program required only a single program step. Hewlett Ladd noted that the use of the DRG function on the TI-95 is not as efficient since the DRG command can only select the next mode in a rotation sequence. Thus, to select a particular mode with the DRG command it is necessary to first establish a position in the Deg-Rad-Grad rotation. One method involves use of the INV DRG sequence which always selects the Deg mode. Then, use one or two additional DRG commands permits selection of the Rad or Grad modes. An alternate method is to use flags 33 and 34, where page C-7 of the TI-95 Programming Guide shows that Flag 33 set selects radians, Flag 34 set selects grads, and neither flag set selects degrees. Program steps which might be used to set the angular units mode are:

For degrees	INV DRG	or	RF 33 RF 34
For radians	INV DRG DRG	or	RF 34 SF 33
For grads	INV DRG DRG DRG	or	RF 33 SF 34

where four program steps are needed to set the GRAD mode with either method. The flag method was used at steps 0650-0653 of Hewlett's complex quadratic program on page 20.

What if both flags 33 and 34 are set? Page C-7 of the manual does not define the result. Tests with a short program will show that with both flags set the display will indicate RAD mode, but the calculator will operate in the GRAD mode.

COMPLEX QUADRATIC SOLUTION OF THE TI-95 WITHOUT THE MATH LIBRARY - Hewlett Ladd

This program was written for the benefit of those who do not have the Math Library module for their TI-95. The method of solution is the same as for William Hawes solution on pages 18/19, but the implementation and the prompts are different.

1. Select the program and see CMPLX QUADRATIC flashed in the display for two Pause cycles. The angular mode is also changed to RAD at this time. The calculator stops with ENTER: in the display and aRe and aIm in the windows above F1 and E2.

2. Enter the value for aRe and press F1. The entered value will be displayed with the aRe notation. Enter the value for aIm and press F2. The entered value will be displayed with the aIm notation, and the window notation will show GO above F1.

3. Press F1 and repeat step 2 for the entry of the remaining coefficients. The calculator will stop with RUN in the window above F5 after cIm has been entered. Note: In this implementation you must enter the coefficients in the order indicated. If you try to enter the imaginary part before the real part of a coefficient, the program will stop with GO above F1, ready to move to the next coefficient, and you will not have an opportunity to enter the real part.

4. Press F5 to solve. The calculator will stop with ROOTS: in the display and the notations Re1, Im1, Re2, Im2, and ESC in the windows. Use F1 through through F4 to bring the solution to the display. Use F5 (ESC) to set up for another problem.

```
0000 GTL GT
0003 LBL PP COL 16 MRG =
0010 RTN
0011 LBL ST STO 001 x~t
0018 STO 000 RTN
0022 LBL RC RCL 000 x~t
0029 RCL 001 INV P-R x~t
0035 RTN
0036 LBL X^ SBL RC x^2 (
0044 x~t *2) P-R SBL ST
0052 RTN
0053 LBL QR SBL RC SQR (
0061 x~t /2) P-R SBL ST
0069 RTN
0070 LBL XY ( RCL 000 *
0078 RCL 002 - RCL 001 *
0086 RCL 003 ) x~t (
0092 RCL 000 * RCL 003 +
0100 RCL 001 * RCL 002 )
0108 SBL ST RTN
0112 LBL X/ 1 +/-
0117 ST* 003 ( RCL 002
0124 x^2 + RCL 003 x^2 )
0131 1/x ST* 000 ST* 001
0138 SBL XY RTN
0142 LBL T1 SBR 0317 CE
0149 RCA 080 RTN
0153 LBL T2 SBR 0332 CE
0160 RCA 080 RTN
0164 LBL A1 STO 031 `aR`
0172 `e` SBL PP HLT
0177 LBL A2 STO 051 `aI`
0185 `m` SBL PP BRK
0190 GTL T1
0193 LBL B1 STO 032 `bR`
0201 `e` SBL PP HLT
0206 LBL B2 STO 052 `bI`
0214 `m` SBL PP BRK
0219 GTL T2
0222 LBL C1 STO 033 `cR`
0230 `e` SBL PP HLT
0235 LBL C2 STO 053 `cI`
0243 `m` SBL PP HLT
0248 LBL R1 RCL 042 `Re`
0256 `1` SBL PP HLT
0261 LBL I1 RCL 062 `Im`
0269 `1` SBL PP HLT
0274 LBL R2 RCL 043 `Re`
0282 `2` SBL PP HLT
0287 LBL I2 RCL 063 `Im`
0295 `2` SBL PP HLT
0300 DFN CLR
0302 DFN F1:aRe@A1
0309 DFN F2:aIm@A2 RTN
0317 DFN F1:bRe@B1
0324 DFN F2:bIm@B2 RTN
0332 DFN CLR
0334 DFN F1:cRe@C1
0341 DFN F2:cIm@C2
0348 DFN F5:RUN@RU RTN
0356 DFN CLR
0358 DFN F1:Re1@R1
0365 DFN F2:Im1@I1
0372 DFN F3:Re2@R2
0379 DFN F4:Im2@I2
0386 DFN F5:ESC@GT RTN
0394 LBL RU RCL 031 *2=
0403 STO 034 *2 +/- =
0410 STO 035 RCL 051 *2=
0419 STO 054 *2 +/- =
0426 STO 055 RCL 032
0432 STO 000 RCL 052
0438 STO 001 SBL X^
0444 STO 036 x~t STO 056
0451 RCL 035 STO 000
0457 RCL 055 STO 001
0463 RCL 033 STO 002
0469 RCL 053 STO 003
0475 SBL XY STO 037 x~t
0482 STO 057 RCL 036 +
0489 RCL 037 = STO 038
0496 STO 000 RCL 056 +
0503 RCL 057 = STO 058
0510 STO 001 SBL QR
0516 STO 039 x~t STO 059
0523 RCL 034 STO 002
0529 RCL 054 STO 003
0535 SBL X/ STO 040 x~t
0542 STO 060 RCL 032 +/-
0549 STO 000 RCL 052 +/-
0556 STO 001 1 +/-
0561 ST* 003 SBL X/
0567 STO 041 x~t STO 061
0574 RCL 041 + RCL 040 =
0582 STO 042 RCL 061 +
0589 RCL 060 = STO 062
0596 RCL 041 - RCL 040 =
0604 STO 043 RCL 061 -
0611 RCL 060 = STO 063
0618 SBR 0356 CE `ROOTS`
0627 `:` HLT
0629 LBL GT CE `CMPLX Q`
0640 `UADRATIC` PAU PAU
0650 RF 34 SF 33 CE
0655 SBR 0300 `ENTER:`
0664 STA 080 HLT
```

TI-95 QUIRKS - Robert Prins.

1. The "LCM" function doesn't work for 13 digit numbers.

2. The "GAM" function in the MATH Library module sometimes produces incorrect results. For example,

0.5 +/- F1(G) returns "G = -3.544907702" which is correct, but

0.5 +/- F2(lnG) returns "lnG = 1.265512123" which is wrong, but the error indicator stays off.

3. The "LIN" program in the "MAT" family in the MATH Library module is sometimes less accurate than ML-02 with double divides. For the 7x7 sub-Hilbert the TI-59 is about a factor of 10 more accurate.

4. The "EIG" program from the "MAT" family in the MATH Library module gives an "E n" for the elements of the eigenvectors, instead of the "n" which is indicated on page 6-33 of the guidebook.

5. The "RAT" program in the "NUM" family in the MATH Library module sometimes produces nonsensical answers. For example, try 0.772453850906 (which is the fractional part of the square root of pi) with an error of zero. The displayed answers are:

NUM = 1.375788 19 and DEN = 1.781062 19

where the exponents are nonsensical, but the ratio of NUM/DEN is correct to all 12 input digits.

6. The "QAD" function on the "FUNC" menu gives incorrect answers if c = 0. This is probably due to use of a more accurate version of the standard quadratic formula. For $ax^2 + bx + c = 0$, the usual formula for the roots is

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If you set a = c = 1 and B = 10e7 and use the calculator mode to find the roots you will get $x_1 = 0$ and $x_2 = 10e7$ where x_1 is obviously incorrect. If you change the formula for the x_1 root to

$$x_1 = \frac{2c}{-b - \sqrt{b^2 - 4ac}}$$

and repeat your calculations x_1 will be 10e-7. Unfortunately, the second form, which is probably used in the TI-95 cannot handle the case where c = 0, as that would give 0/0.

PROGRAMMABLE HAND CALCULATORS IN AVIATION SPORT IN RUSSIA

The announcement at the right appeared on page 2188 of Volume 24, No. 13 of Scientific and Technical Aerospace Reports (STAR). That was the July 8, 1986 issue.

Can anyone describe a MK-56?

N86-23309# Joint Publications Research Service, Arlington, Va.
PROGRAMMABLE HAND CALCULATORS IN AVIATION SPORT
A. Romanyuk *In its* USSR Report: Cybernetics, Computers and Automation Technology (JPRS-UCC-86-003) 20 Mar. 1986 p 18-23 Transl. into ENGLISH from Krylya Rodiny (Moscow, USSR), no. 7, Jul. 1985 p 15-16 (For primary document see N86-23293 13-60)
Avail: NTIS HC A04/MF A01

This research proposes that the MK-54 programmable hand calculator be used as a computer that calculates the points of participants in glider competitions. The cost of this and similar calculators (MK-56, BZ-34) varies between 50 and 100 rubles. The calculators feature a simple programming system, are easy to use and can muster most of the computational power required. It can execute point calculations in different glider class competitions when draws occur both in speed and distance competitions for any combination of finishers. The set-up time to run the calculations is less than 5 minutes, and the time required to calculate the results of one participant is less than 12 seconds. The program has been used in judging oblast competitions. A simplified flow chart of the algorithm used is presented, and a chart of the addressed registers is given. Author

<u>SOLUTION OF CUBIC EQUATIONS</u> - Laurance Leeds notes that the TI-59 version of Ingvar Magnusson's cubic solution which appeared in V11N4P17 does not yield the results claimed on V11N4P16. The error was introduced when the original translation would not terminate for some problems, and the EE-INV-EE sequence was inserted at steps 088-090. To see the effect without the EE-INV-EE you may replace the steps 088-094 with - EXC 08 = Pause Nop and attempt to solve the cubic with A = 6, B = 11 and C = 6. From the ninth iteration on the difference between succeeding solutions alternates between +1.5E-11 and -1.5E-11, and since the difference is tested against zero the program never stops. The program without the EE-INV-EE will terminate for Peter Messer's cubic test (A = -2, B = 4/3, and C = -2/9).

Laurance noted that the more exact answers on V11N4P16 can be obtained by simply pressing R/S when fast mode terminated. The program will then run one more iteration in normal mode, an elapsed time of about two additional seconds. The listing below uses flag 1 to obtain the extra iteration automatically.

000	91	R/S	040	03	03	080	48	EXC	120	01	01	160	00	0	200	50	I×I
001	43	RCL	041	22	INV	081	07	07	121	30	30	161	00	0	201	32	X:T
002	04	04	042	44	SUM	082	50	I×I	122	25	CLR	162	00	0	202	43	RCL
003	42	STO	043	04	04	083	34	√X	123	35	1/X	163	00	0	203	02	02
004	00	00	044	43	RCL	084	42	STO	124	43	RCL	164	00	0	204	50	I×I
005	43	RCL	045	05	05	085	07	07	125	05	05	165	00	0	205	22	INV
006	01	01	046	22	INV	086	43	RCL	126	91	R/S	166	00	0	206	77	GE
007	44	SUM	047	49	PRD	087	04	04	127	43	RCL	167	00	0	207	02	02
008	04	04	048	04	04	088	52	EE	128	07	07	168	00	0	208	10	10
009	43	RCL	049	02	2	089	22	INV	129	91	R/S	169	00	0	209	32	X:T
010	04	04	050	94	+/-	090	52	EE	130	43	RCL	170	00	0	210	43	RCL
011	42	STO	051	22	INV	091	75	-	131	05	05	171	00	0	211	03	03
012	05	05	052	49	PRD	092	48	EXC	132	91	R/S	172	00	0	212	50	I×I
013	44	SUM	053	07	07	093	08	08	133	43	RCL	173	00	0	213	77	GE
014	05	05	054	43	RCL	094	95	=	134	06	06	174	76	LBL	214	02	02
015	42	STO	055	07	07	095	29	CP	135	91	R/S	175	11	A	215	17	17
016	06	06	056	42	STO	096	22	INV	136	00	0	176	42	STO	216	32	X:T
017	42	STO	057	05	05	097	67	EQ	137	00	0	177	01	01	217	85	+
018	07	07	058	49	PRD	098	00	00	138	00	0	178	91	R/S	218	01	1
019	43	RCL	059	07	07	099	01	01	139	00	0	179	76	LBL	219	95	=
020	00	00	060	48	EXC	100	87	IFF	140	00	0	180	12	B	220	55	÷
021	44	SUM	061	06	06	101	01	01	141	00	0	181	42	STO	221	02	2
022	04	04	062	22	INV	102	01	01	142	00	0	182	02	02	222	95	=
023	49	PRD	063	44	SUM	103	09	09	143	00	0	183	91	R/S	223	65	×
024	04	04	064	07	07	104	86	STF	144	00	0	184	76	LBL	224	43	RCL
025	49	PRD	065	29	CP	105	01	01	145	00	0	185	13	C	225	03	03
026	04	04	066	43	RCL	106	61	GTO	146	00	0	186	42	STO	226	69	OP
027	44	SUM	067	07	07	107	00	00	147	00	0	187	03	03	227	10	10
028	05	05	068	32	X:T	108	01	01	148	00	0	188	91	R/S	228	95	=
029	49	PRD	069	77	GE	109	25	CLR	149	00	0	189	76	LBL	229	94	+/-
030	05	05	070	00	00	110	43	RCL	150	00	0	190	14	D	230	42	STO
031	49	PRD	071	74	74	111	04	04	151	00	0	191	09	9	231	04	04
032	06	06	072	48	EXC	112	66	PAU	152	00	0	192	69	OP	232	60	DEG
033	43	RCL	073	07	07	113	81	RST	153	00	0	193	17	17	233	22	INV
034	02	02	074	34	√X	114	76	LBL	154	00	0	194	25	CLR	234	57	ENG
035	44	SUM	075	44	SUM	115	15	E	155	00	0	195	22	INV	235	04	4
036	05	05	076	05	05	116	43	RCL	156	00	0	196	86	STF	236	05	5
037	44	SUM	077	22	INV	117	07	07	157	00	0	197	01	01	237	30	TAN
038	06	06	078	44	SUM	118	29	CP	158	00	0	198	43	RCL	238	33	X^2
039	43	RCL	079	06	06	119	67	EQ	159	00	0	199	01	01	239	86	STF

<u>User Instructions</u>:

1. Enter the value A and press A.

2. Enter the value B and press B.

3. Enter the value C and press C.

4. Press D to start a solution. The calculator stops with a flashing "1." in the display. Press 7 and then EE and wait for a real root to appear in the display. To see the other roots press E.

Solution of Cubic Equations - (cont)

5.a. If the display is flashing the result is the real part of a complex root. Press R/S to see the imaginary part.

5.b. If the display is not flashing after pressing E the result is a second real root. Press R/S to see the third real root.

SOLUTION OF CUBIC EQUATIONS ON THE TI-66 - P. Hanson. The fast mode program on page 22 includes a string of unused instructions from step 136 through 173. This places the STF instruction at step 239 at the end of the partitioning as required by fast mode entry. Users who do not want to use fast mode, or who want to run the program on a TI-66 can enter the program as is, but place GTO 001 at steps 232-234. As an alternative, the following PC-200 listing for the TI-66 eliminates the string of zeroes resulting in a 196 step program.

The TI-66 user instructions are the same as those for the TI-95 fast mode program above except:

* Step 4 is reduced to Press D and wait for for a real root to appear in the display. To see the other roots press E.

* In step 5.a. the display will not be flashing for a complex root; rather the display will include the extra decimal points which indicate an error has occurred. Press CE to remove the extra decimal points and proceed.

Solution for the Messer test is completed in about 95 seconds. The results are among the best achieved; R1 = 0.24669 29833 683, Re = 0.87665 35083 160, and Im = 0.36370 78786 571 where each root is within 1 in the thirteenth place.

	ST	032	06	065	CP	098	00	131	R/S	164	02
000	R/S	033	RCL	066	RCL	099	01	132	RCL	165	IXI
001	RCL	034	02	067	07	100	IFF	133	06	166	INV
002	04	035	SUM	068	X⇌T	101	01	134	R/S	167	X≥T
003	STO	036	05	069	X≥T	102	01	135	LBL	168	01
004	00	037	SUM	070	00	103	09	136	A	169	71
005	RCL	038	06	071	74	104	STF	137	STO	170	X⇌T
006	01	039	RCL	072	EXC	105	01	138	01	171	RCL
007	SUM	040	03	073	07	106	GTO	139	R/S	172	03
008	04	041	INV	074	√X	107	00	140	LBL	173	IXI
009	RCL	042	SUM	075	SUM	108	01	141	B	174	X≥T
010	04	043	04	076	05	109	CLR	142	STO	175	01
011	STO	044	RCL	077	INV	110	RCL	143	02	176	79
012	05	045	05	078	SUM	111	04	144	R/S	177	X⇌T
013	SUM	046	INV	079	06	112	R/S	145	LBL	178	+
014	05	047	PROD	080	EXC	113	LBL	146	C	179	1
015	STO	048	04	081	07	114	E	147	STO	180	=
016	06	049	2	082	IXI	115	RCL	148	03	181	÷
017	STO	050	+/-	083	√X	116	07	149	R/S	182	2
018	07	051	INV	084	STO	117	CP	150	LBL	183	=
019	RCL	052	PROD	085	07	118	X=T	151	D	184	x
020	00	053	07	086	RCL	119	01	152	3	185	RCL
021	SUM	054	RCL	087	04	120	29	153	OP	186	03
022	04	055	07	088	EE	121	CLR	154	17	187	OP
023	PROD	056	STO	089	INV	122	1/X	155	CLR	188	10
024	04	057	05	090	EE	123	RCL	156	INV	189	=
025	PROD	058	PROD	091	-	124	05	157	STF	190	+/-
026	04	059	07	092	EXC	125	R/S	158	01	191	STO
027	SUM	060	EXC	093	08	126	RCL	159	RCL	192	04
028	05	061	06	094	=	127	07	160	01	193	GTO
029	PROD	062	INV	095	CP	128	R/S	161	IXI	194	00
030	05	063	SUM	096	INV	129	RCL	162	X⇌T	195	01
031	PROD	064	07	097	X=T	130	05	163	RCL	196	0

CURVE FITTING WITH ORTHOGONAL POLYNOMIAL METHODS

Pages 155 through 160 of the June 1987 issue of BYTE presented a BASIC program by William Hood which uses orthogonal polynomial methods for curve fitting. The program as listed in BYTE is not compatible with either the CC-40 or the TI-74. The listing at the right is compatible. Mr. Hood has kindly given us permission to present the modified program. He asks that any inquiries about the modified program be addressed to TI PPC Notes. The changes which were made relative to the listing in BYTE were:

Lines 1000-1050 were changed to accept the peculiarities of the TI-74 such as

Variable Dimensioning not allowed in the TI-74.

Functions are not available on the TI-74.

LN changed to LQ since LN is a reserved word in the TI-74.

Deletion of lines 1020 and 1030 since the TI-74 sets all variables to zero at program entry.

Lines 1030-1045 provide printer control needed by the TI-74 and PC-324.

Line 1050 establishes a printout format to be used by the PRINT USING command at line 1780.

Line 1060 has a change in the GOTO address.

Lines 1070-1310 are the same as in the BYTE listing. Lines 1320-1550 of the BYTE program were deleted to conserve memory.

Lines 1400-1550 provide a data entry routine more consistent with the capabilities of the TI-74. A prompt is provided for the entry of each X, Y, or W value.

Line 1680 mechanizes the same equation as in the BYTE listing, but without the use of a function. The solution illustrates a little-used feature of BASIC, that a relational expression evaluates to -1 if the condition is true or to 0 if the condition is false. See page 1-12 of the TI-74 Programming Reference Guide.

Lines 1690-1710 are the same as in the BYTE listing.

Lines 1720-1750 provide an altered output of the polynomial coefficients to implement a preference for C(0) as the constant, C(1) as the coefficient of the first degree term, etc.

```
1000      dim X(50),Y(50)
,W(50),C(11)
1010      DIM D1(11),D2(1
1),D3(11),D4(11),D5(11),
D6(11)
1020 LQ=50:LD=11
1030 INPUT "Use Printer
(Y/N)? ";A$
1035 IF A$="Y"OR A$="y"T
HEN PN=1
1040 IF PN=1 THEN INPUT
"Enter device name: ";F$
1045 IF PN=1 THEN OPEN #
PN,F$,OUTPUT
1050 IMAGE #.######
1060 GOTO 1400
1070 IF MF<0 AND M<MM TH
EN J1=MM+1:MM=M:GOTO 113
0
1080 J1=1:MM=M:S1=0:S2=0
:S3=0:S4=0
1090 FOR I=1 TO N:WT=W(I
)
1100 S1=S1+WT*X(I):S2=S2
+WT:S3=S3+WT*Y(I):S4=S4+
WT*Y(I)*Y(I)
1110 NEXT I
1120 D4(1)=S1/S2:D5(1)=0
:D6(1)=S3/S2:D1(1)=0:D2(
1)=1:VR=S4-S3*D6(1)
1130 FOR J=J1 TO MM:S1=0
:S2=0:S3=0:S4=0
1140 FOR I=1 TO N:P1=0:P
2=1
1150 FOR K=1 TO J:P=P2:P
2=(X(I)-D4(K))*P2-D5(K)*
P1:P1=P:NEXT K
1160 WT=W(I):P=WT*P2*P2
1170 S1=S1+P*X(I):S2=S2+
P:S3=S3+WT*P1*P1:S4=S4+W
T*Y(I)*P2:NEXT I
1180 D4(J+1)=S1/S2:D5(J+
1)=S2/S3:D6(J+1)=S4/S2:D
3(1)=-D4(J)*D2(1)-D5(J)*
D1(1)
1190 IF J<4 THEN 1210
1200 FOR K=2 TO J-2:D3(K
)=D2(K-1)-D4(J)*D2(K)-D5
(J)*D1(K):NEXT K
1210 IF J>2 THEN D3(J-1)
=D2(J-2)-D4(J)*D2(J-1)-D
5(J)
1220 IF J>1 THEN D3(J)=D
2(J-1)-D4(J)
1230 FOR K=1 TO J:D1(K)=
D2(K):D2(K)=D3(K):D6(K)=
D6(K)+D3(K)*D6(J+1):NEXT
 K
1240 NEXT J
1250 FOR J=1 TO M+1:C(J)
=D6(M+2-J):NEXT J
1260 P2=0:FOR I=1 TO N:P
=C(1)
1270 FOR J=1 TO M:P=P*X(
I)+C(J+1):NEXT J
1280 P=P-Y(I):P2=P2+W(I)
*P*P:NEXT I
```

Curve Fitting with Orthogonal Polynomials - (cont)

Lines 1760-1770 are the equivalent of line 1750 in the BYTE listing.

Lines 1775-1790 are the equivalent of lines 1760-1770 in BYTE. The PRINT USING command at line 1780 together with the IMAGE command at line 1050 accomplish the same limiting of the answer to six decimal places as line 1760 of the BYTE listing.

Lines 1800-1870 provide a printout of the residual errors. I have found that this is more useful in finding bad data entry than the tables of the input and calculated dependent variables.

Lines 1900-1910 permit the solution for another degree. I moved this downstream from the table of residuals. This permits reviewing the residuals before selecting another degree. The BYTE program provides the option for another solution before the printout of the data. That means that the user cannot get a printout of the data if he also want to try another degree.

Lines 1900-2130 of the BYTE program were deleted.

The program permits use of weighted or unweighted data. A complete set of prompts are available. With the PC-324 the response to the "Enter Device Name:" prompt is 12.

The run time for the solution to the 10 data pair problem outlined in the BYTE article is very similar that for the row reduction program on page 14 of this issue, and about a factor of two faster than the V11N4P12 solution using in the Mathematics module for the TI-74. The sums of the squares of the residuals are equal to nine decimal places for all three programs. A printout for the sample problem from BYTE appears below.

```
C(0) = -.5700247169
C(1) =  7.19996658
C(2) = -1.113133706
C(3) =  .0669397883
C(4) = -.0012073187

Residual Variance =
 .9917402194

Coeff of Det (R^2) =
 .984184
```

```
D(1) = -.2400328374
D(2) =  .9451840484
D(3) = -1.028420627
D(4) =  .8898320409
D(5) = -.571941066
D(6) =  .4281552822
D(7) = -.8772289335
D(8) =  .7686350189
D(9) = -.502158865
D(10) =  .1879759383
```

```
1290 S2=0:IF N>M+1 THEN S2=P2/(N-M-1)
1300 R2=1:IF VR<>0 THEN R2=1-P2/VR:IF R2<0 THEN R2=0
1310 RETURN
1400 INPUT "Is the data weighted (Y/N)? ";W$
1410 IF W$<>"Y"AND W$<>"y"THEN W$="N"
1420 INPUT "How Many Data Points? ";N
1430 IF N<2 OR N>LQ THEN 1420
1500 FOR K=1 TO N
1510 INPUT "X("&STR$(K)&") = ";X(K)
1520 INPUT "Y("&STR$(K)&") = ";Y(K)
1530 IF W$="N"THEN W(K)=1:GOTO 1550
1540 INPUT "W("&STR$(K)&") = ";W(K)
1550 NEXT K
1680 PM=((LD-1)<(N-1))*(1-LD)+((N-1)<=(LD-1))*(1-N)
1690 INPUT "Degree of Polynomial? ";M
1700 IF M<1 OR M>PM THEN 1690
1710 GOSUB 1070
1720 FOR J=M+1 TO 1 STEP -1
1725 PRINT #PN,"C("&STR$(M+1-J)&") = ";C(J)
1730 IF PN=0 THEN PAUSE
1740 NEXT J
1750 PRINT #PN
1760 PRINT #PN,"Residual Variance =     ";S2
1765 IF PN=0 THEN PAUSE
1770 PRINT #PN
1775 PRINT #PN,"Coeff of Det (R^2) = "
1780 PRINT #PN,USING 1050,R2
1785 IF PN=0 THEN PAUSE
1790 PRINT #PN
1800 INPUT "Print the residuals (Y/N)? ";A$
1810 IF A$<>"Y"AND A$<>"y"THEN 1900
1820 FOR I=1 TO N:P=C(1)
1830 FOR K=1 TO M:P=P*X(I)+C(K+1):NEXT K
1840 PRINT #PN,"D("&STR$(I)&") = ";P-Y(I)
1850 IF PN=0 THEN PAUSE
1860 NEXT I
1870 PRINT #PN
1900 INPUT "Try another degree (Y/N)? ";A$
1910 IF A$="Y"OR A$="y"THEN 1680
3000 END
```

TRANSPORTABILITY OF TI-95 PROGRAMS ON MAGNETIC MEDIA - William Hawes, Hewlett Ladd, and the editor have demonstrated successful transfer of programs using the 8K Constant Memory cartridges. Hewlett and the editor have also demonstrated successful transfer using cassette tapes and the CI-7 Cassette Interface and quite different cassette recorders. That is no mean feat! Readers will recall that there have been some TI-59's that simply couldn't read or write magnetic cards which could be used on other TI-59's. Similarly, Laurance Leeds and the editor have tried to transfer Radio Shack Model 100 programs on cassette tapes with only limited success, but the editor has exchanged cassette tapes with other Model 100's with consistent success. So far no member has responded to my invitation to establish magnetic transfer capability for TI-74 programs.

In order to encourage more work with magnetic transfer of TI-95 programs we will offer a cassette tape with not less than ten TI-95 programs for ten dollars. The programs I intend to include are:

1. Complex Quadratic using the Math Library Module by William Hawes
2. Quartic Solution using the Math Library Module by William Hawes
3. Dates of Easter by Hewlett Ladd
4. Solution of Linear Equations by Palmer Hanson
5. Translation of ML-04 from the TI-59 Master Library by Hewlett Ladd
6. Translation of ML-05 from the TI-59 Master Library by Hewlett Ladd
7. Translation of ML-06 from the TI-59 Master Library by Hewlett Ladd
8. Translation of ML-19 from the TI-59 Master Library by Hewlett Ladd
9. Shell Sorter for 100 registers by Hewlett Ladd
10. Random Numbers; generate, store, and sort by Hewlett Ladd. This program uses the Shell Sorter (item 9) and demonstrates the call of one user program from another user program.

If you do not have the Math Library Module I will substitute other appropriate programs. Items 1 and 4 have been published in TI PPC Notes.

Send five dollars and I will return a tape with the programs. The tape will be a standard Radio Shack low noise tape. I do not use the expensive computer cassettes since I have generally been successful with the lower cost cassettes. Because of the problems which occur occasionally and prevent successful transfer I can not guarantee these tapes. This is NOT a money back offer.

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Magnetic card service continues to be available for TI-59 programs in this issue, and for programs in the 1983, 1984, 1985 and 1986 issues. One dollar per card plus a stamped and self-addressed envelope, please.

PCH