TI PPC NOTES

NEWSLETTER OF THE TI PERSONAL PROGRAMMABLE CALCULATOR CLUB

P. O. Box 1421, Largo, FL 34649

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For everything there is a season,
and a time for every matter under heaven,
a time to be born, and a time to die, ...

That passage from Ecclesiastes 3 is pertinent to this last issue in two ways. First, I am sorry to report that Carl Rabe died of a cerebral hemorrhage due to a heart attack. I never met Carl face-to-face, but considered him as a good friend. I talked to him several times on the telephone and accumulated a lenghthy file of letters on programs and other subjects of common interest. Members will recall that Carl was instrumental in the fine tuning of the smallest circle analysis.

Second, it is time to publish the last issue of our newsletter. I am even later than usual with this final issue, primarily due to difficulty in generating much enthusiasm for a final issue. Several members have asked about the possibility of continuing some level of support in the coming year. My present plans are to:

1. Maintain the post office box address through mid-1992. During that time I will continue to provide magnetic tape service and magnetic card service, will provide back issues if ordered, and will answer correspondence as time permits.
2. Make up compilations of material from the V14 issues for the TI-74, the TI-95 and the TI-81 and offer them to past purchasers.

My personal plans are not well defined. I still like to work on problems whether of the programming variety or of the more basic mathematical kind, so if you have a vexing problem and would like some assistance feel free to write. If the problem captures my imagination I will try to help. I also hope to write some technical papers on some of my work in the early days of inertial navigation.

Finally, I want to thank all of those who have supported the club through the years through continuing membership, submission of programs, and the like. May you all have a Happy Holiday Season.

ERRATA

V14N4P4-7 Polynomial Curve Fit on the TI-81 - George Thomson notes that once again I failed to point out that the solution was done by the method of least squares minimizing errors in Y, and with the X values assumed to be error free and of equal weight. George also wondered how many readers really know how tricky polynomials can be because of the "hill-and-valley" problem. The equation may fit well at or near the observed data points but have ridiculous values between the points. One way to observe problems of this sort is to overlay the plot of the function on the input data as was done in the TI-81 program.

One final personal note: if you look closely at nature you will find that the Lord tended to use logarithmic and exponential functions and statistical methods - He didn't have much use for polynomials.

HARDWARE AND SOFTWARE WANTED - HP-35, HP-45 and HP-65 together with the original documentation (owner's manual, programming guide, handbook, etc.) and external power adapter. Slide rules of any configuration plus books and pamphlets on such items. Also interested in programs which calculate residential heat loads; e.g., to solve for in-house temperatures given various ambient outside temperatures, solar inputs, interior thermal mass and other related parameters. This would be used to size construction parameters for a solar heated greenhouse or solar heated living spaces. Desireable, but not mandatory, that programs will run on an HP-45, HP-65 or TI-59. Write to William S. West, 731 Monroe Street, Apartment 303, Rockville MD 20850-2716 .

TI-66/PC-200 SALE - Page 19 of the August 1991 DAMARK catalog offers a TI-66 and PC-200 for a combined price of $39.99 plus $6.00 for shipping and handling. Ask for Item No. B-474-182785. Write to 7101 Winnetka Ave. N., P. O. Box 29900, Minneapolis MN 55429-0900 or call 1-800-729-9000.

CONTINUING SUPPORT FOR THE CC-40 - The Lima User Group emphasizes support of the TI-99/4, but is also a source of continuing information on the CC-40 including articles on hardware availability and software. Examples of the kind of material available appear in the article on the Wafertape in V14N4P12-13 and the data bank program on page 3 of this issue. Membership dues are $15.00 per year in the United States, $20.00 per year overseas. Members receive ten issues of the newsletter *Bits Bytes & Pixels* each year. Send your subscription to the Lima User Group, Box 647, Venedocia OH 45894.

All back issues that contain CC-40 articles are available for three cents per page. Members are billed for the cost of back issues they request after the material is sent. The CC-40 software library consists of 24 CC-40 BASIC programs, five of which were typed in from *TI PPC NOTES*. The entire collection is available to any member who sends a QuickDisk or Wafertape and a paid return mailer.

Another example of the kind of support that is available is a video tape in which the CC-40 PLUS, with built-in cassette interface is shown. The CC-40 PLUS is a never released product that was under development by TI. The tape also shows the never released TI-99/2 which was designed to compete with the Timex/Sinclair 1000. The price for the tape is five dollars. It runs for six hours, but only an hour or so is devoted to the CC-40 and TI-99/2. The tape was made at the Lima User Group's May 1991 TI-99/4A conference.

USING THE CC-40 (and the TI-74) AS A PORTABLE DATA BANK - Charles Good. Have you seen those electronic "organizers" in the department stores? They are battery operated dedicated computers that look like large calculators. Marketed under names such as "THE BOSS" or "THE ORGANIZER", they are designed to store lists of names and addresses or hour by hour appointment calendars. With these devices it is easy anywhere and anytime to sort through a large data base for a particular name, address, or phone number. With many of these devices you can download their data to a desktop PC or print the information on a printer.

Well, you can do the same thing with a CC-40. Since the CC-40 has CMOS RAM, any BASIC program entered into the CC-40 stays in memory even after the computer is turned "off". BASIC programs will remain in the CC-40's memory for many months in the "computer is turned off" mode before the batteries finally need to be changed. Short appointment calendars, notes or address lists can be stored in the CC-40 as text that is displayed when any of the ten user programmable hot keys are pressed from command mode. Data can also be stored as part of a memory resident BASIC program, but there is a potential problem with this method. Although the CC-40 retains a BASIC program in memory when it is turned "off", it does NOT retain any of the numeric or string variables generated by the BASIC program. There are CC-40 programs in my software library that allow you to open a disk (or wafertape) file and read in a list of names, addresses, and phone numbers. When you do this and then later turn the CC-40 "off" to conserve battery power, the BASIC program remains in memory. However, the data read in from disk and stored in strings is GONE! There is certainly no advantage to the CC-40's portability if you have to go to a disk or tape drive every time you want to look up someone's phone number! The solution to this problem is to store your information as an actual part of the BASIC program in line numbers with DATA statements. When stored in this way, your data is retained in the CC-40's memory even when the computer is "off".

I wrote a CC-40 program to deal with this situation. A somewhat similar CC-40 program was published in the Volume 1 Number 2 issue of *ENTHUSIAST 99*, but it doesn't work on many CC-40's because it POKES to an absolute memory address. My program works! It stores a name/address/phone number list as data statements. Only one person's data at a time is read into string variables; thus, the CC-40's memory is not wasted storing the entire data bank twice, once in data statements and a second time in strings. From the running program you can view all the data or search for the data of one particular person by inputting the person's last name. Because of the POS statement in line 200, you don't even have to enter the entire last name for a search. All you need to enter is a text string that is contained within the last name, such as inputting BUCK when searching for the last name ARBUCKLE. If the data base includes more than one person with the same last name the program will still help you find the information you want. An option also permits the user to view all input in sequence. The data for each person is displayed on a single 80 column line. You can scan left and right across this line of data at your leisure using the CC-40's arrow keys.

You can store about 100 program lines of names, addresses, and "other information" as DATA statements with this program in a minimum 6K CC-40. It takes just a few seconds to find the last of the 100 DATA statements in a name search. Editing is easy. From the CC-40's command mode just bring up the appropriate line number containing the DATA statement and type over or add to the existing DATA of that line number. To add more names to the data bank, just create more BASIC line numbers for the additional data. To obtain a hard copy of the data you can LIST the program to a HexBus compatible printer. You can also use the HexBus RS232 peripheral to list the program with all of your DATA to a non HexBus printer or dump the program (via a cable linking the HexBus RS232 to the TI-99/4A RS232) directly into a TI-99/4A.

Although you can't put a CC-40 in your pocket as can be done with many modern electronic organizers, you can easily put the "smaller than most books" CC-40 in a small briefcase or purse. And you do so much more with the CC-40! Unlike most of the modern "organizers" the vintage 1983 CC-40 is a portable and truly flexible programmable computer. "Modern" does not always mean "better". (Editor's Note: The listed program will operate equally well in either a TI-74 or CC-40. Members will recall that ... storage of data in the TI-74 was discussed in V12N4P20.)

```
100 REM TI-74 DATA BANK FILE
110 REM by Charles Good, Lima, Ohio User Group, June 1991
120 PRINT "  --Name/Phone/Address File--":READALL=0:PAUSE 1
130 INPUT "Read All Names? (Y/N) ";YN$
140 IF YN$="Y"THEN READALL=1:GOTO 180
150 IF YN$="y"THEN READALL=1:GOTO 180
160 PRINT "USE UPPER CASE TO ":PAUSE .5
170 INPUT "ENTER DESIRED LAST NAME- ";INPUT$
180 READ FN$:IF FN$="END"THEN PRINT "END OF FILE":PAUSE 1:RESTORE 1000:GOTO 120
190 READ LN$,REST$:IF READALL=1 THEN 250
200 IF POS(LN$,INPUT$,1)=0 THEN 180
210 INPUT "Is the person "&FN$&" "&LN$&"? ";YN$
220 IF YN$="Y"THEN 250
230 IF YN$="y"THEN 250
240 GOTO 180
250 PRINT FN$&" "&LN$&" "&REST$:PAUSE
260 IF READALL=1 THEN 180
270 RESTORE 1000:GOTO 120
970 REM FIRST NAME, LAST NAME, OTHER INFORMATION such as phone number and address
980 REM Use ONLY UPPER CASE for first and last names. Commas are required after
990 REM the first and last name. Use no commas in the other information field.
1000 DATA BARBARA,GOOD,616-857-2256 11 Lakeshore Dr. Douglas MI 49406
1010 DATA IAN,GOOD,419-667-3131 15276 Main Venedocia OH 45894
1020 DATA JACK,TURNER,Chestnut Lane Douglas MI 49406
5000 DATA END
```

AN ANOMALY IN THE LINEAR EQUATIONS SOLUTION ON THE TI-81, TI-68 AND TI-74

Timothy Baumgartner writes: "My Pre-calculus students have been using the TI-81 to solve matrix equations representing systems of linear equations. To introduce the topic of inconsistent systems I asked them to solve the system

$$3x + 4y = 7$$
$$6x + 8y = -2$$

hoping that they would get an error message after entering the matrices

$$[A] = \begin{vmatrix} 3 & 4 \\ 6 & 8 \end{vmatrix} \quad \text{and } [B] = \begin{vmatrix} 7 \\ -2 \end{vmatrix}$$

and entering the expression [A] [B] . Instead, they saw the display

```
[ -1.066666667E13]
[ 8E12           ]
```

Upon investigating, we found that the determinant of [A] had been calculated as -6E-12 instead of the correct value of zero. This should be a very straightforward calculation:

$$\det[A] = 3 \times 8 - 6 \times 4 = 0$$

My question is this: How does the TI-81 calculate its determinants?"

Editor's Note: I do not know the exact sequence of calculations used to calculate determinants and solve linear equations in the TI-81. The method used is certainly not the simple one you describe since it will not work for systems of higher order. Of course, one can use the old artifice for a 3rd order system of rewriting the first and second columns to the right of the third column, and then doing the diagonal calculations, but as my old college algebra text says "... this method of expansion applies to a determinant of third order but not to one of higher order." Also, almost certainly the TI-81 does not evaluate a determinant by brute force expansion by minors. More probably it accomplishes the task through appropriate matrix manipulations such as additions and subtractions of one row (or column) from another such that zeroes are generated for selected elements of the matrix. Those methods typically involve multiplying or dividing one row (or column) by one of the elements of another row (or column). For example, suppose we want to place a zero in the first element in the second row. One way to do it would be to

(1) Divide each element of the first row by the first element of the first row.

(2) Multiply each element of the result from (1) by the first element of the second row.

(3) Subtract the result from (1) and (2) element by element from the elements of the second row.

Errors can be introduced if divisions occur which result in answers with repeating decimals. The calculations for the replacement values for the second row for your particular problem follow:

(1) Start with the elements of the first row, [3,4] and divide each element by 3, yielding [1,4/3] where the important point is that the second element is not exactly 4/3 as shown, but is actually 1.333333333333 (thirteen decimal digits).

(2) Multiply [1,1.333333333333] by 6 yielding [6, 7.999999999998].

An Anomaly in the Linear Equations Solution on the TI-81, TI-68 aned TI-74 - (cont)

(3) Subtract [6,7.999999999998] from the second row of the original matrix yielding the matrix

$$\begin{vmatrix} 3 & 4 \\ 0 & 2E-12 \end{vmatrix}$$

(4) Evaluate the matrix as 3 x 2E-12 - 0 x 4 = 6E-12. That answer is the same magnitude as the answer from the TI-81, but of different sign, suggesting that our algorithm is similar, but not identical to that in the TI-81.

What if we interchange the variables x and y in the original problem statement? Then the columns of the matrix would be interchanged. For that problem the TI-81 calculates the determinant as exactly zero, and an attempt to solve the linear equations results in the error message "ERROR 05 MATH".

Tests of other linear equation solvers show that for the test problem:

* The ML-02 program in the Master Library module for the TI-59 finds the determinant to be exactly zero. If the user then tries to solve the linear equations, which violates the instructions on page 10 of the manual, then the solution is returned as -1.6666667E99 and 9.9999999E99 where the second output is flashing to indicate an error has occurred. If the columns are reversed the results are the same.

* The linear equations solution of the TI-68 does not display the determinant. Page 7-6 of the manual states "If the system is singular, an error condition occurs." An attempt to solve the test problem yields the solution X1=1.0666667E13, X2= -8E12, the same magnitudes as with the TI-81, but with opposite signs. If the columns are reversed the message "Error" appears in the display.

* The linear equations solution portion of the Mathematics module for the TI-74 finds the determinant to be -6.E-12 and the solutions of the linear equations to be X1 = -1.066667E+13 and X2 = 8.E+12, the same results as those obtained with the TI-81. If the columns are reversed the message "THE SYSTEM IS SINGULAR" is returned.

* The linear equations solution portion of the Mathematics module for the TI-95 finds the determinant to be exactly zero. An attempt to solve the linear equations yields the message "SINGULAR". If the columns are reversed the determinant is still zero and an attempt to solve the linear equations results in the "SINGULAR" message.

There is no discussion of the method of solution in the guidebooks for the TI-68, TI-81 or TI-95 Mathematics Library. Pages 5-10 and 5-11 of the *TI-74 Mathematics Library Guidebook* states that the lower-upper decomposition method is used to find the determinant and to solve the linear equations. The detailed description is nearly identical with that which appeared on page 13 of the manual for the Master Library module for the TI-59. The reference in both the TI-59 and TI-74 manuals is *Numerical Methods*, Germund Dahlquist and Ake Bjork, Prentice Hall, 1974.

ANOTHER SOURCE OF CC-40 HARDWARE - Charles Good writes: "A source of used CC-40 computers, peripherals, and user manuals (including the Wafertape manual) is Jim Lesher, 722 Huntley, Dallas TX 75214. Telephone 214-821-9274. I purchased a used 6K CC-40 with all of the original documentation for $50.00 plus shipping. Prices are subject to change at any time."

EXPERIENCE WITH THE PC INTERFACE CABLE - Greg Lind writes: I recently purchased the PC-Interface for the TI-74 and TI-95. Since I own a TI-74 I'll be referring to that device. This interface lets you connect your TI-74 to any IBM or compatible computer. With the interface connected you now have disk drives for storage, an 80 column printer, and the computer screen for displaying output or program lines. This is now all connected to the TI-74 as if it was all one unit. It is really easy to use. Here's how it works. The interface connects to your parallel printer port. TI uses this port for rapid transmission of data and it's very fast. The only drawback is if your PC has only a single parallel port and your printer needs the parallel port as well. You have to disconnect the interface if you want to use the printer. I made a cable extension to bring the port connection to the front of the computer instead of always trying to reach behind my computer to connect the interface or printer cable.

Once the interface is connected you type PCIF at the DOS prompt. Now your TI-74 has your IBM or compatible at its disposal. Each access device has a special number:

```
Computer parallel printer -------------   14
Computer screen -----------------------   45
Computer disk for program storage -----  100
Computer disk for data storage or
ASCII format for text editor ----------  101
```

Device "14" is for the parallel port if you have two ports. If not, all you do is save in an ASCII format and use a word processor program or anything similar to print to the printer. For example LIST "14.R=C" where R=C is the printer option would dump the entire program to the printer. You can limit the listing to certain line numbers with a command such as LIST "14.R=C",150-200 which will then print only lines 150 through 200. You can print output from a program as well.

Device "45" is for the computer monitor screen. You can use this to list program lines; for example LIST "45.P=Y" where P=Y is also an option. This stops the output when the screen is full until you press ENTER. You can also use device "45" in a program to move text from your program to the monitor. For example:

```
10 A$="TEXAS INSTRUMENTS, PC INTERFACE"
20 OPEN #2,"45.P=Y",VARIABLE 80, OUTPUT
30 PRINT A$
40 CLOSE #2
```

By changing the information inside the quotes in line 20 to "14.R=C" you would send the string to the printer if you had two ports on your PC.

Device "100" is used to store your programs to disk and also to retrieve them. SAVE "100.filename.xxx" is the basic option to save your programs where the filename.xxx portion of the statement would equal the name you give to your program with an extension. For example: SAVE "100.program.doc" stores a program. To retrieve the program you would enter OLD "100.program.doc" on your TI-74.

Device "101" is used for data storage and to save your program in ASCII format. When saved in ASCII format you can use a text editor to make changes or to print the program. You can also save data that the program produced while running. For example:

```
10 A$="TEXAS INSTRUMENTS, PC INTERFACE"
20 OPEN #2,"101.filename.xxx",VARIABLE 80,OUTPUT
30 PRINT #2,A$
40 CLOSE #2
```

will save A$ to the disk for storage. To retrieve it later use the program

Experience with the PC Interface Cable - (cont)

```
20 OPEN #2,"101.filename.xxx",VARIABLE 80,INPUT
30 INPUT #2,A$
35 PRINT A$
40 CLOSE #2
```

LIST "101.filename.xxx" would save it in the ASCII format for a word processor to read.

The nice part is that you can take any program written in, let's say GW-BASIC and run it on the TI-74. You have to change some things. For example, TI-BASIC doesn't use WHILE and WEND statements. These would have to be changed to IF-THEN-ELSE statements. First you need any of the programs in the ASCII format. You need to save the TI-74 programs by using LIST "101.filename.xxx". You need the TI program to convert it to a binary format for the TI-74 to read. When you save your text from the text editor you save it with B74 as the extension, i.e., as filename.B74 . Then at the DOS prompt you type TIC74 filename.B74 and the program does its thing and stores the new binary form as "filename.PGM". To retrieve this you type OLD "100.filename.PGM" on the TI-74 and presto you have a working program and you did not have to use the TI-74 keyboard to enter it. This also works for programs written in Pascal. You can also direct output to the computer screen for all of the software cartridges, i.e., Chemical Engineering, Finance, Mathematics, Statistics and Learn Pascal. In conclusion, the interface is a worth while piece of equipment for use with your TI-74 if you have an IBM compatible computer.

A PUZZLE - Dan Mahony. On the parallel sides of a river which is five miles wide are located the villages A and B. Village B is located 4 miles north of a point directly opposite village A. For a width of 3 miles on village A's side of the river the current flows south at 2 mph. The rest of the channel flows north at 5 mph. You can row your boat at 7 mph. You wish to row from A to B using a constant heading relative to north. What is that angle? What is the time of transit?

The heading is 56.4602... degrees.
The time of transit is 0.8569691599... hours,
or exactly $(25\sqrt{1993} - 80)/1209$ hours.

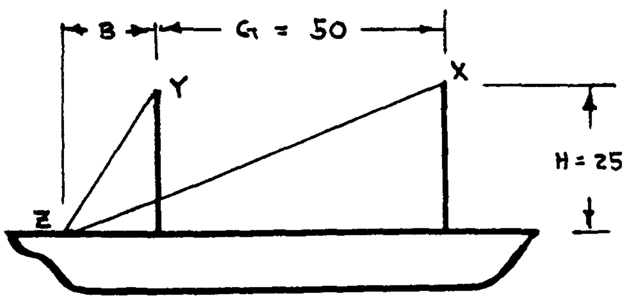
George Petersen notes that the time of transit should be able to be reduced if heading changes are allowed during the transit. He asks "What is the minimum time of transit?" Send your solution to the editor who will forward it to George.

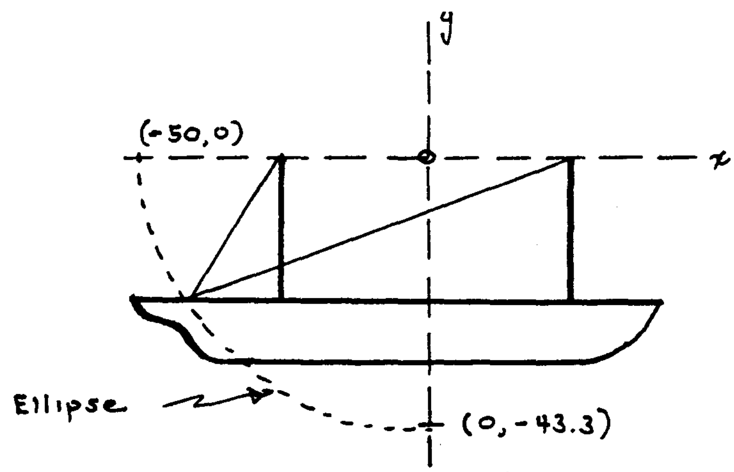
MORE ON PC-324 BATTERY USEAGE - V14N4P11 reported that the editor's PC-324 seemed to be a "battery eater". Members Greg Lind, Scott Garver and Bill Wilburn reported similar experience. They noted that since the PC-324 has no ON/OFF switch it is always in the ON state and there must be some power drain. I also found the following note at the bottom of page 4 of the *PC-324 User's Guide*:

> "We recommend that you use alkaline batteries in your printer. If non-alkaline batteries must be used, remove the batteries when you are not using the printer."

I wrote to TI for an interpretation. Tom Ferrio called to confirm a small drain when the printer is not is use. TI expects a set of alkaline batteries should last 6 to 12 months.

RIGGING A SHIP - Gordon Wichart. I found this problem in the Dover Publications book *Ingenious Math Problems and Methods* by L. A. Graham. The problem was originated by H. F. Spillner, Chief Engineer, Johnson & Jennings of Cleveland, Ohio. A 100 foot rope is stretched from the top of one mast (point x) to a point on the deck (point z) and back to the top of a second mast (point y). The distance between the masts is 50 feet and the height of the masts is 25 feet. The problem is to find the distance from the second mast to point z. From the figure below $(G + B)^2 + H^2 = (I - C)^2$ and $B^2 + H^2 = C^2$.





I solved the problem with the non-linear systems program in the TI-95 Mathematics Library using procedures similar to the solution to the ladder problem in V12N1P10. The listing for the subroutine functions is at the right. One thing I did differently was storing the knowns before starting. For the particular problem:

```
0000 LBL f1 (( RCL G +
0008 RCL B ) x^2 + RCL H
0015 x^2 -( RCL I -
0021 RCL C ) x^2 ) RTN
0027 LBL f2 ( RCL B x^2
0034 + RCL H x^2 - RCL C
0041 x^2 ) RTN
```

1. Store the knowns as 50 STO G, 25 STO H, 100 STO I.

2. Press RUN, press F3 (MTH), press F5 (-->), press F5 (-->), and press F4 (NON).

3. Enter 2, the number of expressions, and press F1 (n); enter .0000001 and press F2 (err); enter 8 and press F3 (#it); press F4 (EOD).

4. Enter 20 as an estimate for B (xo(1)) and press F1 (ENT); enter 35 as an estimate for C (xo(2)) and press F1 (ENT).

5. In response to the prompt EDIT? press F2 (NO). Note the RUN annunciator at the right side of the display.

6. After 37 seconds B is displayed as x1=15.82482905 .

7. Press F1 (NXT) and C is displayed as x2=29.58758548 .

The printout from the PC-324 appears at the right.

```
NONLINEAR SYSTEM

n=              2.
err=    0.0000001
#it=            8.

xo(1)=         20.
xo(2)=         35.

x1=   15.82482905
x2=   29.58758548
```

Editor's Note: There is another method of solution which yields an equation which can be easily solved. We start by recognizing that the definition of the problem is identical to the usual definition of an ellipse; for example, page 105 of my *Analytic Geometry* by Wilson and Tracey, (D.C. Heath, 1937) states "The ellipse is the locus of a point such that the sum of its distances from two fixed points is constant." The fixed points, X and Y, in the diagram of the problem are called foci. We are not particularly interested in their function other than to note that one of the axes of symmetry will pass through the foci, and the other will be the perpendicular bisector of the line segment between the foci.

Rigging A Ship - (cont)

The formula for an ellipse with its center at the origin of the coordinate system is

$$\frac{x^2}{a^2} \quad \frac{y^2}{b^2} = 1$$

where a and b are the semi-major and semi-minor axes of the ellipse. We can determine a and b by inspection from the diagram at the right on page 8 by

1. Pulling the rope tightly so that it lies along the x axis. The distance from the origin to the end of the string will be I/2 which is 50 feet for our problem. a^2 in the formula will be 2500 feet squared.

2. Pulling the rope tightly so that the end is on the y axis. The square of the distance from the origin to the end of the string will be $b^2 = (I/2)^2 - (G/2)^2$ which is 1875 feet squared. The distance is not needed to solve the problem.

The distance B in the problem is the difference between the x coordinate of the ellipse when y = -25 and half of the distance between the masts. Substituting in the equation and doing a little arithmetic yields an x coordinate of exactly $(50\sqrt{6})/3$. The distance B is then 15.82482905 ... .

MORE MEMBER LISTINGS

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TI-95, diagramatic puzzles

RECENT TI-95 PRICES - Page 34 of the October 1991 DAMARK catalog offers a TI-95 together with the Statistics and Chemical Engineering cartridges for $59.99 plus $6.50 shipping and handling, where shipping is normally by UPS. Ask for Item No. B-477-183604. Write to 7101 Winnetka Ave. N., P. O. Box 29900, Mineapolis MN 55429-0900 or call 1-800-729-9000.

EduCALC Catalog #52 offers a TI-95 for $49.95 where you must also buy at least one of the cartridges (Mathematics, Statistics or Chemical Engineering) which are offered at $5.00 each. Shipping and handling is $2.00 for regular mail with two week delivery, or $5.00 for UPS. Write to 27953 Cabot Road, Laguna Niguel CA 92677 or call 1-800-677-7001.

Thus, the cost for the package of a TI-95 with the Statistics and Chemical Engineering cartridges, and shipped by UPS is $66.49 from DAMARK and $64.95 from EduCALC. Furthermore, your have other options with EduCALC such as (1) saving $3.00 if you aren't in a hurry, (2) saving $5.00 if you are only interested in one of the cartridges, (3) obtaining the Mathematics cartridge, etc. Thus, if EduCALC can fill your order there seems to be no good reason to order from DAMARK.

The TI-95 Utilities Cartridge

In the beginning of '82 I joined PPC Notes, and shortly afterwards both Maurice and later Palmer started receiving long letters. Quite a lot of what I sent them during the past almost 10 years has never seen the light, probably because it was too sophisticated(?)

However, now that TI PPC Notes is going to be discontinued, I will give those of you that are really devoted to the TI-95 one last chance to obtain the best program ever written for it, "The TI-95 Utilities Cartridge".

POH has already mentioned it in an earlier issue, but to remind you what it is, it is an almost 8Kb long TMS 7000 assembly language routine, that, once loaded into a RAM cartridge, will add more than 30 new functions to the TI-95.

Those functions include:

OFF - saves the entire machine state	LRN - but with a twist
CP> - CP from the current step	DFA - create DFA without ASM
BKU - a complete backup system for use with the PC Interface	
CRC - the ultimate checksum	IAS - INV ASM, but without bugs
GTL - LL like lister for GTL/GTO	SBL - LL like lister for SBL/SBR
DFN - LL like lister for DFN/DFA	CMS - a nnn.sss register clearer
LR - but with many new features	SHL - a very fast Shell sort
MRF - merge files to end of PGM	REN - rename files in MEM
CJ - date to number (ML-20)	JC - number to date
NOR - normal distribution	INO - inverse normal distribution
SFF - a really fast PF replacement	UCD - to UnCD MEM
ENT - mathematical integer	MOD - calculates X mod T
POL - polynomial evaluator (ML-08)	SGN - a true -1/ 0 /+1 sign function
CHR - redefine CHR 000..004	MRX - a combined MRG FIX
SQR - square roots up to 2500 digits	X! - factorials up to 1000!
DOW - SBA 600 creator (????)	EXE - execute MEM based SBA 600s
REX - access the keystroke coded ROM functions	
ROM - transfer any memory to PGM	POP - change SBR into GTO
R-B - RTN or BRK (TI-59's RTN)	RPO - restore pending operations
SBR - print SBR stack	SPO - save pending operations
STU - system alpha to user alpha	

In other words, I'm talking about several hundred hours of blood, sweat and tears, not to mention dozens of "MEMORY CLEARED"s, which I'm now offering to everyone interested, be it in an unfinished state - the program itself is bug-free, but the documentation is not up to standard, everything is there, but it may take some time to find it.... Also, it is a virtual necessity to own a PC Interface, as loading more than 7000 bytes manually, even with the supplied loader program, is almost impossible.

Everything is supplied on a 3 1/2" 720K floppy, including some other goodies, such as a routine to turn an 8K RAM into 1000 directly (through SBA 00x!) addressable registers, with full register arithmetic, an improved and highly optimized version of TIs PCL PC Interface interface program, supporting 32K cartridges, my own copies of the disassembled and extensively commented TI-95 ROMs and even a TMS 7000 disassembler, so that you can disassemble my code. I will even include some useful source code. (For an additional sum, I will even throw in the complete and fully commented source, be it in assembled format!)

Sofar for the description, if you're still interested, then

- send me 3 one-dollar bills, and I will send a copy of complete dialog as contained in the system, longer descriptions of all functions, and the contents of the disk you can order, OR

- you can order it directly by sending me

  o For the normal package (= limited source):
  $25.- + p&p (Registered Airmail, so about $30.- in total)

  o For the power-user package (= full source, but in assembled format):
  $60.- + p&p (Registered Airmail, so about $65.- in total)

  These last two options also include unlimited technical support.

Payments either cash, or by INTERNATIONAL POSTAL MONEY ORDER with the equivalent in Dutch guilders.

Send all further enquiries to: Robert AH Prins
A Nobelln 112
3731 DX DE BILT
NETHERLANDS

However, as I'm currently living in the UK, there might be some delay in both answering your letters and shipping the software.

DATAFILE V10N2 : Published by the HANDHELD AND PORTABLE COMPUTER CLUB, 42 Heathfield Rd, London, W3 8EJ & printed by the Kemble Press Ltd, Bodicote, Banbury, Oxon, with a print run of 300 & a target of 8 issues annually.

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FOR 1991	£25.00	£27.00	£29.00	£31.00	£33.00	£35.00
Apr-Dec	£19.00	£20.00	£21.00	£24.00	£25.00	£26.00
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DATAFILE EXISTS SOLELY DUE TO YOUR CONTRIBUTIONS - SO KEEP THEM COMING! ALL SUBMISSIONS OF MATERIAL ARE WELCOME AND SHOULD BE SENT TO THE EDITOR. Please use the following guidelines whenever possible.

1. Use black type wherever possible, even for Program Listings.

2. All material is assembled into A4 'master' pages. Use either one 170mm wide column of <= 80 characters or two 80mm wide columns of <= 38 characters separated by a 10mm/4 character gap. The maximum page length is 255mm, at <= 6 lines per inch. Drawings & diagrams in black INK please.

3. Submit the master - Remember to keep a copy for yourself.

4. HP41 programs should always be submitted on magnetic media. If you use ROM subroutines please identify & LIST them, as some members may not have the appropriate ROM & would not be able to use the program otherwise. Remember that some members are more expert than others, so explain your program's construction & function. Please explain synthetic functions & text & include their decimal codes. Remember that worked examples are ALWAYS valuable.

5. Submit PROGRAMS & TEXT on MAGNETIC MEDIA whenever possible. It makes the work of preparation for the printer much easier. All cards, discs or cassettes will be returned to the author. Textfiles should be pure ASCII, in HP or IBM format, on 3.5" or 5.25" discs. Other formats should only be used by prior arrangement with the Editor.

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A MEETING is held on the 2nd Saturday of each month in the Physics Common Room of Imperial College, Prince Consort Rd, London SW7, commencing about 1330 hrs.

DATAFILE

MARCH **V10N2**

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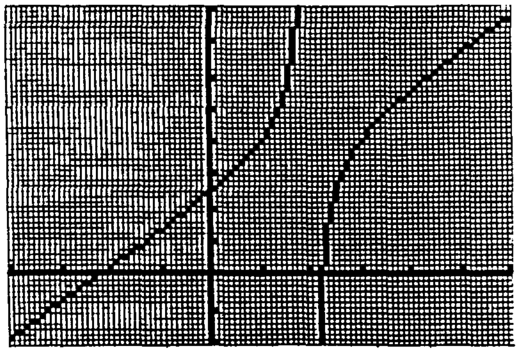
THE LAST OF THE NEWSLETTERS?

GRAPHING ON THE TI-81 and fx-7000G - Timothy Baumgartner writes: I wanted to demonstrate a function which was discontinuous at a single point for my pre-calculus class. Consider the function

$$y = f(x) = (x^2 - 4)/(x - 2)$$

which is not defined when x = 2. Otherwise the graph of the function should be that of the line y = x + 2. When graphed on the TI-81's standard viewing window the gap is apparent since x = 2 happens to be one of the horizontal coordinates. For the fx-7000G the sequence Range Shift Delete will give the default viewing window which must be modified to Ymin = -1.1 and Ymax = 5.1 to see the gap in the graph. I like the way the gap shows up--it is a great motivator of class discussion."

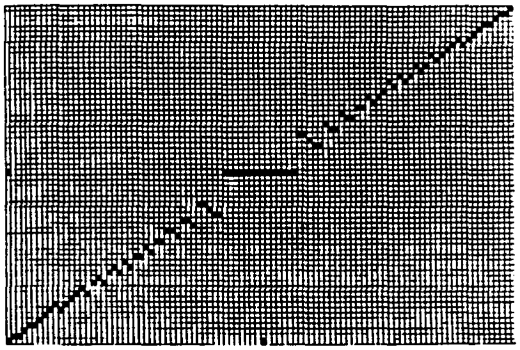


Editor's Note: The example above is one of those discontinuous functions that mathematicians love, but which I find to be somewhat contrived. What first year algebra student wouldn't factor the numerator and divide by the denominator to yield the linear function y = x + 2 ? The figure at the right is an example of a more typical discontinuity which occurs with the function

$$y = (x^2 - 5)/(x - 2).$$

Timothy's discussion of the $(x^2 - 4)/(x - 2)$ function continued: " ... One of my students, Duke Zupanski, used his TI-81 to zoom in on the discontinuity at (2,4) and found a strange result. He set the range screen to show:

```
xmin=1.999995        ymin=3.999995
xmax=2.000005        ymax=4.000005
xscl=1               yscl=1
```



and then put the calculator in the dot mode (rather than connected mode). The behaviour of the graph [at the right] was anything but linear! I was guessing when I told my students that this had something to do with round-off error, and assured them that the graph should appear linear except for the missing point at (2,4). My question here is: Is this due to round-off error for these values close to x = 2, or is there some other factor I am not aware of?"

Editor's Note: An immediate indication that the non-linearity is associated with the calculations can be obtained by graphing the function

$$((x + 2)(x - 2))/(x - 2)$$

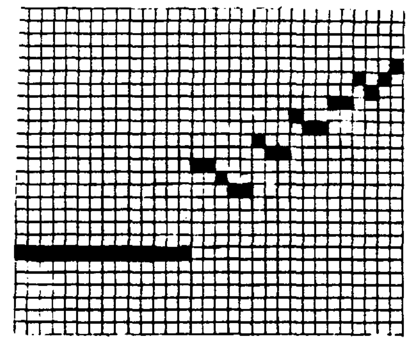
which is algebraically equivalent. The non-linearity does not appear. We will show that the problem with the version of the function which uses $(x^2 - 4)$ in the numerator is induced by the roundoff which occurs after the value of x is squared. To do so we eventually have to determine the values to be plotted to the full acccuracy carried internally in the calculator; i.e., thirteen digits as described on page B-3 of the *TI-81 Graphics Calculator Guidebook*. How do we do this? Consider the pi function. It is displayed on the screen to ten digits as 3.141592654, but page 2-2 of the guidebook states that the number 3.1415926539 is used in calculations. We can determine the additional digits for ourselves by entering the expression $100(\pi - 3.14)$ and seeing the value .15926359 in the display. Similarly, if we calculate the value of e by entering the expression e^1 we see the ten digits 2.718281828 in the display, but by entering 100(e^1 - 2.71) we can determine that the thirteen digit value in the calculator is 2.718281828459.

Graphing on the TI-81 and fx-7000G - (cont)

Additional roundoff appears in the display of the graphed values in TRACE mode. With the $(x^2 - 4)/(x - 2)$ function entered as Y1, and with Zupanski's range values press GRAPH TRACE and then press the right arrow seven times. The trace indicator should be on the first point which is not on the short horizontal line at the center of the display. The coordinates are displayed at the bottom of the screen to eight digits. The exact values of x and the function are available from the X and Y variables. The following table compares the three pairs of values which can be obtained depending upon the method of readout:

	X	Y
From the TRACE readout	2.0000008	4.0000013
X and Y variables from the display	2.000000789	4.000001267
Internal values	2.000000789474	4.000001266666

Using these techniques I read out the x and y values to thirteen digits for the $(x^2-4)/(x-2)$ function over one of the more non-linear portions of the plot, the set of seven points starting at the right hand end of the short horizontal line at the center of the display. (You can get to that point by pressing GRAPH TRACE and then pressing the right arrow six times.) A magnified view of that portion of the display appears at the right. I also read out the corresponding y values for the function ((x-2)(x+2))/(x-2). The results are in the following table:



x	$(x^2-4)/(x-2)$	((x-2)(x+2))/(x-2)
2.000000684211	4.	4.000000684211
2.000000789474	4.000001266666	4.000000789474
2.000000894737	4.000001117647	4.000000894737
2.000001	4.000001	4.000001
2.000001105263	4.000000904762	4.000001105263
2.000001210526	4.000000826870	4.000001210526
2.000001315789	4.000001520001	4.000001315789

The x values increase in value monotonically. The difference between adjacent x values is, as expected, (xmax - x min)/95 = 0.000000105263 where 95 is the number of x axis increments. For the ((x-2)(x+2))/(x-2) function the y values in the right hand column also increase monotonically and are exactly 2 greater than the x values, as would be expected with a linear function. But, for the $(x^2-4)/(x-2)$ function the y values decrease monotonically from the second through the sixth points, and show larger positive steps from the first to the second and from the sixth to the seventh points. This confirms the non-linearity seen in the graph, but with more precision.

The differences between the values for the function $(x^2- 4)/(x-2)$ and the nearly exact values for the function ((x-2)(x+2))/(x-2) begin at the seventh significant figure. To see why that occurs consider the calculation of the numerator (x^2-4) for the second x value in the table, 2.000000789474. The exact square of that value is 4.000003157896 623269196676 where the gap in the number is after the thirteenth significant figure. Since the TI-81 carries only thirteen significant figures it rounds that square to 4.000003157897 . Then, when the 4 is subtracted, the remaining value is 0.000003157897 which includes only seven significant figures, and where the last significant figure is higher than the exact value due to the rounding in the calculator. That is consistent with the difference between the two function values in the table.

Graphing on the TI-81 and fx-7000G - (cont)

As an exercise, you should convince yourself that the specific characteristics of the graph are consistent with the function values as read from the Y variable. You should also convince yourself that the rounding which occurs in the x-squared values is consistent with the resulting function values which are in the Y variable. To assist you with that I have included a table which presents the exact x-squared values for the seven x values which appear in the table on page 13:

x	x^2
2.000000684211	4.000002736844 468144692521
2.000000789474	4.000003157896 623269196676
2.000000894737	4.000003578948 800554299169
2.000001	4.000004000001 000001
2.000001105263	4.000004421053 221606299169
2.000001210526	4.000004842105 465373196676
2.000001315789	4.000005263157 731300692521

"Hamming's Law of logarithms" - Charlie Williamson called my attention to the interesting observation that the logarithm to the base 2 of a number is equal to the sum of the natural logarithm of the number and base 10 logarithm of the number, within one per cent. Charlie noted that Volume 1 of Knuth's *The Art of Computer Programming* ascribes the observation to Hamming, but that he had personal correspondence suggesting that Hamming may not have been the originator. I looked in my copy of Knuth's book. I found no reference to Hamming! After some additional correspondence we realized that, in the first edition, which Charlie uses, Exercise 22 on page 25 states:

22. [20] Prove "Hamming's law of logarithms":

$$\log_2 x \approx \ln x + \log_{10} x,$$

with less than 1% error! (Thus a table of natural logarithms and of common logarithms can be used to get approximate values of binary logarithms as well.)

But, in the second edition, which the editor uses, the problem begins as:

22. [20] Prove that

$$\lg x \approx \ln x + \log_{10} x, \quad \ldots$$

where we note that the reference to Hamming has been deleted and the notation lg x is introduced for the binary logarithm. Of course, the mystery is, if Hamming wasn't the source of the relationship, then who was?

REPAIR OF TI-74/TI-95 PERIPHERALS - P. Hanson. I had a still unexplained double failure of both my CI-7 Cassette Interface and PC-324 Printer. I called 1-800-TI-CARES for repair information. Repair service is not available for the CI-7 so I ordered a replacement from EduCALC for $26.95 plus $2.00 for shipping. Repair service is available for the PC-324. The cost is $45.50 plus state sales tax plus $4.00 for shipping and handling, substantially less than the $89.95 listed for a new unit in the EduCALC catalog. TI reserves the right to either repair the returned unit or to replace it with a reconditioned unit. I shipped my defective unit on October 2 and received a reconditioned unit on October 22.

DISTANCE FROM A POINT TO A PLANE FOR THE TI-95 - W. Wilburn

This program finds the perpendicular distance from a plane defined by three points to a fourth point. When the plane is defined by the equation

$$Ax + By + Cz + D = 0$$

the distance to a point (x,) is found from the equation

$$d = \frac{(Ax_1 + By_1 + Cz_1 + D)}{\sqrt{A^2 + B^2 + C^2}}$$

The coefficients for the equation of the plane are obtained by solving the three linear equations which result when the equation for the plane is evaluated at the three points. The linear equations are solved using similar methodology to that used in the sphere through four points program on V14N1P10, where the solution assumes that the linear equations program from V14N1P8 is available to be called as a subprogram. A program listing and sample solutions appear at the right.

```
0000 FIX 4 `3 PT PLN-PT`
0013 ` DIST ` PRT BRK
0021 ADV CLR `ENTER PLA`
0032 `NE PTS,` PAU PAU
0041 CMS 3 STO A 49
0047 STO B 50 STO C
0053 LBL AA 3 STO D 88
0061 STO E
0063 LBL AB CLR
0067 CHR IND E CHR IND B
0073 `?` BRK STO IND C
0078 CHR IND E CHR IND B
0084 COL 16 MRG = PRT
0089 INC C INC E DSZ D
0095 GTL AB 1 STO IND C
0102 1 ST+ C INC B ADV
0108 DSZ A GTL AA 1
0114 EXC 050 +/- STO 053
0121 1 EXC 054 +/-
0126 STO 057 1 EXC 058
0133 +/- STO 061 39
0139 STO A CLR
0142 LBL EE STO IND A
0148 DSZ A GTL EE CLR
0154 SF 01 50 STO A 3
0161 +/- `V12LIN` RUN
0169 SBL XX CLR
0173 LBL WW CLR ADV `X4`
0180 `?` BRK PRT STO 100
0186 CLR `Y4?` BRK PRT
0192 STO 101 CLR `Z4?`
0199 BRK PRT STO 102 CLR
0205 1 STO 103 RCL L x^2
0212 ST+ 103 RCL M x^2
0218 ST+ 103 RCL 103 SQR
0225 STO 103 RCL 100 +
0232 RCL L * RCL 101 +
0239 RCL M * RCL 102 +
0246 RCL K =/ RCL 103 =
0254 `DIS=` COL 16 MRG =
0262 PRT BRK CLR `NEW P`
0270 `OINT/DIS?` Y/N
0280 GTL WW CLR DFN CLR
0286 `END` HLT
```

Comments on the program:

Steps 0021-0136 provide for entry of the three points which are used to define the plane. The original mechanization defined D = -1. That precluded the use of the origin as one of the input points as discussed in more detail in the documention for the ellipse through five point program in V14N2P17. Steps 0113-0136 relocate the input data such that A=1, but to simplify the process the location of the coefficients of the solution are changed from the sequence BCD to DBC.

Steps 0137-0171 set up the problem for solution by the linear equations subprogram and call the subprogram. In this mechanization the subprogram is assumed to be stored as MEM in a module defined as V12. If you have the subprogram stored in user memory as LIN then the call in steps 0162-0167 would be MEMLIN.

Steps 0172-0204 provide for entry of the point for which the distance from the plane is desired. Steps 0205-0263 solve the equation for the distance from the point to the plane and display the results. Remember that A = 1 by definition and that data registers K through M contain the coefficients of the plane in the order DBC.

Steps 0264-0282 provide for finding the distance from the plane other points.

```
3 PT PLN-PT DIST

X1        21.8193
Y1         9.0628
Z1         0.0000

X2        26.3223
Y2         4.3818
Z2         0.3032

X3        21.8490
Y3         1.0353
Z3         0.7396

          24.9865
           3.0453
           3.4787
DIS=       3.0001
```

```
3 PT PLN-PT DIST

X1         0.0000
Y1         0.0000
Z1         0.0000

X2        -1.0000
Y2         2.0000
Z2         3.0000

X3         2.5000
Y3         4.0000
Z3         7.0000

           1.0000
           1.0000
           1.0000
DIS=       0.4365
```

```
3 PT PLN-PT DIST

X1         1.0000
Y1         2.0000
Z1         2.0000

X2         0.0000
Y2         0.0000
Z2         0.0000

X3        -1.0000
Y3         4.0000
Z3         4.0000

ERROR FLAG SET
```

<u>AVAILABILITY OF PUBLICATIONS</u> - Even though this is the final issue of our newsletter I will continue to provide back issues and other publications through mid-1992. The material that will be available includes:

Back Issues:

V5 (1980, 146 pages)	$ 20.00	V10 (1985, 104 pages)	$ 16.00
V6 (1981, 152 pages)	20.00	V11 (1986, 102 pages)	16.00
V7 (1982, 154 pages)	10.00	V12 (1987, 104 pages)	16.00
V8 (1983, 168 pages)	10.00	V13 (1988/9, 114 pages)	16.00
V9 (1984, 150 pages)	20.00	V14 (1990/1, 108 pages)	16.00

The lower price for the V8 and V9 issues is due to the availability of a limited number of complete sets of the original printing where printing costs were lower due to the large number of copies made. For the remaining years some issues are out of print and copies will be made only in response to requests so the printing costs will be higher. Masters are not available for the V5 and V6 issues so some degradation in legibility must be accepted.

Compilations:

For owners of the TI-74, CC-40, TI-95 and fx-7000G who may not be interested in material about other devices we offer compilations from back issues. We also offer a compilation of material on TI-59 and PC-100 test and repair. Add one dollar per compilation for delivery overseas.

CC-40 Compilation from Volumes 8 and 9, 26 pages	$ 5.00
CC-40 Compilation from Volume 10, 16 pages	4.00
CC-40/TI-74 Compilation from Volume 11, 25 pages	5.00
TI-74/CC-40 Compilation from Volume 12, 32 pages	6.00
TI-74/CC-40 Compilation from Volume 13, 44 pages	8.00
TI-95 Compilation from Volume 11, 18 pages	4.00
TI-95 Compilation from Volume 12, 32 pages	6.00
TI-95 Compilation from Volume 13, 30 pages	6.00
Casio fx-7000G Compilation, 17 pages	4.00
TI-59 and PC-100 Test and Repair Compilation, 24 pages	5.00

We also still have several copies of the listing and flowchart of the TI-95 mathematics cartridge as developed by SeTIC. You can obtain a copy for eight dollars. No additional copies will be printed - first come, first served.

<u>TI-59 MAGNETIC CARDS</u> - I also have two boxes of magnetic cards for the TI-59. The boxes contain forty magnetic cards and a carrying case. Send eight dollars per box. First come, first served.

FUNCTION ANALYSIS ON THE TI-95 - Richard Skarda. V14N2P23 reported the receipt of a function analysis program which provided:

A plotting capability.

Calculation of first and second derivatives at a selected point.

Trapezoidal rule, Simpson's rule, Romberg, and Gauss Legendre quadrature integration.

A routine to calculate the data base for the Gauss Legendre integration.

Neither a detailed program description nor a program listing was published at that time. Several members did take advantage of an offer to obtain preliminary documentation of the program together with a magnetic tape. A complete program listing appears on pages 18 and 19. Detailed documentation including sample outputs follow.

Program Description

Given a function HX the program can calculate the first and second derivatives at given points, and can calculate the definite integral using the trapezoidal rule, Simpson's rule, Romberg integration, or Gauss Legendre quadrature. The Gauss Legendre quadrature routine is capable of using n = 2, 4, 8, 16, 32, 64, 128, 256 or 512 points. It is also capable of dividing the domain into m panels and integrating each panel with n points. Other options include a subprogram "Evaluation" which calculates a series of values of the function which could be used for a hand plot, and another subprogram "Plot" which plots the function on the PC-324. Finally, a subprogram "Generator" calculates the data base, the abscissas and weight factors, used by the Gauss solution. The data base is stored in an 8K Constant Memory cartridge, and uses almost all of the cartridge.

Installing the Program

To place the complete program in operation, install a 8K Constant Memory cartridge and clear the directory of MEM and the cartridge, clear the memories, and program. Set the partitioning to 0 file space, 584 registers, and 2528 program steps. Enter the program.

Editor's Note: The instructions above provide for implementation of the full capability of the function analysis program. However, a potential user can get a feel for the capability of the program without committing the entire user memory (MEM) and an 8K RAM. In fact, that is all that the editor has done to date. First, set the partitioning for 2400 program steps and enter the program. Second, set the number of data registers to as large a value as possible depending upon the amount of file space tied up with other programs, but not less than 150. Third, change the STO 540 at program steps 0962-0963 to STO XYZ where XYZ is consistent with the number of data registers which are available, and also change the 540 at program steps 1043-1045 to XYZ. Fourth, run the Generator program (described below) for a short period of time (a few minutes will do) to calculate and store the values needed by the Gauss Legendre integration. Fifth, proceed to exercise the various options, but remember that the Gauss Legendre integration is limited to the use of smaller values of n (with 150 registers you can use values of n up to 32), and the number of iterations with the Romberg integration will be limited by the XYZ value. Finally, remember to return the XYZ values to 540 if you want to restore full capability of the program.

Function Analysis on the TI-95 - (cont)

```
0000 LBL AA
0003 DFN F1:Dif@BA
0010 DFN F2:Trp@CA
0017 DFN F3:Sim@DA
0024 DFN F4:Rom@EA
0031 DFN F5:-->@AB `Fun`
0041 `ction Analys.` HLT
0055 LBL AB
0058 DFN F1:Gau@FA
0065 DFN F2:Dat@GA
0072 DFN F3:Evl@HA
0079 DFN F4:Plt@HB
0086 DFN F5:-->@AA
0093 COL 01 HLT
0096 LBL BA CLR `Differ`
0106 `entiation ` PRT
0117 DFN F1:A-h@BB
0124 DFN F2: h @BC
0131 DFN F3: x @BD
0138 DFN F4:1st@BE
0145 DFN F5:2nd@BF HLT
0153 LBL BB SF 00 HLT
0159 LBL BC ABS STO H
0165 RF 00 HLT
0168 LBL BD STO A ABS
0174 STO B TF 00 GTL BH
0181 LBL BG RCL A +
0187 RCL H = SBL HX
0193 STO C RCL A - RCL H
0200 = SBL HX STO D `x=`
0208 COL 16 MRG A PRT
0213 CLR `h=` COL 16
0218 MRG H PRT HLT
0222 LBL BE RCL C -
0228 RCL D =/2/ RCL H =
0237 STO E `D'=` COL 16
0244 MRG E PRT HLT
0248 LBL BF RCL A SBL HX
0256 *2= +/- + RCL C +
0264 RCL D =/ RCL H x^2
0271 = STO F `D"=`
0277 COL 16 MRG F PRT
0282 HLT
0283 LBL BH .01 IF< B
0291 GTL BI .00001 STO H
0302 GTL BG
0305 LBL BI RCL B /1000=
0316 STO H GTL BG
0321 LBL CA CLR `Trapez`
0331 `oidal Rule` PRT
0342 DFN F1: a @CB
0349 DFN F2: b @CC
0356 DFN F3: n @CD
0363 DFN F4:I= @CE
0370 DFN F5:13d@CF HLT
0378 LBL CB STO A `a=`
0385 COL 16 MRG A PRT
0390 RTN
0391 LBL CC STO B `b=`
0398 COL 16 MRG B PRT
0403 RTN
0404 LBL CD STO N FRC
0410 STO C 0 INV IF= C
0416 GTL CH C INV IF< N
0423 GTL CH SBL CI HLT
0430 LBL CE RCL B -
0436 RCL A STO C =/
0442 RCL N = STO D RCL A
0449 SBL HX STO E RCL B
0456 SBL HX ST+ E 2
0462 ST/ E 1 IF= N
0467 GTL CJ RCL N -1=
0475 STO F
0477 LBL CG RCL D ST+ C
0484 RCL C SBL HX ST+ E
0491 DSZ F GTL CG RCL E
0498 * RCL D = SBL CK
0505 HLT
0506 LBL CF 1 STO V HLT
0513 LBL CH `n must be `
0526 `a positive intege`
0543 `r` PRT HLT
0546 LBL CI `n=` COL 16
0553 MRG N PRT RTN
0557 LBL CJ RCL E *
0563 RCL D = SBL CK HLT
0570 LBL CK STO I `I=`
0577 COL 16 MRG I PRT 1
0583 IF= V SBL CL RCL I
0590 RTN
0591 LBL CL RCL I 13d
0597 PRT RTN
0599 LBL DA CLR ` Simps`
0609 `on's Rule` PRT
0619 DFN F1: a @CB
0626 DFN F2: b @CC
0633 DFN F3:2n @DB
0640 DFN F4:I= @DC
0647 DFN F5:13d@CF HLT
0655 LBL DB STO C FRC
0661 STO D 0 INV IF= D
0667 GTL DE 1 IF> C
0673 GTL DE RCL C /2=
0681 STO D FRC STO E .5
0688 IF= E GTL DE `2n=`
0696 COL 16 MRG C PRT
0701 HLT
0702 LBL DC RCL B -
0708 RCL A STO E =/
0714 RCL C = STO F RCL A
0721 SBL HX STO G RCL B
0728 SBL HX ST+ G RCL B
0735 - RCL F = SBL HX *4
0744 = ST+ G 2 IF= C
0750 GTL DF 0 STO H
0756 STO J RCL D -1=
0763 STO K
0765 LBL DD RCL F ST+ E
0772 RCL E SBL HX ST+ H
0779 RCL F ST+ E RCL E
0785 SBL HX ST+ J DSZ K
0792 GTL DD RCL H *4+
0800 RCL J *2= ST+ G
0807 GTL DF
0810 LBL DE `2n must be`
0823 ` an even positive`
0840 ` integer.` PRT HLT
0851 LBL DF RCL G *
0857 RCL F /3= SBL CK
0865 HLT
0866 LBL EA CLR `Romber`
0876 `g Integr.` PRT 1
0887 STO V OLD DFN CLR
0892 DFN F1: a @CB
0899 DFN F2: b @CC
0906 DFN F3:I= @EB
0913 DFN F4:HX=@EF HLT
0921 LBL EB RCL B -
0927 RCL A = STO C 0
0933 STO D 1 STO E RCL A
0940 SBL HX STO F RCL B
0947 SBL HX ST+ F RCL F
0954 * RCL C /2= STO G
0962 STO 540 `I1=`
0968 COL 16 MRG G PRT 42
0975 STO H
0977 LBL EC INC D RCL E
0984 STO J 2 ST* E 0
0990 STO F
0992 LBL ED 2* RCL J -1=
1002 / RCL E * RCL C +
1009 RCL A = SBL HX
1015 ST+ F DSZ J GTL ED
1022 2 ST/ G RCL F *
1028 RCL C / RCL E =
1034 ST+ G RCL D STO K 1
1041 STO L 540 STO M
1048 RCL G
1050 LBL EE EXC IND M -4
1058 y^x RCL L *
1062 RCL IND M =/(1-4
1071 y^x RCL L )= INC L
1078 INC M DSZ K GTL EE
1085 STO IND M SBL CK
1091 DSZ H GTL EC `j=43`
1100 PRT HLT
1102 LBL EF STO X `X=`
1109 COL 16 MRG X PRT
1114 RCL X SBL HX `HX=`
1122 COL 16 MRG = PRT
1127 RTN
1128 LBL FA CLR 1 STO M
1135 `Gauss Quadrature`
1151 PRT
```

Function Analysis on the TI-95 - (cont)

```
1152 LBL FB
1155 DFN F1: a @CB
1162 DFN F2: b @CC
1169 DFN F3: n @FC
1176 DFN F4: m @FD
1183 DFN F5:I= @FE HLT
1191 LBL FC STO N STO D
1198 2 IF= N GTL FF 4
1205 IF= N GTL FH 8
1211 IF= N GTL FH 16
1218 IF= N GTL FH 32
1225 IF= N GTL FH 64
1232 IF= N GTL FH 128
1240 IF= N GTL FH 256
1248 IF= N GTL FH 512
1256 IF= N GTL FG `n mu`
1265 `st e4ual 2,4,8,16`
1282 `,32,64,128,256,or`
1299 ` 512.` PRT GTL FB
1308 LBL FF 26 STO D
1315 SBL CI GTL FB
1321 LBL FG 28 STO D 0
1329 IF= W SBL FI SBL CI
1337 GTL FB
1340 LBL FH 24 ST+ D 1
1348 IF= W SBL FJ SBL CI
1356 GTL FB
1359 LBL FI 028 INV
1366 GET +D2 1 STO W RTN
1374 LBL FJ 028 INV
1381 GET +D1 0 STO W RTN
1389 LBL FD STO M FRC
1395 STO E 0 INV IF= E
1401 GTL FK 0 INV IF< M
1408 GTL FK `m=` COL 16
1415 MRG M PRT GTL FB
1421 LBL FK `m must be `
1434 `a positive inte9e`
1451 `r` PRT GTL FB
1456 LBL FE 0 STO I
1462 RCL B - RCL A STO E
1469 =/ RCL M STO F =
1476 STO G + RCL A =
1482 STO H RCL G /2=
1489 STO J RCL N /2=
1496 STO K
1498 LBL FL RCL D STO L
1505 RCL K STO O
1509 LBL FM RCL IND L
1515 INC L * RCL J =
1521 STO P RCL E + RCL H
1528 =/2= STO Q + RCL P
1537 = SBL HX STO R
1543 RCL Q - RCL P =
1549 SBL HX + RCL R =*
1557 RCL IND L INC L =
1563 ST+ I DSZ O GTL FM
1570 RCL G ST+ E ST+ H
1576 DSZ F GTL FL RCL J
1583 * RCL I = SBL CK
1590 HLT
1591 LBL GA CLR DFN CLR
1597 DFN F1:Gen@GB `Gen`
1607 ` re4uires 37hrs. `
1624 `and 43 mins. It s`
1641 `ets calculator to`
1658 ` radians.` PRT HLT
1669 LBL GB CLR 1 STO A
1676 2 STO B 3 STO P
1682 STO Q STO R STO S
1688 STO T 4 STO L STO M
1695 STO N STO O 9 STO C
1702 11 STO D 26 STO E
1710 INV DRG DRG
1713 LBL GC 1 STO F
1719 LBL GD RCL F *4-1=*
1730 PI /(4* RCL B +2)=
1741 STO G +( RCL B -1)/
1751 8/( RCL B y^x 3)/(
1761 RCL G TAN )= COS
1767 STO G RCL IND D
1772 STO H
1774 LBL GE RCL B STO I
1781 0 STO J 1 STO K
1787 LBL GF * RCL K +
1794 RCL G * RCL J =
1800 EXC J +/- + RCL G *
1807 RCL J =/ RCL K =
1814 INC K DSZ I GTL GF
1821 / RCL J = ST- G
1827 DSZ H GTL GE RCL G
1834 STO IND E INC E x^2
1840 -1= 1/x *2/ RCL J
1849 x^2 = +/- STO IND E
1855 INC E INC F DSZ A
1861 GTL GD 2 IF= C
1867 SBL GG RCL B STO A
1874 INC D 2 ST* B DSZ C
1881 GTL GC 512.028 INV
1892 PUT +D2 PRT HLT
1898 LBL GG 508.028 INV
1909 PUT +D1 NAM GLQ 1
1918 STO W 28 STO E RTN
1925 LBL HA CLR `Evalua`
1935 `tion` PRT
1940 DFN F1:F-X@HD
1947 DFN F2:L-X@HE
1954 DFN F3:DEL@HF
1961 DFN F4:RUN@HG
1968 DFN F5:HX=@EF HLT
1976 LBL HD STO A `F-X`
1984 COL 16 MRG A PRT
1989 HLT
1990 LBL HE STO B `L-X`
1998 COL 16 MRG B PRT
2003 HLT
2004 LBL HF STO C `DEL`
2012 COL 16 MRG C PRT
2017 HLT
2018 LBL HG ADV RCL A
2024 STO D SBL EF
2029 LBL HH RCL D +
2035 RCL C = STO D
2040 SBL EF RCL D IF< B
2047 GTL HH HLT
2051 LBL HB CLR `Plot`
2059 PRT
2060 LBL HI
2063 DFN F1:MAX@HJ
2070 DFN F2:MIN@HK
2077 DFN F3:F-X@HL
2084 DFN F4:L-X@HM
2091 DFN F5:-->@HN HLT
2099 LBL HN
2102 DFN F1:DEL@HO
2109 DFN F2:RUN@HP
2116 DFN F3:HX=@EF
2123 DFN F4: * @HQ
2130 DFN F5:-->@HI HLT
2138 LBL HJ STO F 23.999
2149 9999999 STO G CLR
2159 `MAX` COL 16 MRG F
2166 PRT HLT
2168 LBL HK STO H `MIN`
2176 COL 16 MRG H PRT
2181 HLT
2182 LBL HL STO I `F-X`
2190 COL 16 MRG I PRT
2195 HLT
2196 LBL HM STO J `L-X`
2204 COL 16 MRG J PRT
2209 HLT
2210 LBL HO STO K `DEL`
2218 COL 16 MRG K PRT
2223 HLT
2224 LBL HP ADV CLR `**`
2231 `*****************`
2248 `*****` PRT RCL G /
2257 ( RCL F - RCL H )=
2265 STO L * RCL H = +/-
2272 +1= STO M RCL I
2279 STO N
2281 LBL HQ RCL N SBL HX
2289 * RCL L + RCL M =
2296 SBL HR RCL K ST+ N
2303 RCL N INV IF> J
2308 GTL HQ HLT
2312 LBL HR STO O
2317 COL IND O `*` PRT
2322 RTN
2323 LBL HX *10* PI =
2332 SIN /2+1= 1/x RTN
```

Function Analysis on the TI-95 - (cont)

If you plan to use the Gauss Legendre quadrature option you must run the Generator program to calculate the data base. The complete calculation requires 37 hours 43 minutes. You can test it by pressing RUN PGM --> Dat Gen. Wait a few minutes, press HALT and list the data registers starting with 026. Stop listing when you get to a string of zeroes or R060 and compare with the listing at the right. If the listing is OK restart the generator program and run until it prints "File +D2 SAVED" and stops. The weight factors Wi follow immediately after their Xi. There are a total of 1020 numbers stored in the 8K RAM under the name GLQ. File +D1 stores the data base for n=4 through 256. File +D2 stores the data base for n=512. Data registers 026 and 027 store the data base for n=2. The correct data file is brought into data registers when the user enters the value of n in the Gauss program.

Gen requires 37hrs. and 43 mins. It sets calculator to radians.

026	.5773502692
027	1.
028	.8611363116
029	.3478548451
030	.3399810436
031	.6521451549
032	.9602898565
033	.1012285363
034	.7966664774
035	.2223810345
036	.5255324099
037	.3137066459
038	.1834346425
039	.3626837834
040	0.989400935
041	.0271524594
042	.9445750231
043	.0622535239
044	.8656312024
045	.0951585117
046	.7554044084
047	.1246289713
048	.6178762444
049	.1495959888
050	.4580167777
051	.1691565194
052	.2816035508
053	0.182603415
054	.0950125098
055	.1894506105
056	.9972638618
057	0.00701861
058	.9856115115
059	.0162743947
060	.9647622556

Function Definition

The function to be evaluated must be entered as a subroutine which starts with LBL HX and ends with RTN. Press 2nd GTL HX LRN F2 (PC) and enter the function. The current value of X will be in the display register when subroutine HX is called from the main program.. You may use = in your routine. Be sure to select radians, degrees or grads as needed for any trigonometric functions. A sample HX subroutine for the function $x^3 - 6x^2 + 11x - 6$ appears at the right.

```
2323 LBL HX STO X y^x 3-
2331 6* RCL X x^2 +11*
2340 RCL X -6= RTN
```

Differentiation

To perform differentiation press RUN PGM and Dif. The A-h key (F1), which stands for automatic h, instructs the calculator to determine h according to the foloving equations: $h = (.001)|x|$ if $|x| > 0.01$ or $h = 0.00001$ if $|x| \leq 0.01$. To select your own value for h use the h key (F2). Then, when h has been determined, enter the value of x at which the derivatives are to be calculated and press the x key (F3). Press the 1st key (F4) for the first derivative and the 2nd key (F5) for the second derivative. The printout at the right is for differentiation of the sample function at x = 0.1 using the A-h mode. The exact answers are 9.83 and -11.4 .

```
Differentiation
x=          0.1
h=       0.0001
D'=  9.83000001
D"=       -11.4
```

Integration

For all of the integration programs the limits of integration a and b are stored in data registers A and B so that you can go from one integration method to another without re-entry of the limits.

The function which will be used to demonstrate the integration programs is

$$I = \int_{a=0}^{b=1} \frac{dx}{1 + 0.5\sin(10\pi x)}$$

```
2323 LBL HX *10* PI =
2332 SIN /2+1= 1/x RTN
```

Function Analysis on the TI-95 - (cont)

The exact integral is $2/\sqrt{3}$ = 1.154700538379 to thirteen significant figures. An appropriate subroutine appears to the right of the function on page 20. There is no need to use a STO X at the beginning of the subroutine with this mechanization. The calculator must be set to the radians mode.

To perform trapezoidal rule integration press RUN PGM and Trp. Enter the lower limit and press a (F1). Enter the upper limit and press b (F2). Enter the number of subintervals n and press n (F3). Press I (F4) to perform the integration. The 13d key (F5) sets data register V equal to one which causes the 13d display to be printed following the 10 place display. To eliminate the 13 digit printout press 0 STO V. Of course, you can also start the 13 digit printout by pressing 1 STO V. The 13 digit mode only applies to the integration programs. The printout at the right is for the test function using 16 subintervals.

To perform Simpson's rule integration press RUN PGM and Sim. The data entry is the same as with trapezoidal rule integration except that the number of subintervals must be an even number as prompted by the 2n key (F3). An odd entry will result in an error message. The printout at the right is for the test function using 50 subintervals.

To perform Romberg integration press RUN PGM and Rom. The lower and upper limits are entered as with other integration methods. Once the I key (F3) is pressed the program continues to print answers for the integral with increasing accuracy. To stop the Romberg integration press OFF and then ON so that the subroutine stack is cleared. The program will stop itself when j = 43. It then prints "j=43". (Note that you may not be able to observe this feature if you are operating with a reduced number of data registers as discussed in the Editor's Note on page 17.) The Romberg program automatically sets the 13 digit mode. The HX= key (F4) provides a way to test the function subroutine. Simply enter a value for X and press HX= . The value of the function of x will be displayed.

The printout at the right shows 6 iterations of Romberg integration for the test function.

To perform Gauss quadrature you must first be sure that the required data base is in place as described on pages 17 and 20. If you are operating without the full implementation it is adviseable to run the Gen routine immediately before using the Gauss routine. Then press RUN PGM --> and Gau. The upper and lower limits are entered as with other integration methods. Enter the number of points and press n (F3). Enter the number of panels and press m (F4). To calculate the integral press I= (F5). To calculate using other values of m and n you need only enter the changed values. The printout at the right shows evaluations of the test function for n = 2 and for m from 14 through 21.

```
Trapezoidal Rule
a=             0.
b=             1.
n=            16.
I=     1.15470054
+1154700540011
```

```
Simpson's Rule
a=             0.
b=             1.
2n=           50.
I=    1.154696133
+1154696132597
```

```
Romberg Integr.
a=             0.
b=             1.
I1=            1.
I=             1.
+1000000000000
I=    1.237037037
+1237037037038
I=    1.144587218
+1144587217603
I=    1.155121719
+1155121718961
I=     1.15469622
+1154696219749
I=    1.154700531
+1154700530978
```

```
Gauss Quadrature
a=             0.
b=             1.
n=             2.
m=            14.
I=    1.154700517
+1154700517089
m=            15.
I=    1.155456448
+1155456447741
m=            16.
I=     1.15470054
+1154700539906
m=            17.
I=    1.154700538
+1154700538378
m=            18.
I=    1.154700538
+1154700538268
m=            19.
I=    1.154700538
+1154700538378
m=            20.
I=      1.1575105
+1157510499554
m=            21.
I=    1.154700538
+1154700538379
```

Function Analysis on the TI-95 - (cont)

The Evaluation Function

To run the "Evaluation" routine press RUN PGM --> and Evl. Enter the first value to be evaluated and press F-X (F1). Enter the last value and press L-X (F2). Enter the spacing of the x values (delta) and press DEL (F3). Press RUN to obtain the evaluation. The printout at the right is for the test integration function.

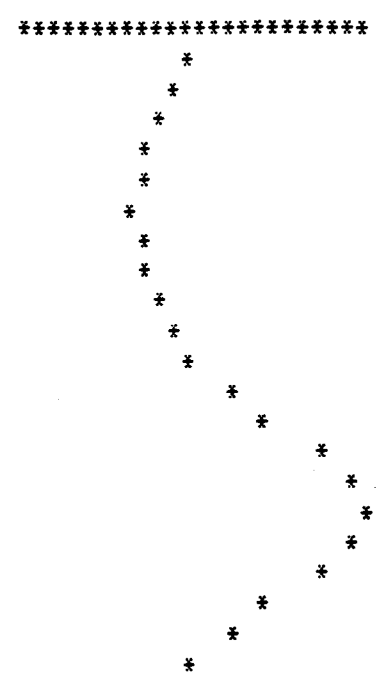
```
Evaluation
F-X              0.
L-X            0.1
DEL           0.01

X=               0.
HX=              1.
X=            0.01
HX=   .8661694586
X=            0.02
HX=   .7728616578
X=            0.03
HX=   .7119928445
X=            0.04
HX=   .6777233811
X=            0.05
HX=   .6666666667
X=            0.06
HX=   .6777233811
X=            0.07
HX=   .7119928445
X=            0.08
HX=   .7728616578
X=            0.09
HX=   .8661694586
X=             0.1
HX=              1.
```

The Plot Function

To run the plot routine press RUN PGM --> and Plt. Enter the msximum value of the function over the interval to be plotted and press MAX (F1). Enter the minimum value of the function over the interval and press MIN (F2). Enter the first x value to be plotted and press F-X (F3). Enter the last x value to be plotted and press L-X (F4). Press --> (F5) and enter the interval between plotted values (delta) and press DEL (F1). Press RUN to obtain the plot. The * key can be pressed to plot additional points at the end of the run in order to take care of cases where the last point is not plotted due to roundoff. The plot at the right is for the integration evaluation function.

```
Plot
MAX              2.
MIN              0.
F-X              0.
L-X             0.2
DEL            0.01
```



The evaluation and plot routines use completely different sets of data registers so that you can switch between the two routines using different parameters.

Some Notes on the Gauss Quadrature Routines

The Gauss quadrature data base is calculated by the data generator program with errors in the eleventh, twelfth and thirteenth digits. Thus, the Gauss quadrature program usually gives results which are accurate to only ten digits. A user also needs to consider that it is necessary to obtain at least two evaluations of the integral as stated on page 91 of H. L. Meck's *Scientific Analysis for Programmable Calculators*

> "...there is no reliable way to determine the accuracy of Gauss integration in advance. It is always necessary to carry out at least two evaluations of an integral using different values of n. The results may be assumed to be correct up to the point through which the digits coincide."

Editor's Note: Generally the accuracy of the solution increases as n and/or m are increased. But that is not always so and it may be prudent to perform more than two evaluations in order to achieve the best accuracy for the range of values of m and n being used. For example, consider the printout for the test problem on page 21 where for values of m divisible by five the solution is substantially worse than for adjacent values of m. When the argument for the sine in the test function is changed the intervals between degraded solutions change. Similar effects are also apparent in results obtained from Robert Prins' program on V14N2P22.

Function Analysis on the TI-95 - (cont)

The following table lists part of the generated data base for the Gauss program to thirteen digits so that you obtain a precision partial check of your Gen program. For n=2, R026 = 0.5773502691895 , and R027 0.9999999999987 .

	W = 0		W = 1	
n	n<512	+D1 in registers	n=512	+D2 in registers
4	R028	0.8611363115941	R028	0.9999889909844
4	R029	0.3478548451378	R029	0.00002825263731350
4	R030	0.3399810435849	R030	0.9999419946068
4	R031	0.6521451548624	R031	0.00006576573169996
8	R032	0.9602898564976	R032	0.9998574463700
8	R033	0.1012285362912	R033	0.00011033319034104
256	R532	0.01837081847882	R532	0.02145312295978
256	R533	0.01224583436957	R533	0.006128523194201
256	R534	0.006123912375182	R534	0.01532423508490
256	R535	0.01224767164009	R535	0.006129214171627

Acknowledgements

The H. R. Beck book contains programs which are the basis for the Romberg and Gen routines. The Gen routine was speeded up using an initial estimate formula from *Methods of Numerical Integration* by Davis and Rabinowitz. The differentiation routine is from *The Sourcebook for Programmable Calculators*.

FAST FACTOR FINDING - Larry Leeds writes "The program UBASIC contains a large number of functions. For my purposes the functions for FACTORS and PRIMES are the important ones. Many of the others are Greek to me but just what a professor of mathematics would appreciate. One function for PI returns any selected number of digits up to 2500. Another solves the Tower of Hanoi (12 disks) which requires 4095 moves. On my machine this runs so fast that the display is almost a blur. It took the 386SX about one minute to factor

999999999999999999999999999999999988 (that is, 34 nines followed by 2 eights) into

2 * 2 * 11 * 23 * 1774093100831 * 556984462668427315679

For another test I multiplied together three eleven digit primes to obtain

778438393067011463161307972470183. It took about 75 seconds to find the factors

99999999907 * 99999999977 * 77843839397

And we worked so hard to get a speedy factor finder for the TI-59!"

A FALSE ALARM? - V13N3P22 and V13N4P25 discussed the indications in the 8K RAM documentation that the battery life may limit the service life of the RAMs to three to five years. In a recent telephone conversation with Hewlett Ladd we noted that we have had many modules in operation since May 1987 and have seen no indication of failure to date, four and one-half years later.

CONTOUR GRAPHS ON THE TI-59 - Gene Friel writes "Recently I used the contour graph program described in V5N9/10P5 and V6N6/7P3. I'm including a page of notes that may help describe the details of the program."

1. For any number of strips, the range of X_1 is from the start value, X1, to X1 + (N-1)ΔX1 where N is the number of steps.

2. For NL strips, the range of X_2 is from X2 to X2 + [19 + 20(NL - 1)]ΔX2.

3. Enter levels only in an ascending sequence of values.

4. For equal gaps between levels, ΔL, setting e = 0.25ΔL will make the printed gaps about the same thickness as the numbered levels and can effectively generate 17 levels. If e = 0.5ΔL, no gaps will occur between numbers.

5. Since the start value, X2, for each line is reset by subtraction rather than by restoring the initial value, drift can occur in the X2 values due to truncation causing unexpected contour plots. To avoid this drift, transform the function so that values of ΔX1 and ΔX2 are exact to less than about ten digits which depends on the number of steps and strips.

Editor's Note: V5N9/10P5-6 presented a contour graph program for the TI-59 written by Harald Otto. V6N6/7P3-4 presented a fast mode version, also by Harald Otto.

ONE LAST HARDWARE OFFER - Through the end of the year the club will continue the offer to obtain used TI-59's for fifty dollars plus shipping. Send sixty dollars. We will give fifty dollars to the present owner, ship the calculator to you, and refund anything remaining. All of the TI-59's will have passed the extended diagnostics in V12N2P4/5. Even so, all used hardware is provided entirely at the buyer's risk. We also can obtain PC-100C's, but most will need the eraser fix to print properly. Write for more information on specific units.

We will continue to offer magnetic tape service for TI-74 and TI-95 programs which were published in TI PPC Notes. Send five dollars for a tape with ten programs.

We will also continue to offer magnetic card service for TI-59 programs which were published in TI PPC Notes. Send one dollar per card plus a stamped and self-addressed envelope.

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