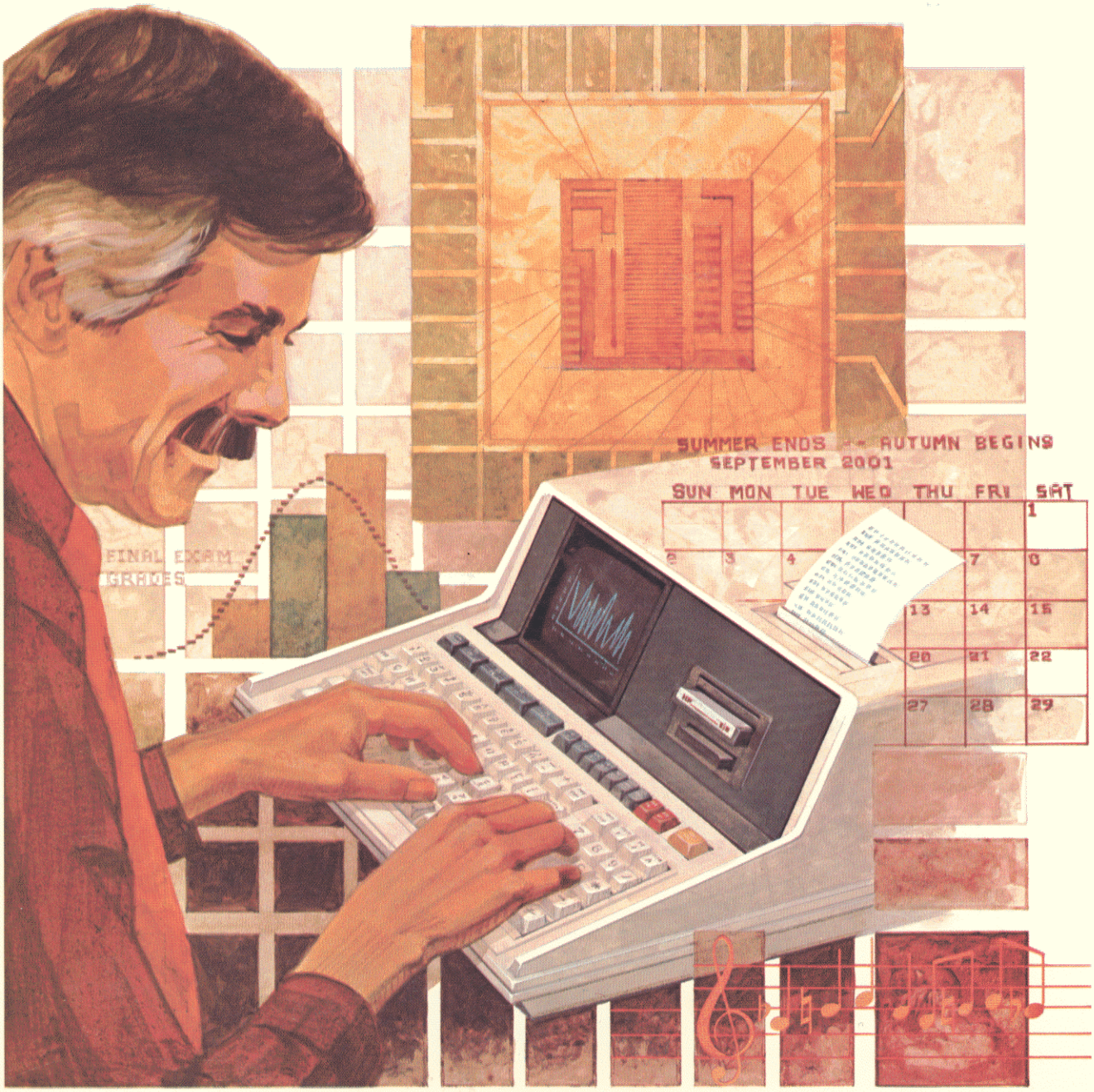
HEWLETT-PACKARD

HP-85

STANDARD PAC



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NOTICE

HP-85

Standard Pac

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Introduction

The Standard Pac has been designed to provide you with many immediate solutions to a wide spectrum of computational problems. The programs deal with business, science, and engineering, as well as providing enjoyable programs such as Music Composer, Biorhythms, and the Ski Game.

A knowledge of programming is not needed to use most of the programs in the Standard Pac. However, you should be familiar with sections *1* through *5* of the Owner's Manual. Some of the programs require you to store a function as part of the program. You should be able to do this after reading the programming section of the Owner's Manual. The examples for these programs should also prove helpful to beginning users.

For each program in the Standard Pac, there is a description, user instructions, examples, and commented program listings (at the back of this manual).

The Standard Pac also contains explanations of important programming techniques which have been used in the programs. Many of these techniques can be used in your own programs. The titles and page numbers of these explanations may be found at the beginning of the appendix.

Before running any of the Standard Pac programs, you should define the output peripherals to your needs. Most of the programs assume that the printer is 2 and the CRT is 1 and use PRINT and DISP statements accordingly. If you want to ensure that the peripherals are defined as the programs assume, press (RESET) before running a program. The currently defined key labels are obtainable at any time while a program is running by pressing (KEY LABEL). Remember to press (CLEAR -LINE) before pressing (END LINE) if the key labels are in the input line. All files on the Standard Pac cartridge have been secured using a security code of HP and a security type of 2. To store a changed version of a program, you must first unsecure the file using HP as the security code and 2 as the security type.

We hope that these programs prove helpful in your daily calculations.

Contents

Format of User Instructions

The user instructions, which accompany each program, are your guide to operating the programs in this Pac.

Certain key words have been used to indicate specific types of operations. You should become familiar with the meanings of these words so that the intent of the user instructions can then easily be followed.

Key Word	Meaning/Use
INSERT	Put the tape cartridge into the tape transport
PRESS	Push an immediate executable key, e.g., (END LINE) or (RUN)
TYPE	Push a series of keys which form a command, e.g., Type: (REW LOAD) "CALEND"
ENTER	Push a series of keys as a response to a machine prompt, e.g., Enter: The name of the file.
GO TO Step n	Change the flow in the user instructions
REPEAT	Designates a repeatable group of instructions
NOTE:	Extra comments concerning instructions for this step

The user instructions are written in outline form so that you can easily follow the instructions and the flow of operation. All of the programs have been designed with a "HELP" section which displays more detailed information concerning the operation of a program than the labels on the special function keys. After running a program using the written user instructions a few times, you should be able to run the programs without referring to the user instructions and use the "HELP" option to refresh your memory.

Running a Program

Loading a Program

The Standard Pac cartridge contains fifteen programs which are all accessible in the same manner. You can obtain a listing of the programs on the tape by doing a catalogue as follows:

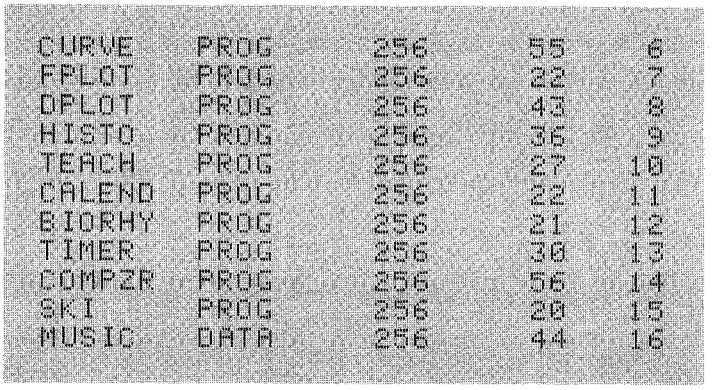
Insert the Standard Pac cartridge into the tape transport with the label up.

Type: CAT

Press: (END LINE)

Your catalogue should look like this:

```
NAME      TYPE    BYTES    RECS FILE
MOVING    PROG      256      40    1
AMORT     PROG      256      18    2
POLY      PROG      256      29    3
SIMUL     PROG      256      47    4
ROOTS     PROG      256      19    5
```



Now, let's load the calendar program from the tape.

Type: (REW LOAD) "CALEND"
Press: (END LINE)

The display will now be blank and the light on the tape transport will be lit. When the light goes out and the display is turned on, the calendar program will be loaded. This program will remain in the machine until you load another program, SCRATCH it, or turn the computer off.

Program Operation Hints

These programs have been designed to execute with a minimum amount of difficulty, but problems may occur which you can easily solve during program operation. There are four different types of errors or warnings that can occur while executing a program: input errors, math errors, tape errors and image format string errors.

The input errors include errors 43, 44, and 45. All of these errors will cause a message to be output followed by a new question mark as a prompt for the input. You should verify your mistake and then enter the corrected input. The programs will not proceed until the input is acceptable. There is a more complete discussion of INPUT in your Owner's Manual.

The second type of error which might occur is the math errors (1 through 13). With DEFAULT ON, the first eight errors listed in appendix E of your Owner's Manual cause a warning message to be output, but program execution will not be halted. The cause of these errors can usually be attributed to specific characteristics of your data and the type of calculations being performed. In most cases, there is no cause for alarm, but you should direct your attention to a possible problem. An example of such a case is found in the Standard Pac when the curve fitting program computes a curve fit to your data which has a value of 1 for the coefficient of determination, r^2. The computation of the F ratio results in a divide by zero, Warning 8.

The third type of error, tape errors (60 through 75) may be due to several different problems. Some of the most likely causes are the tape being write-protected, the wrong cartridge (or no cartridge) being inserted, a bad tape cartridge, or wrong data file name specification during program execution. Appendix E of your Owner's Manual should be consulted for a complete listing.

The fourth type of error is due to generalizing the output to anticipated data ranges. In many cases, the output has assumed ranges which may or may not be appropriate with your data. Adjusting the image format string for your data will solve this type of problem. You may also want to change the image string if you require more digits to the right of the decimal point.

Whenever a running program is interrupted from the keyboard by inadvertantly pressing a key, the system beeps. To continue program execution, press (CONT) .

These are the more common problems which may occur during program operation. Your Owner's Manual should be consulted if you need more assistance.

Notes

Moving Average

In a moving average, a specified number of data points are averaged. When there is a new piece of input data, the oldest piece of data is discarded to make room for the latest input. This replacement scheme makes the moving average a valuable tool in following trends. The fewer the number of data points in the average, the more trend sensitive the average becomes. With a larger number of data points, the moving average behaves more like a regular average and is less sensitive to short lived trends.

This program allows you to specify both the number of points for computing the moving average and the number of points to be retained for tape storage. Both these values can be up to 200. You must specify these values first by pressing KEY #1 (#AV/#R) and entering them when requested. After this step, data can either be entered from the keyboard or optionally from an existing data file. The current moving average can be obtained after entering data by pressing KEY #3 (AVERAGE). The data entry prompt also displays the current moving average. This average is based on either the number of points entered or the number or points in the average specified before data entry, whichever is smaller. The data can be printed, plotted, or stored by pressing the specific key.

In many applications, moving averages are calculated daily, weekly, monthly, or even yearly. In such cases, it is necessary to store the retained data on a data file for future use. To do this, you only have to press KEY #4 (STORE) and then enter the file name. When this data is required again, specify the entry of data from the tape in the ENTER operation and then enter the name of the data file.

The data is stored in an array which is automatically updated as data is entered. For a more detailed explanation of the data structure used in the program, refer to the discussion in the appendix about this program.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "MOVING"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.

   OR:
   a. Press: KEY #1 (#AV#R), to enter the number of points in the average and the number of points to be retained.
   b. Go to step 5.
5. When NUMBER OF POINTS IN AVERAGE? is displayed:
   a. Enter: The number of points in the moving average.

b. Press: END LINE

Note: If RE-ENTER is displayed, the number of points is out of range (1,200). Go to step 5.

6. When NUMBER OF POINTS TO BE RETAINED? is displayed:
   a. Enter: The number of points to be retained before replacing old values with new values.
   b. Press: END LINE

   Note: If RE-ENTER is displayed, the number of points is out of range (# points in average, 200). Go to step 6.
7. To enter data after specifying the number of points in the average and number of points to be retained:
   a. Press: KEY #2 (ENTER)
   b. When OLD OR NEW DATA:O/N? is displayed:
      1) Enter: O, if the data is stored on a data file.
      2) Press: END LINE
      3) Go to step 8.

      OR:

      1) Enter: N, if the data is to be entered from the keyboard.
      2) Press: END LINE
      3) Go to step 9.

   Note: You must enter either "O" or "N" or the program will beep and go to step 7b.
8. When ENTER FILE NAME? is displayed:
   a. Enter: The name of the data file.
   b. Press: END LINE
   c. Go to step 10.

   Note: If FILE NAME-TOO LONG" or _IS NOT ON TAPE! is displayed, go to step 8.
9. When AVE.=_:VALUE,INF TO END? is displayed:
   a. Enter: The next value.
   b. Press: END LINE

   OR:

   a. Enter: INF to designate that there are no more entries.
   b. Press: END LINE
   c. Go to step 11.
10. When MORE ENTRIES:Y/N? is displayed:
    a. Enter: Y, if there are more values.
    b. Press: END LINE
    c. Go to step 9.

    OR:

    a. Enter: N, if there are no more values.
    b. Press: END LINE
11. After entering the data and specifying the number of points for the average and for retention, the following operations can be selected in any order:
    a. Press: KEY #3 (AVERAGE), to print the current moving average.
    b. Go to step 11 after the average is printed.

    OR:

    a. Press: KEY #4 (STORE), to store the array of retained values.
    b. Go to step 12.

    OR:

    a. Press: KEY #7 (VALUES), to print the retained values in order of most recent first.
    b. Go to step 11 after the values are printed.

    OR:

    a. Press: KEY #8 (PLOT), to plot the data and the moving average.
    b. Go to step 13.
12. When ENTER NAME OF FILE? is displayed:
    a. Enter: The name of the data file.
    b. Press: END LINE
    c. Go to step 11 after the data is stored.
13. When DO YOU WANT AVERAGES PRINTED? is displayed:

a. Enter: Y, if the moving averages are to be printed.
b. Press: END LINE

OR:

a. Enter: N, if the averages are not to be printed.
b. Press: END LINE

Note: You must enter either "Y" or "N" or the program will beep and go to step 13.

14. If a plot has already been done and NEW PLOT: Y/N? is displayed:
    a. Enter: Y, if the old plot is to be erased before this plot.
    b. Press: END LINE

    OR:

    a. Enter: N, if the existing plot is not to be erased before this plot.
    b. Press: END LINE
    c. Go to step 23.
15. When VERTICAL/HORIZONTAL LABELS: V/H? is displayed:
    a. Enter: V, if the X-axis labels are to be written vertically.
    b. Press: END LINE

    OR:

    a. Enter: H, if the X-axis labels are to be written horizontally.
    b. Press: END LINE

    Note: You must enter either "V" or "H" or the program will beep and go to step 15.
16. If the number of retained values is greater than 17 and
    NO. OF RETAINED
    VALUES =_
    NO. OF X-AXIS INTERVALS
    (<=16)? is displayed:
    a. Enter: The number of X intervals (<=16).
    b. Press: END LINE

    OR:

    a. Enter: The number of points between X-axis intervals preceded by a minus sign, e.g., -3, for tics at 1, 4, 7, 10, etc.
    b. Press: END LINE

    Note: The number of intervals must be less than or equal to 16 or the program will beep and go to step 16.

    Note: If there are fewer than 18 retained points, the program automatically sets the number of intervals to the number of retained points minus one.
17. When NUMBER X-INT. BETWEEN LABELS? is displayed:
    a. Enter: The number of X-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
    b. Press: END LINE

    OR:

    a. Enter: 0, if no labels are desired on the X-axis.
    b. Press: END LINE

    Note: If the number of intervals is not in the range of 0 to the entered number of X-intervals, the program will beep and go to step 17.
18. When AUTO Y-SCALING: Y/N? is displayed:
    a. Enter: Y, if the Y-minimum and Y-maximum values are to be used by the program.
    b. Press: END LINE
    c. Go to step 21.

    OR:

    a. Enter: N, if you want to enter the Y-minimum and Y-maximum values.
    b. Press: END LINE

    Note: By specifying the end points you can have better control of the axis labels.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 18.
19. When ENTER SCALE YMIN? is displayed:

a. Enter: The minimum Y value for scaling.
b. Press: END LINE

20. When ENTER SCALE YMAX? is displayed:
a. Enter: The maximum Y value for scaling.
b. Press: END LINE

Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 19.

21. When NO. OF Y-AXIS INTERVALS:(<=12)? is displayed:
a. Enter: The number of Y-axis intervals (<=12).
b. Press: END LINE

Note: If the number of intervals is not in the range of 1 to 12, the program will beep and go to step 21.

22. When NUMBER OF Y-INT. BETWEEN LABELS? is displayed:
a. Enter: The number of Y-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
b. Press: END LINE

OR:

a. Enter: 0, if no labels are desired on the Y-axis.
b. Press: END LINE

Note: If the number of intervals is not in the range of 0 to the entered number of Y-intervals, the program will beep and go to step 22.

23. When LABEL PLOT:Y/N? is displayed:
a. Enter: Y, if you want to label the plot.
b. Press: END LINE
c. Go to step 24.

OR:

a. Enter: N, if no label is desired.
b. Press: END LINE
c. Go to step 27.

Note: You must enter either "Y" or "N" or the program will beep and go to step 23.

24. When LABEL ORIGIN:X,Y? is displayed:
a. Enter: The X and Y coordinates where the label is to start.
b. Press: END LINE

Note: If INVALID POSITION is displayed, the entered coordinates are out of the scale limits and the program goes to step 24.

Note: To aid label positioning the following variables may be useful to use.

Variable Name	Description
X0	Minimum X-scaled value
Y0	Minimum Y-scaled value
*	X-value at axes intercept is 1
M1	Y-value at axes intercept
M3	X-value at right end of X-axis
M2	Y-value at top end of Y-axis
Z1	M3—1
Z2	M2—M1
D1	Distance of a dot in X-direction
D2	Distance of a dot in Y-direction

25. When ENTER LABEL? is displayed:
a. Enter: The label.
b. Press: END LINE

Note: If LABEL TOO LONG is displayed, the program beeps and goes to step 25.

26. After the label has been drawn, go to step 23.
27. When CHANGE NUMBER OF POINTS:Y/N? is displayed:
a. Enter: Y, if you want to change the number of points.
b. Press: END LINE
c. Go to step 28.

OR:

a. Enter: N, if you do not want to change the number of points.
b. Press: END LINE
c. Go to step 11.

28. When ENTER NO. OF POINTS IN AVERAGE is displayed:
    a. Enter: The number of points in the average.
    b. Press: END LINE
    c. Go to step 13.

Example 1:

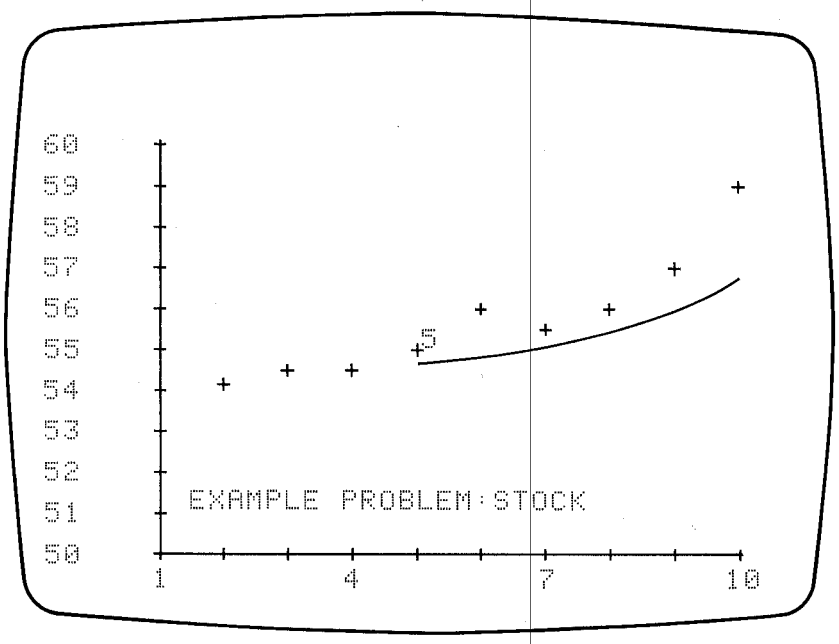
A five period moving average is used to study the trends in a stock's price. The closing price for the first ten days are as follows:

Day	1	2	3	4	5	6	7	8	9	10
Closing Price	55	54-1/8	54-1/2	54-1/2	55	56	55-1/2	56	57	59

Compute the moving average after specifying a five-period moving average and retaining values for 100 periods. After entering the ten values, plot the moving averages and store the retained values in file "STOCK".

To duplicate the example, use 3 intervals between labels on the X-axis, 50 as the Y-minimum, 60 as the Y-maximum, and 1 interval between labels on the Y-axis. To position the label, use 1.5 and 51 as the X and Y values respectively.

```
CURRENT MOVING AVERAGE= 56.7
NUMBER OF POINTS IN AVERAGE= 5

DATA VALUES
MOST RECENT FIRST
NUMBER RETAINED VALUES= 100
 59
 57
 56
 55.5
 56
 55
 54.5
 54.5
 54.125
 55

MOVING AVERAGES
MOST RECENT FIRST
NUMBER OF POINTS = 5
 56.7
 55.9
 55.4
 55.1
 54.825
 54.625
```



Example 2:

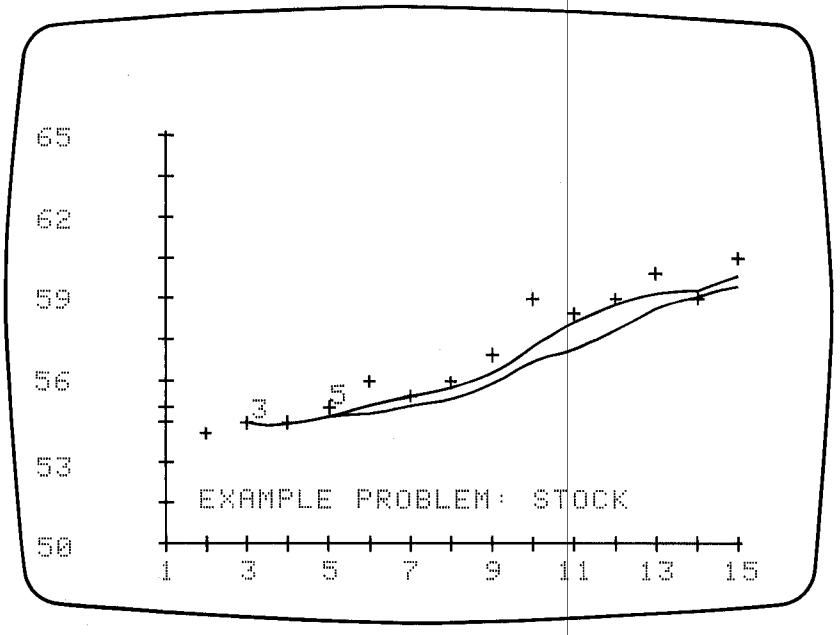
Using the values retained from example 1 in file "STOCK" and the next five days' data, plot the moving average.

Day	11	12	13	14	15
Closing Price	58-1/2	59	60	59	60-1/2

Change the moving average to a 3-period average and plot this average on the same plot as the 5-day average.

```
CURRENT MOVING AVERAGE= 59.4
NUMBER OF POINTS IN AVERAGE= 5

DATA VALUES
MOST RECENT FIRST
NUMBER RETAINED VALUES= 100
 60.5
 59
 60
 59
 58.5
 59
 57
 56
 55.5
 56
 55
 54.5
 54.5
 54.125
 55
```

```
MOVING AVERAGES
MOST RECENT FIRST
NUMBER OF POINTS = 5
 59.4
 59.1
 58.7
 57.9
 57.2
 56.7
 55.9
 55.4
 55.1
 54.825
 54.625

MOVING AVERAGES
MOST RECENT FIRST
NUMBER OF POINTS = 3
 59.8333333333
 59.3333333333
 59.1666666667
 58.8333333333
 58.1666666667
 57.3333333333
 56.1666666667
 55.8333333333
 55.5
 55.1666666667
 54.6666666667
 54.375
 54.5416666667
```



Notes

Annuities and Compound Amounts with Amortization

This program can be used to solve a variety of problems involving money, time and interest. The following variables can be inputs or outputs:

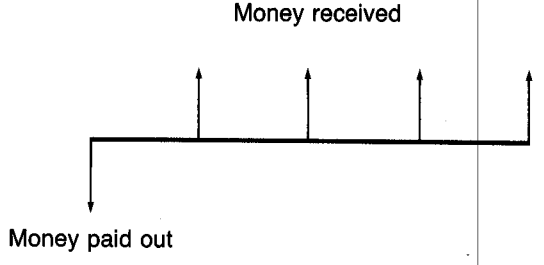
n,	which is the number of compounding periods. (For a 30 year loan with monthly payments, $n = 12 \times 30 = 360$).
i,	which is the annual interest rate expressed as a percent.
PMT,	which is the periodic payment.
PV,	which is the present value of the cash flows or compound amounts.
FV,	which is the future value of a compounded amount or a series of cash flows.

The program accommodates payments which are made at the end of compounding periods or at the beginning. Payments made at the end of compounding periods (ordinary annuity) are common in direct reduction loans and mortgages while payments at the beginning of compounding periods (annuity due) are common in leasing.

Calculations are made in either mode by pressing the KEY #7 (SLV/AD) once for ordinary annuity or twice for annuity due before pressing the key for the unknown variable.

After entering or solving for the necessary values, an ordinary annuity amortization schedule can be obtained for a user specified number of periods by pressing the KEY #6 (AMORT).

A cash flow diagram enables you to describe a compound interest problem in terms that the computer can understand. Once you draw and label your diagram, you simply key in the known data when requested and solve for the unknown value.



Instead of "What is my problem?" ask yourself, "What are the cash flows?"

Solving for any of the values (*n, i, PV, PMT,* or *FV)* is easy with your computer. There are four simple rules to remember—rules that are the same for all compound interest calculations.

1. Given three or four of the financial values *(n, i, PV, PMT,* or *FV),* you can solve for the fourth and/or fifth values, as long as *n* and/or *i* are known.* Both *n* and *i* are involved in all financial calculations. You can enter the values in any order.

2. Use the cash flow sign convention throughout all compound interest calculations (including amortization): *Cash received (arrow pointing up) is represented by a positive value (+). Cash paid out (arrow pointing down) is represented by a negative value (−).*
3. Whenever payments *(PMT)* are involved, it is always necessary to specify whether the payments are made at the beginning of the payment period or whether the payments are made at the end of the payment period. Pressing KEY #7 once for ordinary annuity (payments at end) or twice for annuity due.
4. Remember that n and i must correspond to the same time frame, i.e., the number of compounding periods.

This convention was first introduced on the HP-92 and is designed to decrease the ambiguity involved with financial calculations of this type.

Equations:

$$PV + (1+i)^{\delta}\, PMT\, \frac{1-(1+i)^{-n}}{i} + FV\,(1+i)^{-n} = 0$$

$$\text{where } \delta = \begin{matrix} 0 \text{ ordinary annuity} \\ 1 \text{ annuity due} \end{matrix}$$

The equation above is solved for i using Newton's method where:

$$i_n = i_{n-1} - \frac{f(i_{n-1})}{f'(i_{n-1})}$$

This is why solutions involving i take longer than other solutions.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "AMORT"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When PRINTER OUTPUT:Y/N? is displayed:
   a. Enter: Y, if the results are to be printed.
   b. Press: (END LINE)

   OR:

   a. Enter: N, if the results are not to be printed.
   b. Press: (END LINE)

   Note: You must enter either "Y" or "N" or the program will beep and go to step 4.
5. When the keys are labelled and SELECT OPTION is displayed:
   a. Go to step 6 and enter known values.

   OR:

   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. Go to step 6.
6. To enter the known values:

   n:

   a. Press: KEY #1 (n) to enter the number of periods.

* The computer uses all four variables to solve for the fifth. Zero is assigned to those values that have not been computed or entered since the computer was last cleared.

b. When ENTER # OF COMPOUNDING PERIODS? is displayed:
   1) Enter: The number of compounding periods.
   2) Press: (END LINE)
   3) Go to step 6.

i:

a. Press: KEY #2 (i) to enter the periodic interest rate.
b. When ENTER ANNUAL % RATE? is displayed:
   1) Enter: The annual % rate, e.g., 10% would be entered as 10 not .10.
   2) Press: (END LINE)
c. When ENTER # OF COMPOUNDING PERIODS/YR? is displayed:
   1) Enter: The number of compounding periods per year.
   2) Press: (END LINE)
   3) Go to step 6.

PV:

a. Press: KEY #3 (PV) to enter the present value.
b. When ENTER PRESENT VALUE? is displayed:
   1) Enter: The present value.
   2) Press: (END LINE)
   3) Go to step 6.

PMT:

a. Press: KEY #4 (PMT) to enter the periodic payment.
b. When ENTER PERIODIC PAYMENT? is displayed:
   1) Enter: The periodic payment.
   2) Press: (END LINE)
   3) Go to step 6.

FV:

a. Press: KEY #8 (FV) to enter the future value.
b. When ENTER FUTURE VALUE? is displayed:
   1) Enter: The future value.
   2) Press: (END LINE)
   3) Go to step 6.

7. To solve for an unknown value:
   a. Press: KEY #7 (SLV/AD) to specify ordinary annuity.
   b. Press: The KEY designating the unknown (KEY #1, 2, 3, 4, or 8).

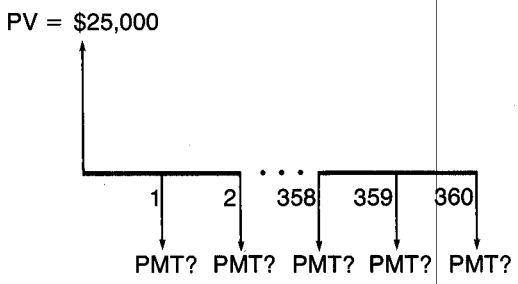
   OR:

   a. Press: KEY #7 (SLV/AD) twice to specify annuity due.
   b. Press: The KEY designating the unknown (KEY #1, 2, 3, 4, or 8).
8. To change values go to step 6.
9. To obtain an amortization schedule:
   a. Press: KEY #6 (AMORT)
   b. When ENTER STARTING PERIOD? is displayed:
      1) Enter: The starting period number.
      2) Press: (END LINE)
   c. When ENTER ENDING PERIOD? is displayed:
      1) Enter: The ending period number.
      2) Press: (END LINE)
   d. After the amortization schedule is printed go to step 6.

Note: If INSUFFICIENT DATA is displayed, you must enter or solve for all five values. Future value *(FV)* is assumed to be zero unless set to another value.

Example 1:

What is the monthly payment required to fully amortize a 30 year, $25,000 mortgage if the annual percentage rate is 10-1/4%? After solving the problem, generate an amortization schedule for the first 12 periods.




```
PERIODIC PAYMENT = -224.03


AMORTIZATION
n =  360.00
i =10.25%
PAYMENT =$ -224.03
PRESENT VALUE =$  25000.00
FUTURE VALUE =$      0.00
 P  PRINCIPAL  INTEREST  BALANCE
 1      10.49    213.54  24989.51
 2      10.58    213.45  24978.93
 3      10.67    213.36  24968.26
 4      10.76    213.27  24957.50
 5      10.85    213.18  24946.65
 6      10.94    213.09  24935.71
 7      11.04    212.99  24924.67
 8      11.13    212.90  24913.54
 9      11.23    212.80  24902.31
10      11.32    212.71  24890.99
11      11.42    212.61  24879.57
12      11.52    212.51  24868.05
TOTALS:
       131.95  2556.41
```

Example 2:

A construction firm owns some equipment worth $15,000. They intend to lease this equipment to another firm for 9 years with monthly payments in advance of $250.00. The equipment is assumed to have no salvage value at the end of the lease. What yield rate does this represent?

```
PERIODIC INTEREST RATE =   1.24%
```

Polynomial Solutions

This program may be used to find the roots, Z, of polynomials of the form:

$$a_0 + ib_0 + (a_1 + ib_1)\, Z + (a_2 + ib_2)\, Z^2 + \ldots + (a_n + ib_n)\, Z^n = 0$$

You must initially enter the complex coefficients of the polynomial and its degree. Tolerances for the root and for functional evaluations and the maximum number of iterations are also needed. After entry of data, you can edit and print the polynomial before roots are found.

The roots are found by expressing the polynomials in terms of Siljak functions and using the method of steepest descent to determine the zeros.

Once a root is found, the polynomial is reduced by synthetic division and the process is repeated. The last root is computed algebraically. The algorithm is very accurate and stable; it will virtually always find the roots and you are not required to provide an initial value. Multiple roots are found at some slightly reduced accuracy, and higher order polynomials may show some loss of accuracy as more roots are found. In general, the program will find "normally" spaced roots accurate to better than 6 decimal places. Newton's method could find the roots faster, but convergence is not guaranteed and with Siljak's method, no a priori information such as the derivative is necessary.

$$F(Z) = \sum_{k=0}^{n} (a_k + ib_k)\, Z^k = 0$$

Siljak Functions X_k and Y_k are defined by $Z^k = X_k + iY_k$ and may be calculated recursively

$$X_0 = 1, X_1 = .1, Y_0 = 0, Y_1 = 1$$

$$X_{k+2} = 2x\, X_{k+1} - (x^2 + y^2)\, X_k$$

where $x+iy$ are the root approximations

$$Y_{k+2} = 2x\, Y_{k+1} - (x^2 + y^2)\, Y_k$$

$$u = \sum_{k=0}^{n} (a_k X_k - b_k Y_k) \qquad \frac{\delta u}{\delta x} = \sum_{k=1}^{n} k\, (a_k X_{k-1} - b_k Y_{k-1})$$

$$v = \sum_{k=0}^{n} (a_k Y_k + b_k X_k) \qquad \frac{\delta v}{\delta x} = \sum_{k=1}^{n} k\, (a_k Y_{k-1} + b_k X_{k-1})$$

REFERENCES:

1. Moore, J.B., "A Convergent Algorithm for Solving Polynomial Equations", *Journal of the Association for Computing Machinery*. vol. 14, No. 2 (April, 1967), pp. 311-315.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "POLY"
   b. Press: (END LINE)
3. To run the program:
   Press: (RUN)
4. When SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation has been displayed, go to step 4.

   OR:

   a. Press: KEY #1 (ENTER), to enter the coefficients.
   b. Go to step 5.
5. When DEGREE OF POLYNOMIAL? is displayed:
   a. Enter: The degree of the polynomial.
   b. Press: (END LINE)
6. When MAX # OF ITERATIONS? is displayed:
   a. Enter: The maximum number of iterations allowed per root.
   b. Press: (END LINE)
7. When TOLERANCE FOR ROOTS? is displayed:
   a. Enter: The tolerance desired for the roots; a root is accepted if the difference in value of the root approximations of two successive iterations is less than this tolerance.
   b. Press: (END LINE)
8. When TOLERANCE FOR FUNCTIONAL EVAL.? is displayed:
   a. Enter: The tolerance for the functional evaluations; a root x is accepted if $|F(x)| \leq$ this tolerance.
   b. Press: (END LINE)
9. When Rcoef(_)=? is displayed:
   a. Enter: The appropriate real part of the coefficient; each subscript corresponds to the exponent of the variable; i.e., $(a_0 + b_0 i) + (a_1 + b_1 i) Z^1 + (a_2 + b_2 i) Z^2 + \ldots + (a_n + b_n i) Z^n$.
   b. Press: (END LINE)
10. When Icoef(_)=? is displayed:
    a. Enter: The appropriate imaginary part of the coefficient as in step 9.
    b. Press: (END LINE)
11. Repeat steps 9 and 10 for each coefficient to the degree of the polynomial.
12. Once the data has been entered:
    a. Press: KEY #2 (EDIT), to change a coefficient.
    b. Go to step 13.

    OR:

    a. Press: KEY #3 (PRINT), to print the polynomial.
    b. Go to step 12 after the printout is finished.

    OR:

    a. Press: KEY #4 (ROOTS), to compute the roots of the polynomial.
    b. Go to step 12 after the real and imaginary parts of the roots are printed.

    Note: Any roots not found will contain 9.999999 E 499.
13. When COEFFICIENT NUMBER? is displayed:
    a. Enter: The number of the coefficient to be changed.
    b. Press: (END LINE)

    Note: If the coefficient number is out of range, go to step 13.
14. When Rcoef(I)? (Where I is the number of the coefficient to be changed) is displayed:
    a. Enter: The new value of Rcoef(I).
    b. Press: (END LINE)

15. When `Icoef(I)?` (Where I is the number of the coefficient to be changed) is displayed:
    a. Enter: The new value of Icoef(I).
    b. Press: END LINE
    c. Go to step 12.

Example 1:

A ball is thrown straight up at a velocity of 15 meters per second, from a balcony 10 meters off the ground. At what time, neglecting air resistance, will it reach the ground? The acceleration due to gravity is 9.81 meters per second per second. From physics:

$$F(t) = x = x_0 + v_0 t + 1/2\, a\, t^2$$

$$x = 0$$
$$x_0 = 10$$
$$v_0 = 15$$
$$a = -9.81$$

The polynomial for this problem is:

$$10 + 15\, t + (-9.81/2)\, t^2 = 0$$

The maximum number of iterations should be 20, the tolerance for roots should be 1E − 8, and the tolerance for functional evaluation should be 1E − 6.

```
COEFFICIENTS:(Rcoef(0)+Icoef.--
        REAL              IMAGINARY
        10.0000             0.0000
        15.0000             0.0000
        -4.9050             0.0000

ROOTS:
        REAL            IMAGINARY
         3.6211             0.0000
        -0.5630            -0.0000
```

Example 2:

Find the roots of the following equation:

$$x^4 - 16 = 0$$

Use maximum number of iterations equals 20, tolerance for roots equals .00000001, and tolerance for functional evaluations equals .000001.

```
COEFFICIENTS: {(Rcoef(0)+Icoef,--
      REAL              IMAGINARY
     -16.0000             0.0000
       0.0000             0.0000
       0.0000             0.0000
       0.0000             0.0000
       1.0000             0.0000

ROOTS:
      REAL             IMAGINARY
     -2.0000             0.0000
      2.0000             0.0000
      0.0000            -2.0000
      0.0000             2.0000
```

Simultaneous Equations

The program allows you to input and solve a system of simultaneous linear equations. You are asked to enter the number of equations you have to solve (the number of equations to be solved is equal to the number of independent variables). The program is designed to handle up to 20 equations. Once the coefficients have been entered, you have the option of editing or printing the equations before solving them. After solving the system of equations, you can then edit the current set of data or enter a new system of equations to be solved.

The method used to solve the system of equations is a modified Gauss-Jordan method with maximum pivot strategy.* If the system of equations has no solution, SYSTEM HAS NO SOLUTION will be printed.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "SIMUL"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.
   OR:
   a. Press: KEY #1 (ENTER), to enter the system of equations.
   b. Go to step 5.
5. When ENTER NUMBER OF EQUATIONS? is displayed:
   a. Enter: The number of equations to be solved.
   b. Press: (END LINE)
6. When ENTER COEFF FOR ELEMENT #_,_? is displayed:
   a. Enter: The jth coefficient of the ith equation.
   b. Press: (END LINE)
7. Repeat step 6 for each coefficient of the ith equation.
8. When ENTER THE RHS OF EQUATION #_? is displayed:
   a. Enter: The right-hand side of the ith equation.
   b. Press: (END LINE)
9. Repeat steps 6-8 for each of the equations in the system.
10. When the system of equations has been entered:
    a. Press: KEY #2 (EDIT), to edit the system of equations.
    b. Go to step 11.
    OR:
    a. Press: KEY #3 (SOLVE), to solve the system of equations.
    b. Go to step 16.

* Applied Numerical Methods—Carnahan, Luther & Wilkes, John Wiley & Sons, NY, 1969—p. 291, 292.

OR:

a. Press: KEY #4 (PRINT), to print out the system of equations.
b. After the printout, go to step 10.

11. When WHICH EQUATION? is displayed:
    a. Enter: The equation number of the equation which needs to be changed.
    b. Press: END LINE
12. When WHICH SIDE: L/R? is displayed:
    a. Enter: L, if you want to change the left-hand side of the equation.
    b. Press: END LINE
    c. Go to step 13.

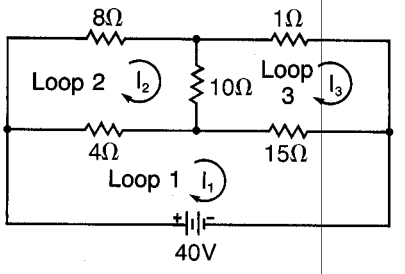
    OR:

    a. Enter: R, if you want to change the right-hand side of the equation.
    b. Press: END LINE
    c. Go to step 15.

    Note: You must enter either "L" or "R" or the program will beep and go to step 12.
13. When WHICH COEFFICIENT IS WRONG? is displayed:
    a. Enter: The subscript of the faulty coefficient.
    b. Press: END LINE
14. When ENTER COEFF FOR ELEMENT #_,_? is displayed:
    a. Enter: The new *j*th coefficient of the *i*th equation.
    b. Press: END LINE
    c. Go to step 10.
15. When ENTER THE RHS OF EQ. #_? is displayed:
    a. Enter: The new right-hand side of the *i*th equation.
    b. Press: END LINE
    c. Go to step 10.
16. When ENTER EPSILON? is displayed:
    a. Enter: The minimum value for a pivot value.
    b. Press: END LINE
    c. After the solution (if it exists) and an absolute error vector have been printed, go to step 4 to enter a new system of equations, or to step 10 to continue working with this system of equations.

Example 1:

Solve for the loop currents in the following circuit.



The three loops are:

LOOP 1: $4I_1 - 4I_2 + 15I_1 - 15I_3 - 40 = 0$
LOOP 2: $4I_2 - 4I_1 + 8I_2 + 10I_2 - 10I_3 = 0$
LOOP 3: $10I_3 - 10I_2 + 1I_3 + 15I_3 - 15I_1 = 0$

or:

$19I_1 - 4I_2 - 15I_3 - 40 = 0$
$-4I_1 + 22I_2 - 10I_3 = 0$
$-15I_1 - 10I_2 + 26I_3 = 0$

Epsilon should be 1E − 6

```
SYSTEM OF EQUATIONS:
Equation #1:    19*X(1) + -4*X(2)
 + -15*X(3)=40
Equation #2:    -4*X(1) + 22*X(2)
 + -10*X(3)=0
Equation #3:    -15*X(1) +
-10*X(2) + 26*X(3)=0

    SOLUTION          ABSOLUTE ERROR
X(  1)=      7.8601     1.0000E-010
X(  2)=      4.2298     2.0000E-010
X(  3)=      6.1615     0.0000E+000
```

Example 2:

Solve the following system of simultaneous equations:

Equation #1: $1 \cdot X(1) + 5 \cdot X(2) + 4 \cdot X(3) + 3 \cdot X(4) + 8 \cdot X(5) = 6$
Equation #2: $7 \cdot X(1) + 8 \cdot X(2) + 5 \cdot X(3) + 4 \cdot X(4) + 8 \cdot X(5) = 9$
Equation #3: $2 \cdot X(1) + 0 \cdot X(2) + 4 \cdot X(3) + 7 \cdot X(4) + 3 \cdot X(5) = 6$
Equation #4: $7 \cdot X(1) + 4 \cdot X(2) + 8 \cdot X(3) + 5 \cdot X(4) + 1 \cdot X(5) = 3$
Equation #5: $1 \cdot X(1) + 2 \cdot X(2) + 2 \cdot X(3) + 4 \cdot X(4) + 0 \cdot X(5) = 0$

Epsilon should be 1E − 6

```
SYSTEM OF EQUATIONS:
Equation #1:    1*X(1) + 5*X(2)
 + 4*X(3) + 3*X(4) + 8*X(5)=6
Equation #2:    7*X(1) + 8*X(2)
 + 5*X(3) + 4*X(4) + 8*X(5)=9
Equation #3:    2*X(1) + 0*X(2)
 + 4*X(3) + 7*X(4) + 3*X(5)=6
Equation #6:    7*X(1) + 4*X(2)
 + 8*X(3) + 5*X(4) + 1*X(5)=3
Equation #5:    1*X(1) + 2*X(2)
 + 2*X(3) + 4*X(4) + 0*X(5)=0

    SOLUTION          ABSOLUTE ERROR
X(  1)=       .8661    -3.0000E-011
X(  2)=      -.7171    -3.0000E-011
X(  3)=      -.3741    -2.0000E-011
X(  4)=       .3291    -1.0000E-011
X(  5)=      1.1536     0.0000E+000
```

Notes

Calculus and Roots of f(x)

This program incorporates four routines for numerical analysis of user specified functions. Suppose figure 1 represents a known function of x called $f(x)$.

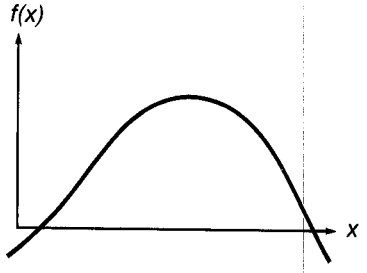


Figure 1

If the formula for $f(x)$ can be entered as a function FNF starting at line 5000, this program can be used to find the value of $f(x)$ at any point x, the derivative of $f(x)$ at any point x, the integral of $f(x)$ over a specified interval and the real roots of $f(x)$.

Once a function has been entered, any of the four routines can be selected. By pressing KEY #4 and entering a value of x, the value of $f(x)$ will be calculated (see figure 2).

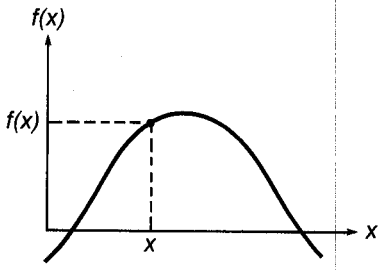


Figure 2

Similarly, the value of the slope of $f(x)$ at a particular point x can be calculated by pressing KEY #1 and entering a value of x (see figure 3). The slope of $f(x)$ is determined using an approximation to the differential:

$$f'(x) = \frac{f(x + \Delta x/2) - f(x - \Delta x/2)}{\Delta x}$$

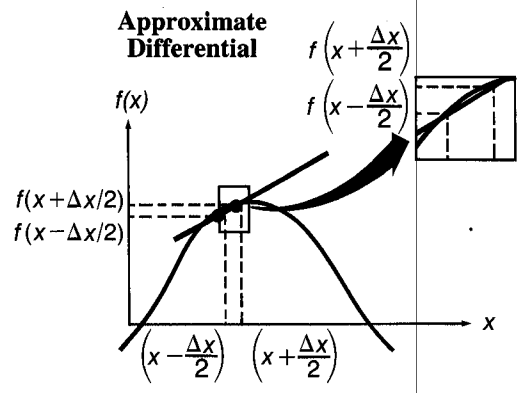


Figure 3

The value of x used to approximate the differential is assumed to be 0.01% of $x(10^{-4} \times x)$ unless a %Δ is specified by the user. That is:

$$\Delta x = \frac{\%\Delta}{100} \cdot x$$

In the special case where $x=0$, x is set equal to %Δ.

For most applications, the assumed value of 0.01% should be adequate. In some cases more accurate results can be obtained using a smaller value of %Δ. However, care must be taken to assure that the computer can accurately resolve the difference between $f(x - \Delta x/2)$ and $f(x + \Delta x/2)$.

The KEY #2 can be used to approximate $\int_a^b f(x)dx$ for the user-defined function $f(x)$. The function must be continuous over the interval $[a,b]$.

The method used is Simpson's one-third rule with truncation error $0(h^4)$ where h is the interval size.

The stopping criterion for this method is either a maximum number of interval halvings or successive computations of the integral differing by less than some user-supplied error tolerance.

Simpson's one-third rule:

$$\int_a^b f(x)dx = \frac{h}{3}\left[f(a) + 4f(a+h) + 2f(a+2h) + 4f(a+3h) + \ldots + 4f(a+(n-1)h) + f(a+nh)\right]$$

where n = *number of intervals*,

$$h = \frac{(b-a)}{n} = \textit{interval size}.$$

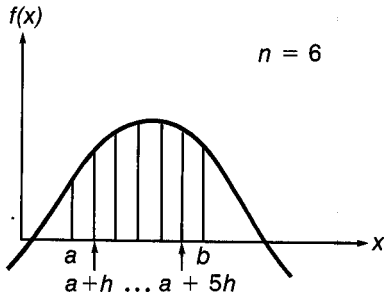


Figure 4

You can search for solutions of $f(x)=0$ over an interval $[a,b]$ by using KEY #3. After you specify the search increment Δx and the error tolerance for $f(x)$, the program then begins at the left of the interval and compares functional values at the ends of the subinterval $[a,a+\Delta x]$. If the functional values are of opposite sign then the bisection method is used to locate the root. Each subinterval $[a+ix,a+(i+1)\Delta x]$ is examined for a possible root. At most one root per interval will be located and if there are multiple roots per interval, none may be located. You must also specify a maximum number of interval-halvings, Maxbi, so that an error tolerance that is not satisfied will result in the root localized to an interval of size $2^{-\text{Maxbi}}(b-a)$. The subprogram will examine $N = int\left(\frac{b-a}{\Delta x}\right)$ intervals.

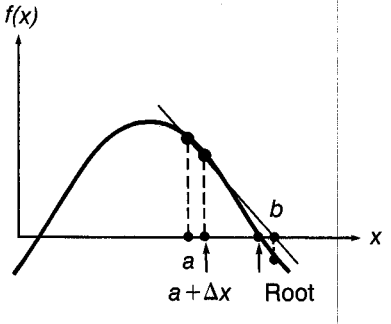


Figure 5

REFERENCES:

1. Becket, Royce and Hurt, James, *Numerical Calculations and Algorithms* (New York: McGraw Hill, 1967), pp. 166-169.
2. Stark, Peter A., *Introduction to Numerical Methods* (London: MacMillan Company, Collier-McMillan Limited, 1970), pp. 95-96.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "ROOTS"
   b. Press: (END LINE)
3. Type the function, FNF, to be analyzed starting at line 5000.

   Note: Make sure that any lines after line 5000 which are not in your function are deleted before running the program.
4. To run program:
   a. Press: (RUN)
5. When the keys are labelled and IS FUNCTION STORED: Y/N? is displayed:
   a. Enter: Y, if the function is stored at line 5000.
   b. Press: (END LINE)
   c. Go to step 6.

   OR:

   a. Enter: N, if the function is not stored.
   b. Press: (END LINE)
   c. Go to step 3.

   Note: You must enter either "Y" or "N" or the program will beep and go to step 5.
6. When SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP) if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 6.

   OR:

   a. Press: KEY #1 (f'(x)) to compute the derivative of $f(x)$ at an entered value of x.
   b. Go to step 7.

   OR:

   a. Press: KEY #2 (INTEG) to compute the integral of $f(x)$ over an interval using Simpson's rule.
   b. Go to step 10.

   OR:

   a. Press: KEY #3 (ROOT) to search for solutions to $f(x)=0$ over an interval.
   b. Go to step 17.

   OR:

   a. Press: KEY #4 (f(x)) to compute the value of the function for an entered value of x.
   b. Go to step 25.
7. When ENTER VALUE OF X? is displayed:
   a. Enter: The value of x for calculating the derivative.
   b. Press: (END LINE)
8. When ENTER %Δ? is displayed:
   a. Enter: The %Δ.
   b. Press: (END LINE)

   OR:

   a. Enter: 0 if the default of .01% is to be used as the %Δ.
   b. Press: (END LINE)
9. After the differential is printed, go to step 6.
10. When ENTER LOWER BOUND? is displayed:
    a. Enter: The lower bound.
    b. Press: (END LINE)
11. When ENTER UPPER BOUND? is displayed:
    a. Enter: The upper bound.
    b. Press: (END LINE)
12. When PRINT INTERMEDIATE POINTS: Y/N? is displayed:
    a. Enter: Y, if the value of the integral is to be printed after every interval halving.
    b. Press: (END LINE)

    OR:

    a. Enter: N, if only the final value is to be printed.
    b. Press: (END LINE)

13. When MAX # OF INTERVAL HALVINGS? is displayed:
    a. Enter: The maximum number of interval halvings. The evaluation of the integral will be made on 2 subintervals, the 4, 16, 32, ..., halving the interval size on each iteration.
    b. Press (END LINE)
14. When ERROR TOLERANCE? is displayed:
    a. Enter: The error tolerance. The value of the integral is accepted if the difference in value of two successive approximations is less than this tolerance.
    b. Press: (END LINE)
15. If ERROR IN DATA is printed, go to step 10.
16. After the integral is printed, go to step 6.
17. When ENTER LOWER BOUND? is displayed:
    a. Enter: The lower bound.
    b. Press: (END LINE)
18. When ENTER UPPER BOUND? is displayed:
    a. Enter: The upper bound.
    b. Press: (END LINE)
19. When ENTER MAXIMUM # OF BISECTIONS? is displayed:
    a. Enter: The maximum number of bisections allowed in searching for any one root in a subinterval.
    b. Press: (END LINE)
20. When ERROR TOLERANCE? is displayed:
    a. Enter: The error tolerance desired.
    b. Press: (END LINE)
21. When ENTER SEARCH INCREMENT? is displayed:
    a. Enter: The search increment.
    b. Press: (END LINE)
22. When ENTER # OF ROOTS? is displayed:
    a. Enter: The number of roots to be found.
    b. Press: (END LINE)
23. If ERROR IN DATA is printed, go to step 17.
24. After the roots are printed, go to step 6.
25. When ENTER VALUE OF X? is displayed:
    a. Enter: The value of x.
    b. Press: (END LINE)
26. After the function value of x is printed, go to step 6.

Example 1:

Numerical integration provides the only solution to the complete elliptic integral of the first kind:

$$u = \int_0^{\pi/2} \frac{d\theta}{\sqrt{(1 - k^2 \sin \theta^2)}}$$

Find the value of u for limits of integration of 0.0 to $\pi/2$. Let K be 0.5. The function should be stored at line 5000 as shown:

```
5000 DEF FNF(X) = 1/SQR (1 - .25 * SIN(X) * SIN(X))
```

The intermediate results should be printed. You should enter a maximum number of interval halvings of 10 and an error tolerance of 1E − 6. After finding the integral, determine the value of the function at $\pi/4$.

```
# INTERVALS  2  INTEGRAL =
 1.6836005540 9
# INTERVALS  4  INTEGRAL =
  1.6857421814
 # INTERVALS  8  INTEGRAL =
  1.6857503546 6
# INTERVALS  16  INTEGRAL =
  1.6857503548 2
INTEGRAL =  1.6857503548 2

 VALUE OF F(X) IS          1.069
```

Example 2:

Find the root of $\ln x - 2x + 5.2249 = 0$ in the range of 1 to 5 using a maximum of 20 bisections, an error tolerance of 1E − 6, and a search increment of .1. After finding the root, determine the slope at the root. Use the default %Δ of .01%. The function should be stored as line 5000 as shown:

```
5000 DEF FNF(X)=LOG(X)-2*X+5.2249
```

```
     RESULTS
   ROOT      FUNCTION      ACCURACY
 3.19E+000   1.14E-006   6.10E-006
APPROXIMATE DIFFERENTIAL OF
f(X) AT  3.19  IS
-1.6865203761 8
```

Curve Fitting

This program can be used to fit data to:

1. Straight lines (linear regression); $y = a - bx$.
2. Exponential curves; $y = ae^{bx}$ $(a>0)$,
3. Logarithmic curves; $y = a + b\ln x$,
4. Power Curves; $y = ax^b$ $(a>0)$.

The type of curve fit is specified after data is entered. Any curve can be specified by pressing the desired key.

The data is entered initially from the keyboard, but can then be stored on the tape for later use and updating. The program is designed for a maximum of 200 data pairs. The data which has been entered can then be edited and printed.

Once the curve fit has been selected, the regression values will be calculated. The coefficient of determination, r^2, indicates the quality of fit achieved by the regression. Values of r^2 close to 1.00 indicate a better fit than values close to zero. The regression coefficients, a and b, define the curve generated, according to the equations shown above.

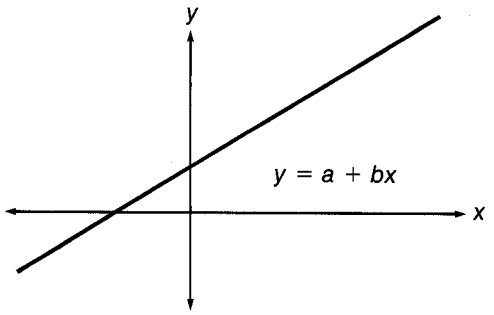
After the analysis of variance has been calculated and printed, you can plot the regression line over the data. Projections can also be made based on the curve fit. You can either enter single values of x or request that all values of x in the data set be used to estimate values of y, $\hat{y}$.

The analysis of variance which is printed for each regression type prints the following values:

1. Degrees of freedom
2. Sum of squares
3. Mean sum
4. F-ratio
5. r^2

The value of the F-ratio is set to 999.9 if it is greater than 999.9. Therefore if the r^2 value is close or equal to 1, the value of the F-ratio will be printed as 999.9.

Linear Regression

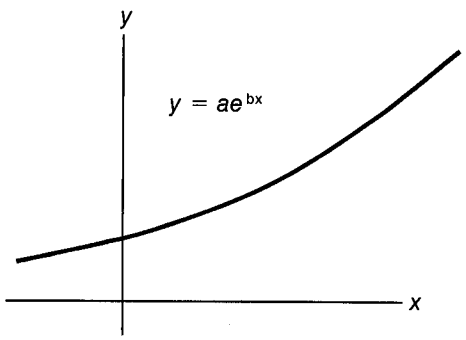


$$b = \frac{\Sigma x_i y_i - \frac{\Sigma x_i \, \Sigma y_i}{n}}{\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n}}$$

$$a = \left[\frac{\Sigma y_i}{n} - b \frac{\Sigma x_i}{n} \right]$$

$$r^2 = \frac{\left[\Sigma x_i y_i - \frac{\Sigma x_i \, \Sigma y_i}{n} \right]^2}{\left[\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n} \right] \left[\Sigma y_i^2 - \frac{(\Sigma y_i)^2}{n} \right]}$$

Exponential Curve Fit

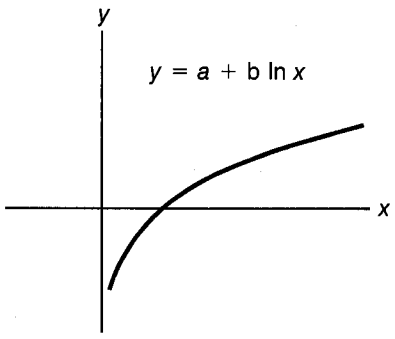


$$b = \frac{\Sigma x_i \ln y_i - \frac{1}{n} (\Sigma x_i)(\Sigma \ln y_i)}{\Sigma x_i^2 - \frac{1}{n} (\Sigma x_i)^2}$$

$$a = \exp \left[\frac{\Sigma \ln y_i}{n} - b \frac{\Sigma x_i}{n} \right]$$

$$r^2 = \frac{\left[\Sigma x_i \ln y_i - \frac{1}{n} \Sigma x_i \, \Sigma \ln y_i \right]^2}{\left[\Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n} \right] \left[\Sigma (\ln y_i)^2 - \frac{(\Sigma \ln y_i)^2}{n} \right]}$$

Logarithmic Curve Fit

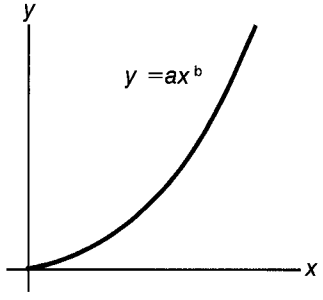


$$b = \frac{\Sigma y_i \ln x_i - \frac{1}{n} \Sigma \ln x_i \Sigma y_i}{\Sigma (\ln x_i)^2 - \frac{1}{n} (\Sigma \ln x_i)^2}$$

$$a = \frac{1}{n} (\Sigma y_i - b \Sigma \ln x_i)$$

$$r^2 = \frac{\left[\Sigma y_i \ln x_i - \frac{1}{n} \Sigma \ln x_i \Sigma y_i\right]^2}{\left[\Sigma (\ln x_i)^2 - \frac{1}{n} (\Sigma \ln x_i)^2\right]\left[\Sigma y_i^2 - \frac{1}{n} (\Sigma y_i)^2\right]}$$

Power Curve Fit



$$b = \frac{\Sigma (\ln x_i)(\ln y_i) - \frac{(\Sigma \ln x_i)(\Sigma \ln y_i)}{n}}{\Sigma (\ln x_i)^2 - \frac{(\Sigma \ln x_i)^2}{n}}$$

$$a = \exp\left[\frac{\Sigma \ln y_i}{n} - b \frac{\Sigma \ln x_i}{n}\right]$$

$$r^2 = \frac{\left[\Sigma (\ln x_i)(\ln y_i) - \frac{(\Sigma \ln x_i)(\Sigma \ln y_i)}{n}\right]^2}{\left[\Sigma (\ln x_i)^2 - \frac{(\Sigma \ln x_i)^2}{n}\right]\left[\Sigma (\ln y_i)^2 - \frac{(\Sigma \ln y_i)^2}{n}\right]}$$

Remarks:

Negative and zero values of x_i will cause a displayed error for logarithmic curve fits. Negative and zero values of y_i will cause a displayed error for exponential curve fits. For power curve fits both x_i and y_i must be positive, non-zero values.

As the differences between x and/or y values become small, the accuracy of the regression coefficients will decrease.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "CURVE"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.
   OR:
   a. Press: KEY #1 (ENTER), to enter the data pairs to be fit.
   b. Go to step 5.
5. When PRINT DATA ON INPUT: Y/N? is displayed:
   a. Enter: Y, if you want the data printed on entry.
   b. Press: (END LINE)
   OR:
   a. Enter: N, if you do not want the data printed on entry.
   b. Press: (END LINE)

   Note: You must enter either "Y" or "N" or the program will beep and go to step 5.
6. When ENTER FROM KEYBOARD/ TAPE: K/T? is displayed:
   a. Enter: K, if the data is to be entered from the keyboard.
   b. Press: (END LINE)
   c. Go to step 7.
   OR:
   a. Enter: T, if the data is to be entered from an existing data file.
   b. Press: (END LINE)
   c. Go to step 12.

   Note: You must enter either "K" or "T" or the program will beep and go to step 6.
7. When NO. OF POINTS? is displayed:
   a. Enter: The number of data pairs.
   b. Press: (END LINE)

   Note: The maximum number of pairs is 200.
8. If INVALID NUMBER OF POINTS is displayed, go to step 7 and reenter a valid number.
9. When X(_),Y(_)=? is displayed:
   a. Enter: The x and y values separated by a comma.
   b. Press: (END LINE)
10. Repeat step 9 for each pair.
11. When DATA ENTERED is displayed, go to step 13.
12. When ENTER FILE NAME? is displayed:
   a. Enter: The file name.
   b. Press: (END LINE)

   Note: If an error occurs during the load, the program returns to step 12.
13. When PLOT DATA: Y/N? is displayed:
   a. Enter: Y, if the data pairs are to be plotted.
   b. Press: (END LINE)
   c. Go to step 14.
   OR:
   a. Enter: N, if the data is not to be plotted.
   b. Press: (END LINE)
   c. Go to step 25.

   Note: You must enter either "Y" or "N" or the program will beep and go to step 13.
14. When AUTO X-SCALING: Y/N? is displayed:
   a. Enter: Y, if the X-minimum and X-

maximum values are to be used by the program.

b. Press: (END LINE)

c. Go to step 17.

OR:

a. Enter: N, if you want to enter the X-minimum and X-maximum values.

b. Press: (END LINE)

Note: By specifying the end points you can have better control of the axis labels.

Note: You must enter either "Y" or "N" or the program will beep and go to step 14.

15. When ENTER SCALE XMIN? is displayed:

a. Enter: The minimum X-value for scaling.

b. Press: (END LINE)

16. When ENTER SCALE XMAX? is displayed:

a. Enter: The maximum X value for scaling.

b. Press: (END LINE)

Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 15.

17. When VERTICAL/HORIZONTAL LABELS:V/H? is displayed:

a. Enter: V, if the X-axis labels are to be written vertically.

b. Press: (END LINE)

OR:

a. Enter: H, if the X-axis labels are to be written horizontally.

b. Press: (END LINE)

Note: You must enter either "V" or "H" or the program will beep and go to step 17.

18. When NO. OF X-AXIS INTERVALS: (<=16)? is displayed:

a. Enter: The number of X-axis intervals (≤16).

b. Press: (END LINE)

Note: If the number of intervals is not in the range of 1 to 16, the program will beep and go to step 18.

19. When NUMBER OF X-INT. BETWEEN LABELS? is displayed:

a. Enter: The number of X-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.

b. Press: (END LINE)

OR:

a. Enter: 0 if no labels are desired on the X-axis.

b. Press: (END LINE)

Note: If the number of intervals is not in the range of 0 to the entered number of X-intervals, the program will beep and go to step 19.

20. When AUTO Y-SCALING:Y/N? is displayed:

a. Enter: Y, if the Y-minimum and Y-maximum values are to be used by the program.

b. Press: (END LINE)

c. Go to step 23.

OR:

a. Enter: N, if you want to enter the Y-minimum and Y-maximum values.

b. Press: (END LINE)

Note: By specifying the end points you can have better control of the axis labels.

Note: You must enter either "Y" or "N" or the program will beep and go to step 20.

21. When ENTER SCALE YMIN? is displayed:

a. Enter: The minimum Y value of scaling.

b. Press: (END LINE)

22. When ENTER SCALE YMAX? is displayed:

a. Enter: The maximum Y value for scaling.

b. Press: (END LINE)

Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 21.

23. When NO. OF Y-AXIS INTERVALS:(<=12)? is displayed:
    a. Enter: The number of Y-axis intervals (<=12).
    b. Press: (END LINE)

    Note: If the number of intervals is not in the range of 1 to 12, the program will beep and go to step 23.

24. When NUMBER OF Y-INT. BETWEEN LABELS? is displayed:
    a. Enter: The number of Y-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
    b. Press: (END LINE)

    OR:

    a. Enter: 0 if no labels are desired on the Y-axis.
    b. Press: (END LINE)

    Note: If the number of intervals is not in the range of 0 to the entered number of Y-intervals, the program will beep and go to step 24.

25. After DONE is displayed or the plot is finished, any of the options can be selected.
    a. Press: KEY #2 (OUTPUT), to output the data to either the printer or a tape file.
    b. Go to step 26.

    OR:

    a. Press: KEY #6 (EDIT), to edit the data.
    b. Go to step 31.

    OR:

    a. Select the desired regression type by pressing the proper key as shown below:
       KEY #3 (LINEAR)
       KEY #4 (EXP)
       KEY #7 (LOG)
       KEY #8 (POWER)
    b. Go to step 39.

    Note: If CAN'T TAKE LOG is displayed, the data contains values less than or equal to 0 and this regression cannot be done. The program returns to step 25.

26. When PRINT DATA:Y/N? is displayed:
    a. Enter: Y, to print the data.
    b. Press: (END LINE)

    OR:

    a. Enter: N, if a printout of the data is not wanted.
    b. Press: (END LINE)

    Note: You must enter either "Y" or "N" or the program will beep and go to step 26.

27. When STORE DATA:Y/N? is displayed:
    a. Enter: Y, if you want to store the data.
    b. Press: (END LINE)
    c. Go to step 28.

    OR:

    a. Enter: N, if you do not want to store the data.
    b. Press: (END LINE)
    c. Go to step 30.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 27.

28. When ENTER NAME OF FILE? is displayed:
    a. Enter: The file name.
    b. Press: (END LINE)

29. When CREATE FILE:Y/N? is displayed:
    a. Enter: Y, to create the file.
    b. Press: (END LINE)

    OR:

    a. Enter: N, if the file already exists.
    b. Press: (END LINE)

Note: You must enter either "Y" or "N" or the program will beep and go to step 29.

30. When DONE is displayed, go to step 25.
31. When 0=OK, 1=CORRECT, 2=DELETE, 3=INSERT? is displayed:
    a. Enter: 0, if the edit is finished.
    b. Press: END LINE
    c. Go to step 38.

    Note: The program will now re-compute values for the curve fitting and allow you to specify the plotting option.

    OR:

    a. Enter: 1, if you want to correct a data pair.
    b. Press: END LINE
    c. Go to step 32.

    OR:

    a. Enter: 2, if you want to delete a data pair.
    b. Press: END LINE
    c. Go to step 35.

    OR:

    a. Enter: 3, if you want to insert a data pair.
    b. Press: END LINE
    c. Go to step 36.
32. When INDEX OF PAIR TO CORRECT? is displayed:
    a. Enter: The index of the data pair.
    b. Press: END LINE
    c. Go to step 33.

    Note: If the index is greater than the number of data pairs in the data set, go to step 32 and re-enter the index.

    OR:

    a. Enter: A value less than 1 to terminate the correction mode.
    b. Press: END LINE
    c. Go to step 31.
33. When NEW X(_)=? is displayed:
    a. Enter: The correct value.
    b. Press: END LINE
34. When NEW Y(_)=? is displayed:
    a. Enter: The correct value.
    b. Press: END LINE
    c. Go to step 31.
35. When ENTER INDEX OF PAIR TO DELETE? is displayed:
    a. Enter: The index of the pair.
    b. Press: END LINE
    c. Go to step 31.

    Note: If the index is greater than the number of data pairs in the data set, go to step 35 and re-enter the index.

    OR:

    a. Enter: A value less than 1 to terminate the deletion mode.
    b. Press: END LINE
    c. Go to step 31.
36. When ENTER INDEX OF PAIR TO INSERT? is displayed:
    a. Enter: The index of the pair to insert before.
    b. Press: END LINE
    c. Go to step 37.

    Note: If the index is greater than the number of data pairs in the data set plus one, go to step 36 and re-enter the index.

    Note: If MAXIMUM NUMBER OF PAIRS = 200 is displayed, go to step 31 since there is no more room.

    OR:

    a. Enter: A value less than 1 to terminate the insertion mode.
    b. Press: END LINE
    c. Go to step 31.
37. When INSERT X(_),Y(_)? is displayed:
    a. Enter: The X and Y values separated by a comma.
    b. Press: END LINE
    c. Go to step 31.
38. When DONE is displayed, go to step 13.
39. When ESTIMATE Y:Y/N? is displayed:
    a. Enter: Y, if $\hat{y}$ is to be calculated.

b. Press: END LINE
c. Go to step 40.
OR:
a. Enter: N, if no estimates are desired.
b. Press: END LINE
c. Go to step 43.

Note: You must enter either "Y" or "N" or the program will beep and go to step 39.

40. When AT ALL X(I):Y/N? is displayed:
a. Enter: Y, if estimates of Y at all entered X-values are desired.
b. Press: END LINE
c. Go to step 41.
OR:
a. Enter: N, if all are not desired.
b. Press: END LINE
c. Go to step 42.

Note: You must enter either "Y" or "N" or the program will beep and go to step 40.

41. When ESTIMATE Y AT ENTERED X:Y/N? is displayed:
a. Enter: Y, to obtain an estimate of Y.
b. Press: END LINE
c. Go to step 42.
OR:
a. Enter: N, if no more estimates are desired.
b. Press: END LINE
c. Go to step 43.

Note: You must enter either "Y" or "N" or the program will beep and go to step 41.

42. When ESTIMATE Y AT X=? is displayed:
a. Enter: The X-value for computing the Y estimate.
b. Press: END LINE

43. If plotting was selected during entry and PLOT:Y/N? is displayed:
a. Enter: Y, if the regression curve is to be plotted.
b. Press: END LINE
c. Go to step 45.
OR:
a. Enter: N, if the plot is not wanted.
b. Press: END LINE
c. Go to step 25.

Note: You must enter either "Y" or "N" or the program will beep and go to step 43.

44. If plotting was not done during entry, go to step 25.

45. When LABEL PLOT:Y/N? is displayed:
a. Enter: Y, if you want to label the plot.
b. Press: END LINE
c. Go to step 46.
OR:
a. Enter: N, if no label is desired.
b. Press: END LINE
c. Go to step 25.

Note: You must enter either "Y" or "N" or the program will beep and go to step 45.

46. When LABEL ORIGIN:X,Y? is displayed:
a. Enter: The X and Y coordinates where the label is to start.
b. Press: END LINE

Note: If INVALID POSITION is displayed, the entered coordinates are out of the scale limits and the program goes to step 46.

Note: To aid label positioning the following variables may be useful to use.

Variable Name	Description
X0	Minimum X-scaled value
Y0	Minimum Y-scaled value
X1	X-value at axes intercept
Y1	Y-value at axes intercept
X2	X-value at right end of X-axis
Y2	Y-value at top end of Y-axis
Z1	X2—X1
Z2	Y2—Y1
D1	Distance of a dot in X-direction
D2	Distance of a dot in Y-direction

47. When ENTER LABEL? is displayed:

a. Enter: The label.
b. Press: (END LINE)

Note: If LABEL TOO LONG is displayed, the program beeps and goes to step 47.

48. After the label has been drawn, go to step 45.

Example 1:

The following table contains temperature data in degrees Fahrenheit and degrees Celsius. Assume that you do not know the relationship of the two scales and derive the equation using linear regression of the form:

$$F° = a + bC°$$

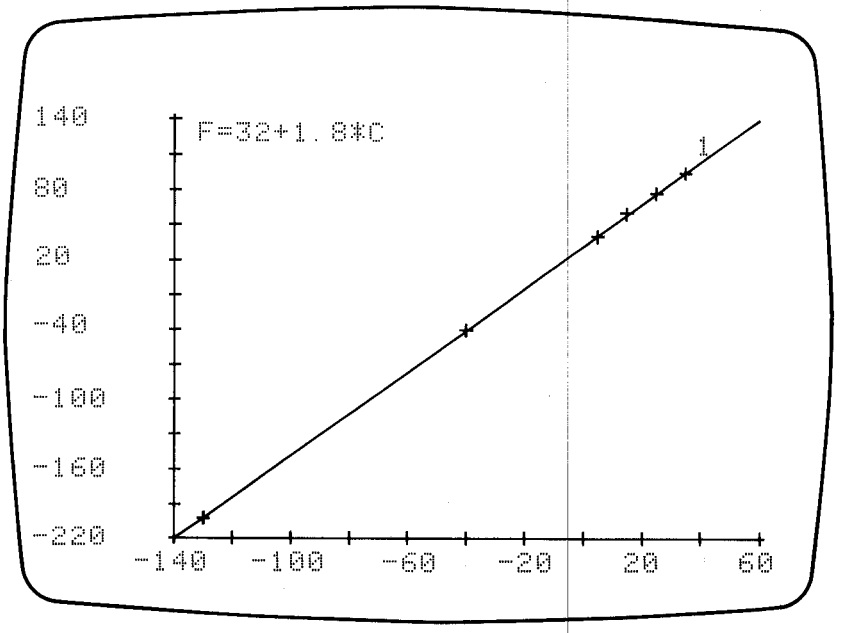
Temperature Values

Celsius	-130	-40	5	15	25	35
Fahrenheit	-202	-40	41	59	77	95

Plot the input and the regression line.

Using the regression curve, what is the temperature in degrees Fahrenheit when C = 22°?

```
   AOV: LINEAR REG:CODE 1
SOURCE/DF       SS        MS        F
TOTAL  5   62370.0
REG    1   62370.0  62370.0  999.9
RESID  4       0.0      0.0
R SQUARE =           1.000

YHAT =     32.000 +        1.800 X

    X(I)        YHAT
    22.00      71.60
```



Example 2:

Many compression processes can be correlated using the power curve

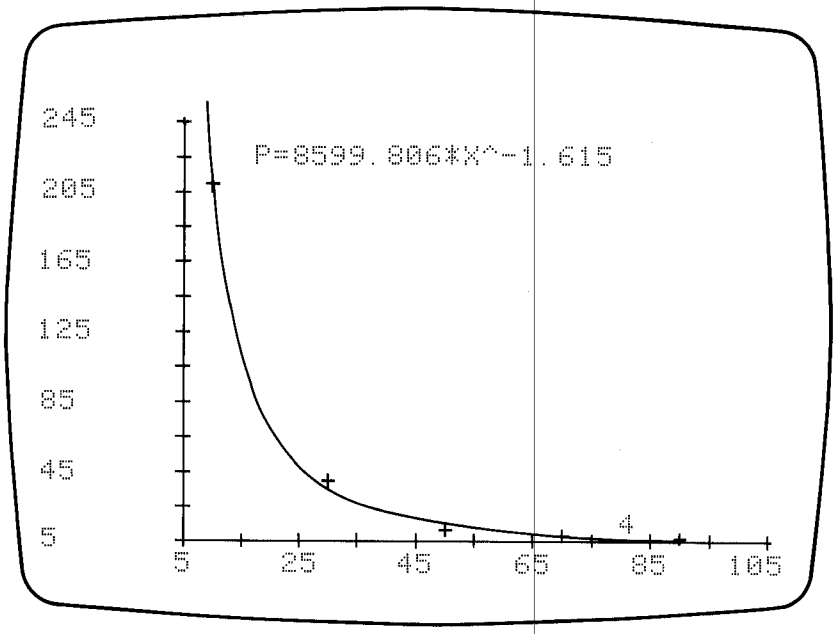
$$p = av^{-b}$$

where b is the polytropic constant of the process.

Pressure-volume data for a compression process is shown below. Run a power curve fit to determine the polytropic constant, $-b$. What is the pressure when v is 15?

v	p
10	210
30	40
50	12
70	9
90	6.8

```
    AOV: POWER: CODE 4
SOURCE/DF       SS        MS        F
TOTAL  4        8.0
REG    1        7.9       7.9  245.5
RESID  3        0.1       0.0
R SQUARE =          0.988

YHAT=  8599.806X ^      -1.615
    X(I)        YHAT
   15.00     108.35
```



Auto Function Plot

This program will automatically set up the scaling factors and plot a user defined function. You must store the function as a single or multi-line function starting at line 5000 before running this program. Up to 25 points of singularity can be entered which will be checked and skipped before calling the function. A table of values can also be printed at your request.

Most of the work involved with plotting is taken care of by this program, but since this program is designed to plot a general function, it has some generalities built into it. The formatting of the labels and the positioning of the axes are areas which may need customization if your plots do not lend themselves to the spacing provided.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "FPLOT"
   b. Press: (END LINE)
3. Type the function, FNF, to be plotted starting at line 5000.
   Note: Make sure that any lines after line 5000 which are not in your function are deleted before running the program.
4. To start the program:
   a. Press: (RUN)
5. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP) if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 5.
   OR:
   a. Press: KEY #1 (DEFINE) to enter the scale parameters.
   b. Go to step 6.
6. When ENTER SCALE XMIN? is displayed:
   a. Enter: The minimum X-value.
   b. Press: (END LINE)
7. When ENTER SCALE XMAX? is displayed:
   a. Enter: The maximum X-value.
   b. Press: (END LINE)

   Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 6.
8. When VERTICAL/HORIZONTAL LABELS: V/H? is displayed:
   a. Enter: V, if the X-axis labels are to be written vertically.
   b. Press: (END LINE)
   OR:
   a. Enter: H, if the X-axis labels are to be written horizontally.
   b. Press: (END LINE)

   Note: You must enter either "V" or "H" or the program will beep and go to step 8.
9. When NO. OF X-AXIS INTERVALS: (<=16)? is displayed:
   a. Enter: The number of X-axis intervals (<=16).
   b. Press: (END LINE)

   Note: If the number of intervals is not in the range of 1 to 16, the program will beep and go to step 9.

10. When NUMBER OF X-INT. BETWEEN LABELS? is displayed:
    a. Enter: The number of X-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
    b. Press: (END LINE)

    OR:

    a. Enter: 0, if no labels are desired on the X-axis.
    b. Press: (END LINE)

    Note: If the number of intervals is not in the range of 0 to the entered number of X-intervals, the program will beep and go to step 10.

11. When AUTO SCALING: Y/N? is displayed:
    a. Enter: Y, if the plotting area is to be scaled using the Y-values generated over the range of XMIN to XMAX.
    b. Press: (END LINE)
    c. Go to step 14.

    OR:

    a. Enter: N, if you want to enter the Y-scaling information.
    b. Press: (END LINE)

    Note: By specifying the end points, you can have better control of the axis labels.

    Note: You must enter "Y" or "N" or the program will beep and go to step 11.

12. When ENTER SCALE YMIN? is displayed:
    a. Enter: The minimum Y-value.
    b. Press: (END LINE)

13. When ENTER SCALE YMAX? is displayed:
    a. Enter: The maximum Y-value.
    b. Press: (END LINE)

    Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 12.

14. When NUMBER OF Y-AXIS INTERVALS: (<=12)? is displayed:
    a. Enter: The number of Y-axis intervals (<=12).
    b. Press: (END LINE)

    Note: If the number of intervals is not in the range of 1 to 12, the program will beep and go to step 14.

15. When NUMBER OF Y-INT. BETWEEN LABELS? is displayed:
    a. Enter: The number of Y-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
    b. Press: (END LINE)

    OR:

    a. Enter: 0, if no labels are desired on the Y-axis.
    b. Press: (END LINE)

    Note: If the number of intervals is not in the range of 0 to the entered number of Y-intervals, the program will beep and go to step 15.

16. After scaling the plotting area and entering the function at line 5000, select the options using the specified function keys:
    a. Press: KEY #2 (SINGUL) to enter points of singularity.
    b. Go to step 17.

    OR:

    a. Press: KEY #3 (FUL PLT) to generate a full plot.
    b. Go to step 19.

    Note: This operation will clear the graphics screen and redraw the axes with labels.

    OR:

    a. Press: KEY #4 (TABLE) to generate a table of function values on the printer.
    b. Go to step 26.

OR:

a. Press: KEY #7 (PLOT) to plot the function only over a specified range.
b. Go to step 19.
OR:
a. Press: KEY #8 (LABEL) to label the plot at an entered position.
b. Go to step 31.

17. When ENTER POINT OF SINGULARITY_? is displayed:
a. Enter: The point of singularity.
b. Press: (END LINE)

18. When MORE POINTS:Y/N?" is displayed:
a. Enter: Y, to enter more points.
b. Press: (END LINE)
c. Go to step 17.
Note: If NO MORE CAN BE ENTERED, SINCE 25 POINTS HAVE BEEN ENTERED is displayed, go to step 16.
OR:
a. Enter: N, if there are no more points.
b. Press: (END LINE)
c. Go to step 16.
Note: You must enter "Y" or "N" or the program will beep and go to step 18.

19. When ENTER XMIN? is displayed:
a. Enter: The minimum X-value to be plotted.
b. Press: (END LINE)

20. When ENTER XMAX? is displayed:
a. Enter: The maximum X-value to be plotted.
b. Press: (END LINE)

21. When ENTER INCREMENT? is displayed:
a. Enter: The increment for plotting.
b. Press: (END LINE)
c. Go to step 23.
OR:
a. Enter: 0 if the number of intervals is to be entered rather than the increment size.
b. Press: (END LINE)

22. When ENTER # PLOT INCREMENTS? is displayed:
a. Enter: The number of plot increments.
b. Press: (END LINE)

23. After the plot is finished, the program will beep.

24. If another option is desired using the same function, go to step 16.

25. If a new function is desired:
a. Press: (STEP PAUSE)
b. Go to step 3.

26. When ENTER XMIN? is displayed:
a. Enter: The minimum X-value to be printed.
b. Press: (END LINE)

27. When ENTER XMAX? is displayed:
a. Enter: The maximum X-value to be printed.
b. Press: (END LINE)

28. When ENTER INCREMENT? is displayed:
a. Enter: The increment for printing.
b. Press: (END LINE)
c. Go to step 30.
OR:
a. Enter: 0 if the number of intervals is to be entered rather than the increment size.
b. Press: (END LINE)

29. When ENTER # PLOT INCREMENTS? is displayed:
a. Enter: The number of increments for printing the table.
b. Press: (END LINE)

30. After the table is printed, go to step 24.

31. When LABEL ORIGIN:X,Y ? is displayed:
a. Enter: The X and Y coordinates where the label is to start.
b. Press: (END LINE)

Note: If INVALID POSITION is displayed, the entered coordinates are out of the scale limits and the program goes to step 31.

Note: To aid label positioning the following variables may be useful.

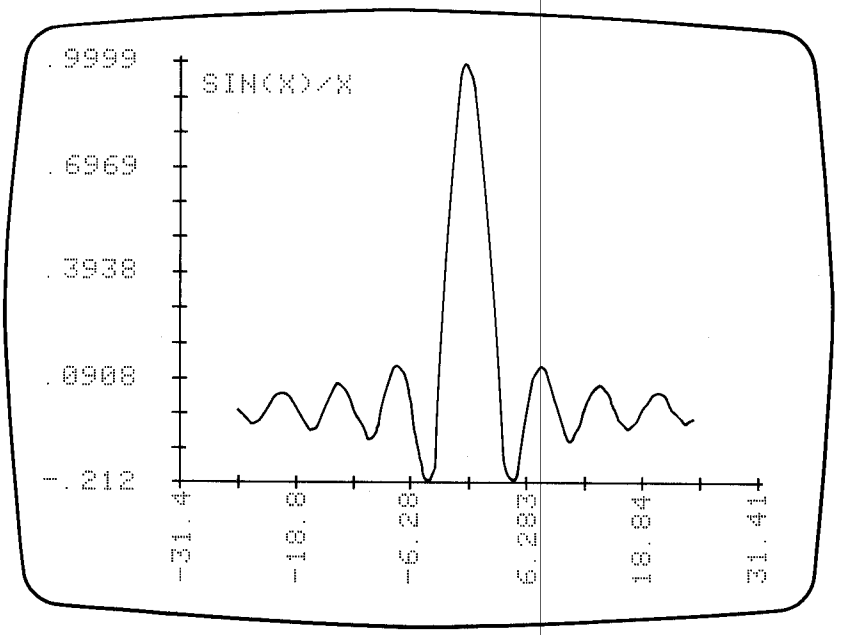
Variable Name	Description
X0	Minimum X-scaled value
Y0	Minimum Y-scaled value
X1	X-value at axes intercept
Y1	Y-value at axes intercept
X2	X-value at right end of X-axis
Y2	Y-value at top end of Y-axis
Z1	X2—X1
Z2	Y2—Y1
D1	Distance of a dot in X-direction
D2	Distance of a dot in Y-direction

32. When ENTER LABEL? is displayed:
    a. Enter: The label.
    b. Press: END LINE

    Note: If LABEL TOO LONG is displayed, the program beeps and goes to step 32.
33. After the label has been drawn, go to step 24.

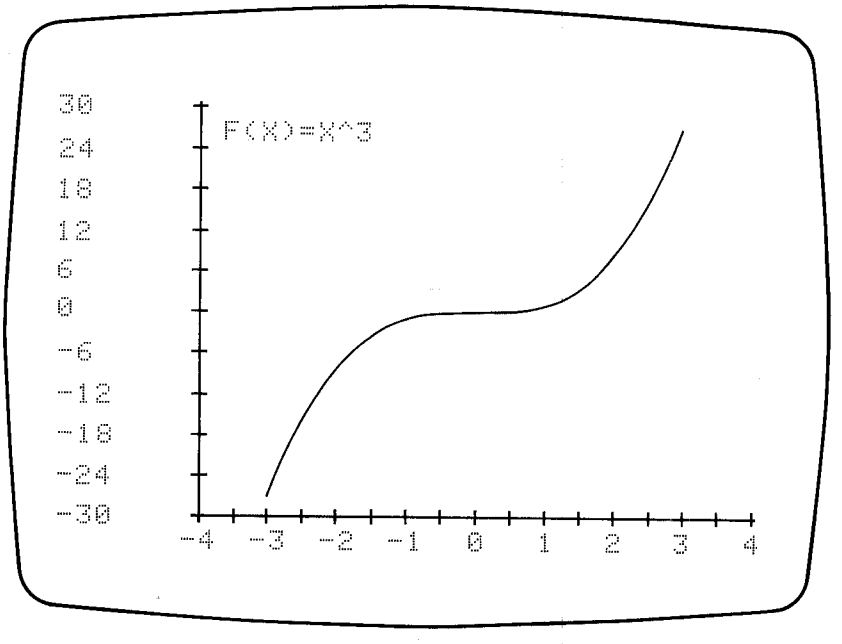
Example 1:

Using the default function, $f(x) = \text{SIN}(x)/x$, which is stored as DEF FNF(X) at line 5000, plot the function over the range of −8*PI to 8*PI using an increment of PI/4. The scaled range should be −10*PI to 10*PI. For the X-axis, specify vertical labels with 10 intervals and labels at every other tic. For the Y-axis, specify auto scaling with 12 intervals and labels at every 3 tics. Remember to enter 0 as a point of singularity.



Example 2:

Replace the default function with X^3 and generate a plot from −3 to 3 using an increment of .05 on a scaled range of −4 to 4. For the X-axis, specify horizontal labels with 16 intervals and labels at every other tic. For the vertical scale, enter a scale maximum of 30 and a minimum of −30. The Y-axis should have 10 intervals with labels at every tic.



Notes

Auto Data Plot

This program will automatically set up the scaling factors and plot a user entered set of paired data. You can either enter the data from the keyboard or from a data file. The data set can contain up to 200 data points.

After the data has been entered, you can print it, edit it, and plot it. In the plot specification, you can specify the scale factors or let the program automatically set up the scale factors. You are able to select tic spacing and label spacing on each axis. The X-axis labels can either be vertical or horizontal. You can also specify no labels on an axis if you wish. After the plot is completed, you can draw a grid or label the plot.

As with other generalized plotting programs, the program may not suit your needs. The formatting of the labels and the position of the axes are areas which may need customization if your plots do not lend themselves to the spacing provided.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "DPLOT"
   b. Press: (END LINE)
3. To run the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP) if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.

   OR:

   a. Press: KEY #1 (ENTER) to enter the data.
   b. Go to step 5.
5. When PRINT DATA ON INPUT: Y/N? is displayed:
   a. Enter: Y, if the data is to be printed on entry.
   b. Press: (END LINE)

   OR:

   a. Enter: N, if the data is not to be printed on entry.
   b. Press: (END LINE)

   Note: You must enter either "Y" or "N" or the program will beep and go to step 5.
6. When ENTER FROM KEYBOARD/TAPE: K/T? is displayed:
   a. Enter: K, if the data is to be entered one pair at a time from the keyboard.
   b. Press: (END LINE)
   c. Go to step 7.

   OR:

   a. Enter: T, if the data in a data file is to be entered.
   b. Press: (END LINE)
   c. Go to step 11.

   Note: You must enter either "K" or "T" or the program will beep and go to step 6.
7. When ENTER NUMBER OF POINTS: 200 MAX. ? is displayed:
   a. Enter: The number of data points.
   b. Press: (END LINE)

   Note: If the number of points is not valid,

INVALID NUMBER OF POINTS will be displayed and the program will go to step 7.

8. When X(_),Y(_)? is displayed:
   a. Enter: The specified point values.
   b. Press: END LINE
9. Repeat step 8 for each point.
10. Go to step 12.
11. When ENTER FILE NAME? is displayed:
    a. Enter: The file name.
    b. Press: END LINE
    c. After the data has been loaded go to step 12.

    Note: If the file does not exist, go to step 11.
12. When the data has been entered, select the desired option using the specified function keys:
    a. Press: KEY #2 (OUTPUT) to output the array values to the printer or to the tape.
    b. Go to step 13.

    OR:

    a. Press: KEY #3 (SETUP) to set up the scale and axes.
    b. Go to step 18.

    OR:

    a. Press: KEY #4 (PLOT) to plot the data on the currently defined axes. Set up first.
    b. Go to step 30.

    OR:

    a. Press: KEY #6 (EDIT) to edit the data in memory.
    b. Go to step 34.

    OR:

    a. Press: KEY #7 (GRID) to draw a grid at the label positions. Set up first.
    b. Go to step 12 after the grid has been drawn.

    OR:

    a. Press: KEY #8 (LABEL) to label the plot at an entered position. Set up first.
    b. Go to step 42.

    OR:

    a. Go to step 4 for a new data set.
13. When PRINT DATA:Y/N? is displayed:
    a. Enter: Y, if the data is to be printed.
    b. Press: END LINE

    OR:

    a. Enter: N, if the data is not to be printed.
    b. Press: END LINE

    Note: You must enter either "Y" or "N" or the program will beep and go to step 13.
14. When STORE DATA:Y/N? is displayed:
    a. Enter: Y, to store the data.
    b. Press: END LINE
    c. Go to step 15.

    OR:

    a. Enter: N, to not store the data.
    b. Press: END LINE
    c. Go to step 12.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 14.
15. When ENTER FILE NAME? is displayed:
    a. Enter: The file name.
    b. Press: END LINE
16. When CREATE FILE:Y/N? is displayed:
    a. Enter: Y, if the file must be created.
    b. Press: END LINE

    OR:

    a. Enter: N, if the file already exists.
    b. Press: END LINE

    Note: You must enter either "Y" or "N" or the program will beep and go to step 16.

    Note: If any errors occur when storing the data, the program will go to step 15.
17. After the data has been stored, go to step 12.
18. When AUTO X-SCALING:Y/N? is displayed:
    a. Enter: Y, if the X-minimum and X-maximum values are to be used by the program.
    b. Press: END LINE
    c. Go to step 21.

OR:

a. Enter: N, if you want to enter the X-minimum and X-maximum values.

b. Press: (END LINE)

Note: By specifying the end points you can have better control of the axis labels.

Note: You must enter either "Y" or "N" or the program will beep and go to step 18.

19. When ENTER SCALE XMIN? is displayed:

a. Enter: The minimum X-value for scaling.

b. Press: (END LINE)

20. When ENTER SCALE XMAX? is displayed:

a. Enter: The maximum X-value for scaling.

b. Press: (END LINE)

Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 19.

21. When VERTICAL/HORIZONTAL LABELS: V/H? is displayed:

a. Enter: V, if the X-axis labels are to be written vertically.

b. Press: (END LINE)

OR:

a. Enter: H, if the X-axis labels are to be written horizontally.

b. Press: (END LINE)

Note: You must enter either "V" or "H" or the program will beep and go to step 21.

22. When NO. OF X-AXIS INTERVALS: (<=16)? is displayed:

a. Enter: The number of X-axis intervals (≤16).

b. Press: (END LINE)

Note: If the number of intervals is not in the range of 1 to 16, the program will beep and go to step 22.

23. When NUMBER X-INT. BETWEEN LABELS? is displayed:

a. Enter: The number of X-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.

b. Press: (END LINE)

OR:

a. Enter: 0 if no labels are desired on the X-axis.

b. Press: (END LINE)

Note: If the number of intervals is not in the range of 0 to the entered number of X-intervals, the program will beep and go to step 23.

24. When AUTO Y-SCALING: Y/N? is displayed:

a. Enter: Y, if the Y-minimum and Y-maximum values are to be used by the program.

b. Press: (END LINE)

c. Go to step 27.

OR:

a. Enter: N, if you want to enter the Y-minimum and Y-maximum values.

b. Press: (END LINE)

Note: By specifying the end points you can have better control of the axis labels.

Note: You must enter either "Y" or "N" or the program will beep and go to step 24.

25. When ENTER SCALE YMIN? is displayed:

a. Enter: The minimum Y value for scaling.

b. Press: (END LINE)

26. When ENTER SCALE YMAX? is displayed:

a. Enter: The maximum Y value for scaling.

b. Press: (END LINE)

Note: If the maximum value is less than or equal to the minimum value, the program will beep and go to step 25.

27. When NO. OF Y-AXIS INTERVALS: (<=12)? is displayed:

a. Enter: The number of Y-axis intervals (<=12).
b. Press: END LINE

Note: If the number of intervals is not in the range of 1 to 12, the program will beep and go to step 27.

28. When NUMBER Y-INT. BETWEEN LABELS? is displayed:
    a. Enter: The number of Y-intervals between labels, e.g., if labels are desired at every other tic, the number of intervals between labels is 2.
    b. Press: END LINE

    OR:

    a. Enter: 0 if no labels are desired on the Y-axis.
    b. Press: END LINE

    Note: If the number of intervals is not in the range of 0 to the entered number of Y-intervals, the program will beep and go to step 28.
29. When PLOT DEFINED is displayed, go to step 12.
30. When INDEX OF FIRST POINT? is displayed:
    a. Enter: The array index of the first point to be plotted.
    b. Press: END LINE

    Note: If the value is less than one, the program assumes that the value is one.

    Note: If MAXIMUM NUMBER OF POINTS IS__ is displayed, the program goes to step 30.
31. When INDEX OF LAST POINT? is displayed:
    a. Enter: The index of the last point to be plotted.
    b. Press: END LINE

    Note: If MAXIMUM NUMBER OF POINTS IS__ is displayed, the program goes to step 31.

    Note: If LAST POINT IS < FIRST is displayed, the program goes to step 30.
32. When LINE TYPE: LINE/DOT/+/o(1,2,3,4)? is displayed:
    a. Enter: The code for the desired line type (1, 2, 3, or 4).
    b. Press: END LINE

    Note: If INVALID LINE TYPE is displayed, the program beeps and goes to step 32.
33. After the plot is finished, go to step 12.
34. When 0=OK,1=CORRECT,2=DELETE,3=INSERT? is displayed:
    a. Enter: 0 if the edit is finished.
    b. Press: END LINE
    c. Go to step 12.

    OR:

    a. Enter: 1 if you want to correct a data pair.
    b. Press: END LINE
    c. Go to step 35.

    OR:

    a. Enter: 2, if you want to delete a data pair.
    b. Press: END LINE
    c. Go to step 38.

    OR:

    a. Enter: 3, if you want to insert a data pair.
    b. Press: END LINE
    c. Go to step 39.
35. When ENTER INDEX OF PAIR TO CORRECT? is displayed:
    a. Enter: The index of the data pair.
    b. Press: END LINE
    c. Go to step 36.

    Note: If the index is greater than the number of data pairs in the data set, go to step 35 and re-enter the index.

    OR:

a. Enter: A value less than 1 to terminate the correction mode.
b. Press: END LINE
c. Go to step 34.

36. When NEW X(_)=? is displayed:
a. Enter: The correct value.
b. Press: END LINE

37. When NEW Y(_)=? is displayed:
a. Enter: The correct value.
b. Press: END LINE
c. Go to step 34.

38. When ENTER INDEX OF PAIR TO DELETE? is displayed:
a. Enter: The index of the pair.
b. Press: END LINE
c. Go to step 34.

Note: If the index is greater than the number of data pairs in the data set, go to step 38 and re-enter the index.

OR:

a. Enter: A value less than 1 to terminate the deletion mode.
b. Press: END LINE
c. Go to step 34.

39. When ENTER INDEX OF PAIR TO INSERT? is displayed:
a. Enter: The index of the pair.
b. Press: END LINE
c. Go to step 40.

Note: If the index is greater than the number of data pairs in the data set plus one, go to step 39 and re-enter the index.

Note: If MAXIMUM NUMBER OF PAIRS = 200 is displayed, go to step 34 since there is no more room.

OR:

a. Enter: A value less than 1 to terminate the insertion mode.
b. Press: END LINE
c. Go to step 34.

40. When INSERT X(_)=? is displayed:
a. Enter: The X value.
b. Press: END LINE

41. When INSERT Y(_)=? is displayed:
a. Enter: The Y value.
b. Press: END LINE
c. Go to step 34.

42. When LABEL ORIGIN:X,Y? is displayed:
a. Enter: The X and Y coordinates where the label is to start.
b. Press: END LINE

Note: If INVALID POSITION is displayed, the entered coordinates are out of the scale limits and the program will beep and go to step 42.

Note: To aid label positioning the following variables may be useful to use.

Variable Name	Description
X0	Minimum X-scaled value
Y0	Minimum Y-scaled value
X1	X-value at axes intercept
Y1	Y-value at axes intercept
X2	X-value at right end of X-axis
Y2	Y-value at top end of Y-axis
Z1	X2—X1
Z2	Y2—Y1
D1	Distance of a dot in X-direction
D2	Distance of a dot in Y-direction

43. When ENTER LABEL? is displayed:
a. Enter: The label.
b. Press: END LINE

Note: If LABEL TOO LONG is displayed, the program beeps and goes to step 43.

44. After the label has been drawn, go to step 12.

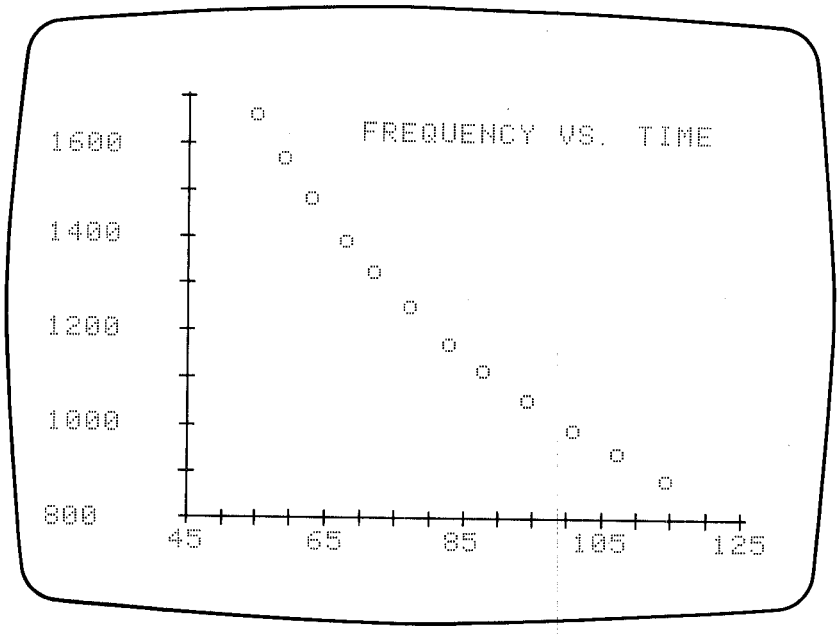
1. The following data was obtained using the BEEP conversion functions in the owner's manual and is to be plotted.

Frequency Parameter	Duration Parameter
114	883
107	935
101	985
94	1050
88	1113
83	1171
77	1250
72	1324
68	1390
63	1483
59	1566
55	1659

The example plot was done using the responses shown in the table below:

Question	Response
AUTO X-SCALING:Y/N	N
ENTER SCALE XMIN	45
ENTER SCALE XMAX	125
VERTICAL/HORIZONTAL LABELS:V/H	H
NO. OF X-AXIS INTERVALS (<=16)	16
NUMBER X-INT. BETWEEN LABELS	4
AUTO Y-SCALING:Y/N	N
ENTER SCALE YMIN	800
ENTER SCALE YMAX	1700
NO. OF Y-AXIS INTERVALS (<=12)	9
NUMBER Y-INT. BETWEEN LABELS	2
INDEX OF FIRST POINT	1
INDEX OF LAST POINT	12
LINE TYPE:LINE/DOT/+/o(1,2,3,4)	4

I	X(I)	Y(I)
1	114.0000	883.0000
2	107.0000	935.0000
3	101.0000	985.0000
4	94.0000	1050.0000
5	88.0000	1113.0000
6	83.0000	1171.0000
7	77.0000	1250.0000
8	72.0000	1324.0000
9	68.0000	1390.0000
10	63.0000	1483.0000
11	59.0000	1566.0000
12	55.0000	1659.0000


FREQUENCY VS. TIME
1600
1400
1200
1000
800
45
65
85
105
125

Notes

Histogram Generator

This program will draw a histogram based on user entered data. The data can be entered either from the keyboard or from a tape file. Once the data has been entered, it can be edited, printed, plotted, stored and output with cell statistics. The program will automatically sort up to 200 values into from 1 to 50 intervals or bins of equal width specified by you. The histogram which is generated will be scaled automatically and labelled. The cell limit labels are limited to 5 spaces. If the labels take more space than this, they will be defaulted to a general message stating the cell size and the starting value.

Since this program has been designed to draw histograms for a generalized data base, there are aspects which could be changed to fit a particular data base. The major limitation in designing a program for a generalized data base, is in the formatting of the output. The spacing for the labelling of the histogram may be insufficient for some applications, but also be too large for others. The size of the data base was arbitrarily set at 200 and the maximum number of cells was set at 50. Both of these limits were selected to fit the anticipated needs of the average user, but can be changed if the data base is larger or the desired number of cells is larger. To make any changes to the program, you should refer to the documentation of this program for further assistance.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "HISTO"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.
   OR:
   a. Press: KEY #1 (ENTER) to enter the data.
5. When PRINT DATA ON INPUT : Y/N? is displayed:
   a. Enter: Y, if the data is to be printed on entry.
   b. Press: (END LINE)
   OR:
   a. Enter: N, if the data is not to be printed.
   b. Press: (END LINE)

   Note: You must enter either "Y" or "N" or the program will beep and go to step 5.
6. When ENTER FROM KEYBOARD OR TAPE : K/T? is displayed:
   a. Enter: K, if the data is to be entered from the keyboard.
   b. Press: (END LINE)
   OR:
   a. Enter: T, if the data is on a tape file.
   b. Press: (END LINE)
   c. Go to step 11.

   Note: You must enter either "K" or "T" or the program will beep and go to step 6.
7. When ENTER NUMBER OF POINTS? is displayed:

a. Enter: The number of points.
b. Press: (END LINE)

Note: If the number of points is not in the range of 2 to 200, go to step 7 and enter a number in the acceptable range.

8. When X(__)? is displayed:
   a. Enter: The value specified.
   b. Press: (END LINE)
9. Repeat step 8 for each value.
10. Go to step 12.
11. When ENTER FILE NAME? is displayed:
    a. Enter: The file name.
    b. Press: (END LINE)
    c. After the data has been loaded go to step 12.

    Note: If the file does not exist, go to step 11.
12. When the data has been entered and DONE is displayed, select the desired option using the specified function keys:
    a. Press: KEY #2 (OUTPUT) to output the array values to the printer or to the tape.
    b. Go to step 13.

    OR:

    a. Press: KEY #3 (PLOT) to plot the histogram.
    b. Go to step 19.

    OR:

    a. Press: KEY #4 (NORMAL) to have a normal curve overlaid over the plot.
    b. Go to step 12.

    OR:

    a. Press: KEY #6 (EDIT) to edit the data in memory.
    b. Go to step 24.

    OR:

    a. Press: KEY #7 (LABEL) to label the plot at an entered position.
    b. Go to step 30.

    OR:

    a. Press: KEY #8 (COPY) to print the cell statistics and copy the histogram to the printer.
    b. Go to step 12.
13. When PRINT DATA:Y/N? is displayed:
    a. Enter: Y, if the data is to be printed.
    b. Press: (END LINE)
    c. Go to step 14.

    OR:

    a. Enter: N, if the data is not to be printed.
    b. Press: (END LINE)
    c. Go to step 15.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 13.
14. When PRINT DATA ON PRINTER/DISP:P/D? is displayed:
    a. Enter: P, if the data is to be printed on the printer.
    b. Press: (END LINE)

    OR:

    a. Enter: D, if the data is to be printed on the display.
    b. Press: (END LINE)

    Note: You must enter either "P" or "D" or the program will beep and go to step 14.
15. When STORE DATA:Y/N? is displayed:
    a. Enter: Y, to store the data.
    b. Press: (END LINE)
    c. Go to step 16.

    OR:

    a. Enter: N, to not store the data.
    b. Press: (END LINE)
    c. Go to step 12.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 15.
16. When ENTER NAME OF FILE? is displayed:
    a. Enter: The file name.
    b. Press: (END LINE)
17. When CREATE FILE:Y/N? is displayed:

a. Enter: Y, if the file must be created.
b. Press: END LINE

OR:

a. Enter: N, if the file already exists.
b. Press: END LINE

Note: You must enter either "Y" or "N" or the program will beep and go to step 17.

Note: If any errors occur when storing the data, the program will go to step 16.

18. After the data has been stored, go to step 12.
19. When OFFSET=? is displayed:
    a. Enter: The desired offset.
    b. Press: END LINE

    Note: If OFFSET TOO BIG: MAX VALUE=_ is displayed, go to step 19 and enter a smaller offset.
20. When # OF CELLS? is displayed:
    a. Enter: The number of cells.
    b. Press: END LINE

    Note: If # OF CELLS OUT OF BOUNDS: (1,50) is displayed, go to step 20 and enter a valid number of cells.
21. When OPTIMUM CELL WIDTH=_ CELL WIDTH? is displayed:
    a. Enter: The desired cell width.
    b. Press: END LINE

    Note: The optimum cell width is given by:

$$\frac{X_{max} - \text{offset}}{\#\text{ of cells}}$$

22. If _ OBS. TOO SMALL FOR OFFSET or _ OBS. TOO LARGE FOR OFFSET is displayed and then OFFSET & CELL WIDTH OK:Y/N? displayed:
    a. Enter: Y, if the specified information is acceptable.
    b. Press: END LINE

    OR:

    a. Enter: N, if you want to change the offset or cell width.
    b. Press: END LINE
    c. Go to step 19.

    Note: This case results when there are observations, i.e., data values, which fall outside of the specified range. (Offset, Offset + # Cells * Cell Width). The histogram will still be drawn if you want it.
23. After the histogram is generated, go to step 12.
24. When 0=OK,1=CORRECT,2= DELETE,3=INSERT? is displayed:
    a. Enter: 0 if the edit is finished.
    b. Press: END LINE
    c. Go to step 12.

    OR:

    a. Enter: 1 if you want to correct a data item.
    b. Press: END LINE
    c. Go to step 25.

    OR:

    a. Enter: 2 if you want to delete a data item.
    b. Press: END LINE
    c. Go to step 27.

    OR:

    a. Enter: 3 if you want to insert a data item.
    b. Press: END LINE
    c. Go to step 28.
25. When ENTER INDEX OF ITEM TO CORRECT? is displayed:
    a. Enter: The index of the item.
    b. Press: END LINE
    c. Go to step 26.

    Note: If the index is greater than the number in the data set, go to step 25 and re-enter the index.

    OR:

    a. Enter: A value less than 1 to terminate the correction mode.
    b. Press: END LINE
    c. Go to step 24.

26. When NEW X(_)=? is displayed:
    a. Enter: The correct value.
    b. Press: END LINE
    c. Go to step 24.
27. When ENTER INDEX OF ITEM TO DELETE? is displayed:
    a. Enter: The index of the item.
    b. Press: END LINE
    c. Go to step 24.

    Note: If the index is greater than the number of items in the data set, go to step 27 and re-enter the index.

    OR:

    a. Enter: A value less than 1 to terminate the deletion mode.
    b. Press: END LINE
    c. Go to step 24.
28. When ENTER INDEX OF ITEM TO INSERT? is displayed:
    a. Enter: The index of the item.
    b. Press: END LINE
    c. Go to step 29.

    Note: If the index is greater than the number of items in the data set plus one, go to step 28 and re-enter the index.

    Note: If MAXIMUM NUMBER OF ITEMS = 200 is displayed, go to step 24 since there is no more room.

    OR:

    a. Enter: A value less than 1 to terminate the insertion mode.
    b. Press: END LINE
    c. Go to step 24.
29. When INSERT X(_)=? is displayed:
    a. Enter: The X value.
    b. Press: END LINE
    c. Go to step 24.
30. When LABEL ORIGIN:X,Y? is displayed:
    a. Enter: The X and Y coordinates where the label is to start.
    b. Press: END LINE

    Note: If INVALID POSITION is displayed, the entered coordinates are out of the scale limits and the program goes to step 30.

    Note: To aid label positioning the following variables may be useful to use.

Variable Name	Description
X0	Minimum X-scaled value
Y0	Minimum Y-scaled value
O	Offset
N9	Maximum number of points in a cell
C	Cell width
D1	Distance of a dot in X-direction
D2	Distance of a dot in Y-direction

31. When ENTER LABEL? is displayed:
    a. Enter: The label.
    b. Press: END LINE

    Note: If LABEL TOO LONG is displayed, the program beeps and goes to step 31.
32. After the label has been drawn, go to step 12.

Example:

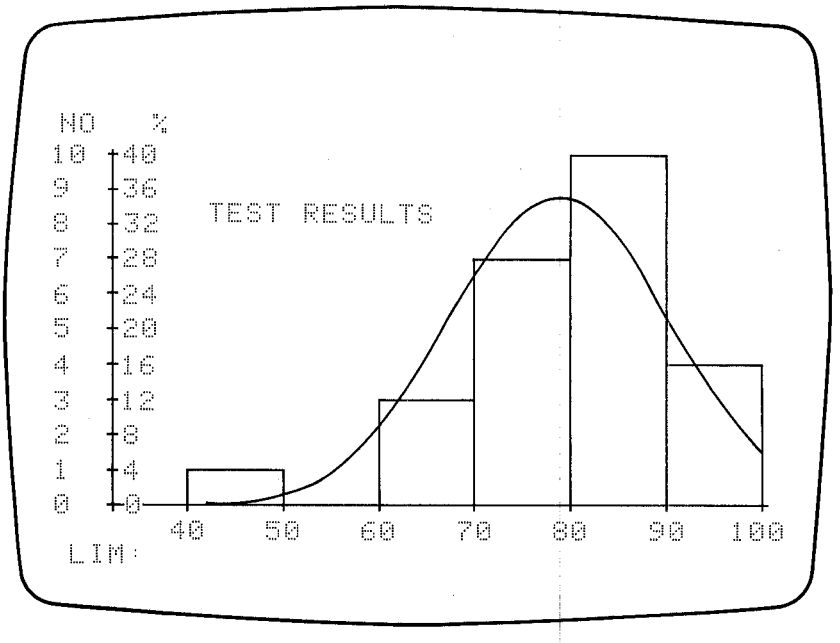
A teacher gave a test to 25 students and wishes to see a histogram of the results to determine whether the grades were skewed high or low. The test grades are shown below:

Student #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Grade	77	65	82	91	74	83	96	61	48	72	81	88	89	73	83	84	90	71	66	88	83	77	94	85	72

After entering the test scores, use the responses shown below to duplicate the example plot.

Question	Response
OFFSET=?	40
# OF CELLS	6
OPTIMUM CELL WIDTH = 9.33342666666	
CELL WIDTH?	10

```
   I          X(I)          X(I+1)
   1          77.0000       65.0000
   3          82.0000       91.0000
   5          74.0000       83.0000
   7          96.0000       61.0000
   9          48.0000       72.0000
  11          81.0000       88.0000
  13          89.0000       73.0000
  15          83.0000       84.0000
  17          90.0000       71.0000
  19          66.0000       88.0000
  21          83.0000       77.0000
  23          94.0000       85.0000
  25          72.0000

 OFFSET=                    40
 CELL WIDTH= 10
```



CELL STATISTICS

CELL#	LOWER LIMIT	NUMBER OF OBS.	%RELATIVE FREQUENCY
1	40.00	1	4.00
3	60.00	3	12.00
4	70.00	7	28.00
5	80.00	10	40.00
6	90.00	4	16.00

Arithmetic Teacher

Preschool and elementary school students may use this program to help them learn addition, subtraction, multiplication, and division. Secondary school students can test algebra skills using the algebra section of this program. The program randomly generates problems within a specified range which is defaulted to 9. A lesson consists of 10 correctly answered problems. After problem 10, the number correct on first and second tries and the total number of problems tried will be printed. The child can select any type of problem or a mixed set of arithmetic problems. The problem type will be printed after pressing the selection key.

The algebra section provides a basic drill in 4 types of algebra problems as shown:

$$ax = b$$
$$ax + b = c$$
$$a(x + b) = c$$
$$a(x - b) + c(x - d) = e$$

A student can select any type of algebra problem.

All problems require mental computation of the answer and check for usage of the computer to solve the problem. The random numbers are generated using the built-in generator. The seed used by the random number generator can be entered in the "START" section. When the lesson is finished, a report will be printed showing the student's success during the lesson.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "TEACH"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When WHAT IS YOUR NAME? is displayed:
   a. Enter: Your name. (<=32 characters)
   b. Press: (END LINE)
5. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 5.

   OR:
   a. Press: KEY #6 (START), if you want to specify either the maximum number size or the seed for generating the problems which are not as defaulted.
   b. Go to step 6.

   OR:
   a. Go to step 8 to select the problem type.
6. When ENTER MAXIMUM NUMBER? is displayed:
   a. Enter: The maximum value for factors.

b. Press: END LINE

Note: If MAXIMUM MUST BE POSITIVE is displayed, go to step 6 and enter a value greater than 1.

7. When ENTER OPTIONAL SEED:0=NONE? is displayed:
   a. Enter: A value for seeding the random number generator.
   b. Press: END LINE

   OR:

   a. Enter: 0, if no seed is to be used.
   b. Press: END LINE
8. To select problem type:
   a. Press: KEY #1 (+) for addition problems.
   b. Go to step 9.

   OR:

   a. Press: KEY #2 (−) for subtraction problems.
   b. Go to step 9.

   OR:

   a. Press: KEY #3 (*) for multiplication problems.
   b. Go to step 9.

   OR:

   a. Press: KEY #4 (/) for division problems.
   b. Go to step 9.

   OR:

   a. Press: KEY #7 (MIXED) for mixed addition, subtraction, multiplication, and division problems.
   b. Go to step 9.

   OR:

   a. Press: KEY #8 (ALGEBRA) for algebra problems.
   b. Go to step 14.

   OR:

   a. Go to step 5 to specify new problem conditions or obtain an explanation.
9. When ANSWER? is displayed:
   a. Enter: The answer to the displayed problem.
   b. Press: END LINE
10. If YOUR ANSWER IS WRONG. TRY AGAIN is displayed, go to step 9 and try again.
11. If YOUR ANSWER IS STILL WRONG RIGHT ANSWER IS__ is displayed, you entered the wrong answer twice.
12. Repeat steps 9-11 until you have answered 10 problems correctly on either the first or second try.
13. When your lesson is finished, the number of problems answered correctly on the first try, number of problems answered correctly on the second try, and the total number of problems tried will be printed.
    a. Go to step 5 to specify new problem conditions.

    OR:

    a. Go to step 8 to start a new problem set.
14. When the problem types and WHICH DO YOU WANT? are displayed:
    a. Enter: The type code (1-4) to specify the desired problem type.
    b. Press: END LINE

    Note: You must enter a number in the range of 1 to 4 or the program will go to step 14.
15. When the problem is displayed:
    a. Enter: The answer to the displayed problem:
    b. Press: END LINE
16. If YOUR ANSWER IS WRONG: TRY AGAIN is displayed, go to step 15 and try again.
17. If YOUR ANSWER IS STILL WRONG
    RIGHT ANSWER IS__ is displayed, you entered the wrong answer twice.
18. Repeat steps 15-17 until you have answered 10 problems correctly on either the first or second try.
19. Go to step 13.

Example 1:

Using PI as the seed for the random number generator and twelve as the maximum number, do a set of 10 multiplication problems.

```
MULTIPLICATION PROBLEMS
MAXIMUM FACTOR =  12

HI I. QUEUE
YOU GOT ALL YOUR PROBLEMS RIGHT
ON THE 1ST TRY. CONGRATULATIONS!
```

Example 2:

Using .61422533 as the seed for the random number generator and ten as the maximum number, do a set of 10 type 2 algebra problems.

```
ALGEBRA PROBLEMS:TYPE  2
MAXIMUM FACTOR =  10

HI I. QUEUE
YOU TRIED  10  PROBLEMS.
 9  WERE RIGHT ON THE 1ST TRY.
 1  WAS CORRECT ON THE 2ND TRY.
```

Notes

Calendar Functions

For the period October 15, 1582 through November 25, 4046, this program interchangeably solves for dates and days. Given two dates, the number of days between them or the number of week days between them can be calculated. Given one date and a specified number of days, a second date can be found. Given a date, the day-of-week and day-of-year can be calculated. Given a month and year, a calendar can be plotted and printed.

A date must be input in mm.ddyyyy format. For instance, April 6, 1978 is keyed in as 4.061978. It is important that the zero between the decimal point and the day of the month be included when the day of the month is less than 10. The number of weekdays between two dates is based on a noon-to-noon time length, so the difference between a weekday and a non-weekday will have the half-day in it, e.g., the number of week days between a Friday and Saturday in the same week is .5.

Equations:

To compute the day number from the date:

$$\begin{aligned} \textit{Julian Day number} &= \text{INT}(365.25y') - \text{INT}(y'/100) \\ &\quad + \text{INT}(y'/400) + \text{INT}(30.6001m') \\ &\quad + D - 478164 \end{aligned}$$

The range of calculations allows for this value to be in the range

$$100000 < JD_{\text{ADJ}} < 999999.$$

where

$$y' = \begin{cases} Y - 1 & \text{if } M = 1 \text{ or } 2 \\ Y & \text{if } M > 2 \end{cases}$$

$$m' = \begin{cases} M + 13 & \text{if } M = 1 \text{ or } 2 \\ M + 1 & \text{if } M > 2. \end{cases}$$

Then days between dates is found by

$$Days = Day\ \#2 - Day\ \#1$$

To compute the date from a day number:

$$\begin{aligned} Day\# &= JD_{\text{ADJ.}} + 478164 \\ y' &= \text{INT}((Day\# - 121.5)/365.2425) \\ m' &= \text{INT}((Day\# - \text{INT}(365.25y') + \text{INT}(y'/100) \\ &\quad - \text{INT}(y'/400))/30.6001) \end{aligned}$$

$$\begin{aligned} \textit{Day of month} &= \textit{Day\#} - \text{INT}(365.25y') + \text{INT}(y'/100) \\ &\quad -\text{INT}(y'/400) - \text{INT}(30.6001m') \\ \textit{MONTH} &= m = m' - 13 \quad \text{if } m' = 14 \text{ or } 15 \\ &\qquad\quad m' - 1 \quad \text{if } m' < 14 \\ \textit{YEAR} &= y' \quad \text{if } m > 2 \\ &\qquad\quad y' + 1 \quad \text{if } m = 1 \text{ or } 2 \end{aligned}$$

To compute week days between dates.

$$W(m,d,y) = 5*\text{INT}\,(D(m,d,y)/7) + .5*\text{INT}(1.801*(D(m,d,y) \bmod 7))$$

where

$$\begin{aligned} D(m,d,y) &= d - \text{INT}(.75\text{INT}(g(y,m)/100)-7) \\ &\quad + \text{INT}(365.25\,g(y,m)) + \text{INT}(30.6f(m)) \\ f(m) &= \begin{cases} m + 13 & \text{if } m = 1,2 \\ m + 1 & \text{if } m > 2 \end{cases} \\ g(y,m) &= \begin{cases} y - 1 & \text{if } m = 1,2 \\ y & \text{if } m > 2 \end{cases} \end{aligned}$$

W is the number of weekdays since a certain fixed date in antiquity. The number of weekdays between two dates is then the difference between the values of W.

To compute day of the week:

$$\textit{Day of the week} = 7 \times \text{FP}((\textit{Day\#} + 5)/7)$$

To compute day of the year:

$$\textit{Day of year} = JD_{\text{ADJ}} - JD_{\text{ADJ}}\,(\textit{January 1, Year}) + 1$$

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "CALEND"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation is displayed, go to step 4.

   OR:

   a. Press: KEY #1 (D1/D2), to enter two dates for computing days between them (KEY #2) or weekdays between them (KEY #6).
   b. Go to step 5.

   OR:

a. Press: KEY #2 (Δ DAYS), if two dates have already been entered and the number of days between them is desired.
b. After the number of days is displayed, go to step 4.

OR:

a. Press: **KEY #3** (DT+DAYS), to compute a date N-days before or after an entered date.
b. Go to step 7.

OR:

a. Press: KEY #4 (DOW/DOY) to compute the day of week and day of year of a date.
b. Go to step 10.

OR:

a. Press: KEY #6 (ΔW. DAYS), if two dates have already been entered and the number of weekdays between them is desired.
b. After the number of weekdays is displayed, go to step 4.

a. Press: KEY #8 (PRT-CAL), if a calendar for a particular month and year is desired.
b. Go to step 12.

Note: If NO DATES ENTERED is displayed, go to step 4.

OR:

5. When ENTER FIRST DATE: MM.DDYYYY? is displayed:
   a. Enter: The date as specified, e.g., April 6, 1978 would be entered as 4.061978.
   b. Press: (END LINE)

   Note: If INVALID DATE is displayed, the date must be re-entered. Go to step 5.
6. When ENTER SECOND DATE: MM.DDYYYY? is displayed:
   a. Enter: The second date.
   b. Press: (END LINE)
   c. Go to step 4.

   Note: If INVALID DATE is displayed, go to step 6 and re-enter date.
7. When ENTER DATE: MM.DDYYYY? is displayed:
   a. Enter: The date as specified, e.g., April 6, 1978 would be entered as 4.061978.
   b. Press: (END LINE)

   Note: If INVALID DATE is displayed, go to step 7 and re-enter date.
8. When ENTER DAYS BETWEEN DATES '-' IMPLIES BEFORE? is displayed:
   a. Enter: The number of days. Negative values will indicate that the unknown date is before the known date.
   b. Press: (END LINE)

   Note: If DATE IS OUT OF RANGE is displayed the resulting date is out of range. Go to step 8.
9. After the resulting date is displayed, go to step 4.
10. When ENTER DATE: MM.DDYYYY? is displayed:
    a. Enter: The date as specified, e.g., April 6, 1978 would be 4.061978.
    b. Press: (END LINE)

    Note: If INVALID DATE is displayed, go to step 10 and re-enter date.
11. After the day-of-week and day-of-year is displayed, go to step 4.
12. When MONTH,YEAR=? is displayed:
    a. Enter: The month and year separated by a comma, e.g., April 1978 would be entered as 4,1978.
    b. Press: (END LINE)

    Note: If GREGORIAN CALENDAR BEGINS, 1753 or WHAT MONTH IS_TRY AGAIN is displayed, go to step 12 and re-enter month and year.

    Note: If the year is two digits, the program will add 1900 automatically.

13. When ENTER HEADING? is displayed:
    a. Enter: The heading for the calendar. The maximum number of characters in the heading is 32.
    b. Press: (END LINE)

    Note: If no heading is desired, enter a blank.

14. After the plot is finished:
    a. Press: (COPY) to get another copy on the printer.
    b. Go to step 4 when the copy is finished.

    OR:

    a. Go to step 4.

Example 1:

Bjorn Borg won his first Wimbledon singles championship on July 3, 1976 and his third singles championship on July 8, 1978. How many days had passed between his first win and his third win? How many of these days were week days? Generate a calendar for July 1978.

```
NUMBER OF DAYS BETWEEN
 7.031976 AND  7.081978 IS
 735  DAYS

NUMBER OF WEEKDAYS BETWEEN
 7.031976 AND  7.081978 IS
525 DAYS.
```

EXAMPLE CALENDAR
JULY 1978

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23 / 30	24 / 31	25	26	27	28	29

Example 2:

An individual received a bill dated July 10, 1978. If the bill must be paid in 30 days, what is this date and what day of the week is it?

```
ENTER DATE:MM.DDYYYY
?
7.101978
ENTER DAYS BETWEEN DATES
'-' IMPLIES BEFORE
?
30
RESULTING DATE IS  8.091978
ENTER DATE:MM.DDYYYY
?
8.091978
WEDNESDAY
AND DAY NO.  221  OF THE YEAR
```

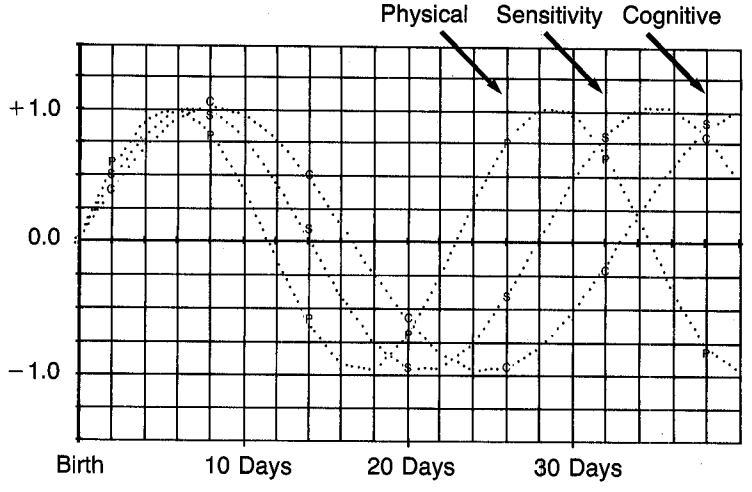
Notes

Biorhythms

From the ancient of days, philosophers and sages have taught that human happiness lies in the harmonious integration of body, mind, and heart. Now a twentieth-century theory claims to be able to quantitatively gauge the functioning of these three aspects of ourselves: the physical, sensitive, and cognitive.

The biorhythm theory is based on the assumption that the human body has inner clocks or metabolic rhythms with constant cycle times. Currently, three cycles starting at birth in a positive direction are postulated. The 23-day or physical cycle relates with physical vitality, endurance and energy. The 28-day or sensitivity cycle relates with sensitivity, intuition and cheerfulness. The 33-day or cognitive cycle relates with mental alertness and judgement.

For each cycle a day is considered either high, low or critical. The high ($0 < x \leq 1$) times are regarded as energetic times, you are your most dynamic in the cycle. The low ($-1 \leq x < 0$) times are regarded as the recuperative periods. The critical days ($x = 0$) are regarded as your accident prone days especially for the physical and sensitivity cycles.



This program will plot the biorhythms for a month at a time. The critical days during the 33-day period from an entered date can also be printed.

Operating Limits and Warnings:

The birthday and bio-date must occur between October 15, 1582 through November 25, 4046.

The date format for input is MM.DDYYYY (May 4, 1978 is entered as 5.041978). The program does not exhaustively check the date for validity. Thus, if an improper format or an invalid date (e.g., February 29, 1978) is entered, erroneous answers will result.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "BIORHY"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation of the program.
   b. After the explanation is displayed, go to step 4.
   OR:
   a. Press: KEY #1 (ENTER) to enter birthdate and name.
   b. Go to step 5.
   OR:
   a. Press: KEY #6 (EXPLAIN), if you need an explanation of biorhythms printed.
   b. After the explanation is printed, go to step 4.
5. When ENTER YOUR NAME? is displayed:
   a. Enter: Your name in 32 characters or less.
   b. Press: (END LINE)
6. When WHAT IS YOUR BIRTHDAY: MM.DDYYYY? is displayed:
   a. Enter: Your birthday in the specified format, e.g., May 4, 1974 would be entered as 5.041974.
   b. Press: (END LINE)
   c. Go to step 7.
   Note: If INVALID DATE is displayed, go to step 6.
7. After the birthdate has been entered:
   a. Press: KEY #2 (CRIT. DY) to obtain the critical days during a 33-day period after a date.
   b. Go to step 8.
   OR:
   a. Press: KEY #4 (PLOT) to plot the biorhythms for a given month.
   b. Go to step 11.
   OR:
   a. Go to step 4 for another person or explanations.
8. When ENTER STARTING DATE: MM.DDYYYY? is displayed:
   a. Enter: The first date for checking for critical days in the specified form, e.g., May 4, 1974 would be entered as 5.041974.
   b. Press: (END LINE)
9. If INVALID DATE or YOU CANNOT GO BACK__ is displayed, go to step 8 and re-enter the starting date.
10. After the critical days are displayed, go to step 7.
11. When ENTER MONTH/YEAR: MM.YYYY? is displayed:
   a. Enter: The month and year in the specified form, e.g., May, 1978 would be entered as 5.1978.
   b. Press: (END LINE)
12. If INVALID DATE or SPECIFIED MONTH IS BEFORE BIRTHDAY is displayed, go to step 11 and re-enter the month and year.
13. After the plot is finished and COPY TO PRINTER: Y/N? is displayed:
   a. Enter: Y, if you want a copy of the plot.
   b. Press: (END LINE)
   OR:
   a. Enter: N, if you do not want a copy.
   b. Press: (END LINE)
   Note: You must enter either "Y" or "N" or the program will beep and go to step 13.
14. After viewing the plot:

a. Press: (CONT), when you are ready to proceed.

15. When NEXT MONTH:Y/N? is displayed:
a. Enter: Y, if you want a plot of the next month.
b. Press: (END LINE)
c. Go to step 13.
OR:
a. Enter: N, if the next month is not to be plotted.
b. Press: (END LINE)
c. Go to step 7 after pressing (KEY LABEL).

Example 1:

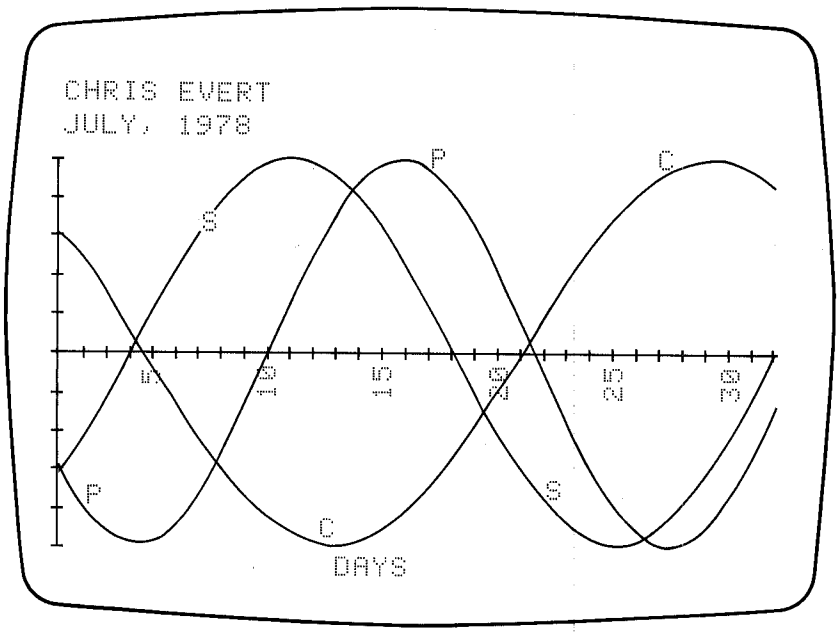
Steve Cauthen was born on May 1, 1960 and Jorge Velasquez was born on December 27, 1946. The triple crown races in 1978, Kentucky Derby, Preakness, and Belmont Stakes, were run on May 6, May 20, and June 10 respectively. Generate the critical days for the months of May and June for both jockeys. By looking at the biorhythms for the race days, there might be something about the cycles that resulted in Affirmed winning.

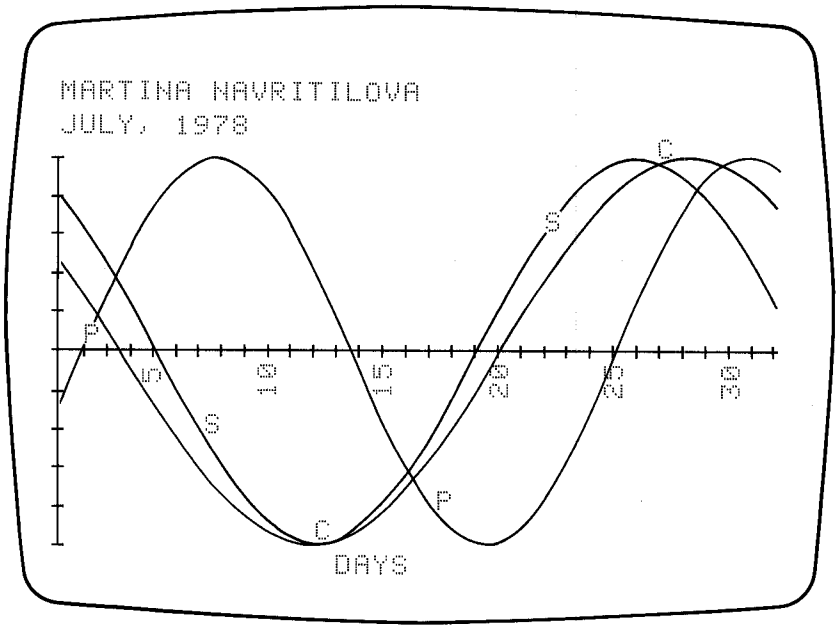
```
ENTER STARTING DATE:MM.DDYYYY
5.011978
CRITICAL DAYS FOR STEVE CAUTHEN

PHYSICAL CRITICAL DAYS
 5/ 5/1978
 5/16/1978
 5/28/1978

SENSITIVITY CRITICAL DAYS
 5/ 7/1978
 5/21/1978

COGNITIVE CRITICAL DAYS
 5/10/1978
 5/27/1978

ENTER STARTING DATE:MM.DDYYYY
6.011978
CRITICAL DAYS FOR STEVE CAUTHEN

PHYSICAL CRITICAL DAYS
 6/ 8/1978
 6/20/1978
 7/ 1/1978

SENSITIVITY CRITICAL DAYS
 6/ 4/1978
 6/18/1978
 7/ 2/1978

COGNITIVE CRITICAL DAYS
 6/12/1978
 6/29/1978
```

```
ENTER STARTING DATE:MM.DDYYYY
5.011978
CRITICAL DAYS FOR JORGE VELASQUEZ

PHYSICAL CRITICAL DAYS
 5/ 7/1978
 5/18/1978
 5/30/1978

SENSITIVITY CRITICAL DAYS
 5/ 5/1978
 5/19/1978
 6/ 2/1978

COGNITIVE CRITICAL DAYS
 5/ 4/1978
• 5/20/1978

ENTER STARTING DATE:MM.DDYYYY
6.011978
CRITICAL DAYS FOR JORGE VELASQUEZ

PHYSICAL CRITICAL DAYS
• 6/10/1978
 6/22/1978
 7/ 3/1978

SENSITIVITY CRITICAL DAYS
 6/ 2/1978
 6/16/1978
 6/30/1978

COGNITIVE CRITICAL DAYS
 6/ 6/1978
 6/22/1978
```

Example 2:

The Wimbledon singles championships in 1978 were July 7 for women. Generate the biorhythms for Chris Evert (December 21, 1954) and Martina Navritilova (October 10, 1956) for July 1978.


CHRIS EVERT
JULY, 1978
P
C
S
S
P
C
5
10
15
20
25
30
DAYS


MARTINA NAVRITILOVA
JULY, 1978
C
S
P
S
P
C
5
10
15
20
25
30
DAYS

Notes

Timer

This program is a collection of routines that implement various timing functions available to the user. The program contains five different timers:

1. Five-second timer
2. Count-Up timer with splits
3. Count-Down timer
4. Digital Clock timer
5. Clock with chimes

The timers are not accurate enough to be used for extended periods of time over more than a few hours. The main intention of these routines is to provide you with example timing routines for your own use. The clock with chimes is included more as a novelty than to be used in your own applications.

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "TIMER"
   b. Press: (END LINE)
3. To run the program:
   a. Press: (RUN)

   Note: PROGRAM BEING INITIALIZED will be displayed.
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the explanation has been displayed, go to step 4.

   OR:

   a. Press: KEY #1 (SET/STOP) to set the time.
   b. Go to step 5 to enter the time and specify form of display.

   OR:

   a. Press: KEY #3 (CNT UP) to select the count up timer with split capability.
   b. Go to step 10.

   OR:

   a. Press: KEY #7 (CNT DWN) to select the count down timer.
   b. Go to step 12.
5. When ENTER TIME:HH.MMSS? is displayed:
   a. Enter: The time for setting the clock.
   b. Press: (END LINE)

   Note: 1:31 P.M. would be entered as 13.3100

   OR:

   a. Enter: −1, if the time has been set.
   b. Press: (END LINE)

   Note: If INVALID TIME is displayed, go to step 5.
6. When PRESS CONT TO SET TIME is displayed:
   a. Press: (CONT) when the time is to be set.
7. To specify the display format:

a. Press: KEY #2 (DIGITAL) to specify the digital clock format.
b. Go to step 8.
OR:
a. Press: KEY #6 (CLOCK) to select the graphical clock with chimes.
b. Go to step 8.
OR:
a. Press: KEY #8 (5-SEC) to specify the five-second display mode.
b. Go to step 8.

Note: If TIME NOT SET is displayed, go to step 4.

8. To stop the output of the time, press KEY #1 (SET/STOP).

9. To display the time:
a. Press: KEY #2 (DIGITAL) for digital clock format.
b. Go to step 8.
OR:
a. Press: KEY #6 (CLOCK) for the clock with chimes.
b. Go to step 8.
OR:
a. Press: KEY #8 (5-SEC) for time update every five seconds.
b. Go to step 8.
OR:
a. Go to step 4 to change the timing operation.

10. When PRESS CONT WHEN READY is displayed:
a. Press: (CONT), when you are ready to start the count up timer.
b. Go to step 11 to take splits or stop the time.

11. To take splits:
a. Press: KEY #4 (SPLIT) to store the current time since starting the timer.
b. Go to step 11.

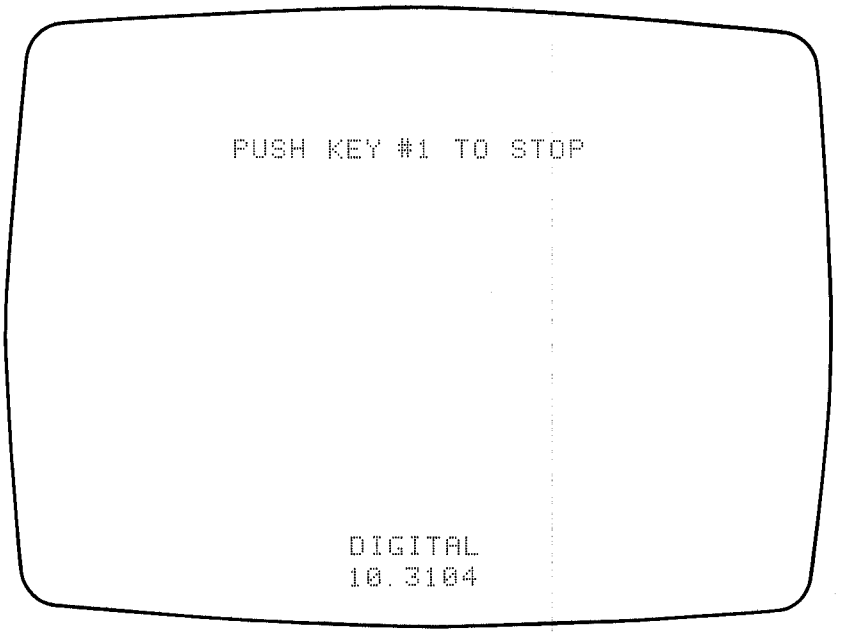
Note: Up to 100 splits can be taken and retained.
OR:
a. Press: KEY #1 (SET/STOP) to stop the timer and store this as the last split.
b. Press: KEY #4 (SPLIT) to print out the split values.
c. Go to step 4 to select the timing operation.

12. When ENTER COUNT DOWN SECONDS? is displayed:
a. Enter: The number of seconds for the count down.
b. Press: (END LINE)

13. When PRESS CONT WHEN READY is displayed:
a. Press: (CONT), when ready to start the count down.
b. Go to step 4 to select the timing operation when finished.

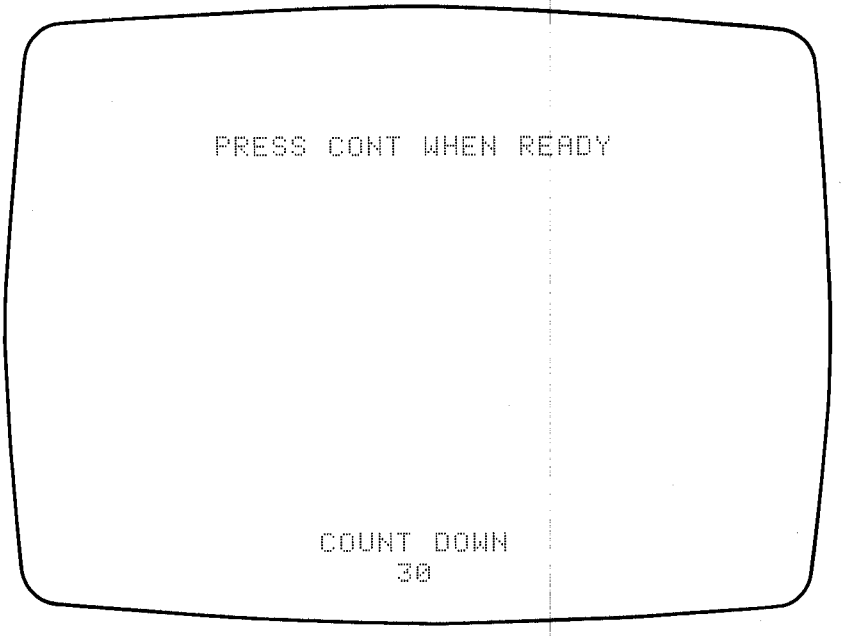
Example 1:

Set the time to 10:3100 and specify the digital clock format. After starting the display, stop the time output.



Example 2:

Set the count down timer for a count down of 30 seconds and then start it.



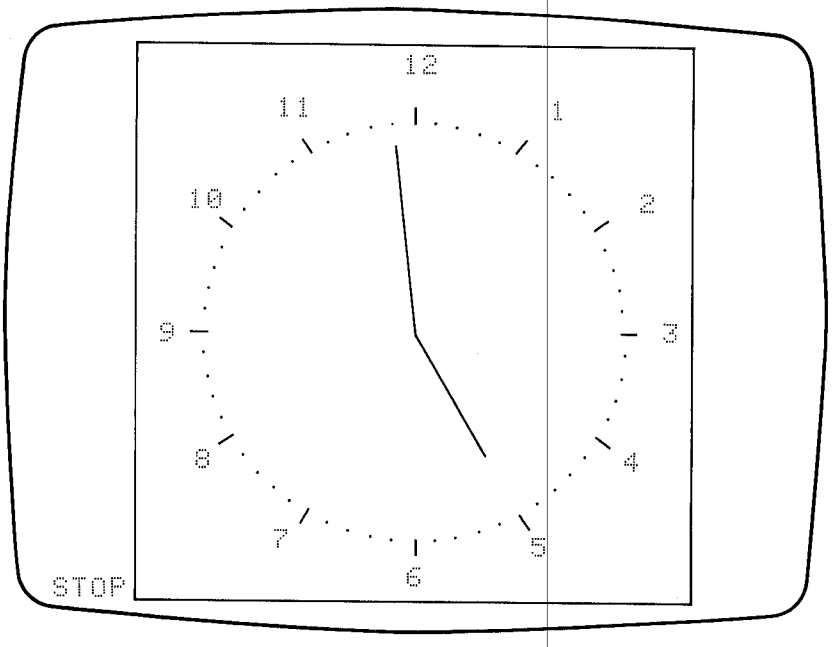
Example 3:

Start the count up timer and take 5 splits. The fifth split should be taken by stopping the timer using KEY #1. After taking the splits, print out the split values.

```
SPLIT#      ΔTIME SEC
   1              .7460
   2             1.5860
   3             2.3530
   4             3.1290
   5             4.0370
```

Example 4:

Set up and start the clock with chimes for 4:59.



Music Composer

This program is designed to enable you to create, edit, store, output and play music composed of single notes using the internal speaker and the programmable BEEP command. The tones which are generated cover a range of six octaves starting from 55 cps (A). Using the composing symbols recognized by this program, you can specify the note, e.g., A, B, C, etc., the octave, the timing, e.g., eighth, quarter, etc., a rest, repeat of a passage, and the metronome setting, i.e., number of whole beats/minute. The natural notes are entered as the capital letters A through G. Flats are lower case letters a through g. Sharps are entered using the CONTROL key and the capital letters A through G, which generates the characters ¿, $\bar{x}$, $\bar{N}$, α, β, Γ, and $\bar{n}$ for A#, B#, C#, D#, E#, F#, and G# respectively.

The result of parsing the entered composition is a numeric array which contains BEEP parameters and codes which specify rests, repeats, and metronome timing changes.

While the tonal quality is not exceptional, this program can be used as an example of parse techniques which are often useful to know. After becoming familiar with the program, you should be able to add your own customized routines. The example tune has been selected to demonstrate some of the capabilities of this program and the type of music performable by the machine.

Enjoy your machine—play some music for your friends!

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "COMPZR"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled and SELECT OPTION is displayed:
   a. Press: KEY #5 (HELP), if you need a more detailed explanation.
   b. After the key explanation is displayed, press (CONT) for the explanation of the composition symbols.
   c. After the example theme is played, go to step 4.
   OR:
   a. Press: KEY #1 (CREATE), to enter the composition.
   b. Go to step 5.
5. When OLD OR NEW TUNE : O/N? is displayed:
   a. Enter: O, if the tune is stored on tape.
   b. Press: (END LINE)
   c. Go to step 6.
   OR:
   a. Enter: N, if the tune is to be entered from the keyboard.
   b. Press: (END LINE)
   c. Go to step 7.

   Note: You must enter either "O" or "N" or the program will beep and go to step 5.
6. When FILE NAME? is displayed:
   a. Enter: The name of the file on the tape.
   b. Press: (END LINE)

c. After the array is loaded, go to step 15.

Note: If an error occurs during the load the program will go to step 6.

7. When METRONOME? is displayed:
   a. Enter: The number of whole notes per minute.
   b. Press: (END LINE)
8. When REVIEW:Y/N? is displayed:
   a. Enter: Y, if you want the option of rejecting an input string after it is parsed.
   b. Press: (END LINE)

   OR:

   a. Enter: N, if any acceptable input will be stored.
   b. Press: (END LINE)

   Note: You must enter either "Y" or "N" or the program will beep and go to step 8.

   Note: If you turn down the review option, corrections may be difficult.
9. When COMPOSITION? is displayed:
   a. Enter: The encoded music as a string input, maximum 96 characters per entry.
   b. Press: (END LINE)

   OR:

   a. Type: END, to terminate entry.
   b. Press: (END LINE)
   c. Go to step 15.

   Note: Use the following codes as given in the HELP section to enter the composition.

```
        COMPOSING SYMBOLS
Naturals→ABCDEFG
Flats→abcdefg
Sharps→CTRL ABCDEFG or
   ¿%ÑαßΓΠ

Octave→On, 1<=n<=6
Timing→Tn/m or Tm if n=1
Rest→R, uses current timing
Repeat→:n/m or :n if m=0
      n=# ARRAY VALUES TO
        REPEAT
      m=# ARRAY VALUES TO
        SKIP
Metronome→Mn, n=Whole
   Notes/Min.
DEFAULT VALUES→O4T1
   EX:M60O3T8GO4CET4GT
   8RET2G
```

   Note: In addition to notes, the numeric array which is created, contains codes for rests, repeats, and metronome timing changes. The repeat parameters, n and m, must include all array locations which are repeated and/or skipped. The optional second parameter, m, can be used to specify a second ending to a repeated passage. The value of m is the number of array values in the first ending which will be skipped. The second ending will start at the next array location after the repeat.
10. If ?__AT__ is displayed, go to step 14.
11. If the review option was specified and OK:Y/N? is displayed:
    a. Enter: Y, if the entry is correct.
    b. Press: (END LINE)
    c. Go to step 12.

    OR:

    a. Enter: N, if you want to re-enter this entry with changes.
    b. Press: (END LINE)
    c. Go to step 14.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 11.
12. Repeat steps 9—11 until the composition is entered.
13. Go to step 15.
14. When RE-ENTER? is displayed:
    a. Enter: The composition.
    b. Press: (END LINE)
    c. Go to step 10.

    Note: The easiest method is to edit the previous entry using the editing features of your computer.
15. When DONE has been displayed:

a. Press: KEY #2 (CHANGE), if either the overall timing of the piece or individual notes need to be changed.
b. Go to step 16.
OR:
a. Press: KEY #3 (STORE), to store the composed array.
b. Go to step 28.
OR:
a. Press: KEY #4 (PLAY), to play the composed array.
b. After END PERFORMANCE is displayed, go to step 15 or step 4 to enter a new tune.
OR:
a. Press: KEY #6 (DELETE), to delete array elements.
b. Go to step 32.
OR:
a. Press: KEY #7 (INSERT), to insert notes in the array.
b. Go to step 35.
OR:
a. Press: KEY #8 (PRINT), to print out the contents of the array using composing symbols or plot the score.
b. Go to step 44.

16. When CHANGE TIMING: Y/N? is displayed:
a. Enter: Y, if the timing of the entire array is to be changed.
b. Press: (END LINE)
c. Go to step 17.
OR:
a. Enter: N, if the timing is correct.
b. Press: (END LINE)
c. Go to step 18.
Note: You must enter either "Y" or "N" or the program will beep and go to step 16.

17. When METRONOME? is displayed:
a. Enter: The new metronome setting.
b. Press: (END LINE)
Note: If a negative or zero value is entered, the program will go to step 18 and not change the array values.

18. When CHANGE NOTES: Y/N? is displayed:
a. Enter: Y, if you want to change any array values.
b. Press: (END LINE)
c. Go to step 19.
OR:
a. Enter: N, if no changes are needed.
b. Press: (END LINE)
c. Go to step 15 or step 4 to enter a new tune.
Note: You must enter either "Y" or "N" or the program will beep and go to step 18.

19. When REVIEW: Y/N? is displayed:
a. Enter: Y, if you want the option of rejecting an input string after it is parsed.
b. Press: (END LINE)
OR:
a. Enter: N, if any acceptable input will be stored.
b. Press: (END LINE)
Note: You must enter either "Y" or "N" or the program will beep and go to step 19.
Note: If you turn down the review option, corrections may be difficult.

20. When NOTE #? is displayed:
a. Enter: The index of the note or array element to change.
b. Press: (END LINE)

21. When SET TIMING: Y/N? is displayed:
a. Enter: Y, if the array is to be checked for timing changes so that the note timing can be determined accurately.
b. Press: (END LINE)
OR:
a. Enter: N, if the timing has not been changed or the current timing of the note to be changed is not important.
b. Press: (END LINE)

Note: You must enter either "Y" or "N" or the program will beep and go to step 21.

22. If the current array contents are printed and METRONOME? is displayed:
    a. Enter: The new metronome setting.
    b. Press: (END LINE)
    c. Go to step 26.

    Note: If a negative or zero value is entered, the program will go to step 26 and not change the array values.

23. If the current array contents are printed and NEW NOTE? is displayed:
    a. Enter: The new encoded string.
    b. Press: (END LINE)

    OR:

    a. Enter: OK, if the note is correct.
    b. Press: (END LINE)
    c. Go to step 26.

24. If ?_AT_ is displayed, go to step 27.

25. If the review option was specified and OK : Y/N? is displayed:
    a. Enter: Y, if the entry is correct.
    b. Press: (END LINE)
    c. Go to step 26.

    OR:

    a. Enter: N, if you want to re-enter this entry with changes.
    b. Press: (END LINE)
    c. Go to step 27.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 25.

26. When MORE : Y/N? is displayed:
    a. Enter: Y, if there are more changes.
    b. Press: (END LINE)
    c. Go to step 20.

    OR:

    a. Enter: N, if there are no more changes.
    b. Press: (END LINE)
    c. Go to step 15 or step 4 to enter a new tune.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 26.

27. When RE-ENTER? is displayed:
    a. Enter: The composition.
    b. Press: (END LINE)
    c. Go to step 23.

    Note: The easiest method is to edit the previous entry using the editing features of your computer.

28. If NO TUNE! is displayed, a tune must be entered first, therefore, go to step 4.

29. When FILE NAME? is displayed:
    a. Enter: The name of the file.
    b. Press: (END LINE)

30. When CREATE : Y/N? is displayed:
    a. Enter: Y, if the file must be created.
    b. Press: (END LINE)

    OR:

    a. Enter: N, if the file already exists.
    b. Press: (END LINE)

    Note: You must enter either "Y" or "N" or the program will beep and go to step 30.

31 When DONE is displayed, go to step 15 or step 4 to enter a new tune.

32. When DELETE STARTING AT? is displayed:
    a. Enter: The number of the first note to be deleted.
    b. Press: (END LINE)

    Note: If the value is less than or equal to 0, go to step 15.

33. When HOW MANY? is displayed:
    a. Enter: The number of notes to be deleted.
    b. Press: (END LINE)

    Note: If the value is equal to zero or greater than the number of notes in the composition, go to step 15.

34. When DONE is displayed, go to step 15.

35. When INSERT NOTES AFTER? is displayed:
    a. Enter: The number of the note before the inserted note(s).
    b. Press: (END LINE)

Note: If -1 is entered, go to step 15.

Note: If N, the current number of notes, is entered, go to step 8 to add notes to the end.

Note: If the value is greater than the number of notes in the machine, go to step 34 and re-enter.

36. When HOW MANY? is displayed:
    a. Enter: The number of notes or array elements to be inserted.
    b. Press: (END LINE)

    Note: If 0 is entered, go to step 15.
37. If TOO MANY MAX.IS__ is displayed, go to step 36 and enter a smaller number.
38. When REVIEW:Y/N? is displayed:
    a. Enter: Y, if you want the option of rejecting an input string after it is parsed.
    b. Press: (END LINE)

    OR:

    a. Enter: N, if any acceptable input will be stored.
    b. Press: (END LINE)

    Note: You must enter either "Y" or "N" or the program will beep and go to step 38.

    Note: If you turn down the review option, corrections may be difficult.
39. When COMPOSITION? is displayed:
    a. Enter: The composition.
    b. Press: (END LINE)
40. If ?__AT__ is displayed:
    a. Enter: The correct character(s).
    b. Press: (END LINE)
41. If the review option was specified and OK:Y/N? is displayed:
    a. Enter: Y, if the entry is correct.
    b. Press: (END LINE)
    c. Go to step 42.

    OR:

    a. Enter: N, if you want to re-enter this entry with changes.
    b. Press: (END LINE)
    c. Go to step 43.

    Note: You must enter either "Y" or "N" or the program will beep and go to step 41.
42. When DONE is displayed, go to step 15.
43. When RE-ENTER? is displayed:
    a. Enter: The composition.
    b. Press: (END LINE)
    c. Go to step 40.

    Note: The easiest method is to edit the previous entry using the editing features of your computer.
44. When 1ST VALUE? is displayed:
    a. Enter: The index of the first value.
    b. Press: (END LINE)

    Note: If 0 is entered, go to step 15.
45. When LAST VALUE? is displayed:
    a. Enter: The index of the last value.
    b. Press: (END LINE)

    Note: If these values are not valid, go to step 44 and re-enter.
46. When PRINT OR SCORE:P/S? is displayed:
    a. Enter: P, if the notes are to be printed using composing symbols.
    b. Press: (END LINE)

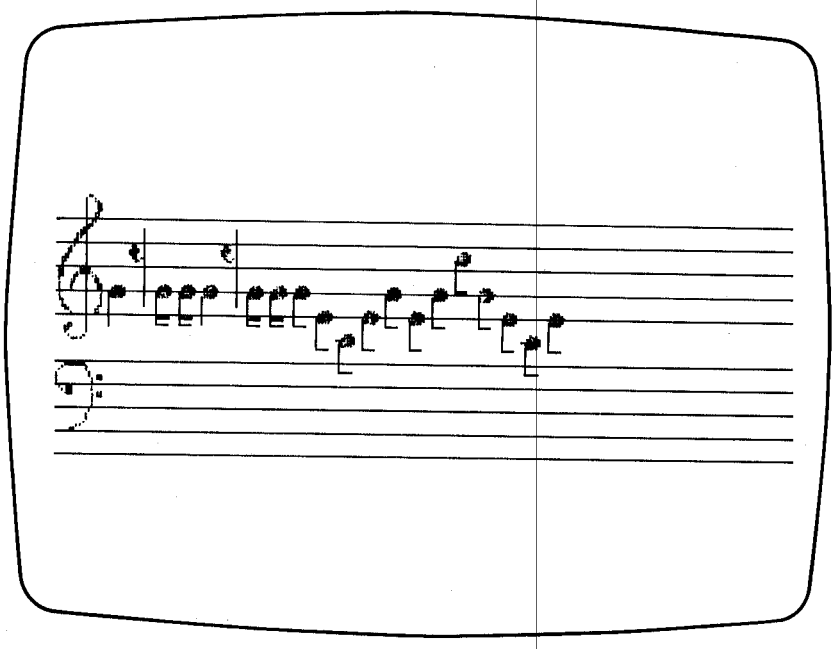
    OR:

    a. Enter: S, if the notes are to be plotted using musical notation.
    b. Press: (END LINE)

    Note: You must enter either "P" or "S" or the program will beep and go to step 46.
47. When DONE is displayed or the final page of the score has been copied, go to step 15.

Example 1:

Using the example tune which is stored on the Standard Pac cartridge as the data file, "MUSIC", create and play this tune. After playing the tune, plot the first 20 array values using the score option.



If the print option had been specified, the following would result.

```
NOTES FROM  1  TO  20
T403G R.152 T1603G T1603G T403G
R.152 T1603G T1603G T803G T803E
T803C T803E T803G T803E T803G
T804C T803G T803E T803C T803E
```

Note that the rests also take up array locations.

Example 2:

Using the data shown below, enter the tune and then play it. After playing it, change the metronome setting to 30 and play it again.

Metronome setting = 60

Tune Data

```
T8EET2GT8EET2GT8EG05T4CBAA
T3/804GT8DET4FDT8DET4FDT8
DF05BA04T4G05BT3/4C
```

Ski Game

This game simulates skiing through a slalom course. The user has control of motion to the left and right, but the downward motion is determined by the machine. The course is generated by the machine, but is based on input by you so that you can repeat the same course later if you wish. Your running time will be displayed as you descend through the gates.

The object of the game is to make it through all the gates in the least amount of time. If you go through a gate, an audible signal will be made. If you hit a pole, the pole will fall over, but you still have been credited with making it through the gate. If you drop below a gate, there is no way for you to recover on this run, but you can continue and try to make the remaining gates and check your time. You are able to specify your ability at the start of the game. This value is used to determine the speed down the slope. Therefore, your time will be faster as your ability increases, but your ability to control your motion will decrease as your ability level increases. Another aspect of the game, which you should notice after playing a few times is the effect of turning on the speed down the slope. The more you turn, the slower you will move down the slope, but if you don't turn, the downward speed will be increased by the machine. Finally, you are able to specify the background color as black or white to suit your own visual sense.

The functions used to simulate the motion were derived for this game and have no direct correspondence to actual equations of motion. Have fun skiing!

User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
2. To load the program:
   a. Type: (REW LOAD) "SKI"
   b. Press: (END LINE)
3. To start the program:
   a. Press: (RUN)
4. When the keys are labelled:
   a. Press: KEY #1 (SET UP) to start the game and set up the course.
   b. Go to step 5.
   OR:
   a. Press: KEY #5 (HELP), if you need an explanation of the game.
   b. After the explanation is printed, go to step 4.
5. When ENTER BACKGROUND COLOR: 0=W, 1=B? appears in the display:
   a. Enter: 0, if the desired background color is white.
   b. Press: (END LINE)
   OR:
   a. Enter: 1, if the desired background color is black.
   b. Press: (END LINE)

   Note: Entering any value other than 0 will result in a black background.
6. When ENTER COURSE CODE? appears in the display:
   a. Enter: The course code (any number is

acceptable, but integers in the range of 1 to 999999 are preferable.

b. Press: END LINE

7. When WHAT'S YOUR ABILITY:
1 TO 5
(1 IS EASY, 5 IS HARD)?
appears in the display:
   a. Enter: Your ability level.
   b. Press: END LINE

   Note: Values less than 1 will be rejected, but values greater than 5 will be accepted.

8. After the course is displayed and START is blinking:
   a. Press: KEY #2 (START) when you are ready to start skiing.
   b. There will be an audible sequence before the dot appears in the starting gate.

9. To increment the velocity component in the left direction:
   a. Press: KEY #3 (LEFT)

   Note: Do not hold key down!

10. To increment the velocity component in the right direction:
   a. Press: KEY #4 (RIGHT)

   Note: Do not hold key down!

11. Repeat steps 9 and 10 as needed until you are below the finish gate.

12. After the final time is printed and any missed gates are labelled, select the next option:
   a. Press: KEY #8 (REPEAT) if you want to repeat the same course with the same ability level.
   b. Go to step 8.

   OR:

   a. Press: KEY #2 (START) if you want to stop the game or set up a new course.

13. When TRY AGAIN: YES/NO?
appears in the display:
   a. Enter: Y, if you want to try again.
   b. Press: END LINE

   OR:

   a. Enter: N, if you want to stop.
   b. Press: END LINE
   c. The program ends.

   Note: You must enter either "Y" or "N" or the program will beep and go to step 13.

14. When NEW COURSE: YES/NO?
appears in the display:
   a. Enter: Y, if you want to specify a different course.
   b. Press: END LINE
   c. Go to step 5.

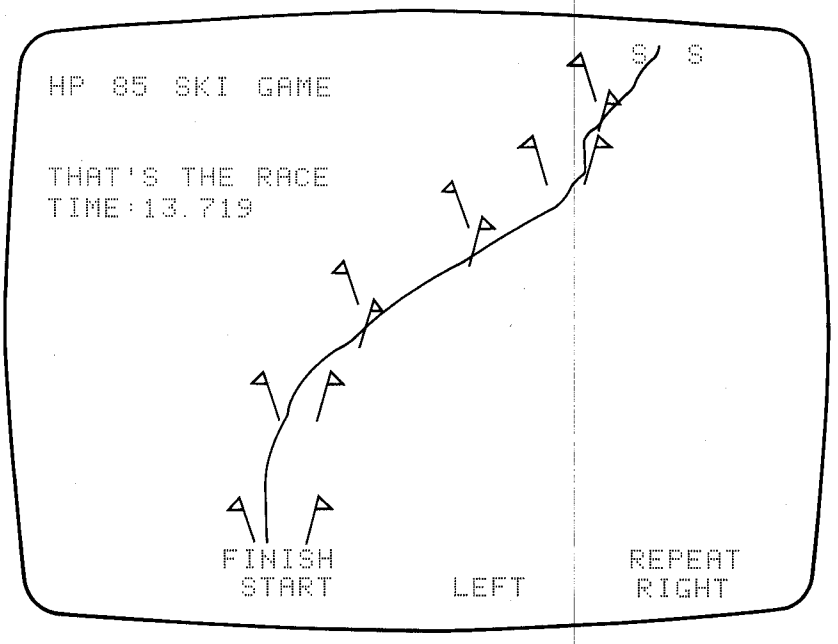
   OR:

   a. Enter: N, if you only want to change your ability level.
   b. Press: END LINE
   c. Go to step 7.

   Note: You must enter either "Y" or "N" or the program will beep and go to step 14.

Example:

The following is an example run using black background, a course code of 52249 and an ability level of 3. Try your skill on the same course.


HP 85 SKI GAME
THAT'S THE RACE
TIME: 13.719
S S
FINISH
START
LEFT
REPEAT
RIGHT

Program Documentation and Programming Techniques

Program

Moving Average

Circular List

The efficient use of data in a computer is directly related to the choice of data structure used to store the information. While it would be beneficial to the user to have a detailed explanation of data structures here, it would require far more space than this entire book to properly cover the subject. Instead, the data structure used in the "Moving Average" program will be explained.

A circular list was employed to store the retained values. The first 200 elements of the array, A, are allotted to the circular list. The element A(201) contains the index of the next available location in the array for storing data. The array elements A(202) and A(203) contain pointers to the oldest and newest entries respectively. These pointers are used to traverse the array from oldest to newest values or vice versa. The number of points to be retained is stored in A(204). Since there is no need for inserting or deleting values once they have been entered, the array structure used in this program departs from the actual definition of a circular list since there are no pointers stored with the data elements. The index of the array element is used as a pointer in this example. Following through a few operations on this structure should help your understanding of how the pointers are used.

Lines 610 through 660 control the addition of a point onto the end of this list.

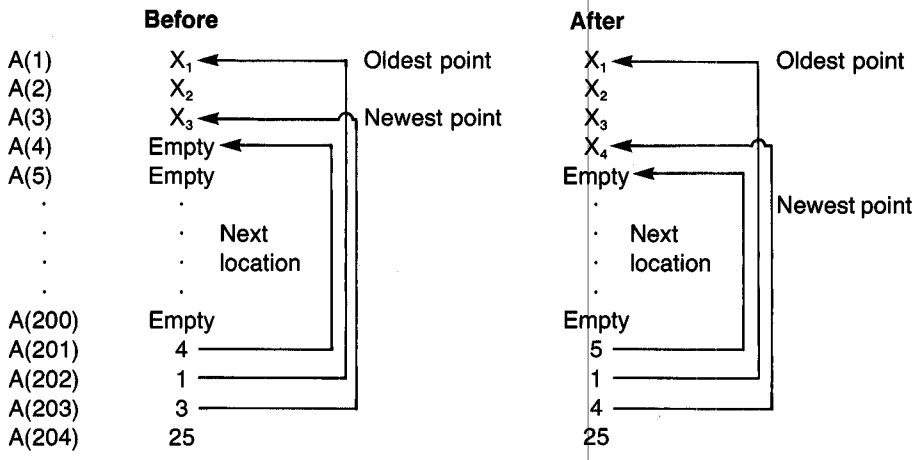
```
610 A(A(201))=T

620 A(203)=A(201)

630 A(201)=A(201)*(A(201)
    <A(204))+1



640 IF A(201)=1 THEN A(202)=
    1 @ GOTO 570

650 IF A(203)=A(202) THEN
    A(202)=A(201)

660 GOTO 570
```

New Value→ A (next available location)

Next available location→ location of last entered value
Location of last entered value + 1 → next available location, unless location of last entered value equaled the number of retained values when the next available location is set to 1.

Set oldest value if it is the first entry or it is changed

If we examine the contents of the array before and after the 4th point is entered, this process should be clearer. For this example, assume that 25 points are to be retained.



As you can see the pointers were changed after the fourth point was entered.

Variable Definitions

A[ ] – Circular list containing entered values and list pointers
A$ – Response string
B[ ] – Averages
V$ – Label
A – Number of points in average
D1 – Distance of a dot in x-direction
D2 – Distance of a dot in y-direction
E – Position of "E" in string
F – Plot flag
F1 – Print averages flag
G9 – Temporary
I – Loop counter and temporary
J – List pointer used in traversing the list
J1 – List pointer used in traversing the list
L – Label length
L1 – Number of X-axis intervals
L2 – Number of Y-axis intervals
L3 – Number of X-intervals between labels
L4 – Number of Y-intervals between labels
L9 – Label position

M1 – Axis Y-minimum
M2 – Axis Y-maximum
M3 – Number of retained values
P – Temporary pointer
S – Sum
S7 – Y-label flag
S8 – X-label flag
S9 – Vertical/Horizontal label flag
T – Average temporary
U – Count of values in sum
V – Length of label
W – Temporary for label
W1 – Temporary for label
X – Label position and temporary
X0 – Scale X-minimum
Y – Label position
Y0 – Scale Y-minimum
Z1 – M3−1
Z2 – M2−M1
Z3 – X dot range
Z4 – Y dot range
Z5 – Scale X-maximum

```
 10 DIM A(205),A$[33],B(204)
 20 F=0 @ PEN 1
 30 ON KEY# 1,"#AV/#R" GOSUB 260
 40 ON KEY# 2,"ENTER" GOSUB 400
 50 ON KEY# 3,"AVERAGE" GOSUB 72
    0
 60 ON KEY# 4,"STORE" GOSUB 940
 70 ON KEY# 5,"HELP" GOSUB 130
 80 ON KEY# 7,"VALUES" GOSUB 235
    0
 90 ON KEY# 8,"PLOT" GOSUB 1030
100 CLEAR @ KEY LABEL
110 DISP "SELECT OPTION"
120 GOTO 120
130 DISP "  MOVING AVERAGE INSTR
    UCTIONS"
140 DISP "K1:ENTER #PTS. FOR AV/
    #RETAINED"
150 DISP "    (MUST BE DONE FIRS
    T)"
160 DISP "K2:ENTER VALUES:OPT. F
    ROM EXIST-"
170 DISP "   ING DATA FILE-SECON
    D STEP"
180 DISP "K3:PRINT CURRENT MOVIN
    G AVERAGE"
190 DISP "K4:STORE RETAINED VALU
    ES ON TAPE"
200 DISP "K5 HELP"
210 DISP "K7:PRINT RETAINED VALU
    ES - MOST"
220 DISP "   RECENT FIRST"
230 DISP "K8:PLOT DATA/MOVING AV
    ERAGE -"
240 DISP "   OPTION TO PLOT MORE
     AVERAGES"
250 RETURN
260 CLEAR @ KEY LABEL
270 DISP "NUMBER OF POINTS IN AV
    ERAGE";
280 INPUT A
290 IF A>=1 AND A<=200 THEN A(20
    5)=A @ GOTO 320
300 DISP "RE-ENTER ";
310 GOTO 280
320 DISP "NUMBER OF POINTS TO BE
     RETAINED";
330 INPUT A(204)
340 IF A(204)>=A AND A(204)<201
    THEN 370
350 DISP "RE-ENTER ";
360 GOTO 320
370 A(201)=1
380 A(202),A(203)=0
390 DISP "DONE" @ RETURN
400 CLEAR
410 DISP "OLD OR NEW DATA:O/N";
420 INPUT A$[1,32]
430 IF UPC$(A$[1,1])="N" THEN 57
    0
440 IF UPC$(A$[1,1])#"O" THEN BE
    EP @ GOTO 400
450 DISP "ENTER FILE NAME";
460 INPUT A$
470 IF LEN(A$)<=6 THEN 500
480 DISP "FILE NAME-TOO LONG"
490 GOTO 450
500 ON ERROR GOTO 520 @ ASSIGN#
    1 TO A$
510 GOTO 550
520 DISP A$&" IS NOT ON TAPE!"
530 BEEP
540 GOTO 450
550 READ# 1 ; A()
560 A=A(205) @ OFF ERROR @ GOTO
    670
570 GOSUB 740
580 DISP "AVE.=";T;":VALUE,INF T
    O END";
590 INPUT T
600 IF T=INF THEN DISP "DONE" @
    RETURN
610 A(A(201))=T
620 A(203)=A(201)
630 A(201)=A(201)*(A(201)<A(204)
    )+1
640 IF A(201)=1 THEN A(202)=1 @
    GOTO 570
650 IF A(203)=A(202) THEN A(202)
    =A(201)
660 GOTO 570
670 DISP "MORE ENTRIES:Y/N";
680 INPUT A$[1,32]
690 IF UPC$(A$[1,1])="Y" THEN 57
    0
700 IF UPC$(A$[1,1])#"N" THEN BE
    EP @ GOTO 670
710 GOTO 390
720 GOSUB 740
730 GOTO 910
740 S=0 @ U=1
750 P=A(203)
760 IF F=0 THEN T=INF @ RETURN
770 IF A>A(203) AND A(202)=0 THE
    N 840
780 S=A(P)+S
790 IF U=A THEN 890
800 U=U+1
810 P=P-1
820 IF P>0 THEN 780
830 P=A(204) @ GOTO 780
840 S=A(P)+S
850 IF P=1 THEN 890
860 U=U+1
870 P=P-1
880 GOTO 840
890 T=S/U
900 RETURN
910 PRINT "CURRENT MOVING AVERAG
    E=";T
920 PRINT "NUMBER OF POINTS IN A
    VERAGE=";U
930 GOTO 390
940 CLEAR @ KEY LABEL
950 DISP "ENTER NAME OF FILE";
960 INPUT A$
970 ON ERROR GOTO 990 @ ASSIGN#
    1 TO A$
980 GOTO 1010
990 IF ERRN#87 THEN 950
1000 CREATE A$,8 @ ASSIGN# 1 TO
     A$
1010 PRINT# 1 ; A()
1020 ASSIGN# 1 TO * @ OFF ERROR
     @ GOTO 390
1030 CLEAR
1040 DISP "DO YOU WANT AVERAGES
     PRINTED";
1050 INPUT A$[1,32]
1060 F1=0
1070 IF UPC$(A$[1,1])="Y" THEN F
     1=1 @ GOTO 1090
1080 IF UPC$(A$[1,1])#"N" THEN B
     EEP @ GOTO 1040
1090 IF F=0 THEN 1140
1100 DISP "NEW PLOT:Y/N";
1110 INPUT A$[1,32]
1120 IF UPC$(A$[1,1])="N" THEN 1
     980
1130 IF UPC$(A$[1,1])#"Y" THEN B
     EEP @ GOTO 1100
1140 GCLEAR @ ALPHA
1150 F=1
1160 DISP "VERTICAL/HORIZONTAL L
     ABELS:V/H";
1170 INPUT A$[1,32]
1180 IF UPC$(A$[1,1])="V" THEN S
     9=0 @ GOTO 1210
1190 IF UPC$(A$[1,1])="H" THEN S
     9=1 @ GOTO 1210
1200 BEEP @ GOTO 1160
1210 M3=A(203)*(A(202)=0)+A(204)
     *(A(202)<>0)
1220 IF M3<=17 THEN L1=M3-1 @ DI
     SP "NUMBER OF X-AXIS INTERV
     ALS=";L1 @ GOTO 1290
1230 DISP "NUMBER OF RETAINED VA
     LUES=";M3
1240 DISP "NO. OF X-AXIS INTERVA
     LS:(<=16)";
1250 INPUT L1
1260 IF L1<0 THEN L1=(M3-1)/(-L1
     ) @ GOTO 1280
1270 IF L1#INT(L1) THEN BEEP @ G
     OTO 1240
1280 IF L1<1 OR L1>16 THEN 1240
1290 DISP "NUMBER X-INT. BETWEEN
      LABELS";
1300 INPUT L3
1310 S8=0 @ IF L3=0 THEN S8=1 @
     L3=1
1320 IF L3<1 OR L3>L1 THEN BEEP
     @ GOTO 1290
1330 DISP "AUTO Y-SCALING:Y/N";
1340 INPUT A$[1,32]
1350 IF UPC$(A$[1,1])="Y" THEN 1
     430
1360 IF UPC$(A$[1,1])#"N" THEN B
     EEP @ GOTO 1330
1370 DISP "ENTER SCALE YMIN";
1380 INPUT M1
1390 DISP "ENTER SCALE YMAX";
1400 INPUT M2
1410 IF M1>=M2 THEN BEEP @ GOTO
     1370
1420 GOTO 1490
1430 M1=INF
1440 M2=-INF
1450 FOR I=1 TO M3
1460 IF A(I)>M2 THEN M2=A(I)
1470 IF A(I)<M1 THEN M1=A(I)
1480 NEXT I
1490 DISP "NO. OF Y-AXIS INTERVA
     LS:(<=12)";
1500 INPUT L2
1510 IF L2<1 OR L2>12 OR L2#INT(
     L2) THEN BEEP @ GOTO 1490
1520 DISP "NUMBER Y-INT. BETWEEN
      LABELS";
1530 INPUT L4
1540 S7=0 @ IF L4=0 THEN S7=1 @
     L4=1
1550 IF L4<1 OR L4>L2 THEN BEEP
     @ GOTO 1520
```

Initialization

Wait loop until key is pressed
HELP subroutine

Enter # points in average

Enter # points to be retained

Verify values

Initialize pointers

Data Entry

Old or New Data?

Enter old data file name

Read array

New entry from keyboard

Update pointers (see programming hints for more details)

More entries? after reading data from data file

Start AVERAGE subroutine
Go to print out average
Compute current moving average subroutine

Print out current moving average

Store data routine
Enter file name

Print data on file

Start PLOT routine
PRINT AVERAGES?

Plot done before?
Yes, erase old or overlay

Specify Scaling and labelling information

```
1560 Z1=M3-1
1570 Z3=INT(200/L1)*L1
1580 Z2=M2-M1
1590 Z4=INT(144/L2)*L2
1600 D1=Z1/Z3 @ D2=Z2/Z4 @ Z5=M3
     +(207-Z3)*D1
1610 X0=1-48*D1
1620 Y0=M1-40*D2
1630 SCALE X0,Z5,Y0,M2+(151-Z4)*
     D2
1640 XAXIS M1,Z1/L1,1,Z1+1+D1
1650 YAXIS 1,Z2/L2,M1,M2+D2
1660 IF S8 THEN 1750
1670 W1=LGT(ABS(Z1/L1*L3))
1680 IF S9 THEN 2450
1690 LDIR 90
1700 FOR I=1 TO M3+D1 STEP Z1/L1
     *L3
1710 MOVE I+4*D1,Y0
1720 GOSUB 2560
1730 LABEL V$[1,V]
1740 NEXT I
1750 IF S7 THEN 1930
1760 W1=LGT(ABS(Z2/L2*L4))
1770 W=LGT(ABS(M1+(M1=0)))+1
1780 IF W>4-(SGN(M1)=-1) OR W1<-
     3 THEN 1860
1790 LDIR 0
1800 FOR I=M1 TO M2+D2 STEP Z2/L
     2*L4
1810 MOVE X0,I-4*D2
1820 GOSUB 2560
1830 LABEL V$[1,V]
1840 NEXT I
1850 GOTO 1930
1860 LDIR 90
1870 I=M1 @ GOSUB 2680
1880 MOVE X1+12*D1,M1
1890 LABEL "YMIN="&V$[1,10]
1900 MOVE X1+24*D1,M1
1910 I=Z2/L2 @ GOSUB 2680
1920 LABEL "TICS="&V$[1,10]
1930 J=A(202)+(A(202)=0)
1940 FOR I=1 TO M3
1950 MOVE I-2*D1,A(J)-4*D2 @ LAB
     EL "+"
1960 J=J*(J<>M3)+1
1970 NEXT I
1980 J=A(202)+(A(202)=0) @ S,U=0
1990 S=A(J)+S @ U=U+1
2000 IF U=A OR U>=M3 THEN 2030
2010 J=J*(J<>M3)+1
2020 GOTO 1990
2030 T=S/U @ B(U)=T
2040 PENUP @ PLOT U,T
2050 IF U<>A OR A>=M3 THEN 2150
2060 J1=A(202)+(A(202)=0) @ J=J*
     (J#M3)+1
2070 FOR I=A+1 TO M3
2080 S=S-A(J1)
2090 J1=J1*(J1<>M3)+1
2100 S=S+A(J)
2110 J=J*(J<>M3)+1
2120 B(I)=S/A
2130 DRAW I,B(I)
2140 NEXT I
2150 MOVE U,T @ LABEL VAL$(A)
2160 IF F1=0 THEN 2230
2170 PRINT "MOVING AVERAGES"
2180 PRINT "MOST RECENT FIRST"
2190 PRINT "NUMBER OF POINTS =";
     A
2200 FOR I=M3 TO A STEP -1
2210 PRINT B(I)
2220 NEXT I
2230 ALPHA @ DISP "LABEL PLOT:Y/
     N";
2240 INPUT A$[1,32]
2250 IF UPC$(A$[1,1])="Y" THEN G
     OSUB 2720 @ GOTO 2230
2260 IF UPC$(A$[1,1])#"N" THEN B
     EEP @ GOTO 2230
2270 ALPHA @ DISP "CHANGE NUMBER
      OF POINTS:Y/N";
2280 INPUT A$[1,32]
2290 IF UPC$(A$[1,1])="N" THEN 2
     340
2300 IF UPC$(A$[1,1])#"Y" THEN 9
     EEP @ GOTO 2270
2310 DISP "ENTER NO. OF POINTS I
     N AVERAGE";
2320 INPUT A
2330 GOTO 1030
2340 GRAPH @ RETURN
2350 PRINT "DATA VALUES"
2360 PRINT "MOST RECENT FIRST"
2370 PRINT "NUMBER RETAINED VALU
     ES=";A(204)
2380 J=A(203)
2390 M3=A(203)*(A(202)=0)+A(204)
     *(A(202)<>0)
2400 FOR I=M3 TO 1 STEP -1
2410 PRINT A(J)
2420 J=A(204)*(J=1)+J-1
2430 NEXT I
2440 RETURN
2450 LDIR 0 @ L9=-INF
```

Compute SCALE factors

SCALE Plot

Draw AXES

Label plot

Plot data points

Plot moving averages

Label moving average curve

Print moving average values

Label plot?

Change number of points in average?

Enter number of points in average

Print out retained values

Horizontal label routine

```
2460 FOR I=1 TO M3+D1 STEP Z1/L1
     *L3
2470 GOSUB 2560
2480 IF L9>I-(V$4+6)*D1 OR L9>Z5
     +(1-V$8)*D1 THEN PRINT USIN
     G 2490 ; I @ GOTO 2540
2490 IMAGE "LABEL DELETED AT ",7
     D.4D
2500 MOVE I+(2-V$4)*D1,M1-12*D2
2510 L9=I+(V$4+2)*D1
2520 IF L9>Z5 THEN MOVE Z5+(2-V$
     8)*D1,M1-12*D2
2530 LABEL V$[1,V]
2540 NEXT I
2550 GOTO 1750
2560 V$=""
2570 X=I
2580 V$=VAL$(X)
2590 IF POS(V$,"E") THEN 2650
2600 G9=LGT(ABS(X+(X=0)))
2610 IF LEN(V$)>5 AND ABS(G9)>4-
     (SGN(X)=-1) THEN V=5 @ V$="
     -----" @ RETURN
2620 IF LEN(V$)<5 THEN V=LEN(V$)
      @ RETURN
2630 V$[1,5]=VAL$(X) @ V=5
2640 RETURN
2650 E=POS(V$,"E")
2660 IF VAL(V$[E+1])>9 THEN V$[2
     ,2]=V$[3,3] @ V$[3,3]="E" @
      V$[4,5]=V$[E+2] @ V=5 @ RE
     TURN
2670 V$[2,3]=V$[3,4] @ V$[4,4]="
     E" @ V$[5,5]=V$[E+3] @ V=5
     @ RETURN
2680 V$=""
2690 V$=VAL$(I)
2700 IF POS(V$,"E") THEN V$[7,10
     ]=V$[POS(V$,"E")] ELSE V$[1
     ,10]=VAL$(I)
2710 RETURN
2720 CLEAR
2730 DISP "LABEL ORIGIN:X,Y";@ I
     NPUT X,Y
2740 IF X>=X0 AND X<=M3 AND Y>=Y
     0 AND Y<=M2+3*D2 THEN 2760
2750 DISP "INVALID POSITION" @ B
     EEP @ GOTO 2730
2760 DISP "ENTER LABEL";
2770 INPUT A$
2780 L=LEN(A$)
2790 IF L/32>(Z5-X)/(Z5-X0) THEN
      DISP "LABEL TOO LONG" @ BE
     EP @ GOTO 2760
2800 MOVE X,Y @ LABEL A$
2810 RETURN
```

Label string construction

Enter LABEL ORIGIN

Enter LABEL

Too long?

LABEL plot

Notes

Annuities and Compound Amounts with Amortization

Interchangable Solutions

In programs like ''Annuities and Compound Amounts with Amortization'', it is necessary to be able to calculate any value given the other values. In this program, known values are entered by pressing the key designating the known value (e.g., KEY #1 for entering the number of compounding periods, *n*) and then entering the value when requested. The unknown value is then specified by first pressing KEY #7 (SLV/AD) followed by the key designating the unknown value (e.g., KEY #4 for periodic payment, PMT). Pressing KEY #7 sets the value of the variable *S* to 6 which indicates that the next key pressed will designate the unknown value to be calculated and printed. A closer look at the actual program should clarify this technique. The essential lines which show the control logic are shown below:

```
 80 V1,V2,P,N,J1,J=0
 90 ON KEY# 1,"n" GOSUB 220
100 ON KEY# 2,"i" GOSUB 240
110 ON KEY# 3,"PV" GOSUB 280
120 ON KEY# 4,"PMT" GOSUB 260
130 ON KEY# 5,"HELP" GOSUB 340
140 ON KEY# 6,"AMORT" GOSUB 300
150 ON KEY# 7,"SLV/AD" GOSUB 480
160 ON KEY# 8,"FV" GOSUB 320
170 KEY LABEL
180 DISP "SELECT OPTION"
190 F,S=0 @ A=1
200 ON S+F+1 GOTO 200,560,600,66
    0,690,720,200,750,810,1070,1
    130,1180,210
210 GOTO 1230
220 F=1
230 RETURN
240 F=2
250 RETURN
260 F=3
270 RETURN
280 F=4
290 RETURN
```

```
300 F=12 @ S=0
310 RETURN
320 F=5
330 RETURN
```

The variable *F* is used to specify which key has been pressed. The variable *S* indicates whether the solve key has been pressed. A trace of the program will show the flow of execution in solving for the periodic payment (PMT) after the known values were entered.

This technique, while being rather complicated, is quite versatile and powerful when implemented in programs which require the user to select the flow of operations.

```
 Trace line 200 to 200
 Trace line 200 to 200
 Trace line 200 to 260
 Trace line 270 to 200
 Trace line 200 to 1070
PERIODIC PAYMENT =-224.03
 Trace line 1120 to 180
 Trace line 200 to 200
 Trace line 200 to 200
```

Variable Definitions

A$ – Response string
A – Annuity due/ordinary annuity flag
A1 – Temporary = 1 + A * J
F – Key pressed code
F1 – Temporary
I – Loop counter and temporary
J – Periodic interest rate
J1 – Annual interest rate
N – Number of compounding periods
N1 – Number of compounding periods/year
P – Periodic payment
P1 – Starting period for amortization
P2 – Ending period for amortization
R – Temporary
R8 – Temporary
R9 – Temporary
S – Solve flag

S1 – Amortization principal portion
S2 – Amortization interest portion
S3 – Remaining balance
T1 – Total principal and temporary
T2 – Total interest and temporary
T3 – Temporary
T4 – Temporary
V1 – Present value
V2 – Future value

```
 10 DIM A$[33]
 20 CLEAR @ DISP "PRINTER OUTPUT
    (Y/N)";
 30 INPUT A$[1,32]
 40 PRINTER IS 1 @ P9=0
 50 IF UPC$(A$[1,1])="Y" THEN PR
    INTER IS 2 @ P9=1 @ GOTO 70
 60 IF UPC$(A$[1,1])#"N" THEN BE
    EP @ GOTO 20
 70 CLEAR
 80 V1,V2,P,N,J1,J=0
 90 ON KEY# 1,"n" GOSUB 220
100 ON KEY# 2,"i" GOSUB 240
110 ON KEY# 3,"PV" GOSUB 280
120 ON KEY# 4,"PMT" GOSUB 260
130 ON KEY# 5,"HELP" GOSUB 340
140 ON KEY# 6,"AMORT" GOSUB 300
150 ON KEY# 7,"SLV/AD" GOSUB 480
160 ON KEY# 8,"FV" GOSUB 320
170 KEY LABEL
180 DISP "SELECT OPTION"
190 F,S=0 @ A=1
200 ON S+F+1 GOTO 200,560,600,66
    0,690,720,200,750,810,1070,1
    130,1180,210
210 GOTO 1230
220 F=1
230 RETURN
240 F=2
250 RETURN
260 F=3
270 RETURN
280 F=4
290 RETURN
300 F=12 @ S=0
310 RETURN
320 F=5
330 RETURN
340 GOSUB 5000 @ PRINT " ANNUITI
    ES AND COMPOUND AMOUNTS"
350 PRINT "PRESS VARIABLE KEY TH
    EN ENTER" @ PRINT "KNOWN WHE
    N REQUESTED. TO SOLVE"
370 PRINT "FOR VALUE, PRESS SLV/
    AD(K7),THEN" @ PRINT "UNKNOW
    N (K1-K4 & K8)."
390 PRINT "K1:n,# OF COMPOUNDING
     PERIODS" @ PRINT "K2:i,PERI
    ODIC INTEREST RATE"
410 PRINT "K3:PV,PRESENT VALUE"
420 PRINT "K4:PMT,PERIODIC PAYME
    NT" @ PRINT "K5:HELP"
440 PRINT "K6:PRINT AMORTIZATION
     SCHEDULE" @ PRINT "K7:SET S
    OLVE AND ANNUITY TYPE"
460 PRINT "K8:FV,FUTURE VALUE"
465 IF P9 THEN PRINT USING "4/"
470 RETURN
475 IMAGE K,8D.DD
480 GOSUB 5000 @ A=NOT A
490 ON A+1 GOTO 500,520
500 A$="ORDINARY ANNUITY" @ DISP
     A$ @ IF P9 THEN PRINT A$
510 GOTO 530
520 DISP "ANNUITY DUE" @ IF P9 T
    HEN PRINT "ANNUITY DUE"
530 S=6 @ A1=1+A*J
550 RETURN
560 GOSUB 5000 @ DISP "ENTER # O
    F COMPOUNDING PERIODS";
570 INPUT N
575 IF P9 THEN PRINT USING "K,5D
    " ; "# OF COMPOUNDING PERIOD
    S =",N
580 F=0 @ GOTO 180
600 GOSUB 5000 @ DISP "ENTER ANN
    UAL % RATE";
610 INPUT J1
615 IF P9 THEN PRINT USING "K,2D
    .3D" ; "ANNUAL % RATE = ",J1
620 DISP "ENTER # COMPOUNDING PE
    RIODS/YR.";
630 INPUT N1
635 IF P9 THEN PRINT USING "K,4D
    " ; "# COMPOUNDING PERIODS/Y
    R.",N1
640 J=J1/N1/100 @ GOTO 580
660 GOSUB 5000 @ DISP "ENTER PER
    IODIC PAYMENT";
670 INPUT P
675 IF P9 THEN PRINT USING 475 ;
     "PERIODIC PAYMENT =",P
680 GOTO 580
690 GOSUB 5000 @ DISP "ENTER PRE
    SENT VALUE";
700 INPUT V1
705 IF P9 THEN PRINT USING 475 ;
     "PRESENT VALUE =",V1
710 GOTO 580
720 GOSUB 5000 @ DISP "ENTER FUT
    URE VALUE";
730 INPUT V2
735 IF P9 THEN PRINT USING 475 ;
     "FUTURE VALUE =",V2
740 GOTO 580
750 N=-(V1+V2)/(A1*P-J*V2)
760 IF J=0 THEN 790
770 IF -J*N>=0 THEN N=-LOG(1-J*N
    )/LOG(1+J) @ GOTO 790
780 N=LOG(1+J*(V1+V2)/(A1*P+J*V1
    ))/LOG(1+J)
790 PRINT USING "18A,5D.2D" ; "N
    UMBER OF PERIODS=",N
800 GOTO 180
810 F2=0 @ R8=V1+A*P
820 R9=V2+(1-A)*P
830 IF N=1 THEN 850
840 IF P#0 THEN 880
850 IF R8*R9=0 THEN DISP "ERROR
    IN DATA" @ BEEP @ GOTO 180
860 J=(-R9/R8)^(1/N)-1
870 GOTO 1000
880 IF R8*R9>0 THEN DISP "ERROR
    IN DATA" @ BEEP @ GOTO 180
890 J=1+1/N
900 IF R8*P<0 THEN GOSUB 1030
910 T1=EXP(N*LOG(J))-1
920 IF J-1=0 THEN T1=N ELSE T1=T
    1/(J-1)
930 T2=(T1-1)*P+R8*J^N @ T3=N-T1
950 IF J-1=0 THEN T3=N*(1-N)/2 E
    LSE T3=T3/(J-1)*J*P
960 J1=J*(-R9/T2)^(T2/(T2*N+T3))
970 IF ABS((J-J1)/J1)>.00000001
    THEN J=J1 @ GOTO 910 ELSE J=
    J1
980 IF F2 THEN GOSUB 1030
990 F2=0 @ J=J-1
1000 J1=100*J
1010 PRINT USING "24A,4D.2D,A" ;
      "PERIODIC INTEREST RATE ="
     ,J1,"%"
1020 GOTO 180
1030 F2=1 @ J=1/J @ T4=R8 @ R9=R
     9 @ R9=T4 @ RETURN
1070 R=(1+J)^(-N)
1080 P=-(V1+V2*R)/(A1*(1-R)/J)
1090 P=INT(P*100+.5)/100
1100 PRINT USING "19A,5D.2D" ; "
     PERIODIC PAYMENT = ",P
1110 DISP
1120 GOTO 180
1130 R=(1+J)^(-N)
1140 V1=-(A1*P*((1-R)/J)+V2*R)
1150 V1=INT(V1*100+.5)/100
1160 PRINT USING "16A,6D.2D" ; "
     PRESENT VALUE = ",V1
1170 GOTO 180
1180 R=(1+J)^N
1190 V2=-A1*P*((R-1)/J)-V1*R
1200 V2=INT(V2*100+.5)/100
1210 PRINT USING 475 ; "FUTURE V
     ALUE =",V2
1220 GOTO 180
1230 GOSUB 5000 @ IF N*J=0 THEN
     DISP "INSUFFICIENT DATA" @
     BEEP 50,150 @ GOTO 180
1240 DISP "ENTER STARTING PERIOD
     ";
1250 INPUT P1
1260 IF P1>0 AND P1<=N THEN 1290
1270 DISP "RE-";@ GOTO 1240
1290 DISP "ENTER ENDING PERIOD";
1300 INPUT P2
1310 IF P2>=P1 AND P2<=N THEN 13
     40
1320 DISP "RE-";@ GOTO 1290
1340 PRINT TAB(10),"","AMORTIZAT
     ION"
1350 PRINT USING "3A,5D.2D" ; "n
     =",N
1360 PRINT USING "3A,2D.2D,A" ;
     "i =",J1,"%"
1370 PRINT USING "10A,5D.2D" ; "
     PAYMENT =$",P
1380 PRINT USING "16A,7D.2D" ; "
     PRESENT VALUE =$",V1
1390 PRINT USING "15A,7D.2D" ; "
     FUTURE VALUE =$",V2
1400 PRINT " P  PRINCIPAL  INTER
     EST  BALANCE"
1410 T1,T2=0 @ S3=V1
1420 FOR I=1 TO P1-1
1430 S2=J*S3 @ S2=INT(S2*100+.5)
     /100 @ S3=S3+S2+P
1450 NEXT I
1460 FOR I=P1 TO P2
1470 S2=J*S3 @ S2=INT(S2*100+.5)
     /100 @ S1=-P-S2 @ S3=S3-S1
1510 T1=T1+S1 @ T2=T2+S2
1520 PRINT USING "3D,6D2.2D,5DZ.
     2D,6DZ.2D" ; I,S1,S2,S3
1530 NEXT I
1540 PRINT "TOTALS:"
1550 PRINT USING "3X,6D2.2D,5DZ.
     2D" ; T1,T2
1560 PRINT @ GOTO 180
1580 END
5000 CLEAR @ KEY LABEL @ RETURN
```

Initialization
Specify printer or display output

Wait loop until key is pressed and then branch according to values of S and F
Set F according to option

HELP subroutine

Toggle Annuity Due/Ordinary Annuity flag

Set S to Solve

Enter number of compounding periods

Enter i

Enter PMT

Enter PV

Enter FV

Compute N

Compute i

Compute PMT

Compute PV

Compute FV

Start AMORT

Enter starting period

Enter ending period

Print amortization schedule

Polynomial Solutions

Variable Definitions

I( ) – Imaginary part of coefficients
I1( ) – Working array containing imaginary part of coefficients
J( ) – Imaginary part of roots
R( ) – Real part of coefficients
R1( ) – Working array containing real part of coefficients
S( ) – Real part of roots
X( ), Y( ) – Siljak function where $Z^k = X(k) + i\,Y(k)$
A – Temporary
B – Temporary
C – Temporary
D – Temporary
D4 – Δx
D5 – Δv
F – $u^2 + v^2$, function value for Siljak Functions
G – Former value of F, used for convergence
I – Loop counter
K – Loop counter
L – Counter for checking convergence against maximum iterations
M – Quartering counter
N – Degree of polynomial; number of roots to be found
N1 – Temporary
P – $\delta u/\delta x$
Q – $\delta v/\delta x$
T – Temporary
T1 – Tolerance for functional evaluation
T2 – Tolerance for the root
U – Real part of F
V – Imaginary part of F
X – Current root approximation real part
Y – Current root approximation imaginary part
Z – Temporary used in computing Siljak Functions

```
 10 DIM R(50),I(50),S(50),J(50),
    X(50),Y(50),R1(50),I1(50)
 20 ON KEY# 1,"ENTER" GOSUB 210
 30 ON KEY# 2,"EDIT" GOSUB 470
 40 ON KEY# 3,"PRINT" GOSUB 690
 50 ON KEY# 4,"ROOTS" GOSUB 790
 60 ON KEY# 5,"HELP" GOSUB 100
 70 CLEAR
 80 KEY LABEL @ DISP "SELECT OPT
    ION"
 90 GOTO 90
100 GOSUB 1730
110 DISP "   POLYNOMIAL ROOT FIN
    DER"
120 DISP "K1:DATA ENTRY AND PROB
    LEM"
130 DISP "   SPECIFICATION"
140 DISP "K2:EDIT DATA BY COEFFI
    CIENT"
150 DISP "   NUMBER"
160 DISP "K3:PRINT CURRENT PROBL
    EM"
170 DISP "   SPECIFICATIONS AND
    DATA"
180 DISP "K4:SOLVE AND PRINT ROO
    TS"
190 DISP "K5:HELP"
200 RETURN
210 CLEAR
220 DISP "DEGREE OF POLYNOMIAL";
230 INPUT N
240 DISP "MAX # OF ITERATIONS";
250 INPUT I1
260 IF I1<=0 THEN 240
270 DISP "TOLERANCE FOR ROOTS";
280 INPUT T2
290 IF T2<=0 THEN 270
300 DISP "TOLERANCE FOR FUNCTION
    AL EVAL.";
310 INPUT T1
320 IF T1<=0 THEN 300
330 PRINT
340 PRINT
350 PRINT "COEFFICIENTS:E(Rcoef(
    0)+Icoef.--"
360 PRINT
370 PRINT "      REAL          IM
    AGINARY"
380 FOR I=0 TO N
390 DISP "Rcoef(";I;")=";
400 INPUT R(I)
410 DISP "Icoef(";I;")=";
420 INPUT I(I)
430 PRINT USING 450 ; R(I),I(I)
440 NEXT I
450 IMAGE M6DZ.4D,3X,M6DZ.4D
460 DISP "PROBLEM ENTERED" @ RET
    URN
470 GOSUB 1750
480 DISP "COEFFICIENT NUMBER";
490 INPUT I
500 IF I<0 OR I>N THEN 480
510 DISP "Rcoef(";I;")=";
520 INPUT R(I)
530 DISP "Icoef(";I;")=";
540 INPUT I(I)
550 PRINT USING 560 ; I,R(I),I,I
    (I)
560 IMAGE "Rcoef(",DDD,")=",M6DZ
    .4D,/,"Icoef(",DDD,")=",M6DZ
    .4D
570 RETURN
580 PRINT
590 PRINT
600 PRINT "ROOTS:"
610 PRINT "      REAL        IMAG
    INARY"
620 PRINT
630 FOR I=1 TO N
635 IF S(I)=INF THEN PRINT "NOT
    FOUND" @ GOTO 650
640 PRINT USING 450 ; S(I),J(I)
650 NEXT I
660 PRINT
670 PRINT
680 RETURN
690 GOSUB 1750 @ PRINT @ PRINT
700 PRINT "MAX # ITERATIONS =",I
    1
710 PRINT "TOLERANCE FOR ROOTS =
    ",T2
720 PRINT "TOL. FOR FUNC. EVAL.=
    ",T1
730 PRINT " I          REAL
      IMAGINARY"
740 FOR I=0 TO N
750 PRINT USING  "DDD,2X,M6DZ.3D
    ,3X,M6DZ.3D" ; I,R(I),I(I)
760 NEXT I
770 PRINT
780 RETURN
790 GOSUB 1750
800 B=N<=0 OR T2<=0 OR T1<=0 OR
    I1<=0
810 IF B=0 THEN 870
820 PRINT "ERROR IN DATA"
830 PRINT "N=";N,"Tola=";T2
840 PRINT "Tolf=";T1,"Itmax=";I1
850 PAUSE
860 GOTO 800
870 FOR I=1 TO N
880 S(I),J(I)=INF
890 NEXT I
900 FOR I=0 TO N
910 R1(I)=R(I) @ I1(I)=I(I)
920 NEXT I
930 N1=N
940 IF N=1 THEN 1530
950 Y,Y(1),X(0)=1
960 X,X(1)=.1
970 Y(0),L=0
980 GOSUB 1620
990 G=F
1000 M,Q,P=0
1010 L=L+1
1020 FOR K=1 TO N
1030 P=P+K*(R1(K)*X(K-1)-I1(K)*Y
     (K-1))
1040 Q=Q+K*(R1(K)*Y(K-1)+I1(K)*X
     (K-1))
1050 NEXT K
1060 Z=P*P+Q*Q
1070 D4=-(U*P+V*Q)/Z
1080 D5=(U*Q-V*P)/Z
1090 M=M+1
1100 X(1)=X+D4
1110 Y(1)=Y+D5
1120 GOSUB 1620
1130 IF F>=G THEN 1190
1140 IF ABS(D4)<T2 AND ABS(D5)<T
     2 THEN 1340
1150 IF L>I1 THEN 1290
1160 X=X(1)
1170 Y=Y(1)
1180 GOTO 990
1190 IF M>20 THEN 1230
1200 D4=D4/4
1210 D5=D5/4
1220 GOTO 1090
1230 IF ABS(U)<=T1 AND ABS(V)<=T
     1 THEN 1340
1240 PRINT "ERROR IN FUNCTION"
1250 PRINT "THE INTERVAL SIZE HA
     S BEEN       QUARTERED 20 TI
     MES AND THE"
1260 PRINT "TOLERANCE FOR FUNCTI
     ONAL       EVALUATIONS IS
     STILL NOT MET."
1270 PRINT "Tolf=";T1,"U=";U,"V=
     ";V
1280 PAUSE
1290 PRINT "ERROR IN FUNCTION"
1300 PRINT "MAXIMUM # OF ITERATI
     ONS HAS BEENEXCEEDED."
1310 PRINT "L=";L,"Itmax=";I1
1320 PAUSE
1330 GOTO 1150
1340 S(N)=X(1)
1350 J(N)=Y(1)
1360 A=R1(N)
1370 B=I1(N)
1380 R1(N),I1(N)=0
1390 X=X(1)
1400 Y=Y(1)
1410 FOR K=N-1 TO 0 STEP -1
1420 C=R1(K)
1430 D=I1(K)
1440 U=R1(K+1)
1450 V=I1(K+1)
1460 R1(K)=A+X*U-Y*V
1470 I1(K)=B+X*V+Y*U
1480 A=C
1490 B=D
1500 NEXT K
1510 N=N-1
1520 IF N<>1 THEN 950
1530 A=R1(0)
1540 U=R1(1)
1550 B=I1(0)
1560 V=I1(1)
1570 T=U*U+V*V
1580 S(1)=-(A*U+B*V)/T
1590 J(1)=(A*V-U*B)/T
1600 N=N1
1610 GOTO 580
1620 Z=X(1)*X(1)+Y(1)*Y(1)
1630 T=2*X(1)
1640 FOR K=0 TO N-2
1650 X(K+2)=T*X(K+1)-Z*X(K)
1660 Y(K+2)=T*Y(K+1)-Z*Y(K)
1670 NEXT K
1680 U,V=0
1690 FOR K=0 TO N
1700 U=U+R1(K)*X(K)-I1(K)*Y(K)
1710 V=V+R1(K)*Y(K)+I1(K)*X(K)
1720 NEXT K
1730 F=U*U+V*V
1740 RETURN
1750 CLEAR @ KEY LABEL @ RETURN
```

Initialize

Wait loop until key is pressed
HELP subroutine

Enter problem data

Enter coefficients

Edit coefficients

Print roots subroutine

Start root finder

Initialize roots

Copy master to working arrays

N=1?

X( ), Y( ) are Siljak Coefficients

Compute Siljak coefficients

Increment iteration counter

Compute changes in X and Y
Increment successive quartering counter
New Root approximations
Recompute Siljak coefficients
New error > old error?
Stopping conditions met?

Iterations > Max?

Iterate again
Quarterings > 20?

Error messages

Root found—store it

Initialize variables for synethetic division

Synthetic division to calculate new coefficients

Reduce number of coefficients
Degree = 1?
Compute final root algebraically

Compute Siljak coefficients

Simultaneous Equations

Data Entry With Edit Options

In order to use a program, you must be able to enter, verify, and correct data values. The "Simultaneous Equations" program is designed to allow the user to do any of these options. By setting up the equations as an array, each row in the array contains the coefficients of an equation in the first N columns and the right hand side of the equation in the N + 1 column. The editing of the equations is reduced to specifying the array element to be edited. The print-out of the entire set of equations is accomplished by two nested FOR-NEXT loops which effectively associate the array elements with their respective equation and coefficient.

Storing data values in an array minimizes the addressing problems in specifying the individual elements and, therefore, simplifies any operations using the data.

Variable Definitions

A( ) - Absolute error vector
C(,) - System of equations as entered
D( ) - Vector $\bar{j}$
I( ) - Vector of pivot element row subscriptions, r_k
J( ) - Vector of pivot element column subscriptions, c_k
S( ) - Vector of solutions
T(,) - Working set of equations; the inverse of the original matrix is contained in the nxn matrix after the solutions are found.
Y( ) - Vector y, used in unscrambling the inverse matrix
D - Determinant of the inverted matrix
E - Minimum allowable magnitude, epsilon, for a pivot element
I - Loop counter
I2 - Loop counter
I4 - Temporary pointer
J - Loop counter
J2 - Loop counter
J4 - Temporary pointer
K - Loop counter
K1 - Temporary pointer
M - Number of columns in C(,)
N - Number of rows in C(,)
N1 - N−1

P – Pivot element
P1 – Temporary pointer
T – Number of pairwise interchanges required to order elements of D( )
T1 – Temporary
W – Equation number to edit

```
 10 OPTION BASE 1
 20 DIM C(20,21),S(20),A(20),T(2
    0,21),Y(20)
 30 INTEGER I(20),J(20),D(20)
 40 PRINTER IS 2
 50 ON KEY# 1,"ENTER" GOSUB 130
 60 ON KEY# 2,"EDIT" GOSUB 480
 70 ON KEY# 3,"SOLVE" GOSUB 800
 80 ON KEY# 4,"PRINT" GOSUB 960
 90 ON KEY# 5,"HELP" GOSUB 2000
100 CLEAR @ KEY LABEL
110 DISP "SELECT OPTION"
120 GOTO 120
130 CLEAR @ DISP "This program a
    llows the user to input and
    solve a system of"
140 DISP "simultaneous linear eq
    uations    and solves them. B
    elow, you are"
150 DISP "asked to enter the num
    ber of"
160 DISP "equations you have to
    solve      (the number of equ
    ations to be"
170 DISP "solved is equal to the
     number   of independent var
    iables)."
180 DISP "Enter number of equati
    ons";
190 INPUT N
200 N=INT(N)
210 IF N=0 THEN RETURN
220 DISP "Enter the coefficient
    matrix of the system of equa
    tions. The"
230 DISP "subscript conventions
    used by   the prompts issued
     by this"
240 DISP "program follow this fo
    rm:"
250 DISP "A(1,1)*X(1)+...+A(1,n)
    *X(n)=B(1)"
260 DISP "A(2,1)*X(1)+...+A(2,n)
    *X(n)=B(2)"
270 DISP "A(3,1)*X(1)+...+A(3,n)
    *X(n)=B(3)"
280 IMAGE "
    :          ."
290 FOR I=1 TO 3
300 DISP USING 280
310 NEXT I
320 DISP "A(n,1)*X(1)+...+A(n,n)
    *X(n)=B(n)"
330 FOR I=1 TO N
340 PRINT "Equation #"&VAL$(I)&"
    :  ";
350 FOR J=1 TO N
360 DISP "Enter Coeff. for eleme
    nt #"&VAL$(I)&","&VAL$(J);
370 INPUT C(I,J)
380 IF J#1 THEN PRINT " + ";
390 PRINT VAL$(C(I,J))&"*X("&VAL
    $(J)&")";
400 NEXT J
410 DISP "Enter the RHS of equat
    ion #"&VAL$(I);
420 INPUT C(I,N+1)
430 PRINT "="&VAL$(C(I,N+1))
440 NEXT I
450 PRINT
460 DISP "SYSTEM ENTERED"
470 RETURN
480 CLEAR @ DISP "Which equation
    ";
490 INPUT W
500 W=INT(W)
510 IF W>=1 AND W<=N THEN 540
520 BEEP
530 GOTO 480
540 A$=""
550 DISP "WHICH SIDE:(L/R)";
560 INPUT A$
570 IF UPC$(A$)="L" THEN 610
580 IF UPC$(A$)="R" THEN 770
590 BEEP
600 GOTO 550
610 J=0
620 DISP "WHICH COEFF.";
630 INPUT J
640 J=INT(J)
650 IF J>=1 AND J<=N THEN 680
660 BEEP
670 GOTO 610
680 DISP "ENTER COEFF. FOR ELEME
    NT #"&VAL$(W)&","&VAL$(J);
690 INPUT C(W,J)
700 PRINT "Equation #"&VAL$(W)&"
    :  ";
710 FOR J=1 TO N
720 IF J#1 THEN PRINT " + ";
730 PRINT VAL$(C(W,J))&"*X("&VAL
    $(J)&")";
740 NEXT J
750 PRINT VAL$(C(W,N+1))
760 GOTO 460
770 DISP "ENTER THE RHS OF EQ. #
    "&VAL$(W);
780 INPUT C(W,N+1)
790 GOTO 700
800 GOSUB 2130 @ FOR I=1 TO N
810 FOR J=1 TO N+1
820 T(I,J)=C(I,J)
830 NEXT J
840 NEXT I
850 GOSUB 960
860 DISP "ENTER EPSILON";
870 INPUT E
880 DISP "SOLVING SYSTEM" @ GOSU
    B 1130
890 IF ABS(D)>.000000000001 THEN
     930
900 BEEP
910 PRINT "SYSTEM HAS NO SOLUTIO
    N"
920 RETURN
930 GOSUB 1920
940 GOSUB 1070
950 RETURN
960 PRINT "SYSTEM OF EQUATIONS:"
970 FOR I=1 TO N
980 PRINT "Equation #"&VAL$(I)&"
    :  ";
990 FOR J=1 TO N
1000 IF J#1 THEN PRINT " + ";
1010 PRINT VAL$(C(I,J))&"*X("&VA
     L$(J)&")";
1020 NEXT J
1030 PRINT "="&VAL$(C(I,N+1))
1040 NEXT I
1050 PRINT
1060 RETURN
1070 PRINT "   SOLUTION       ABS
     OLUTE ERROR"
1080 FOR I=1 TO N
1090 PRINT USING 1100 ; I,S(I),A
     (I)
1100 IMAGE "X(",DDD,")=",6D.4D,2
     X,MZ.4DE
1110 NEXT I
1120 RETURN
1130 M=N+1
1140 D=1
1150 FOR K=1 TO N
1160 K1=K-1
1170 P=0
1180 FOR I=1 TO N
1190 FOR J=1 TO N
1200 IF K=1 THEN 1270
1210 FOR I2=1 TO K1
1220 FOR J2=1 TO K1
1230 IF I=I(I2) THEN 1310
1240 IF J=J(J2) THEN 1310
1250 NEXT J2
1260 NEXT I2
1270 IF ABS(T(I,J))<=ABS(P) THEN
     1310
1280 P=T(I,J)
1290 I(K)=I
1300 J(K)=J
1310 NEXT J
1320 NEXT I
1330 IF ABS(P)>E THEN 1360
1340 D=0
1350 RETURN
1360 I3=I(K)
1370 J3=J(K)
1380 D=D*P
1390 FOR J=1 TO M
1400 T(I3,J)=T(I3,J)/P
1410 NEXT J
1420 T(I3,J3)=1/P
1430 FOR I=1 TO N
1440 T=T(I,J3)
1450 IF I=I3 THEN 1500
1460 T(I,J3)=-T/P
1470 FOR J=1 TO M
1480 IF J<>J3 THEN T(I,J)=T(I,J)
     -T*T(I3,J)
1490 NEXT J
1500 NEXT I
1510 NEXT K
1520 FOR I=1 TO N
1530 I4=I(I)
1540 J4=J(I)
1550 D(I4)=J4
1560 S(J4)=T(I4,M)
1570 NEXT I
1580 T=0
1590 N1=N-1
1600 FOR I=1 TO N1
1610 P1=I+1
1620 FOR J=P1 TO N
1630 IF D(J)>=D(I) THEN 1680
1640 T1=D(J)
1650 D(J)=D(I)
1660 D(I)=T1
1670 T=T+1
1680 NEXT J
1690 NEXT I
1700 IF INT(T/2)*2<>T THEN D=-D
1710 FOR J=1 TO N
1720 FOR I=1 TO N
1730 I4=I(I)
1740 J4=J(I)
1750 Y(J4)=T(I4,J)
```

Initialization

Wait loop until key pressed
Data entry routine

Enter number of equations

Enter coefficients

Enter RHS

Edit equation

Enter new coefficient

Print new system equation

Enter new RHS

Save entered system

Enter Epsilon

Print system of equations

Print solution with absolute error

Start modified Gauss-Jordan elimination method
Search for pivot

Pivot > epsilon

Update determinant row

Normalize pivot row

Carry out elimination and develop inverse

Order solution values (if any) and create D array

Adjust sign of determinant

Unscramble the inverse by rows

```
1760 NEXT I
1770 FOR I=1 TO N
1780 T(I,J)=Y(I)
1790 NEXT I
1800 NEXT J
1810 FOR I=1 TO N                    Then columns
1820 FOR J=1 TO N
1830 I4=I(J)
1840 J4=J(J)
1850 Y(I4)=T(I,J4)
1860 NEXT J
1870 FOR J=1 TO N
1880 T(I,J)=Y(J)
1890 NEXT J
1900 NEXT I
1910 RETURN
1920 FOR I=1 TO N                    Compute absolute error
1930 T=0
1940 FOR J=1 TO N
1950 T=T+C(I,J)*S(J)
1960 NEXT J
1970 A(I)=C(I,N+1)-T
1980 NEXT I
1990 RETURN
2000 GOSUB 2130 @ DISP "     SIM     HELP subroutine
     ULTANEOUS EQUATIONS"
2010 DISP
2020 DISP "K1:ENTER NUMBER OF EQ
     UATIONS AND"
2030 DISP "   THEN COEFFICIENTS.
     "
2040 DISP "K2:EDIT THE COEFFICIE
     NTS BY"
2050 DISP "   ELEMENT."
2060 DISP "K3:SOLVE THE SET OF E
     QUATIONS AS"
2070 DISP "   ENTERED AND PRINT
     THE"
2080 DISP "   SOLUTION AND ERROR
      ARRAYS."
2090 DISP "K4:PRINT THE SYSTEM O
     F EQUATIONS"
2100 DISP "   CURRENTLY ENTERED.
     "
2110 DISP "K5:HELP"
2120 RETURN
2130 CLEAR @ KEY LABEL @ RETURN
```

Calculus and Roots of f(x)

User Entered Function

In the "Calculus and Roots of $f(x)$" program, you are required to enter the function of interest at line 5000. Once this function has been stored, the program can then reference it and obtain functional values when needed. The following example should help to demonstrate these steps.

```
5000 DEF FNF(X)
5010 K=.5
5020 A=K*K*SIN(X*X)
5030 B=SQR(1-A)
5040 FNF=1/B
5050 FN END
```

The above function uses the variables, A, B, and K, as temporary storage values. It is important for you not to assign values to variables which are also used in the main program.

Before using variables as temporary storage locations, you should check for duplications in the calling program. The above example could have been written as one line as shown below:

```
5000 DEF FNF(X)=1/SQR(1-.5*.5*SIN(X*X))
```

The results would be the same and would not require any temporary storage locations.

Variable Definitions

A$ - Response string
E( ) - Accuracy vector
F( ) - Function value at root
R( ) - Root value
A - Roots lower bound temporary
A1 - Roots lower bound
B - Roots upper bound temporary
C - Iteration counter
D - %Δ
D1 - Δx
D2 - Derivative
E - Bad data flag
F - First iteration indicator
F1 - Print intermediate point flag

G – Integral value
G2 – Former integral value for convergence check
I – Iteration counter
I1 – Maximum number of interval halvings
L – Lower bound
M – Maximum number of bisections
N – Number of intervals
N1 – Number of roots
P – Product of function at different values for detecting root
R – Integration upper bound
S – Integration search increment
T – Error tolerance
X – Temporary argument for function
Y – Temporary function
Z – Temporary error value

```
 10 DIM A$[33],R(10),F(10),E(10)
 20 ON KEY# 1,"f'(X)" GOSUB 300
 30 ON KEY# 2,"INTEG" GOSUB 440
 40 ON KEY# 3,"ROOT" GOSUB 1030
 50 ON KEY# 4,"f(X)" GOSUB 1940
 60 ON KEY# 5,"HELP" GOSUB 170
 70 CLEAR @ KEY LABEL
 80 DISP "IS FUNCTION STORED:Y/N
    ";
 90 INPUT A$[1,32]
100 IF UPC$(A$[1,1])="Y" THEN 15
    0
110 IF UPC$(A$[1,1])#"N" THEN BE
    EP 50,10 @ GOTO 90
120 DISP "STORE FUNCTION FNF AT
    LINE 5000"
130 PAUSE
140 GOTO 80
150 DISP "SELECT OPTION"
160 GOTO 160
170 GOSUB 2010 @ DISP "  CALCULU
    S AND ROOTS OF f(X)=0"
180 DISP "ALL OPERATIONS ASSUME
    THAT THE"
190 DISP "FUNCTION HAS BEEN ENTE
    RED AS"
200 DISP "DEF FNF(X) AT LINE 500
    0."
210 DISP "K1:DERIVATIVE OF f(X)
    AT X."
220 DISP "K2:INTEGRATE f(X) FROM
     A TO B"
230 DISP "   USING SIMPSON'S RUL
    E."
240 DISP "K3:SEARCH FOR SOLUTION
     TO f(X)=0"
250 DISP "   OVER INTERVAL A TO
    B."
260 DISP "K4:FOR ENTERED VALUE O
    F X,RETURN"
270 DISP "   FUNCTION VALUE."
280 DISP "K5:HELP"
290 RETURN
300 GOSUB 2010
310 DISP "ENTER VALUE OF X";
320 INPUT X
330 DISP "ENTER %Δ";
340 INPUT D
350 IF D THEN 370
360 D=.01
370 D1=D/100*X
380 D2=(FNF(X+D1/2)-FNF(X-D1/2))
    /D1
390 PRINT "APPROXIMATE DIFFERENT
    IAL OF"
400 PRINT "f(X) AT ";X;" IS ";D2
     @ RETURN
410 PRINT USING 420 ; X,D2
420 IMAGE "f(X) AT",9D.3D," IS
    ",5D.3D
430 RETURN
440 CLEAR
450 DISP "ENTER LOWER BOUND";
460 INPUT L
470 DISP "ENTER UPPER BOUND";
480 INPUT R
490 DISP "PRINT INTERMEDIATE POI
    NTS:Y/N";
500 INPUT A$[1,32]
510 IF UPC$(A$[1,1])="Y" THEN F1
    =1 @ GOTO 540
520 IF UPC$(A$[1,1])="N" THEN F1
    =-1 @ GOTO 540
530 GOTO 490
540 DISP "MAX # OF INTERVAL HALV
    INGS";
550 INPUT I1
560 DISP "ERROR TOLERANCE";
570 INPUT T
580 B=R<=L OR F1=0 OR I1<=0 OR T
    <=0
590 IF B=0 THEN 630
600 PRINT "ERROR IN DATA"
610 PRINT "RIGHT =";R;" LOW =";L
    ;" MAX # INT =";I1;" TOL =";
    T
620 GOTO 450
630 G,I=0
640 F=1
650 X=L
660 Y=FNF(X)
670 G=G+Y
680 X=R
690 Y=FNF(X)
700 T1,G=G+Y
710 I=I+1
720 IF I<=I1 THEN 760
730 PRINT "MAX # OF ITERATIONS "
740 PRINT "INTEG =";G;" INTEG' =
    ";G2;"MAX # INT =";I1;" TOL
    =";T
750 PAUSE
760 N=2^I
770 S=(R-L)/N
780 X=S+L
790 Y=FNF(X)
800 G=G+4*Y
810 D=L
820 D=D+2*S
830 IF D<R THEN 940
840 G=S*G/3
850 IF F1=-1 THEN 870
860 PRINT "# INTERVALS ";N;" INT
    EGRAL = ";G
870 IF F=0 THEN 900
880 F=0
890 GOTO 910
900 IF ABS(G2-G)<T THEN 1010
910 G2=G
920 G=T1
930 GOTO 710
940 X=D
950 Y=FNF(X)
960 G=G+2*Y
970 X=D+S
980 Y=FNF(X)
990 G=G+4*Y
1000 GOTO 820
1010 PRINT "INTEGRAL = ";G
1020 RETURN
1030 CLEAR
1040 DISP "ENTER LOWER BOUND";
1050 INPUT A1
1060 DISP "ENTER UPPER BOUND";
1070 INPUT B
1080 DISP "ENTER MAXIMUM # OF BI
     SECTIONS";
1090 INPUT M
1100 DISP "ENTER ERROR TOLERANCE
     ";
1110 INPUT T
1120 DISP "ENTER SEARCH INCREMEN
     T";
1130 INPUT S
1140 DISP "ENTER # OF ROOTS";
1150 INPUT N1
1160 A=A1
1170 E=A1>=B OR M<=0 OR T<=0 OR
     S<=0 OR N1<=0
1180 IF E=0 THEN 1260
1190 PRINT "ERROR IN INPUT DATA"
1200 PRINT "A= ";A1;" B= ";B
1210 PRINT "MAX. # BISECTIONS =
     ";M
1220 PRINT "ERROR TOLERANCE = ";
     T
1230 PRINT "SEARCH INCREMENT = "
     ;S
1240 PRINT "NUMBER OF ROOTS = ";
     N1
1250 GOTO 1040
1260 N=0
1270 FOR I=1 TO N1
1280 R(I),F(I),E(I)=INF
1290 NEXT I
1300 X=A
1310 IF N>=N1 THEN 1870
1320 N=N+1
1330 Y=FNF(X)
1340 F=Y
1350 A=A+S
1360 IF A>B THEN 1870
1370 X=A
1380 Y=FNF(X)
1390 P=F*Y
1400 IF P>0 THEN 1340

1410 IF P<0 THEN 1510
1420 IF F<>0 THEN 1450
1430 X=A-S
1440 Y=F
1450 R(N)=X
1460 F(N)=Y
1470 A=A+S
1480 Z=.000000000001
1490 LET E(N)=Z
1500 GOTO 1300
1510 L=A-S
1520 R=A
1530 C=0
1540 X=(L+R)/2
1550 Y=FNF(X)
1560 C=C+1
1570 IF C>M THEN 1710
1580 IF ABS(Y)<T*MAX(1,X) THEN 1
     660
1590 P=F*Y
1600 IF P<=0 THEN 1630
1610 L=X
1620 GOTO 1540
1630 IF P=0 THEN 1660
1640 R=X
1650 GOTO 1540
1660 R(N)=X
1670 F(N)=Y
1680 Z=R-L
1690 LET E(N)=Z
1700 GOTO 1300
1710 PRINT "MAX # OF ITERATIONS
     REACHED ON"
1720 PRINT USING 1730 ; N
1730 IMAGE "ROOT # ",3D
1740 PRINT USING 1750 ; L,R
1750 IMAGE "X BETWEEN ",5DZ.2D,"
      AND ",5DZ.2D
```

Initialization

Function stored?

Wait loop until key pressed

HELP subroutine

Enter x

Enter %Δ

Compute derivative

Enter bounds

Set print intermediate point flag

Enter problem data

Verify data

Initialize variables

Max. # iterations exceeded?

Compute # intervals

Interval size

Interval value

Lower bound

Increment

Upper bound reached?

Calculate approximation to integral

Print intermediate value

Stopping criteria met?

Save former sum for later convergence check

Half interval size again

Multiply function values by 2 and 4 and update sum

Print integral

Enter problem specifications

Data check?

Initialize roots

Number of roots found?

Search for new root

Advance to next search interval

Greater than upper bound?

If product is +, search next interval

If negative, look for root

Exact root?

Search next interval for remaining roots

Root has been bracketed look for root until error tolerance is satisfied or maximum # of iterations is exceeded

Determine search direction

ROOT FOUND

Print approximate root after exceeding maximum number of iterations

```
1760 PRINT "f(X) = ";Y
1770 Z=R-L
1780 PRINT USING 1790 ; Z
1790 IMAGE "ACCURACY TO ",5DZ.5D
1800 PRINT "AVERAGE VALUE STORED
      IN R(*) AS"
1810 PRINT "APPROXIMATE X."
1820 PRINT
1830 R(N)=(L+R)/2
1840 F(N)=Y
1850 LET E(N)=Z
1860 GOTO 1300
1870 PRINT "     RESULTS"
1880 PRINT "   ROOT    FUNCTION
      ACCURACY"
1890 FOR I=1 TO N
1900 PRINT USING 1910 ; R(I),F(I
     ),E(I)
1910 IMAGE MD.DDE,2(X,MD.DDE)
1920 NEXT I
1930 RETURN
1940 GOSUB 2010
1950 DISP "ENTER VALUE OF X";
1960 INPUT X
1970 F=FNF(X)
1980 PRINT USING 1990 ; F
1990 IMAGE "VALUE OF F(X) IS ",7
     DZ.3D
2000 RETURN
2010 CLEAR @ KEY LABEL @ RETURN
5000 DEF FNF(X) = 1/SQR(1-.25*SI
     N(X)*SIN(X))
```

Print roots

Enter argument

Print functional value

Curve Fitting

Computed GOTO Branching

The "Curve Fitting" program uses many of the same routines for each of the regression types, with modifications for each type. The program flow within these routines is controlled by the regression type code using statements like line 1710: `1710 ON R GOTO 1720,1810,1840,1870`. The effect of line 1710 is to change the flow based on the regression, e.g., if $R = 1$ or linear regression, the program will branch to line 1720. Using this technique, program space can in some instances be used more efficiently. The major consideration is the trade-off between the savings obtained by using the same routines and the cost of branching to the same routines.

Variable Definitions

A( )	– Sums for regression
F$	– File name
M( )	– Sums for regression
R$	– Response string
V$	– Label temporary
X(,)	– Data values
Y( )	– Plotting extremes
Z$	– Label temporary
A	– Temporary storage
B	– Temporary storage
C	– Temporary storage
D	– Temporary storage
D1	– Distance of a dot in X-direction
D2	– Distance of a dot in Y-direction
D5	– Plot flag
E	– Temporary storage
E0	– Location of "E" in string
F	– Temporary storage
G9	– Temporary storage
I	– Loop counter
I1	– Loop counter
J	– Loop counter
K	– Loop counter
L	– Label length
L1	– Number of X-axis intervals

L2 – Number of Y-axis intervals
L3 – Number of X-intervals between labels
L4 – Number of Y-intervals between labels
L9 – Temporary storage
N – Number of points
Q1 – Temporary storage
Q2 – Temporary storage
Q3 – Temporary storage
Q4 – Temporary storage
Q5 – Temporary storage
R – Regression code
R5 – Temporary storage
S – Temporary storage
S7 – Y-label flag
S8 – X-label flag
S9 – Vertical/Horizontal label flag
T – Print routine or subroutine flag
T1 – Temporary storage
T2 – Temporary storage
V – Length of label
W – Temporary for label
W1 – Temporary for label
X – Label position and temporary
X0 – Scale X-minimum
X1 – X-value at axes intercept
X2 – X-value at right end of X-axis
X6 – Print data on input flag
Y – Label position
Y0 – Scale Y-minimum
Y1 – Y-value at axes intercept
Y2 – Y-value at top end of Y-axis
Z1 – X2−X1
Z2 – Y2−Y1
Z3 – X dot range
Z4 – Y dot range
Z5 – Scale X-maximum

```
 10 OPTION BASE 1
 20 DIM X(200,2),R$[32],F$[6],Y(
    4),A(5),M(5),Z$[19],V$[19]
 30 ON KEY# 1,"ENTER" GOSUB 200
 40 ON KEY# 2,"OUTPUT" GOSUB 490
 50 ON KEY# 3,"LINEAR" GOSUB 130
    0
 60 ON KEY# 4,"EXP" GOSUB 1400
 70 ON KEY# 5,"HELP" GOSUB 140
 80 ON KEY# 6,"EDIT" GOSUB 870
 90 ON KEY# 7,"LOG" GOSUB 1320
100 ON KEY# 8,"POWER" GOSUB 1420
110 GOSUB 3540
120 DISP "SELECT OPTION"
130 GOTO 130
140 GOSUB 3540 @ DISP "   CURVE
    FITTING"
150 DISP "K1:ENTER DATA VIA KEYB
    OARD OR      DATA FILE ON CA
    RTRIDGE(FIRST)"
160 DISP "K2:OUTPUT DATA TO PRIN
    TER/TAPE"
170 DISP "K3:LINEAR CURVE FIT" @
     DISP "K4:EXPONENTIAL CURVE
    FIT" @ DISP "K5:HELP"
180 DISP "K6:EDIT DATA-CHANGE/DE
    LETE/ADD  K7:LOGARITHMIC CUR
    VE" @ DISP "K8:POWER CURVE F
    IT"
190 RETURN
200 CLEAR @ DISP "PRINT DATA ON
    INPUT:Y/N";
210 INPUT R$
220 X6=0 @ ON FNR GOTO 200,240,2
    50
240 X6=1
250 DISP "ENTER FROM KEYBOARD/TA
    PE:K/T";
260 INPUT R$
265 IF NOT LEN(R$) THEN BEEP @ G
    OTO 250
270 IF UPC$(R$[1,1])="T" THEN 42
    0
280 IF UPC$(R$[1,1])#"K" THEN BE
    EP @ GOTO 250
290 IF X6<>1 THEN 320
300 PRINT
310 PRINT "   I         X(I)
        Y(I)"
320 DISP "NO. OF POINTS";
330 INPUT N
340 IF N>200 OR N<=1 THEN DISP "
    INVALID NO. OF POINTS" @ BEE
    P 10,25 @ GOTO 320
350 FOR I=1 TO N
360 DISP "X(";I;"),Y(";I;")=";
370 INPUT X(I,1),X(I,2)
380 IF X6=1 THEN PRINT USING 390
    ; I,X(I,1),X(I,2)
390 IMAGE 4D,4X,6DZ.4D,6DZ.4D
400 NEXT I
410 DISP "DATA ENTERED" @ GOTO 1
    130
420 DISP "ENTER FILE NAME";
430 INPUT F$
440 ON ERROR GOTO 420
450 ASSIGN# 1 TO F$
460 READ# 1 ; N,X(,)
470 OFF ERROR @ ASSIGN# 1 TO *
480 IF X6<>1 THEN 1130 ELSE T=1
    @ GOTO 540
490 T=0 @ GOSUB 3540
500 DISP "PRINT DATA:Y/N";
510 INPUT R$
520 ON FNR GOTO 500,540,600
540 PRINT "   I         X(I)
        Y(I)"
550 FOR I=1 TO N
560 PRINT USING 390 ; I,X(I,1),X
    (I,2)
570 NEXT I
580 PRINT
590 IF T=1 THEN 1130
600 DISP "STORE DATA:Y/N";
610 INPUT R$
620 ON FNR GOTO 600,640,760
640 ON ERROR GOTO 650
650 DISP "NAME OF FILE";
660 INPUT F$
670 DISP "CREATE FILE:Y/N";
680 INPUT R$
690 ON FNR GOTO 670,710,720
710 CREATE F$,15
720 ASSIGN# 1 TO F$
730 PRINT# 1 ; N,X(,)
740 ASSIGN# 1 TO *
750 OFF ERROR
760 DISP "DONE" @ RETURN
770 DISP "INDEX OF PAIR TO CORRE
    CT";
780 INPUT I
790 IF I<1 THEN 870
800 IF I>N THEN 770
810 DISP "X(";I;")=";X(I,1)
820 DISP "NEW X(";I;")=";
830 INPUT X(I,1)
840 DISP "Y(";I;")=";X(I,2)
850 DISP "NEW Y(";I;")=";
860 INPUT X(I,2)
870 GOSUB 3540 @ DISP "0=OK,1=CO
    RRECT,2=DELETE,3=INSERT";
880 INPUT I
890 IF I>3 OR I<0 THEN 870
900 ON I+1 GOTO 910,770,920,1020
910 DISP "DONE" @ GOTO 1130
920 DISP "INDEX OF PAIR TO DELET
    E";
930 INPUT I
940 IF I<1 THEN 870
950 IF I>N THEN 920
960 DISP "DELETE X(";I;")=";X(I,
    1);" Y(";I;")=";X(I,2)
970 IF I=N THEN 1000
980 DISP "NEW X(";I;")=";X(I+1,1
    );" Y(";I;")=";X(I+1,2)
990 FOR J=I+1 TO N @ X(J-1,1)=X(
    J,1) @ X(J-1,2)=X(J,2) @ NEX
    T J
1000 N=N-1
1010 DISP "N=";N @ GOTO 870
1020 DISP "INDEX OF PAIR TO INSE
     RT";
1030 INPUT I
1040 IF N>=200 THEN DISP "MAX. N
     O. OF PAIRS=200" @ GOTO 870
1050 IF I<1 THEN 870
1060 IF I>N+1 THEN 1020
1070 N=N+1
1080 IF I=N THEN 1100
1090 FOR J=N TO I+1 STEP -1 @ X(
     J,1)=X(J-1,1) @ X(J,2)=X(J-
     1,2) @ NEXT J
1100 DISP "INSERT X(";I;");Y(";I
     ;")=";
1110 INPUT X(I,1),X(I,2)
1120 GOTO 1010
1130 DISP "COMPUTING-- PLEASE WA
     IT!" @ Y(1),Y(3)=INF @ Y(2)
     ,Y(4)=-INF @ A(1),A(2),A(3)
     ,A(4),A(5)=0
1140 FOR I1=1 TO N
1150 IF Y(2)<X(I1,1) THEN Y(2)=X
     (I1,1)
1160 IF Y(1)>X(I1,1) THEN Y(1)=X
     (I1,1)
1170 IF Y(4)<X(I1,2) THEN Y(4)=X
     (I1,2)
1180 IF Y(3)>X(I1,2) THEN Y(3)=X
     (I1,2)
1190 A(1)=A(1)+X(I1,1) @ A(2)=A(
     2)+X(I1,1)*X(I1,1) @ A(3)=A
     (3)+X(I1,2)
1200 A(4)=A(4)+X(I1,2)*X(I1,2) @
      A(5)=A(5)+X(I1,1)*X(I1,2)
1210 NEXT I1
1220 M(1)=A(1)/N @ M(2)=(A(2)-A(
     1)*A(1)/N)/(N-1) @ M(3)=A(3
     )/N
1230 M(4)=(A(4)-A(3)*A(3)/N)/(N-
     1) @ M(5)=(A(5)-A(1)*A(3)/N
     )/(A(2)-A(1)*A(1)/N)
1240 R5=M(3)-M(1)*M(5) @ D5=0
1250 DISP "PLOT DATA:Y/N";
1260 INPUT R$
1270 ON FNR GOTO 1250,2280,1290
1290 DISP "DONE" @ RETURN
1300 R=1 @ PRINT "   AOV: LINEAR
      REG:CODE 1" @ GOTO 1450
1310 RETURN
1320 IF Y(1)<=0 THEN PRINT "CAN'
     T TAKE LOG" @ RETURN
1330 R=2 @ Q1=A(1) @ Q2=A(2) @ Q
     5=A(5) @ Q3=R5 @ Q4=M(5) @
     A(1),A(2),A(5)=0
1340 FOR I=1 TO N
1350 A(1)=A(1)+LOG(X(I,1)) @ A(2
     )=A(2)+LOG(X(I,1))*LOG(X(I,
     1)) @ A(5)=A(5)+LOG(X(I,1))
     *X(I,2)
1360 NEXT I
1370 M(5)=(A(5)-A(1)*A(3)/N)/(A(
     2)-A(1)^2/N) @ R5=M(3)-A(1)
     /N*M(5)
1380 PRINT "   AOV: LOG REG:CODE
      2" @ GOTO 1450
1390 A(1)=Q1 @ A(2)=Q2 @ R5=Q3 @
      M(5)=Q4 @ A(5)=Q5 @ RETURN
1400 R=3 @ PRINT "   AOV: EXPONE
     NTIAL:CODE 3" @ GOTO 1450
1410 A(3)=Q1 @ A(4)=Q2 @ R5=F @
     M(5)=C @ A(5)=Q3 @ M(3)=D @
      M(4)=E @ RETURN
1420 R=4 @ PRINT "   AOV: POWER:
      CODE 4" @ GOTO 1450
1430 A(3)=Q1 @ A(4)=Q2 @ R5=F @
     M(5)=C @ A(5)=Q3 @ M(3)=D @
      M(4)=E @ M(1)=A @ M(2)=B @
      A(1)=Q4 @ A(2)=Q5
1440 RETURN
1450 IF R>2 THEN 1590
1460 S=M(5)*(A(5)-A(1)*A(3)/N)
1470 PRINT "SOURCE/DF      SS
      MS      F"
1480 PRINT USING 1490 ; N-1,A(4)
     -A(3)*A(3)/N
```

Initialization

Wait loop until key is pressed
HELP subroutine

ENTER subroutine

Keyboard or tape

Keyboard entry

No. of points

Enter points

Tape entry

Read file

OUTPUT subroutine
Print data?

Print loop

Store data?

Enter file name

Create?

Print data on tape

Correction routine

Edit type specification

Deletion routine

Insertion routine

Compute values needed for regressions

Plot data?

LINEAR regression

LOG regression

EXP regression

POWER regression

AOV print out

```
1490 IMAGE "TOTAL",3D,6DZ.D
1500 R2=S/(A(4)-A(3)*A(3)/N)
1510 F1=MIN(999.9,S/((S/R2-S)/(N
     -2)))
1520 PRINT USING 1530 ; S,S,F1
1530 IMAGE "REG     1",6DZ.D,5DZ.
     D,3DZ.D
1540 PRINT USING 1550 ; N-2,A(4)
     -A(3)*A(3)/N-S,(A(4)-A(3)*A
     (3)/N-S)/(N-2)
1550 IMAGE "RESID",3D,6DZ.D,5DZ.
     D
1560 PRINT USING 1570 ; R2
1570 IMAGE "R SQUARE = ",7DZ.3D,
     2/
1580 GOTO 1710
1590 IF Y(1)<=0 OR Y(3)<=0 THEN
     PRINT "CAN'T TAKE LOG" @ PR
     INT @ RETURN
1600 Q1=A(3) @ Q2=A(4) @ Q3=A(5)
      @ A(3),A(4),A(5)=0
1610 IF R#3 THEN Q4=A(1) @ Q5=A(
     2) @ A(1),A(2)=0
1620 FOR I=1 TO N
1630 T1=LOG(X(I,1)) @ T2=LOG(X(I
     ,2)) @ A(3)=A(3)+T2 @ A(4)=
     A(4)+T2*T2
1640 IF R=4 THEN A(1)=A(1)+T1 @
     A(2)=A(2)+T1*T1 @ A(5)=A(5)
     +T1*T2 @ GOTO 1660
1650 A(5)=A(5)+X(I,1)*T2
1660 NEXT I
1670 IF R=4 THEN A=M(1) @ B=M(2)
      @ M(1)=A(1)/N @ M(2)=(A(2)
     -A(1)*A(1)/N)/(N-1)
1680 C=M(5) @ D=M(3) @ E=M(4) @
     F=R5 @ M(3)=A(3)/N
1690 M(4)=(A(4)-A(3)^2/N)/(N-1)
     @ M(5)=(A(5)-A(1)*A(3)/N)/(
     A(2)-A(1)*A(1)/N) @ R5=M(3)
     -M(1)*M(5)
1700 GOTO 1460
1710 ON R GOTO 1720,1810,1840,18
     70
1720 PRINT USING 1730 ; R5,M(5)
1730 IMAGE /"YHAT =",5DZ.3D," +
     ",5DZ.3D," X"/
1740 GOTO 1910
1750 IF O5=0 THEN 1900
1760 DISP "PLOT:Y/N";
1770 INPUT R$
1780 ON FNR GOTO 1760,1800,1900
1800 PENUP @ GOSUB 2260 @ GOTO 1
     900
1810 PRINT USING 1820;R5,M(5)
1820 IMAGE   "YHAT=",5DZ.3D,"+",
     5DZ.3D,"LOG X"/
1830 GOTO 1910
1840 PRINT USING 1850 ; EXP(R5),
     M(5)
1850 IMAGE "YHAT=",5DZ.3D,"EXP("
     ,5DZ.3D," X)"/
1860 GOTO 1910
1870 PRINT USING 1880 ; EXP(R5),
     M(5)
1880 IMAGE "YHAT=",5DZ.3D,"X ^ "
     ,5DZ.3D/
1890 GOTO 1910
1900 ON R GOTO 1310,1390,1410,14
     30
1910 GOSUB 3540 @ DISP "ESTIMATE
      Y:Y/N";
1920 INPUT R$
1930 ON FNR GOTO 1910,1950,2170
1950 PRINT
1960 DISP "AT ALL X(I):Y/N";
1970 INPUT R$
1980 ON FNR GOTO 1960,2000,2100
2000 PRINT "   X(I)     Y(I)     YHA
     T   RESIDUALS"
2010 PRINT
2020 FOR I=1 TO N
2030 Y=FNV(X(I,1))
2040 PRINT USING  "4DZ.2D,4DZ.2D
     ,4DZ.2D,4DZ.2D" ; X(I,1),X(
     I,2),Y,X(I,2)-Y
2050 NEXT I
2060 DISP "ESTIMATE Y AT ENTERED
      X:Y/N";
2070 INPUT R$
2080 ON FNR GOTO 2060,2100,2170
2100 PRINT "    X(I)       YHAT"
2110 PRINT
2120 DISP "ESTIMATE Y AT X=";
2130 INPUT T
2140 Y=FNV(T)
2150 PRINT USING  "4DZ.2D,4DZ.2D
     ";T,Y
2160 GOTO 2060
2170 PRINT
2180 GOTO 1750
2190 DEF FNV(X)
2200 ON R GOTO 2210,2220,2230,22
     40
2210 FNV=R5+M(5)*X @ GOTO 2250
2220 FNV=R5+M(5)*LOG(X+.01*(X=0)
     ) @ GOTO 2250
```

Modify sums for EXP and POWER curves

Branch to output equation

LINEAR

Plot regression curve?

LOG

EXP

POWER

Return branch

Estimate y

Print ŷ at all x

Equation computation routine

LINEAR

LOG

```
2230 FNV=EXP(R5+M(5)*X) @ GOTO 2
     250
2240 FNV=EXP(R5)*X^M(5)
2250 FN END
2260 FOR K=X1 TO X2 STEP Z1/25
2265 IF R=4 AND K=0 AND M(5)<0 T
     HEN 2267
2266 PLOT K,FNV(K)
2267 NEXT K
2270 MOVE X1+R*Z1/5,FNV(X1+R*Z1/
     5) @ LABEL VAL$(R) @ GOSUB
     3210 @ RETURN
2280 CLEAR @ D5=1 @ DISP "AUTO X
     -SCALING:Y/N";
2290 INPUT R$
2300 ON FNR GOTO 2280,2320,2330
2320 X1=Y(1) @ X2=Y(2) @ GOTO 23
     80
2330 DISP "ENTER SCALE XMIN";
2340 INPUT X1
2350 DISP "ENTER SCALE XMAX";
2360 INPUT X2
2370 IF X1>=X2 THEN BEEP @ GOTO
     2330
2380 DISP "VERTICAL/HORIZONTAL L
     ABELS:V/H";
2390 INPUT R$
2395 IF NOT LEN(R$) THEN BEEP @
     GOTO 2380
2400 S9=1 @ IF UPC$(R$[1,1])="V"
      THEN S9=0 @ GOTO 2420
2410 IF UPC$(R$[1,1])#"H" THEN B
     EEP @ GOTO 2380
2420 DISP "NO. OF X-AXIS INTERVA
     LS:(<=16)";
2430 INPUT L1
2440 IF L1<1 OR L1>16 OR L1#INT(
     L1) THEN BEEP @ GOTO 2420
2450 DISP "NUMBER X-INT. BETWEEN
      LABELS";
2460 INPUT L3
2470 S8=0 @ IF L3=0 THEN S8=1 @
     L3=1
2480 IF L3<1 OR L3>L1 THEN BEEP
     @ GOTO 2450
2490 DISP "AUTO Y-SCALING:Y/N";
2500 INPUT R$
2510 ON FNR GOTO 2490,2580,2530
2530 DISP "ENTER SCALE YMIN";
2540 INPUT Y1
2550 DISP "ENTER SCALE YMAX";
2560 INPUT Y2
2570 IF Y1>=Y2 THEN BEEP @ GOTO
     2530 ELSE 2590
2580 Y1=Y(3) @ Y2=Y(4)
2590 DISP "NO. OF Y-AXIS INTERVA
     LS:(<=12)";
2600 INPUT L2
2610 IF L2<1 OR L2>12 OR L2#INT(
     L2) THEN BEEP @ GOTO 2590
2620 DISP "NUMBER Y-INT. BETWEEN
      LABELS";
2630 INPUT L4
2640 S7=0 @ IF L4=0 THEN S7=1 @
     L4=1
2650 IF L4<1 OR L4>L2 THEN BEEP
     @ GOTO 2620
2660 Z1=X2-X1 @ Z3=INT(200/L1)*L
     1 @ Z2=Y2-Y1 @ Z4=INT(144/L
     2)*L2
2670 D1=Z1/Z3 @ D2=Z2/Z4 @ Z5=X2
     +(207-Z3)*D1 @ X0=X1-48*D1
     @ Y0=Y1-40*D2
2680 GCLEAR @ SCALE X0,Z5,Y0,Y2+
     (151-Z4)*D2
2690 XAXIS Y1,Z1/L1,X1,X2+D1
2700 YAXIS X1,Z2/L2,Y1,Y2+D2
2710 IF S8 THEN 2870
2720 W1=LGT(ABS(Z1/L1*L3))
2730 W=LGT(ABS(X1+(X1=0)))+1
2740 IF W>5-(SGN(X1)=-1) OR W1<-
     3 THEN 2830
2750 IF S9 THEN 3420
2760 LDIR 90
2770 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
2780 MOVE I+4*D1,Y0
2790 GOSUB 3080
2800 LABEL V$[1,V]
2810 NEXT I
2820 GOTO 2870
2830 MOVE X0,Y0
2840 LDIR 0
2850 I=X1 @ GOSUB 3350 @ I=Z1/L1
      @ Z$=V$ @ GOSUB 3350
2860 LABEL "XMIN="&Z$[1,10]&":TI
     CS="&V$[1,10]
2870 IF S7 THEN 3050
2880 W1=LGT(ABS(Z2/L2*L4))
2890 W=LGT(ABS(Y1+(Y1=0)))+1
2900 IF W>5-(SGN(Y1)=-1) OR W1<-
     3 THEN 2980
2910 LDIR 0
2920 FOR I=Y1 TO Y2+D2 STEP Z2/L
     2*L4
2930 MOVE X0,I-4*D2
2940 GOSUB 3080
```

EXP

POWER

Plot regression line

Plot setup

Compute SCALE parameters

Draw axes

LABEL X-AXIS

LABEL Y-AXIS

```
2950 LABEL V$[1,V]
2960 NEXT I
2970 GOTO 3050
2980 LDIR 90
2990 I=Y1 @ GOSUB 3350
3000 MOVE X0+12*D1,Y1
3010 LABEL "YMIN="&V$[1,10]
3020 MOVE X0+24*D1,Y1
3030 I=Z2/L2 @ GOSUB 3350
3040 LABEL "TICS="&V$[1,10]
3050 PENUP @ LDIR 0
3060 MOVE X(1,1),X(1,2)
3070 FOR I=1 TO N @ MOVE X(I,1)-
     2*D1,X(I,2)-4*D2 @ LABEL "+
     " @ NEXT I @ BEEP @ GOTO 31
     50
3080 V$="" @ X=I
3090 V$=VAL$(X)
3100 IF POS(V$,"E") THEN 3160
3110 G9=LGT(ABS(X+(X=0)))
3120 IF LEN(V$)>5 AND ABS(G9)>4-
     (SGN(X)=-1) THEN V=5 @ V$="
     -----" @ RETURN
3130 IF LEN(V$)<5 THEN V=LEN(V$)
      @ RETURN
3140 V$[1,5]=VAL$(X) @ V=5
3150 GRAPH @ RETURN
3160 E0=POS(V$,"E")
3170 IF V$[1,1]="-" THEN V$[3]=V
     $[E0] @ GOTO 3190
3180 V$[2]=V$[E0]
3190 V=LEN(V$) @ IF V>5 THEN PRI
     NT USING 3460 ; I @ V=5 @ V
     $="-----"
3200 RETURN
3210 GOSUB 3550 @ DISP "LABEL PL
     OT:Y/N";
3220 INPUT R$
3230 ON FNR GOTO 3210,3250,3150
3250 DISP "LABEL ORIGIN:X,Y";
3260 INPUT X,Y
3270 IF X>=X0 AND X<=X2 AND Y>=Y
     0 AND Y<=Y2+3*D2 THEN 3290
3280 DISP "INVALID POSITION" @ B
     EEP @ GOTO 3210
3290 DISP "ENTER LABEL";
3300 INPUT R$
3310 L=LEN(R$)
3320 IF L/32>(Z5-X)/(Z5-X0) THEN
      DISP "LABEL TOO LONG" @ BE
     EP @ GOTO 3290
3330 MOVE X,Y @ LABEL R$
3340 GOTO 3210
3350 V$=""
3360 V$=VAL$(I)
3370 IF POS(V$,"E") THEN 3400
3380 V$[1,10]=VAL$(I)
3390 RETURN
3400 V$[6,10]=V$[POS(V$,"E")]
3410 RETURN
3420 LDIR 0 @ L9=-INF
3430 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
3440 GOSUB 3080
3450 IF L9>I-(V%4+6)*D1 OR L9>Z5
     +(1-V%8)*D1 THEN PRINT USIN
     G 3460 ; I @ GOTO 3510
3460 IMAGE "LABEL DELETED AT ",7
     D.4D
3470 MOVE I+(2-V%4)*D1,Y1-12*D2
3480 L9=I+(V%4+2)*D1
3490 IF L9>Z5 THEN MOVE Z5+(2-V%
     8)*D1,Y1-12*D2
3500 LABEL V$[1,V]
3510 NEXT I
3520 GOTO 2870
3530 DEF FNR
3531 IF NOT LEN(R$) THEN I=1 @ G
     OTO 3535
3535 I=POS("YN",UPC$(R$[1,1]))+1
3536 IF I=1 THEN BEEP
3537 FNR=I
3538 FN END
3540 CLEAR @ KEY LABEL
3550 ALPHA @ RETURN
```

Plot data points with "+"

LABEL string subroutine

LABEL PLOT?

Enter label origin

LABEL plot at X,Y

Horizontal labelling of X-axis

Function to test for "Y" or "N"

Subroutine to clear screen

Notes

Auto Function Plot

Scaling Data

The "Auto Function Plot" program employs a routine to scale a plot based on a specified range and the number of tic-intervals over this range. The major consideration in this routine is to minimize the errors which result when a fixed distance must be mapped onto a different range. This program maps your functional ranges onto the 256 × 192 dot matrix of the CRT. The routine makes allowances for labels on both axes and margins at the top and right side of the screen. Lines 1030 to 1100 compute the desired SCALE values and set up the scale for the plot. By studying this listing and the annotations the technique should be clarified.

```
1030 Z1=X2-X1
1040 Z3=INT(200/L1)*L1
1050 Z2=Y2-Y1
1060 Z4=INT(144/L2)*L2
1070 D1=Z1/Z3 @D2=Z2/Z4 @ Z5=X2+
     (207-Z3)*D1
1080 X0=X1-48*D1
1090 Y0=Y1-40*D2
1100 SCALE X0,Z5,Y0,Y2+(151-Z4)*
     D2
```

X-axis User range
X-axis CRT range
Y-axis User range
Y-axis CRT range
Dot distances and X scale max

X scale min
Y scale min

An attempt has been made to use consistent scaling routines in the entire Standard Pac. If you become familiar with this routine, the scaling routines used by other programs should be easily understood.

Variable Definitions

A$ – Response string
S( ) – Points of singularity
R$ – Response string
V$ – Label
D – Increment
D1 – Distance of a dot in X-direction
D2 – Distance of a dot in Y-direction
E – Position of "E" in label
F – Print temporary
G9 – Temporary storage
I – Loop counter
J – Loop counter
L – Label length
L1 – Number of X-axis intervals

L2 – Number of Y-axis intervals
L3 – Number of X-intervals between labels
L4 – Number of Y-intervals between labels
L9 – Label position
N – Number of plot increments
P – Plot flag
S – Number of singularity points
S1 – Auto Y-scale flag
S2 – Point of singularity flag
S7 – Y-label flag
S8 – X-label flag
S9 – Vertical/Horizontal label flag
T – Temporary storage
V – Length of label
W – Temporary for label
W1 – Temporary for label
X – Label position and temporary
X0 – Scale X-minimum
X1 – X-value at axes intercept
X2 – X-value at right end of X-axis
X3 – Plotting X-minimum
X4 – Plotting X-maximum
Y – Label position
Y0 – Scale Y-minimum
Y1 – Y-value at axes intercept
Y2 – Y-value at top end of Y-axis
Z1 – X2−X1
Z2 – Y2−Y1
Z3 – X dot range
Z4 – Y dot range
Z5 – Scale X-maximum

```
 10 DIM S(25),A$[33],R$[33]
 20 ON KEY# 1,"DEFINE" GOSUB 270
 30 ON KEY# 2,"SINGUL" GOSUB 640
 40 ON KEY# 3,"FUL PLT" GOSUB 78
    0
 50 ON KEY# 4,"TABLE" GOSUB 1690
 60 ON KEY# 5,"HELP" GOSUB 120
 70 ON KEY# 7,"PLOT" GOSUB 1490
 80 ON KEY# 8,"LABEL" GOSUB 2050
 90 CLEAR @ KEY LABEL @ S=0
100 DISP "SELECT OPTION"
110 GOTO 110
120 CLEAR @ KEY LABEL @ DISP "
        GENERAL FUNCTION PLOT"
130 DISP "ALL OPERATIONS ASSUME
    THAT THE"
140 DISP "FUNCTION HAS BEEN ENTE
    RED AS"
150 DISP "DEF FNF(X) AT LINE 500
    0."
160 DISP "K1:ENTER SCALE PARAMET
    ERS"
170 DISP "K2:ENTER UPTO 25 POINT
    S OF"
180 DISP "    SINGULARITY (OPTION
    AL)"
190 DISP "K3:GENERATE FULL PLOT
    WITH AXES"
200 DISP "    AND LABELS. CLEARS
    GRAPHICS!"
210 DISP "K4:GENERATE TABLE ON P
    RINTER"
220 DISP "K5:HELP"
230 DISP "K7:GENERATE FUNCTION P
    LOT ONLY"
240 DISP "K8:LABEL PLOT - SPECIF
    Y LOCATION"
250 DISP "    AND LABEL"
260 RETURN
270 CLEAR @ ALPHA @ DISP "ENTER
    SCALE XMIN";
280 INPUT X1
290 DISP "ENTER SCALE XMAX";
300 INPUT X2
310 DISP "VERTICAL/HORIZONTAL LA
    BELS:V/H";
320 INPUT A$[1,32]
330 IF UPC$(A$[1,1])="V" THEN S9
    =0 @ GOTO 360
340 IF UPC$(A$[1,1])="H" THEN S9
    =1 @ GOTO 360
350 GOTO 310
360 DISP "NUMBER OF X-AXIS INTER
    VALS:(<=16)";
370 INPUT L1
380 IF L1<1 OR L1>16 OR L1#INT(L
    1) THEN BEEP @ GOTO 360
390 DISP "NUMBER X-INT. BETWEEN
    LABELS";
400 INPUT L3
410 S8=0 @ IF L3=0 THEN S8,L3=1
420 IF L3<1 OR L3>L1 THEN BEEP @
     GOTO 390
430 DISP "AUTO Y-SCALING:Y/N";
440 INPUT A$[1,32]
450 IF UPC$(A$[1,1])="Y" THEN 53
    0
460 IF UPC$(A$[1,1])#"N" THEN BE
    EP @ GOTO 430
470 DISP "ENTER SCALE YMIN";
480 INPUT Y1
490 DISP "ENTER SCALE YMAX";
500 INPUT Y2
510 S1=1
520 GOTO 560
530 Y1=INF
540 Y2=-INF
550 S1=0
560 DISP "NUMBER OF Y-AXIS INTER
    VALS:(<=12)";
570 INPUT L2
580 IF L2<1 OR L2>12 OR L2#INT(L
    2) THEN BEEP @ GOTO 560
590 DISP "NUMBER Y-INT. BETWEEN
    LABELS";
600 INPUT L4
610 S7=0 @ IF L4=0 THEN S7,L4=1
620 IF L4<1 OR L4>L2 THEN BEEP @
     GOTO 590
630 DISP "PLOT DEFINED" @ RETURN
640 CLEAR @ S=0
650 IF S=25 THEN 760
660 S=S+1
670 DISP "ENTER POINT OF SINGULA
    RITY ";S;
680 INPUT S(S)
690 DISP "MORE POINTS:Y/N";
700 INPUT A$[1,32]
710 IF UPC$(A$[1,1])="Y" THEN 65
    0
720 IF UPC$(A$[1,1])#"N" THEN BE
    EP @ GOTO 690
730 DISP USING 740 ; S
740 IMAGE 5D," POINTS HAVE BEEN
    ENTERED"
750 RETURN
760 PRINT "NO MORE CAN BE ENTERE
    D,SINCE"
770 GOTO 730
780 GCLEAR @ CLEAR @ GOSUB 800
790 GOTO 910
800 DISP "ENTER XMIN";
810 INPUT X3
820 DISP "ENTER XMAX";
830 INPUT X4
840 DISP "ENTER INCREMENT";
850 INPUT D
860 IF D THEN 900
870 DISP "ENTER # PLOT INCREMENT
    S";
880 INPUT N
890 D=(X4-X3)/N
900 RETURN
910 IF S1 THEN 1030
920 FOR I=X3 TO X4 STEP D
930 S2=0
940 IF NOT S THEN 990
950 FOR J=1 TO S
960 IF I=S(J) THEN S2=1
970 NEXT J
980 IF S2 THEN 1020
990 T=FNF(I)
1000 IF Y1>T THEN Y1=T
1010 IF Y2<T THEN Y2=T
1020 NEXT I
1030 Z1=X2-X1
1040 Z3=INT(200/L1)*L1
1050 Z2=Y2-Y1
1060 Z4=INT(144/L2)*L2
1070 D1=Z1/Z3 @ D2=Z2/Z4 @ Z5=X2
     +(207-Z3)*D1
1080 X0=X1-48*D1
1090 Y0=Y1-40*D2
1100 SCALE X0,Z5,Y0,Y2+(151-Z4)*
     D2
1110 XAXIS Y1,Z1/L1,X1,X2+D1
1120 YAXIS X1,Z2/L2,Y1,Y2+D2
1130 IF S8 THEN 1290
1140 W1=LGT(ABS(Z1/L1*L3))
1150 W=LGT(ABS(X1+(X1=0)))+1
1160 IF W>5-(SGN(X1)=-1) OR W1<-
     3 THEN 1250
1170 IF S9 THEN 2160
1180 LDIR 90
1190 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
1200 MOVE I+4*D1,Y0
1210 GOSUB 1840
1220 LABEL V$[1,V]
1230 NEXT I
1240 GOTO 1290
1250 MOVE X0,Y0
1260 LDIR 0
1270 I=X1 @ GOSUB 1980 @ Z$=V$ @
      I=Z1/L1 @ GOSUB 1980
1280 LABEL "XMIN="&Z$[1,10]&":TI
     CS="&V$[1,10]
1290 IF S8 THEN 1470
1300 W1=LGT(ABS(Z2/L2*L4))
1310 W=LGT(ABS(Y1+(Y1=0)))+1
1320 IF W>5-(SGN(Y1)=-1) OR W1<-
     3 THEN 1400
1330 LDIR 0
1340 FOR I=Y1 TO Y2+D2 STEP Z2/L
     2*L4
1350 MOVE X0,I-4*D2
1360 GOSUB 1840
1370 LABEL V$[1,V]
1380 NEXT I
1390 GOTO 1470
1400 LDIR 90
1410 MOVE X0+12*D1,Y1
1420 I=Y1 @ GOSUB 1980
1430 LABEL "YMIN="&V$[1,10]
1440 MOVE X0+24*D1,Y1
1450 I=Z2/L2 @ GOSUB 1980
1460 LABEL "TICS="&V$[1,10]
1470 GOSUB 1520
1480 RETURN
1490 CLEAR @ GOSUB 800
1500 GOSUB 1520
1510 RETURN
1520 PENUP @ P=0
1530 FOR I=X3 TO X4 STEP D
1540 IF NOT S THEN 1600
1550 S2=0
1560 FOR J=1 TO S
1570 IF I=S(J) THEN S2=1
1580 NEXT J
1590 IF S2 THEN 1660
1600 T=FNF(I)
1610 IF P THEN 1650
1620 PLOT I,T
1630 P=1
1640 GOTO 1660
1650 DRAW I,T
1660 NEXT I
1670 BEEP @ RETURN
1680 GOSUB 800
1690 PRINT "FUNCTION VALUE TABLE
     "
1700 PRINT "        X
        f(X)"
```

Initialization

Wait loop until key pressed
HELP subroutine

Plot definition subroutine

SINGULARITY POINT
subroutine

FULL PLOT subroutine after GCLEAR
PLOT subroutine

Increment entry

If 0, then enter number of increments

Compute Y extremes for AUTO SCALE

Test for point of singularity

Compute SCALE parameters

LABEL X-axis

LABEL Y-axis

Plot values

Test for point of singularity

Print TABLE

```
1710 FOR I=X3 TO X4 STEP D
1720 IF NOT S THEN 1780
1730 S2=0
1740 FOR J=1 TO S
1750 IF I=S(J) THEN S2=1
1760 NEXT J
1770 IF S2 THEN 1810
1780 F=FNF(I)
1790 PRINT USING  "10D.5D,10D.5D
     ";I,F
1800 NEXT I
1810 PRINT
1820 PRINT
1830 RETURN
1840 V$=""
1850 X=I
1860 V$=VAL$(X)
1870 IF POS(V$,"E") THEN 1930
1880 G9=LGT(ABS(X+(X=0)))
1890 IF LEN(V$)>5 AND ABS(G9)>4-
     (SGN(X)=-1) THEN V=5 @ V$="
     -----" @ RETURN
1900 IF LEN(V$)<5 THEN V=LEN(V$)
      @ RETURN
1910 V$[1,5]=VAL$(X) @ V=5
1920 RETURN
1930 E=POS(V$,"E")
1940 IF V$[1,1]="-" THEN V$[3]=V
     $[E] @ V=LEN(V$) @ GOTO 196
     0
1950 V$[2]=V$[E] @ V=LEN(V$)
1960 IF V>5 THEN PRINT USING 220
     0 ; I @ V=5 @ V$="-----"
1970 RETURN
1980 V$=""
1990 V$=VAL$(I)
2000 IF POS(V$,"E") THEN 2030
2010 V$[1,10]=VAL$(I)
2020 RETURN
2030 V$[7,10]=V$[POS(V$,"E")]
2040 RETURN
2050 CLEAR
2060 DISP "LABEL ORIGIN:X,Y"
2070 INPUT X,Y
2080 IF X>=X0 AND X<=X2 AND Y>=Y
     0 AND Y<=Y2+3*D2 THEN 2100
2090 DISP "INVALID POSITION" @ B
     EEP @ GOTO 2060
2100 DISP "ENTER LABEL"
2110 INPUT R$
2120 L=LEN(R$)
2130 IF L/32>(Z5-X)/(Z5-X0) THEN
      DISP "LABEL TOO LONG" @ BE
     EP @ GOTO 2100
2140 MOVE X,Y @ LABEL R$
2150 RETURN
2160 LDIR 0 @ L9=-INF
2170 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
2180 GOSUB 1840
2190 IF L9>I-(V%4+6)*D1 OR L9>Z5
     +(10-V%8)*D1 THEN PRINT USI
     NG 2200 ; I @ GOTO 2250
2200 IMAGE "LABEL DELETED AT ",7
     D.4D
2210 MOVE I+(2-V%4)*D1,Y1-12*D2
2220 L9=I+(V%4+2)*D1
2230 IF L9>Z5 THEN MOVE Z5+(2-V%
     8)*D1,Y1-12*D2
2240 LABEL V$[1,V]
2250 NEXT I
2260 GOTO 1290
5000 DEF FNF(X)
5010 RAD
5020 FNF=SIN(X)/X
5030 FN END
```

Test for point of singularity

Label string routine

Enter LABEL origin

Label plot at X, Y

Horizontal labelling for X-axis

Function to be plotted

Auto Data Plot

Variable Definitions

B – Maximum number of values
C – Entry flag
D1 – Distance of a dot in X-direction
D2 – Distance of a dot in Y-direction
E – Position of "E" in string
G9 – Temporary storage
I – Loop counter
J – Loop counter
L0 – Line type
L – Label length
L1 – Number of X-axis intervals
L2 – Number of Y-axis intervals
L3 – Number of X-intervals between labels
L4 – Number of Y-intervals between labels
L9 – Label position
N – Number of plot increments
N1 – First point to plot
N2 – Last point to plot
S1 – Auto y-scale flag
S2 – Auto x-scale flag
S7 – Y-label flag
S8 – X-label flag
S9 – Vertical/Horizontal label flag
T – Temporary storage
U – Plot set up flag
V – Length of label
W – Temporary for label
W1 – Temporary for label
X – Label position and temporary
X0 – Scale X-minimum
X1 – X-value at axes intercept
X2 – X-value at right end of X-axis
X6 – Print data on input flag

Y – Label position
Y0 – Scale Y-minimum
Y1 – Y-value at axes intercept
Y2 – Y-value at top end of Y-axis
Z1 – X2−X1
Z2 – Y2−Y1
Z3 – X dot range
Z4 – Y dot range
Z5 – Scale X-maximum

```
 10 OPTION BASE 1
 20 DIM X(200,2),R$[33],F$[6]
 30 ON KEY# 1,"ENTER" GOSUB 270
 40 ON KEY# 2,"OUTPUT" GOSUB 650
 50 ON KEY# 3,"SETUP" GOSUB 1440
 60 ON KEY# 4,"PLOT" GOSUB 1910
 70 ON KEY# 5,"HELP" GOSUB 140
 80 ON KEY# 6,"EDIT" GOSUB 1040
 90 ON KEY# 7,"GRID" GOSUB 2950
100 ON KEY# 8,"LABEL" GOSUB 2850
110 N=INF @ CLEAR @ KEY LABEL
120 DISP "SELECT OPTION"
130 GOTO 130
140 CLEAR @ KEY LABEL @ DISP "
          AUTO DATA PLOT"
150 DISP "K1:ENTER DATA VIA KEYB
    OARD OR"
160 DISP "    DATA FILE ON CARTRI
    DGE(FIRST)"
170 DISP "K2:OUTPUT DATA TO PRIN
    TER/TAPE"
180 DISP "K3:SETUP FOR PLOT-SCAL
    ES/AXES"
190 DISP "K4:PLOT DATA-LINE/POIN
    T/+/o"
200 DISP "K5:HELP"
210 DISP "K6:EDIT DATA-CHANGE/DE
    LETE/ADD"
220 DISP "K7:DRAW A GRID @ LABEL
     INTERVALS"
230 DISP "K8:LABEL PLOT - SPECIF
    Y LOCATION"
240 DISP "    AND LABEL"
250 DISP
260 RETURN
270 CLEAR @ DISP "PRINT DATA ON
    INPUT:Y/N";
280 INPUT R$[1,32]
290 X6=0
300 IF UPC$(R$[1,1])="Y" THEN X6
    =1 @ GOTO 320
310 IF UPC$(R$[1,1])#"N" THEN BE
    EP @ GOTO 270
320 DISP "ENTER FROM KEYBOARD/TA
    PE:K/T";
330 INPUT R$[1,32]
340 C=1
350 IF UPC$(R$[1,1])="T" THEN C=
    2 @ GOTO 370
360 IF UPC$(R$[1,1])#"K" THEN BE
    EP @ GOTO 320
370 B=200
380 IF X6<>1 OR C=2 THEN 420
390 PRINT
400 PRINT "   I         X(I)
        Y(I)"
410 GOTO 430
420 IF C=2 THEN 570
430 DISP "ENTER NUMBER OF POINTS
    :200 MAX.";
440 INPUT N
450 IF N<=200 AND N>1 THEN 480
460 DISP "INVALID NUMBER OF POIN
    TS"
470 BEEP @ GOTO 430
480 FOR I=1 TO N
490 DISP "X(";I;"),Y(";I;")=";
500 INPUT X(I,1),X(I,2)
510 IF X6<>1 THEN 540
520 PRINT USING 530 ; I,X(I,1),X
    (I,2)
530 IMAGE 4D,3X,6DZ.4D,6DZ.4D
540 NEXT I
550 DISP "MAXIMUM NUMBER ENTERED
    "
560 GOTO 920
570 DISP "ENTER FILE NAME";
580 INPUT F$
590 ON ERROR GOTO 570
600 ASSIGN# 1 TO F$
610 READ# 1 ; N,X(,)
620 OFF ERROR
630 IF X6<>1 THEN 920
640 GOTO 710
650 T=0 @ CLEAR
660 DISP "PRINT DATA:Y/N";
670 INPUT R$[1,32]
680 IF UPC$(R$[1,1])="N" THEN 78
    0
690 IF UPC$(R$[1,1])#"Y" THEN 66
    0
700 GOTO 720
710 T=1
720 PRINT "   I         X(I)
        Y(I)"
730 FOR I=1 TO N
740 PRINT USING 530 ; I,X(I,1),X
    (I,2)
750 NEXT I
760 PRINT
770 IF T=1 THEN 920
780 DISP "STORE DATA:Y/N";
790 INPUT R$[1,32]
800 IF UPC$(R$[1,1])="N" THEN 92
    0
810 IF UPC$(R$[1,1])#"Y" THEN BE
    EP @ GOTO 780
820 ON ERROR GOTO 830
830 DISP "ENTER NAME OF FILE";
840 INPUT F$
850 DISP "CREATE FILE:Y/N";
860 INPUT R$[1,32]
870 IF UPC$(R$[1,1])="Y" THEN CR
    EATE F$,15 @ GOTO 890
880 IF UPC$(R$[1,1])#"N" THEN BE
    EP @ GOTO 850
890 ASSIGN# 1 TO F$
900 PRINT# 1 ; N,X(,)
910 OFF ERROR
920 DISP "DONE"
930 RETURN
940 CLEAR @ DISP "ENTER INDEX OF
     PAIR TO CORRECT";
950 INPUT I
960 IF I<1 THEN 1040
970 IF I>N THEN BEEP @ GOTO 940
980 DISP "X(";I;")=";X(I,1)
990 DISP "NEW X(";I;")=";
1000 INPUT X(I,1)
1010 DISP "Y(";I;")=";X(I,2)
1020 DISP "NEW Y(";I;")=";
1030 INPUT X(I,2)
1040 DISP "0=OK,1=CORRECT,2=DELE
     TE,3=INSERT"
1050 INPUT I
1060 IF I>3 OR I<0 THEN BEEP @ G
     OTO 1040
1070 ON I+1 GOTO 1080,940,1090,1
     230
1080 GOTO 920
1090 DISP "ENTER INDEX OF PAIR T
     O DELETE";
1100 INPUT I
1110 IF I<1 THEN 1040
1120 IF I>N THEN BEEP @ GOTO 109
     0
1130 DISP "DELETE X(";I;")=";X(I
     ,1);" Y(";I;")=";X(I,2)
1140 IF I=N THEN 1200
1150 DISP "NEW X(";I;")=";X(I+1,
     1);" Y(";I;")=";X(I+1,2)
1160 FOR J=I+1 TO N
1170 X(J-1,1)=X(J,1)
1180 X(J-1,2)=X(J,2)
1190 NEXT J
1200 N=N-1
1210 DISP "N=";N
1220 GOTO 1040
1230 DISP "ENTER INDEX OF PAIR T
     O INSERT";
1240 INPUT I
1250 IF N<200 THEN 1280
1260 DISP "MAXIMUM NUMBER OF PAI
     RS=200"
1270 GOTO 1040
1280 IF I<1 THEN 1040
1290 N=N+1
1300 IF I>N+1 THEN 1230
1310 IF I<N THEN 1340
1320 I=N
1330 GOTO 1380
1340 FOR J=N TO I+1 STEP -1
1350 X(J,1)=X(J-1,1)
1360 X(J,2)=X(J-1,2)
1370 NEXT J
1380 DISP "INSERT X(";I;")=";
1390 INPUT X(I,1)
1400 DISP "INSERT Y(";I;")=";
1410 INPUT X(I,2)
1420 DISP "N=";N
1430 GOTO 1040
1440 CLEAR @ U=0 @ DISP "AUTO X-
     SCALING:Y/N";
1450 INPUT R$[1,32]
1460 IF UPC$(R$[1,1])="N" THEN S
     2=1 @ GOTO 1520
1470 IF UPC$(R$[1,1])#"Y" THEN B
     EEP @ GOTO 1440
1480 S2=0
1490 X1=INF
1500 X2=-INF
1510 GOTO 1570
1520 ALPHA @ DISP "ENTER SCALE X
     MIN";
1530 INPUT X1
1540 DISP "ENTER SCALE XMAX";
1550 INPUT X2
1560 IF X1>=X2 THEN BEEP @ GOTO
     1520
1570 DISP "VERTICAL/HORIZONTAL L
     ABELS:V/H";
1580 INPUT R$[1,32]
1590 IF UPC$(R$[1,1])="V" THEN S
     9=0 @ GOTO 1620
1600 IF UPC$(R$[1,1])="H" THEN S
     9=1 @ GOTO 1620
1610 BEEP @ GOTO 1570
1620 DISP "NO. OF X-AXIS INTERVA
     LS:(<=16)";
1630 INPUT L1
1640 IF L1<1 OR L1>16 OR L1#INT(
     L1) THEN BEEP @ GOTO 1620
1650 DISP "NUMBER X-INT. BETWEEN
      LABELS";
```

Initialization

Wait loop until key is pressed

HELP subroutine

Data entry subroutine

Keyboard or tape?

Keyboard entry

Number of points

Enter pair

Tape entry

Read data

OUTPUT subroutine

Print data?

Print data

Store data?

Print data on tape

Correction routine

Edit type specification

Deletion routine

Insertion routine

Set up plot specification

```
1660 INPUT L3
1670 S8=0 @ IF L3=0 THEN S8=1 @
     L3=1
1680 IF L3<1 OR L3>L1 THEN BEEP
     @ GOTO 1650
1690 DISP "AUTO Y-SCALING:Y/N";
1700 INPUT R$[1,32]
1710 IF UPC$(R$[1,1])="Y" THEN 1
     800
1720 IF UPC$(R$[1,1])#"N" THEN B
     EEP @ GOTO 1690
1730 DISP "ENTER SCALE YMIN";
1740 INPUT Y1
1750 DISP "ENTER SCALE YMAX";
1760 INPUT Y2
1770 IF Y1>=Y2 THEN BEEP @ GOTO
     1730
1780 S1=1
1790 GOTO 1830
1800 Y1=INF
1810 Y2=-INF
1820 S1=0
1830 DISP "NO. OF Y-AXIS INTERVA
     LS:(<=12)";
1840 INPUT L2
1850 IF L2<1 OR L2>12 OR L2#INT(
     L2) THEN BEEP @ GOTO 1830
1860 DISP "NUMBER Y-INT. BETWEEN
      LABELS";
1870 INPUT L4
1880 S7=0 @ IF L4=0 THEN S7=1 @
     L4=1
1890 IF L4<1 OR L4>L2 THEN BEEP
     @ GOTO 1860
1900 DISP "PLOT DEFINED" @ RETUR
     N
1910 CLEAR
1920 DISP "INDEX OF FIRST POINT"
     ;@ INPUT N1
1930 IF N1<1 THEN N1=1 @ GOTO 19
     50
1940 IF N1>N THEN DISP "MAXIMUM
     NUMBER OF POINTS IS ";N @ G
     OTO 1920
1950 DISP "INDEX OF LAST POINT";
1960 INPUT N2
1970 IF N2>N THEN DISP "MAXIMUM
     NUMBER OF POINTS IS ";N @ G
     OTO 1950
1980 IF N1>N2 THEN DISP "LAST PO
     INT IS < FIRST" @ GOTO 1920
1990 DISP "LINE TYPE:LINE/DOT/+/
     o(1,2,3,4)";
2000 INPUT L0
2010 IF L0>=1 AND L0<=4 THEN 203
     0
2020 DISP "INVALID LINE TYPE" @
     BEEP @ GOTO 1990
2030 IF U THEN 2590
2040 U=1
2050 IF S2 THEN 2100
2060 FOR I=N1 TO N2
2070 IF X1>X(I,1) THEN X1=X(I,1)
2080 IF X2<X(I,1) THEN X2=X(I,1)
2090 NEXT I
2100 IF S1 THEN 2150
2110 FOR I=N1 TO N2
2120 IF Y1>X(I,2) THEN Y1=X(I,2)
2130 IF Y2<X(I,2) THEN Y2=X(I,2)
2140 NEXT I
2150 Z1=X2-X1
2160 Z3=INT(200/L1)*L1
2170 Z2=Y2-Y1
2180 Z4=INT(144/L2)*L2
2190 D1=Z1/Z3 @ D2=Z2/Z4 @ Z5=X2
     +(207-Z3)*D1
2200 X0=X1-48*D1
2210 Y0=Y1-40*D2
2220 PEN 1 @ GCLEAR @ SCALE X0,Z
     5,Y0,Y2+(151-Z4)*D2
2230 XAXIS Y1,Z1/L1,X1,X2+D1
2240 YAXIS X1,Z2/L2,Y1,Y2+D2
2250 IF S8 THEN 2410
2260 W1=LGT(ABS(Z1/L1*L3))
2270 W=LGT(ABS(X1+(X1=0)))+1
2280 IF W>5-(SGN(X1)=-1) OR W1<-
     3 THEN 2370
2290 IF S9 THEN 3120
2300 LDIR 90
2310 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
2320 MOVE I+4*D1,Y0
2330 GOSUB 2720
2340 LABEL V$[1,V]
2350 NEXT I
2360 GOTO 2410
2370 MOVE X0,Y0
2380 LDIR 0
2390 I=X1 @ GOSUB 3050 @ I=Z1/L1
      @ Z$=V$ @ GOSUB 3050
2400 LABEL "XMIN="&Z$[1,10]&" TI
     CS="&V$[1,10]
2410 IF S7 THEN 2590
2420 W1=LGT(ABS(Z2/L2*L4))
2430 W=LGT(ABS(Y1+(Y1=0)))+1
2440 IF W>5-(SGN(Y1)=-1) OR W1<-
     3 THEN 2520
2450 LDIR 0
2460 FOR I=Y1 TO Y2+D2 STEP Z2/L
     2*L4
2470 MOVE X0,I-4*D2
2480 GOSUB 2720
2490 LABEL V$[1,V]
2500 NEXT I
2510 GOTO 2590
2520 LDIR 90
2530 I=Y1 @ GOSUB 3050
2540 MOVE X0+12*D1,Y1
2550 LABEL "YMIN="&V$[1,10]
2560 MOVE X0+24*D1,Y1
2570 I=Z2/L2 @ GOSUB 3050
2580 LABEL "TICS="&V$[1,10]
2590 GOSUB 2610
2600 RETURN
2610 PENUP @ LDIR 0
2620 MOVE X(N1,1),X(N1,2)
2630 FOR I=N1 TO N2
2640 ON L0 GOTO 2650,2660,2670,2
     680
2650 DRAW X(I,1),X(I,2) @ GOTO 2
     690
2660 PLOT X(I,1),X(I,2) @ PENUP
     @ GOTO 2690
2670 MOVE X(I,1)-2*D1,X(I,2)-4*D
     2 @ LABEL "+" @ GOTO 2690
2680 MOVE X(I,1)-2*D1,X(I,2)-3*D
     2 @ LABEL "o"
2690 NEXT I
2700 BEEP
2710 RETURN
2720 V$=""
2730 X=I
2740 V$=VAL$(X)
2750 IF POS(V$,"E") THEN 2810
2760 G9=LGT(ABS(X+(X=0)))
2770 IF LEN(V$)>5 AND ABS(G9)>4-
     (SGN(X)=-1) THEN V=5 @ V$="
     -----" @ RETURN
2780 IF LEN(V$)<5 THEN V=LEN(V$)
      @ RETURN
2790 V$[1,5]=VAL$(X) @ V=5
2800 RETURN
2810 E=POS(V$,"E")
2820 IF VAL(V$[E+1])>9 THEN 2840
2830 V$[2,3]=V$[3,4] @ V$[4,4]="
     E" @ V$[5,5]=V$[E+3] @ V=5
     @ RETURN
2840 V$[2,2]=V$[3,3] @ V$[3,3]="
     E" @ V$[4,5]=V$[E+2] @ V=5
     @ RETURN
2850 CLEAR
2860 DISP "LABEL ORIGIN:X,Y";@ I
     NPUT X,Y
2870 IF X>=X0 AND X<=X2 AND Y>=Y
     0 AND Y<=Y2+3*D2 THEN 2890
2880 DISP "INVALID POSITION" @ B
     EEP @ GOTO 2860
2890 DISP "ENTER LABEL";
2900 INPUT R$
2910 L=LEN(R$)
2920 IF L/32>(Z5-X)/(Z5-X0) THEN
      DISP "LABEL TOO LONG" @ BE
     EP @ GOTO 2890
2930 MOVE X,Y @ LABEL R$
2940 RETURN
2950 IF N=INF THEN BEEP @ RETURN
2960 FOR I=X1+Z1/L1*L3 TO X2+D1
     STEP Z1/L1*L3
2970 MOVE I,Y1
2980 DRAW I,Y2
2990 NEXT I
3000 FOR I=Y1+Z2/L2*L4 TO Y2+D2
     STEP Z2/L2*L4
3010 MOVE X1,I
3020 DRAW X2,I
3030 NEXT I
3040 RETURN
3050 V$=""
3060 V$=VAL$(I)
3070 IF POS(V$,"E") THEN 3100
3080 V$[1,10]=VAL$(I)
3090 RETURN
3100 V$[7,10]=V$[POS(V$,"E")]
3110 RETURN
3120 LDIR 0 @ L9=-INF
3130 FOR I=X1 TO X2+D1 STEP Z1/L
     1*L3
3140 GOSUB 2720
3150 IF L9>I-(V*4+6)*D1 OR L9>Z5
     +(1-V*8)*D1 THEN PRINT USIN
     G 3160 ; I @ GOTO 3210
3160 IMAGE "LABEL DELETED AT ",7
     D.4D
3170 MOVE I+(2-V*4)*D1,Y1-12*D2
3180 L9=I+(V*4+2)*D1
3190 IF L9>Z5 THEN MOVE Z5+(2-V*
     8)*D1,Y1-12*D2
3200 LABEL V$[1,V]
3210 NEXT I
3220 GOTO 2410
```

Enter indices to plot

Enter line type to use

Auto X-SCALE

Auto Y-SCALE

Compute SCALE parameters

Draw axes

LABEL X-axis

LABEL Y-axis

Plot data

Branch depending on line type

Line

Point

"+"

"o"

LABEL string routine

Enter label origin

Label plot at X, Y

GRID subroutine

Horizontal labelling of X-axis

Histogram Generator

Data Storage and Retrieval

A major part of working with computational machines is the use of data. In many cases, the entry of data can be the most time consuming operation in running a program. If the same data is to be used again either in the same form or with minor editions, it is probably easier to store and later retrieve data from tape, than to re-enter the data. The "Histogram Generator" program allows the user to store and retrieve data. The subroutine at line 930 to 1020 shows the storage operations for the array A which contains the histogram data values.

Lines	Comments
930 ON ERROR GOTO 910	Set up for possible error
940 DISP "CREATE FILE:Y/N";	CREATE?
950 INPUT R$	
960 IF UPC$(R$[1,1])="Y" THEN CR EATE F$,8 @ GOTO 930	Yes—create it
970 IF UPC$(R$[1,1])#"N" THEN BE EP @ GOTO 940	Invalid answer
980 ASSIGN# 1 TO F$	Assign—(open buffer)
990 PRINT # 1 ; N,X()	Print count and array
1000 ASSIGN# 1 TO *	Close buffer
1010 OFF ERROR	Void error routine
1020 GOTO 1540	

The subroutine at lines 600 to 650 shows the retrieval operations for the array A which was stored using the storage subroutine above.

Lines	Comments
600 DISP "ENTER FILE NAME";	Enter file name
610 INPUT F$	
620 ON ERROR GOTO 600	Set up for possible error
630 ASSIGN# 1 TO F$	Assign—(open buffer)
640 READ# 1 ; N,X()	Read count and array
650 OFF ERROR	Void error routine

This example is a very simple example of data storage, but it should serve to demonstrate some of the power of data storage for you in your own applications.

Variable Definitions

B - Maximum number of values

B1 - Highest numbered cell with any points

C - Cell width and keyboard/tape entry flag

D1 – Distance of a dot in X-direction
D2 – Distance of a dot in Y-direction
E – Position of "E" in string
I – Loop counter
J – Loop counter
K – Temporary storage
L – Label length
L1 – Number of X-axis intervals
L2 – Number of Y-axis intervals
L3 – Number of X-intervals between labels
L9 – Label position
N – Number of points
N1 – Temporary storage for normal curve
N9 – Maximum number of points in a cell
O – Offset
P – Temporary counter
S2 – Sum of squares
S5 – Mean
S6 – Sample standard deviation
S9 – Vertical/Horizontal label flag
T – Sum of values and number of cells
T2 – Maximum value
T4 – Number of observations too small for offset
T5 – Number of observations too large for number of cells
V – Length of label
X – Temporary storage and label position
X0 – Scale X-minimum
X6 – Print data on input flag
Y – Temporary storage and label position
Y0 – Scale Y-minimum
Z0 – Temporary storage for number of cells to use for scaling plot
Z1 – C * Z0
Z2 – N9
Z3 – X dot range
Z4 – Y dot range = 120
Z5 – Scale X-maximum

```
  10 OPTION BASE 1
  20 INTEGER F(50)
  30 DIM X(200),R$[33],F$[6]
  40 ON KEY# 1,"ENTER" GOSUB 290
  50 ON KEY# 2,"OUTPUT" GOSUB 680
  60 ON KEY# 3,"PLOT" GOSUB 1560
  70 ON KEY# 4,"NORMAL" GOSUB 257
     0
  80 ON KEY# 5,"HELP" GOSUB 150
  90 ON KEY# 6,"EDIT" GOSUB 1030
 100 ON KEY# 7,"LABEL" GOSUB 2940
 110 ON KEY# 8,"COPY" GOSUB 2660
 120 CLEAR @ KEY LABEL
 130 DISP "HISTOGRAM GENERATOR" @
     DISP "SELECT OPTION"
 140 GOTO 140
 150 CLEAR @ KEY LABEL @ DISP "
         HISTOGRAM GENERATOR"
 160 DISP "K1:ENTER DATA VIA KEYB
     OARD OR"
 170 DISP "    DATA FILE ON CARTRI
     DGE(FIRST)"
 180 DISP "K2:PRINT DATA ON PRINT
     ER/DISPLAY"
 190 DISP "    AND STORE DATA ON T
     APE"
 200 DISP "K3:PLOT THE HISTOGRAM
     BASED ON"
 210 DISP "    # OF CELLS AND CELL
      WIDTH"
 220 DISP "K4:DRAW A NORMAL CURVE
     OVERLAY"
 230 DISP "K5:HELP"
 240 DISP "K6:EDIT DATA-CHANGE/DE
     LETE/ADD"
 250 DISP "K7:LABEL PLOT - SPECIF
     Y LOCATION"
 260 DISP "    AND LABEL"
 270 DISP "K8:COPY THE PLOT WITH
     STATISTICS"
 280 RETURN
 290 CLEAR @ DISP "PRINT DATA ON
     INPUT:Y/N";
 300 INPUT R$[1,32]
 310 X6=0
 320 IF UPC$(R$[1,1])="Y" THEN X6
     =1 @ GOTO 340
 330 IF UPC$(R$[1,1])#"N" THEN BE
     EP @ GOTO 290
 340 DISP "ENTER FROM KEYBOARD/TA
     PE:K/T";
 350 INPUT R$[1,32]
 360 C=1
 370 IF UPC$(R$[1,1])="T" THEN C=
     2 @ GOTO 390
 380 IF UPC$(R$[1,1])#"K" THEN BE
     EP @ GOTO 340
 390 B=200
 400 IF X6<>1 OR C=2 THEN 440
 410 PRINT
 420 PRINT "  I        X(I)
      X(I+1)"
 430 GOTO 450
 440 IF C=2 THEN 600
 450 DISP "ENTER NUMBER OF POINTS
     "
 460 INPUT N
 470 IF N<=200 AND N>1 THEN 500
 480 DISP "INVALID NUMBER OF POIN
     TS"
 490 BEEP 10,25 @ GOTO 450
 500 FOR I=1 TO N
 510 DISP "X(";I;")=";
 520 INPUT X(I)
 530 IF X6<>1 OR I#I\2*2 THEN 560
 540 PRINT USING 550 ; I-1,X(I-1)
     ,X(I)
 550 IMAGE 4D,2X,6DZ.4D,2X,6DZ.4D
 560 NEXT I
 570 IF X6=1 AND N#N\2*2 THEN PRI
     NT USING 550 ; N,X(N)
 580 DISP "MAXIMUM NUMBER ENTERED
     "
 590 GOTO 1470
 600 DISP "ENTER FILE NAME";
 610 INPUT F$
 620 ON ERROR GOTO 600
 630 ASSIGN# 1 TO F$
 640 READ# 1 ; N,X(*)
 650 OFF ERROR
 660 IF X6<>1 THEN 1470
 670 GOTO 780
 680 T=0 @ CLEAR
 690 DISP "PRINT DATA:Y/N";
 700 INPUT R$[1,32]
 710 IF UPC$(R$[1,1])="Y" THEN 73
     0
 720 IF UPC$(R$[1,1])#"N" THEN BE
     EP @ GOTO 690 ELSE 860
 730 DISP "PRINT DATA ON PRINTER/
     DISP:P/D";
 740 INPUT R$[1,32]
 750 IF UPC$(R$[1,1])="P" THEN PR
     INTER IS 2 @ GOTO 790
 760 IF UPC$(R$[1,1])="D" THEN PR
     INTER IS 1 ELSE BEEP @ GOTO
     730
 770 GOTO 790
 780 T=1
 790 PRINT "  I        X(I)
      X(I+1)"
 800 FOR I=1 TO N STEP 2
 810 IF I=N THEN PRINT USING 550
     ; I,X(N) @ GOTO 830
 820 PRINT USING 550 ; I,X(I),X(I
     +1)
 830 NEXT I
 840 PRINT
 850 IF T=1 THEN 1470
 860 DISP "STORE DATA:Y/N";
 870 INPUT R$[1,32]
 880 IF UPC$(R$[1,1])="Y" THEN 90
     0
 890 IF UPC$(R$[1,1])#"N" THEN BE
     EP @ GOTO 860 ELSE 1540
 900 IF N<2 THEN DISP "NOTHING TO
     STORE" @ RETURN
 910 DISP "ENTER NAME OF FILE";
 920 INPUT F$
 930 ON ERROR GOTO 910
 940 DISP "CREATE FILE:Y/N";
 950 INPUT R$[1,32]
 960 IF UPC$(R$[1,1])="Y" THEN CR
     EATE F$,8 @ GOTO 980
 970 IF UPC$(R$[1,1])#"N" THEN BE
     EP @ GOTO 940
 980 ASSIGN# 1 TO F$
 990 PRINT# 1 ; N,X(*)
1000 ASSIGN# 1 TO *
1010 OFF ERROR
1020 GOTO 1540
1030 CLEAR @ GOTO 1110
1040 DISP "ENTER INDEX OF ITEM T
     O CORRECT";
1050 INPUT I
1060 IF I<1 THEN 1110
1070 IF I>N THEN BEEP @ GOTO 104
     0
1080 DISP "X(";I;")=";X(I)
1090 DISP "NEW X(";I;")=";
1100 INPUT X(I)
1110 DISP "0=OK,1=CORRECT,2=DELE
     TE,3=INSERT";
1120 INPUT T
1130 IF T>3 OR T<0 THEN 1110
1140 ON T+1 GOTO 1150,1040,1160,
     1290
1150 GOTO 1470
1160 DISP "ENTER INDEX OF ITEM T
     O DELETE";
1170 INPUT I
1180 IF I<1 THEN 1110
1190 IF I>N THEN BEEP @ GOTO 116
     0
1200 DISP "DELETE X(";I;")=";X(I
     )
1210 IF I=N THEN 1260
1220 DISP "NEW X(";I;")=";X(I+1)
1230 FOR J=I+1 TO N
1240 X(J-1)=X(J)
1250 NEXT J
1260 N=N-1
1270 DISP "N=";N
1280 GOTO 1110
1290 DISP "ENTER INDEX OF ITEM T
     O INSERT";
1300 INPUT I
1310 IF N<200 THEN 1340
1320 DISP "MAXIMUM NUMBER OF ITE
     MS=200"
1330 BEEP @ GOTO 1110
1340 IF I<1 THEN 1110
1350 N=N+1
1360 IF I>N+1 THEN 1290
1370 IF I<N THEN 1400
1380 I=N
1390 GOTO 1430
1400 FOR J=N TO I+1 STEP -1
1410 X(J)=X(J-1)
1420 NEXT J
1430 DISP "INSERT X(";I;")=";
1440 INPUT X(I)
1450 DISP "N=";N
1460 GOTO 1110
1470 T,S2=0
1480 FOR I=1 TO N
1490 T=T+X(I)
1500 S2=S2+X(I)*X(I)
1510 NEXT I
1520 S5=T/N
1530 S6=SQR((S2-S5*S5*N)/(N-1))
1540 DISP "DONE"
1550 RETURN
1560 CLEAR @ T2=-INF
1570 FOR J=1 TO N
1580 IF X(J)>T2 THEN T2=X(J)
1590 NEXT J
1600 DISP "OFFSET=";
1610 INPUT O
1620 PRINT "OFFSET=",O
1630 IF T2>O THEN 1660
1640 DISP "OFFSET TOO BIG;MAX VA
     LUE=";T2
1650 GOTO 1600
1660 DISP "# OF CELLS";
```

Initialization

Wait loop until key pressed

HELP subroutine

Data Entry subroutine

Keyboard or tape?

Keyboard entry

Enter value

Tape entry

Read data

OUTPUT subroutine

PRINT data?

Print data

Store data?

Print data on tape

Correction routine

Edit type specification

Deletion routine

Insertion routine

Compute sum and sum of squares

Plot subroutine

Enter offset

```
1670 INPUT T
1680 IF T>0 AND T<=50 THEN 1710
1690 DISP "# OF CELLS OUT OF BOU
     NDS:(1,50)"
1700 GOTO 1650
1710 DISP "# OF CELLS=";T
1720 DISP "OPTIMUM CELL WIDTH ="
     ;(T2-0)/T#1.00001
1730 DISP "CELL WIDTH";
1740 INPUT C
1750 FOR J=1 TO T
1760 F(J)=0
1770 NEXT J
1780 PRINT "CELL WIDTH=";C
1790 T4,T5,B1,N9=0
1800 FOR I=1 TO N
1810 IF X(I)<0 THEN 1860
1820 Y=INT((X(I)-O)/C+1)
1830 IF Y<=T THEN 1880
1840 T5=T5+1
1850 GOTO 1910
1860 T4=T4+1
1870 GOTO 1910
1880 F(Y)=F(Y)+1
1890 B1=MAX(B1,Y)
1900 N9=MAX(N9,F(Y))
1910 NEXT I
1920 IF T4=0 AND T5=0 THEN 2010
1930 IF T4=0 THEN 1950
1940 DISP T4;"OBS. TOO SMALL FOR
      OFFSET"
1950 IF T5=0 THEN 1970
1960 DISP T5;"OBS. TOO LARGE FOR
     ";T;"CELLS"
1970 DISP "OFFSET & CELL WIDTH O
     K:Y/N"
1980 INPUT R$[1,32]
1990 IF UPC$(R$[1,1])="N" THEN 1
     600
2000 IF UPC$(R$[1,1])#"Y" THEN B
     EEP @ GOTO 1970
2010 K=N%C/(S6$SQR(2*PI))
2020 Z0=T @ P=1
2030 S9=0 @ IF T<7 THEN S9=1 @ L
     1=T @ GOTO 2080
2040 L1=24
2050 IF INT(Z0/L1)=Z0/L1 THEN 20
     80
2060 IF L1>7 THEN L1=L1-1 @ GOTO
      2050
2070 Z0=T+P @ P=P+1 @ GOTO 2040
2080 L3=1
2090 IF L1>12 THEN L3=2
2100 Z3=INT(200/L1)%L1
2110 Z2=N9 @ Z1=Z0%C
2120 Z4=120 @ D1=Z1/Z3 @ D2=Z2/Z
     4
2130 L2=10
2140 X0=0-48%D1
2150 Z5=X0+255%D1
2160 Y0=-40%D2
2170 SCALE X0,O+Z0%C+(207-Z3)%D1
     ,Y0,N9+(151-Z4)%N9/Z4
2180 GCLEAR
2190 MOVE O-26%D1,0
2200 DRAW 0,0
2210 XAXIS 0,Z1/L1%L3,0,O+Z1+D1
2220 YAXIS O-26%D1,INT((N9+9)/10
     ),0,N9+D2
2230 MOVE X0+4%D1,N9+6%D2
2240 LABEL "NO  %"
2250 FOR J=0 TO N9 STEP INT((N9+
     9)/10)
2260 MOVE X0,J-4%D2
2270 V$[1,3]=VAL$(J)
2280 Z$[1,3]=VAL$(100%J/N)
2290 LABEL V$[1,3]
2300 MOVE X0+26%D1,J-4%D2 @ LABE
     L Z$[1,3]
2310 NEXT J
2320 IF O+T%C>9999 THEN 2540
2330 MOVE X0+8%D1,-20%D2
2340 LABEL "LIM:"
2350 IF S9 THEN 3060
2360 LDIR 90
2370 FOR J=0 TO O+D1+Z1 STEP Z1
     L1%L3
2380 MOVE J+4%D1,Y0
2390 GOSUB 2810
2400 LABEL V$[1,V]
2410 NEXT J
2420 LDIR 0
2430 FOR I=1 TO T
2440 MOVE O+(I-1)%C,F(I)
2450 DRAW O+I%C,F(I)
2460 NEXT I
2470 IDRAW 0,-F(T)
2480 FOR I=T-1 TO 1 STEP -1
2490 MOVE O+I%C,0
2500 DRAW O+I%C,MAX(F(I),F(I+1))
2510 NEXT I
2520 MOVE 0,0 @ DRAW 0,F(1)
2530 BEEP @ RETURN
2540 MOVE X0,Y0
2550 LABEL "CELL="&VAL$(C)&" OFF
     SET="&VAL$(O)
2560 GOTO 2420
2570 FOR I=0 TO O+T%C+D1 STEP MI
     N(C,T%C/20)
2580 N1=-((I-S5)/S6)^2/2
2590 N1=N1%(N1>=-150)-150%(N1<-1
     50)
2600 IF I=0 THEN 2630
2610 DRAW I,K%EXP(N1)
2620 GOTO 2640
2630 MOVE I,K%EXP(N1)
2640 NEXT I
2650 BEEP @ RETURN
2660 PRINT
2670 PRINT
2680 GRAPH
2690 COPY
2700 PRINT
2710 PRINT "CELL STATISTICS"
2720 PRINT
2730 PRINT "CELL#  LOWER  NUMBER
       %RELATIVE"
2740 PRINT "       LIMIT  OF OBS
     . FREQUENCY"
2750 PRINT
2760 FOR I=1 TO B1
2770 IF NOT F(I) THEN 2790
2780 PRINT USING  "3D,7D.2D,7D,8
     D.2D" ; I,O+(I-1)%C,F(I),10
     0%F(I)/N
2790 NEXT I
2800 RETURN
2810 V$=""
2820 X=J
2830 V$=VAL$(X)
2840 IF POS(V$,"E") THEN 2900
2850 G9=LGT(ABS(X+(X=0)))
2860 IF LEN(V$)>5 AND ABS(G9)>4-
     (SGN(X)=-1) THEN X=X+10^(G9
     -11) @ GOTO 2830
2870 IF LEN(V$)<5 THEN V=LEN(V$)
      @ RETURN
2880 V$[1,5]=VAL$(X) @ V=5
2890 RETURN
2900 E=POS(V$,"E")
2910 IF VAL(V$[E+1])>9 THEN 2930
2920 V$[2,3]=V$[3,4] @ V$[4,4]="
     E" @ V$[5,5]=V$[E+3] @ V=5
     @ RETURN
2930 V$[2,2]=V$[3,3] @ V$[3,3]="
     E" @ V$[4,5]=V$[E+2] @ V=5
     @ RETURN
2940 CLEAR
2950 DISP "LABEL ORIGIN:X,Y"
2960 INPUT X,Y
2970 IF X>=X0 AND X<=X0+249%D1 A
     ND Y>=Y0 AND Y<=Y0+181%D2 T
     HEN 2990
2980 DISP "INVALID POSITION" @ B
     EEP @ GOTO 2950
2990 DISP "ENTER LABEL"
3000 INPUT R$
3010 L=LEN(R$)
3020 IF L/32>(Z5-X)/(Z5-X0) THEN
      DISP "LABEL TOO LONG" @ BE
     EP @ GOTO 2990
3030 MOVE X,Y @ LABEL R$
3040 RETURN
3050 END
3060 LDIR 0 @ L9=-INF
3070 FOR J=0 TO O+D1+Z1 STEP Z1/
     L1
3080 GOSUB 2810
3090 IF L9>J-(V%4+6)%D1 OR L9>Z5
     -(6+V%8)%D1 THEN PRINT USIN
     G 3100 ; J @ GOTO 3150
3100 IMAGE "LABEL DELETED AT",7D
     .4D
3110 MOVE J+(2-V%4)%D1,-12%D2
3120 L9=J+(V%4+2)%D1
3130 IF L9>Z5 THEN MOVE Z5+(2-V%
     8)%D1,-12%D2
3140 LABEL V$[1,V]
3150 NEXT J
3160 GOTO 2420
```

Enter CELL WIDTH

Sort values into cells

Compute SCALE parameters

Draw axes

Label Y-axis

Label X-axis

Draw Histogram

Label X-axis when values are too large

Draw Normal curve

Copy subroutine

Copy

Print cell statistics

Label string routine

Enter label origin

Label plot at X, Y

X-axis label routine

Arithmetic Teacher

Pseudorandom Numbers

"Arithmetic Teacher" uses the random number generator in the machine to generate a sequence of numbers between zero and one. These numbers are then used to generate the problems displayed by the program.

The term "Pseudorandom" implies that the sequence of numbers is predictable from the algorithm and the initial value or seed used for the generator. A truly random device, such as a fair roulette wheel, is totally unpredictable. However, pseudorandom generators can be used to model random events provided they yield uniformly distributed numbers (i.e., as many values fall between 0.00 and 0.10 as fall between 0.10 and 0.20 etc.) and they do not repeat the same sequence of values during the simulation.

Line 3430 demonstrates how to convert the random numbers from zero to one to the range of integers used in the "Arithmetic Teacher."

```
3430 DEF FNR(X) = INT(M*RND+1)
```

Variable Definitions

A$ - Variable name
A1$ - Answer string
B$ - Variable names—"ABCJKUWXYZ"
S$ - Operator string
T$ - Temporary string
U$ - Operator string
V$ - Operator string
Z$ - Name of user
A - Value of answer
A1 - Problem constant
A2 - Problem constant
A3 - Problem constant
A4 - Problem constant
A5 - Problem constant
A6 - Answer to algebra problem
C - Lesson length
C7 - One more message flag
C8 - Halfway through message flag
D - Number of problems tried
F1 - Try flag

I – Loop counter
I9 – String pointer
M – Maximum factor
N1 – Problem constant
N2 – Problem constant
N3 – Problem constant
N4 – Problem constant
N5 – Problem constant for checking problem duplication
N6 – Answer to arithmetic problems
N9 – Temporary storage
O – Algebra type
S – Seed for random number generator
T – Mixed problem type
X – Count of problems answered correctly on first try
Y – Count of problems answered correctly on second try
Z – Count of problems missed on both tries

```
 10 DIM Z$[32],T$[5],A$[1],B$[1A
    ],S$[1],U$[1],V$[1],A1$[32]
 20 D,X,Y,Z=0 @ C=10
 40 M=9 @ F$="2D" @ CLEAR
 50 DISP "WHAT IS YOUR NAME";
 60 INPUT Z$
 70 S=.61422533 @ N5=INF
 80 ON KEY# 1,"+" GOTO 1710
 90 ON KEY# 2,"-" GOTO 2040
100 ON KEY# 3,"*" GOTO 2370
110 ON KEY# 4,"/" GOTO 2680
120 ON KEY# 5,"HELP" GOSUB 190
130 ON KEY# 6,"START" GOTO 1500
140 ON KEY# 7,"MIXED" GOTO 2980
150 ON KEY# 8,"ALGEBRA" GOTO 320
160 KEY LABEL
170 DISP "SELECT OPTION"
180 GOTO 130
185 DISP "                PROBLEM ";D
    @ RETURN
190 CLEAR @ KEY LABEL @ DISP " A
    RITHMETIC TEACHER INSTRUCTIO
    NS"
200 DISP "K1:SELECT ADDITION PRO
    BLEMS     K2:SELECT SUBTRACT
    ION PROBLEMS"
220 DISP "K3:SELECT MULTIPLICATI
    ON PROBLEMK4:SELECT DIVISION
     PROBLEMS"
240 DISP "K5:HELP"
250 DISP "K6:SPECIFY MAX. NO. A"
260 DISP "    SEED-THIS STEP OVER
    RIDES THE    DEFAULT CONDITI
    ONS."
280 DISP "K7:SELECT MIXED PROBLE
    M LESSON      OF +,-,*,AND /"
300 DISP "K8:SELECT ALGEBRA PROB
    LEMS"
310 RETURN
320 GOSUB 3470
330 CLEAR @ DISP "THIS IS A COMP
    UTER-ASSISTED     DRILL IN B
    ASIC ALGEBRA.A SESSION"
350 DISP "LASTS UNTIL YOU GET 10
     CORRECT  ANSWERS.  ALL ANSWE
    RS ARE"
370 DISP "POSITIVE OR NEGATIVE I
    NTEGERS."
380 B$="ABCJKUWXYZ"
390 D,X,Y,Z,C7,C8=0
400 C=10
410 DISP "ALGEBRA PROBLEMS"
420 DISP "TYPE:"
430 DISP "1:3X=15"
440 DISP "2:3X+5=20"
450 DISP "3:2(X+4)=12"
460 DISP "4:2(X-3)+4(X-7)=-10"
470 DISP
480 DISP "WHICH DO YOU WANT"
490 INPUT O
500 IF O<1 OR O>4 THEN 420
510 PRINT "ALGEBRA PROBLEMS:TYPE
    ";O
520 GOSUB 3550
530 ON O GOTO 540,620,700,780
540 IF X+Y#C THEN GOSUB 870 ELSE
     1310
550 DISP A1;A$&"=";A1*A2
560 GOSUB 1510 @ A6=A2
570 IF A=A2 THEN 1260
580 GOSUB 3450
590 GOSUB 1510
600 IF A=A2 THEN 1280
610 GOTO 1210
620 IF X+Y#C THEN GOSUB 870 ELSE
     1310
630 DISP A1;A$&S$;ABS(A2);"=";A1
    *A3+A2
640 GOSUB 1510 @ A6=A3
650 IF A3=A THEN 1260
660 GOSUB 3450
670 GOSUB 1510
680 IF A3=A THEN 1280
690 GOTO 1210
700 IF X+Y#C THEN GOSUB 870 ELSE
     1310
710 DISP A1;"(";A$&S$;ABS(A2);")
    =";A1*(A2+A3)
720 GOSUB 1510 @ A6=A3
730 IF A3=A THEN 1260
740 GOSUB 3450
750 GOSUB 1510
760 IF A3=A THEN 1280
770 GOTO 1210
780 IF X+Y#C THEN GOSUB 870 ELSE
     1310
790 DISP A1;"(";A$&S$;ABS(A2);")
    "&U$;ABS(A4);"(";A$&V$;ABS(A
    3);")=";
800 DISP (A1+A4)*A5+A1*A2+A4*A3
810 GOSUB 1510 @ A6=A5
820 IF A=A5 THEN 1260
830 GOSUB 3450
840 GOSUB 1510
850 IF A=A5 THEN 1280
860 GOTO 1210
870 A1=FNR(0) @ A2=FNR(0) @ A3=F
    NR(0) @ A4=FNR(0) @ A5=FNR(0
    )
920 I9=INT(10*RND+1)
930 A$=B$[I9,I9]
940 S$="+" @ V$="+" @ U$="+"
970 IF RND<.5 THEN A2=-A2 @ S$="
    -"
1000 IF RND<.5 THEN A3=-A3 @ V$=
    "-"
1030 IF RND<.5 AND A4#A1 THEN A4
    =-A4 @ U$="-"
1060 IF RND<.5 THEN A5=-A5
1080 IF X+Y=C/2 OR X+Y=.5*C/2 TH
    EN 1110
1090 IF X+Y=C-1 AND C7=0 THEN 11
    50
1100 GOTO 1170
1110 IF C8=1 THEN 1170
1120 DISP "YOU'RE HALF WAY THROU
    GH NOW."
1130 C8=1
1140 GOTO 1170
1150 DISP "YOU ONLY NEED ONE MOR
    E CORRECT."
1160 C7=1
1170 D=D+1
1180 DISP USING 1190
1190 IMAGE 32("-")
1200 RETURN
1210 GOSUB 3460
1220 DISP "RIGHT ANSWER FOR "&A$
    &" IS ";A6
1230 DISP "TRY ANOTHER PROBLEM."
1240 Z=Z+1
1250 ON O GOTO 540,620,700,780
1260 GOSUB 3440 @ X=X+1
1270 ON O GOTO 540,620,700,780
1280 Y=Y+1
1290 GOSUB 3440
1300 ON O GOTO 540,620,700,780
1310 PRINT
1320 PRINT Z$
1330 IF D=C AND Y=0 THEN 1350
1340 GOTO 1410
1350 PRINT "YOU GOT ALL YOUR PRO
    BLEMS RIGHT"
1360 PRINT "ON THE 1ST TRY. CONG
    RATULATIONS!"
1370 FOR I=60 TO 40 STEP -1
1380 BEEP I,RND#10
1390 NEXT I
1400 GOTO 1580
1410 PRINT "YOU TRIED ";D;" PROB
    LEMS."
1420 IF X=0 THEN 1460
1430 N9=X
1440 GOSUB 1550
1450 PRINT X;T$&" RIGHT ON THE 1
    ST TRY."
1460 IF Y=0 THEN 1500
1470 N9=Y
1480 GOSUB 1550
1490 PRINT Y;T$&" CORRECT ON THE
     2ND TRY."
1500 GOTO 1580
1510 DISP A$&"=";
1520 INPUT A1$
1530 A=VAL(A1$)
1540 RETURN
1550 T$=" WERE"
1560 IF N9=1 THEN T$=" WAS"
1570 RETURN
1580 D,X,Y,Z=0 @ PRINT
1590 PRINT USING "4/" @ CLEAR @
     GOTO 80
1600 GOSUB 3470 @ CLEAR
1610 DISP "ENTER MAXIMUM NUMBER"
1620 INPUT M
1630 IF M>1 THEN 1655
1640 DISP "MAXIMUM MUST BE POSIT
    IVE"
1650 GOTO 1610
1655 F$=VAL$(INT(LGT(M))+2)&"D"
1660 DISP "ENTER OPTIONAL SEED:0
    =NONE"
1670 INPUT S
1680 IF S=0 THEN 1520
1690 RANDOMIZE FP(S*.612542331)
1700 GOTO 1580
1710 GOSUB 3470
1720 CLEAR
1730 PRINT "ADDITION PROBLEMS" @
     GOSUB 3550
1740 F1=0
1750 D=D+1
1760 N1=FNN(1)
1770 N2=FNN(1)
1780 N3=N1+N2
1790 N4=N1+N2/(N3+1*(N3=0))
1800 IF N4=N5 THEN 1760
1810 N5=N4
1820 DISP USING 1190 @ GOSUB 185
1830 DISP USING "6X,"&F$ ; N1
1840 DISP USING "K,"&F$ ; "
    +";N2
```

Initialization

Wait loop until key pressed

HELP subroutine

ALGEBRA routine

Select type

Branch based on type

1

2

3

4

Construct problem

Test for progress

Wrong 2 times

Results

Fanfare for all right

Results when some were wrong on 1st try

Entry routine

Try to block expression entry

START routine

Enter maximum number

Optional seed entry

ADD

```
1850 DISP "                    "
1860 DISP "ANSWER"
1870 INPUT A1$
1880 N6=VAL(A1$)
1890 IF N3<>N6 THEN 1950
1900 IF F1=0 THEN X=X+1
1910 IF F1=1 THEN Y=Y+1
1920 GOSUB 3440
1930 IF X+Y<>C THEN 1740
1940 GOTO 1310
1950 F1=F1+1
1960 ON F1 GOTO 1970,1990
1970 GOSUB 3450
1980 GOTO 1830
1990 GOSUB 3460
2000 DISP " RIGHT ANSWER IS ";N3
2010 DISP "TRY ANOTHER PROBLEM "
2020 Z=Z+1
2030 GOTO 1740
2040 GOSUB 3470
2050 CLEAR
2060 PRINT "SUBTRACTION PROBLEMS
     " @ GOSUB 3550
2070 F1=0
2080 D=D+1
2090 N1=FNN(1)
2100 N2=FNN(1)
2105 IF N2>N1 THEN N3=N1 @ N1=N2
      @ N2=N3
2110 N3=N1-N2
2120 N4=N1+N2/(N3+1*(N3=0))
2130 IF N4=N5 THEN 2090
2140 N5=N4
2150 DISP USING 1190 @ GOSUB 185
2160 DISP USING "6X,"&F$ ; N1
2170 DISP USING "K,"&F$ ; "
     -";N2
2180 DISP "                    "
2190 DISP "ANSWER"
2200 INPUT A1$
2210 N6=VAL(A1$)
2220 IF N3<>N6 THEN 2280
2230 IF F1=0 THEN X=X+1
2240 IF F1=1 THEN Y=Y+1
2250 GOSUB 3440
2260 IF X+Y<>C THEN 2070
2270 GOTO 1310
2280 F1=F1+1
2290 ON F1 GOTO 2300,2320
2300 GOSUB 3450
2310 GOTO 2150
2320 GOSUB 3460
2330 DISP "RIGHT ANSWER IS ";N3
2340 DISP "TRY ANOTHER PROBLEM "
2350 Z=Z+1
2360 GOTO 2070
2370 GOSUB 3470
2380 CLEAR
2390 PRINT "MULTIPLICATION PROBL
     EMS" @ GOSUB 3550
2400 F1=0
2410 D=D+1
2420 N1=FNN(1)
2430 N2=FNN(1)
2440 N3=N1*N2
2450 N4=N1+N2/(N3+1*(N3=0))
2460 IF N4=N5 THEN 2420
2470 N5=N4
2480 DISP USING 1190 @ GOSUB 185
2490 DISP N1;" * ";N2
2500 DISP "ANSWER"
2510 INPUT A1$
2520 N6=VAL(A1$)
2530 IF N3<>N6 THEN 2590
2540 IF F1=0 THEN X=X+1
2550 IF F1=1 THEN Y=Y+1
2560 GOSUB 3440
2570 IF X+Y<>C THEN 2400
2580 GOTO 1310
2590 F1=F1+1
2600 ON F1 GOTO 2610,2630
2610 GOSUB 3450
2620 GOTO 2500
2630 GOSUB 3460
2640 DISP "RIGHT ANSWER IS ";N3
2650 DISP "TRY ANOTHER PROBLEM"
2660 Z=Z+1
2670 GOTO 2400
2680 GOSUB 3470
2690 CLEAR
2700 PRINT "DIVISION PROBLEMS" @
      GOSUB 3550
2710 F1=0
2720 D=D+1
2730 N2=FNN(1)
2740 N3=FNN(1)
2750 N1=N2*N3
2760 N4=N1+N2/(N3+1*(N3=0))
2770 IF N4=N5 OR N2=0 THEN 2720
2780 N5=N4
2790 DISP USING 1190 @ GOSUB 185
2800 DISP N1;" / ";N2
2810 DISP "ANSWER"
2820 INPUT A1$
2830 N6=VAL(A1$)
2840 IF N3<>N6 THEN 2900
```

SUBTRACT

MULTIPLY

DIVIDE

```
2850 IF F1=0 THEN X=X+1
2860 IF F1=1 THEN Y=Y+1
2870 GOSUB 3440
2880 IF X+Y<>C THEN 2710
2890 GOTO 1310
2900 F1=F1+1
2910 ON F1 GOTO 2920,2940
2920 GOSUB 3450
2930 GOTO 2790
2940 GOSUB 3460
2950 DISP "TRY ANOTHER PROBLEM "
2960 Z=Z+1
2970 GOTO 2710
2980 GOSUB 3470
2990 CLEAR @ PRINT "MIXED TYPE P
     ROBLEMS"
3000 F1=0
3010 D=D+1
3020 T=INT(RND*4)+1
3030 N1,N3=FNN(1)
3040 N2=FNN(1)
3050 ON T GOTO 3060,3080,3100,31
     20
3060 N3=N1+N2
3070 GOTO 3150
3080 IF N2>N1 THEN N3=N1 @ N1=N2
      @ N2=N3
3090 N3=N1-N2 @ GOTO 3150
3100 N3=N1*N2
3110 GOTO 3150
3120 N1=N2*N3
3130 N4=N1+N2/(N3+1*(N3=0))
3140 IF N4=N5 OR T=4 AND N2=0 TH
     EN 3020
3150 DISP USING 1190 @ DISP "PRO
     BLEM ";D
3160 ON T GOTO 3170,3190,3210,32
     30
3170 DISP N1;" + ";N2
3180 GOTO 3240
3190 DISP N1;" - ";N2
3200 GOTO 3240
3210 DISP N1;" * ";N2
3220 GOTO 3240
3230 DISP N1;" / ";N2
3240 DISP "ANSWER"
3250 INPUT A1$
3260 N6=VAL(A1$)
3270 IF N3<>N6 THEN 3330
3280 IF F1=0 THEN X=X+1
3290 IF F1=1 THEN Y=Y+1
3300 GOSUB 3440
3310 IF X+Y<>C THEN 3000
3320 GOTO 1310
3330 F1=F1+1
3340 ON F1 GOTO 3350,3370
3350 GOSUB 3450
3360 GOTO 3150
3370 GOSUB 3460
3380 DISP "RIGHT ANSWER IS ";N3
3390 DISP "TRY ANOTHER PROBLEM"
3400 Z=Z+1
3410 GOTO 3000
3420 DEF FNN(X) = INT((M+1)*RND)
3430 DEF FNR(X) = INT(M*RND+1)
3440 DISP "CORRECT ANSWER" @ BEE
     P 45,25 @ BEEP 25,35 @ RETU
     RN
3450 DISP "YOUR ANSWER IS WRONG
      TRY AGAIN" @ BEEP 150,25 @
      RETURN
3460 DISP "YOUR ANSWER IS STILL
     WRONG." @ BEEP 300,20 @ RET
     URN
3470 OFF KEY# 1
3480 OFF KEY# 2
3490 OFF KEY# 3
3500 OFF KEY# 4
3510 OFF KEY# 6
3520 OFF KEY# 7
3530 OFF KEY# 8
3540 RETURN
3550 PRINT "MAXIMUM FACTOR = ";M
      @ RETURN
```

MIXED

Randomize type

Branch on type

\+

\-

*

/

Display problem

\+

\-

*

/

Answer entry

Functions to generate values for problems

Subroutines to display messages after checking answer

Turn off keys during lesson

Print maximum factor at start of lesson

Calendar Functions

Multiple Storage in Variables

In "Calendar Functions" the dates are input in mm.ddyyyy format. This allows three pieces of information (the day, the month, and the year) to be carried in one variable. In "Calendar Functions", this provides a convenient means of entering and displaying the date.

When multiple storage techniques are used, two types of code are usually required. The first type breaks a combined number into its individual components. The second type assembles the individual components into a single number.

Lines 400 through 540 of "Calendar Functions" break the date into its individual components. The individual components are also checked for validity, though not exhaustively, since 2.311978 would be accepted.

```
400 M=INT(T)
410 IF M<1 OR M>12 THEN 550
420 T=T-M
430 D=INT(100*T)
440 T=100*T-D
450 Y=INT(10000*T)
460 S=Y+M/100+D/10000
470 IF S<1582.1015 OR S>4046.112
    5 THEN 550
480 IF D<1 OR D>31 THEN 550
490 IF M>2 THEN 520
500 M=M+12
510 Y=Y-1
520 M=M+1
530 J=INT(365.25*Y)-INT(Y/100)+I
    NT(Y/400)+INT(30.600*M)+D-4
    78164
540 RETURN
```

Line 970 of "Calendar Functions" assembles the three values into one number for display.

```
970 T=M1+D/100+Y1/1000000
```

Variable Definitions

A$ - Heading
B$ - Year
D$ - Days
C - Century

D – Day
D1 – Day of 1st date
D2 – Day of 2nd date
D3 – Δ days
E1 – Temporary storage for day
F1 – Temporary storage for month
G1 – Temporary storage for year
I – Loop counter
J – Julian date
J1 – Julian date of 1st date
J2 – Julian date of 2nd date
K – Temporary storage
L – Temporary storage
L1 – Label position
M – Month
M1 – Month of 1st date
M2 – Month of 2nd date
Q – Temporary storage
R – Temporary storage
S – YYYY.MMDD form of date
T – Date
R1 – First date
T2 – Second date
T9 – Temporary storage
W – Day of week
W1 – Number of weekdays of first date
W2 – Number of weekdays of second date
X – Function parameter
Y – Year
Y1 – Year of 1st date
Y2 – Year of 2nd date

```
10 DIM A$[32],B$[10],D$[21]
20 D$="SUNMONTUEWEDTHUFRISAT"
30 J,T1=INF
40 ON KEY# 1,"D1/D2→" GOSUB 270
50 ON KEY# 2,"ΔDAYS" GOSUB 580
60 ON KEY# 3,"DT→DAYS" GOSUB 770
70 ON KEY# 4,"DOW/DOY" GOSUB 1030
80 ON KEY# 5,"HELP" GOSUB 140
90 ON KEY# 6,"ΔW.DAYS" GOSUB 640
100 ON KEY# 8,"PRT-CAL" GOSUB 1280
110 CLEAR @ KEY LABEL
120 DISP "SELECT OPTION"
130 GOTO 130
140 CLEAR @ KEY LABEL @ DISP "
    CALENDAR FUNCTIONS"
150 DISP "K1:NO DATE ENTRY FOR
#DAYS/WEEK"
160 DISP "   DAYS BETWEEN DATES(
K2 AND K3)"
170 DISP "K2:NUMBER OF DAYS BETW
EEN D1,D2"
180 DISP "K3:COMPUTE DATE N-DAYS
 BEFORE OR"
190 DISP "   AFTER ENTERED DATE.
 N"
200 DISP "K4:COMPUTE DAY-OF-WEEK
 AND DAY-"
210 DISP "   OF-YEAR OF ENTERED
DATE."
220 DISP "K5:HELP"
230 DISP "K6:NUMBER OF WEEKDAYS
BETWEEN"
240 DISP "   D1 AND D2."
250 DISP "K8:GENERATE CALENDAR F
OR MO.&YR."
260 RETURN
270 GOSUB 2450 @ DISP "ENTER FIR
ST DATE:MM.DDYYYY";
280 INPUT T
290 T1=T
300 GOSUB 400
310 IF J=0 THEN 270
320 J1=J @ M1=M @ D1=D @ Y1=Y
330 DISP "ENTER SECOND DATE:MM.D
DYYYY";
340 INPUT T
350 T2=T
360 GOSUB 400
370 IF J=0 THEN 330
380 J2=J @ M2=M @ D2=D @ Y2=Y
390 DISP "DATES ENTERED" @ RETUR
N
400 M=INT(T)
410 IF M<1 OR M>12 THEN 550
420 T=T-M
430 D=INT(100*T)
440 T=100*T-D
450 Y=INT(10000*T)
460 S=Y+M/100+D/10000
470 IF S<1582.1015 OR S>4046.112
5 THEN 550
480 IF D<1 OR D>31 THEN 550
490 IF M>2 THEN 520
500 M=M+12
510 Y=Y-1
520 M=M+1
530 J=INT(365.25*Y)-INT(Y/100)+I
NT(Y/400)+INT(30.6001*M)+D-4
78164
540 RETURN
550 DISP "INVALID DATE"
560 J=0
570 RETURN
580 IF T1=INF THEN CLEAR @ DISP
"NO DATES ENTERED" @ BEEP @
RETURN
590 CLEAR @ KEY LABEL @ DISP "NU
MBER OF DAYS BETWEEN"
600 DISP USING 610 ; T1,T2
610 IMAGE DD.DDDDDD," AND ",DD.D
DDDDD," IS"
620 DISP J2-J1;" DAYS"
630 RETURN
640 IF T1=INF THEN CLEAR @ DISP
"NO DATES ENTERED" @ BEEP @
RETURN
650 CLEAR @ KEY LABEL @ DISP "NU
MBER OF WEEKDAYS BETWEEN"
660 DISP USING 610 ; T1,T2
670 G1=Y1-1*(M1<3)
680 F1=M1+1+12*(M1<3)
690 E1=D1-INT( 75*(INT(G1/100)-7
))+INT(365.25*G1)+INT(30.6*F
1)
700 W1=5*INT(E1/7)+.5*INT(1 801*
(E1 MOD 7))
710 G1=Y2-1*(M2<3)
720 F1=M2+1+12*(M2<3)
730 E1=D2-INT(.75*(INT(G1/100)-7
))+INT(365.25*G1)+INT(30.6*F
1)
740 W2=5*INT(E1/7)+.5*INT(1 801*
(E1 MOD 7))
750 DISP VAL$(W2-W1)&" DAYS."
760 RETURN
770 GOSUB 2450 @ DISP "ENTER DAT
E:MM.DDYYYY";
780 INPUT T
790 GOSUB 400
800 IF J=0 THEN 770
810 DISP "ENTER DAYS BETWEEN DAT
ES"
820 DISP "'-' IMPLIES BEFORE";
830 INPUT D3
840 D3=IP(D3)
850 J2=J+D3+478164
860 IF 1A000>J2 OR J2>999999 THE
N 1010
870 Y1=INT((J2-121.5)/365.2425)
880 M1=INT((J2-INT(Y1*365.25)+IN
T(Y1/100)-INT(Y1/400))/30.60
01)
890 D=J2-INT(Y1*365.25)+INT(Y1/1
00)-INT(Y1/400)-INT(30.6001*
M1)
900 IF M1/7>1 THEN 930
910 Y1=Y1-1
920 GOTO 880
930 IF M1<14 THEN 960
940 M1=M1-12
950 Y1=Y1+1
960 M1=M1-1
970 T=M1+D/100+Y1/1000000
980 DISP USING 990 ; T
990 IMAGE "RESULTING DATE IS ",D
    D DDDDDD
1000 RETURN
1010 DISP "DATE IS OUT OF RANGE"
1020 GOTO 810
1030 GOSUB 2450 @ DISP "ENTER DA
TE:MM.DDYYYY";
1040 INPUT T
1050 T9=T
1060 GOSUB 400
1070 IF J=0 THEN 1030
1080 J1=J
1090 W=J-7*INT(J/7)
1100 ON W+1 GOTO 1110,1130,1150,
1170,1190,1210,1230
1110 DISP "SUNDAY"
1120 GOTO 1240
1130 DISP "MONDAY"
1140 GOTO 1240
1150 DISP "TUESDAY"
1160 GOTO 1240
1170 DISP "WEDNESDAY"
1180 GOTO 1240
1190 DISP "THURSDAY"
1200 GOTO 1240
1210 DISP "FRIDAY"
1220 GOTO 1240
1230 DISP "SATURDAY"
1240 T=1.01+FP(T9*100)/100
1250 GOSUB 400
1260 DISP "AND DAY NO. ";J1-J+1;
" OF THE YEAR"
1270 RETURN
1280 CLEAR @ KEY LABEL
1290 DISP "MONTH,YEAR=";
1300 INPUT M,Y
1310 M=INT(ABS(M))
1320 Y=INT(ABS(Y))
1330 C=INT(Y/100)
1340 C=C+19*(C=0)
1350 Y=Y-100*C*(Y>99)
1360 B$=VAL$(100*C+Y)
1370 IF 100*C+Y>1752 THEN 1420
1380 DISP "GRECORIAN CALENDAR BE
GINS, 1753"
1390 GOTO 1290
1400 DEF FNL(X) = X=4*INT(X/4) A
ND X*100#INT(X/100) OR X=40
0*INT(X/400)
1410 DEF FNT(X) = 31*(X-1)-INT(2
.2+.4*X)*(X>2)
1420 IF M>0 AND M<13 THEN 1450
1430 DISP "WHAT MONTH IS ";M;" T
RY AGAIN"
1440 GOTO 1290
1450 DISP "ENTER HEADING";
1460 INPUT A$
1470 L1=INT(44-11*LEN(A$)/8)
1480 W=FNT(M)+36-28*M+Y+INT(Y/4)
-2*(C-A*INT(C/4))-FNL(100*C
+Y)*(M<3)
1490 W=W-7*INT(W/7)
1500 W=W+7*(W=0)
1510 L=FNT(M+1)-FNT(M)+FNL(100*C
+Y)*(M=2)
1520 R=5-(L=28)*(W=1)
1530 PEN 1 @ LDIR 0 @ GCLEAR
1540 SCALE -4,251,-54,14
1550 J=-1
1560 K=250
1570 FOR I=0 TO -10*R STEP -10
1580 MOVE J,I
1590 DRAW K,I
1600 NEXT I
1610 J=-10*R
1620 K=0
1630 FOR I=-2 TO 250 STEP 36
1640 MOVE I,J
```

Initialization

Wait loop until key pressed
HELP subroutine

Two date entry

Date verification and
conversion routine

Compute Julian date

Display number of days
between dates

Display number of weekdays
between dates
Compute weekdays

Enter base date

Enter Δ days

Compute date

Format date

Display resulting date

Enter base date

Compute day of week

Branch to output day of week

Compute day of year

Display day of year

Enter month and year for
calendar

Verify year

Century function

Month function

Verify month

Enter heading

Compute centering coordinate

Compute number of weeks in
month

SCALE and draw grid

```
1650 DRAW I,K
1660 NEXT I
1670 SCALE 0,88,0,60
1680 MOVE L1,64
1690 LABEL A$
1700 FOR I=1 TO M
1710 READ K
1720 NEXT I
1730 RESTORE
1740 K=K+6
1750 L1=44-(K/2-.2)*4.5333
1760 MOVE L1,60
1770 ON M GOSUB 1790,1810,1830,1
     850,1870,1890,1910,1930,195
     0,1970,1990,2010
1780 GOTO 2040
1790 LABEL "JANUARY "&B$
1800 RETURN
1810 LABEL "FEBRUARY "&B$
1820 RETURN
1830 LABEL "MARCH "&B$
1840 RETURN
1850 LABEL "APRIL "&B$
1860 RETURN
1870 LABEL "MAY "&B$
1880 RETURN
1890 LABEL "JUNE "&B$
1900 RETURN
1910 LABEL "JULY "&B$
1920 RETURN
1930 LABEL "AUGUST "&B$
1940 RETURN
1950 LABEL "SEPTEMBER "&B$
1960 RETURN
1970 LABEL "OCTOBER "&B$
1980 RETURN
1990 LABEL "NOVEMBER "&B$
2000 RETURN
2010 LABEL "DECEMBER "&B$
2020 RETURN
2030 DATA 7,8,5,5,3,4,4.6,9,7.8,
     8
2040 SCALE -4,251,-4,64
2050 FOR J=6 TO 222 STEP 36
2060 J=(I-6)/36*3+1 @ MOVE I,50.
     5 @ LABEL D$[J,J+2]
2070 NEXT I
2080 D,P=1
2090 S=(L>29)*(W=7)+(L>30)*(W>5)
     *2
2100 L=L-(S>0)-(S>2)
2110 IF S=0 OR R<5 THEN 2140
2120 Q=D*S*S
2130 IF Q=23 OR Q=96 OR Q=207 OR
      Q=216 THEN 2160
2140 MOVE 36*(W-1),10*(6-R)-3.25
2150 LABEL VAL$(D)
2160 D=D+1
2170 IF D>L THEN 2210
2180 W=W*(W<7)+1
2190 R=R+(W=1)
2200 GOTO 2110
2210 D=23
2220 I=0
2230 ON S+1 GOTO 2240,2260,2290,
     2320
2240 PRINT USING  "4/" @ COPY
2250 RETURN
2260 MOVE 0,0
2270 GOSUB 2390
2280 GOTO 2240
2290 MOVE 0,0
2300 GOSUB 2380
2310 GOTO 2240
2320 MOVE 0,0
2330 GOSUB 2390
2340 MOVE 36,0
2350 GOSUB 2370
2360 GOTO 2240
2370 I=36
2380 D=D+1
2390 DRAW I+36,10
2400 MOVE I,10*(6-R)-3.25
2410 LABEL VAL$(D)
2420 MOVE I+20,10*(5-R)+1
2430 LABEL VAL$(D+7)
2440 RETURN
2450 IF J THEN CLEAR @ KEY LABEL
2460 RETURN
```

SCALE for labelling

Label dates

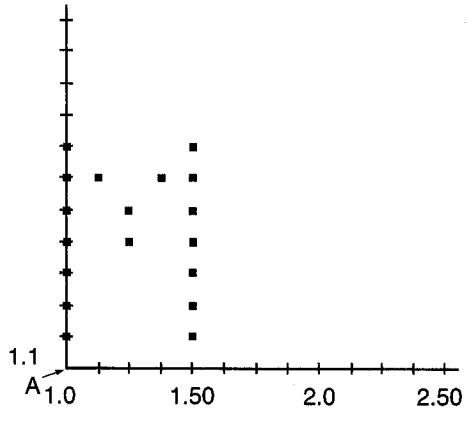
End of month routine for shared squares

Biorhythms

Label Positioning

Included in the graphics capability of your machine is the ability to label plots using the LABEL statement. The size of the characters is the same as the character size in alpha mode, but the positioning of these characters is much more flexible. Labels can be printed either horizontally or vertically by specifying the direction using the LDIR statement. The starting position is based on the last plotted point.

Lines 1680 to 1690 of the "Biorhythms" program shown below demonstrates horizontal labelling. The starting location is specified as (1,1.1) which is point A in figure 1.




```
1680 MOVE 1,1.1
1690 LABEL USING "#,A",VAL$(F2)
```

Lines 1720 to 1790 are used to label the X-axis with vertical labels. The scale used in this program was selected based on the resolution of labels in graphics. Vertical labels can start at every dot in the horizontal direction after allowing for the character height. If the horizontal scale was 0 to 255, vertical labels could start from 8 through 255. Since the scale used in the "Biorhythms" program is 0 to 31.875, the labels must start at 1 through 31.875 in units of .125. If the last plotted point does not map directly into one of these points, the labels may be one dot to the left or right of the expected location since the resolution of graphics is limited to the number of dots on the screen.

```
1720 MOVE 13,-1.15
1730 LABEL "DAYS"
1740 LDIR 90 @ MOVE 5.5,-.11
1750 LABEL "5"
1760 FOR I=10 TO 5 STEP 5
1770 MOVE I+.5,-.24
1780 LABEL VAL$(I)
1790 NEXT I
```

These examples should help you to see how labels are positioned in graphics. In most instances, the rounding of the coordinates used for positioning labels will not be of concern, but when this is not the case, the techniques used in the "Biorhythms" programs should be helpful.

Variable Definitions

N$ – Name
M$ – Month string
O$ – Month
C – Critical day period
D – Day
E1 – Month temporary
E2 – Year temporary
F1 – Month temporary
F2 – Year temporary
I – Loop counter
J – Julian date
J1 – Julian date temporary
J2 – Julian date temporary
J3 – Temporary storage
J4 – Temporary storage
L – Temporary storage
M – Month
M1 – Month temporary
O – String pointer
P1 – Temporary storage
P2 – Temporary storage
S – Temporary storage
T – Date
T1 – Date temporary
T2 – Date temporary
Y – Year
Y1 – Year temporary

```
 10 DIM N$[32],M$[120],D$[10]
 20 DEG @ PRINTER IS 2
 30 M$[1,30]="JANUARY***FEBRUARY
    **MARCH*****"
 40 M$[31,60]="APRIL*****MAY****
    ***JUNE******"
 50 M$[61,90]="JULY******AUGUST*
    ***SEPTEMBER*"
 60 M$[91,120]="OCTOBER***NOVEMB
    ER**DECEMBER**"
 70 ON KEY# 1,"ENTER" GOSUB 270
 80 ON KEY# 2,"CRIT.DY" GOSUB 55
    0
 90 ON KEY# 4,"PLOT" GOSUB 1440
100 ON KEY# 3,"HELP" GOSUB 150
110 ON KEY# 6,"EXPLAIN" GOSUB 11
    20
120 CLEAR @ KEY LABEL
130 DISP "SELECT OPTION"
140 GOTO 140
150 CLEAR @ KEY LABEL @ DISP "
              BIORHYTHMS"
160 DISP "K1:ENTER BIRTHDATE AND
    NAME-THIS"
170 DISP "   MUST BE DONE FIRST.
    "
180 DISP "K2:ENTER DATE TO START
    CHECKING"
190 DISP "   FOR CRITICAL DAYS A
    ND OUTPUT"
200 DISP "   THE DATES FOR CRITI
    CAL DAYS."
210 DISP "K4:PLOT THE BIORHYTHMS
    FOR A MO."
220 DISP "   AT A TIME. USER CAN
    REPEAT"
230 DISP "   FOR THE NEXT MONTH
    OR STOP."
240 DISP "K5:HELP"
250 DISP "K6:EXPLANATION IS PRIN
    TED."
260 RETURN
270 CLEAR @ KEY LABEL @ DISP "EN
    TER YOUR NAME";
280 INPUT N$
290 DISP "WHAT IS YOUR BIRTHDAY:
    MM.DDYYYY";
300 INPUT T
310 T1=T
320 GOSUB 370
330 IF J=0 THEN 290
340 J1=J
350 DISP "BIO-DATE COMPUTED"
360 RETURN
370 M=INT(T)
380 IF M<1 OR M>12 THEN 520
390 T=T-M
400 D=INT(100*T)
410 T=100*T-D
420 Y=INT(10000*T)
430 S=Y+M/100+D/10000
440 IF S<1582.1015 OR S>4096.112
    5 THEN 520
450 IF D<1 OR D>31 THEN 520
460 IF M>2 THEN 490
470 M=M+12
480 Y=Y-1
490 M=M+1
500 J=INT(365.25*Y)-INT(Y/100)+1
    NT(Y/400)+INT(30.6001*M)+D-4
    78164
510 RETURN
520 DISP "INVALID DATE"
530 BEEP @ J=0
540 RETURN
550 CLEAR @ KEY LABEL
560 DISP "ENTER STARTING DATE:MM
    .DDYYYY";
570 INPUT T
580 T2=T
590 GOSUB 370
600 IF J=0 THEN 560
610 J2=J
620 IF J1<=J2 THEN 650
630 DISP "YOU CANNOT GO BACK",N$
640 GOTO 560
650 J3=J2-J1 @ J4=J2+33
660 GOTO 940
670 L=INT(J+478164)
680 IF 10000>L OR L>999999 THEN
    820
690 Y1=INT((L-121.5)/365.2425)
700 M1=INT((L-INT(Y1*365.25)+INT
    (Y1/100)-INT(Y1/400))/30.600
    1)
710 D=L-INT(Y1*365.25)+INT(Y1/10
    0)-INT(Y1/400)-INT(30.6001*M
    1)
720 IF M1<3>1 THEN 750
730 Y1=Y1-1
740 GOTO 700
750 IF M1<14 THEN 780
760 M1=M1-12
770 Y1=Y1+1
780 M1=M1-1
790 T=M1+D/100+Y1/1000000
800 RETURN
810 DISP "DATE IS OUT OF RANGE"
820 L=0
830 RETURN
840 C=11.5
850 GOSUB 1000
860 DISP "CRITICAL DAYS FOR "
870 DISP N$
880 DISP
890 DISP "PHYSICAL CRITICAL DAYS
    "
900 GOSUB 1020
910 C=14
920 GOSUB 1000
930 DISP "SENSITIVITY CRITICAL D
    AYS"
940 GOSUB 1020
950 C=16.5
960 GOSUB 1000
970 DISP "COGNITIVE CRITICAL DAY
    S"
980 GOSUB 1020
990 RETURN
1000 J=J3\C#C+J1
1010 RETURN
1020 IF J>=J2 THEN 1050
1030 J=J+C
1040 GOTO 1020
1050 IF J>J4 THEN 1100
1060 GOSUB 670
1070 IF L=0 THEN 1100
1080 DISP USING "2(DD,A),4D";
     M1,"/",D,"/",Y1
1090 GOTO 1030
1100 DISP
1110 RETURN
1120 PRINT "EXPLANATION:"
1130 PRINT "  THE BIORHYTHM THEO
     RY IS BASED"
1140 PRINT "ON THE ASSUMPTION TH
     AT THE HUMAN"
1150 PRINT "BODY HAS INNER CLOCK
     S OR"
1160 PRINT "METABOLIC RHYTHMS WI
     TH CONSTANT"
1170 PRINT "CYCLE TIMES. CURRENT
     LY, THREE"
1180 PRINT "CYCLES STARTING AT B
     IRTH IN A"
1190 PRINT "POSITIVE DIRECTION A
     RE CLAIMED"
1200 PRINT "TO EXIST. THE 23-DAY
      OR PHYSICAL"
1210 PRINT "CYCLE RELATES WITH P
     HYSICAL,"
1220 PRINT "VITALITY, ENDURANCE,
      AND ENERGY."
1230 PRINT "THE 28-DAY OR SENSIT
     IVITY CYCLE"
1240 PRINT "RELATES WITH SENSITI
     VITY,"
1250 PRINT "INTUITION, AND CHEER
     FULNESS. THE"
1260 PRINT "33-DAY OR COGNITIVE
     CYCLE"
1270 PRINT "RELATES WITH MENTAL
     ALERTNESS"
1280 PRINT "AND JUDGEMENT."
1290 PRINT
1300 PRINT "  FOR EACH CYCLE, A
     DAY IS"
1310 PRINT "CONSIDERED EITHER HI
     GH, LOW, OR"
1320 PRINT "CRITICAL.  THE HIGH (
     0<X<=1)"
1330 PRINT "TIMES ARE REGARDED A
     S ENERGETIC"
1340 PRINT "TIMES, YOU ARE YOUR
     MOST DYNAMIC"
1350 PRINT "DURING THIS. THE LOW
      (-1<=X<0)"
1360 PRINT "TIME ARE REGARDED AS
      THE"
1370 PRINT "RECUPERATIVE PERIODS
     . CRITICAL"
1380 PRINT "DAYS (X=0) ARE REGAR
     DED AS YOUR"
1390 PRINT "ACCIDENT PRONE DAYS,
     ESPECIALLY"
1400 PRINT "FOR THE PHYSICAL AND
     SENSITIVITY"
1410 PRINT "CYCLES "
1420 PRINT
1430 RETURN
1440 CLEAR @ KEY LABEL
1450 DISP "ENTER MONTH/YEAR:MM.Y
     YYY";
1460 INPUT T
1470 F1=INT(T)
1480 F2=INT((T-F1)*10000)
1490 T.T1.T2=F1+.01+F2/1000000
1500 GOSUB 370
1510 IF J=0 THEN 1450
1520 LET F1=F1+1-12*(F1=12)
1530 LET E2=F2+1*(F1=12)
1540 P1=J-J1
1550 T=C1+.01+E2/1000000
1560 GOSUB 370
1570 IF J=0 THEN 1450
1580 IF J>J1 THEN 1610
```

Initialization

Wait loop until key is pressed

HELP subroutine

Enter name

Enter birthdate

Compute Julian day number and verify date

Critical day subroutine

Enter starting date

Verify date

Convert Julian date to MM.DDYYYY form

Call routines for each cycle

Compute 1st critical date

Critical day incremental routine

Explanation subroutine

PLOT subroutine

Enter month.year

Verify

```
1590 DISP "SPECIFIED MONTH IS BE
     FORE BIRTHDAY"
1600 BEEP @ GOTO 1450
1610 P2=J-1-J1
1620 S=P2-P1+1
1630 GCLEAR @ SCALE .5,32 275 -1
     .2,1.562
1640 MOVE 1,1.28
1650 LABEL N$
1660 O=POS(M$[(P1-1)*10+1],"*")+
     (P1-1)*10-1
1670 O$=M$[(P1-1)*10+1,O]
1680 MOVE 1,1.1
1690 LABEL O$@ "&VAL$(P2)
1700 XAXIS 0,1,1,S+.99
1710 YAXIS 1,.2,-1,1
1720 MOVE 13,-1.15
1730 LABEL "DAYS"
1740 LDIR 90 @ MOVE 5.5,-.11
1750 LABEL "5"
1760 FOR I=10 TO S STEP 5
1770 MOVE I+.5,-.24
1780 LABEL VAL$(I)
1790 NEXT I
1900 LDIR 0 @ C=23
1810 O$="P"
1820 GOSUB 2100
1830 C=28
1840 O$="S"
1850 GOSUB 2100
1860 C=33
1870 O$="C"
1880 GOSUB 2100
1890 ALPHA
1900 DISP "COPY TO PRINTER:Y/N";
1910 INPUT O$[1,9]
1920 IF UPC$(O$[1,1])="N" THEN 1
     960
1930 IF UPC$(O$[1,1])#"Y" THEN B
     EEP @ GOTO 1900
1940 GRAPH
1950 COPY
1960 SCALE 0,255,0,191
1970 MOVE 1,0
1980 LABEL "PRESS CONT WHEN READ
     Y"
1990 PAUSE
2000 ALPHA
2010 DISP "NEXT MONTH:Y/N";
2020 INPUT O$[1,9]
2030 IF UPC$(O$[1,1])="N" THEN 2
     080
2040 IF UPC$(O$[1,1])#"Y" THEN 2
     010
2050 P2=P2+1*(P1=12)
2060 P1=P1+1-12*(P1=12)
2070 GOTO 1430
2080 GCLEAR 10 @ MOVE 0,1 @ LABE
     L "PRESS KEYLABEL WHEN READ
     Y" @ GRAPH
2090 RETURN
2100 MOVE 1,SIN(P1 MOD C/C*360)
2110 J=2
2120 FOR I=P1+J TO P2+1
2130 DRAW J,SIN(I MOD C/C*360)
2140 IF J<>C-21 AND J<>C-6 THEN
     2180
2150 MOVE J,SIN(I MOD C/C*360)
2160 LABEL O$
2170 MOVE J,SIN(I MOD C/C*360)
2180 J=J+1
2190 NEXT I
2200 RETURN
```

Scale plot

Label name

Label month

Label axis

Plot physical cycle

Plot sensitivity cycle

Plot cognitive cycle

Copy?

Copy

Label instructions?

Next month?

Increment month and plot it

Plot cycle subroutine

Label cycle

Timer

Variable Definitions

C(,) – Clock chime parameters
D(,) – Second marks
D1(,) – Hour marks
D2(,) – Hour marks
S( ) – Splits
V$ – Output string
C – Loop counter
D – Date
M – Minute
N – Chime index start
N1 – Chime index end
R – Time flag
R1 – Time set flag
S – Split counter
S1 – Split start time
S2 – Temporary storage
T0 – Temporary storage
T1 – Entered time
T8 – Prior time
T9 – Current time
X – Function parameter

```
  10 OPTION BASE 1
  20 DIM S(100),C(24,2),D(60,2),D
     1(12,2),D2(12,2)
  30 CLEAR @ DISP "PROGRAM BEING
     INITIALIZED" @ DEG
  40 FOR M=1 TO 60
  50 T=360*(1-M/60)
  60 D(M,1)=-4.5*SIN(T) @ D(M,2)=
     4.5*COS(T)
  70 IF M MOD 5 THEN 100
  80 D1(M/5,1)=-.3*SIN(T) @ D1(M/
     5,2)=.3*COS(T)
  90 X=.25*SGN(30-M) @ Y=.7 @ D2(
     M/5,1)=FNX(T) @ D2(M/5,2)=FN
     Y(T)
 100 NEXT M
 110 INTEGER T9
 120 S=1 @ R,R1,S1,T0=0 @ CLEAR
 130 C(1,1),C(5,1),C(8,1),C(10,1)
     ,C(16,1),C(19,1)=35
 140 C(1,2),C(5,2),C(10,2),C(19,2
     )=222
 150 C(2,1),C(7,1),C(9,1),C(15,1)
     ,C(17,1)=25
 160 C(2,2),C(7,2),C(9,2),C(15,2)
     ,C(17,2)=281
 170 C(3,1),C(6,1),C(11,1),C(14,1
     ),C(18,1)=30
 180 C(3,2),C(6,2),C(11,2),C(14,2
     ),C(18,2)=248
 190 C(4,1),C(12,1),C(13,1),C(20,
     1)=51
 200 C(4,2),C(12,2),C(20,2)=497
 210 C(17,2)=165
 220 C(8,2),C(16,2)=665
 230 GCLEAR
 240 GOSUB 1890
 250 SCALE 0,255,0,191
 260 KEY LABEL
 270 DISP "SELECT OPTION"
 280 GOTO 280
 290 ALPHA @ CLEAR @ KEY LABEL
 300 DISP "ENTER TIME:HH.MMSS";
 310 INPUT T1
 320 DISP T1
 330 IF T1>23.5959 THEN DISP "INV
     ALID TIME" @ BEEP @ GOTO 300
 340 IF T1=-1 THEN S1,T0=0 @ GOTO
      400
 350 D=DATE @ T0,S1=0
 360 T=3600*INT(T1)+60*INT(FP(T1)
     *100)+FP(T1*100)*100
 370 DISP "PRESS CONT TO SET TIME
     "
 380 PAUSE
 390 SETTIME T,D
 400 R,R1=1 @ DISP "SELECT DISPLA
     Y MODE"
 410 GOTO 410
 420 OFF TIMER# 1
 430 S(S)=TIME-S1
 440 ON KEY# 1,"SET/STOP" GOSUB 2
     90
 450 R=0
 460 GOSUB 1890
 470 KEY LABEL
 480 RETURN
 490 IF R1 THEN R=1 @ S1,T0=0
 500 IF R THEN GCLEAR @ MOVE 100,
     12 @ LABEL "DIGITAL" ELSE DI
     SP "TIME NOT SET" @ BEEP @ G
     OTO 270
 510 GOSUB 1800
 520 ON KEY# 1,"SET/STOP" GOSUB 4
     20
 530 GOSUB 1200
 540 GOSUB 570
 550 ON TIMER# 1,1000 GOSUB 570
 560 IF R THEN 560 ELSE 250
 570 GCLEAR 12 @ T=TIME-T0
 580 T1=INT(T/3600) MOD 12+INT(T
     MOD 3600/60)/100+INT(T MOD 6
     0)/10000
 590 V$=VAL$(T1+.00001+12*(T1<1)*
     (S1=0))
 600 MOVE 100,0 @ LABEL V$[1,POS(
     V$," ")+4]
 610 RETURN
 620 R,S=1
 630 GOSUB 1800
 640 ON KEY# 1,"SET/STOP" GOSUB 4
     20
 650 ON KEY# 4,"SPLIT" GOSUB 700
 660 CLEAR @ KEY LABEL @ DISP "PR
     ESS CONT WHEN READY"
 670 PAUSE
 680 T0,S1=TIME
 690 RETURN
 700 IF R THEN S(S)=TIME-S1 @ S=S
     +1 @ RETURN
 710 IF S=1 THEN DISP "NO SPLITS
     TAKEN" @ BEEP @ RETURN
 720 PRINT "SPLIT#     ΔTIME SEC"
 730 FOR I=1 TO S
 740 PRINT USING "DDDD,3X,7D.4D"
     ;I,S(I)
 750 NEXT I
```

Initialization

Set up for drawing clock face

Wait loop until key is pressed

Enter time

Verify

Compute seconds

Set time

Wait loop until key is pressed

Stop timer interrupt-restore keys

DIGITAL display

Set key #1 for STOP

Set timer #1

Update time

Set up for COUNT UP Timer

Initialize starting time

Take split

Check for splits taken

Print out splits

```
 760 RETURN
 770 DISP "       TIMER OPERATIONS
     "
 780 DISP "K1:SET/STOP TIMER-ENTE
     R REAL"
 790 DISP "   TIME FOR K2,K6&K8 D
     ISPLAY-"
 800 DISP "   STOP DISPLAY OR COU
     NT UP"
 810 DISP "K2:DIGITAL DISPLAY MOD
     E SELECT"
 820 DISP "K3:SELECT COUNT UP-INI
     T. SPLITS"
 830 DISP "K4:TAKE SPLIT/PRINT SP
     LITS AFTER"
 840 DISP "   STOPPING USING KEY#
     1"
 850 DISP "K5:HELP"
 860 DISP "K6:CLOCK DISPLAY MODE
     SELECT"
 870 DISP "K7:SELECT COUNT DOWN-S
     ET START"
 880 DISP "K8:FIVE SECOND DISPLAY
     SELECT"
 890 RETURN
 900 GOSUB 1800
 910 ALPHA @ CLEAR @ KEY LABEL @
     DISP "ENTER COUNT DOWN SECON
     DS";
 920 INPUT S2
 930 GCLEAR
 940 MOVE 88,12
 950 LABEL "COUNT DOWN"
 960 MOVE 120,0
 970 LABEL VAL$(S2)
 980 MOVE 56,150 @ LABEL "PRESS C
     ONT WHEN READY"
 990 PAUSE
1000 ON TIMER# 1,1000 GOSUB 1020
1010 IF S2<=0 THEN OFF TIMER# 1
     @ GOSUB 1780 @ ALPHA @ GOSU
     B 1890 @ KEY LABEL @ RETURN
      ELSE 1010
1020 S2=S2-1
1030 GCLEAR 10
1040 MOVE 120,0
1050 LABEL VAL$(S2)
1060 RETURN
1070 IF R1 THEN R=1 @ S1,T0=0
1080 IF R THEN GOSUB 1800 ELSE D
     ISP "TIME NOT SET" @ BEEP @
      GOTO 270
1090 ON KEY# 1,"SET/STOP" GOSUB
     420 @ KEY LABEL
1100 GCLEAR @ MOVE 108,12 @ LABE
     L "5 SEC"
1110 GOSUB 1200
1120 GOSUB 1150
1130 ON TIMER# 1,5000 GOSUB 1150
1140 IF R THEN 1140 ELSE 250
1150 T=TIME-T0
1160 T1=INT(T/3600) MOD 12+INT(T
      MOD 3600/60)/100+INT(T MOD
      60)/10000
1170 V$=VAL$(T1+.00001+12*(T1<1)
     *(S1=0))
1180 GCLEAR 10 @ MOVE 100,0 @ LA
     BEL V$[1,POS(V$,".")+4]
1190 RETURN
1200 OFF TIMER# 1 @ MOVE 56,150
1210 LABEL "PUSH KEY#1 TO STOP"
1220 RETURN
1230 IF R1 THEN R=1 @ S1,T0=0
1240 IF R=0 THEN DISP "TIME NOT
     SET" @ BEEP @ GOTO 270
1250 DEG
1260 PEN 1 @ SCALE -8.8,-5.8,6.2
      @ GCLEAR @ S=0
1270 MOVE -8,-5.8 @ LABEL "STOP"
1280 GOSUB 1800
1290 MOVE -6,-5.8 @ DRAW -6,6.2
     @ DRAW 6,6.2 @ DRAW 6,-5.8
     @ DRAW -6,-5.8 @ PENUP
1300 FOR M=1 TO 60
1310 T=360*(1-M/60)
1320 PLOT D(M,1),D(M,2) @ PENUP
1330 IF M MOD 5 THEN 1370
1340 IDRAW D1(M/5,1),D1(M/5,2) @
      PENUP
1350 X=.25*SGN(30-M) @ Y=.7 @ IM
     OVE D2(M/5,1),D2(M/5,2)
1360 LABEL VAL$(M/5)
1370 NEXT M
1380 ON KEY# 1,"SET/STOP" GOSUB
     420
1390 M=INT(TIME/60) MOD 720
1400 GOSUB 1350
1410 S=INT(TIME) MOD 60
1420 T9,T8=INT(TIME)
1430 IF T9#INT(TIME) THEN T9=INT
     (TIME) @ GOSUB 1450
1440 IF R THEN 1430 ELSE 240
1450 S1=INT(T9-T8) @ S1=S1+86400
     *(S1<0) @ T8=T9
1460 PEN -1
1470 GOSUB 1650
```

HELP subroutine

COUNT DOWN

Update count down

Check if done

Display new count

5 SEC

Set timer

Update time

Label instructions

Set up and draw clock

Draw hands initially

Increment hands

Check for stop

Update hands

```
1480 IF S=INT(S/2)*2 THEN BEEP 3
     50,1 ELSE BEEP 75,1
1490 S2=S @ S=(S+S1) MOD 60
1500 PEN 1
1510 GOSUB 1650
1520 IF S2<S THEN RETURN
1530 PEN -1 @ GOSUB 1690
1540 M=M+1
1550 PEN 1 @ GOSUB 1690
1560 IF M/60-INT(M/60) THEN 1590
1570 N=1 @ N1=16 @ GOSUB 1790
1580 FOR C=1 TO INT(M/60) @ BEEP
      214,185 @ WAIT 250 @ NEXT
     C @ RETURN
1590 IF M/15-INT(M/15) THEN RETU
     RN
1600 N=INT(M/15) MOD 4 @ ON N GO
     SUB 1620,1630,1640 @,1790
1610 RETURN
1620 N=17 @ N1=20 @ RETURN
1630 N=1 @ N1=8 @ RETURN
1640 N=9 @ N1=20 @ RETURN
1650 T=-S*6
1660 MOVE -4.4*SIN(T),4.4*COS(T)
1670 IDRAW .4*SIN(T),-.4*COS(T)
1680 RETURN
1690 T=-M*6
1700 MOVE 0,0
1710 DRAW -4*SIN(T),4*COS(T)
1720 T=-M*6/12
1730 MOVE 0,0
1740 DRAW -3*SIN(T),3*COS(T)
1750 RETURN
1760 DEF FNX(T) = X*COS(T)-Y*SIN
     (T)
1770 DEF FNY(T) = Y*COS(T)+X*SIN
     (T)
1780 N=1 @ N1=20
1790 FOR C=N TO N1 @ BEEP C(C,1)
     ,C(C,2) @ NEXT C @ RETURN
1800 OFF KEY# 1
1810 OFF KEY# 2
1820 OFF KEY# 3
1830 OFF KEY# 4
1840 OFF KEY# 5
1850 OFF KEY# 6
1860 OFF KEY# 7
1870 OFF KEY# 8
1880 RETURN
1890 ON KEY# 1,"SET/STOP" GOSUB
     290
1900 ON KEY# 2," DIGITAL" GOTO 4
     90
1910 ON KEY# 3," CNT UP" GOSUB 6
     20
1920 ON KEY# 4,"SPLIT" GOSUB 700
1930 ON KEY# 5,"HELP" GOSUB 770
1940 ON KEY# 6," CLOCK" GOTO 123
     0
1950 ON KEY# 7,"CNT DWN" GOSUB 9
     00
1960 ON KEY# 8," 5 SEC" GOTO 107
     0
1970 CLEAR @ RETURN
```

Hour
Chime for hour

Strike the hour

1/4 hour
Set up for chimes

1/4 hour
1/2 hour

3/4 hour

Draw second mark

Minute hand

Hour hand

Turn off keys

Turn on keys

Notes

Music Composer

Programmable BEEP

The "Music Composer" program uses the programmable BEEP instruction to generate the tones for the generated music. The parameters used by the BEEP instruction designate frequency and duration, but they are not in actual units. The relation between the BEEP parameters and actual frequency (F) and duration (T) are:

$$P1 = 613062.5/(11 * F) - 134/11$$
$$P2 = 613062.5/(11 * P1 + 134) * T$$

where

F = frequency in hertz
T = duration in seconds

The actual functions used by the program compensate for the time required to determine the type of array element and act accordingly.

Parse Techniques

In much the same manner as programs written in BASIC are converted into a form executable by a machine, the "Music Composer" program takes an input string and converts it into array elements which will be used to play music. This technique is called parsing. The program uses a simple set of rules, i.e., a grammar, to interpret the composition symbols. Once the program has determined what kind of symbol is currently being checked then program execution will branch accordingly. The lines form 510 to 940 are used to parse the entered composition string. The program checks the string by moving from position 1 to the end of the entered string a character at a time.

```
510 C=1 @ N1=N @ Q=0 @ O1=O @ T1
    =T @ B1=B
520 R$=R$&"   "
530 IF C>LEN(R$) THEN 490 ELSE P
    =POS(S$,R$[C,C])
540 IF P=28 THEN C=C+1 @ GOTO 53
    0
550 IF P THEN 580
560 DISP "? "&R$[C,C];" AT ";C
570 O=O1 @ T=T1 @ B=B1 @ N=N1 @
    GOTO 490
580 IF P<22 THEN Q=P @ GOTO 740
590 ON P-21 GOTO 740,610,680,600
    ,700,870,740
600 Q=-1 @GOTO 740
610 U=1
620 IF NOT FNP THEN 650
```

```
630 U=FNV
640 C=C+FNP
650 D=FNV
660 B=U/D @ C=C+2+(D>9)
670 GOTO 530
680 O=FNV @ C=C+2
690 IF O>6 OR O<1 THEN C=C-1 @ G
    OTO 560 ELSE 530
700 T(N,1)=0 @ T(N,2)=FNV
710 C=C+LEN(VAL$(T(N,2)))+1
720 T=60/T(N,2)
730 GOTO 850
740 C=C+1
750 IF Q#-1 THEN 770
760 T(N,1)=9999 @ T(N,2)=1000*(T
    *B-.015) @ GOTO 850
770 IF Q=0 THEN 530
780 IF Q=8 THEN O=O-1 @ P1=11 @
    GOTO 810
790 P1=POS(T$,P$[Q,Q])-1
800 Q=0
810 T(N,1)=FNB(O-1) @ T(N,2)=B9/
    (11*T(N,1)+134)*(T*B-.032)
820 BEEP T(N,1),T(N,2)
830 IF Q=8 THEN O=O+1
840 IF T(N,2)<1 THEN T(N,2)=1
850 N=N+1 @ Q=0
860 GOTO 530
870 T(N,1)=FNV-N
880 R1=-T(N,1) @ R=N @ R3=FNV
890 IF FNP THEN C=C+FNP @ R3=FNV
    @ R=N-R3
900 C=C+2+(R3>9)+(R3>99)
910 IF R<R1 OR R<0 OR R1<0 THEN
    640
920 T(N,2)=R
930 GOTO 850
940 IF R2 THEN RETURN
```

By tracing the program flow in the subroutine when parsing the simple string, T8O3A, the technique should be clarified. We can assume that this is the first entry and that the timing factor is set at one. The effect of this input string is to set the timing and octave of the first note which is a natural A.

```
COMPOSITION
?
T8Q3A
 Trace line 330 to 510
 Trace line 510 C=1
 Trace line 510 N1=1
 Trace line 510 Q=0
 Trace line 510 O1=4
 Trace line 510 T1=1
 Trace line 510 B1=1
 Trace line 520 R$
 Trace line 530 P=23
 Trace line 550 to 580
 Trace line 590 to 610
 Trace line 610 U=1
 Trace line 620 to 650
 Trace line 650 D=8
 Trace line 650 to 660
 Trace line 660 B=.125
 Trace line 660 C=3
 Trace line 670 to 530
 Trace line 530 P=24
 Trace line 550 to 580
 Trace line 590 to 680
 Trace line 680 O=3
 Trace line 680 C=5
 Trace line 680 to 690
 Trace line 690 to 530
 Trace line 530 P=1
 Trace line 550 to 580
 Trace line 580 O=1
 Trace line 580 to 740
 Trace line 740 C=6
 Trace line 750 to 770
 Trace line 790 P1=0
 Trace line 800 Q=0
 Trace line 810 T(1,1)=241
 Trace line 810 T(1,2)=28
 Trace line 810 to 820
 Trace line 850 N=2
 Trace line 850 Q=0
 Trace line 860 to 530
 Trace line 530 P=28
 Trace line 540 C=7
 Trace line 540 to 530
 Trace line 530 P=28
 Trace line 540 C=8
 Trace line 540 to 530
 Trace line 530 to 940
 Trace line 940 to 340
```

By following through this example, the technique of parsing should be simplified.

Variable Definitions

C1$ – Bass clef
F$ – File name
F1$ – Treble clef
N$ – Scale symbols
N1$ – Scale symbol code string
P$ – Parse string
R(,) – Repeat stack
R$ – Response string
S$ – Composing symbols
T(,) – Composed array
T$ – Scale with sharp symbols
B – Beats/sec
B1 – Temporary storage
B9 – Conversion constant
C – Counter
C2 – Power of two
D – Denominator
F – Flag and temporary storage
I – Loop counter
I9 – Temporary storage
J – Loop counter
L1 – Maximum size of array
M – Metronome
M1 – Metronome temporary storage
N – Array counter
N1 – Array counter temporary storage
O – Octave
O1 – Octave temporary storage
P – String pointer
P1 – String pointer
P2 – String pointer
P9 – Page count
Q – Symbol type
R – Repeat pointer
R1 – Repeat pointer
R2 – Repeat pointer
R3 – Last value to print
S – Starting value to print and temporary storage
S0 – Sharp flag

T – Beats per second timing
T1 – Timing temporary storage
U – Numerator of fraction for conversion
Y – Plot position for notes
Z – Insert/delete pointer and temporary storage
Z0 – Insert/delete pointer and temporary storage

Program	Comment
10 OPTION BASE 1	Initialization
20 INTEGER T(700,2),I9,U,O,N,M, C,N1,Q,O1,P,R1,R,I,M1,P1,S,J ,Z,Z0,R2,P2,S0,P9,R(5,2),R3	
30 DIM S$[23],P$[26],T$[13],R$[98]	
40 DIM N1$[12],F$[6],N$[12],F1$ [98],C1$[48]	
50 F1$[1,49]="◀ö◀$◀&◀#◀#◀#◀&◀&◀ ◀◀,◀8◀ᴘ◀¿¿_Ñ ◀◀Γ µ µ ö 9 0 ◀"	
60 F1$[50,98]="◀`paxc,F&F&D#D#◀ ◀@!@!`! !0#ö&α&◀◀◀ ◀ µ α ö θ Δ@ñ◀" @ N=1	
70 C1$="◀◀※@ @ ◀8◀A◀λ◀Δ◀◀LΔ,Δα λ◀λ◀Δ◀Δ◀Δ◀◀◀8◀ ◀ ◀ ◀@¿◀Γ◀"	
80 L1=700 @ B9=613062.5 @ S$="A BCDEFGabcdefg¿XÑαβΓñ;TORM: "	
90 P$="ABCDEFGñ¿BÑαEΓ¿CÑαFΓñ " @ T$="A¿BCÑDαEFΓGñ " @ N$="A bBCdDeEFgGa" @ N1$="11233445 6677"	
100 ON KEY# 1,"CREATE" GOSUB 210	
110 ON KEY# 2,"CHANGE" GOSUB 118 0	
120 ON KEY# 3,"STORE" GOSUB 370	
130 ON KEY# 4,"PLAY" GOSUB 990	
140 ON KEY# 5,"HELP" GOSUB 1800	
150 ON KEY# 6,"DELETE" GOSUB 198 0	
160 ON KEY# 7,"INSERT" GOSUB 213 0	
170 ON KEY# 8,"PRINT" GOSUB 2340	
180 CLEAR @ KEY LABEL @ DISP "MU SIC COMPOSER"	
190 DISP "SELECT OPTION"	
200 GOTO 200	Wait loop until key is pressed
210 O=4 @ N,B=1 @ CLEAR	
220 DISP "OLD OR NEW TUNE:O/N";	Old or new tune
230 INPUT R$[1,32]	
240 IF FNR=3 THEN 260	New tune
250 IF UPC$(R$[1,1])#"O" THEN BE EP @ GOTO 220 ELSE 1110	
260 DISP "METRONOME";	Enter Metronome
270 INPUT M	
280 GOSUB 2590	
290 T=60/M	
300 DISP "COMPOSITION"	Enter composition
310 INPUT R$	
320 IF R$="END" THEN 350	Check for "END"
330 GOSUB 510	
340 IF N<=L1 THEN 300	Too big
350 N=N-1	
360 DISP "DONE" @ RETURN	
370 GOSUB 2640 @ IF N=1 THEN DIS P "NO TUNE!" @ RETURN	STORE tune
380 ON ERROR GOTO 380 @ GOSUB 32 90	Set up error jump
390 DISP "CREATE:Y/N";	Create?
400 INPUT R$[1,32]	
410 IF FNR=2 THEN CREATE F$,INT(N/16)+2 @ GOTO 430	
420 IF FNR=1 THEN BEEP @ GOTO 39 0	
430 ASSIGN# 1 TO F$	
440 PRINT# 1 ; N,M	Print count and metronome
450 FOR I=1 TO N	
460 PRINT# 1 ; T(I,1),T(I,2)	Print array values on file
470 NEXT I	
480 ASSIGN# 1 TO * @ OFF ERROR @ GOTO 360	Close file
490 DISP "RE-ENTER";	Re-enter composition
500 INPUT R$	
510 C=1 @ N1=N @ Q=0 @ O1=O @ T1 =T @ B1=B	Set pointers
520 R$=R$&" "	Add buffer
530 IF C>LEN(R$) THEN 940 ELSE P =POS(S$,R$[C,C])	Get next character to parse
540 IF P=28 THEN C=C+1 @ GOTO 53 0	Blank?
550 IF P THEN 580	Valid character?
560 DISP "? "&R$[C,C];" AT ";C	
570 O=O1 @ T=T1 @ B=B1 @ N=N1 @ GOTO 490	Error routine
580 IF P<22 THEN Q=P @ GOTO 740	Note?
590 ON P-21 GOTO 740,610,690,600 ,700,870,740	Branch according to character
600 Q=-1 @ GOTO 740	Rest
610 U=1	Timing
620 IF NOT FNP THEN 650	
630 U=FNV	
640 C=C+FNP	
650 D=FNV	
660 B=U/D @ C=C+2+(D>9)	Change beat
670 GOTO 530	
680 O=FNV @ C=C+2	Octave
690 IF O>6 OR O<1 THEN C=C-1 @ G OTO 560 ELSE 530	
700 T(N,1)=0 @ T(N,2)=FNV	Metronome
710 C=C+LEN(VAL$(T(N,2)))+1	
720 T=60/T(N,2)	
730 GOTO 850	
740 C=C+1	; - Measure delimeter
750 IF Q#-1 THEN 770	
760 T(N,1)=9999 @ T(N,2)=1000*(T *B-.015) @ GOTO 850	Rest
770 IF Q=0 THEN 530	Blank
780 IF Q=8 THEN O=O-1 @ P1=11 @ GOTO 810	Check for A flat
790 P1=POS(T$,P$[Q,Q])-1	Compute BEEP parameters
800 Q=0	
810 T(N,1)=FNB(O-1) @ T(N,2)=B9/ (11*T(N,1)+134)*(T*B-.032)	
820 BEEP T(N,1),T(N,2)	
830 IF Q=8 THEN O=O+1	A flat
840 IF T(N,2)<1 THEN T(N,2)=1	Force length of 1
850 N=N+1 @ C=0	Update array count and continue
860 GOTO 530	
870 T(N,1)=FNV-N	Repeat
880 R1=-T(N,1) @ R=N @ R3=FNV	
890 IF FNP THEN C=C+FNP @ R3=FNV @ R=N-R3	
900 C=C+2+(R3>9)+(R3>99)	
910 IF R<R1 OR R<0 OR R1<0 THEN 640	
920 T(N,2)=R	
930 GOTO 850	
940 IF R2 THEN RETURN	Review?
950 DISP "OK:Y/N";	OK?
960 INPUT R$[1,32]	
970 ON FNR GOTO 980,1100,570	
980 BEEP @ GOTO 950	
990 R,R1,R2=0	PLAY
1000 FOR I=1 TO N	
1010 GOSUB 3320	
1020 IF I>N THEN 1080	End
1030 IF T(I,1)=9999 THEN WAIT T(I,2) @ GOTO 1080	Rest
1040 ON SGN(T(I,1))+2 GOTO 1050, 1080,1070	Repeat Metronome
1050 GOSUB 3350 @ GOTO 1010	Note
1070 BEEP T(I,1),T(I,2)	BEEP
1080 NEXT I	
1090 DISP "END PERFORMANCE"	
1100 RETURN	
1110 ON ERROR GOTO 1110 @ GOSUB 3290	READ old tune
1120 ASSIGN# 1 TO F$	
1130 READ# 1 ; N,M	
1140 FOR I=1 TO N	
1150 READ# 1 ; T(I,1),T(I,2)	
1160 NEXT I	
1170 ASSIGN# 1 TO * @ OFF ERROR @ T=60/M @ GOTO 360	
1180 GOSUB 2640 @ DISP "CHANGE T IMING:Y/N";	Change timing?
1190 INPUT R$[1,32]	
1200 ON FNR GOTO 1210,1220,1300	
1210 BEEP @ GOTO 1180	
1220 DISP "METRONOME";	Enter metronome
1230 INPUT M1	
1240 IF M1=M OR M1<1 THEN 1300	
1250 FOR I=1 TO N	
1260 IF T(I,1)=0 THEN T(I,2)=T(I ,2)*M1/M @ GOTO 1280	Change metronome
1270 IF T(I,1)>-1 THEN T(I,2)=T(I,2)*M/M1	Change note and rest timing
1280 NEXT I	
1290 M=M1	
1300 DISP "CHANGE NOTES:Y/N";	Change notes?
1310 INPUT R$[1,32]	
1320 ON FNR GOTO 1330,1340,360	
1330 BEEP @ GOTO 1300	
1340 GOSUB 2590	
1350 DISP "NOTE #";	Enter note number in array
1360 INPUT I	
1370 DISP "SET TIMING:Y/N";	SET timing for converting note to string?
1380 INPUT R$[1,32]	
1390 IF FNR=2 THEN S=I @ GOSUB 2 550 @ GOTO 1410	Set time
1400 IF FNR=1 THEN BEEP @ GOTO 1 370	
1410 GOSUB 1420 @ PRINT R$ @ GOT O 1590	Convert and print note
1420 IF T(I,1)=0 THEN R$="M"&VAL $(T(I,2)) @ T=60/T(I,2) @ R ETURN	Metronome
1430 IF T(I,1)=9999 THEN R$="R"& VAL$(T(I,2)/1000) @ RETURN	Rest
1440 IF T(I,1)<0 THEN R$=":"&VAL $(I+T(I,1))&"/"&VAL$(I-T(I, 2)) @ RETURN	Repeat
1450 B=(T(I,2)/INT(B9/(11*T(I,1) +134))+.032)/T @ D=.5 @ P1, O=0	Compute Note String
1460 D=2*D	Find timing
1470 IF B<1/D*.9 THEN 1460	
1480 U=B*D	
1490 IF ABS(U/D-B)>1/64 THEN 146 0	
1500 IF D=1 THEN 1520	
1510 IF INT(U/2)/INT(D/2)=U/D AN D U#1 THEN U=U/2 @ D=D/2 @ GOTO 1500	
1520 I9=B9/(11*(55*2^O))-134/11	
1530 IF T(I,1)<=I9 THEN O=O+1 @ GOTO 1520	Find octave
1540 I9=FNB(O-1)	
1550 IF T(I,1)#I9 THEN P1=P1+1 @ GOTO 1540	Find note
1560 IF U=1 THEN R$="T"&VAL$(D) ELSE R$="T"&VAL$(U)&"/"&VAL $(D)	Set R$

```
1570 R$=R$&"O"&VAL$(O+(P1=11))&N
     $[P1+1,P1+1] @ BEEP T(I,1),
     T(I,2) @ RETURN
1580 IF NOT T(I,1) THEN 1690
1590 DISP "NEW NOTE";
1600 INPUT R$
1610 IF R$="OK" THEN 1650
1620 T=60/M @ S=N @ N=I
1630 GOSUB 510
1640 N=S%(N<=S+1)+(N-1)*(N>S+1)
1650 DISP "MORE:Y/N";
1660 INPUT R$[1,32]
1670 ON FNR GOTO 1680,1350,360
1680 BEEP @ GOTO 1650
1690 DISP "METRONOME";
1700 INPUT M1
1710 IF M1=T(I,2) OR M1<1 THEN 1
     650 ELSE M2=T(I,2) @ T(I,2)
     =M1 @ T=60/M1 @ F=0
1740 FOR J=I+1 TO N
1750 IF F THEN 1780
1760 IF T(J,1)=0 THEN F=1 @ GOTO
      1780
1770 T(J,2)=MAX(T(J,2)*M2/M1,1)
1780 NEXT J
1790 GOTO 1650
1800 GOSUB 2640 @ DISP "       M
     USIC COMPOSER"
1810 DISP "K1:ENTER COMPOSITION
     FROM TAPE     FILE OR KEYBO
     ARD(DONE FIRST)"
1820 DISP "K2:CHANGE TIMING OR N
     OTE BY LOC.K3:STORE COMPOSE
     D ARRAY ON TAPE"
1830 DISP "K4:PLAY COMPOSITION A
     RRAY          K5:HELP"
1840 DISP "K6:DELETE ARRAY VALUE
     S          K7:INSERT NOTES
     IN STRING FORM"
1850 DISP "    AFTER SPECIFIED LO
     CATION     K8:PRINT CONVERT
     ED ARRAY VALUES"
1860 DISP "*** PRESS CONT FOR CO
     MPOSING ***" @ DISP "
          SYMBOLS" @ PAUSE
1870 DISP @ DISP "          COMPOSI
     NG SYMBOLS          Naturals→
     ABCDEFG"
1880 DISP "Flats→abcdefg" @ DISP
      "Sharps→CTRL ABCDEFG or &%
     Ñø$ΓR"
1890 DISP @ DISP "Octave→On,1<=n
     <=6" @ DISP "Timing→Tn/m or
      Tm if n=1"
1900 DISP "Rest→R,uses current t
     iming" @ DISP "Repeat→:n/m
     or :n if m=0"
1910 DISP "       n=# ARRAY VALUE
     S TO REPEAT"
1920 DISP "       m=# ARRAY VALUE
     S TO SKIP"
1930 DISP "Metronome→Mn,n=WHOLE
     NOTES/MIN."
1940 DISP "DEFAULT VALUES→04T1"
1950 DISP "  EX:M6003T8G04CET4GT
     8RET2G"
1960 BEEP 130,49 @ BEEP 94,66 @
     BEEP 72,83 @ BEEP 59,196 @
     WAIT 125
1970 BEEP 72,83 @ BEEP 59,391 @
     RETURN
1980 GOSUB 2640
1990 DISP "DELETE STARTING AT";
2000 INPUT Z0
2010 IF Z0<=0 THEN RETURN
2020 IF Z0>N THEN BEEP @ GOTO 19
     90
2030 DISP "HOW MANY";
2040 INPUT Z
2050 IF Z=0 OR Z>=N THEN RETURN
2060 FOR I=Z0 TO N-Z
2070 S=I+Z
2080 IF T(S,1)<0 THEN T(I,1)=T(S
     ,1)+Z*(-T(S,1))>Z0) @ T(I,2)
     =T(S,2)-Z*(T(S,2))>Z0) @ GOT
     O 2110
2090 T(I,1)=T(S,1) @ T(I,2)=T(S,
     2)
2110 NEXT I
2120 N=N-Z @ GOTO 360
2130 GOSUB 2640
2140 DISP "INSERT NOTES AFTER";
2150 INPUT Z
2160 IF Z=-1 THEN RETURN
2170 IF Z>N THEN BEEP @ GOTO 214
     0
2180 IF Z=N THEN N=N+1 @ GOTO 28
     0
2190 DISP "HOW MANY";
2200 INPUT Z1
2210 IF Z1=0 THEN RETURN
2220 IF N+Z1>L1 THEN DISP "TOO M
     ANY" @ DISP "MAX. IS ";L1-N
      @ GOTO 2190
2230 FOR I=N TO Z+1 STEP -1
2240 IF T(I,1)<0 THEN T(I+Z1,1)=
     T(I,1)-Z1*(-T(I,1)>Z) @ T(I
     +Z1,2)=T(I,2)+Z1*(T(I,2)>Z)
      @ GOTO 2270
2250 T(I+Z1,1)=T(I,1) @ T(I+Z1,2
     )=T(I,2)
2270 NEXT I
2280 GOSUB 2590
2290 DISP "COMPOSITION";
2300 INPUT R$
2310 S=N @ N=Z+1
2320 GOSUB 510
2330 N=S+Z1 @ GOTO 360
2340 GOSUB 2640 @ DISP "ARRAY HA
     S "&VAL$(N)&" VALUES"
2350 DISP "1ST VALUE";
2360 INPUT S
2370 IF S=0 THEN RETURN
2380 DISP "LAST VALUE";
2390 INPUT R3
2400 IF S<1 OR R3<S OR R3>N THEN
      BEEP @ GOTO 2350
2410 T=60/M
2420 GOSUB 2550
2430 PRINT "NOTES FROM ";S;" TO
     ";R3
2440 R;R1,R2=0
2450 DISP "PRINT OR SCORE:P/S";
2460 INPUT R$[1,32]
2470 IF UPC$(R$[1,1])="P" THEN 2
     500
2480 IF UPC$(R$[1,1])#"S" THEN B
     EEP @ GOTO 2450
2490 GOTO 2650
2500 FOR I=S TO R3
2510 GOSUB 1420
2520 PRINT R$&" ";
2530 NEXT I
2540 PRINT @ PRINT @ GOTO 360
2550 FOR J=1 TO S-1
2560 IF T(J,1)=0 THEN T=60/T(J,2
     )
2570 NEXT J
2580 RETURN
2590 P2=1 @ DISP "REVIEW:Y/N";
2600 INPUT R$[1,32]
2610 ON FNR GOTO 2630,2620,3310
2620 R2=0 @ RETURN
2630 BEEP @ GOTO 2590
2640 CLEAR @ KEY LABEL @ RETURN
2650 SCALE -1,30.875,-2,45.75 @
     P9=1 @ GCLEAR @ GOSUB 2950
     @ C=1 @ I=S
2690 IF C=31 THEN GOSUB 2940
2700 GOSUB 3320
2710 IF I>R3 THEN 2900
2720 IF T(I,1)=0 THEN T=60/T(I,2
     ) @ I=I+1 @ GOTO 2720
2730 IF T(I,1)=9999 THEN 3140
2740 IF T(I,1)<0 THEN GOSUB 3350
      @ GOTO 2700
2750 GOSUB 1450 @ GOSUB 2930
2760 Y=(O-1)*7+P2+.5
2770 IF S0 THEN GOSUB 3080
2780 C2=LOG(D)/LOG(2)+1 @ F=U/D
2790 IF U=1 THEN T1=F @ GOTO 281
     0
2800 T1=1 @ C2=1
2810 IF T1>F THEN T1=T1/2 @ C2=C
     2+1 @ GOTO 2810
2820 ON C2 GOSUB 2860,2870,2890,
     2880,2880,2880,2880,2880
2830 F=F-T1
2840 IF F<1/128 THEN 2900
2850 C=C+(C=-1)+(C=1)*(NOT FNP9)
      @ MOVE C-.5,Y+1.25 @ BPLOT
      "µ£3!",1 @ GOTO 2800
2860 MOVE C,Y @ BPLOT "<BBB<",1
     @ GOTO 3000
2870 MOVE C,Y @ BPLOT "τΩΩ!>
          ",1 @ GOTO 3000
2880 FOR J=C2 TO 4 STEP -1 @ MOV
     E C,Y-(1.75+.5*(7-J)) @ BPL
     OT "£",1 @ NEXT J
2890 MOVE C,Y @ BPLOT "τ%%?>
          ",1 @ GOTO 3000
2900 IF I>R3 THEN 3360
2910 I=I+1
2920 GOTO 2690
2930 P2=VAL(N1$[P1+1,P1+1]) @ S0
     =NUM(N$[P1+1,P1+1])>96 @ RE
     TURN
2940 COPY @ GCLEAR @ P9=P9+1 @ C
     =1
2950 FOR J=7 TO 27 STEP 2
2960 IF J#17 THEN XAXIS J
2970 NEXT J
2980 IF FNP9 THEN C=-1 @ RETURN
2990 PRINT USING  "//////" @ MOVE
      -1,29 @ BPLOT F1$,2 @ MOVE
      -1,15 @ BPLOT C1$,2 @ RETU
     RN
3000 Z0=2*INT(INT(Y-.5)/2)+1 @ J
     =MAX(7,MIN(Z0-4,29))
3010 FOR Z=Z0 TO J STEP 2*SGN(J-
     Z0)+(J=Z0)
3020 IF Z=17 AND Z#Z0 OR Z0>27 A
     ND Z0>Y AND Z=Z0 OR Z<7 AND
      Y>7 THEN 3040
3030 MOVE C+.125,Z @ DRAW C+.875
     ,Z
3040 NEXT Z
```

Metronome change?
Enter new note

No change check?

Parse new string

More?

Enter new metronome setting

Modify following notes accordingly

HELP subroutine

Example tune

DELETE

Delete address
Exit
Error

How many?

Exit

Move array elements

INSERT

Insert address
Exit
Error
Append

How many?

Make room

Enter composition

PRINT
Enter range

Print or Score?

PRINT routine

Review? Subroutine

SCORE routine
Set note counter
Page

Done
Metronome

Rest
Repeat

Note convert to string
Compute location to plot

Compute timing

Plot note

Too small
Tie

Whole note

Half

Flags

Quarter note

Done

Sharp flag set

New page

Staff

Treble and bass clefs

Fill in lines

```
3050 C=C+1 @ IF C=31 AND F-T1>=1
     /128 THEN 2940 ELSE RETURN
3060 END
3070 DEF FNR = POS("YN",UPC$(R$[
     1,1])>+1
3080 IF C=30 AND FNP9 THEN GOSUB
      2940
3090 MOVE C+.25,Y-1.5 @ LABEL "#
     " @ C=C+1
3100 IF C=31 THEN 2940 ELSE RETU
     RN
3110 DEF FNB(X) = B9/(11*55*2^(X*
     2^(P1/12))-134/11
3120 DEF FNV = VAL(R$[C+1])
3130 DEF FNP = POS(R$[C+1,C+3+(F
     NV>99)],"/")
3140 F=(T(I,2)/1000+.015)/T
3150 T1=1 @ C2=1
3160 IF T1>F+1/128 THEN T1=T1/2
     @ C2=C2+1 @ GOTO 3160
3170 ON C2 GOSUB 3210,3210,3220,
     3260,3250,3240,3230,3270
3180 F=F-T1
3190 IF F<1/128 THEN 2900
3200 GOTO 3150
3210 MOVE C,25.75-C2 @ BPLOT "<<
     <",1 @ GOTO 3050
3220 MOVE C,26.75 @ BPLOT "00ΔΔα
     αXψψõ000↑↓>fbba 0↓Δα",1 @
     GOTO 3050
3230 MOVE C,20.75 @ GOSUB 3280
3240 MOVE C,26.75 @ GOSUB 3280
3250 MOVE C,22.75 @ GOSUB 3280
3260 MOVE C,24.75 @ GOSUB 3280
3270 MOVE C+.75,26.25 @ DRAW C+.
     75,19.75 @ GOTO 3050
3280 BPLOT "0xxp4õ",1 @ RETURN
3290 DISP "FILE NAME";
3300 INPUT F$
3310 RETURN
3320 IF I#R THEN RETURN ELSE I=R
     (R2,2) @ R2=R2-1
3330 IF R2 THEN R=R(R2,1)
3340 GOTO 3320
3350 R2=R2+1 @ R,R(R2,1)=T(I,2)
     @ R(R2,2)=I+1 @ I=-T(I,1) @
      RETURN
3360 IF C=-1 OR C=1 AND NOT FNP9
      THEN RETURN ELSE COPY @ RE
     TURN
3370 DEF FNP9 = P9=INT(P9/2)*2
```

Y or N check function

Sharp

Compute frequency

Value function

Position of "/" function

Rest plotter

Whole and half

Quarter

64th
32nd
16th
8th

64th symbol

File name input

Repeat pointer control

Copy?

Page logic identifier

Ski Game

Dynamic Variable Alteration

The user is able to change the value of the skier's lateral velocity by pressing the special function KEYS #3 and #4 while the program is running. The program execution is interrupted each time the special function key is pressed and then subroutines at lines 1520 and 1540 are executed before resuming program execution. These subroutines only increment and decrement the value of the variable F, but the technique can be carried much further. Programs could be written where this technique would allow the user to control the flow of a program, to specify the type of output desired, to specify the starting location of a label in graphics, etc.

```
30 ON KEY #3 GOSUB 1520
40 ON KEY #4 GOSUB 1540

1520 F=F-1
1530 RETURN
1540 F=F+1
1550 RETURN
```

Variable Color Graphics

The color of graphics operations is completely left to the user. The default mode of white lines on a black background can be over-ridden easily by changing the sense of the pen. The "Ski" program demonstrates the ability of user definable color. By setting the sense of the pen using a variable, you can easily change the mode of plotting since PEN −1 specifies black on white plotting and PEN 1 specifies white on black plotting. To plot in a different color you only need to execute a PEN 'color code' statement. In this program, the variable V9 contains the value of the selected mode. The ability to change modes allows you to blink labels as seen in lines 700 to 720.

```
700 PEN -V9 @ MOVE 73,0 @ LABEL
    "START" @ BEEP 15,10
710 PEN V9 @ MOVE 73,0 @ LABEL "
    START" @ BEEP 25,20
720 IF F THEN 700
```

By using this technique the user is able to enhance graphics in many ways by varying the color of the background and blinking labels.

Variable Definitions

F(,) – Left or top pole positions

G(,) – Right or lower pole positions

M( ) - Missed gate vector
P$ - Response string
A - Acceleration factor
B - Initial time
C - Temporary storage
C1 - Temporary storage
C2 - Temporary storage
C3 - Temporary storage
D - Temporary storage
D1 - Temporary storage
D2 - Temporary storage
D3 - Temporary storage
F - Key hit indicator
F1 - Repeat key indicator
G - Gate counter
I - Loop counter
K - Loop counter
M - Temporary storage
M1 - Temporary storage
P - Current Y position
Q - Ability level
R - Line intercept
S - Line intercept
S1 - Course code
T - Time
T1 - Time
V - Downward velocity
V8 - Background color entry
V9 - Pen setting
W - Lateral velocity
X - X-coordinate
X1 - X-coordinate
Y - Y-coordinate
Y1 - Y-coordinate

```
 10 ON KEY# 1,"SET UP" GOSUB 174
    0
 20 ON KEY# 5," HELP " GOSUB 176
    0
 30 ON KEY# 2 GOSUB 1560
 40 ON KEY# 4 GOSUB 1540
 50 ON KEY# 8 GOSUB 1580
 60 ON KEY# 3 GOSUB 1520
 70 LDIR 0 @ CLEAR @ KEY LABEL @
     DISP "SKI GAME"
 80 DIM F(10,2),G(10,2),M(10),P$
    [10]
 90 V9=-1
100 F=0
110 IF NOT F THEN 110
120 IF F=1 THEN 1600
130 V9=-1
140 W=0 @ B=1 @ CLEAR @ DISP "EN
    TER BACKGROUND COLOR:0=W,1=B
    ";
150 INPUT V8
160 SCALE 0,255,0,191
170 IF V8 THEN V9=1
180 DISP "ENTER COURSE CODE"
190 INPUT S1
200 DISP "WHAT'S YOUR ABILITY:1
    TO 5      (1 IS EASY,5 IS HA
    RD)"
210 INPUT Q
220 IF Q<1 THEN 200
230 RANDOMIZE S1*.6142332571
240 PEN V9 @ GCLEAR @ MOVE 6,180
     @ LABEL "HP 85 SKI GAME"
250 G=1
260 MOVE 210,182 @ LABEL "S"
270 MOVE 227,182 @ LABEL "S"
280 X=196 @ Y=170
290 F(G,1)=INT(X) @ F(G,2)=INT(Y
    )
300 MOVE INT(X),INT(Y)
310 GOSUB 1780
320 IF RND<=.5 THEN 380
330 X,G(G,1)=INT(F(G,1)+13)
340 G(G,2)=INT(Y)
350 MOVE INT(X),INT(Y)
360 GOSUB 1820
370 GOTO 400
380 G(G,1)=INT(X) @ Y,G(G,2)=INT
    (Y-13)
390 GOTO 350
400 IF RND>.5 THEN 440
410 X=218+RND*16-30*G
420 Y=Y-13-RND*19
430 GOTO 460
440 X=218-RND*16-30*G
450 GOTO 420
460 IF Y<35 THEN 490
470 G=G+1
480 GOTO 290
490 X=F(G,1)-8 @ G=G+1
500 F(G,1)=X @ G(G,1)=X+17
510 Y,F(G,2),G(G,2)=18
520 MOVE X-16,10 @ LABEL "FINISH
    "
530 MOVE X,18
540 GOSUB 1780
550 MOVE X+17,18
560 GOSUB 1820
570 MOVE 203,10 @ LABEL "REPEAT"
580 MOVE 73,0 @ LABEL "START
    LEFT     RIGHT"
590 W=.001
600 P=190
610 A=.25+.1*Q @ V=1 @ D=190
620 C=218
630 FOR I=0 TO 10
640 M(I)=0
650 NEXT I
660 M1=1
670 X1=218 @ Y1=190 @ F=0
680 MOVE 8,131 @ LABEL "TIME:"
690 F=1
700 PEN -V9 @ MOVE 73,0 @ LABEL
    "START" @ BEEP 15,10
710 PEN V9 @ MOVE 73,0 @ LABEL "
    START" @ BEEP 25,20
720 IF F THEN 700
730 FOR I=-5 TO 0 STEP .1
740 BEEP 90-ABS(I*15),10
750 NEXT I
760 T=0
770 MOVE X1,Y1
780 B=TIME
790 MOVE 50,131 @ LABEL VAL$(T)
    @ MOVE X1,Y1
800 V=V+A/2 @ Y=V+A/4*P/190 @ X=
    W
810 IF F=0 THEN 870
820 W=W+3*A*F
830 F=0
840 V=V-(1.5-A)/2
850 IF V>.8 THEN 870
860 V=1 @ W=.75*W
870 IF W>V THEN X=.75*W
880 C=X1 @ D=Y1
890 C1,X1=X1+X @ D1,Y1=Y1-Y @ DR
    AW X1,Y1
900 C2=MIN(C,C1) @ C3=MAX(C,C1)
910 D2=MIN(D,D1) @ D3=MAX(D,D1)
920 M=M1
930 IF Y1<G(M,2) THEN M1=MIN(G,M
    +1)
940 S=-Y/X*F(M,1)+D+Y*C/X
950 R=-X/Y*(F(M,2)-D-Y*C/X)
960 IF (C2>R OR R>C3) AND F(M,2)
    =G(M,2) THEN 1190
970 IF (D2>S OR S>D3) AND F(M,1)
    =G(M,1) THEN 1190
980 IF F(M,2)=G(M,2) AND R>=F(M,
    1) AND G(M,1)>=R THEN 1010
990 IF F(M,1)=G(M,1) AND F(M,2)>
    =S AND S>=G(M,2) THEN 1110
1000 GOTO 1190
1010 IF F(M,1)+1<R THEN 1060
1020 PEN -V9 @ MOVE F(M,1),F(M,2
     ) @ GOSUB 1780
1030 PEN V9 @ MOVE F(M,1),F(M,2)
      @ IDRAW -17,0 @ IDRAW 3,-5
      @ IDRAW 0,5
1040 MOVE X1,Y1
1050 BEEP 45,100 @ GOTO 1150
1060 IF R<G(M,1)-1 THEN 1150
1070 PEN -V9 @ MOVE G(M,1),G(M,2
     ) @ GOSUB 1820
1080 PEN V9 @ MOVE G(M,1)+14,G(M
     ,2) @ IDRAW 0,-5 @ IDRAW 3,
     5 @ IDRAW -17,0
1090 MOVE X1,Y1
1100 BEEP 10,200 @ GOTO 1150
1110 IF F(M,2)-1>S THEN 1130
1120 GOTO 1020
1130 IF S>G(M,2)+1 THEN 1150
1140 GOTO 1070
1150 M(M)=1
1160 FOR K=1 TO 15
1170 BEEP 75+K,5
1180 NEXT K
1190 T1=INT(TIME-B)
1200 IF T=T1 THEN 1240
1210 PEN -V9 @ MOVE 50,131 @ LAB
     EL VAL$(T) @ PEN V9
1220 T=T1
1230 MOVE 50,131 @ LABEL VAL$(T)
      @ MOVE X1,Y1
1240 P=P-Y
1250 IF P>17 THEN 800
1260 DRAW X1+X,Y1-Y
1270 MOVE 8,142 @ LABEL "THAT'S
     THE RACE"
1280 PEN -V9 @ MOVE 50,131 @ LAB
     EL VAL$(T) @ PEN V9
1290 T=TIME-B
1300 MOVE 50,131 @ LABEL VAL$(T)
1310 FOR I=1 TO G
1320 IF M(I)=1 THEN 1340
1330 MOVE G(I,1),G(I,2) @ LABEL
     "MISSED"
1340 NEXT I
1350 F1,F=1
1360 PEN -V9 @ MOVE 73,0 @ LABEL
      "START" @ BEEP 15,10
1370 PEN -V9 @ MOVE 203,10 @ LAB
     EL "REPEAT" @ BEEP 40,15
1380 PEN V9 @ MOVE 73,0 @ LABEL
     "START" @ BEEP 25,20
1390 PEN V9 @ MOVE 203,10 @ LABE
     L "REPEAT" @ BEEP 12,25
1400 IF F THEN 1360
1410 IF F1=0 THEN 230
1420 ALPHA @ DISP "TRY AGAIN:YES
     /NO";
1430 INPUT P$[1,9]
1440 IF UPC$(P$[1,1])="N" THEN 1
     510
1450 IF UPC$(P$[1,1])#"Y" THEN B
     EEP @ GOTO 1420
1460 DISP "NEW COURSE:YES/NO";
1470 INPUT P$[1,9]
1480 IF UPC$(P$[1,1])="N" THEN 2
     00
1490 IF UPC$(P$[1,1])#"Y" THEN B
     EEP @ GOTO 1460
1500 GOTO 130
1510 STOP
1520 F=F-1
1530 RETURN
1540 F=F+1
1550 RETURN
1560 F=0
1570 RETURN
1580 F1,F=0 @ BEEP 15,200
1590 RETURN
1600 CLEAR @ KEY LABEL @ DISP "
                SKI GAME"
1610 DISP "K1:SET UP GAME CONDIT
     IONS"
1620 DISP "K5:HELP"
1630 DISP "====================
     ==========="
1640 DISP "EXPLANATION OF KEYS I
     N GRAPHICS:"
1650 DISP "START-PRESS TO START
     GAME OR TO"
1660 DISP " SET UP NEW COURSE"
```

Initialization

Loop until key is pressed
Go to HELP

Enter background color

Enter course code

Enter ability

Generate course

Initialize variables for run

Loop and blink "START" until key is pressed

Count down to start

Read initial time

Set up initial speed values

Increment values for changed course

Gate check?

Hit pole?

Set gate made flag
Make sound

Update time

End race?
Print final time and missed gates

Loop until user pressed START or REPEAT

Repeat same course

Try again or change course

Left

Right

Start

Repeat

HELP

```
1670 DISP "LEFT/RIGHT-CONTROL SK
     IER BY"
1680 DISP " HITTING DESIRED KEY"
1690 DISP "REPEAT-DUPLICATE COUR
     SE"
1700 DISP "THE OBJECT OF GAME IS
      TO MAKE"
1710 DISP "EACH GATE IN LEAST TI
     ME!"
1720 BEEP 10,200
1730 GOTO 100
1740 F=2                          Set up flag
1750 RETURN
1760 F=1                          HELP flag
1770 RETURN
1780 IDRAW -5,17                  Left pole
1790 IDRAW -4,-4
1800 IDRAW 4,0 @ PENUP
1810 RETURN
1820 IDRAW 5,17                   Right pole
1830 IDRAW 4,-4
1840 IDRAW -4,0 @ PENUP
1850 RETURN
```

Appendix A

Use of 7225A Plotter

Various programs in the Standard Pac use CRT graphics. By following the instructions given here, these programs may be converted to run with the 7225A plotter.

The instructions for each program are listed below. After making the revisions be sure to execute the TRANSLATE command. To preserve the original programs, you must store these programs with a different name or on a different cartridge.

The new lines are shown for each program as well as the lines which must be deleted.

Program: MOVING

```
15 PLOTTER IS 705 @ CSIZE 7 @ DE
   G
1690 LDIR 90 @ LORG 7
1710 MOVE I+4*D1,M1-8*D2
1790 LDIR 0 @ LORG 7
1810 MOVE I-8*D1,I-4*D2
1935 LORG 1
1985 LORG 1
2150 MOVE U,T+1 @ LABEL VAL$(A)
2340 RETURN
2455 LORG 1
```

Label X-axis vertical

Label Y-axis

Label plot

TRANSLATE END LINE

Program: CURVE

Because this program is so large the data capacity must be decreased to 175 points.
DELETE 9999 END LINE → De-allocated memory

```
15 PLOTTER IS 705 @ CSIZE 7 @ DE
   G

20 DIM X(175,2),R$[32],F$[6],Y(4
   ),A(5),M(5),Z$[19],V$[19]

125 LORG 1

340 IF N>175 OR N<=1 THEN DISP "
    INVALID NO. OF POINTS" @ BEE
    P 10,25 @ GOTO 320

1040 IF N>=175 THEN DISP "MAX. N
     O. OF PAIRS=175" @ GOTO 870

1810 PRINT USING 1820;R5,M(5)

2150 PRINT USING "4DZ.2D,4DZ.2D"
     ;T,Y

2270 MOVE X1+R*Z1/5,FNV(X1+R*Z1/
     5)+10*D2 @ LABEL VAL$(R) @
     GOSUB 3210 @ RETURN

2760 LDIR 90 @ LORG 7

2780 MOVE I+4*D1,Y1-3*D2

2910 LDIR 0 @ LORG 7

2930 MOVE X1-8*D1,I-4*D2

3050 PENUP @ LDIR 0 @ LORG 5

3070 FOR I=1 TO N @ MOVE X(I,1),
     X(I,2) @ LABEL "+" @ NEXT I
     @ BEEP @ GOTO 3150

3150 RETURN

3265 LORG 1

3420 LDIR 0 @ L9=-INF @ LORG 1
```

Plot regression lines

Label X-axis vertically

Label Y-axis

Plot data points

TRANSLATE END LINE

Program: FPLOT

```
15 PLOTTER IS 705 @ CSIZE 7

1125 DEG
```

```
1180 LDIR 90 @ LORG 7
1200 MOVE I+4*D1,Y1-8*D2
1260 LDIR 0 @ LORG 1
1330 LDIR 0 @ LORG 7
1350 MOVE X1-8*D1,I-4*D2
1520 PENUP @ P=0 @ LORG 1
1670 BEEP @ PENUP @ RETURN
1790 PRINT USING "10D.5D,10D.5D";
     I,F
```

Label X-axis vertically

Label Y-axis

TRANSLATE END LINE

Program: DPLOT

```
15 PLOTTER IS 705 @ CSIZE 7 @ DE
   G
2300 LDIR 90 @ LORG 7
2320 MOVE I+4*D1,Y1-8*D2
2450 LDIR 0 @ LORG 7
2470 MOVE X1-8*D1,I-4*D2
2610 PENUP @ LDIR 0 @ LORG 1
2700 BEEP @ PENUP
3120 LDIR 0 @ L9=-INF @ LORG 1
```

Label X-axis vertically

Label Y-axis

TRANSLATE END LINE

Program: HISTO

```
15 PLOTTER IS 705 @ CSIZE 7 @ DE
   G
2530 BEEP @ PENUP @ RETURN
2660 RETURN
```

To remove copy soft key

TRANSLATE END LINE

Program: CALEND

```
15 PLOTTER IS 705 @ CSIZE 7
1675 LORG 6
```

```
1680 MOVE 44,64
1760 MOVE 44,60
2045 LORG 1
2240 RETURN
2390 IMOVE -2.3,0 @ DRAW I+36,10
```

} Heading label locations

TRANSLATE END LINE

Program: BIORHY

```
15 PLOTTER IS 705 @ CSIZE 7
1630 SCALE .5,32.375,-1.3,1.565
2080 CLEAR @ DISP "PLOT COMPLETE
     "
2200 PENUP @ RETURN
```

DELETE 1890,2000 END LINE
TRANSLATE END LINE

These program modifications will produce reasonable plots. Special case data sets may need the axis labeling to be further modified. This can be easily done by referring to the locations which have been noted.

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