

HEWLETT-PACKARD

HP-85

STANDARD PAC





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.

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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

CURVE	PROG	256	55	6
FPLOT	PROG	256	22	7
DPLOT	PROG	256	43	8
HISTO	PROG	256	36	9
TEACH	PROG	256	27	10
CALEND	PROG	256	22	11
BIORHY	PROG	256	21	12
TIMER	PROG	256	30	13
COMPZR	PROG	256	56	14
SKI	PROG	256	20	15
MUSIC	DATA	256	44	16

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

Type:  "CALEND"
 Press: 

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 inadvertently 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 of 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: "MOVING"
 - b. Press:
 3. To start the program:
 - a. Press:
 4. When the keys are labelled and SELECT OPTION is displayed:
 - a. Press: KEY #5 (HELP), if you need a more detailed explanation.
 5. When NUMBER OF POINTS IN AVERAGE? is displayed:
 - a. Enter: The number of points in the moving average.
- 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.

- b. Press:
- 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:
- Enter: The number of points to be retained before replacing old values with new values.
 - Press:
- 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:
- Press: KEY #2 (ENTER)
 - When OLD OR NEW DATA: O/N? is displayed:
 - Enter: O, if the data is stored on a data file.
 - Press:
 - Go to step 8.

OR:

 - Enter: N, if the data is to be entered from the keyboard.
 - Press:
 - 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:
- Enter: The name of the data file.
 - Press:
 - 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:
- Enter: The next value.
- b. Press:
- OR:
- Enter: INF to designate that there are no more entries.
- b. Press:
- c. Go to step 11.
10. When MORE ENTRIES: Y/N? is displayed:
- Enter: Y, if there are more values.
 - Press:
 - Go to step 9.
- OR:
- Enter: N, if there are no more values.
- b. Press:
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:
- Press: KEY #3 (AVERAGE), to print the current moving average.
 - Go to step 11 after the average is printed.
- OR:
- Press: KEY #4 (STORE), to store the array of retained values.
 - Go to step 12.
- OR:
- Press: KEY #7 (VALUES), to print the retained values in order of most recent first.
 - Go to step 11 after the values are printed.
- OR:
- Press: KEY #8 (PLOT), to plot the data and the moving average.
 - Go to step 13.
12. When ENTER NAME OF FILE? is displayed:
- Enter: The name of the data file.
 - Press:
 - 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:
- OR:
- a. Enter: N, if the averages are not to be printed.
- b. Press:
- 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:
- OR:
- a. Enter: N, if the existing plot is not to be erased before this plot.
- b. Press:
- 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:
- OR:
- a. Enter: H, if the X-axis labels are to be written horizontally.
- b. Press:
- 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 ( $\leq 16$ ).
- b. Press:
- 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:
- 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:
- OR:
- a. Enter: 0, if no labels are desired on the X-axis.
- b. Press:
- 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:
- c. Go to step 21.
- OR:
- a. Enter: N, if you want to enter the Y-minimum and Y-maximum values.
- b. Press:
- 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 |

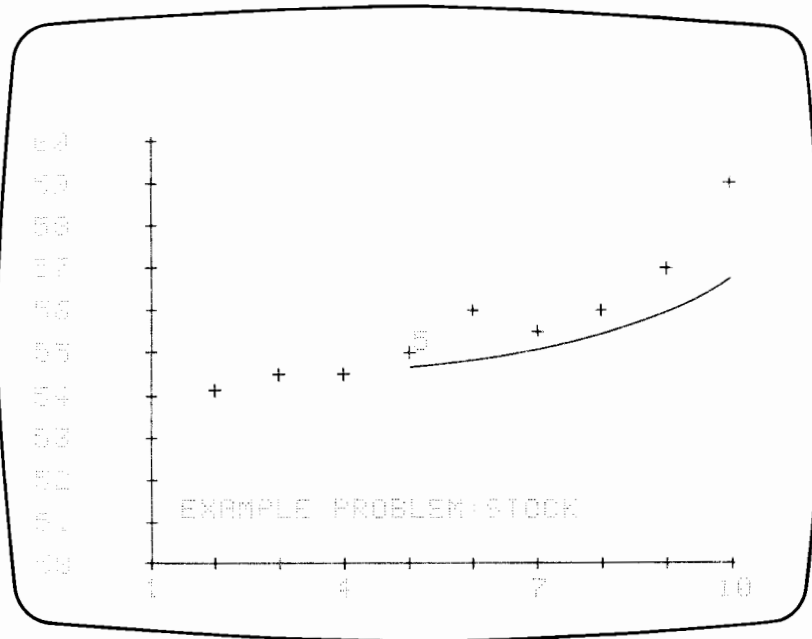
Compute the moving average after specifying a five-period moving average and retaining values for 100 periods. After entering the ten values, plot the moving averages and store the retained values in file "STOCK".

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
```

```

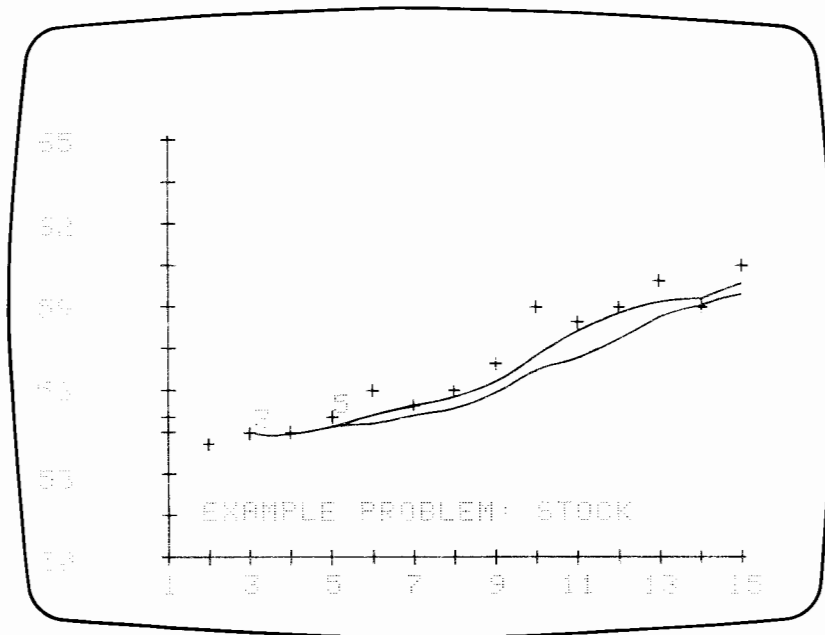
MOVING AVERAGES
MOST RECENT FIRST
NUMBER OF POINTS = 5
59.4
59.1
58.7
57.9
57.2
56.7
55.9
55.4
55.1
54.825
54.625

```

```

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:

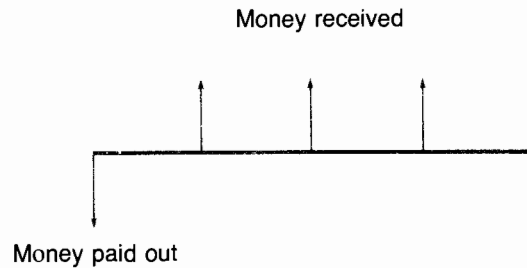
- $n$ , which is the number of compounding periods. (For a 30 year loan with monthly payments,  $n = 12 \times 30 = 360$ ).
- $i$ , which is the annual interest rate expressed as a percent.
- $PMT$ , which is the periodic payment.
- $PV$ , which is the present value of the cash flows or compound amounts.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

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

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

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 (r) 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:

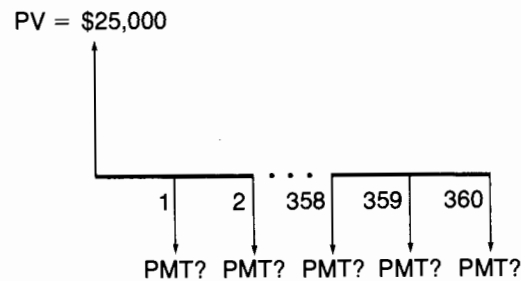
- 1) Enter: The ending period number.
- 2) Press: **END LINE**

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:

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

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

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

$$X_{k+2} = 2x X_{k+1} - (x^2 + y^2) X_k \quad \text{where } x+iy \text{ are the root approximations}$$

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

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

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

---

### 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:  $\text{\textcircled{REW LOAD}}$  "POLY"
  - b. Press:  $\text{\textcircled{END LINE}}$
3. To run the program:
 

Press:  $\text{\textcircled{RUN}}$
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:  $\text{\textcircled{END LINE}}$
6. When MAX # OF ITERATIONS? is displayed:
  - a. Enter: The maximum number of iterations allowed per root.
  - b. Press:  $\text{\textcircled{END LINE}}$
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:  $\text{\textcircled{END LINE}}$
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:  $\text{\textcircled{END LINE}}$
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.,  $(a_0 + b_0i) + (a_1 + b_1i)Z^1 + (a_2 + b_2i)Z^2 + \dots + (a_n + b_ni)Z^n$ .
  - b. Press:  $\text{\textcircled{END LINE}}$
10. When Icoef( )=? is displayed:
  - a. Enter: The appropriate imaginary part of the coefficient as in step 9.
  - b. Press:  $\text{\textcircled{END LINE}}$
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:  $\text{\textcircled{END LINE}}$

**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:  $\text{\textcircled{END LINE}}$

15. When Icoef(I)? (Where I is the number of the coefficient to be changed) is displayed:
- Enter: The new value of Icoef(I).
  - Press: 
  - 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:

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

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: C(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:  $E(Rcoef(0)+Icoef, --$

| 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:  "SIMUL"
  - b. Press:
3. To start the program:
  - a. Press:
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:
6. When ENTER COEFF FOR ELEMENT #\_? is displayed:
  - a. Enter: The  $j$ th coefficient of the  $i$ th equation.
  - b. Press:
7. Repeat step 6 for each coefficient of the  $i$ th equation.
8. When ENTER THE RHS OF EQUATION #\_? is displayed:
  - a. Enter: The right-hand side of the  $i$ th equation.
  - b. Press:
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:
- Press: KEY #4 (PRINT), to print out the system of equations.
  - After the printout, go to step 10.
- When WHICH EQUATION? is displayed:
    - Enter: The equation number of the equation which needs to be changed.
    - Press: **END LINE**
  - When WHICH SIDE :L/R? is displayed:
    - Enter: L, if you want to change the left-hand side of the equation.
    - Press: **END LINE**
    - Go to step 13.

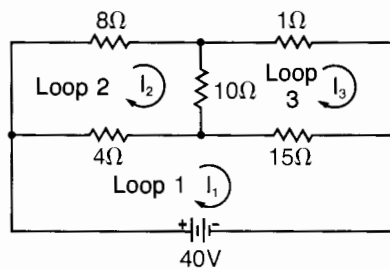
OR:

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

Note: You must enter either "L" or "R" or the program will beep and go to step 12.
  - When WHICH COEFFICIENT IS WRONG? is displayed:
    - Enter: The subscript of the faulty coefficient.
    - Press: **END LINE**
  - When ENTER COEFF FOR ELEMENT #\_? is displayed:
    - Enter: The new  $j$ th coefficient of the  $i$ th equation.
    - Press: **END LINE**
    - Go to step 10.
  - When ENTER THE RHS OF EQ. #\_? is displayed:
    - Enter: The new right-hand side of the  $i$ th equation.
    - Press: **END LINE**
    - Go to step 10.
  - When ENTER EPSILON? is displayed:
    - Enter: The minimum value for a pivot value.
    - Press: **END LINE**
    - 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:

$$\text{LOOP 1: } 4I_1 - 4I_2 + 15I_1 - 15I_3 - 40 = 0$$

$$\text{LOOP 2: } 4I_2 - 4I_1 + 8I_2 + 10I_2 - 10I_3 = 0$$

$$\text{LOOP 3: } 10I_3 - 10I_2 + 1I_3 + 15I_3 - 15I_1 = 0$$

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 #4: 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  $f(x)$ .

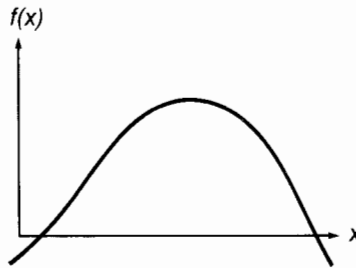


Figure 1

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).

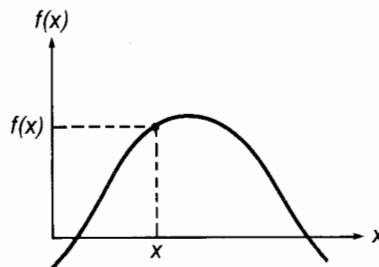


Figure 2

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:

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

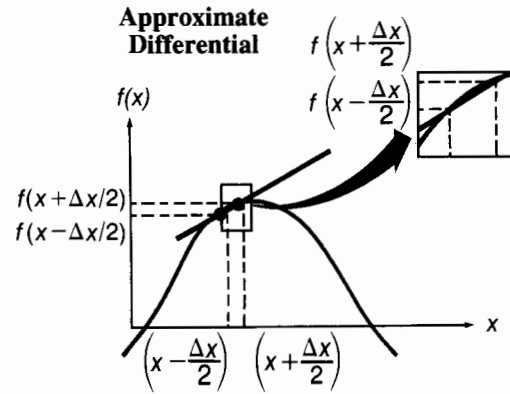


Figure 3

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

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  $\% \Delta$ . 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  $O(h^4)$  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:

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

where  $n = \text{number of intervals}$ ,

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

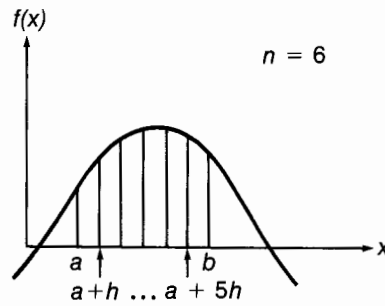


Figure 4

You can search for solutions of  $f(x)=0$  over an interval  $[a, b]$  by using KEY #3. After you specify the search increment  $\Delta x$  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,  $\text{Maxbi}$ , 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  $N = \text{int} \left( \frac{b - a}{\Delta x} \right)$  intervals.

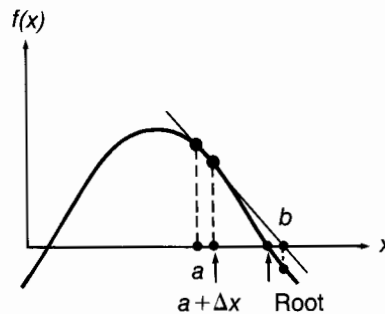


Figure 5

## 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:  $\text{\textcircled{REW LOAD}}$  "ROOTS"
  - b. Press:  $\text{\textcircled{END LINE}}$
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:  $\text{\textcircled{RUN}}$
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:  $\text{\textcircled{END LINE}}$
  - c. Go to step 6.

OR:

  - a. Enter: N, if the function is not stored.
  - b. Press:  $\text{\textcircled{END LINE}}$
  - 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:  $\text{\textcircled{END LINE}}$
8. When ENTER % $\Delta$ ? is displayed:
  - a. Enter: The % $\Delta$ .
  - b. Press:  $\text{\textcircled{END LINE}}$

OR:

  - a. Enter: 0 if the default of .01% is to be used as the % $\Delta$ .
  - b. Press:  $\text{\textcircled{END LINE}}$
9. After the differential is printed, go to step 6.
10. When ENTER LOWER BOUND? is displayed:
  - a. Enter: The lower bound.
  - b. Press:  $\text{\textcircled{END LINE}}$
11. When ENTER UPPER BOUND? is displayed:
  - a. Enter: The upper bound.
  - b. Press:  $\text{\textcircled{END LINE}}$
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:  $\text{\textcircled{END LINE}}$

OR:

  - a. Enter: N, if only the final value is to be printed.
  - b. Press:  $\text{\textcircled{END LINE}}$

13. When MAX # OF INTERVAL HALVINGS? is displayed:
- 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.
  - Press: **END LINE**
14. When ERROR TOLERANCE? is displayed:
- 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.
  - 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:
- Enter: The lower bound.
  - Press: **END LINE**
18. When ENTER UPPER BOUND? is displayed:
- Enter: The upper bound.
  - Press: **END LINE**
19. When ENTER MAXIMUM # OF BISECTIONS? is displayed:
- Enter: The maximum number of bisections allowed in searching for any one root in a subinterval.
  - Press: **END LINE**
20. When ERROR TOLERANCE? is displayed:
- Enter: The error tolerance desired.
  - Press: **END LINE**
21. When ENTER SEARCH INCREMENT? is displayed:
- Enter: The search increment.
  - Press: **END LINE**
22. When ENTER # OF ROOTS? is displayed:
- Enter: The number of roots to be found.
  - 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:
- Enter: The value of  $x$ .
  - 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:

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

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 =
 1.68360055409
INTERVALS 4 INTEGRAL =
 1.6857421814
INTERVALS 8 INTEGRAL =
 1.68575035466
INTERVALS 16 INTEGRAL =
 1.68575035409
 1.00010000100
 1.00010000100
INTEGRAL = 1.68575035482
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  $\% \Delta$  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
-1.68652037618

```

# 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.

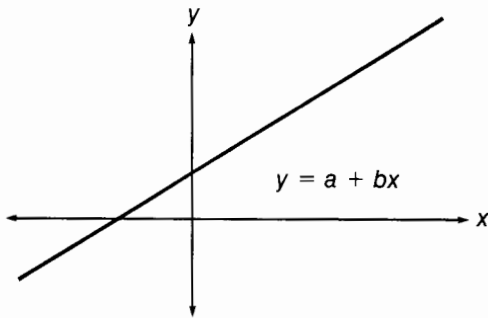
After the analysis of variance has been calculated and printed, you can plot the regression line over the data. Projections can also be made based on the curve fit. You can either enter single values of  $x$  or request that all values of  $x$  in the data set be used to estimate values of  $y$ ,  $\hat{y}$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

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

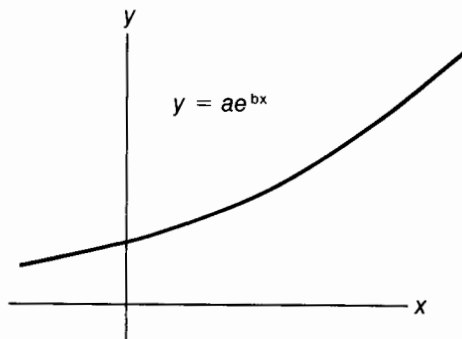


$$b = \frac{\sum x_i y_i - \frac{\sum x_i \sum y_i}{n}}{\sum x_i^2 - \frac{(\sum x_i)^2}{n}}$$

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

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

## Exponential Curve Fit

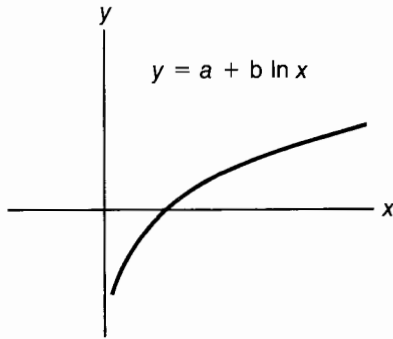


$$b = \frac{\sum x_i \ln y_i - \frac{1}{n} (\sum x_i)(\sum \ln y_i)}{\sum x_i^2 - \frac{1}{n} (\sum x_i)^2}$$

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

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

### Logarithmic Curve Fit

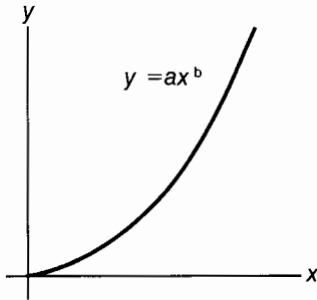


$$b = \frac{\sum y_i \ln x_i - \frac{1}{n} \sum \ln x_i \sum y_i}{\sum (\ln x_i)^2 - \frac{1}{n} (\sum \ln x_i)^2}$$

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

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

### Power Curve Fit



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

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




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

#### 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:  "CURVE"
  - b. Press: 
3. To start the program:
  - a. Press: 
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: 


OR:



    - a. Enter: N, if you do not want the data printed on entry.
    - b. Press: 


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: 
  - c. Go to step 7.
 

OR:


    - a. Enter: T, if the data is to be entered from an existing data file.
    - b. Press: 
- 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: 

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: 
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: 

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: 
  - c. Go to step 14.
 

OR:

    - a. Enter: N, if the data is not to be plotted.
    - b. Press: 
    - 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:

c. Go to step 17.

OR:

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

b. Press:

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:

16. When ENTER SCALE XMAX? is displayed:

a. Enter: The maximum X value for scaling.

b. Press:

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:

OR:

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

b. Press:

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 ( $\leq 16$ ).

b. Press:

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:

OR:

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

b. Press:

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:

c. Go to step 23.

OR:

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

b. Press:

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:

22. When ENTER SCALE YMAX? is displayed:

a. Enter: The maximum Y value for scaling.

b. Press:



- 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:
- Enter: The number of Y-axis intervals ( $\leq 12$ ).
  - Press:
- 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:
- 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.
  - Press:
- OR:
- Enter: 0 if no labels are desired on the Y-axis.
  - Press:
- 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.
- Press: `KEY #2 (OUTPUT)`, to output the data to either the printer or a tape file.
  - Go to step 26.
- OR:
- Press: `KEY #6 (EDIT)`, to edit the data.
  - Go to step 31.
- OR:
- 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)`
- 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:
- Enter: Y, to print the data.
  - Press:
- OR:
- Enter: N, if a printout of the data is not wanted.
  - Press:
- 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:
- Enter: Y, if you want to store the data.
  - Press:
  - Go to step 28.
- OR:
- Enter: N, if you do not want to store the data.
  - Press:
  - 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:
- Enter: The file name.
  - Press:
29. When `CREATE FILE:Y/N?` is displayed:
- Enter: Y, to create the file.
  - Press:
- OR:
- Enter: N, if the file already exists.
  - Press:

**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:
- Enter: 0, if the edit is finished.
  - Press:
  - 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:

- Enter: 1, if you want to correct a data pair.
- Press:
- Go to step 32.

OR:

- Enter: 2, if you want to delete a data pair.
- Press:
- Go to step 35.

OR:

- Enter: 3, if you want to insert a data pair.
- Press:
- Go to step 36.

32. When ENTER INDEX OF PAIR TO CORRECT? is displayed:
- Enter: The index of the data pair.
  - Press:
  - 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:

- Enter: A value less than 1 to terminate the correction mode.
- Press:
- Go to step 31.

33. When NEW X( )=? is displayed:
- Enter: The correct value.
  - Press:
34. When NEW Y( )=? is displayed:
- Enter: The correct value.

- Press:
- Go to step 31.

35. When ENTER INDEX OF PAIR TO DELETE? is displayed:

- Enter: The index of the pair.
- Press:
- 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:

- Enter: A value less than 1 to terminate the deletion mode.
- Press:
- Go to step 31.

36. When ENTER INDEX OF PAIR TO INSERT? is displayed:

- Enter: The index of the pair to insert before.
- Press:
- 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:

- Enter: A value less than 1 to terminate the insertion mode.
- Press:
- Go to step 31.

37. When INSERT X( ), Y( )? is displayed:

- Enter: The X and Y values separated by a comma.
- Press:
- Go to step 31.

38. When DONE is displayed, go to step 13.

39. When ESTIMATE Y:Y/N? is displayed:

- Enter: Y, if  $\hat{y}$  is to be calculated.

- b. Press:
- c. Go to step 40.
- OR:
- a. Enter: N, if no estimates are desired.
- b. Press:
- 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:
- c. Go to step 41.
- OR:
- a. Enter: N, if all are not desired.
- b. Press:
- 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:
- c. Go to step 42.
- OR:
- a. Enter: N, if no more estimates are desired.
- b. Press:
- 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:
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:
- c. Go to step 45.
- OR:
- a. Enter: N, if the plot is not wanted.
- b. Press:
- 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:
- c. Go to step 46.
- OR:
- a. Enter: N, if no label is desired.
- b. Press:
- 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:
- 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.

played, the program beeps and goes to

b. Press: **END LINE**

step 47.

**Note:** If LABEL TOO LONG is dis-

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:

$$F^{\circ} = a + bC^{\circ}$$

**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  $C = 22^{\circ}$ ?

```

ADV: 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

```

```

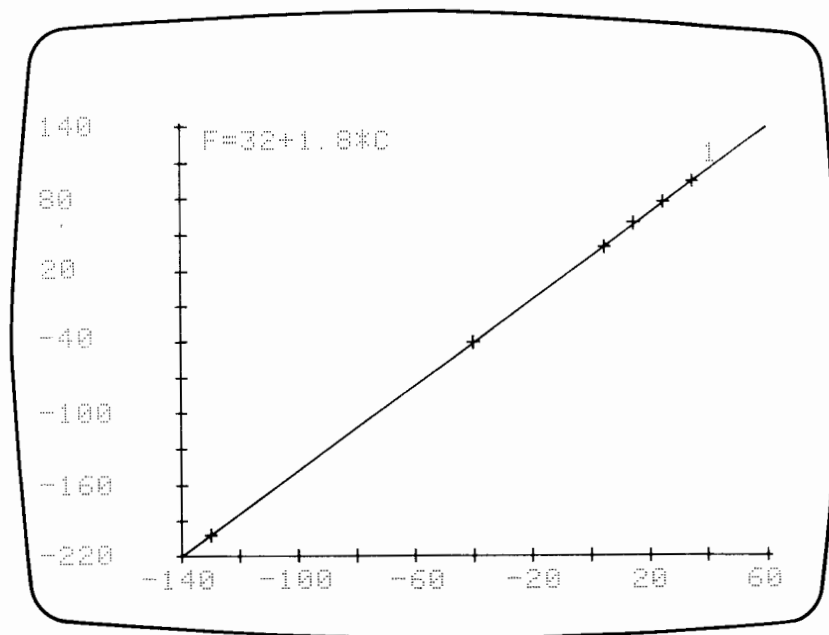
X(I) YHAT

```

```

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 |

```

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

```

```

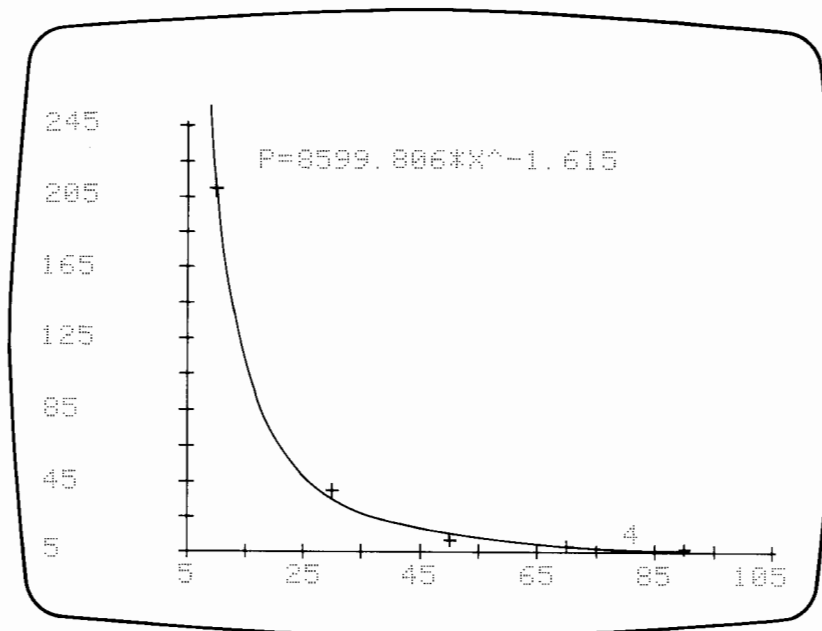
YHAT= 8599.806X ^ -1.615

```

```

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:  "FPLOTT"
  - b. Press:
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:
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:
7. When ENTER SCALE XMAX? is displayed:
  - a. Enter: The maximum X-value.
  - b. Press:










**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:

**OR:**

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

**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:

**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:
- 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.
  - Press: 
- OR:
- Enter: 0, if no labels are desired on the X-axis.
  - Press: 
- 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:
- Enter: Y, if the plotting area is to be scaled using the Y-values generated over the range of XMIN to XMAX.
  - Press: 
  - Go to step 14.
- OR:
- Enter: N, if you want to enter the Y-scaling information.
  - Press: 
- 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:
- Enter: The minimum Y-value.
  - Press: 
13. When ENTER SCALE YMAX? is displayed:
- Enter: The maximum Y-value.
  - Press: 
- 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:
- Enter: The number of Y-axis intervals (<=12).
  - Press: 
- 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:
- 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.
  - Press: 
- OR:
- Enter: 0, if no labels are desired on the Y-axis.
  - Press: 
- 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:
- Press: KEY #2 (SINGUL) to enter points of singularity.
  - Go to step 17.
- OR:
- Press: KEY #3 (FUL PLT) to generate a full plot.
  - Go to step 19.
- Note:** This operation will clear the graphics screen and redraw the axes with labels.
- OR:
- Press: KEY #4 (TABLE) to generate a table of function values on the printer.
  - 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.

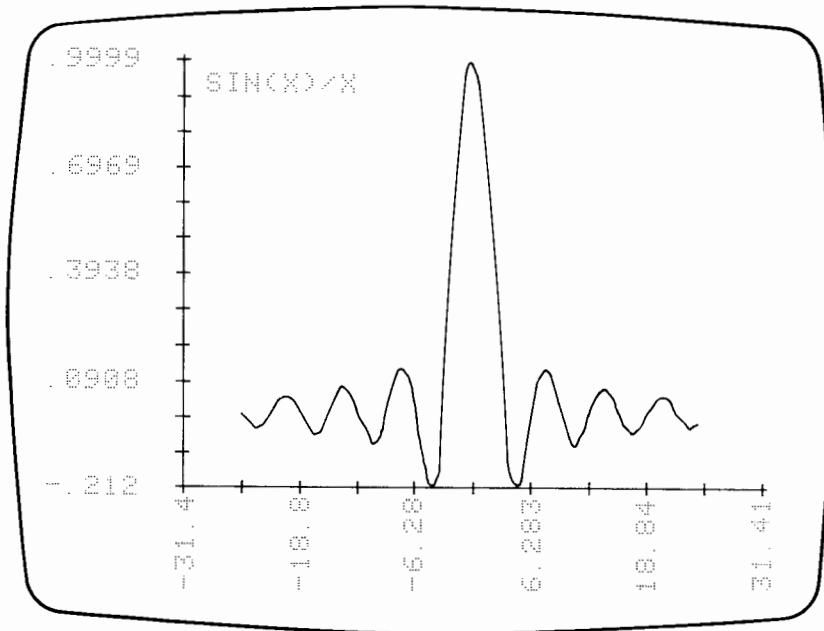
b. Press: **END LINE**

**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.

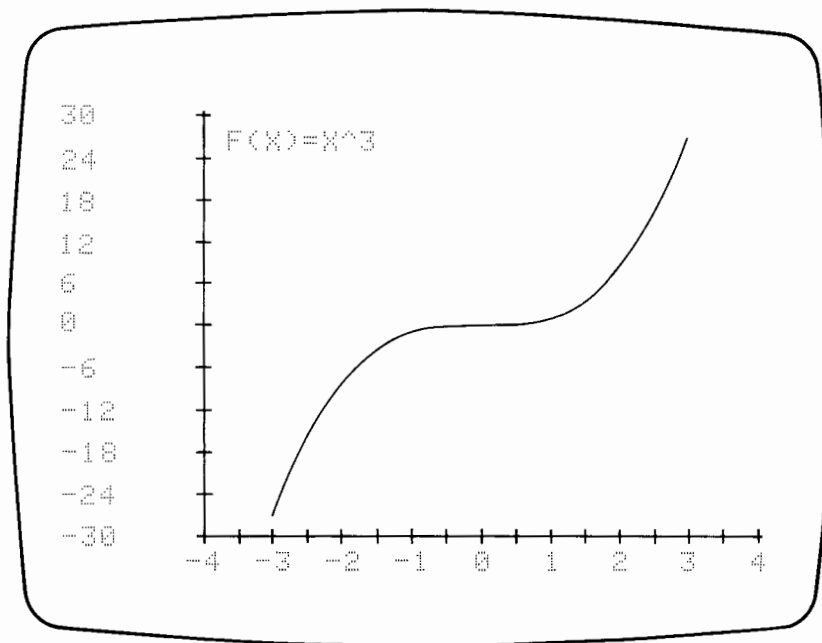
### Example 1:

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  $-8*\text{PI}$  using an increment of  $\text{PI}/4$ . The scaled range should be  $-10*\text{PI}$  to  $10*\text{PI}$ . 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:
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: 
  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: 
    - 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: 



OR:

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


**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: 
    - c. Go to step 15.

OR:


    - a. Enter: N, to not store the data.
    - b. Press: 
    - 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: 
  16. When `CREATE FILE:Y/N?` is displayed:
    - a. Enter: Y, if the file must be created.
    - b. Press: 

OR:

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

**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: 
    - 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 ( $\leq 16$ ).
    - 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 ( $\leq 12$ ).
- 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/+/*(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               |

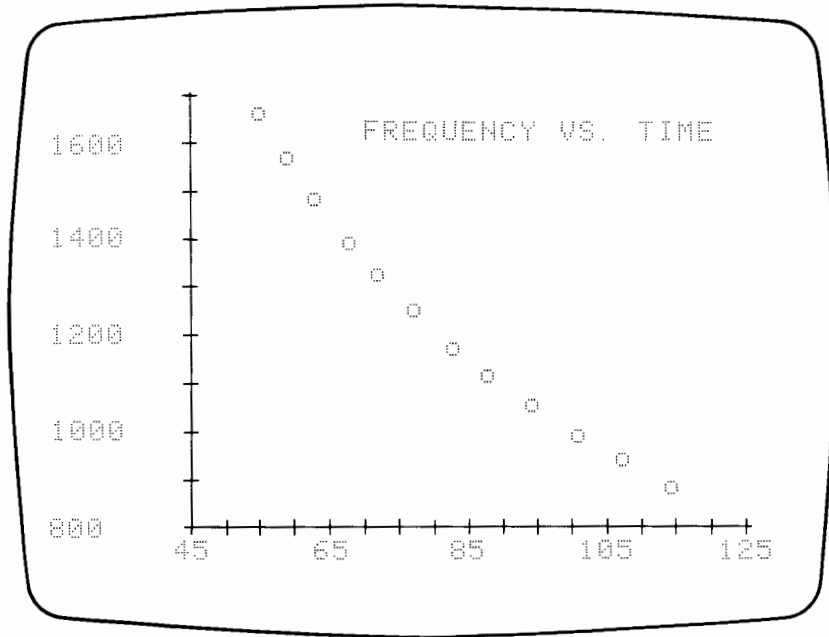
The example plot was done using the responses shown in the table below:

| 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

```



**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:  "HISTO"
  - b. Press:
3. To start the program:
  - a. Press:
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:
  - OR:
    - a. Enter: N, if the data is not to be printed.
  - b. Press:

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:
  - OR:
    - a. Enter: T, if the data is on a tape file.
  - b. Press:
  - 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  $X(\underline{\quad})?$  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:   
 OR:  
 a. Enter: N, if the file already exists.  
 b. Press:   
**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:   
**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:   
**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:   
**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:   
 OR:
- a. Enter: N, if you want to change the offset or cell width.  
 b. Press:   
 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:   
 c. Go to step 12.  
 OR:  
 a. Enter: 1 if you want to correct a data item.  
 b. Press:   
 c. Go to step 25.  
 OR:  
 a. Enter: 2 if you want to delete a data item.  
 b. Press:   
 c. Go to step 27.  
 OR:  
 a. Enter: 3 if you want to insert a data item.  
 b. Press:   
 c. Go to step 28.
25. When ENTER INDEX OF ITEM TO CORRECT? is displayed:  
 a. Enter: The index of the item.  
 b. Press:   
 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:   
 c. Go to step 24.

26. When `NEW X( )=?` is displayed:
- Enter: The correct value.
  - Press: **END LINE**
  - Go to step 24.
27. When `ENTER INDEX OF ITEM TO DELETE?` is displayed:
- Enter: The index of the item.
  - Press: **END LINE**
  - 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:
- Enter: A value less than 1 to terminate the deletion mode.
  - Press: **END LINE**
  - Go to step 24.
28. When `ENTER INDEX OF ITEM TO INSERT?` is displayed:
- Enter: The index of the item.
  - Press: **END LINE**
  - 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:
- Enter: A value less than 1 to terminate the insertion mode.
- Press: **END LINE**
  - Go to step 24.
29. When `INSERT X( )=?` is displayed:
- Enter: The X value.
  - Press: **END LINE**
  - Go to step 24.
30. When `LABEL ORIGIN: X, Y?` is displayed:
- Enter: The X and Y coordinates where the label is to start.
  - 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:
- Enter: The label.
  - 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:

|                  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| <b>Student #</b> | 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 |
| <b>Grade</b>     | 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            |

```

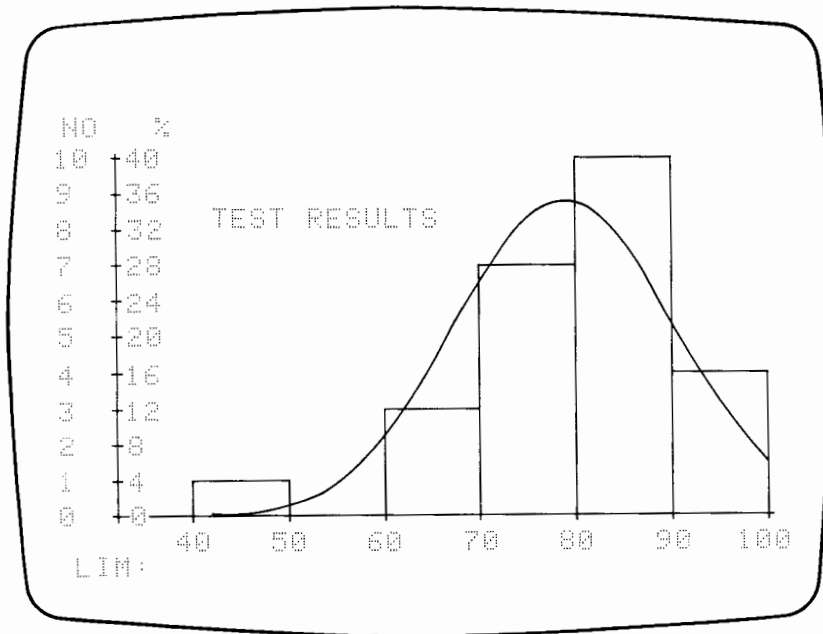
I X(I) X(I+1)
1 77.0000 65.0000
3 82.0000 91.0000
5 74.0000 83.0000
7 96.0000 61.0000
9 48.0000 72.0000
11 81.0000 88.0000
13 89.0000 73.0000
15 83.0000 84.0000
17 90.0000 71.0000
19 66.0000 88.0000
21 83.0000 77.0000
23 94.0000 85.0000
25 72.0000

```

```

OFFSET= 40
CELL WIDTH= 10

```





## CELL STATISTICS

| CELL# | LOWER<br>LIMIT | NUMBER<br>OF OBS. | %RELATIVE<br>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:  "TEACH"
  - b. Press: 
3. To start the program:
  - a. Press: 
4. When WHAT IS YOUR NAME? is displayed:
  - a. Enter: Your name. (<=32 characters)
  - b. Press: 
5. When the keys are labelled and SELECT OPTION is displayed:
  - a. Press: KEY #5 (HELP), if you need a more detailed explanation.
6. When ENTER MAXIMUM NUMBER? is displayed:
  - a. Enter: The maximum value for factors.
7. 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.

- 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:
- Enter: A value for seeding the random number generator.
  - Press: **END LINE**  
OR:
    - Enter: 0, if no seed is to be used.
  - Press: **END LINE**
8. To select problem type:
- Press: KEY #1 (+) for addition problems.
  - Go to step 9.  
OR:
    - Press: KEY #2 (-) for subtraction problems.
  - Go to step 9.  
OR:
    - Press: KEY #3 (\*) for multiplication problems.
  - Go to step 9.  
OR:
    - Press: KEY #4 (/) for division problems.
  - Press: KEY #7 (MIXED) for mixed addition, subtraction, multiplication, and division problems.
  - Go to step 9.  
OR:
    - Press: KEY #8 (ALGEBRA) for algebra problems.
  - Go to step 14.  
OR:
    - Go to step 5 to specify new problem conditions or obtain an explanation.
9. When ANSWER? is displayed:
- 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.
- Go to step 5 to specify new problem conditions.  
OR:
    - Go to step 8 to start a new problem set.
14. When the problem types and WHICH DO YOU WANT? are displayed:
- Enter: The type code (1-4) to specify the desired problem type.
  - 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:
- Enter: The answer to the displayed problem:
  - 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:

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

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

$$\text{Days} = \text{Day \#2} - \text{Day \#1}$$

To compute the date from a day number:

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

$$\text{Day of month} = \text{Day \#} - \text{INT}(365.25y') + \text{INT}(y'/100) \\ - \text{INT}(y'/400) - \text{INT}(30.6001m')$$

$$\text{MONTH} = m = m' - 13 \quad \text{if } m' = 14 \text{ or } 15 \\ m' - 1 \quad \text{if } m' < 14$$

$$\text{YEAR} = y' \quad \text{if } m > 2 \\ y' + 1 \quad \text{if } m = 1 \text{ or } 2$$

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

$$D(m,d,y) = d - \text{INT}(.75 \text{INT}(g(y,m)/100) - 7) \\ + \text{INT}(365.25 g(y,m)) + \text{INT}(30.6f(m))$$

$$f(m) = \begin{cases} m + 13 & \text{if } m = 1, 2 \\ m + 1 & \text{if } m > 2 \end{cases}$$

$$g(y,m) = \begin{cases} y - 1 & \text{if } m = 1, 2 \\ y & \text{if } m > 2 \end{cases}$$

$W$  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:

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

To compute day of the year:

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

## User Instructions

1. Insert the Standard Pac cartridge into the tape transport.
  2. To load the program:
    - a. Type:  "CALEND"
    - b. Press: 
  3. To start the program:
    - a. Press: 
  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 (/), 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 ( $\Delta$  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 (DAYS+DT), 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 ( $\Delta$ W. 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.
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:
    - 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:
    - 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:
    - 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:
    - 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:
    - 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:
    - 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:
- Enter: The heading for the calendar. The maximum number of characters in the heading is 32.
  - Press: **END LINE**
- Note: If no heading is desired, enter a blank.
14. After the plot is finished:
- Press: **COPY** to get another copy on the printer.
  - Go to step 4 when the copy is finished.  
OR:
  - 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 |
|-----|-----|-----|-----|-----|-----|-----|
|     |     |     |     |     |     |     |
| 2   | 3   | 4   | 5   | 6   | 7   | 8   |
| 9   | 10  | 11  | 12  | 13  | 14  | 15  |
| 16  | 17  | 18  | 19  | 20  | 21  | 22  |
| 23  | 24  | 25  | 26  | 27  | 28  | 29  |
|     | 30  | 31  |     |     |     |     |

**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
```

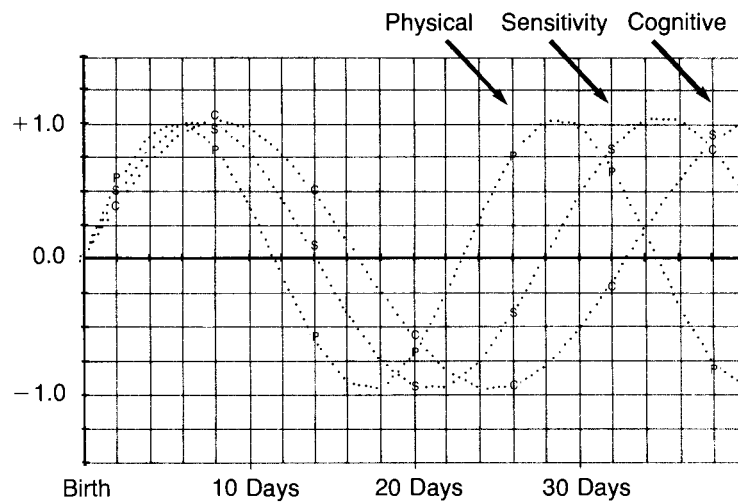
**Notes**

# 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:  "BIORHY"
  - b. Press:
3. To start the program:
  - a. Press:
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:
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:
  - 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:
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:
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:

OR:

  - a. Enter: N, if you do not want a copy.
  - b. Press:

**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

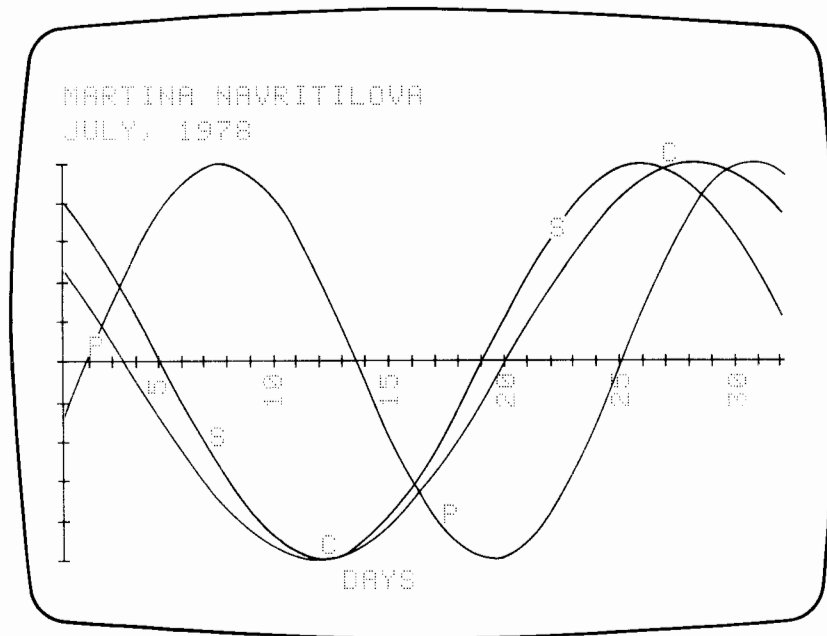
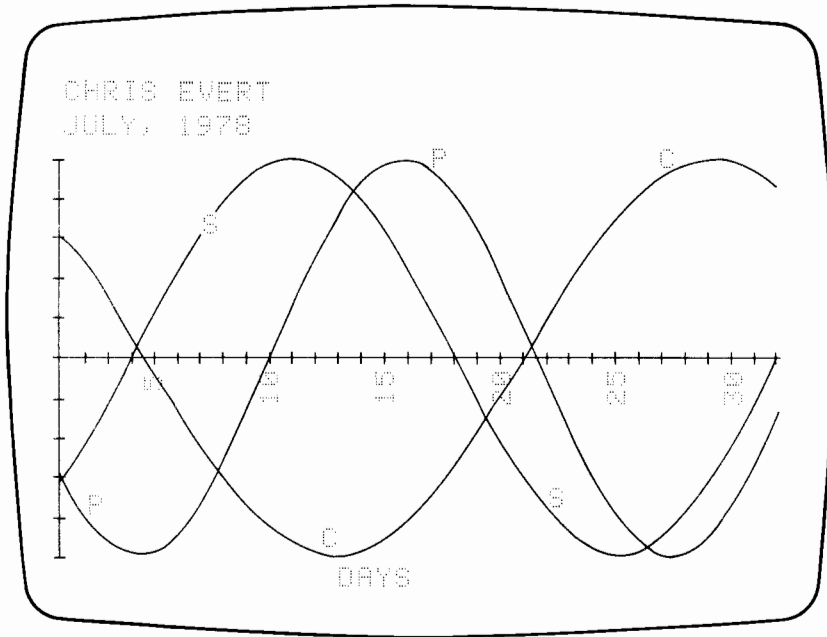
6/ 2/1978  
 6/16/1978  
 6/30/1978

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.





**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:

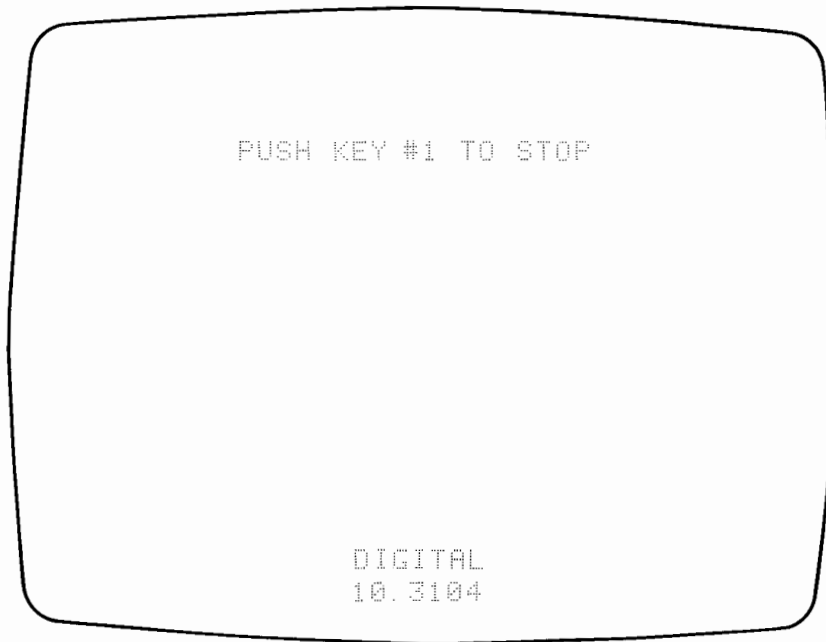
- a. Press: KEY #2 (DIGITAL) to specify the digital clock format.
  - b. Go to step 8.  
OR:
  - a. Press: KEY #6 (CLOCK) to select the graphical clock with chimes.
  - b. Go to step 8.  
OR:
  - a. Press: KEY #8 (5-SEC) to specify the five-second display mode.
  - b. Go to step 8.
- Note:** If TIME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

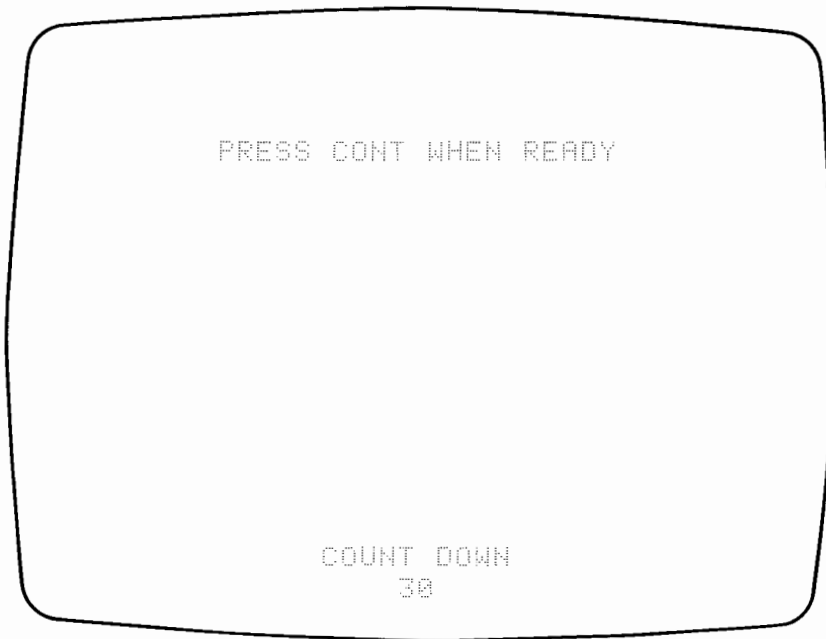
**Example 1:**

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.



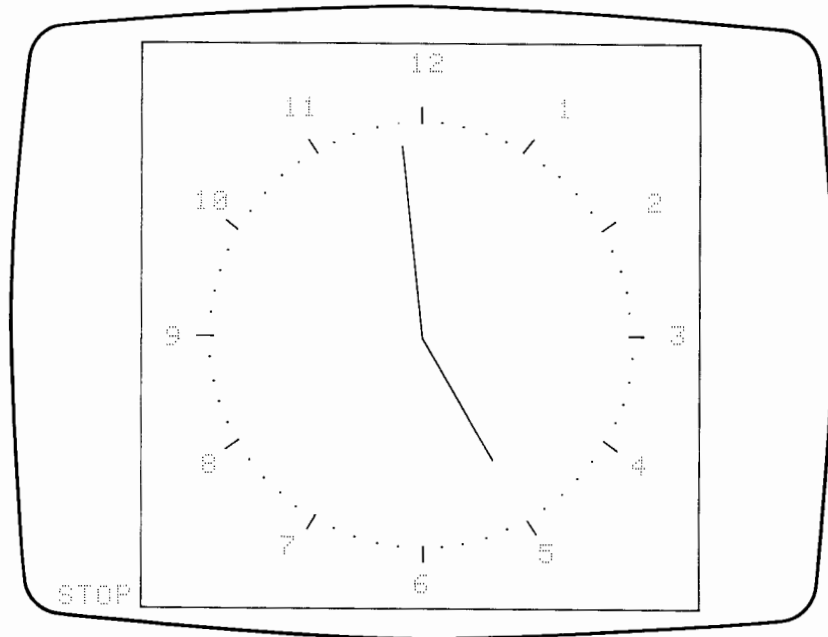
**Example 3:**

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  $\grave{c}$ ,  $\bar{x}$ ,  $\bar{N}$ ,  $\alpha$ ,  $\beta$ ,  $\Gamma$ , 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:  "COMPZR"
  - b. Press:
3. To start the program:
  - a. Press:
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  for the explanation of the composition symbols.
  - c. After the example theme is played, go to step 4.  
OR:
5. When OLD OR NEW TUNE: O/N? is displayed:
  - a. Enter: O, if the tune is stored on tape.
  - b. Press:
  - c. Go to step 6.  
OR:
    - a. Enter: N, if the tune is to be entered from the keyboard.
    - b. Press:
    - 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:

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: 
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: 

OR:


    - a. Enter: N, if any acceptable input will be stored.
    - b. Press: 

**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: 

OR:

    - a. Type: END, to terminate entry.
    - b. Press: 
  - 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
 0̂x̂Âôêf̂ĝ

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:M6003T8G04CET4GT
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: 
  - c. Go to step 12.

OR:

  - a. Enter: N, if you want to re-enter this entry with changes.
  - b. Press: 
  - c. Go to step 14.
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: 
  - 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:
- c. Go to step 17.  
OR:
- a. Enter: N, if the timing is correct.
- b. Press:
- 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:
- 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:
- c. Go to step 19.  
OR:
- a. Enter: N, if no changes are needed.
- b. Press:
- 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:
- OR:
- a. Enter: N, if any acceptable input will be stored.
- b. Press:
- 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:
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:
- 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:



- 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:
    - 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:
    - OR:
      - a. Enter: OK, if the note is correct.
      - b. Press:
      - 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:
    - c. Go to step 26.
    - OR:
      - a. Enter: N, if you want to re-enter this entry with changes.
      - b. Press:
      - 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:
    - c. Go to step 20.
    - OR:
      - a. Enter: N, if there are no more changes.
      - b. Press:
      - 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:
    - 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:
  30. When CREATE:Y/N? is displayed:
    - a. Enter: Y, if the file must be created.
    - b. Press:
    - OR:
      - a. Enter: N, if the file already exists.
      - b. Press:

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:

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:

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:

**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:

**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:

OR:

a. Enter: N, if any acceptable input will be stored.

b. Press:

**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:

40. If ?\_AT\_ is displayed:

a. Enter: The correct character(s).

b. Press:

41. If the review option was specified and OK:Y/N? is displayed:

a. Enter: Y, if the entry is correct.

b. Press:

c. Go to step 42.

OR:

#### 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.

a. Enter: N, if you want to re-enter this entry with changes.

b. Press:

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:

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:

**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:

**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:

OR:

a. Enter: S, if the notes are to be plotted using musical notation.

b. Press:

**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.



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:  "SKI "
  - b. Press:
3. To start the program:
  - a. Press:
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:

OR:

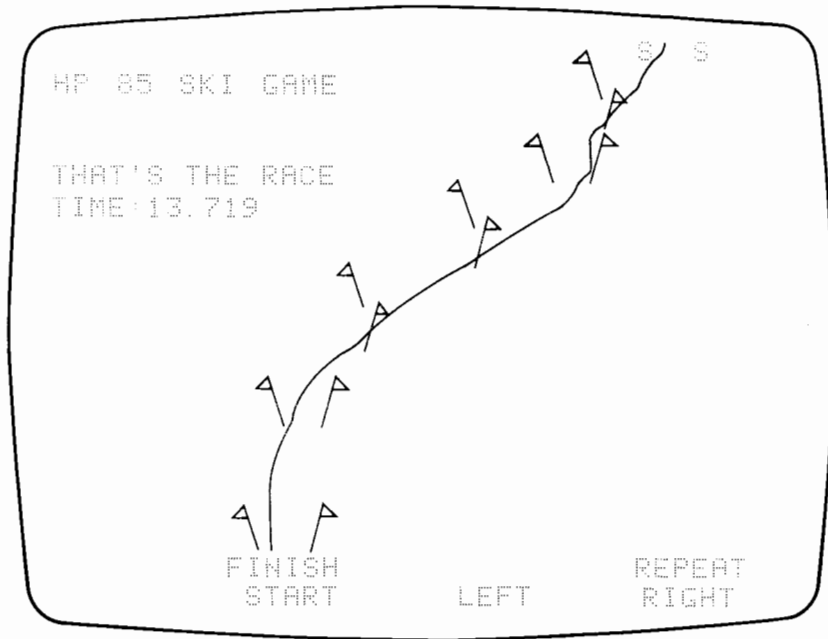
  - a. Enter: 1, if the desired background color is black.
  - b. Press:

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:
7. When WHAT'S YOUR ABILITY:  
1 TO 5  
(1 IS EASY, 5 IS HARD)?  
appears in the display:
- Enter: Your ability level.
  - Press:
- 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:
- Press: KEY #2 (START) when you are ready to start skiing.
  - There will be an audible sequence before the dot appears in the starting gate.
9. To increment the velocity component in the left direction:
- Press: KEY #3 (LEFT)
- Note:** Do not hold key down!
10. To increment the velocity component in the right direction:
- 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:
- Press: KEY #8 (REPEAT) if you want to repeat the same course with the same ability level.
- b. Go to step 8.
- OR:
- 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:
- Enter: Y, if you want to try again.
  - Press:
- OR:
- Enter: N, if you want to stop.
  - Press:
  - 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:
- Enter: Y, if you want to specify a different course.
  - Press:
  - Go to step 5.
- OR:
- Enter: N, if you only want to change your ability level.
  - Press:
  - 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.



# Program Documentation and Programming Techniques

## Program

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# 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.

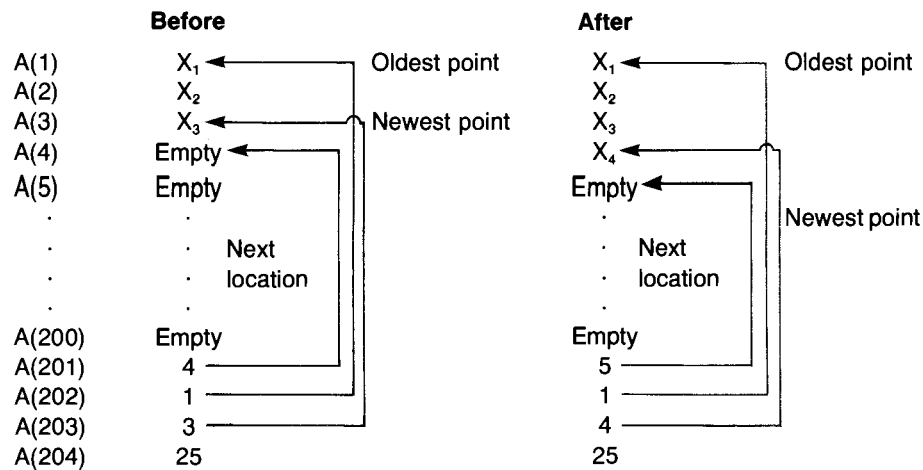
A circular list was employed to store the retained values. The first 200 elements of the array, A, are allotted to the circular list. The element A(201) contains the index of the next available location in the array for storing data. The array elements A(202) and A(203) contain pointers to the oldest 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                              | New Value→ A (next available location)                                                                                                                                                  |
| 620 A(203)=A(201)                            | Next available location→ location of last entered value                                                                                                                                 |
| 630 A(201)=A(201)*(A(201)<br><A(204))+1      | 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. |
| 640 IF A(201)=1 THEN A(202)=<br>1 @ GOTO 570 |                                                                                                                                                                                         |
| 650 IF A(203)=A(202) THEN<br>A(202)=A(201)   | Set oldest value if it is the first entry or it is changed                                                                                                                              |
| 660 GOTO 570                                 |                                                                                                                                                                                         |



If we examine the contents of the array before and after the 4<sup>th</sup> 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                |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| <pre> 10 DIM A(205),A#(32),B(204) 20 F=0 @ PEN 1 30 ON KEY# 1,"AV/#P" 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 170 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 FIRST)" 160 DISP "K2 ENTER VALUES OPT. F   ROM EXIST-" 170 DISP " K3 ING DATA FILE-SECON   D STEP" 180 DISP "K7 PRINT CURRENT MOVIN   G AVERAGE" 190 DISP "K1 STORE RETAINED VALU   ES ON TAPE" 200 DISP "K5 HELP" 210 DISP "K7 PRINT RETAINED VALU   ES - MOST" 220 DISP " K8 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#&gt;1 AND A#&lt;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)&gt;=A AND A(204)&lt;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(Y/N)" 420 INPUT A#(1,32) 430 IF UPC#(A#(1,13))="N" THEN 57   0 440 IF UPC#(A#(1,13))="0" THEN BE   EP @ GOTO 400 450 DISP "ENTER FILE NAME" 460 INPUT A# 470 IF LEN(A#)&gt;=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#&amp;" 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 ENO" 590 INPUT T 600 IF T=INF THEN DISP "DONE" @   RETURN 610 A(201)=T 620 A(203)=A(201) 630 A(201)=A(201)*A(201)&lt;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#(1,13))="Y" THEN 57   0 700 IF UPC#(A#(1,13))="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 </pre> | <p>Initialization</p> <p>Wait loop until key is pressed<br/>HELP subroutine</p> <p>Enter # points in average</p> <p>Enter # points to be retained</p> <p>Verify values</p> <p>Initialize pointers</p> <p>Data Entry</p> <p>Old or New Data?</p> <p>Enter old data file name</p> <p>Read array</p> <p>New entry from keyboard</p> <p>Update pointers (see pro-<br/>gramming hints for more<br/>details)</p> <p>More entries? after reading data<br/>from data file</p> <p>Start AVERAGE subroutine<br/>Go to print out average<br/>Compute current moving<br/>average subroutine</p> | <pre> 800 U=U+1 810 P=P-1 820 IF P&gt;0 THEN 700 830 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 ERR#67 THEN 950 1000 CREATE A#;S @ 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#(1,13))="Y" THEN F   1=1 @ GOTO 1090 1080 IF UPC#(A#(1,13))="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#(1,13))="N" THEN 1   960 1130 IF UPC#(A#(1,13))="Y" THEN B   EEP @ GOTO 1100 1140 CLEAR @ ALPHA 1150 F=1 1160 DISP "VERTICAL/HORIZONTAL L   ABELS(Y/N)"; 1170 INPUT A#(1,32) 1180 IF UPC#(A#(1,13))="V" THEN S   9=0 @ GOTO 1210 1190 IF UPC#(A#(1,13))="H" THEN S   9=1 @ GOTO 1210 1200 BEEP @ GOTO 1160 1210 M3=A(203)*A(202)=0)+A(204)   *A(202)&lt;&lt;0) 1220 IF M3&lt;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&lt;&lt;=16"; 1250 INPUT L1 1260 IF L1&lt;0 THEN L1=(M3-1)&lt;-(L1   ) @ GOTO 1290 1270 IF L1#INT(L1) THEN BEEP @ G   OTO 1240 1280 IF L1&lt;1 OR L1&gt;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&lt;1 OR L3&gt;L1 THEN BEEP   @ GOTO 1290 1330 DISP "AUTO Y-SCALING(Y/N)"; 1340 INPUT A#(1,32) 1350 IF UPC#(A#(1,13))="Y" THEN 1   430 1360 IF UPC#(A#(1,13))="N" THEN @   EEP @ GOTO 1230 1370 DISP "ENTER SCALE YMIN"; 1380 INPUT M1 1390 DISP "ENTER SCALE YMAX"; 1400 INPUT M2 1410 IF M1&gt;M2 THEN BEEP @ GOTO   1370 1420 GOTO 1490 1430 M1=INF 1440 M2=-INF 1450 FOR I=1 TO M3 1460 IF A(I)&gt;M2 THEN M2=A(I) 1470 IF A(I)&lt;M1 THEN M1=A(I) 1480 NEXT I 1490 DISP "NO. OF Y-AXIS INTERVA   LS&lt;&lt;=12"; 1500 INPUT L2 1510 IF L2&lt;1 OR L2&gt;12 OR L2#INT(L   2) 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&lt;1 OR L4&gt;L2 THEN BEEP   @ GOTO 1520 </pre> | <p>Print out current moving<br/>average</p> <p>Store data routine<br/>Enter file name</p> <p>Print data on file</p> <p>Start PLOT routine<br/>PRINT AVERAGES?</p> <p>Plot done before?<br/>Yes, erase old or overlay</p> <p>Specify Scaling and labeling<br/>information</p> |
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| <pre> 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=1-46*D1 1620 Y0=M1-49*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 98 THEN 1750 1670 W1=LGTCABS(Z1/L1*L3)) 1680 IF 99 THEN 2450 1690 LDIR 90 1700 FOR I=1 TO M3+D1 STEP Z1/L1       KL3 1710 MOVE I+4*D1,Y0 1720 GOSUB 2560 1730 LABEL V#E1,VJ 1740 NEXT I 1750 IF 97 THEN 1930 1760 W1=LGTCABS(Z2/L2*L4)) 1770 W=LGT(ABS(M1+(M1-0))) +1 1780 IF W&gt;4-(SGN(W1)=-1) OR W1&lt;-       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#E1,VJ 1840 NEXT I 1850 GOTO 1930 1860 LDIR 90 1870 I=M1 @ GOSUB 2600 1880 MOVE X1+12*D1,M1 1890 LABEL "YMIN="V#E1,10J 1900 MOVE X1+24*D1,M1 1910 I=2*L2 @ GOSUB 2600 1920 LABEL "TICS="V#E1,10J 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&lt;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=0 OR U&gt;M3 THEN 2030 2010 J=J+(J&lt;M3)+1 2020 GOTO 1990 2030 T=S/U @ B(U)=T 2040 PENUP @ PLOT U,T 2050 IF U&gt;A OR A&gt;M3 THEN 2150 2060 J1=A(202)+(A(202)=0) @ J=J+       (J&lt;M3)+1 2070 FOR I=A+1 TO M3 2080 S=S-A(J1) 2090 J1=J1+(J1&lt;M3)+1 2100 S=S+A(J) 2110 J=J+(J&lt;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#E1,32J 2250 IF UPC#(A#E1,1J)="Y" THEN G       OSUB 2720 @ GOTO 2230 2260 IF UPC#(A#E1,1J)="N" THEN B       EEP @ GOTO 2230 2270 ALPHA @ DISP "CHANGE NUMBER       OF POINTS:Y/N"; 2280 INPUT A#E1,32J 2290 IF UPC#(A#E1,1J)="N" THEN 2       340 2300 IF UPC#(A#E1,1J)="Y" THEN S       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 </pre> | <p>Compute SCALE factors</p> <p>SCALE Plot</p> <p>Draw AXES</p> <p>Label plot</p> <p>Plot data points</p> <p>Plot moving averages</p> <p>Label moving average curve</p> <p>Print moving average values</p> <p>Label plot?</p> <p>Change number of points in average?</p> <p>Enter number of points in average</p> <p>Print out retained values</p> <p>Horizontal label routine</p> | <pre> 2460 FOR I=1 TO M3+D1 STEP Z1/L1       KL3 2470 GOSUB 2560 2480 IF L9&gt;1-(V#4+6)*D1 OR L9&gt;Z5       *(1-V#3)*D1 THEN PRINT UGTH       G 2490 : I @ GOTO 2540 2490 IMAGE "LABEL DELETED AT ",Z       0,40 2500 MOVE I+(2-V#4)*D1,M1-12*D2 2510 L9=I+(V#4+2)*D1 2520 IF L9&gt;Z5 THEN MOVE Z5+(2-V#       8)*D1,M1-12*D2 2530 LABEL V#E1,VJ 2540 NEXT I 2550 GOTO 1750 2560 V#="" 2570 X=I 2580 V#=VAL#(X) 2590 IF POS(V#,"E") THEN 2650 2600 G9=LGTCABS(X+(X=0)) 2610 IF LEN(V#)&gt;5 AND ABS(G9)&gt;4-       (SGN(X)=-1) THEN V#="       -----" @ RETURN 2620 IF LEN(V#)&gt;5 THEN V=LEN(V#)       @ RETURN 2630 V#E1,5J=VAL#(X) @ V=5 2640 RETURN 2650 E=POS(V#,"E") 2660 IF VAL(V#E+1J)&gt;9 THEN V#E2       ,2J=V#E2,3J @ V#E3,3J="E" @       V#E4,5J=V#E+2J @ V=5 @ RE       TURN 2670 V#E2,3J=V#E3,4J @ V#E4,4J="       E" @ V#E5,5J=V#E+3J @ V=5       @ RETURN 2680 V#="" 2690 V#=VAL#(I) 2700 IF POS(V#,"E") THEN V#E7,10       J=V#EPOS(V#,"E")J ELSE V#E1       ,10J=VAL#(I) 2710 RETURN 2720 CLEAR 2730 DISP "LABEL ORIGIN=X,Y": @ I       NPUT X,Y 2740 IF X&gt;98 AND X&lt;M3 AND Y&gt;=Y       0 AND Y&lt;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&gt;32*(Z5-X)/(Z5-X0) THEN       DISP "LABEL TOO LONG" @ BE       EP @ GOTO 2760 2800 MOVE X,Y @ LABEL A# 2810 RETURN </pre> | <p>Label string construction</p> <p>Enter LABEL ORIGIN</p> <p>Enter LABEL</p> <p>Too long?</p> <p>LABEL plot</p> |
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**Notes**

# Annuities and Compound Amounts with Amortization

## Interchangeable 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



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| <pre> 10 DIM A#E33J 20 CLEAR @ DISP "PRINTER OUTPUT   Y#N" 30 INPUT A#E1.32J 40 PRINTER IS 1 @ P9=0 50 IF UPC(A#E1.13)="Y" THEN PR   INTER IS 2 @ P9=1 @ GOTO 70 60 IF UPC(A#E1.13)="#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/RD" 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 200,550,600,66   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/   RD(K?), THEN" @ PRINT "UNKNOW   N (K1-K4 &amp; K8)." 390 PRINT "K1:n, # OF COMPOUNDING   PERIODS" @ PRINT "K2:1, 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 # 0   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           </pre> | <p>Initialization<br/>Specify printer or display output</p> <p>Wait loop until key is pressed and then branch according to values of S and F<br/>Set F according to option</p> <p>HELP subroutine</p> <p>Toggle Annuity Due/Ordinary Annuity flag</p> <p>Set S to Solve</p> <p>Enter number of compounding periods</p> <p>Enter i</p> <p>Enter PMT</p> <p>Enter PV</p> <p>Enter FV</p> <p>Compute N</p> | <pre> 770 IF -J#N&gt;=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&gt;0 THEN DISP "ERROR   IN DATA" @ BEEP @ GOTO 180 890 J=1+1/N 900 IF R8#P&lt;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=T2/(1-J)#J#P 960 J1=J*(1-P9/T2)^(T2/(T2#N+T3)) 970 IF ABS((J1-J)/J1)&gt;.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 @ R8=R   9 @ R9=T4 @ RETURN 1070 R=(1+J)^(1-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)^(1-N) 1140 V1=(A1#P*(1-R)/(1-R)+V2#R) 1150 V1=INT(V1#100+.5)/100 1160 PRINT USING "16A,5D,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&gt;0 AND P1&lt;=N THEN 1290 1270 DISP "RE-"; @ GOTO 1240 1290 DISP "ENTER ENDING PERIOD:" 1300 INPUT P2 1310 IF P2&gt;=P1 AND P2&lt;=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 "18A,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,6D,2,2D,5DZ.   2D,6D,2,2D" ; I, S1, S2, S3 1530 NEXT I 1540 PRINT "TOTALS:" 1550 PRINT USING "3X,6DZ,2D,5DZ.   2D" ; T1, T2 1560 PRINT @ GOTO 180 1580 END 5000 CLEAR @ KEY LABEL @ RETURN           </pre> | <p>Compute i</p> <p>Compute PMT</p> <p>Compute PV</p> <p>Compute FV</p> <p>Start AMORT</p> <p>Enter starting period</p> <p>Enter ending period</p> <p>Print amortization schedule</p> |
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# 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( ) } - Siljak function where  $Z^k = X(k) + i Y(k)$
- Y( ) }
- A - Temporary
- B - Temporary
- C - Temporary
- D - Temporary
- D4 -  $\Delta x$
- D5 -  $\Delta v$
- 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

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| <pre> 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 1750 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&lt;=0 THEN 240 270 DISP "TOLERANCE FOR ROOTS": 280 INPUT T2 290 IF T2&lt;=0 THEN 270 300 DISP "TOLERANCE FOR FUNCTION AL EVAL ": 310 INPUT T1 320 IF T1&lt;=0 THEN 300 330 PRINT 340 PRINT 350 PPINT "COEFFICIENTS:R(Rcoef( 0)+Icoef,--" 360 PRINT " REAL IM AGINARY" 370 FOR I=0 TO N 380 DISP "Rcoef(";I;")="; 390 INPUT R(I) 400 INPUT I(I) 410 DISP "Icoef(";I;")="; 420 INPUT I(I) 430 PRINT USING 450 ; R(I),I(I) 440 NEXT I 450 IMAGE M60Z .4D,3X,M60Z.4D 460 DISP "PROBLEM ENTERED" @ RET URN 470 GOSUB 1750 480 DISP "COEFFICIENT NUMBER": 490 INPUT I 500 IF I&lt;=0 OR I&gt;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,"=",M60Z .4D,/, "Icoef(",DDD,"=",M60Z .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=";I1 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,M60Z.3D .3X,M60Z.3D" ; I,R(I),I(I) 760 NEXT I 770 PRINT 780 RETURN 790 GOSUB 1750 800 B=N&lt;=0 OR T2&lt;=0 OR T1&lt;=0 OR I1&lt;=0 810 IF B=0 THEN 870 820 PRINT "ERROR IN DATA" 830 PRINT "N=";N,"ToIa=";T2 </pre> | <p>Initialize</p> <p>Wait loop until key is pressed<br/>HELP subroutine</p> <p>Enter problem data</p> <p>Enter coefficients</p> <p>Edit coefficients</p> <p>Print roots subroutine</p> <p>Start root finder</p> | <pre> 840 PRINT "ToIa=";T1,"I1max=";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 R(I)=R(I) @ I1(I)=I(I) 920 NEXT I 930 N1=N 940 IF N=1 THEN 1530 950 V,Y(1),X(0)=1 960 X,X(1)=1 970 Y(0),L=0 980 GOSUB 1620 990 C=F 1000 M,O,P=0 1010 L=L+1 1020 FOR K=1 TO N 1030 P=P+X(R1(K))*X(K-1)-I1(K)*Y (K-1) 1040 Q=0+X(I1(K))*Y(K-1)+I1(K)*X (K-1) 1050 NEXT K 1060 Z=P+P*O+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&gt;=G THEN 1190 1140 IF ABS(D4)&gt;T2 AND ABS(D5)&gt;T 2 THEN 1340 1150 IF L&gt;I1 THEN 1290 1160 X=X(1) 1170 Y=Y(1) 1180 GOTO 890 1190 IF M&gt;20 THEN 1230 1200 D4=D4/4 1210 D5=D5/4 1220 GOTO 1090 1230 IF ABS(U)*X&lt;=T1 AND ABS(V)* Y&lt;=T1 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 "ToIa=";T1,"U=";U,"V=" ;V 1280 PAUSE 1290 PRINT "ERROR IN FUNCTION" 1300 PRINT "MAXIMUM # OF ITERATI ONS HAS BEEN EXCEEDED." 1310 PRINT "L=";L,"I1max=";I1 1320 PAUSE 1330 GOTO 1150 1340 S(N)=X(1) 1350 J(N)=Y(1) 1360 A=R(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&lt;&gt;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=1 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)-2*X(K) 1660 Y(K+2)=T*Y(K+1)-2*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 </pre> | <p>Initialize roots</p> <p>Copy master to working arrays</p> <p>N=1?<br/>X( ), Y( ) are Sijak Coefficients</p> <p>Compute Sijak coefficients</p> <p>Increment iteration counter</p> <p>Compute changes in X and Y<br/>Increment successive<br/>quartering counter<br/>New Root approximations<br/>Recompute Sijak coefficients<br/>New error &gt; old error?<br/>Stopping conditions met?</p> <p>Iterations &gt; Max?</p> <p>Iterate again<br/>Quarterings &gt; 20?</p> <p>Error messages</p> <p>Root found—store it</p> <p>Initialize variables for<br/>synthetic division</p> <p>Synthetic division to<br/>calculate new coefficients</p> <p>Reduce number of coefficients<br/>Degree = 1?<br/>Compute final root algebraically</p> <p>Compute Sijak coefficients</p> |
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# 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                                                                      | Initialization                                    | 790 GOTO 799                                    |                                                      |
| 20 DIM C(20,21),S(20),A(20),T(2<br>0,21),Y(20)                                        |                                                   | 800 GOSUB 2130 @ FOR I=1 TO N                   | Save entered system                                  |
| 30 INTEGER K(20),J(20),D(20)                                                          |                                                   | 810 FOR J=1 TO N+1                              |                                                      |
| 40 PRINTER IS 2                                                                       |                                                   | 820 T(I,J)=C(I,J)                               |                                                      |
| 50 ON KEY# 1,"ENTER" GOSUB 130                                                        |                                                   | 830 NEXT J                                      |                                                      |
| 60 ON KEY# 2,"EDIT" GOSUB 480                                                         |                                                   | 840 NEXT I                                      |                                                      |
| 70 ON KEY# 3,"SOLVE" GOSUB 390                                                        |                                                   | 850 GOSUB 960                                   | Enter Epsilon                                        |
| 80 ON KEY# 4,"PRINT" GOSUB 960                                                        |                                                   | 860 DISP "ENTER EPSILON:"                       |                                                      |
| 90 ON KEY# 5,"HELP" GOSUB 2000                                                        |                                                   | 870 INPUT E                                     |                                                      |
| 100 CLEAR @ KEY LABEL                                                                 |                                                   | 880 DISP "SOLVING SYSTEM" @ GOSU<br>B 1130      |                                                      |
| 110 DISP "SELECT OPTION"                                                              |                                                   | 890 IF ABS(D)>.00000000001 THEN                 |                                                      |
| 120 GOTO 120                                                                          | Wait loop until key pressed<br>Data entry routine | 900 BEEP                                        |                                                      |
| 130 CLEAR @ DISP "This program a<br>llows the user to input and<br>solve a system of" |                                                   | 910 PRINT "SYSTEM HAS NO SOLUTIO<br>N"          |                                                      |
| 140 DISP "simultaneous linear eq<br>uations and solves them. E<br>elow, you are"      |                                                   | 920 RETURN                                      |                                                      |
| 150 DISP "asked to enter the num<br>ber of"                                           |                                                   | 930 GOSUB 1920                                  |                                                      |
| 160 DISP "equations you have to<br>solve (the number of equa<br>tions to be"          |                                                   | 940 GOSUB 1070                                  |                                                      |
| 170 DISP "solved is equal to the<br>number of independent var<br>iables)"             |                                                   | 950 RETURN                                      |                                                      |
| 180 DISP "Enter number of equati<br>ons:"                                             | Enter number of equations                         | 960 PRINT "SYSTEM OF EQUATIONS "                | Print system of equations                            |
| 190 INPUT N                                                                           |                                                   | 970 FOR I=1 TO N                                |                                                      |
| 200 N=INT(N)                                                                          |                                                   | 980 PRINT "Equation #"&VAL(I)&"                 |                                                      |
| 210 IF N=0 THEN RETURN                                                                |                                                   | 990 FOR J=1 TO N                                |                                                      |
| 220 DISP "Enter the coefficient<br>matrix of the system of equa<br>tions. The"        |                                                   | 1000 IF J#1 THEN PRINT " + "                    |                                                      |
| 230 DISP "subscript conventions<br>used by the prompts issued<br>by this"             |                                                   | 1010 PRINT VAL\$(C(I,J))&"*X("&VA<br>L(J)&")&"; |                                                      |
| 240 DISP "program follow this fo<br>rm:"                                              |                                                   | 1020 NEXT J                                     |                                                      |
| 250 DISP "A(1,1)X(1)+...+A(1,n)<br>X(n)=B(1)"                                         |                                                   | 1030 PRINT "="&VAL\$(C(I,N+1))                  |                                                      |
| 260 DISP "A(2,1)X(1)+...+A(2,n)<br>X(n)=B(2)"                                         |                                                   | 1040 NEXT I                                     |                                                      |
| 270 DISP "A(3,1)X(1)+...+A(3,n)<br>X(n)=B(3)"                                         |                                                   | 1050 PRINT                                      |                                                      |
| 280 IMAGE " . "                                                                       |                                                   | 1060 RETURN                                     |                                                      |
| 290 FOR I=1 TO 3                                                                      |                                                   | 1070 PRINT " SOLUTION ABS                       | Print solution with absolute<br>error                |
| 300 DISP USING 280                                                                    |                                                   | 1080 FOR I=1 TO N                               |                                                      |
| 310 NEXT I                                                                            |                                                   | 1090 PRINT USING 1100 : I,S(I),A<br>(I)         |                                                      |
| 320 DISP "A(n,1)X(1)+...+A(n,n)<br>X(n)=B(n)"                                         |                                                   | 1100 IMAGE "X("&DDD,")=",E0.4D,2<br>X:M2.4DE    |                                                      |
| 330 FOR I=1 TO N                                                                      |                                                   | 1110 NEXT I                                     |                                                      |
| 340 PRINT "Equation #"&VAL(I)&"                                                       |                                                   | 1120 RETURN                                     |                                                      |
| 350 FOR J=1 TO N                                                                      |                                                   | 1130 M=N+1                                      |                                                      |
| 360 DISP "Enter Coeff. for elene<br>nt #"&VAL(I)&","&VAL(J)&:"                        | Enter coefficients                                | 1140 D=1                                        | Start modified Gauss-Jordan<br>elimination method    |
| 370 INPUT C(I,J)                                                                      |                                                   | 1150 FOR K=1 TO N                               | Search for pivot                                     |
| 380 IF J#1 THEN PRINT " + "                                                           |                                                   | 1160 K1=K-1                                     |                                                      |
| 390 PRINT VAL\$(C(I,J))&"*X("&VAL<br>(J)&")&";                                        |                                                   | 1170 P=0                                        |                                                      |
| 400 NEXT J                                                                            |                                                   | 1180 FOR I=1 TO N                               |                                                      |
| 410 DISP "Enter the RHS of equat<br>ion #"&VAL(I)&:"                                  | Enter RHS                                         | 1190 FOR J=1 TO N                               |                                                      |
| 420 INPUT C(I,N+1)                                                                    |                                                   | 1200 IF K=1 THEN 1270                           |                                                      |
| 430 PRINT "="&VAL\$(C(I,N+1))                                                         |                                                   | 1210 FOR I2=1 TO K1                             |                                                      |
| 440 NEXT I                                                                            |                                                   | 1220 FOR J2=1 TO K1                             |                                                      |
| 450 PRINT                                                                             |                                                   | 1230 IF I=K(2) THEN 1310                        |                                                      |
| 460 DISP "SYSTEM ENTERED"                                                             |                                                   | 1240 IF J=K(J2) THEN 1310                       |                                                      |
| 470 RETURN                                                                            |                                                   | 1250 NEXT J2                                    |                                                      |
| 480 CLEAR @ DISP "Which equation<br>,"                                                | Edit equation                                     | 1260 NEXT I2                                    |                                                      |
| 490 INPUT W                                                                           |                                                   | 1270 IF ABS(T(I,J))<=ABS(P) THEN                |                                                      |
| 500 W=INT(W)                                                                          |                                                   | 1280 P=T(I,J)                                   |                                                      |
| 510 IF W=1 AND W<N THEN 540                                                           |                                                   | 1290 I(K)=I                                     |                                                      |
| 520 BEEP                                                                              |                                                   | 1300 J(K)=J                                     |                                                      |
| 530 GOTO 490                                                                          |                                                   | 1310 NEXT J                                     |                                                      |
| 540 A\$=""                                                                            |                                                   | 1320 NEXT I                                     |                                                      |
| 550 DISP "WHICH SIDE:(L/R):"                                                          |                                                   | 1330 IF ABS(P)>E THEN 1360                      | Pivot > epsilon                                      |
| 560 INPUT A\$                                                                         |                                                   | 1340 D=0                                        |                                                      |
| 570 IF UPC\$(A\$)="L" THEN 610                                                        |                                                   | 1350 RETURN                                     |                                                      |
| 580 IF UPC\$(A\$)="R" THEN 770                                                        |                                                   | 1360 I3=I(K)                                    | Update determinant row                               |
| 590 BEEP                                                                              |                                                   | 1370 J3=J(K)                                    | Normalize pivot row                                  |
| 600 GOTO 550                                                                          |                                                   | 1380 D=D*P                                      |                                                      |
| 610 J=0                                                                               |                                                   | 1390 FOR J=1 TO M                               |                                                      |
| 620 DISP "WHICH COEFF.:"                                                              |                                                   | 1400 T(I3,J)=T(I3,J)/P                          |                                                      |
| 630 INPUT J                                                                           |                                                   | 1410 NEXT J                                     |                                                      |
| 640 J=INT(J)                                                                          |                                                   | 1420 T(I3,J3)=1/P                               |                                                      |
| 650 IF J>=1 AND J<=N THEN 680                                                         |                                                   | 1430 FOR I=1 TO N                               | Carry out elimination and<br>develop inverse         |
| 660 BEEP                                                                              |                                                   | 1440 T= T(I,J3)                                 |                                                      |
| 670 GOTO 610                                                                          |                                                   | 1450 IF I=I3 THEN 1500                          |                                                      |
| 680 DISP "ENTER COEFF. FOR ELEME<br>NT #"&VAL\$(H)&","&VAL\$(J)&:"                    | Enter new coefficient                             | 1460 T(I,J3)=-T/P                               |                                                      |
| 690 INPUT C(N,J)                                                                      |                                                   | 1470 FOR J=1 TO M                               |                                                      |
| 700 PRINT "Equation #"&VAL\$(N)&"                                                     | Print new system equation                         | 1480 IF J=J3 THEN T(I,J)=T(I,J)<br>-T*T(I3,J)   |                                                      |
| 710 FOR J=1 TO N                                                                      |                                                   | 1490 NEXT J                                     |                                                      |
| 720 IF J#1 THEN PRINT " + "                                                           |                                                   | 1500 NEXT I                                     |                                                      |
| 730 PRINT VAL\$(C(N,J))&"*X("&VAL<br>(J)&")&";                                        |                                                   | 1510 NEXT K                                     |                                                      |
| 740 NEXT J                                                                            |                                                   | 1520 FOR I=1 TO N                               | Order solution values (if any)<br>and create D array |
| 750 PRINT VAL\$(C(N,N+1))                                                             |                                                   | 1530 I4=I(I)                                    |                                                      |
| 760 GOTO 460                                                                          |                                                   | 1540 J4=J(I)                                    |                                                      |
| 770 DISP "ENTER THE RHS OF EQ. #<br>"&VAL\$(N)&:"                                     | Enter new RHS                                     | 1550 D(I4)=J4                                   |                                                      |
| 780 INPUT C(N,N+1)                                                                    |                                                   | 1560 S(J4)=T(I4,M)                              |                                                      |
|                                                                                       |                                                   | 1570 NEXT I                                     | Adjust sign of determinant                           |
|                                                                                       |                                                   | 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 M                               | Unscramble the inverse by rows                       |
|                                                                                       |                                                   | 1720 FOR I=1 TO N                               |                                                      |
|                                                                                       |                                                   | 1730 I4=I(I)                                    |                                                      |
|                                                                                       |                                                   | 1740 J4=J(I)                                    |                                                      |
|                                                                                       |                                                   | 1750 Y(J4)=T(I4,J)                              |                                                      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                          |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--|--|
| <pre> 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 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 1930 T=8 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       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 </pre> | <p>Then columns</p> <p>Compute absolute error</p> <p>HELP subroutine</p> |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--|--|

# 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 -  $\% \Delta$
- D1 -  $\Delta x$
- 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\$(10),P(10),F(10),E(10)   | Initialization                    | 810 D=L                          | Increment                                                                                                       |
| 20 ON KEY# 1,"f'(X)" GOSUB 300     |                                   | 820 D=D+2*E                      | Upper bound reached?                                                                                            |
| 30 ON KEY# 2,"INTEG" GOSUB 400     |                                   | 830 IF D<R THEN 940              | Calculate approximation to integral                                                                             |
| 40 ON KEY# 3,"ROOT" GOSUB 1030     |                                   | 840 G=SIG/2                      | Print intermediate value                                                                                        |
| 50 ON KEY# 4,"f(X)" GOSUB 1940     |                                   | 850 IF F1=-1 THEN 870            |                                                                                                                 |
| 60 ON KEY# 5,"HELP" GOSUB 170      |                                   | 860 PRINT "N INTERVALS ";N;" INT |                                                                                                                 |
| 70 CLEAR @ KEY LABEL               | Function stored?                  | EGRAL = ";G                      |                                                                                                                 |
| 80 DISP "IS FUNCTION STORED Y/N    |                                   | 870 IF F=0 THEN 900              |                                                                                                                 |
| 90 INPUT A\$(1,32)                 |                                   | 880 F=0                          |                                                                                                                 |
| 100 IF UPC\$(A\$(1,1))="Y" THEN 15 |                                   | 890 GOTO 910                     | Stopping criteria met?                                                                                          |
| 110 IF UPC\$(A\$(1,1))="N" THEN BE |                                   | 900 IF ABS(G2-G)>T THEN 1010     | Save former sum for later convergence check                                                                     |
| 120 DISP "STORE FUNCTION FNF AT    |                                   | 910 G2=G                         | Half interval size again                                                                                        |
| 130 PAUSE                          |                                   | 920 G=T1                         | Multiply function values by 2 and 4 and update sum                                                              |
| 140 GOTO 80                        | Wait loop until key pressed       | 930 GOTO 710                     |                                                                                                                 |
| 150 DISP "SELECT OPTION"           |                                   | 940 X=D                          |                                                                                                                 |
| 160 GOTO 160                       |                                   | 950 Y=FNF(X)                     |                                                                                                                 |
| 170 GOSUB 2010 @ DISP "CALCULU     | HELP subroutine                   | 960 G=G+2*Y                      |                                                                                                                 |
| S AND ROOTS OF f(X)=0"             |                                   | 970 X=D+S                        |                                                                                                                 |
| 180 DISP "ALL OPERATIONS ASSUME    |                                   | 980 Y=FNF(X)                     |                                                                                                                 |
| THAT THE"                          |                                   | 990 G=G+4*Y                      |                                                                                                                 |
| 190 DISP "FUNCTION HAS BEEN ENTE   |                                   | 1000 GOTO 820                    | Print integral                                                                                                  |
| RED AS"                            |                                   | 1010 PRINT "INTEGRAL = ";G       |                                                                                                                 |
| 200 DISP "DEF FNF(X) AT LINE 500   |                                   | 1020 RETURN                      | Enter problem specifications                                                                                    |
| 0 "                                |                                   | 1030 CLEAR                       |                                                                                                                 |
| 210 DISP "K1 DERIVATIVE OF f(X)    |                                   | 1040 DISP "ENTER LOWER BOUND";   |                                                                                                                 |
| AT X .                             |                                   | 1050 INPUT A1                    |                                                                                                                 |
| 220 DISP "K2 INTEGRATE f(X) FROM   |                                   | 1060 DISP "ENTER UPPER BOUND";   |                                                                                                                 |
| A TO B"                            |                                   | 1070 INPUT B                     |                                                                                                                 |
| 230 DISP " USING SIMPSON'S RUL     |                                   | 1080 DISP "ENTER MAXIMUM # OF BI |                                                                                                                 |
| E."                                |                                   | SECTIONS";                       |                                                                                                                 |
| 240 DISP "K3 SEARCH FOR SOLUTION   |                                   | 1090 INPUT M                     |                                                                                                                 |
| TO f(X)=0"                         |                                   | 1100 DISP "ENTER ERROR TOLERANCE |                                                                                                                 |
| 250 DISP " OVER INTERVAL A TO      |                                   | "                                |                                                                                                                 |
| B."                                |                                   | 1110 INPUT T                     |                                                                                                                 |
| 260 DISP "K4 FOR ENTERED VALUE O   |                                   | 1120 DISP "ENTER SEARCH INCREMEN |                                                                                                                 |
| F X RETURN"                        |                                   | T"                               |                                                                                                                 |
| 270 DISP " FUNCTION VALUE."        | Enter x                           | 1130 INPUT S                     |                                                                                                                 |
| 280 DISP "KS HELP"                 | Enter %Δ                          | 1140 DISP "ENTER # OF ROOTS";    | Data check?                                                                                                     |
| 290 RETURN                         |                                   | 1150 INPUT N1                    |                                                                                                                 |
| 300 GOSUB 2010                     |                                   | 1160 A=A1                        |                                                                                                                 |
| 310 DISP "ENTER VALUE OF X"        |                                   | 1170 E=A1>B OR M<=0 OR T<=0 OR   |                                                                                                                 |
| 320 INPUT X                        |                                   | S<=0 OR N1<=0                    |                                                                                                                 |
| 330 DISP "ENTER %Δ"                |                                   | 1180 IF E=0 THEN 1260            |                                                                                                                 |
| 340 INPUT D                        |                                   | 1190 PRINT "ERROR IN INPUT DATA" |                                                                                                                 |
| 350 IF D THEN 370                  |                                   | 1200 PRINT "A=";A1;" B=";B       |                                                                                                                 |
| 360 D=.01                          |                                   | 1210 PRINT "MAX. # BISECTIONS =  |                                                                                                                 |
| 370 D1=D/10000                     |                                   | "M                               |                                                                                                                 |
| 380 D2=(FNF(X+D1/2)-FNF(X-D1/2))   | Compute derivative                | 1220 PRINT "ERROR TOLERANCE = "  |                                                                                                                 |
| /D1                                |                                   | T                                |                                                                                                                 |
| 390 PRINT "APPROXIMATE DIFFERENT   |                                   | 1230 PRINT "SEARCH INCREMENT = " |                                                                                                                 |
| IAL OF"                            |                                   | S                                |                                                                                                                 |
| 400 PRINT "f(X) AT ";X;" IS ";D2   |                                   | 1240 PRINT "NUMBER OF ROOTS = "  |                                                                                                                 |
| @ RETURN                           |                                   | N1                               |                                                                                                                 |
| 410 PRINT USING 420 ; X,D2         |                                   | 1250 GOTO 1040                   | Initialize roots                                                                                                |
| 420 IMAGE "f(X) AT ",90,30;" IS    |                                   | 1260 N=0                         |                                                                                                                 |
| " ,50,70                           |                                   | 1270 FOR I=1 TO N1               | Number of roots found?                                                                                          |
| 430 RETURN                         |                                   | 1280 R(1),F(1),E(1)=INF          | Search for new root                                                                                             |
| 440 CLEAR                          | Enter bounds                      | 1290 NEXT I                      | Advance to next search interval                                                                                 |
| 450 DISP "ENTER LOWER BOUND";      |                                   | 1300 X=A                         | Greater than upper bound?                                                                                       |
| 460 INPUT L                        |                                   | 1310 IF N=N1 THEN 1870           |                                                                                                                 |
| 470 DISP "ENTER UPPER BOUND";      |                                   | 1320 N=N+1                       |                                                                                                                 |
| 480 INPUT R                        |                                   | 1330 Y=FNF(X)                    |                                                                                                                 |
| 490 DISP "PRINT INTERMEDIATE POI   | Set print intermediate point flag | 1340 F=Y                         |                                                                                                                 |
| NTS:Y/N";                          |                                   | 1350 A=A+S                       |                                                                                                                 |
| 500 INPUT A\$(1,32)                |                                   | 1360 IF A>B THEN 1870            |                                                                                                                 |
| 510 IF UPC\$(A\$(1,1))="Y" THEN F1 |                                   | 1370 X=A                         |                                                                                                                 |
| =1 @ GOTO 540                      |                                   | 1380 Y=FNF(X)                    | If product is +, search next interval                                                                           |
| 520 IF UPC\$(A\$(1,1))="N" THEN F1 |                                   | 1390 P=F*Y                       | If negative, look for root                                                                                      |
| =-1 @ GOTO 540                     |                                   | 1400 IF P>0 THEN 1340            | Exact root?                                                                                                     |
| 530 GOTO 490                       |                                   | 1410 IF P<0 THEN 1510            |                                                                                                                 |
| 540 DISP "MAX # OF INTERVAL HALV   | Enter problem data                | 1420 IF F<>0 THEN 1450           |                                                                                                                 |
| INGS";                             |                                   | 1430 X=A-S                       |                                                                                                                 |
| 550 INPUT I1                       |                                   | 1440 Y=F                         | Search next interval for remaining roots                                                                        |
| 560 DISP "ERROR TOLERANCE";        |                                   | 1450 R(N)=X                      | Root has been bracketed look for root until error tolerance is satisfied or maximum # of iterations is exceeded |
| 570 INPUT T                        | Verify data                       | 1460 F(N)=Y                      |                                                                                                                 |
| 580 B=R<L OR F1=0 OR I1<=0 OR T    |                                   | 1470 A=A+S                       |                                                                                                                 |
| <=0                                |                                   | 1480 Z=.00000000001              |                                                                                                                 |
| 590 IF B=0 THEN 630                |                                   | 1490 LET E(N)=Z                  |                                                                                                                 |
| 600 PRINT "ERROR IN DATA"          |                                   | 1500 GOTO 1300                   |                                                                                                                 |
| 610 PRINT "RIGHT =";R;" LOW =";L   |                                   | 1510 L=A-S                       |                                                                                                                 |
| ;" MAX # INT =";I1;" TOL =";       |                                   | 1520 R=A                         |                                                                                                                 |
| T                                  |                                   | 1530 C=0                         |                                                                                                                 |
| 620 GOTO 450                       | Initialize variables              | 1540 X=(L+R)/2                   |                                                                                                                 |
| 630 G1=0                           |                                   | 1550 Y=FNF(X)                    |                                                                                                                 |
| 640 F=1                            |                                   | 1560 C=C+1                       | Determine search direction                                                                                      |
| 650 X=L                            |                                   | 1570 IF C>M THEN 1710            |                                                                                                                 |
| 660 Y=FNF(X)                       |                                   | 1580 IF ABS(Y)<T*MAX(1,X) THEN 1 |                                                                                                                 |
| 670 G=G+Y                          |                                   | 660                              |                                                                                                                 |
| 680 X=R                            |                                   | 1590 P=F*Y                       |                                                                                                                 |
| 690 Y=FNF(X)                       |                                   | 1600 IF P<=0 THEN 1630           |                                                                                                                 |
| 700 T1=G+Y                         |                                   | 1610 L=X                         |                                                                                                                 |
| 710 I=I+1                          |                                   | 1620 GOTO 1540                   |                                                                                                                 |
| 720 IF I<=I1 THEN 760              |                                   | 1630 IF P=0 THEN 1660            |                                                                                                                 |
| 730 PRINT "MAX # OF ITERATIONS "   | Max. # iterations exceeded?       | 1640 R=X                         |                                                                                                                 |
| 740 PRINT "INTEG =";G;" INTEG "    |                                   | 1650 GOTO 1540                   | ROOT FOUND                                                                                                      |
| ;"G2;"MAX # INT =";I1;" TOL        |                                   | 1660 R(N)=X                      |                                                                                                                 |
| =";T                               |                                   | 1670 F(N)=Y                      |                                                                                                                 |
| 750 PAUSE                          |                                   | 1680 Z=R-L                       |                                                                                                                 |
| 760 N=C+1                          | Compute # intervals               | 1690 LET E(N)=Z                  | Print approximate root after exceeding maximum number of iterations                                             |
| 770 S=(R-L)/N                      | Interval size                     | 1700 GOTO 1300                   |                                                                                                                 |
| 780 X=S+L                          | Interval value                    | 1710 PRINT "MAX # OF ITERATIONS  |                                                                                                                 |
| 790 Y=FNF(X)                       | Lower bound                       | REACHED ON"                      |                                                                                                                 |
| 800 G=G+4*Y                        |                                   | 1720 PRINT USING 1730 ; N        |                                                                                                                 |
|                                    |                                   | 1730 IMAGE "ROOT # ",30          |                                                                                                                 |
|                                    |                                   | 1740 PRINT USING 1750 ; L,R      |                                                                                                                 |
|                                    |                                   | 1750 IMAGE "% BETWEEN ",50Z,2D," |                                                                                                                 |
|                                    |                                   | AND ",50Z,2D                     |                                                                                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                        |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--|--|
| <pre> 1760 PRINT "f(x) = ":Y 1770 Z=R-L 1780 PRINT USING 1790 : Z 1790 IMAGE "ACCURACY TO ".50Z.50 1800 PRINT "AVERAGE VALUE STORED       IN P(4) 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.00E,2(X.MD.00E) 1920 NEXT I 1930 RETURN 1940 GOSUB 2010 1950 DISP "ENTER VALUE OF X": 1960 INPUT X 1970 F=FN(X) 1980 PRINT USING 1990 : F 1990 IMAGE "VALUE OF F(X) IS ".7       0Z.3D 2000 RETURN 2010 CLEAR @ KEY LABEL @ RETURN 5000 DEF FN(X) = 1/SQR(1-.25*SI       N(X))*SIN(X) </pre> | <p>Print roots</p> <p>Enter argument</p> <p>Print functional value</p> |  |  |
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# 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 | - $X_2 - X_1$                          |
| Z2 | - $Y_2 - Y_1$                          |
| Z3 | - X dot range                          |
| Z4 | - Y dot range                          |
| Z5 | - Scale X-maximum                      |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| <pre> 10 OPTION BASE 1 20 DIM X(200),Y(200),R#E333,F#E63,Y# 40 R#5:R#5:2#E193/V#E193 30 ON KEY# 1:"ENTER" GOSUB 200 40 ON KEY# 2:"OUTPUT" GOSUB 450 50 ON KEY# 3:"LINEAR" GOSUB 130 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 GOT 130 140 GOSUB 7540 @ DISP " CURVE FITTING" 150 DISP "K1 ENTER DATA VIA KEYS OARD OR DATA FILE ON CA PTPIDGE(FIRST)" 160 DISP "K2 OUTPUT DATA TO PRIM 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 Y/T" 260 INPUT R# 265 IF NOT LEN(R#) THEN BEEP @ G OTO 250 270 IF UPC#(R#E1,1)="" THEN 42 0 280 IF UPC#(R#E1,1)="" THEN BE EP @ GOTO 250 290 IF X6&lt;&gt;1 THEN 320 300 PRINT 310 PRINT " I X(I) Y(I)" 320 DISP "NO. OF POINTS" 330 INPUT N 340 IF N&gt;200 OR N&lt;=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);X(I,2);Y(I,2)" 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 40,4X,6DZ 40,6DZ 40 400 NEXT I 410 DISP "DATA ENTERED" @ GOTO 1 30 420 DISP "ENTER FILE NAME" 430 INPUT F# 440 ON ERROR GOTO 420 450 ASSIGN# 1 TO F# 460 READ# 1 ; N,X(I) 470 OFF ERROR @ ASSIGN# 1 TO # 480 IF X6&lt;&gt;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 600,640,700 640 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(I) 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&lt;1 THEN 870 800 IF I&gt;N THEN 770 810 DISP "X(I);Y(I);X(I,1) 820 DISP "NEW X(I);Y(I);" 830 INPUT X(I,1) 840 DISP "Y(I);Y(I);X(I,2) 850 DISP "NEW Y(I);Y(I);" </pre> | <p>Initialization</p> <p>Wait loop until key is pressed<br/>HELP subroutine</p> <p>ENTER subroutine</p> <p>Keyboard or tape</p> <p>Keyboard entry</p> <p>No. of points</p> <p>Enter points</p> <p>Tape entry</p> <p>Read file</p> <p>OUTPUT subroutine<br/>Print data?</p> <p>Print loop</p> <p>Store data?</p> <p>Enter file name</p> <p>Create?</p> <p>Print data on tape</p> <p>Correction routine</p> | <pre> 860 INPUT X(I,2) 870 GOSUB 7540 @ DISP "0=OK,1=00 RECT,2=DELETE,3=INSERT" 880 INPUT I 890 IF I&gt;3 OR I&lt;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&lt;1 THEN 870 950 IF I&gt;N THEN 920 960 DISP "DELETE X(I);Y(I);X(I, 1);Y(I,1);X(I,2) 970 IF I=N THEN 1000 980 DISP "NEW X(I);Y(I);X(I+1,1 );Y(I+1,1);X(I+1,2) 990 FOR J=I+1 TO N @ X(J,1)=X( J,1) @ X(J,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&lt;1 THEN 870 1060 IF I&gt;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);X(I, 1);Y(I,1)" 1110 INPUT X(I,1),X(I,2) 1120 GOTO 1010 1130 DISP "COMPUTING-- PLEASE WA IT" 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 @ 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)&lt;=0 THEN PRINT "CAN' T TAKE LOG" @ RETURN 1330 R=2 @ Q1=A(1) @ Q2=A(2) @ Q 3=A(3) @ Q4=R5 @ Q5=M(5) @ A(1)=A(2)/A(5) 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)*A(1)/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&gt;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 </pre> | <p>Edit type specification</p> <p>Deletion routine</p> <p>Insertion routine</p> <p>Compute values needed for regressions</p> <p>Plot data?</p> <p>LINEAR regression</p> <p>LOG regression</p> <p>EXP regression</p> <p>POWER regression</p> <p>AOV print out</p> |
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| <pre> 1490 IMAGE "TOTAL",30,602,0 1500 R2=S/(A(4)-A(3)*A(3)/N) 1510 F1=MIN(999.9,S/(C(5)/P2-S)/(N-2)) 1520 PRINT USING 1530 , S,S,F1 1530 IMAGE "REG 1",602,0,502,0,302,0 1540 PRINT USING 1550 , N-2,A(4)-A(3)*A(3)/N,S,(A(4)-A(3)*A(3)/N)/(N-2) 1550 IMAGE "RESID",30,602,0,502,0 1560 PRINT USING 1570 , R2 1570 IMAGE "R SQUARE =",702,30,2 1580 GOTO 1710 1590 IF Y(1)=0 OR Y(3)=0 THEN PRINT "CAN'T TAKE LOG" &amp; PRINT @ 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)+T1*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=P5 @ M(2)=A(3)/N 1690 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) @ R5=M(3)-M(1)*M(5) 1700 GOTO 1460 1710 ON R GOTO 1720,1810,1840,1870 1720 PRINT USING 1730 , P5,M(5) 1730 IMAGE "YHAT =",502,30," +",502,30," X" 1740 GOTO 1910 1750 IF D=0 THEN 1900 1760 DISP "PLOT:Y/N"; 1770 INPUT R# 1780 ON FNR GOTO 1760,1800,1900 1800 PENUP @ GOSUB 2260 @ GOTO 1900 1810 PRINT USING 1820,P5,M(5) 1820 IMAGE "YHAT =",502,30,"+",502,30," LOG X" 1830 GOTO 1910 1840 PRINT USING 1850 , EXP(R5),M(5) 1850 IMAGE "YHAT =",502,30," EXP(",502,30," X)" 1860 GOTO 1910 1870 PRINT USING 1880 , EXP(R5),M(5) 1880 IMAGE "YHAT =",502,30," X ^ ",502,30 1890 GOTO 1910 1900 ON R GOTO 1310,1330,1410,1430 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=FNU(X(I,1)) 2040 PRINT USING "4D2,20,402,20,402,20,402,20" , 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=FNU(T) 2150 PRINT USING "4D2,20,402,20" , T,Y 2160 GOTO 2060 2170 PRINT 2180 GOTO 1750 2190 DEF FNU(X) 2200 ON R GOTO 2210,2220,2230,2240 2210 FNU=P5+M(5)*X @ GOTO 2250 2220 FNU=P5+M(5)*LOG(X+0.1*(X=0)) @ GOTO 2250                 </pre> | <p>Modify sums for EXP and POWER curves</p> <p>Branch to output equation</p> <p>LINEAR</p> <p>Plot regression curve?</p> <p>LOG</p> <p>EXP</p> <p>POWER</p> <p>Return branch</p> <p>Estimate y</p> <p>Print <math>\hat{y}</math> at all x</p> <p>Equation computation routine</p> <p>LINEAR</p> <p>LOG</p> | <pre> 2230 FNU=EXP(R5+M(5)*X) @ GOTO 2250 2240 FNU=EXP(R5)*X^M(5) 2250 FN END 2260 FOR K=X1 TO X2 STEP Z1/Z5 2265 IF R=4 AND K=0 AND M(5)&lt;0 THEN 2261 2266 PLOT K,FNU(K) 2267 NEXT K 2270 MOVE X1+R#Z1/5,FNU(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 2380 2330 DISP "ENTER SCALE XMIN"; 2340 INPUT X1 2350 DISP "ENTER SCALE XMAX"; 2360 INPUT X2 2370 IF X1&gt;X2 THEN BEEP @ GOTO 2370 2380 DISP "VERTICAL/HORIZONTAL LABELS:V/H"; 2390 INPUT R# 2395 IF NOT LEN(R#) THEN BEEP @ GOTO 2380 2400 S9=1 @ IF UPC#(R#C1,11)="V" THEN S9=0 @ GOTO 2420 2410 IF UPC#(R#C1,11)="H" THEN BEEP @ GOTO 2380 2420 DISP "NO. OF X-AXIS INTERVALS (&lt;=16)"; 2430 INPUT L1 2440 IF L1&lt;1 OR L1&gt;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&lt;1 OR L3&gt;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 INTERVALS (&lt;=12)"; 2600 INPUT L2 2610 IF L2&lt;1 OR L2&gt;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&lt;1 OR L4&gt;L2 THEN BEEP @ GOTO 2620 2660 Z1=X2-X1 @ Z3=INT(200/L1)*L1 @ Z2=Y2-Y1 @ Z4=INT(144/L2)*L2 2670 D1=Z1/Z3 @ D2=Z2/Z4 @ Z5=X2+(207-Z3)*D1 @ X0=X1-48*D1 @ Y0=Y1-48*D2 2680 CLEAR @ 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 W=LGT(ABS(Z1/L1)*L3) 2730 W=LGT(ABS(X1+(X1=0)))**+1 2740 IF W&gt;5-(SGN(X1)=-1) OR W1&lt;3 THEN 2830 2750 IF S9 THEN 3420 2760 LDIR 90 2770 FOR I=X1 TO X2+D1 STEP Z1/L1*L3 2780 MOVE I+4*D1,Y0 2790 GOSUB 3080 2800 LABEL W#C1,V3 2810 NEXT I 2820 GOTO 2870 2830 MOVE X0,Y0 2840 LDIR 0 2850 I=X1 @ GOSUB 3350 @ I=Z1/L1 @ Z#=Y# @ GOSUB 3350 2860 LABEL "XMIN="&amp;Z#C1,103&amp;" YI CS="&amp;V#C1,103 2870 IF S7 THEN 3050 2880 W1=LGT(ABS(Z2/L2)*L4) 2890 W=LGT(ABS(Y1+(Y1=0)))**+1 2900 IF W&gt;5-(SGN(Y1)=-1) OR W1&lt;3 THEN 2980 2910 LDIR 0 2920 FOR I=Y1 TO Y2+D2 STEP Z2/L2*L4 2930 MOVE X0,I-4*D2 2940 GOSUB 3080                 </pre> | <p>EXP</p> <p>POWER</p> <p>Plot regression line</p> <p>Plot setup</p> <p>Compute SCALE parameters</p> <p>Draw axes</p> <p>LABEL X-AXIS</p> <p>LABEL Y-AXIS</p> |
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| <pre> 2950 LABEL V#E1,VJ 2960 NEXT I 2970 GOTO 3050 2980 LDIR 90 2990 I=Y1 @ GOSUB 3350 3000 MOVE X0+12*D1,Y1 3010 LABEL "YMIN=%V#E1.10J 3020 MOVE X0+24*D1,Y1 3030 I=22/L2 @ GOSUB 3350 3040 LABEL "TICS=%V#E1.10J 3050 PENUP @ LDIR 0 3060 MOVE X(I,1),X(I,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#)&gt;5 AND ABS(G9)&gt;4- (SGN(X)=-1) THEN V#=" -----" @ RETURN 3130 IF LEN(V#)&lt;5 THEN V=LEN(V#) @ RETURN 3140 V#E1.5J=VAL\$(X) @ V=5 3150 GRAPH @ RETURN 3160 E0=POS(V#,"E") 3170 IF V#E1.1J="-" THEN V#E3J=V #E0J @ GOTO 3190 3180 V#E2J=V#E0J 3190 V=LEN(V#) @ IF V&gt;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&gt;Y0 AND X&lt;X2 AND Y&gt;=Y 0 AND Y&lt;=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&gt;(Z5-X)/(Z5-Y0) 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#E1.10J=VAL\$(I) 3390 RETURN 3400 V#E6.10J=V#EPOS(V#,"E")J 3410 RETURN 3420 LDIR 0 @ L9=-INF 3430 FOR I=X1 TO X2+D1 STEP Z1/L 1*L7 3440 GOSUB 3080 3450 IF L9&gt;1-(V#4+6)*D1 OR L9&gt;Z5 +(1-V#8)*D1 THEN PRINT USIN G 3460 ; I @ GOTO 3510 3460 IMAGE "LABEL DELETED AT ",7 D,40 3470 MOVE I+(2-V#4)*D1,Y1-12*D2 3480 L9=I+(V#4+2)*D1 3490 IF L9&gt;Z5 THEN MOVE Z5+(2-V# 8)*D1,Y1-12*D2 3500 LABEL V#E1,VJ 3510 NEXT I 3520 GOTO 2870 3530 DEF FNR 3531 IF NOT LEN(R#) THEN I=1 @ G OTO 3533 3535 I=POS("YN",UPC\$(R#E1.1J)))+1 3536 IF I=1 THEN BEEP 3537 FNR=I 3538 FN END 3540 CLEAR @ KEY LABEL 3550 ALPHA @ RETURN </pre> | <p>Plot data points with "+"</p> <p>LABEL string subroutine</p> <p>LABEL PLOT?</p> <p>Enter label origin</p> <p>LABEL plot at X,Y</p> <p>Horizontal labelling of X-axis</p> <p>Function to test for "Y" or "N"</p> <p>Subroutine to clear screen</p> |  |  |
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**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 X-axis User range
1040 Z3=INT(200/L1)*L1 X-axis CRT range
1050 Z2=Y2-Y1 Y-axis User range
1060 Z4=INT(144/L2)*L2 Y-axis CRT range
1070 D1=Z1/Z3 @D2=Z2/Z4 @ Z5=X2+ Dot distances and X scale max
 (207-Z3)*D1
1080 X0=X1-48*D1 X scale min
1090 Y0=Y1-40*D2 Y scale min
1100 SCALE X0,Z5,Y0,Y2+(151-Z4)*
 D2
```

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 | - $X_2 - X_1$                          |
| Z2 | - $Y_2 - Y_1$                          |
| Z3 | - X dot range                          |
| Z4 | - Y dot range                          |
| Z5 | - Scale X-maximum                      |

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| <pre> 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 PLOT" GOSUB 730 50 ON KEY# 4,"TABLE" GOSUB 1630 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 " 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 PINTER" 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 W#H": 320 INPUT A#(1,32) 330 IF UPC(A#(1,1))="V" THEN S0 =0 @ GOTO 360 340 IF UPC(A#(1,1))="H" THEN S0 =1 @ GOTO 360 350 GOTO 310 360 DISP "NUMBER OF X-AXIS INTER VALS (&lt;=16)": 370 INPUT L1 380 IF L1&lt;1 OR L1&gt;16 OR L1#INT(L 1) THEN BEEP @ GOTO 360 390 DISP "NUMBER X-INT. BETWEEN LABELS": 400 INPUT L2 410 S7=0 @ IF L2=0 THEN S7,L4=1 420 IF L2&lt;1 OR L2&gt;16 THEN BEEP @ GOTO 390 430 DISP "AUTO Y-SCALING(Y/N)": 440 INPUT A#(1,32) 450 IF UPC(A#(1,1))="Y" THEN S3 =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 (&lt;=12)": 570 INPUT L2 580 IF L2&lt;1 OR L2&gt;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&lt;1 OR L4&gt;12 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 650 @ 720 IF UPC(A#(1,1))="N" THEN BE EP @ GOTO 690 730 DISP USING 740 ; S 740 IMAGE 50," POINTS HAVE BEEN ENTERED" 750 RETURN </pre> | <p>Initialization</p> <p>Wait loop until key pressed<br/>HELP subroutine</p> <p>Plot definition subroutine</p> <p>SINGULARITY POINT<br/>subroutine</p> | <pre> 760 PRINT "NO MORE CAN BE ENTERE D,SINCE" 770 GOTO 730 780 GCLLEAR @ 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&gt;T THEN Y1=T 1010 IF Y2&lt;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+48*D2 1100 SCALE X0,Z5,Y0,Y2+(151-Z4)* D2 1110 X#(1) Y1,Z1/L1,X1,X2+D1 1120 Y#(1) X1,Z2/L2,Y1,Y2+D2 1130 IF S8 THEN 1290 1140 W1=LGTRABS(Z1/L1*L3)) 1150 W=LGTRABS(X1+(X1=0)))+1 1160 IF W&gt;5-(SGN(X1)=-1) OR W1&lt; 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 1040 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 "MIN="&amp;Z#(1,10)@ "TI CS="&amp;V#(1,10) 1290 IF S8 THEN 1470 1300 W1=LGTRABS(Z2/L2*L4)) 1310 W=LGTRABS(Y1+(Y1=0)))+1 1320 IF W&gt;5-(SGN(Y1)=-1) OR W1&lt; 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 1040 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 "MIN="&amp;V#(1,10) 1440 MOVE X0+24#D1,Y1 1450 I=Z2/L2 @ GOSUB 1980 1460 LABEL "TICS="&amp;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 (X)" </pre> | <p>FULL PLOT subroutine after<br/>GCLLEAR<br/>PLOT subroutine</p> <p>Increment entry</p> <p>If 0, then enter number of<br/>increments</p> <p>Compute Y extremes for<br/>AUTO SCALE</p> <p>Test for point of singularity</p> <p>Compute SCALE parameters</p> <p>LABEL X-axis</p> <p>LABEL Y-axis</p> <p>Plot values</p> <p>Test for point of singularity</p> <p>Print TABLE</p> |
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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(X)
1790 PRINT USING "100.50,100.50
" 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$E1,53=VAL*(X) @ V=5
1920 RETURN
1930 E=POS(V$,"E")
1940 IF V$E1,13="-" THEN V$E33=V
$E33 @ V=LEN(V$) @ GOTO 196
@
1950 V$E23=V$E33 @ V=LEN(V$)
1960 IF V>5 THEN PRINT USING 220
@ ; I @ V=5 @ V$="-----"
1970 RETURN
1980 V$=""
1990 V=VAL*(I)
2000 IF POS(V$,"E") THEN 2030
2010 V$E1,103=VAL*(I)
2020 RETURN
2030 V$E7,103=V$EPOS(V$,"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+Z*D2 THEN 2100
2090 DISP "INVALID POSITION" @ @
EEP @ GOTO 2060
2100 DISP "ENTER LABEL"
2110 INPUT R#
2120 L=LEN(R#)
2130 IF L/32>(25-X)<(25-X0) THEN
DISP "LABEL TOO LONG" @ @E
EP @ GOTO 2100
2140 MOVE X,Y @ LABEL R#
2150 RETURN
2160 LDIP @ @ L9=-INF
2170 FOR I=X1 TO X2+D1 STEP 21/L
1#L
2180 GOSUB 1940
2190 IF L9>I-(X1+6)*D1 OR L9>25
+(10-V*3)*D1 THEN PRINT USI
NG 2200 ; I @ GOTO 2250
2200 IMAGE "LABEL DELETED AT ".7
D 40
2210 MOVE I+(2-V*4)*D1,Y1-12*D2
2220 L9=I+(V1+6)*D1
2230 IF L9>25 THEN MOVE 25+(2-V*
8)*D1,Y1-12*D2
2240 LABEL V$E1,V3
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 -  $X_2 - X_1$
- Z2 -  $Y_2 - Y_1$
- Z3 - X dot range
- Z4 - Y dot range
- Z5 - Scale X-maximum

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <pre> 10 OPTION BASE 1 20 DIM X(200),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 " DISP "K1 ENTER DATA VIA KEYB OARD OR" 150 DISP " " DATA FILE ON CARTRI DGE(FIRST)" 160 DISP "K2 OUTPUT DATA TO PRIN TER/TAPE" 170 DISP "K3 SETUP FOR PLOT-SCAL ES/RAMES" 180 DISP "K4 PLOT DATA-LINE/POIN T/40" 190 DISP "K5 HELP" 200 DISP "K6 EDIT DATA-CHANGE/DE LETE/ADD" 210 DISP "K7 DRAW A GRID @ LABEL INTERVALS" 220 DISP "K8 LABEL PLOT - SPECIF Y LOCATION" 230 DISP " " AND LABEL" 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/TR APE Y/N" 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&lt;&gt;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&lt;200 AND N&gt;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&lt;&gt;1 THEN 540 520 PRINT USING 530 ; I,X(I,1),X (I,2) 530 IMAGE 40,3X,60Z,40,60Z,40 540 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&lt;&gt;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 70 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 </pre> | <p>Initialization</p> <p>Wait loop until key is pressed</p> <p>HELP subroutine</p> <p>Data entry subroutine</p> <p>Keyboard or tape?</p> <p>Keyboard entry</p> <p>Number of points</p> <p>Enter pair</p> <p>Tape entry</p> <p>Read data</p> <p>OUTPUT subroutine<br/>Print data?</p> <p>Print data</p> <p>Store data?</p> | <pre> 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&lt;1 THEN 1040 970 IF I&gt;N THEN BEEP @ GOTO 940 980 DISP "X( ;I);Y( ;I);" 990 DISP "NEW X( ;I);" 1000 INPUT X(I,1) 1010 DISP "Y( ;I);" 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&gt;3 OR I&lt;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&lt;1 THEN 1040 1120 IF I&gt;N THEN BEEP @ GOTO 109 0 1130 DISP "DELETE X( ;I);" 1140 IF I=N THEN 1200 1150 DISP "NEW X( ;I);" 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&lt;200 THEN 1280 1260 DISP "MAXIMUM NUMBER OF PAI RS=200" 1270 GOTO 1040 1280 IF I&lt;1 THEN 1040 1290 N=N+1 1300 IF I&gt;N+1 THEN 1230 1310 IF I&lt;N THEN 1340 1320 I=N 1330 GOTO 1390 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 Y MIN"; 1530 INPUT X1 1540 DISP "ENTER SCALE YMAX"; 1550 INPUT X2 1560 IF X1&gt;X2 THEN BEEP @ GOTO 1520 1570 DISP "VERTICAL/HORIZONTAL L ABELS Y/N"; 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 (&lt;=16)"; 1630 INPUT L1 1640 IF L1&lt;1 OR L1&gt;16 OR L1#INT( L1) THEN BEEP @ GOTO 1620 1650 DISP "NUMBER X-INT. BETWEEN LABELS"; </pre> <p>Print data on tape</p> <p>Correction routine</p> <p>Edit type specification</p> <p>Deletion routine</p> <p>Insertion routine</p> <p>Set up plot specification</p> |
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| <pre> 1660 INPUT L3 1670 S8=0 @ IF L3=0 THEN S8=1 @ L3=1 1680 IF L3&lt;1 OR L3&gt;L1 THEN BEEP @ GOTO 1650 1690 DISP "AUTO Y-SCALING Y/N" 1700 INPUT R#C1.32J 1710 IF UPCK(R#C1.1J)="Y" THEN 1 800 1720 IF UPCK(R#C1.1J)*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 INTERVALS LS(←=12)" 1840 INPUT L3 1850 IF L2&lt;1 OR L2&gt;12 OR L2=INT(L 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&lt;1 OR L4&gt;L2 THEN BEEP @ GOTO 1860 1900 DISP "PLOT DEFINED" @ RETUR N 1910 CLEAR 1920 DISP "INDEX OF FIRST POINT" @ INPUT N1 1930 IF N1&lt;1 THEN N1=1 @ GOTO 19 50 1940 IF N1&gt;N THEN DISP "MAXIMUM NUMBER OF POINTS IS "N @ G OTO 1920 1950 DISP "INDEX OF LAST POINT" 1960 INPUT N2 1970 IF N2&gt;N THEN DISP "MAXIMUM NUMBER OF POINTS IS "N @ G OTO 1950 1980 IF N1&gt;N2 THEN DISP "LAST PO INT. IS "FIRST" @ GOTO 1920 1990 DISP "LINE TYPE: LINE/DOT/+ /-(1,2,3,4)" 2000 INPUT L0 2010 IF L0&gt;=1 AND L0&lt;=4 THEN 202 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=M1 TO M2 2070 IF X1&gt;X(I,1) THEN X1=X(I,1) 2080 IF X2&lt;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&gt;Y(I,2) THEN Y1=Y(I,2) 2130 IF Y2&lt;Y(I,2) THEN Y2=Y(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=X1-40*D1 2210 Y0=Y1-40*D2 2220 PEN 1 @ GCLEAR @ SCALE X0,Z 5,Y0,Y2+(151-24)*D2 2230 XAXIS Y1,Z1/L1,X1,X2+D1 2240 YAXIS X1,Z2/L2,Y1,Y2+D2 2250 IF S8 THEN 2410 2260 W1=LG(ABS(Z1/L1)*L3) 2270 W=LG(ABS(X1-X1=0)))+1 2280 IF W&gt;5-(SGN(X1)=-1) OR W1&lt; 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#C1.VJ 2350 NEXT I 2360 GOTO 2410 2370 MOVE X0,Y0 2380 LDIR 0 2390 I=Y1 @ GOSUB 3050 @ I=Z1/L1 @ Z4=V# @ GOSUB 3050 2400 LABEL "YMIN="Z4C1.10J"YI CS="V#C1.10J 2410 IF S7 THEN 2590 2420 W1=LG(ABS(Z2/L2*L4)) 2430 W=LG(ABS(Y1+(Y1=0)))+1 2440 IF W&gt;5-(SGN(Y1)=-1) OR W1&lt; 3 THEN 2520                 </pre> | <p>Enter indices to plot</p> <p>Enter line type to use</p> <p>Auto X-SCALE</p> <p>Auto Y-SCALE</p> <p>Compute SCALE parameters</p> <p>Draw axes</p> <p>LABEL X-axis</p> <p>LABEL Y-axis</p> | <pre> 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#C1.VJ 2500 NEXT I 2510 GOTO 2590 2520 LDIR 90 2530 I=Y1 @ GOSUB 3050 2540 MOVE X0+12*D1,Y1 2550 LABEL "YMIN="V#C1.10J 2560 MOVE X0+24*D1,Y1 2570 I=Z2/L2 @ GOSUB 3050 2580 LABEL "TICS="V#C1.10J 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=LG(ABS(X+(X=0))) 2770 IF LEN(V#)&gt;5 AND ABS(G9)&gt;4- (SGN(X)=-1) THEN V#="" ----- @ RETURN 2780 IF LEN(V#)&gt;5 THEN V#="" @ RETURN 2790 V#C1.5J=VAL*(X) @ V=5 2800 RETURN 2810 E=POS(V#,"E") 2820 IF VAL(V#E+1J)&gt;9 THEN 2940 2830 V#C2.3J=V#C3.4J @ V#C4.4J=" E" @ V#C5.5J=V#E+3J @ V=5 @ RETURN 2840 V#C2.2J=V#C3.3J @ V#C3.3J=" E" @ V#C4.5J=V#E+2J @ V=5 @ RETURN 2850 CLEAR 2860 DISP "LABEL ORIGIN X,Y" @ I NPUT X,Y 2870 IF X&gt;X0 AND X&lt;X2 AND Y&gt;Y 0 AND Y&lt;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&gt;32-(Z5-X)/(Z5-X0) THEN DISP "LABEL TOO LONG" @ BEEP @ 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#C1.10J=VAL*(I) 3090 RETURN 3100 V#E7.10J=V#EPOS(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 L9I-(V#4+6)*D1 OR L9&gt;Z5 +(1-V#8)*D1 THEN PRINT USIN G 2160 @ I @ GOTO 2210 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&gt;Z5 THEN MOVE Z5+(2-V# 8)*D1,Y1-12*D2 3200 LABEL V#C1.VJ 3210 NEXT I 3220 GOTO 2410                 </pre> | <p>Plot data</p> <p>Branch depending on line type</p> <p>Line</p> <p>Point</p> <p>"+"</p> <p>"o"</p> <p>LABEL string routine</p> <p>Enter label origin</p> <p>Label plot at X, Y</p> <p>GRID subroutine</p> <p>Horizontal labelling of X-axis</p> |
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# 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#C1,1)="Y" THEN CR<br>EATE F#,8 @ GOTO 980 | Yes—create it             |
| 970 IF UPC\$(R#C1,1)="#" THEN BE<br>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                                               |

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| <pre> 10 OPTION BASE 1 30 INTEGER F(50) 30 DIM X(200),R#(32),F#(6) 40 ON KEY# 1,"ENTER" GOSUB 200 50 ON KEY# 2,"OUTPUT" GOSUB 600 60 ON KEY# 3,"PLOT" GOSUB 1500 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 2600 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 TA   PE" 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   LETS: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 X#=0 320 IF UPC#(R#(1,1))="Y" THEN X#   =1 @ GOTO 340 330 IF UPC#(R#(1,1))="N" THEN BE   EP @ GOTO 290 340 DISP "ENTER FROM KEYBOARD/TA   PE Y/N?" 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 X#&lt;01 OR C=2 THEN 440 410 PRINT 420 PRINT "  I      X(I)" 430 GOTO 450 440 IF C=2 THEN 600 450 DISP "ENTER NUMBER OF POINTS   " 460 INPUT N 470 IF N&lt;200 AND N&gt;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 X#&lt;01 OR I#N-2#2 THEN 560 540 PRINT USING 550 ; I-1,X(I)-1)   ,X(I) 550 IMAGE 40,2X,60Z,40,2X,60Z,40 560 NEXT I 570 IF X#=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 EPROP 660 IF X#&lt;01 THEN 1470 670 GOTO 700 680 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 F/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 </pre> | <p>Initialization</p> <p>Wait loop until key pressed<br/>HELP subroutine</p> <p>Data Entry subroutine</p> <p>Keyboard or tape?</p> <p>Keyboard entry</p> <p>Enter value</p> <p>Tape entry</p> <p>Read data</p> <p>OUTPUT subroutine</p> <p>PRINT data?</p> | <pre> 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&lt;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&lt;1 THEN 1110 1070 IF I&gt;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 I 1130 IF I&lt;0 OR I&gt;0 THEN 1110 1140 ON I+1 GOTO 1150,1040,1150,   1290 1150 GOTO 1470 1160 DISP "ENTER INDEX OF ITEM T   O DELETE"; 1170 INPUT I 1180 IF I&lt;1 THEN 1110 1190 IF I#N THEN BEEP @ GOTO 116   0 1200 DISP "DELETE X(I):";X(I) 1210 IF I#N THEN 1250 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-I 1270 DISP "N=";N 1280 GOTO 1110 1290 DISP "ENTER INDEX OF ITEM T   O INSERT"; 1300 INPUT I 1310 IF N&lt;200 THEN 1340 1320 DISP "MAXIMUM NUMBER OF ITE   MS=200" 1330 BEEP @ GOTO 1110 1340 IF I&lt;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:=0 1480 FOR I=1 TO N 1490 T=T+X(I) 1500 S2=S2+X(I)*X(I) 1510 NEXT I 1520 S=S+T 1530 S#=(S0R(S2-S5+551N)/N-1) 1540 DISP "DONE" 1550 RETURN 1560 CLEAR @ T2=-INF 1570 FOR J=1 TO N 1580 IF X(J)&gt;T2 THEN T2=X(J) 1590 NEXT J 1600 DISP "OFFSET="; 1610 INPUT 0 1620 PRINT "OFFSET=";0 1630 IF T2&gt;0 THEN 1660 1640 DISP "OFFSET TOO BIG;MAX VA   LUE=";T2 1650 GOTO 1600 1660 DISP "# OF CELLS"; </pre> | <p>Print data</p> <p>Store data?</p> <p>Print data on tape</p> <p>Correction routine</p> <p>Edit type specification</p> <p>Deletion routine</p> <p>Insertion routine</p> <p>Compute sum and sum of squares</p> <p>Plot subroutine</p> <p>Enter offset</p> |
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| <pre> 1670 INPUT T 1680 IF T=0 AND T&lt;=50 THEN 1710 1690 DISP "# OF CELLS OUT OF ROW NOS*(1.50)" 1700 GOTO 1650 1710 DISP "# OF CELLS=";T 1720 DISP "OPTIMUM CELL WIDTH =" ;T/2-0.5;T1.00001 1730 DISP "CELL WIDTH="; 1740 INPUT C 1750 FOR J=1 TO T 1760 FCJ=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)&gt;0 THEN 1860 1820 Y=INT((X(I)-0)/C+1) 1830 IF Y=C THEN 1890 1840 T5=T5+1 1850 GOTO 1910 1860 T4=T4+1 1870 GOTO 1910 1880 FCY=FCY+1 1890 B1=MAX(B1,Y) 1900 N9=MAX(N9,FCY) 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 &amp; CELL WIDTH 0 ";Y;"N" 1980 INPUT P#E1.32 1990 IF UPD#P#E1.13&gt;="N" THEN I 500 2000 IF UPD#P#E1.13&gt;="Y" THEN B EEP @ GOTO 1970 2010 K=H/C&lt;&lt;50/SQR(2#P1) 2020 Z0=P @ P=1 2030 S9=0 @ IF T&lt;7 THEN S9=1 @ L 1=T @ GOTO 2080 2040 L1=24 2050 IF INT(Z0/L1)&gt;=Z0/L1 THEN Z0 =0 2060 IF L1&gt;7 THEN L1=L1-1 @ GOTO 2050 2070 Z0=T+P @ P=P+1 @ GOTO 2040 2080 L2=1 2090 IF L1&gt;12 THEN L2=2 2100 Z3=INT(Z0/L1)*L1 2110 Z2=N9 @ Z1=Z0#C 2120 Z4=120 @ D1=Z1/Z3 @ D2=Z2/Z 4 2130 L2=10 2140 X0=0-4#D1 2150 Z5=X0+25#D1 2160 Y0=-40#D2 2170 SCALE X0,C+20#C+(207-Z7)#D1 ;Y0,N9+(151-Z4)*N9/24 2180 CLEAR 2190 MOVE 0-26#D1,0 2200 DRAW 0,0 2210 XAXIS 0,Z1/L1*#L3,0,0+Z1#D1 2220 YAXIS 0-26#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#E1.33=VAL*(J) 2280 Z#E1.33=VAL*(100*J/N) 2290 LABEL V#E1.33 2300 MOVE X0+26#D1,J-4#D2 @ LABE L;Z#E1.33 2310 NEXT J 2320 IF 0+T#C&gt;9999 THEN 2540 2330 MOVE X0+0#D1,-20#D2 2340 LABEL "LIM=" 2350 IF S9 THEN 3060 2360 LDIR 90 2370 FOR J=0 TO 0+D1+Z1 STEP Z1 L1#L3 2380 MOVE J+4#D1,Y0 2390 GOSUB 2810 2400 LABEL V#E1.33 2410 NEXT J 2420 LDIR 0 2430 FOR I=1 TO T 2440 MOVE 0+(I-1)*C,F(I) 2450 DRAW 0+I#C,F(I) 2460 NEXT I 2470 IORAW 0,-F(I) 2480 FOR I=T-1 TO 1 STEP -1 2490 MOVE 0+I#C,0 2500 DRAW 0+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="&amp;VAL*(C)&amp;" OFF SET="&amp;VAL*(C) 2560 GOTO 2420 </pre> | <p>Enter CELL WIDTH</p> <p>Sort values into cells</p> <p>Compute SCALE parameters</p> <p>Draw axes</p> <p>Label Y-axis</p> <p>Label X-axis</p> <p>Draw Histogram</p> <p>Label X-axis when values are too large</p> | <pre> 2570 FOR I=0 TO 0+T#C+D1 STEP MI M#C#T#C/20) 2580 M1=-(I-55)/S6)^2/2 2590 M1=M1*(N1)=-150)-150*(N1&lt;-1 50) 2600 IF I=0 THEN 2630 2610 DRAW I,F#EXP(N1) 2620 GOTO 2640 2630 MOVE I,F#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 NUMEER ";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.9 D.2D)";I,0+(I-1)*C,F(I),10 0#F(I)/N 2790 NEXT I 2800 RETURN 2810 V#=# 2820 X=# 2830 V#=#VAL*(X) 2840 IF POS(V#,"E") THEN 2900 2850 G9=#GT(ABS(X+(X#0))) 2860 IF LEN(V#)&gt;5 AND ABS(G9)&gt;4- (SGN(X)=-1) THEN X=X+10*(G9 -1) @ GOTO 2830 2870 IF LEN(V#)&lt;5 THEN V#=#LEN(V#) @ RETURN 2880 V#E1.53=VAL*(X) @ V=5 2890 RETURN 2900 E=#POS(V#,"E") 2910 IF VAL(V#E+13)&gt;9 THEN 2930 2920 V#E2.23=V#E3.43 @ V#E4.43=" E" @ V#E5.53=V#E+33 @ V=5 @ RETURN 2930 V#E2.23=V#E3.33 @ V#E3.33=" E" @ V#E4.53=V#E+23 @ V=5 @ RETURN 2940 CLEAR 2950 DISP "LABEL ORIGIN;X,Y" 2960 INPUT X,Y 2970 IF X&gt;X0 AND X&lt;=X0+249#D1 @ ND Y&gt;=Y0 AND Y&lt;=Y0+181#D2 T HEN 2990 2980 DISP "INVALID POSITION" @ B EEP @ GOTO 2950 2990 DISP "ENTER LABEL" 3000 INPUT P# 3010 L=#LEN(P#) 3020 IF L/32&gt;(Z5-X)/&lt;(Z5-X0) THEN DISP "LABEL TOO LONG" @ BE EP @ GOTO 2990 3030 MOVE X,Y @ LABEL P# 3040 RETURN 3050 END 3060 LDIR 0 @ L9=-INF 3070 FOR J=0 TO 0+D1+Z1 STEP Z1/ L1 3080 GOSUB 2810 3090 IF L9&gt;-(V#4+6)*D1 @ L9&gt;Z5 -(6+V#8)*D1 THEN PRINT USIN G 3100";J @ GOTO 3150 3100 IMAGE "LABEL DELETED AT";7D 40 3110 MOVE J+(2-V#4)*D1,-12#D2 3120 L9=J+(V#4+2)*D1 3130 IF L9&gt;Z5 THEN MOVE Z5+(2-V# 8)*D1,-12#D2 3140 LABEL V#E1.33 3150 NEXT J 3160 GOTO 2420 </pre> <p>Draw Normal curve</p> <p>Copy subroutine</p> <p>Copy</p> <p>Print cell statistics</p> <p>Label string routine</p> <p>Enter label origin</p> <p>Label plot at X, Y</p> <p>X-axis label routine</p> |
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# 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

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| <pre> 10 DIM Z#C20, T#C5, A#C1, B#C10 11 S#C1, U#C1, V#C1, W#C1, R#C3 20 D, X, Y, Z=0 @ C=10 40 M=0 @ P="20" @ 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 2840 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 1600 140 ON KEY# 7, "MIXED" GOTO 2980 150 ON KEY# 8, "ALGEBRA" GOTO 320 160 KEY LABEL 170 DISP "SELECT OPTION" 180 GOTO 190 185 DISP "          PROBLEM #:"     @ RETURN 190 CLEAR @ KEY LABEL @ DISP " @ RITHMETIC TEACHER INSTRUCTIO NS" 200 DISP "K1:SELECT ADDITION PRO BLEMS  K2:SELECT SUBTRACT ION PROBLEMS" 220 DISP "K3:SELECT MULTIPLICATI ON PROBLEMSK4:SELECT DIVISIO N PROBLEMS" 240 DISP "K5:HELP" 250 DISP "K6:SPECIFY MAX. NO. @" 260 DISP "          SEED-THIS STEP OVEP RIDES THE          DEFAULT CONDITI ONS " 280 DISP "K7:SELECT MIXED PROBLE M LESSON          OF +, -, *, AND /" 300 DISP "K9:SELECT ALGEBRA PRO BLEMS" 310 RETURN 320 GOSUB 3470 330 CLEAR @ DISP "THIS IS A COM PUTER-ASSISTED          DRILL IN P 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# "ABCKUNXYZ" 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 0 500 IF 0&lt;1 OR 0&gt;4 THEN 420 510 PRINT "ALGEBRA PROBLEMS TYPE #" 520 GOSUB 3550 530 ON 0 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 1710 630 DISP A1, A##S#ABS(A2): "=": A1 A2+A2 640 GOSUB 1510 @ A6=A2 650 IF A=A2 THEN 1260 660 GOSUB 3450 670 GOSUB 1510 680 IF A=A2 THEN 1280 690 GOTO 1210 700 IF X+Y#C THEN GOSUB 870 ELSE 1710 710 DISP A1: "("A##S#ABS(A2):") =": A1*(A2+A2) 720 GOSUB 1510 @ A6=A2 730 IF A=A2 THEN 1260 740 GOSUB 3450 750 GOSUB 1510 760 IF A=A2 THEN 1280 770 GOTO 1210 780 IF X+Y#C THEN GOSUB 870 ELSE 1710 790 DISP A1: "("A##S#ABS(A2):") "@U#ABS(A4): "("A#U#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 </pre> | <p>Initialization</p> <p>Wait loop until key pressed</p> <p>HELP subroutine</p> <p>ALGEBRA routine</p> <p>Select type</p> <p>Branch based on type</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> | <pre> 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#C#D#E#F#G#H#I#J#K#L#M#N#O#P#Q#R#S#T#U#V#W#X#Y#Z# 940 S# "+" @ U# "-" @ V# "*" @ W# "/" 970 IF RND&lt;.5 THEN A2=A2 @ S# "-" " 1000 IF RND&lt;.5 THEN A3=A3 @ U# "-" " 1030 IF RND&lt;.5 AND A4#A1 THEN A4 =A4 @ U# "-" 1060 IF RND&lt;.5 THEN A5=A5 1090 IF X+Y#C/2 OR X+Y&lt;A5+C/2 TH EN 1110 1090 IF X+Y#C-1 AND C7#A THEN 11 50 1100 GOTO 1170 1110 IF C8=1 THEN 1170 1120 DISP "YOU'RE HALF WAY THROU GH NOW " 1120 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# S" IS "A6 1230 DISP "TRY ANOTHER PROBLEM." 1240 Z=Z+1 1250 ON 0 GOTO 540, 620, 700, 780 1260 GOSUB 3440 @ X=X+1 1270 ON 0 GOTO 540, 620, 700, 780 1280 Y=Y+1 1290 GOSUB 3440 1300 ON 0 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. CONC PATULATIONS!" 1370 FOR I=60 TO 40 STEP -1 1380 BEEP 1, RND*10 1390 NEXT I 1400 GOTO 1580 1410 PRINT "YOU TRIED "D:" PRO BLEMS " 1420 IF X=0 THEN 1460 1430 N9=X 1440 GOSUB 1550 1450 PRINT X, T#&amp;" RIGHT ON THE 1 ST TRY " 1460 IF Y=0 THEN 1500 1470 N9=Y 1480 GOSUB 1550 1490 PRINT Y, T#&amp;" CORRECT ON THE 2ND TRY " 1500 GOTO 1580 1510 DISP A##"=": 1520 INPUT A1# 1530 A=VAL(A1#) 1540 RETURN 1550 T#=" HERE" 1560 IF N9=1 THEN T#=" WAS" 1570 RETURN 1580 D, X, Y, Z=0 @ PRINT 1590 PRINT USING "4/" @ CLEAR @ GOTO 30 1600 GOSUB 3470 @ CLEAR 1610 DISP "ENTER MAXIMUM NUMBE R" 1620 INPUT M 1630 IF M&gt;1 THEN 1655 1640 DISP "MAXIMUM MUST BE POSIT IVE" 1650 GOTO 1610 1655 F#VAL\$(INT(CLG(M))+2)*"0" 1660 DISP "ENTER OPTIONAL SEED. @ =NONE" 1670 INPUT S 1680 IF S=0 THEN 1520 1690 RANDOMIZE PP(S#.61254273) 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-A)) 1800 IF N4#N5 THEN 1760 1810 N5=N4 1820 DISP USING 1190 @ GOSUB 135 1830 DISP USING "6X,"@F1: N1 1840 DISP USING "K,"@F# : " +","N2 </pre> | <p>Construct problem</p> <p>Test for progress</p> <p>Wrong 2 times</p> <p>Results</p> <p>Fanfare for all right</p> <p>Results when some were wrong on 1<sup>st</sup> try</p> <p>Entry routine<br/>Try to block expression entry</p> <p>START routine</p> <p>Enter maximum number</p> <p>Optional seed entry</p> <p>ADD</p> |
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| <pre> 1850 DISP " 1860 DISP "ANSWER" 1870 INPUT A1# 1880 N6=VAL(A1#) 1890 IF N3&lt;&gt;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&lt;&gt;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&gt;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 195 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&lt;&gt;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&lt;&gt;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 195 2490 DISP N1;" * "N2 2500 DISP "ANSWER" 2510 INPUT A1# 2520 N6=VAL(A1#) 2530 IF N3&lt;&gt;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&lt;&gt;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 2730 2780 N5=N4 2790 DISP USING 1190 @ GOSUB 195 2800 DISP N1;" / "N2 2810 DISP "ANSWER" 2820 INPUT A1# 2830 N6=VAL(A1#) 2840 IF N3&lt;&gt;N6 THEN 2900                 </pre> | <p style="text-align: center;">SUBTRACT</p> | <pre> 2850 IF F1=0 THEN X=X+1 2860 IF F1=1 THEN Y=Y+1 2870 GOSUB 3440 2880 IF X+Y&lt;&gt;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(PND*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&gt;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 "PR0 BLEM "D 3160 ON T GOTO 3170,3190,3210,32 20 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&lt;&gt;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&lt;&gt;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)*PND) 3430 DEF FNR(X) = INT(M*RND+1) 3440 DISP "CORRECT ANSWER" @ BEE P 45,25 @ BEEP 25,35 @ PETU RN 3450 DISP "YOUR ANSWER IS WRONG. TRY AGAIN" @ BEEP 150,25 @ RETURN 3460 DISP "YOUR ANSWER IS STILL WRONG " @ BEEP 300,20 @ PETU RN  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 @ PETURN                 </pre> | <p style="text-align: center;">MIXED</p> <p style="text-align: center;">Randomize type</p> <p style="text-align: center;">Branch on type</p> <p style="text-align: center;">+</p> <p style="text-align: center;">-</p> <p style="text-align: center;">*</p> <p style="text-align: center;">/</p> <p style="text-align: center;">Display problem</p> <p style="text-align: center;">+</p> <p style="text-align: center;">-</p> <p style="text-align: center;">*</p> <p style="text-align: center;">/</p> <p style="text-align: center;">Answer entry</p> <p style="text-align: center;">Functions to generate values for problems</p> <p style="text-align: center;">Subroutines to display messages after checking answer</p> <p style="text-align: center;">Turn off keys during lesson</p> <p style="text-align: center;">Print maximum factor at start of lesson</p> |
| <pre> 2700 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 195 2490 DISP N1;" * "N2 2500 DISP "ANSWER" 2510 INPUT A1# 2520 N6=VAL(A1#) 2530 IF N3&lt;&gt;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&lt;&gt;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 2730 2780 N5=N4 2790 DISP USING 1190 @ GOSUB 195 2800 DISP N1;" / "N2 2810 DISP "ANSWER" 2820 INPUT A1# 2830 N6=VAL(A1#) 2840 IF N3&lt;&gt;N6 THEN 2900                 </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p style="text-align: center;">MULTIPLY</p> | <pre> 2850 IF F1=0 THEN X=X+1 2860 IF F1=1 THEN Y=Y+1 2870 GOSUB 3440 2880 IF X+Y&lt;&gt;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(PND*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&gt;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 "PR0 BLEM "D 3160 ON T GOTO 3170,3190,3210,32 20 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&lt;&gt;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&lt;&gt;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)*PND) 3430 DEF FNR(X) = INT(M*RND+1) 3440 DISP "CORRECT ANSWER" @ BEE P 45,25 @ BEEP 25,35 @ PETU RN 3450 DISP "YOUR ANSWER IS WRONG. TRY AGAIN" @ BEEP 150,25 @ RETURN 3460 DISP "YOUR ANSWER IS STILL WRONG " @ BEEP 300,20 @ PETU RN  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 @ PETURN                 </pre> | <p style="text-align: center;">SUBTRACT</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <pre> 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 2730 2780 N5=N4 2790 DISP USING 1190 @ GOSUB 195 2800 DISP N1;" / "N2 2810 DISP "ANSWER" 2820 INPUT A1# 2830 N6=VAL(A1#) 2840 IF N3&lt;&gt;N6 THEN 2900                 </pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p style="text-align: center;">DIVIDE</p>   | <pre> 2850 IF F1=0 THEN X=X+1 2860 IF F1=1 THEN Y=Y+1 2870 GOSUB 3440 2880 IF X+Y&lt;&gt;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(PND*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&gt;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 "PR0 BLEM "D 3160 ON T GOTO 3170,3190,3210,32 20 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&lt;&gt;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&lt;&gt;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)*PND) 3430 DEF FNR(X) = INT(M*RND+1) 3440 DISP "CORRECT ANSWER" @ BEE P 45,25 @ BEEP 25,35 @ PETU RN 3450 DISP "YOUR ANSWER IS WRONG. TRY AGAIN" @ BEEP 150,25 @ RETURN 3460 DISP "YOUR ANSWER IS STILL WRONG " @ BEEP 300,20 @ PETU RN  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 @ PETURN                 </pre> | <p style="text-align: center;">DIVIDE</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

# 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 1 <sup>st</sup> date         |
| D2 | - Day of 2 <sup>nd</sup> date         |
| D3 | - $\Delta$ days                       |
| E1 | - Temporary storage for day           |
| F1 | - Temporary storage for month         |
| G1 | - Temporary storage for year          |
|    | - Loop counter                        |
| J  | - Julian date                         |
| J1 | - Julian date of 1 <sup>st</sup> date |
| J2 | - Julian date of 2 <sup>nd</sup> date |
| K  | - Temporary storage                   |
| L  | - Temporary storage                   |
| L1 | - Label position                      |
| M  | - Month                               |
| M1 | - Month of 1 <sup>st</sup> date       |
| M2 | - Month of 2 <sup>nd</sup> 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 1 <sup>st</sup> date        |
| Y2 | - Year of 2 <sup>nd</sup> date        |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| <pre> 10 DIM A\$(32) P\$(10) D\$(2) 20 DEF=SUMMONTHEDTHURISAT" 30 J:T=INF 40 ON KEY# 1:"01/02" GOSUB 200 50 ON KEY# 2:"ADAYS" GOSUB 500 60 ON KEY# 3:"DT+DAYS" GOSUB 70  0 70 ON KEY# 4:"DOM/DOY" GOSUB 10  30 80 ON KEY# 5:"HELP" GOSUB 140 90 ON KEY# 6:"AN DAYS" GOSUB 64  0 100 ON KEY# 8:"PRT-CAL" GOSUB 12  30 110 CLEAR @ KEY LABEL 120 DISP "SELECT OPTION" 130 GOTO 130 140 CLEAR @ KEY LABEL @ DISP "   CALENDAR FUNCTIONS" 150 DISP "K1-TWO DATE ENTRY FOR   #DAYS/WEEK" 160 DISP "K2-DAYS BETWEEN DATES   K2 AND K3" 170 DISP "K3-NUMBER OF DAYS BETW   EEN D1-D2" 180 DISP "K7-COMPUTE DATE N-DAYS   BEFORE OR" 190 DISP "K8-AFTER ENTERED DATE   " 200 DISP "K4-COMPUTE DAY-OF-WEEK   AND DAY-" 210 DISP "K5-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 NO BYR." 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&lt;1 OR M&gt;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+(100+D)/10000 470 IF S&lt;150.1015 OR S&gt;404.112   5 THEN 550 480 IF D&lt;1 OR D&gt;31 THEN 550 490 IF M&gt;12 THEN 550 500 M=M+12 510 Y=Y-1 520 M=M+1 530 J=INT(365.25*Y)-INT(Y/100)+1   N*(Y/400)-INT(30.6013*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 510 : T1:T2 610 IMAGE DD.DDDDDD." AND ".DD.D   DDDDD." IS" 620 DISP J2-T1) " 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 510 : T1:T2 670 C1=Y1-1*(M1&lt;3) 680 F1=M1+12*(M1&lt;3) 690 E1=C1-INT(.75*(INT(G1/100)-1   ))+INT(305.25*(G1)+INT(30.6*(F   1)) 700 M1=S*INT(E1/7)+5*INT(C) 2013   (E1 MOD 7) 710 C1=Y2-1*(M2&lt;3) 720 F1=M2+12*(M2&lt;3) 730 E1=C2-INT(.75*(INT(G2/100)-1   ))+INT(305.25*(G2)+INT(30.6*(F   1)) 740 M2=S*INT(E1/7)+5*INT(C1 8013   (E1 MOD 7) 750 DISP "M1-Y1-M1-D1" DAYS " </pre> | <p>Initialization</p> <p>Wait loop until key pressed<br/>HELP subroutine</p> <p>Two date entry</p> <p>Date verification and<br/>conversion routine</p> <p>Compute Julian date</p> <p>Display number of days<br/>between dates</p> <p>Display number of weekdays<br/>between dates<br/>Compute weekdays</p> | <pre> 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   E" 820 DISP "=-" IMPLIES BEFORE" 830 INPUT D3 840 D3=1P(D3) 850 J2=-403+478164 860 IF 10000/J2 OR J2&gt;999999 THE   N 1016 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   1) 890 D=J2-INT(Y1*365.25)+INT(Y1/1   00)-INT(Y1/400)-INT(30.6013*   M1) 900 IF M1&lt;1 THEN 930 910 Y1=Y1-1 920 GOTO 880 930 IF M1&lt;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 390 : T 990 IMAGE "RESULTING DATE IS ".D   D.DDDDD 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 M=J-7*INT(J/7) 1100 ON M+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=101+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&gt;99)) 1360 B=VAL\$(100*(C+Y)) 1370 IF 100*(C+Y)&gt;1752 THEN 1420 1380 DISP "GREGORIAN CALENDAR BE   GINS" 1753" 1390 GOTO 1290 1400 DEF FNL(X) = X+4*INT(X/4) 0   ND Y#100*(INT(X/100) OR M#40   0)*INT(X/400) 1410 DEF FNT(X) = 31*(X-1)-INT(C   2+4*(X)*(X)2) 1420 IF M=0 AND M&lt;13 THEN 1450 1430 DISP "WHAT MONTH IS ".M) " T   PY AGAIN" 1440 GOTO 1290 1450 DISP "ENTER HEADING" 1460 INPUT R# 1470 L1=INT(44-11*LEN(R#)/8) 1480 M=INT(C)+36-28*(M+Y+INT(Y/4)   +2*(C-45*INT(C/4))-FNL(100*(C   +Y)*(M&lt;3) 1490 M=M-7*INT(M/7) 1500 M=M+7*(M=0) 1510 L=FNT(M+1)-FNT(M)+FNL(100*(C   +Y)*(M=2) 1520 R#=(L-28)*(M=1) 1530 PEN J @ LDIR 0 @ GCLEAR 1540 SCALE -4,251,-54,11 1550 J=1 1560 K=250 1570 FOR I=0 TO -10*(STEP -10) 1580 MOVE J,I 1590 DRAW K,I 1600 NEXT I 1610 J=-10*(P 1620 K=0 1630 FOR I=-2 TO 250 STEP 36 1640 MOVE I,J </pre> | <p>Enter base date</p> <p>Enter Δ days</p> <p>Compute date</p> <p>Format date</p> <p>Display resulting date</p> <p>Enter base date</p> <p>Compute day of week</p> <p>Branch to output day of week</p> <p>Compute day of year</p> <p>Display day of year</p> <p>Enter month and year for<br/>calendar</p> <p>Verify year</p> <p>Century function</p> <p>Month function</p> <p>Verify month</p> <p>Enter heading</p> <p>Compute centering coordinate</p> <p>Compute number of weeks in<br/>month</p> <p>SCALE and draw grid</p> |
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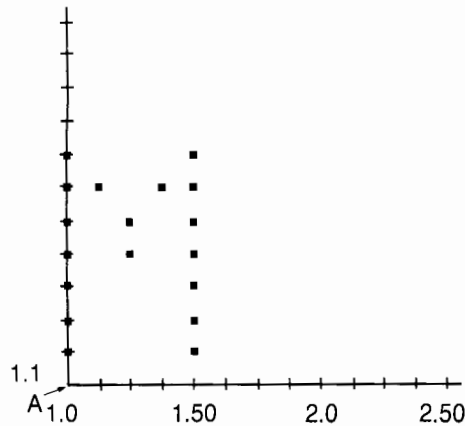
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |  |  |
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| <pre> 1650 DRAW I,K 1660 NEXT I 1670 SCALE 0,88,0,60 1680 MOVE L1,64 1690 LABEL A# 1700 FOR J=1 TO M 1710 READ K 1720 NEXT I 1730 RESTORE 1740 K=K+K 1750 L1=44-(K/2)-2)*4 5333 1760 MOVE L1,66 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, 9 2040 SCALE -1,251,-4,64 2050 FOR I=6 TO 222 STEP 36 2060 J=(I-6)/36+1 @ MOVE I 5@ 5 @ LABEL O#EJ J+2J 2070 NEXT I 2080 D,P=1 2090 S=(L/29)*(M=7)+(L/30)*(M&gt;5) +6 2100 L=L-(S)*R)-(S)*2) 2110 IF S=0 OR R&lt;5 THEN 2140 2120 O=D+S+S 2130 IF O=23 OR O=96 OR O=207 OR O=216 THEN 2160 2140 MOVE 36*(M-1)+10*(6-R)-7.25 2150 LABEL VAL#(O) 2160 O=O+1 2170 IF O=1 THEN 2210 2180 W=H*(K/7)+1 2190 R=P+W=1) 2200 GOTO 2110 2210 O=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 2270 2360 GOTO 2240 2370 I=36 2380 O=O+1 2390 DRAW I+36,10 2400 MOVE I,10*(6-R)-3.25 2410 LABEL VAL#(O) 2420 MOVE I+20,10*(5-R)+1 2430 LABEL VAL#(O+7) 2440 RETURN 2450 IF J THEN CLEAR @ KEY LABEL 2460 RETURN </pre> | <p>SCALE for labelling</p> <p>Label dates</p> <p>End of month routine for shared squares</p> |  |  |
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# 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 O#&"", "&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

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                   |
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| <pre> 10 BIN #DEC31, #DEC1971, #F197 20 DEG @ PRINTER-15 2 30 #DEC1, 307=" JANUARY###FEBRUARY ###MARCH###" 40 #DEC31, 607=" APRIL###MAY### ###JUNE###" 50 #DEC01, 907=" JULY###AUGUST ###SEPTEMBER" 60 #DEC01, 1207=" 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 "Y1 ENTER BIRTHDATE AND NAME-THIS" 170 DISP " MUST BE DONE FIRST. " 180 DISP "NO ENTER DATE TO START CHECKING" 190 DISP " FOR CRITICAL DAYS O ND OUTPUT" 200 DISP " THE DATES FOR CRITI CAL DAYS " 210 DISP "Y4 PLOT THE BIORHYTHMS FOR A MO. " 220 DISP " AT A TIME USE@ 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 N1 290 DISP "WHAT IS YOUR BIRTHDAY- MM.DD.YYYY" 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&lt;1 OR M&gt;12 THEN 520 390 T1=M 400 D=INT(100*T) 410 T1=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 530 450 IF D&lt;1 OR D&gt;31 THEN 520 460 IF M&gt;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 .DD.YYYY" 570 INPUT T 580 T2=T 590 GOSUB 270 600 IF J=0 THEN 560 610 J2=J 620 IF J1&lt;J2 THEN 650 630 DISP "YOU CANNOT GO BACK".N1 640 GOTO 560 650 J7=J2-J1 @ J4=J2+33 660 GOTO 340 670 L=INT(J+478164) 680 IF 10000&lt;L OR L&gt;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&lt;1 THEN 750 730 Y1=Y1-1 740 GOTO 700 750 IF M1&lt;12 THEN 780 760 M1=M1-12 770 Y1=Y1+1 780 M1=M1-1 790 T=M1*10/100+Y1/1000000 800 RETURN 810 DISP "DATE IS OUT OF RANGE" </pre> | <p>Initialization</p> <p>Wait loop until key is pressed<br/>HELP subroutine</p> <p>Enter name</p> <p>Enter birthdate</p> <p>Compute Julian day number and<br/>verify date</p> <p>Critical day subroutine</p> <p>Enter starting date</p> <p>Verify date</p> <p>Convert Julian date to<br/>MM.DD.YYYY form</p> | <pre> 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=J2+C*(C+J1) 1010 RETURN 1020 IF J&gt;=12 THEN 1050 1030 J=J+6 1040 GOTO 1020 1050 IF J&gt;=34 THEN 1100 1060 GOSUB 670 1070 IF L=0 THEN 1100 1080 DISP USING "2000.A.40" M1, "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 0 15TH JAN. 00" 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 "32-DAY OR COGNITIVE CYCLE" 1270 PRINT "RELATES WITH MENTAL ADAPTIVE" 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 C YCLES IS" 1330 PRINT "TIMES ARE REGARDED A S ENERGETIC" 1340 PRINT "TIMES, YOU ARE YOUR MOST DYNAMIC" 1350 PRINT "DURING THIS. THE LOW CYCLES" 1360 PRINT "TIME ARE REGARDED AS THE" 1370 PRINT "RECUPERATIVE PERIODS CRITICAL" 1380 PRINT "DAYS (X=0) ARE REGAR DED AS ZERO" 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 T1=T1, T2=F1+.01+F2/1000000 1500 GOSUB 370 1510 IF J=0 THEN 1450 1520 LET F1=F1+12*(F1-12) 1530 LET F2=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&gt;=1 THEN 1610 </pre> | <p>Call routines for each cycle</p> <p>Compute 1<sup>st</sup> critical date<br/>Critical day incremental<br/>routine</p> <p>Explanation subroutine</p> <p>PLOT subroutine<br/>Enter month, year</p> <p>Verify</p> |
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| 1590 DISP "SPECIFIED MONTH IS BEFORE BIRTHDAY"                              |                             |  |  |
| 1600 BEEP @ GOTO 1450                                                       |                             |  |  |
| 1610 P2=J-1-J1                                                              |                             |  |  |
| 1620 S=P2-P1+1                                                              |                             |  |  |
| 1630 GCLARR @ SCALE .5,30,275,-1<br>7,1,500                                 | Scale plot                  |  |  |
| 1640 MOVE 1,1,28                                                            |                             |  |  |
| 1650 LABEL N#                                                               | Label name                  |  |  |
| 1660 O=POSOME((F1-1)*10+1).**" +<br>(F1-1)*10-1                             |                             |  |  |
| 1670 O#=#(F1-1)*10+1,07                                                     | Label month                 |  |  |
| 1680 MOVE 1,1,1                                                             |                             |  |  |
| 1690 LABEL O#O: "&VAL*(F2)                                                  |                             |  |  |
| 1700 XAXIS @ 1,1,10+99                                                      |                             |  |  |
| 1710 YAXIS 1, 2,-1-1                                                        |                             |  |  |
| 1720 MOVE 13,-1,15                                                          |                             |  |  |
| 1730 LABEL "DAYS"                                                           | Label axis                  |  |  |
| 1740 LDIP 90 @ MOVE 5,5,-1,1                                                |                             |  |  |
| 1750 LABEL "5"                                                              |                             |  |  |
| 1760 FOR I=10 TO 5 STEP 5                                                   |                             |  |  |
| 1770 MOVE I+5,- 24                                                          |                             |  |  |
| 1780 LABEL VAL*(I)                                                          |                             |  |  |
| 1790 NEXT I                                                                 |                             |  |  |
| 1800 LDIP 0 @ C=27                                                          | Plot physical cycle         |  |  |
| 1810 O#="P"                                                                 |                             |  |  |
| 1820 GOSUB 2100                                                             |                             |  |  |
| 1830 C=28                                                                   |                             |  |  |
| 1840 O#="S"                                                                 | Plot sensitivity cycle      |  |  |
| 1850 GOSUB 2100                                                             |                             |  |  |
| 1860 C=27                                                                   |                             |  |  |
| 1870 O#="C"                                                                 | Plot cognitive cycle        |  |  |
| 1880 GOSUB 2100                                                             |                             |  |  |
| 1890 ALPHA                                                                  |                             |  |  |
| 1900 DISP "COPY TO PRINTER(Y/N)"                                            | Copy?                       |  |  |
| 1910 INPUT O#I(,0)                                                          |                             |  |  |
| 1920 IF UPC(04E1,17)="#N" THEN I<br>900                                     |                             |  |  |
| 1930 IF UPC(04E1,17)="#Y" THEN B<br>EEP @ GOTO 1980                         | Copy                        |  |  |
| 1940 GRAPH                                                                  |                             |  |  |
| 1950 COPY                                                                   |                             |  |  |
| 1960 SCALE @,255,0,191                                                      |                             |  |  |
| 1970 MOVE 1,0                                                               |                             |  |  |
| 1980 LABEL "PRESS CONT WHEN READY"                                          | Label instructions?         |  |  |
| 1990 PAUSE                                                                  |                             |  |  |
| 2000 ALPHA                                                                  |                             |  |  |
| 2010 DISP "NEXT MONTHLY(Y/N)"                                               | Next month?                 |  |  |
| 2020 INPUT O#I(,0)                                                          |                             |  |  |
| 2030 IF UPC(04E1,17)="#N" THEN C<br>800                                     |                             |  |  |
| 2040 IF UPC(04E1,17)="#Y" THEN I<br>010                                     |                             |  |  |
| 2050 F#=#(F1+1)*10+1                                                        |                             |  |  |
| 2060 F#*(F1+1)*12*(F1=10)                                                   | Increment month and plot it |  |  |
| 2070 GOTO 1450                                                              |                             |  |  |
| 2080 GCLARR 10 @ MOVE 0,1,10<br>1,1,PRESS KEY LABEL WHEN READY<br>Y @ GRAPH |                             |  |  |
| 2090 RETURN                                                                 |                             |  |  |
| 2100 MOVE 1,1,SINCF1 MOD C*(C360)<br>2110 J=2                               | Plot cycle subroutine       |  |  |
| 2120 FOR I=P1+1 TO P2+1                                                     |                             |  |  |
| 2130 GRAPH J,SINCF1 MOD C*(C360)                                            |                             |  |  |
| 2140 IF J=0/21 AND J=0/6 THEN<br>2100                                       |                             |  |  |
| 2150 MOVE J,SINCF1 MOD C*(C360)                                             |                             |  |  |
| 2160 LABEL O#                                                               | Label cycle                 |  |  |
| 2170 MOVE J,SINCF1 MOD C*(C360)                                             |                             |  |  |
| 2180 J=J+1                                                                  |                             |  |  |
| 2190 NEXT I                                                                 |                             |  |  |
| 2200 RETURN                                                                 |                             |  |  |

# 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     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| <pre> 10 OPTION BASE 1 20 DIM S(100),C(24,2),D(60,2),D   I(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 DCM,1)=1:SF(SIN(X)) @ DCM,2)=   4.5*COS(X) 70 IF M MOD 5 THEN 100 80 D1(M/5,1)=.3*(SIN(X)) @ D1(M/   5,2)=.3*(COS(X)) 90 X=.25*(SGN(38-M)) @ Y=.7 @ D2(   M/5,1)=F1(X) @ D2(M/5,2)=F2(   Y) 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)   )=223 150 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)=261 170 C(3,1),C(6,1),C(11,1),C(14,1)   ,C(18,1)=70 180 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 1000 250 SCALE @ 255,0,191 260 KEY LABEL 270 DISP "SELECT OPTION" 280 GOTO 200 290 ALPHA @ CLEAR @ KEY LABEL 300 DISP "ENTER TIME:HH.MMSS" 310 INPUT T1 320 DISP T1 330 IF T1&gt;27.9999 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 1200 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 1000 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 @ 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&lt;1)   *(S1=0)) 600 MOVE 100,0 @ LABEL V\$(1,POS(   V\$,"")+4] 610 RETURN 620 R,S=1 630 GOSUB 1000 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# @TIME SEC" 730 FOR I=1 TO S 740 PRINT USING "DDDD,3X,7D 4D"   ;I,S(I) 750 NEXT I </pre> | <p>Initialization</p> <p>Set up for drawing clock face</p> <p>Wait loop until key is pressed</p> <p>Enter time</p> <p>Verify</p> <p>Compute seconds</p> <p>Set time</p> <p>Wait loop until key is pressed</p> <p>Stop timer interrupt-restore keys</p> <p>DIGITAL display</p> <p>Set key #1 for STOP</p> <p>Set timer #1</p> <p>Update time</p> <p>Set up for COUNT UP Timer</p> <p>Initialize starting time</p> <p>Take split</p> <p>Check for splits taken</p> <p>Print out splits</p> | <pre> 760 RETURN 770 DISP "          TIMER OPERATIONS   " 780 DISP "K1:SET/STOP TIMER-ENTE   R REAL" 790 DISP "          TIME FOR K2,K6&amp;K8 D   ISFLAY-" 800 DISP "          STOP DISPLAY OR COU   NT UP" 810 DISP "K2: DIGITAL DISPLAY MOD   E SELECT" 820 DISP "K3: SELECT COUNT UP-INI   T SPLIT" 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 1000 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&lt;=0 THEN OFF TIMER# 1   @ GOSUB 1700 @ ALPHA @ GOSU   B 1800 @ KEY LABEL @ RETURN   ELSE 1010 1020 S2=S2-1 1030 GCLEAR @ 1040 MOVE 120,0 1050 LABEL VAL\$(S2) 1060 RETURN 1070 IF R1 THEN R=1 @ S1,T0=0 1080 IF R THEN GOSUB 1000 ELSE D   ISP "TIME NOT SET" @ BEEP @   GOTO 270 1090 ON KEY# 1,"SET/STOP" GOSUB   420 @ KEY LABEL 1100 GCLEAR @ MOVE 100,12 @ 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&lt;1)   *(S1=0)) 1180 GCLEAR @ 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 -9.0,-5.8,6.2   @ GCLEAR @ S=0 1270 MOVE -6,-5.8 @ LABEL "STOP" 1280 GOSUB 1000 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 DCM,1),DCM,2) @ PENUP 1330 IF M MOD 5 THEN 1370 1340 IDRAW D1(M/5,1),D1(M/5,2) @   PENUP 1350 X=.25*(SGN(38-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 1750 1410 S=INT(TIME) MOD 60 1420 T0,T9=INT(TIME) 1430 IF T0=INT(TIME) THEN T9=INT   (TIME) @ GOSUB 1450 1440 IF R THEN 1430 ELSE 240 1450 S1=INT(T9-T8) @ S1=S1+86400   *(S1&lt;0) @ T8=T9 1460 PEN -1 1470 GOSUB 1650 </pre> | <p>HELP subroutine</p> <p>COUNT DOWN</p> <p>Update count down</p> <p>Check if done</p> <p>Display new count</p> <p>5 SEC</p> <p>Set timer</p> <p>Update time</p> <p>Label instructions</p> <p>Set up and draw clock</p> <p>Draw hands initially</p> <p>Increment hands</p> <p>Check for stop</p> <p>Update hands</p> |
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| <pre> 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&lt;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 FNK(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       250 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 </pre> | <p>Hour<br/>Chime for hour</p> <p>Strike the hour<br/>1/4 hour<br/>Set up for chimes</p> <p>1/4 hour<br/>1/2 hour<br/>3/4 hour</p> <p>Draw second mark</p> <p>Minute hand<br/>Hour hand</p> <p>Turn off keys</p> <p>Turn on keys</p> |  |  |
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**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:

$$\begin{aligned} P1 &= 613062.5/(11 * F) - 134/11 & \text{where} & & F &= \text{frequency in hertz} \\ P2 &= 613062.5/(11 * P1 + 134) * T & & & T &= \text{duration in seconds} \end{aligned}$$

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 from 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=0 @ 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 Q=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$(T(N,2)))+1
720 T=60/T(N,2)
730 GOTO 850
740 C=C+1
750 IF O#-1 THEN 770
760 T(N,1)=9999 @ T(N,2)=1000*(T
 *B-.015) @ GOTO 850
770 IF O=0 THEN 530
780 IF O=8 THEN O=O-1 @ P1=11 @
 GOTO 810
790 P1=POS(T$,P#[O,Q])-1
800 O=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 O=8 THEN O=O+1
840 IF T(N,2)<1 THEN T(N,2)=1
850 N=N+1 @ O=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

?

T803A

```

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 O=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



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| <pre> 1570 R#R#*0"0"VAL*(C0+P1=11)N #EP1+P1+13 @ 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=1 1630 GOSUB 510 1640 N=S*(N+S+1)+(N-1)*(N+S+1) 1650 DISP "MORE Y/N" 1660 INPUT R#I,323 1670 ON FNP GOTO 1680,1350,360 1680 BEEP @ GOTO 1650 1690 DISP "METRONOME" 1700 INPUT M1 1710 IF M1=T(I,2) OR M1&lt;1 THEN 1 550 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 KEYB0 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 Naturalz+ ARDEF C" 1880 DISP "Flats+abcdefg" @ DISP "Sharps+CTRL ABCDEFG or GR NAEDR" 1890 DISP @ DISP "Octave+On,14n &lt;=6" @ DISP "Timing+T/n or Tn if n=1" 1900 DISP "Rest+R,uses current t iming" @ DISP "Repeat+n/m or n if n=0" 1910 DISP " n=# ARRAY VALUE S TO REPEAT" 1920 DISP " n=# ARRAY VALUE S TO SKIP" 1930 DISP "Metronome+n,n=WHOLE NOTES/MIN." 1940 DISP "DEFAULT VALUES+04T1" 1950 DISP " EX:M6003T8G04CET4GT 8RET3G" 1960 BEEP 130.49 @ BEEP 94.66 @ BEEP 72.87 @ BEEP 59.196 @ WAIT 125 1970 BEEP 72.87 @ BEEP 59.391 @ RETURN 1980 GOSUB 2640 1990 DISP "DELETE STARTING AT" 2000 INPUT Z 2010 IF Z&lt;=0 THEN RETURN 2020 IF Z&gt;N THEN BEEP @ GOTO 19 90 2030 DISP "HOW MANY" 2040 INPUT Z 2050 IF Z=0 OR Z&gt;N THEN RETURN 2060 FOR I=Z0 TO N-Z 2070 S=I+Z 2080 IF T(S,1)&lt;0 THEN T(I,1)=T(S ,1)+Z*(T(S,1)-Z0) @ T(I,2) =T(S,2)+Z*(T(S,2)-Z0) @ GOTO 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&gt;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&gt;N1 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)&lt;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 </pre> | <p>Metronome change?<br/>Enter new note</p> <p>No change check?</p> <p>Parse new string</p> <p>More?</p> <p>Enter new metronome setting</p> <p>Modify following notes accordingly</p> <p>HELP subroutine</p> <p>Example tune</p> <p>DELETE</p> <p>Delete address</p> <p>Error</p> <p>How many?</p> <p>Exit</p> <p>Move array elements</p> <p>INSERT</p> <p>Insert address</p> <p>Exit</p> <p>Error</p> <p>Append</p> <p>How many?</p> <p>Make room</p> | <pre> 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)X" VALUES" 2350 DISP "1ST VALUE" 2360 INPUT S 2370 IF S=0 THEN RETURN 2380 DISP "LAST VALUE" 2390 INPUT R3 2400 IF S&lt;1 OR P3&lt;S OR R3&gt;N THEN BEEP @ GOTO 2350 2410 T=60/M 2420 GOSUB 2550 2430 PRINT "NOTES FROM "S:" TO "R3 2440 P,R1,P2=0 2450 DISP "PRINT OR SCORE P/S" 2460 INPUT R#I,323 2470 IF UPC*(R#I,13)="P" THEN 2 560 2480 IF UPC*(R#I,13)="S" THEN B EEP @ GOTO 2450 2490 GOTO 2650 2500 FOR I=S TO R3 2510 GOSUB 1420 2520 PRINT R#I " " 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#I,323 2610 ON FNP GOTO 2620,2620,3310 2620 R2=0 @ RETURN 2630 BEEP @ GOTO 2590 2640 CLEAR @ KEY LABEL @ RETURN 2650 SCALE -1.70,875,-2.45,75 @ P2=1 @ GCLEAR @ GOSUB 2950 @ C=1 @ I=S 2660 IF C=31 THEN GOSUB 2940 2670 GOSUB 2320 2670 IF I&gt;R3 THEN 2900 2680 IF T(I,1)=0 THEN T=60/T(I,2 ) @ I=I+1 @ GOTO 2720 2690 IF T(I,1)=9999 THEN 3140 2700 IF T(I,1)&lt;0 THEN GOSUB 3750 @ GOTO 2700 2710 GOSUB 1450 @ GOSUB 2930 2720 Y=C*(I-1)*7+P2+.5 2730 IF S0 THEN GOSUB 3000 2740 C2=LOG(C)/LOG(2)+1 @ F=U/D 2750 IF U=1 THEN T1=F @ GOTO 281 0 2760 T1=1 @ C2=1 2770 IF T1&gt;F THEN T1=T1/2 @ C2=C 2+1 @ GOTO 2810 2780 ON C2 GOSUB 2860,2870,2890, 2880,2880,2880,2880 2830 F=F-T1 2840 IF F&lt;1/128 THEN 2900 2850 C=C+(C=1)+(C=1)*(NOT FNP9) @ MOVE C-.5,Y+1.25 @ BPL0T "Y3",1 @ GOTO 2800 2860 MOVE C,Y @ BPL0T "&lt;BBB&lt;" ,1 @ GOTO 3000 2870 MOVE C,Y @ BPL0T "r00!" "1 @ GOTO 3000 2880 FOR J=C2 TO 4 STEP -1 @ MOV E C,Y-(1.75+.5*(7-J)) @ BPL OT "f",1 @ NEXT J 2890 MOVE C,Y @ BPL0T "r###?" "1 @ GOTO 3000 2900 IF I&gt;R3 THEN 3360 2910 I=I+1 2920 GOTO 2690 2930 P2=VAL(N#EP1+1,P1+13) @ S0 =NUM(N#EP1+1,P1+13)&gt;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 @ BPL0T F1*.2 @ MOVE -1.15 @ BPL0T C1*.2 @ RETU RN 3000 Z0=2*INT(INT(Y-.5)/2)+1 @ J =MAX(7,MIN(20-4.29)) 3010 FOR Z=Z0 TO J STEP 2*SGN(J- Z0)+(J=29) 3020 IF Z=17 AND Z#20 OR Z0&gt;27 A ND Z0&gt;Y AND Z=Z0 OR Z&lt;7 AND Y?7 THEN 3040 3030 MOVE C+.125,Z @ DRAN C+ .875 NEXT Z 3040 NEXT Z </pre> | <p>Enter composition</p> <p>PRINT</p> <p>Enter range</p> <p>Print or Score?</p> <p>PRINT routine</p> <p>Review? Subroutine</p> <p>SCORE routine</p> <p>Set note counter</p> <p>Page</p> <p>Done</p> <p>Metronome</p> <p>Rest</p> <p>Repeat</p> <p>Note convert to string</p> <p>Compute location to plot</p> <p>Compute timing</p> <p>Plot note</p> <p>Too small</p> <p>Tie</p> <p>Whole note</p> <p>Half</p> <p>Flags</p> <p>Quarter note</p> <p>Done</p> <p>Sharp flag set</p> <p>New page</p> <p>Staff</p> <p>Treble and bass clefs</p> <p>Fill in lines</p> |
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| <pre> 3050 C=C+1 @ IF C=31 AND F-T1&gt;=1 /128 THEN 2940 ELSE RETURN 3060 END 3070 DEF FNR = POS("YN".UPC*(R#C 1.11))&gt;+1 3080 IF C=20 AND FNPR 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(Y) = 89&lt;&lt;11*55*2^N# 2^&lt;(P1/12)))-134/11 3120 DEF FNU = VAL(R#C+1) 3130 DEF FNF = POS(R#C+1.C+3*(F NU&gt;99)1,"") 3140 F=(T(I.2)/1000+.015)/T 3150 T1=1 @ C2=1 3160 IF T1&gt;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&lt;1/128 THEN 2900 3200 GOTO 3150 3210 MOVE C,25.75-C2 @ BPL0T "&lt;&lt; &lt;" @ GOTO 3050 3220 MOVE C,26.75 @ BPL0T "00ΔΔα αS4αα000†4&gt;fbbα 04Δα".1 @ GOTO 3050 3230 MOVE C,20.75 @ GOSUB 3280 3240 MOVE C,26.75 @ GOSUB 3290 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 BPL0T "0&gt;&gt;α46".1 @ RETURN 3290 DISP "FILE NAME", 3300 INPUT F# 3310 RETURN 3320 IF I#R THEN RETURN ELSE I=R &lt;R2,2&gt; @ R2=R2-1 3330 IF R2 THEN R=R&lt;R2,1&gt; 3340 GOTO 3320 3350 R2=R2+1 @ R.P&lt;R2,1&gt;=T&lt;I,2&gt; @ R&lt;R2,2&gt;=I+1 @ I=-T&lt;I,1&gt; @ RETURN 3360 IF C=-1 OR C=1 AND NOT FNPR THEN RETURN ELSE COPY @ RE TURN 3370 DEF FNPR = P9=INT&lt;P9/2&gt;#2 </pre> | <p>Y or N check function</p> <p>Sharp</p> <p>Compute frequency</p> <p>Value function</p> <p>Position of "f" function</p> <p>Rest plotter</p> <p>Whole and half</p> <p>Quarter</p> <p>64<sup>th</sup><br/>32<sup>nd</sup><br/>16<sup>th</sup><br/>8<sup>th</sup></p> <p>64<sup>th</sup> symbol<br/>File name input</p> <p>Repeat pointer control</p> <p>Copy?</p> <p>Page logic identifier</p> |  |  |
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# 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           |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| <pre> 10 ON KEY# 1:"SET UP" GOSUB 174   0 20 ON KEY# 5:" HELP " GOSUB 170   0 30 ON KEY# 2 GOSUB 1560 40 ON KEY# 4 GOSUB 1540 50 ON KEY# 8 GOSUB 1520 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#   C(1) 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 "EH   TER BACKGROUND COLOR:0=N,1=B   " 150 INPUT W8 160 SCALE 0 255,0 191 170 IF W8 THEN V9=1 180 DISP "ENTER COURSE CODE" 190 INPUT S1 200 DISP "WHAT'S YOUR ABILITY:1   TO 5 &lt;1 IS EASY,5 IS HA   RD" 210 INPUT 0 220 IF C(1) THEN 200 230 RANDOMIZE S1#.6142332571 240 PEN V9 @ CLEAR @ 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&lt;=.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&lt;=.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&lt;35 THEN 490 470 G=G+1 480 GOTO 290 490 X=F(G,1)-8 @ C=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= 801 600 P=190 610 A= 25+ 110 @ V=1 @ D=190 620 C=218 630 FOR I=0 TO 10 640 M(1)=0 650 NEXT I 660 M1=1 670 Y1=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/4P/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 W&gt;0 THEN 870 860 W=1 @ W=.75*W 870 IF W&lt;0 THEN X=.75*W 880 C=X1 @ D=Y1 890 C1,Y1=X1+X @ D1,Y1=Y1-Y @ DR   AW X1,Y1 </pre> | <pre> 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? </pre> | <pre> 900 C2=MIN(C,C1) @ C3=MAX(C,C1) 910 D2=MIN(D,D1) @ D3=MAX(D,D1) 920 M=M1 930 IF Y1&lt;G(M,2) THEN M1=MIN(G,M   +1) 940 S=-Y*(F(M,1)+D)+Y*(C/X) 950 P=-X*(F(M,2)+D)+Y*(C/X) 960 IF (C2)&gt;R OR (D3)&gt;3 AND F(M,2)   =G(M,2) THEN 1190 970 IF (D2)&gt;S OR (D3)&gt;3 AND F(M,1)   =G(M,1) THEN 1190 980 IF F(M,2)=G(M,2) AND R&gt;=F(M,   1) AND G(M,1)&gt;R THEN 1010 990 IF F(M,1)=G(M,1) AND F(M,2)&gt;   =S AND S&gt;=G(M,2) THEN 1110 1000 GOTO 1190 1010 IF F(M,1)+1&lt;P 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 P&lt;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&gt;S THEN 1130 1120 GOTO 1020 1130 IF S&gt;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&lt;17 THEN 900 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(1)=1 THEN 1340 1330 MOVE G(1,1),G(1,2) @ 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" </pre> | <pre> 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 </pre> |
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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 180
1740 F=2
1750 RETURN
1760 F=1
1770 RETURN
1780 IDRAW -5,17
1790 IDRAW -4,-4
1800 IDRAW 4,0 @ PENUP
1810 RETURN
1820 IDRAW 5,17
1830 IDRAW 4,-4
1840 IDRAW -4,0 @ PENUP
1850 RETURN

```

Set up flag

HELP flag

Left pole

Right pole

# 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, N1-8*D2 Label X-axis vertical

1790 LDIR 0 @ LORG 7

1810 MOVE I-8*D1, I-4*D2 Label Y-axis
1935 LORG 1
1985 LORG 1

2150 MOVE U, T+1 @ LABEL VAL$(A) Label plot

2340 RETURN

2455 LORG 1
```

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$(19),U$(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,Y1-8*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 **ENDLINE**

### 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: DPLOTT**

```

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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