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PLOT: A BASIC PLOTTING ROUTINE FOR THE TEKTRONIX 4654
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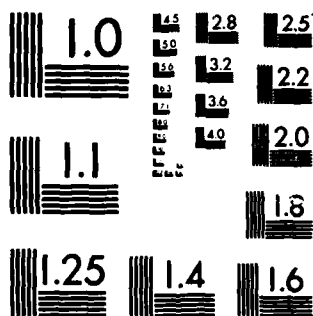
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TEKTRONIX 4054 TERMINAL AND 4663 PLOTTER (U)

by

M.D. Gauthier-Mayer

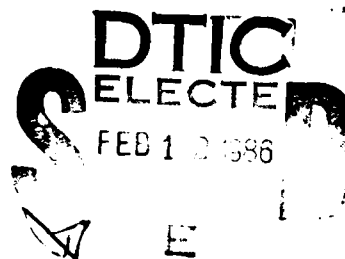
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ABSTRACT

A BASIC plotting routine for the Tektronix 4054 terminal and 4663 plotter has been developed. It is named PLOT. The program is capable of plotting in a variety of coordinate systems - Cartesian, semilog on X, semilog on Y or log-log. Two separate Y axes can be used. The user can input the axes boundaries, axes titles, the block of data to be plotted, legends for the data, and a figure caption. Model equations can be represented by dashed lines on the plot. The program will accommodate up to 70 data sets, and a total of six data columns. The data can be manipulated by changing data points or sets, adding sets and columns, deleting sets or columns, sorting data in a column, generating columns from existing data and adding two data files together. This report is a working manual for the PLOT program.

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The author would like to thank Betty Larson and Andrew Eagles for help with some of the programming routines. As well, Dr. Joan Armour made many useful suggestions and helped to test run the program.

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FIGURE NUMBER

1 Typical Plot obtained from the PLOT program

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M.D. Gauthier-Mayer

INTRODUCTION

1. There is a continuing need in the physical chemistry group at DRES to produce a variety of graphs, quickly and in a publishable format. To meet these requirements, a BASIC plotting program was written for use with the Tektronix 4054 terminal and the 4663 plotter. Several Tektronix manuals were used as references for the program¹⁻⁵. The program has the capability of producing plots in log-log, semilog or Cartesian coordinates. It is entitled PLOT, and allows the user to input data into an array, choose the type of plot required, and plot all or part of the data. This report is designed as a user's guide to the program.

2. The data is entered into an array, dimensioned for 70 data sets and 6 columns of data. The data can be manipulated in several ways. Individual points or data sets can be changed. Data sets or columns can be deleted. Data may be added as sets or columns. Columns can

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be generated (through an equation) from existing data. The data can be sorted, using any column. The data can be stored in a file on tape. As well, two data files can be added together to form one file.

3. The plotting routine allows the user to plot any column as X, and any column as Y, in the coordinate system of his choice - Cartesian, semilog on X, semilog on Y or log-log. The user can also have a second Y axis, along the right hand side of the graph (called the Z axis). Any column can be chosen as Z, and the axis type can be different from the Y axis. The user determines the range of the X, Y and Z axes and which points are to be plotted in the X,Y or X,Z plots. The data can be plotted with axes, or without. After plotting, a least squares fit of the plotted data is calculated (for X,Y and X,Z data) and the user has the option of plotting the best straight line through the data. The equation of the line is displayed on the screen. The user can input a legend to identify the plotting symbols, and a title or figure caption. As well, the user has the option to input an equation, or model, as a function of the X data, and plot the resulting curve with a dashed line pattern. Once a plot is satisfactory, it can be repeated any number of times - either on the screen, or on the plotter.

4. The data can be listed on the screen or on a printer (such as a Datacom 1200 terminal). For the printer, the user can list the data with a different number of significant figures for each column. The columns of data are centered for an 8½ x 11 sheet of paper. The resulting list is in publishable format, although column headings and a table number must be added.

5. This report is a working guide to the PLOT program. Each section

describes a particular routine, and how to use it. The program is designed to be versatile and can accommodate a wide range of plotting needs. However, it can be tailored by the user to meet specific requirements. Suggestions for such changes are included wherever possible. Appendix I contains the USER KEY assignments, Appendix II documents the variables used in the program, and Appendix III lists the sizes of the arrays in the program. A hard copy of the program is in Appendix IV. The required set ups for the DATACOM 1220 printer and the Tektronix 4663 plotter are in Appendix V and Appendix VI, respectively.

STORAGE REQUIREMENTS

6. The program is in File 1 of the tape. The file length is 65024 bytes, of which the program uses 40585 bytes. After loading the program into the Tektronix 4054 terminal, there are ~ 7200 bytes of memory remaining. About 1000 bytes are required for variables in the different routines. The remainder is available for data storage.

7. The data is stored in an array, A. The size of A is limited by the number of bytes (~ 6200) available in the memory. The array is dimensioned for 70 data sets and six columns of data. If the user has more than 70 sets, or 6 columns, then the data must be split into two data files.

STARTING THE PROGRAM

8. Insert the program tape, entitled PLOT, into the terminal. To input the program into memory and start it, use the AUTOLOAD button², or the following procedure:²

- a. Find the file the program is stored in. FIND 1 (return)

- b. Load the program. OLD (return)
- c. Start the program. RUN (return)

9. At the start of the program, the terminal settings are initialized and the variables are dimensioned. Many of the variables are set to their default values. The screen displays the name of the program and is ready for data input (see DATA ENTRY).

10. Once the program has been loaded, USER KEY #1 will also restart the program. This will eliminate any previous data though and reset all the parameters to their initial values.²

DATA ENTRY (USER KEY #1)

11. Data is entered from a file on a data tape, or from the keyboard.

- a. Tape entry - the user is asked to insert the data tape, and input the file number containing the data. The input read from the tape is:
 - (1) S1, number of sets of data
 - (2) V1, number of columns of data
 - (3) sets of data
 - (4) S\$, data identification (if applicable)

The data identification and the data sets are automatically listed on the screen, once the tape input is finished.

Note: The data identification is not always in the data file, especially with older data files. If it is not found in the file, the data identification is requested by the program.

b. Keyboard entry - the user is asked to input

- (1) data identification (S\$)
- (2) number of columns (V1)
- (3) number of data sets (S1)
- (4) data sets

A bell will sound at the end of the data entry, when S1 data sets have been input.

12. The data is stored in the array A. The array is dimensioned for 70 data sets and six columns. If the number of user data sets (S1) exceeds 70, or the number of user columns (V1) exceeds 6, then only part of the data will be read in - enough to fill the array. The memory of the 4054 is not large enough to accommodate a larger array, without a memory error. The remaining data must be entered through the keyboard into another file, or some of the data must be deleted to accommodate it.

13. If there are more data sets to enter, use USER KEY #3, adding sets of data. Otherwise the data can now be listed (USER KEY #2), modified through deletions or changes, or plotted (USER KEY #9).

Note: In some cases there may be several columns of data, but not all columns are full of data. However, all data sets must have a number in each column. It is not advisable to put a zero in blank spots, as this will cause an error in any log plots involving this column (log 0 is undefined). The number 1E-10 should be used. This will also facilitate the data listing, when done in scientific notation on the printer (see DATA LIST).

DATA LIST (USER KEY #2)

14. This can be used for listing data on the screen, or on the printer.

- a. Screen Listing - the output format is -5D.3D, which results in a maximum of 5 digits left of the decimal point and 3 digits to the right¹ (program line 1220). If the number is larger than 10^6 or smaller than 10^{-3} , the format is 3E (scientific notation, with three digits right of the decimal point, line 1240). Values of $1E-10$ (i.e., zero values) are printed as ' - '.
- b. Printer Listing - two format types are possible. The printer set-up is described in Appendix V. The user is asked 'Is scientific notation format required? (Y or N)'.

(1) Yes - the scientific notation format allows the user to have a different number of significant figures (3 to 6) for each column. This is especially useful for printing tables of data for publication. The format statements are in lines 10540 to 10770. If the program encounters a value of $1E-10$ (i.e., a blank) then a '-' is printed, indicating that no value is available. The columns are spaced to fit on an 8½" wide page. Table I is a sample printer output using the scientific notation format.

Note: The scientific notation formats for the printer are designed for 5 or less columns of data. The formats must be changed if more columns are required.

- (2) No - the printer output is the same as the screen output above. That is the format is -5D.3D, unless the number is larger than 10^6 or smaller than 10^{-3} , in which case the format is 3E. Values of $1E-10$ are printed as ' - '. Table II is a sample printer output using the screen format.

Note: Any of these formats can be changed to fit a specific requirement. The formats written into the program were for general usage.

ADDING SETS OF DATA (USER KEY #3)

15. When the program is started, the initial number of data sets (S1) is input with the data. The array is dimensioned for 70 data sets. If S1 is less than 70, then more data sets can be added. When USER KEY #3 is pressed, the screen shows the number of additional sets that are allowed. Input from the user is:

- a. number of sets to be added
- b. input data after set number? This allows the new data to be placed anywhere in the data array.
- c. input additional sets. Each data set must have the same number of columns (V1) as the original data.

16. The new data set is then listed on the screen.

ADDING COLUMNS OF DATA (USER KEY #4)

17. When the program is started, the initial number of columns (V1) is input with the data. The data array is dimensioned for six columns of data. If V1 is less than 6, then additional columns may be added. For each new column, there should be S1 data points, so every data set has a number in each column. There should be no blanks in the new columns. If there is a blank, use 1E-10 instead of zero (see DATA LIST Section).

18. The user is asked for:

- a. the number of additional columns
- b. the data. For two additional columns, the two values for the first data set are entered, then the two for the second data set, etc.

The data is listed automatically at the end of the new data entry.

CHANGING DATA (USER KEY #5)

19. This is used to change either individual data points, or a whole row (set) of data.

- a. data points
 - (1) input the data set number to be changed
 - (2) input the column number
 - (3) input the new data point
- b. sets of data
 - (1) input the data set number to be changed
 - (2) input the new row.

There must be a value in each column of the row.

Note: To stop either type of change routine, press the carriage return twice.

DELETING DATA SETS (USER KEY #6)

20. This is used to delete data sets, either individually or in a block. For both types of deletion, all the sets to be deleted are input, then a carriage return with no set number stops the input. At this point, no deletions have occurred, but all the set numbers are stored in the array, E. The sets are sorted by set number, and the deletions start at the highest set number. Thus the set numbers to be deleted can be input randomly.

Note: If an incorrect set number, or block of sets has been input for deletion, the deletions can be cancelled by pressing the BREAK key. This must be done BEFORE the sorting routine has started though. Also note that this will cancel ALL deletions.

a. Deleting single sets

- (1) input the set number to be deleted
- (2) the values in the deleted set are printed on the screen
- (3) the user is asked for the next set to be deleted

b. Deleting a block of sets

- (1) input the first set number of the block, and the last set number of the block
- (2) the first and last set numbers for the block are printed on the screen.
- (3) the user is asked for the first set number of the next block to be deleted

After the deletions, the remaining data sets (renumbered) are listed on the screen. The value of S1 (number of sets) is updated.

DELETING DATA COLUMNS (USER KEY #7)

21. This is used to delete a whole column of data at once. The user is asked to input the column number to be deleted. The column is deleted and the remaining data is printed on the screen. Note that there is no way to stop the deletion, once the column number has been input.

SORTING ROUTINE (USER KEY #11)

22. The sorting routine allows the user to choose a column, which is then sorted by value, with the highest value placed first. Any column can be sorted. The data in the other columns is automatically moved too, to ensure that each data set stays intact. The sorting routine is useful when the data has been input randomly, but should be in order before listing on the printer. This routine can be used any number of times. The sorted data is printed on the screen at the end of the routine.

STORING DATA ON TAPE (USER KEY #8)

23. This option is used if the data was input through the keyboard, or the data has been altered.

- a. The program states the minimum number of bytes required for the data in the file. The file should be marked with this number of bytes.²

- b. The data tape is then inserted (arrow in the UNSAFE position).²
- c. The user inputs the file number for storage of the data. If there is not enough room in the file, error message 48¹ will result.

24. The data is stored on the tape in the following order:

- a. number of sets (S1) and number of columns (V1)
- b. data sets (array A)
- c. data identification (S\$)

25. The data tape is removed then, to prevent accidentally writing on it.

Note: The data tape should be secured by putting the arrow to the SAFE position.² In this position, the tape can be read only, not written on.

GENERATING A COLUMN FROM DATA (USER KEY #12)

26. This option allows the user to generate a column of data using the existing data, by inputting a transformation equation. The column to be transformed is written in array format, i.e., $A(I,n)$ where n is the column number used in the transformation. The equation is input by recalling line 10260, and changing the RIGHT HAND SIDE of the equation.

$$\text{i.e. } 10260 \ A(I, V1+1)=A(I,4)*10$$

As written in the program, column 4 is multiplied by ten to generate a new column. The right hand side of the equation is changed according to the transformation required.

27. The new column is generated by pressing USER KEY #13.

Note: A second column can be generated at the same time by adding another line at 10265, similar to 10260, with the second transformation. Use the notation

$$10265 \ A(I, V1+2)=A(I, V1+1)/2.2$$

$$10280 \ V1 = V1+2$$

Note: Using this routine to generate two columns at once should be used with caution. The array is only designed to hold six columns. If more are attempted, a dimension error will result.

28. All data will be listed on the screen automatically.

ADDING TWO FILES OF DATA (USER KEY #16)

29. Two files of data, with the same number of columns, may be added to form one large file. However, the total number of data sets cannot exceed 70, or a dimension error will result. There are two options - data may be added to the current file of data, or two data tape files may be added together. If two tape files are added together, the current data in memory is erased.

a. Adding to the current file -

- (1) the user is asked to insert the data tape containing the second file, and input the file number.
- (2) the number of sets, number of columns and the data from this file is read in.

- (3) then one large array is formed containing both sets.
- (4) the user is asked to input the data identification (S\$) for the new file.
- (5) the new data is then printed on the screen.

b. Adding two data tape files -

- (1) the first tape is inserted and the file number input
- (2) the number of sets, number of columns and the data is read from this file
- (3) the second tape is inserted and the file number input
- (4) the number of sets, number of columns and the data is read from this file
- (5) one large array is formed
- (6) the user is asked to input the data identification (S\$)
- (7) the data is listed on the screen.

It is a good idea to store the new data on a tape now.

Note: The routine will end if the two files of data do not have the same number of columns. The number of columns can be changed by deletion, adding a column, or generating a column.

PLOTTING AXES AND DATA (USER KEY #9)

30. This is the main plotting routine. The program is capable of plotting Cartesian coordinates, semilog on X, semilog on Y or log-log plots. Two separate Y axes are allowed. The user inputs the boundaries for the axes, the axes titles, and the data points to be plotted. There is also an option for printing a legend and a figure title. A typical plot is shown in Figure 1.

31. There is a choice of symbol size, symbol type (seven different ones) and output device (screen or plotter). A least squares fit is calculated for all plots, with the option to plot the best straight line through the data. This is only relevant, though, for linear plots. As well, the user has the option to input an equation to calculate Y values from X data. The calculated Y vs X will be plotted as a dashed line.

32. The user is asked several questions before the plot is finalized. The input is outlined in the following paragraphs. The set-up required for the plotter is detailed in Appendix VI.

33. Are two separate Y axes required? Two separate Y axes (Y and Z) are used, on occasion, with a common X axis. If this option is chosen, further information about the X, Y and Z axes are required. Otherwise, only the X and Y axes are dealt with.

34. Enter the X column number and the Y column number (and the Z column number if required).

35. Select the plot type for X, Y plot

- (a) Cartesian
- (b) semilog (log along X)
- (c) semilog (log along Y)
- (d) log-log

36. For an X, Y, Z plot, the Z axis can be the same as the Y axis, or different. The user then chooses for Z either

- (a) Cartesian axis, or
- (b) log axis

Note: When the axis types are selected, the corresponding columns, as a whole, are processed. For a log axis, all of the numbers in that column are transformed to log values, in anticipation of the plot. It is essential that the data be in the correct format at this stage, or error message 23 will result¹. There should be no zeros in the data, if log axes are selected (log 0 is undefined).

37. Draw axes and data or data only? Usually, both axes and data are drawn first. Other data can be added later then, with the data only option.

38. Input titles for X, Y (and Z) axes. For each axis, either upper or lower case letters or any characters can be used. The maximum number of characters (including blanks) is 50. The titles are automatically centered about the corresponding axis. Titles with subscripts and superscripts can be handled using the CTRL K and CTRL J characters (i.e. holding the CTRL and K or J keys at the same time)¹. For example, the following title:

SHEAR RATE (sec⁻¹)

would be input as:

SHEAR RATE (sec CTRL K -1 CTRL J).

In this example, the CTRL K moves the pen up one line so the -1 appears as a superscript. The CTRL J moves the pen down one line so the end bracket is properly aligned. Subscripts would be input in a similar manner, using CTRL J, then CTRL K.

Note: If multiple plots are being produced, with the same axes titles, it is more convenient to delete the lines inputting the titles and enter titles directly into the program. To do this, delete lines 4240, 4250, 4260 and 4270 (also 4290 and 4300 for Z axis). Then insert the titles as follows:

4240 X\$= " _____ " (chosen title for X axis)
4260 Y\$= " _____ " (for Y axis)
(4290 W\$= " _____ "(for Z axis))

The titles will remain in memory as long as the machine is on and the program is not reloaded into memory.

39. Input the first and last set numbers to be plotted

(a) for X,Y plot

((b) for X,Z plot)

All of the data can be plotted, or any fraction of it.

40. Input a legend and title. The user has three options for the legends and titles.

(a) No legend

(b) New legend. If this option is chosen, the plot will be displayed automatically on the screen, at the end of the selection process. The user inputs the legend and title when the two crosshairs appear on the screen at the end of the plot.

(c) Old legend. The legend that is memory will be printed after the plot has been displayed, on either the screen or the plotter. The user cannot change it at all. If this option is selected, and there is no legend in the memory, then it is as if the "No Legend" option had been chosen.

The legends and titles input is more fully explained under the LEGENDS AND TITLES routine.

41. Selection Menu Routine - this allows the user to choose the symbol size, the output device, the symbol type, and the dashed line option.

- (a) Symbol Size. This is a multiplier to the symbol size. The default is one. Values < 1 will result in smaller symbols while values > 1 will yield larger symbols.
- (b) Output device. This is where the plot will be drawn. The choices are:
 - (1) Screen - used initially to check the plot for any errors
 - (2) Plotter - used for the final output
- (c) Symbol type. There are seven different symbol types to choose from.
 - (1) triangle (default)
 - (2) square
 - (3) diamond
 - (4) cross
 - (5) X
 - (6) star
 - (7) dot

The symbol type is chosen for the X, Y plot, then (if necessary) for the X, Z plot.

Note: When plotting data, sometimes it is convenient to use more than one symbol type for the data i.e., a star inside a box or a dot inside a triangle. This is done by plotting with one symbol, then repeating the plot (or drawing data points only) with the second symbol.

- (d) Dashed lines on a plot. This is used for drawing fitted curves. The equation for the curve is input by the user.

The options are

- (1) no dashed line
- (2) dashed line on the X,Y graph
- ((3) dashed line on the X,Z graph)

Note: It is important to distinguish between the X,Y and the X,Z graphs, so the dashed line is positioned properly.

If a dashed line is selected, there are three different dash patterns for the plotter. (There is only one for the screen

- ____).
(1) ____
(2) _.-.-.-.
(3)

Note: More than one set of dashed lines can be plotted on a single graph, by using the PLOT DATA ONLY option (USER KEY #10).

The equation of the dashed line is input in line 14890. It is of the form $N=f(R)$, where R is the X column data and N is the generated Y component.

i.e. 14890 $N(I)=R(I)*1.5$

In this example, the X data (R(I)) is multiplied by 1.5 to generate the Y data (N(I)).

To input the dashed line equation

- (1) recall line 14890
- (2) change the right hand side of the equation
- (3) press USER KEY #18

- (e) END Selection - The selection menu reappears after each choice, until END Selection is chosen.

42. At this point, all the selections have been made and the graph is ready to be plotted. The plot is drawn in the following manner:

- (a) bottom X axis and tic marks
- (b) top X axis and tic marks
- (c) left Y axis and tic marks
- (d) right Y axis (or Z axis) and tic marks
- (e) numbering the Z axis
- (f) numbering the X axis
- (g) numbering the Y axis
- (h) labelling the X axis
- (i) labelling the Y axis
- (j) labelling the Z axis
- (k) drawing the X, Y data points
- (l) calculation of best straight line through the X,Y data
- (m) drawing the X,Z data points
- (n) calculation of the best straight line through the X,Z data
- (o) drawing the dashed line (if selected)
- (p) printing any legends or titles (if selected) or accepting input of new legends and titles

A typical plot is shown in Figure 1.

43. The program calculates the best straight line through the X, Y data using a least squares routine. The user has the option of

- a. plotting the line (on the chosen output display) and printing the equation (on the screen only),
- b. printing the equation only, on the screen
- c. neither

The best straight line is calculated, no matter what the shape of the curve. It only has meaning, though, for a linear plot. The best straight line through the X,Z data points is also calculated, and the options for printing are the same as for the X, Y data.

44. If the "Old Legend" option was selected, it is printed on the plot, at the end of the plotting routine. If the "New Legend" option was selected, two crosshairs now appear on the screen, waiting for input. The input for this is fully described in the section LEGENDS AND TITLES.

45. Once the graph has been completed, the user can repeat the graph, using the same parameters, by selecting the REPEATING A PLOT option (USER KEY #19). Otherwise, more data can be added to the graph by using the PLOTTING DATA ONLY option (USER KEY #10).

LEGENDS AND TITLES

46. This section describes how to input the legends and titles, if the "New Legend" option was selected. If this was selected, the plot will be displayed on the screen only - not on the plotter. Two crosshairs will appear on the screen at the end of the plot, awaiting input. There are also two grids superimposed on the plot for convenience:

- a. below the X axis title, for the figure caption
- b. at the top third of the axes grid, for the legend

The crosshairs can be positioned anywhere on the screen, not only where the grid lines appear.

47. To input a legend, position the two crosshairs to the desired location on the graph. The type of input at this position is governed by the key pressed. The key selections are as follows:

- a. Ø - writing only, no symbols. When this is selected, a question mark appears, waiting for alphanumeric input. The input is stopped when the carriage return is pressed.
- b. 1 - triange

- c. 2 - square
- d. 3 - diamond
- e. 4 - cross
- f. 5 - X
- g. 6 - star
- h. 7 - dot
- i. 8 - correct last entry. Pressing the 8 key erases the previous entry, entirely. If the previous entry was a symbol, it is erased from memory (but not from the screen display). If the previous entry was a line of writing, the whole line of writing is erased from the memory.
- j. 9 - end of input. The crosshairs disappear when 9 is pressed.

Note: For option Ø, the writing appears slightly above the horizontal cursor. However, for options 1-7, the symbols are centered around the intersection of the two crosshairs.

Note: It is easy to forget to press Ø when writing only is required. Then, the crosshairs remain until one of the 10 keys specified above is pressed. If the 9 key is pressed, then all input stops. To get around this problem, press USER KEY #17, and reinput all the legend and title information.

48. USER KEY #17 can be used to delete the old legend, and input a new legend. This is particularly useful when a typing error occurs or when the input was accidentally stopped, as described in the note above. Once USER KEY #17 is pressed the memory is cleared of the previous legend and title information. The two grids appear, and the two crosshairs. While this key can be pressed anytime, it is a good idea to only use it when plot is displayed on the screen, especially if writing/symbols are required outside of the grids.

49. The grids are displayed only for convenience in aligning the alphanumeric input. They are not displayed when the "OLD LEGEND" option is selected, and the legend in memory is printed.

50. Each grid has room for 5 lines of writing. To use the grid, position the vertical crosshair, place the horizontal crosshair on one of the horizontal grid lines, press Ø, then input the line of writing. For symbols, line the horizontal crosshair half way between two horizontal grid lines, then press the desired symbol number.

REPEATING A PLOT (USER KEY #19)

51. If the identical plot to the last one is required (i.e., same axes, titles, and data points) then this option is used. This is convenient when the plot is correct on the screen, and a plotter copy is required, or when more than one plotter copies are needed. The user can change the items in the Selection Menu only. That is:

- a. symbol size
- b. output device
- c. symbol type
- d. dashed line

There is also the option for plotting the best straight line through the data or not.

PLOTTING DATA ONLY (USER KEY #10)

52. Sometimes more than one set of data is required on a graph. Then, the Plotting Data Only option is used, after the 'initial' plot is finished, to add on other data points. No axes are drawn with this option.

53. The user input is:

- a. number of first and last data points to be plotted
- b. the legends and titles option
- c. selection menu for
 - (1) symbol size
 - (2) output device
 - (3) symbol selection
 - (4) dashed line

54. The data points are then plotted on the specified output device.

The user again has the option of:

- a. plotting the best straight line on the output device and printing the line equation on the screen
- b. printing the line equation on the screen only
- c. neither

Next, any dashed lines are drawn, and the legends and titles are printed.

55. This option can be repeated any number of times, to plot all the data needed for an axes set.

Note: If a zero is input for either the first or last number to be plotted, then no points are drawn, but the dashed line and legends will be plotted. This is useful if more than one dashed line is required on a graph. It is also useful if a legend is required, but it was not input when the axes were drawn.

CALCULATING Y OR Z FROM X, AFTER LEAST SQUARES CALCULATION
(USER KEY #14)

56. After plotting the X, Y data points, the program calculates the

best straight line through the data. The equation of the straight line can be used to calculate values of Y from X, with this routine. The values of Z can also be calculated from X, using the equation from the X, Z data. The goodness of the fit depends on the value of R^2 , calculated in the least squares routine.

Note: USER KEY #14 should only be used after a plot has been made, and the least squares fit calculated for the current data.

57. The user input is:

- a. calculate Y or Z from X?
- b. list on screen or printer? Both X and the calculated Y (or Z) values are listed.
- c. input X values.

The routine stops with an empty carriage return. A sample output from the printer is listed in Table III.

CALCULATING X FROM Y OR Z, AFTER LEAST SQUARES CALCULATION
(USER KEY #15)

58. This routine calculates X, from either Y or Z, based on the equation of the best straight line through the data points (either the X, Y data or the X, Z data). The goodness of the fit depends on the value of R^2 , calculated in the least squares routine.

Note: User Key #15 should only be used after a plot has been made, and the least squares fit calculated for the current data.

59. The user input is:

- a. calculate X from Y or Z?
- b. list on screen or printer? Both the Y (or Z) value and the calculated X value are listed.
- c. input Y (or Z) values

The routine is stopped with an empty carriage return. A sample output from the printer is listed in Table IV.

REFERENCES

1. Tektronix 4050 Series Graphic System Reference Manual, 1980
Tektronix Inc., P.O. Box 500, Beaverton, Oregon, 97077
2. Tektronix 4050 Series Graphic Computing System Operator's Manual, 1980
3. Tektronix Plot 50 Introduction to Programming in BASIC, 1980
4. Tektronix 4663 Interactive Digital Plotter Operator's Manual, 1980
5. Tektronix 4663 Interactive Digital Plotter Programmer's Reference Manual, 1982

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TABLE I: SAMPLE PRINTER OUTPUT USING THE SCIENTIFIC NOTATION FORMAT

<u>X</u>	<u>Y</u>	<u>Z</u>
1.31E+002	4.785E+001	3.6634E-001
7.84E+001	3.006E+001	3.8356E-001
5.53E+001	2.168E+001	3.9211E-001
3.92E+001	1.556E+001	3.9714E-001
2.76E+001	1.116E+001	4.0371E-001
1.57E+001	6.383E+000	4.0726E-001
1.11E+001	4.588E+000	4.1494E-001

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TABLE II: SAMPLE PRINTER OUTPUT USING THE SCREEN FORMAT

TEST DATA

1	130.611	47.848	0.366
2	78.366	30.058	0.384
3	55.283	21.677	0.392
4	39.183	15.561	0.397
5	27.641	11.159	0.404
6	15.673	6.383	0.407
7	11.057	4.588	0.415

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TABLE III: SAMPLE PRINTER OUTPUT FOR Y CALCULATED FROM X, AFTER THE LEAST
SQUARES CALCULATION

TEST DATA

X=131	Y EST=48.5731458317
X=78.4	Y EST=29.5025326632
X=55.3	Y EST=21.1274154733
X=39.2	Y EST=15.2902125833
X=27.6	Y EST=11.084526029
X=15.7	Y EST=6.77007171904
X=11.1	Y EST=5.10229946476

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TABLE IV: SAMPLE PRINTER OUTPUT FOR X CALCULATED FROM Y, AFTER THE LEAST
SQUARES CALCULATION

TEST DATA

Y=47.85	X EST=129.005440601
Y=30.06	X EST=79.9375898853
Y=21.68	X EST=56.8241222634
Y=15.56	X EST=39.9441196565
Y=11.16	X EST=27.8081700698
Y=6.383	X EST=14.6323902571
Y=4.588	X EST=9.68147445982

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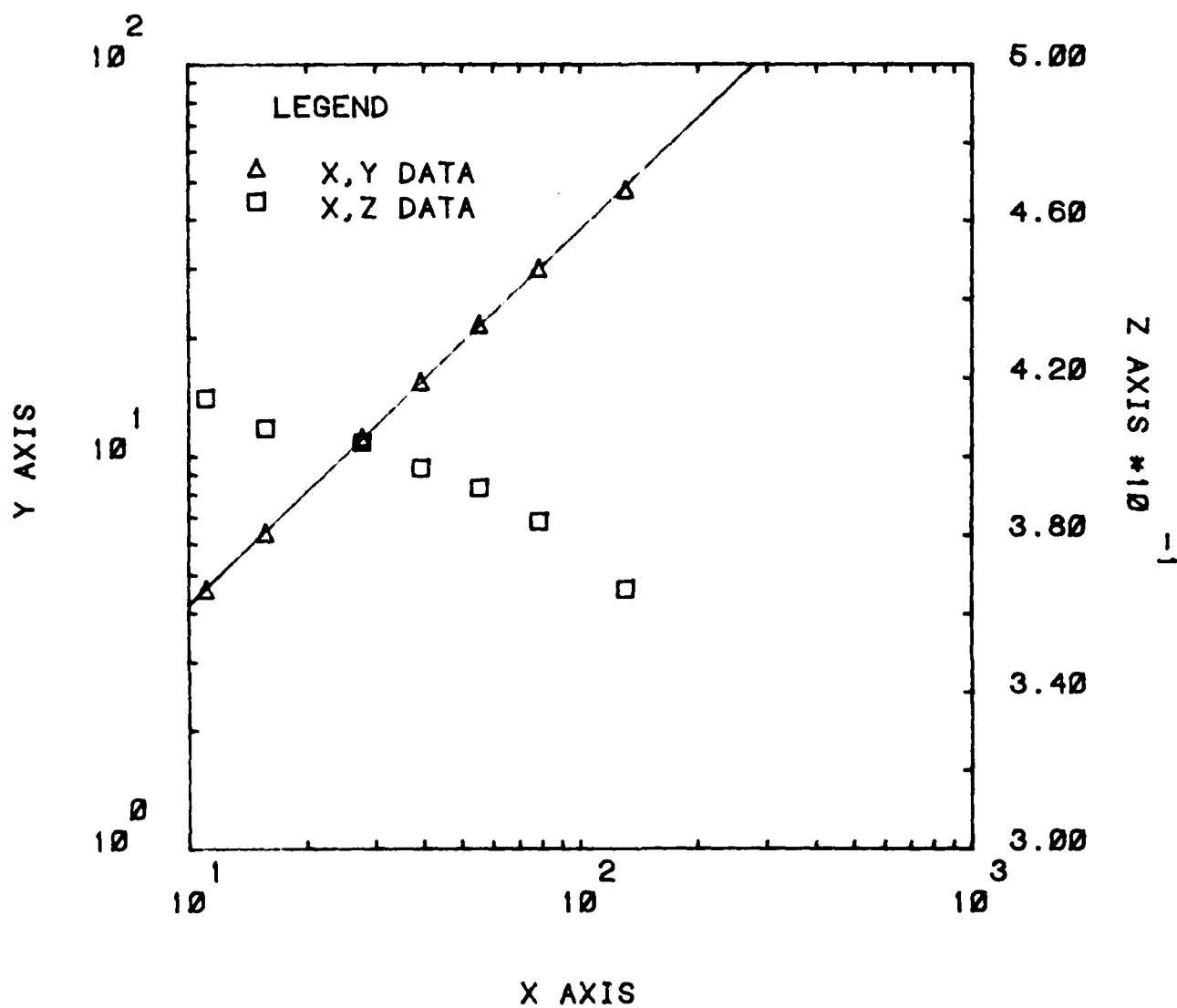


Figure 1

Typical plot obtained from the PLOT program, showing the best straight line through the X,Y data.

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Appendix I

USER KEY ASSIGNMENTS

- #1 data entry (tape or keyboard)
- #2 data list (on screen or printer)
- #3 adding sets of data
- #4 adding columns of data
- #5 changing data (points or sets)
- #6 deleting data sets (individually or in blocks)
- #7 deleting data columns
- #8 storing data on mag tape
- #9 plotting data and axes
- #10 plotting data only
- #11 sorting routine
- #12 generating a column from existing data
- #13 continuation of column generation
- #14 calculate Y or Z from X, after Least Squares Calculation
- #15 calculate X from Y or Z after Least Squares Calculation
- #16 adding two files of data (same number of columns)
- #17 input Legend and Title
- #18 continuation of dashed line on plot
- #19 repeating a plot

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VARIABLES USED

Appendix II

- A - 2-dimensional array used to hold all the data
- A1 - variable used when adding sets of data. It is the actual number of added sets.
- A2 - number of additional columns, when adding columns of data
- A3 - used in the least squares calculation
- A4 - symbol selection number for X,Z plot
- A5,A6 - used when calculating X from Y or Z (after least squares calculation) where A3=A6 for X from Y calculation
and A3=A5 for X from Z calculation
- A9 - used in numbering the Z axis in Cartesian coordinates. When A9=0, there are no exponents in the axis numbers.
- A\$ - symbol type associated with A4 in X,Z plot
- B - 2-dimensional array used for additional data sets when adding sets of data
- B1 - used in the least squares calculation
- B3,B4 - used when calculating X from Y or Z (after least squares calculation) where B1=B4 for X from Y calculation
and B1=B3 for X from Z calculation
- C - 1-dimensional array used for additional columns when adding columns of data
- C1, C\$ - used for changing data points, indicates the column number
- D - 1-dimensional array used for initial input of data from the keyboard
- D1, D\$ - number of set deleted, in the set deletion routine
- D2 - number of column deleted, in the column deletion routine
- D3,D4 - first and last sets to be deleted in the block deletion routine
- D6, D7 - used in the least squares calculation

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E - 1-dimensional array used in deleting data sets
E1 - used in deleting data sets
E4 - used to identify type of coordinate on Z-axis (E4=0 for Cartesian, E4=2 for log)
E\$ - string storage for dashed line status
F, F1 - used in the least squares calculation
F2 - used to calculate Y from X (or X from Y) after the least squares calculations
F3 - file number for input data
F4 - used to sort data sets before deletions
F\$ - value of X in calculating Y from X
G, G1 - used in the least squares calculation
G2 - used to calculate Y from X (or X from Y) after least squares calculations
G\$ - value of Y in calculating X from Y
H - 2 dimensional array to hold the legend and title data
H(I,1)=type of input; H(I,2)=H4; H(I,3)=H3; H(I,4)=H1;
H(I,5)=H2
H1 - initial X position of legend entry
H2 - initial Y position of legend entry
H3 - length of K\$ (individual legend entry)
H4 - length of L\$ to the position of K\$
H6 - legend choice (1=no legend, 2=new legend, 3=old legend)
H7 - counter for number of legend entries
H\$ - flag for pointer function, in the legend and title routine
(0=writing only, 1=triangle, 2=square, 3=diamond, 4=+, 5=X, 6=*, 7=dot, C=correct last, E=end)
I, J, K - temporary variables, usually in do-loops
K\$ - string input for legend entry
L - used in drawing data points
L\$ - storage for all K\$ from legend routine (dimensioned to 700)

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M - 1-dimensional array used to print data on the printer
M1 - dimension of plotting symbol in the X direction (width)
M2 - dimension of plotting symbol in the Y direction (height)
M3 - symbol size multiplier
M4 - symbol number selector
M5 - selection number in plotting menu (1=symbol size, 2=output device, 3=symbol type, 4=dashed line, 5=end selection)
M6 - dimension of plotting symbol in the Z direction
M7 - used in drawing X,Z points
M\$ - symbol selection variable in plot routine
N - one dimensional array used for the Y component data, in the dashed line routine
N1, N2 - used in the least squares calculation
N4 - flag indicator for type of X axis in X,Z plot (1=Cartesian X, 2= log X)
N5 - dash pattern selection (for plotter only)
(1=___, 2=_._._., 3=....)
N8 - dashed line selection (1=no dashed line, 2=dashed line in X,Y plot, 3=dashed line in X,Z plot)
O1 - output selection variable in plot routine
P - used in the least squares calculation
P0 - used in numbering the axes
P1 - type of plot required for X,Y plots (1=Cartesian, 2=semilog on X, 3=semilog on Y, 4=log-log)
P2 - selection for axis plot (P2=1) or data only (P2=2)
P3 - first set of data to be plotted (X, Y plot)
P4 - last set of data to be plotted (X, Y plot)
P5 - exponential multiplier in title of X axis of Cartesian plot (P5=0 for all other types)
P6 - temporary variable for numbering Cartesian axes

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- | | |
|---------|---|
| P7 | - exponential multiplier in the title of Y axis of Cartesian plot (P7=0 for all other types) |
| P9 | - indicator for repeat plot
1 = initial plot
2 = repeat plot |
| P8 | - flag for Z axis different type than Y axis (0=Z same as Y,
1=Z different from Y) |
| P\$ | - used with P5, P7 |
| Q | - 2-dimensional temporary array used when adding together two sets of data |
| Q1 | - number of first data file when adding two data sets |
| Q2 | - number of second data file when adding two data sets |
| Q3 | - first set of data to be plotted (X, Z plot) |
| Q4 | - last set of data to be plotted (X, Z plot) |
| Q9 | - input/output selection device used for printing, plotting, storing on data tape (1=plotter, 32=screen, 33=tape drive, 41=printer) |
| Q\$ | - plot output device (1=plotter, 2=screen) |
| R | - one dimensional array used for the X component data, in the dashed line routine |
| R1, R\$ | - used for changing data points, indicates the raw number |
| R2 | - value of R^2 in least squares calculation |
| R3 | - used when changing data sets |
| S | - BASIC variable used in formating output |
| S1 | - number of data sets |
| S2 | - S2=70 This is used to dimension the data array, A. |
| S4 | - column number to be sorted in the sorting routine |
| S5, S6 | - used when adding sets of data. Data is added after S5. |
| S\$ | - data identification string |
| T1 | - used in sorting routine |
| T2 | - number of sets of data in second data file, when adding two |

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data files

- T7,T8,T9 - used in making axis tic marks
- V - used to define FNX, FNY as Cartesian or logarithmic
- V1 - number of columns in data set
- V2 - V2=6 This is used to dimension the array, A.
- V8 - number of columns in second data file, when adding two data files
- W - 1-dimensional array used for Z data in X, Z plot
- W1, W2 - min and max boundaries for Z axis
- W3 - range of Z axis (W2-W1) for Cartesian axis, or number of cycles for a log Z axis
- W5 - status indicator for X, Z plot, used to determine when points are to be drawn or least squares calculations to be done (0=before X,Z plot; 1=printed X,Z least squares coefficients, 4=plotted X,Z points)
- W7 - column number for Z data points
- W9 - indicator for Z axis in plot (1=Z axis, 0= no Z axis)
- W\$ - the Z axis title
- X - 1-dimensional array containing X data for X, Y or X, Z plots
- X1, X2 - min and max boundaries for X axis
- X3 - range for X axis (X2 - X1) for Cartesian axis, or number of cycles for a log X axis
- X6 - used when moving cursor to draw points
- X7 - the X-column number
- X8 - maximum value within data set (1E300)
- X9 - minimum value within data set (-1E300)
- X\$ - the X axis title
- Y - 1-dimensional array containing Y data for X, Y plot
- Y1, Y2 - min and max boundaries for Y axis

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- Y3 - range of Y axis ($Y_2 - Y_1$) for Cartesian axis, or number of cycles for log Y axis
- Y6 - used in least squares calculation
- Y7 - the Y column number
- Y\$ - the Y axis title
- Z - temporary variable
- Z8, Z9 - used in making axis tic marks
- Z\$ - temporary variable used for input of answers to questions asked by program (usually Y or N responses)

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SIZE OF DIMENSIONED VARIABLES

Appendix III

A(70,6)
A\$(10)
B(V1)
B\$(25)
C(A2)
C\$(5)
D(V1)
D\$(5)
E(S1)
E\$(20)
F\$(12)
G\$(12)
H(30,5)
H\$(2)
K\$(72)
L\$(700)
M(V1)
M\$(10)
N(S1)
Q(100,V1)
Q\$(10)
S\$(72)
W(S1)
W\$(55)
X(S1)
X\$(55)
Y(S1)
Y\$(55)
Z\$(5)

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FILE # 1

```
1 REM *** PLOT - A ROUTINE FOR PLOTTING IN CARTESIAN, SEMILOG
2 REM *** AND LOG-LOG COORDINATES.      M. GAUTHIER, FEB 22, 1983
3 REM *** REVISED MAY/85      MDG MAYER.      VERSION 5.1
4 REM *** DATA ENTRY***
5 GO TO 100
8 REM *** DATA LIST***
9 GO TO 1040
12 REM *** ADD SETS OF DATA***
13 GO TO 1360
16 REM *** ADD COLUMNS OF DATA***
17 GO TO 1760
20 REM *** CHANGE DATA***
21 GO TO 2030
24 REM *** DELETE DATA SETS***
25 GO TO 2430
28 REM *** DELETE DATA COLUMNS***
29 GO TO 3170
32 REM *** STORE DATA ON MAGTAPE***
33 GO TO 3450
36 REM *** PLOT AXES AND DATA***
37 GO TO 3650
40 REM *** PLOT DATA ONLY***
41 P2=2
42 PAGE
43 GO TO 4360
44 REM *** DATA SORT ROUTINE***
45 GO TO 9800
48 REM *** COLUMN GENERATED FROM EXISTING DATA***
49 GO TO 10100
52 REM *** CONTINUATION OF COLUMN GENERATION***
53 GO TO 10250
56 REM *** CALCULATE Y FROM X AFTER L.S.***
57 GO TO 10840
60 REM *** CALCULATE X FROM Y AFTER L.S.***
61 GO TO 11290
64 REM *** ADDING TWO FILES OF DATA (SAME NUMBER OF COLUMNS)***
65 GO TO 11750
68 REM *** LEGEND AND TITLE***
69 H6=2
70 GO TO 5550
72 REM *** CONTINUATION OF PLOT AFTER DASHED LINE ROUTINE***
73 GO TO 6740
76 REM *** REPEAT PLOT***
77 GO TO 12470
90 REM *** INITIALIZATION OF PARAMETERS***
100 INIT
102 SET KEY
104 CHAPSIZE 2
106 X9=-1.0E+100
108 X8=1.0E+300
110 H4=1
```

+++++

```
112 DELETE A$,B$,C$,D$,E$,F$,G$,H$,K$
114 DELETE M$,P$,Q$,S$,W$,X$,Y$,Z$
116 DIM A$(10),M$(10),Q$(10)
118 DIM E$(20)
120 DIM B$(25)
122 DIM C$(5),D$(5),P$(5),Z$(5)
124 DIM H$(2)
126 DIM F$(12),G$(12)
128 DIM K$(72),S$(72)
130 DIM W$(55),X$(55),Y$(55)
160 Q$="SCREEN"
170 Q9=32
180 M$="TRIANGLE"
190 A$="SQUARE"
200 E$="SET TO OFF"
210 N8=1
220 A4=2
230 A9=0
240 DELETE H
250 DIM H(30,5)
260 H=0
270 H6=1
290 X7=0
300 DELETE L$
310 DIM L$(700)
320 P7=0
330 P5=0
340 P9=1
350 P1=0
360 W5=0
370 P8=0
380 REM ***DATA ENTRY***
385 PRINT "LIPLLOT Program"
397 PRINT "JJ NOTE: A MAXIMUM OF 70 DATA SETS AND 6 COLUMNS ARE ALLOWED"
399 PRINT "JJDATA ENTRY FROM TAPE(1) OR KEYBOARD(2)?"
400 INPUT Z
410 GO TO Z OF 420,780
420 PAGE
430 PRINT "IDATA INPUT FROM TAPE"
440 PRINT
450 PRINT "INSERT DATA TAPE NOW GGG"
460 PRINT
470 PRINT "INPUT FILE NUMBER:"
490 INPUT F3
490 FIND F3
500 ON EOF (0) THEN 660
502 READ @33:S1
504 READ @33:V1
506 J1=0
507 J2=6
510 IF S1<=70 AND V1<=6 THEN 530
520 GOSUB 1008
530 V2=6
```

```

540 S2=70
550 DELETE A
560 DIM A(S2,V2)
570 A=0
580 FOR I=1 TO S1
590   FOR J=1 TO V1
600     READ @33:A(I,J)
610   NEXT J
612   IF J2<=6 THEN 620
614   FOR J=1 TO J2-V1
616     READ @33:K
618   NEXT J
+++1+++ 620 NEXT I
622 IF J1=0 THEN 630
624 FOR I=1 TO J1*J2
626   READ @33:J
628 NEXT I
+++1+++ 630 READ @33:S$
640 PRINT S$
650 GO TO 680

-----1----- 660 PRINT "INPUT DATA IDENTIFICATION (<72 CHARACTERS)"
670 INPUT S$
+++1+++ 680 FOR I=1 TO S1
690   PRINT I;" "
700   FOR J=1 TO V1
710     PRINT A(I,J);" "
720   NEXT J
730   PRINT
740 NEXT I
750 PRINT
760 END
770 REM *** DATA INPUT FROM KEYBOARD***
+++1+++ 780 PRINT "IDATA INPUT FROM KEYBOARD"
790 PRINT "JINPUT DATA IDENTIFICATION (<72 CHARACTERS)"
800 INPUT S$
810 PRINT "NUMBER OF VARIABLES?"
820 INPUT V1
830 PRINT
840 PRINT "NUMBER OF SETS?"
850 INPUT S1
855 IF S1<=70 AND V1<=6 THEN 860
855 GOSUB 1008
+++1+++ 860 S2=70
870 V2=6
880 DELETE A
890 DIM A(S2,V2)
900 A=0
910 PRINT "INPUT DATA SETS"
920 DELETE D
930 DIM D(V1)
940 D=0

```

```

950 FOR I=1 TO S1
960 PRINT "J";I;" "
970 INPUT D
980 FOR J=1 TO V1
990 A(I,J)=D(J)
1000 NEXT J
1002 NEXT I
1004 PRINT "END OF DATA INPUT GGGG"
1006 END

```

```

---2--- 1008 REM DATA FILE LARGER THAN DATA ARRAY
1010 PRINT "JGGGGNOTE: DATA FILE IS LARGER THAN ALLOWED!"
1012 PRINT "          ONLY 70 DATA SETS AND 6 COLUMNS"
1014 PRINT "          WILL BE READ IN"
1016 IF S1<=70 THEN 1019
1017 J1=S1-70
1018 S1=70
+++1+++ 1019 J2=V1
1020 IF V1<=6 THEN 1024
1022 V1=6
+++1+++ 1024 RETURN
+++1+++ 1040 REM *** LIST DATA***
1050 PRINT "LIST DATA LIST"
1060 PRINT "JJ";S$;"JJ"
1070 PRINT "LIST ON SCREEN(1), OR PRINTER(2)?"
1080 INPUT Z
+++3+++ 1090 GO TO Z OF 1100,1120
+++8+++ 1100 Q9=32
1110 GO TO 1150
+++1+++ 1120 Q9=41
1130 GO TO 10320
1140 PRINT @Q9:"L"
+++4+++ 1150 FOR I=1 TO S1
1160 PRINT @Q9: USING 1170:I
1170 IMAGE 5T:FD.9T,S
1180 FOR J=1 TO V1
1185 IF A(I,J)=0 THEN 1210
1190 IF ABS(A(I,J))=>100000 THEN 1240
1200 IF ABS(A(I,J))<=1.0E-3 THEN 1240
+++1+++ 1210 PRINT @Q9: USING 1220:A(I,J)
1220 IMAGE -5D.3D,1X,S
1230 GO TO 1300
+++2+++ 1240 IF ABS(A(I,J))<1.0E-9 THEN 1290
1250 PRINT @Q9: USING 1270:A(I,J)
1260 IF ABS(A(I,J))<1.0E-9 THEN 1290
1270 IMAGE 3E,1X,S
1280 GO TO 1300
+++2+++ 1290 PRINT @Q9:" - "
+++2+++ 1300 NEXT J
1310 PRINT @Q9:
1320 NEXT I
1330 PRINT @Q9:
1340 Q9=32

```

```
1350 END
+++1+++ 1360 REM *** ADD SETS OF DATA ***
1370 PRINT "LIADDING SETS OF DATA"
1380 PRINT "J";S$;"JJ"
1390 IF S2>S1 THEN 1420
1400 PRINT "ARRAY IS FULL, NO MORE SETS CAN BE ADDED"
1410 GO TO 1750
+++2+++ 1420 PRINT "ONLY ";S2-S1;" ADDITIONAL SETS OF DATA ARE ALLOWED"
1430 PRINT "JNUMBER OF SETS TO BE ADDED=";
1440 INPUT A1
1450 IF A1<=S2-S1 THEN 1480
1460 PRINT "GGGGGGJJ"
1470 GO TO 1420
+++2+++ 1480 PRINT "JINPUT DATA AFTER SET NUMBER=";
1490 INPUT S5
1500 IF S5<=S1 THEN 1530
1510 PRINT "JSET ";S5;" IS OUT OF RANGE (HIGHEST SET # IS ";S1;" )GGGGG"
1520 GO TO 1480
+++1+++ 1530 S6=S5+A1+1
1540 IF S5=S1 THEN 1600
1550 FOR I=S1+A1 TO S6 STEP -1
1560   FOR J=1 TO V1
1570     A(I,J)=A(I-A1,J)
1580   NEXT J
1590 NEXT I
+++1+++ 1600 S1=A1+S1
1610 DELETE B
1620 DIM B(V1)
1630 B=0
1640 PRINT "JINPUT ADDITIONAL SETS, EACH WITH ";V1;" VARIABLES"
1650 FOR I=1 TO A1
1660   PRINT "JSET#";I+S5;"   ";
1670   INPUT B
1680   FOR J=1 TO V1
1690     A(S5+I,J)=B(J)
1700   NEXT J
1710 NEXT I
1720 PRINT "JEND OF DATA ENTRY GGGGGJ"
1730 Z=1
1740 GO TO 1090
+++1+++ 1750 END
+++1+++ 1760 REM ***ADD COLUMNS OF DATA ***
1770 PRINT "LIADD COLUMNS OF DATA"
1780 PRINT "JJ";S$;"JJ"
1790 IF V1<V2 THEN 1820
1800 PRINT "ALL THE COLUMNS ARE FULL"
1810 GO TO 2020
+++2+++ 1820 PRINT " ONLY ";V2-V1;" ADDITIONAL COLUMNS ARE ALLOWED"
1830 PRINT "J NUMBER OF COLUMNS TO BE ADDED=";
1840 INPUT A2
```

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```
1850 IF A2<=V2-V1 THEN 1880
1860 PRINT "GGGGJ"
1870 GO TO 1820
+++1+++ 1880 DELETE C
1890 DIM C(A2)
1900 C=0
1910 PRINT "JINPUT ADDITIONAL COLUMNS FOR ";S1;" SETS"
1920 FOR I=1 TO S1
1930   PRINT "J";I;" ";
1940   INPUT C
1950   FOR J=1 TO A2
1960     A(I,V1+J)=C(J)
1970   NEXT J
1980 NEXT I
1990 PRINT "JEND OF DATA INPUT GGGGGJ"
2000 V1=V1+A2
2010 GO TO 1150
+++1+++ 2020 END
+++1+++ 2030 REM *** CHANGE DATA***
2040 PRINT "L";S$
2050 PRINT " JCHANGING DATA "
2060 PRINT "JJCHANGE A SINGLE POINT (1) OR A DATA SET (2)?";
2070 INPUT K
2080 PRINT "JTO STOP, PRESS CARRIAGE RETURN TWICE"
+++4+++ 2090 PRINT "JROW OF DATA TO BE CHANGED=";
2100 INPUT R$
2110 IF R$="" THEN 2400
2120 R1=VAL(R$)
2130 IF R1=2 THEN 2250
2140 PRINT "JCOLUMN OF DATA POINT TO BE CHANGED=";
2150 INPUT C$
2160 IF C$="" THEN 2400
2170 C1=VAL(C$)
2180 IF R1=>1 OR R1<=S1 THEN 2220
2190 IF C1=>1 OR C1<=V1 THEN 2220
2200 PRINT "JDATA POINT IS OUT OF RANGE"
2210 GO TO 2090
+++2+++ 2220 PRI "JCURRENT VALUE OF (";R1;" ";C1;"")=";A(R1,C1);", CHANGE TO ";
2230 INPUT A(R1,C1)
2240 GO TO 2090
+++1+++ 2250 IF R1=>1 OR R1<=S1 THEN 2280
2260 PRINT "JDATA POINT IS OUT OF RANGEGGGGG"
2270 GO TO 2090
+++1+++ 2280 PRINT "JCURRENT DATA SET ";R1;" IS:"
2290 FOR I=1 TO V1
2300   PRINT A(R1,I);
2310 NEXT I
2320 PRINT
2330 PRINT "JINPUT VALUES FOR ALL ";V1;" COLUMNS:J"
2340 FOR I=1 TO V1
```

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```
2350 PRINT "COLUMN #";I;" ";
2360 INPUT R3
2370 A(R1,I)=R3
2380 NEXT I
+++2+++ 2390 GO TO 2090
2400 PRINT
2410 GO TO 1150
2420 END
+++1+++ 2430 REM *** DELETING DATA SETS***
2440 PRINT "LIDELETING DATA SETS"
2450 PRINT "JJ";S$;"JJ"
2460 DELETE E
2470 DIM E(S1)
2480 E=0
2490 E1=0
2500 IF S1>0 THEN 2550
2510 PRINT "ARRAY IS EMPTY"
2520 END
+++1+++ 2550 PRINT "JA CARRIAGE RETURN WITH NO SET NUMBER STOPS INPUT "
2560 PRINT "JJIF A WRONG NUMBER IS INPUT, USE BREAK KEY. THEN a11"
2570 PRINT "      DELETIONS ENTERED WILL BE CANCELLED"
2572 PRINT "JDELETING A SINGLE SET (1) OR A BLOCK OF DATA (2)?";
2574 INPUT K
2580 IF K=2 THEN 2740
+++2+++ 2590 PRINT "JNUMBER OF SET TO BE DELETED=";
2600 INPUT D$
2610 IF D$="" THEN 2960
2620 D1=VAL(D$)
2630 IF D1=>1 AND D1<=S1 THEN 2660
2640 PRINT "JSET NUMBER IS OUT OF RANGE"
2650 GO TO 2590
+++1+++ 2660 PRINT "SET DELETED =";
2670 FOR J=1 TO V1
2680 PRINT A(D1,J);
2690 NEXT J
2700 PRINT
2710 E1=E1+1
2720 E(E1)=D1
2730 GO TO 2590
+++2+++ 2740 PRINT "JJDELETION OF A BLOCK OF DATA"
+++2+++ 2750 PRINT "JINPUT THE FIRST SET OF THE BLOCK:";
2760 INPUT D$
2770 IF D$="" THEN 2960
2780 D3=VAL(D$)
2790 IF D3<1 OR D3>S1 THEN 2850
2800 PRINT "INPUT THE LAST SET OF THE BLOCK:";
2810 INPUT D4
2820 IF D4<1 OR D4>S1 THEN 2850
2830 IF D4<D3 THEN 2870
2840 GO TO 2900
```

```
+++24++ 2850 PRINT "JGGGGBLOCK IS OUT OF RANGE"
2860 GO TO 2750
+++1+++ 2870 PRINT "JGGGG LAST SET # MUST BE HIGHER THAN FIRST SET #"
2880 GO TO 2750
+++1+++ 2900 FOR I=D3 TO D4
2910   E1=E1+1
2920   E(E1)=I
2930 NEXT I
2940 PRINT "SET NUMBERS ";D3;" TO ";D4;" DELETED"
2950 GO TO 2740
+++2+++ 2960 REM *** SORTING THE SETS TO BE DELETED, THEN RENUMBERING ARRAY***
+++1+++ 2970 F4=0
2980 FOR I=1 TO E1
2990   IF E(I)=E(I+1) THEN 3040
3000   F4=1
3010   T1=E(I)
3020   E(I)=E(I+1)
3030   E(I+1)=T1
+++1+++ 3040 NEXT I
3050 IF F4=1 THEN 2970
3060 FOR I=1 TO E1
3070   FOR J=E(I)+1 TO S1
3080     FOR K=1 TO V1
3090       A(J-1,K)=A(J,K)
3100     NEXT K
3110   NEXT J
3120   S1=S1-1
3130 NEXT I
3140 PRINT
3150 PRINT "LIST OF REMAINING DATA:"
3160 GO TO 1100
+++1+++ 3170 REM *** DELETE DATA COLUMNS***
3180 PRINT "LIDELETING DATA COLUMNS"
3190 PRINT "JJ";S$;"JJ"
+++1+++ 3200 IF V1>0 THEN 3230
3210 PRINT "ARRAY IS EMPTY"
3220 GO TO 3430
+++1+++ 3230 PRINT "JNUMBER OF COLUMN TO BE DELETED=";
3240 INPUT D$
3250 IF D$="" THEN 3440
3260 D2=VAL(D$)
3270 IF D2=>1 AND D2<=V1 THEN 3300
3280 PRINT "JGGGGC COLUMN NUMBER IS OUT OF RANGE"
3290 GO TO 3200
+++1+++ 3300 PRINT "JCOLUMN DELETED="
3310 FOR I=1 TO S1
3320   PRINT "I";A(I,D2)
3330 NEXT I
3340 IF D2=V1 THEN 3400
3350 FOR J=D2+1 TO V1
```

```
3360   FOR K=1 TO S1
3370     A(K,J-1)=A(K,J)
3380   NEXT K
3390 NEXT J
+++1+++ 3400 V1=V1-1
3410 Z=1
3420 PRINT "JREMAINING DATA :J"
+++1+++ 3430 GO TO 1090
+++1+++ 3440 END
+++1+++ 3450 REM *** STORE DATA ON MAG TAPE ***
3460 PRINT "L STORING DATA ON TAPE"
3470 PRINT "JJ";S$;"JJ"
3480 J=(1+S1*V1)*10
3490 PRINT "JFILE MUST HAVE A MINIMUM OF ";J;" BYTES FOR THIS DATA"
3500 PRINT "JJINSERT DATA TAPE NOW GGG"
3510 PRINT
3520 PRINT "NUMBER OF FILE FOR STORAGE=";
3530 INPUT Z
3540 FIND Z
3550 WRITE @33:S1,V1
3560 FOR I=1 TO S1
3570   FOR J=1 TO V1
3580     WRITE @33:A(I,J)
3590   NEXT J
3600 NEXT I
3610 WRITE @33:S$
3620 CLOSE
3630 PRINT "OPERATION COMPLETE; REMOVE DATA TAPE, INSERT PROGRAM TAPE"
3640 END
+++2+++ 3650 REM *** PLOTTING AXES AND DATA ***
3660 PRINT "LIPLOTTING ROUTINE"
3670 PRINT "JJ";S$;"JJ"
3680 P9=1
3690 PRINT "JDO YOU REQUIRE 2 SEPARATE Y AXES? (Y OR N):";
3700 INPUT Z$
3710 IF Z$="N" THEN 3750
3720 W9=1
3730 PRINT "THE SECOND Y AXIS WILL BE CALLED THE Z AXIS"
3740 GO TO 3760
+++1+++ 3750 W9=0
+++2+++ 3760 PRINT "JJENTER THE X COLUMN NUMBER"
3770 INPUT X7
3780 IF X7<1 OR X7>V1 THEN 3760
+++1+++ 3790 PRINT "ENTER THE Y COLUMN NUMBER"
3800 INPUT Y7
3810 IF Y7<1 OR Y7>V1 THEN 3790
3820 IF W9=0 THEN 3860
+++1+++ 3830 PRINT "ENTER THE Z COLUMN NUMBER"
3840 INPUT W7
3850 IF W7<1 OR W7>V1 THEN 3830
```

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```
+++1+++ 3860 PRINT 'I PLOT TYPE SELECTION'
3870 PRINT 'JJ1. CARTESIAN COORDINATES'
3880 PRINT 'J 2. SEMILOG (LOG ALONG X)'
3890 PRINT 'J 3. SEMILOG (LOG ALONG Y)'
3900 PRINT 'J 4. LOG-LOG'
3910 PRINT 'JJINDICATE THE TYPE OF X,Y PLOT NEEDED: ';
3920 INPUT P1
3930 IF W9=0 THEN 4060
3940 IF P1>2 THEN 3980
3950 B$='CARTESIAN COORDINATES'
3960 E4=0
3970 GO TO 4000
+++1+++ 3980 B$='LOG COORDINATES'
3990 E4=2
+++1+++ 4000 PRINT 'J';B$;' FOR Z AXIS (SAME AS Y AXIS)? Y OR N : ';
4010 INPUT Z$
4020 IF Z$='Y' THEN 4050
4030 P8=1
4040 GO TO 4060
+++1+++ 4050 P8=0
+++2+++ 4060 DELETE X
4070 DELETE Y
4080 DIM X(S1)
4090 DIM Y(S1)
4100 X=0
4110 Y=0
4120 IF W9=0 THEN 4160
4130 DELETE W
4140 DIM W(S1)
4150 W=0
+++1+++ 4160 GOSUB P1 OF 7510,7780,8190,8740
4170 IF W9=0 THEN 4190
4180 IF P8=1 THEN 14130
+++3+++ 4190 PRINT 'L DRAW AXES AND DATA(1) OR DATA ONLY(2)? ';
4200 INPUT P2
4210 GO TO 4230
4220 P2=1
+++1+++ 4230 IF P2=2 THEN 4305
4240 PRINT 'INPUT TITLE FOR X AXIS'
4250 INPUT X$
4260 PRINT 'INPUT TITLE FOR Y AXIS (ALONG LEFT SIDE)'
4270 INPUT Y$
4280 IF W9=0 THEN 4360
4290 PRINT 'INPUT TITLE FOR Z AXIS (ALONG RIGHT SIDE)'
4300 INPUT W$
+++1+++ 4305 IF W9=0 THEN 4360
+++1+++ 4310 PRINT 'FOR X,Y PLOT ENTER FIRST AND LAST SETS TO BE PLOTTED: ';
4320 INPUT P3,P4
4330 PRINT 'JFOR X,Z PLOT ENTER FIRST AND LAST SETS TO BE PLOTTED: ';
4340 INPUT Q3,Q4
```

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```
      4350 GO TO 4390
+++3+++ 4360 IF W9=1 THEN 4310
      4370 PRINT 'ENTER NUMBER OF FIRST AND LAST SETS TO BE PLOTTED:';
      4380 INPUT P3,P4
+++1+++ 4390 REM LEGEND AND TITLE
      4400 PRINT 'LILEGENDS AND TITLES'
      4410 PRINT 'LEGEND CHOICES:'
      4420 PRINT '      1. NO LEGEND'
      4430 PRINT '      2. NEW LEGEND'
      4440 PRINT '      3. OLD LEGEND'
      4450 INPUT H6
+++1+++ 4460 REM*** GOTO SELECTION MENU FOR SYMBOL TYPE ETC.***
      4470 GOSUB 6720
+++1+++ 4480 REM *** AXES PLOT***
      4490 PRINT 'L';S$
      4500 VIEWPORT 20,85,33,98
      4510 WINDOW X1,X2,Y1,Y2
      4520 IF Q9=32 THEN 4550
      4530 VIEWPORT 17,82,50,115
      4540 WINDOW X1,X2,Y1,Y2
+++1+++ 4550 W5=0
      4560 IF P2=2 THEN 4800
      4570 MOVE @Q9;X1,Y1
      4580 T9=Y3/100
      4590 T8=0
      4600 T7=X3
      4610 GOSUB P1 OF 6320,5580,6320,5580
      4620 MOVE @Q9;X1,Y2
      4630 T9=-T9
      4640 GOSUB P1 OF 6320,5580,6320,5580
      4650 MOVE @Q9;X1,Y1
      4660 T7=Y3
      4670 T9=X3/100
      4680 GOSUB P1 OF 6410,6410,5700,5700
      4690 IF W9=1 THEN 12590
      4700 T9=-T9
      4710 MOVE @Q9;X2,Y1
      4720 GOSUB P1 OF 6410,6410,5700,5700
+++2+++ 4730 MOVE @Q9;X1,Y1
      4740 P0=X1
      4750 GOSUB P1 OF 6500,5820,6500,5820
      4760 T9=X1
      4770 P0=Y1
      4780 GOSUB P1 OF 6610,6610,5890,5890
      4790 GOSUB 5990
+++1+++ 4800 REM *** DRAWING POINTS FOR X,Y PLOT ***
      4810 IF P3=0 OR P4=0 THEN 5520
      4820 FOR I=P3 TO P4
      4830   X6=X(I)
      4840   IF X(I)>X8 OR X(I)<X9 THEN 4900
```

```
4850 L=Y(I)
4860 G1=0
4870 MOVE @Q9:X6,L
4880 REM *** DRAW POINT USING CHOSEN SYMBOL***
4890 GOSUB 9360
+++1+++ 4900 NEXT I
4910 REM *** CALCULATION OF LEAST SQUARES***
4920 IF P3=0 OR P4=0 THEN 5470
4930 P=0
4940 G=0
4950 F=0
4960 F1=0
4970 N1=0
4980 FOR I=P3 TO P4
4990 X6=X(I)
5000 IF X(I)<X9 OR X(I)>X8 THEN 5090
5010 Y6=Y(I)
5020 P=P+X6*Y6
5030 G=G+Y6
5040 F=F+X6
5050 F1=F1+X6^2
5060 N1=N1+1
5070 G1=G1+Y6^2
5080 HOME
+++1+++ 5090 NEXT I
+++1+++ 5100 IF N1>1 THEN 5130
5110 PRINT 'NO DATA IN CURRENT SELECTION'
5120 END
+++1+++ 5130 IF N1*F1-F^2<>0 THEN 5170
5140 HOME @Q9:
5150 PRINT USING '32''J''IX''REGRESSION LINE IS VERTICAL''':
5160 END
+++1+++ 5170 B1=(N1*P-G*F)/(N1*F1-F^2)
5180 A3=(G-B1*F)/N1
5190 D6=X1
5200 D7=X2
5210 N2=1/N1
5220 R2=(A3*G+B1*P-N2*G^2)/(G1-N2*G^2)
5230 REM ***DRAW G(Y)=A3+B1*F(X)
5240 PRINT 'J '
5250 PRINT 'J PLOT THE BEST STRAIGHT LINE AND PRINT R^2 (1), '
5260 PRINT ' PRINT R^2 ONLY (2) OR NEITHER (3)?':
5270 INPUT Z
5280 GO TO Z OF 5290,5310,5470
+++1+++ 5290 MOVE @Q9:D6,A3+D6*B1
5300 DRAW @Q9:D7,A3+D7*B1
+++1+++ 5310 HOME
5320 PRINT 'JJJJJ'
5330 IF W5=4 THEN 13900
5340 GO TO P1 OF 5350,5380,5410,5440
```

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```
+++1+++ 5350 PRINT USING 5360:A3,B1
5360 IMAGE 'Y= ',+4E,X,+4E,'* X'
5370 GO TO 5460
+++1+++ 5380 PRINT USING 5390:A3,B1
5390 IMAGE 'Y= ',+4E,X,+4E,'* LOG X'
5400 GO TO 5460
+++1+++ 5410 PRINT USING 5420:A3,B1
5420 IMAGE 'LOG Y= ',+4E,X,+4E,'* X'
5430 GO TO 5460
+++1+++ 5440 PRINT USING 5450:A3,B1
5450 IMAGE 'LOG Y= ',+4E,X,+4E,'* LOG X'
+++3+++ 5460 PRINT 'COEF OF DETERMINATION (R^2) = ';R2
+++2+++ 5470 IF W9=0 THEN 5500
5480 IF W5=0 THEN 13530
5490 GO TO 14050
+++1+++ 5500 B4=B1
5510 A6=A3
+++2+++ 5520 REM **DASHED LINE ROUTINE**
5530 IF N8=1 THEN 5550
5540 GOSUB 14820
+++2+++ 5550 REM ***PRINTING LEGEND AND TITLE ***
5560 GOSUB H6 OF 5570,15490,16380
```

-----1----- 5570 END

-----4----- 5580 REM *** DRAW LOG TICK MARKS AND X AXIS***

```
5590 FOR I=1 TO T7
5600   Z8=0
5610   FOR J=2 TO 10
5620     Z9=LGT(J)
5630     RDRAW @Q9:Z9-Z8,T8
5640     RDRAW @Q9:T8,T9
5650     RDRAW @Q9:T8,-T9
5660     Z8=Z9
5670   NEXT J
5680 NEXT I
5690 RETURN
```

-----4----- 5700 REM *** LOG TICK MARKS AND Y AXIS***

```
5710 FOR I=1 TO T7
5720   Z8=0
5730   FOR J=2 TO 10
5740     Z9=LGT(J)
5750     RDRAW @Q9:T8,Z9-Z8
5760     RDRAW @Q9:T9,T8
5770     RDRAW @Q9:-T9,T8
5780     Z8=Z9
```

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```
5790 NEXT J
5800 NEXT I
5810 RETURN
```

```
---2--- 5820 REM *** NUMBERING THE X AXIS***
5830 FOR I=1 TO X3+1
5840 PRINT @Q9:"JJH10K";P0;
5850 MOVE @Q9:X1+I,Y1
5860 P0=P0+1
5870 NEXT I
5880 RETURN
```

```
---2--- 5890 REM ***NUMBERING THE Y AXIS***
5900 FOR I=0 TO Y3
5910 MOVE @Q9:T9,Y1+I
5920 PRINT @Q9:"HHHHH10K";P0;
5930 P0=P0+1
5940 NEXT I
5950 RETURN
5960 F4=0
5970 FOR I=1 TO S1-1
5980 IF A(I,S4)=>A(I+1,S4) THEN 9970
```

```
---1--- 5990 REM *** PRINTING X TITLE***
6000 CHARSIZE 3
6010 MOVE @Q9:X1+X3/2,Y1
6020 IF P9=0 THEN 6070
6030 IF P7=0 THEN 6070
6040 P$=STR(P7)
6050 X$=X$&" *10K"
6060 X$=X$&P$
+++2+++ 6070 FOR J=1 TO LEN(X$)/2
6080 PRINT @Q9:"H";
6090 NEXT J
6100 PRINT @Q9:"JJJJJ";X$
6110 MOVE @Q9:X1,Y1+Y3/2
6120 REM *** Y TITLE ***
6130 IF P1=3 OR P1=4 THEN 6160
+++1+++ 6160 PRINT @Q9:"HHHHHHHH";
6170 SET DEGREES
6180 PRINT @Q9,25:90
6190 IF P9=0 THEN 6240
6200 IF P5=0 THEN 6240
6210 P$=STR(P5)
6220 Y$=Y$&" *10K"
6230 Y$=Y$&P$
+++2+++ 6240 FOR J=1 TO LEN(Y$)/2
```

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```
6250      PRINT @Q9:"H";
6260      NEXT J
6270      PRINT @Q9:Y$
6280      PRINT @Q9,25:0
6290      IF W9=1 THEN 13130
+++1+++ 6300      CHARSIZE 2
6310      RETURN
```

```
-----4----- 6320      REM ***DRAW CARTESIAN TICK MARKS AND X AXIS***
6330      Z8=0
6340      Z9=(X2-X1)/10
6350      FOR J=1 TO 10
6360          RDRAW @Q9:Z9,T8
6370          RDRAW @Q9:T8,T9
6380          RDRAW @Q9:T8,-T9
6390      NEXT J
6400      RETURN
```

```
-----4----- 6410      REM *** DRAW CARTESIAN TICK MARKS AND Y AXIS***
6420      Z8=0
6430      Z9=(Y2-Y1)/10
6440      FOR J=1 TO 10
6450          RDRAW @Q9:T8,Z9
6460          RDRAW @Q9:T9,T8
6470          RDRAW @Q9:-T9,T8
6480      NEXT J
6490      RETURN
```

```
-----2----- 6500      REM *** NUMBER X AXIS (CARTESIAN)***
6510      Z9=(X2-X1)/5
6520      P7=INT(LGT(ABS(X1)+ABS(Z9))+1.0E-8)
6530      FOR I=1 TO 6
6540          P6=P0/10^P7
6550          PRINT @Q9:"JJHHH";
6560          PRINT @Q9: USING "-2D.2D":P6
6570          P0=X1+Z9*I
6580          MOVE @Q9:P0,Y1
6590      NEXT I
6600      RETURN
```

```
-----2----- 6610      REM *** NUMBER Y AXIS (CARTESIAN)***
6620      Z9=(Y2-Y1)/5
6630      P5=INT(LGT(ABS(Y1)+ABS(Z9))+1.0E-8)
6640      FOR I=1 TO 6
6650          MOVE @Q9:T9,P0
6660          P6=P0/10^P5
```

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```

6670      PRINT @Q9:"HHHHHHHH";
6680      PRINT @Q9: USING "-2D.2D":P6
6690      PO=Y1+Z9*I
6700      NEXT I
6710      RETURN

```

```

-----1----- 6720      REM *** SELECTION MENU ROUTINE ***
6730      M3=1
+++16+++ 6740      HOME
6750      PAGE
6760      IF M6<>2 THEN 6780
6770      Q9=32
+++1+++ 6780      IF Q9=1 THEN 6810
6790      Q$="SCREEN"
6800      GO TO 6820
+++1+++ 6810      Q$="PLOTTER"
+++1+++ 6820      PRINT "1 SELECTION MENU"
6830      PRINT "1. ALTER SYMBOL SIZE (SET TO ";M3;" NOW)"
6840      PRINT "2. SELECT OUTPUT DEVICE (SET TO ";Q$;" NOW)"
6850      IF W9=0 THEN 6890
6860      PRINT "3. SELECT SYMBOL (SET TO ";M$;" FOR X,Y POINTS)"
6870      PRINT "                      (SET TO ";A$;" FOR X,Z POINTS)"
6880      GO TO 6900
+++1+++ 6890      PRINT "3. SELECT SYMBOL (SET TO ";M$;" NOW)"
+++1+++ 6900      PRINT "4. DASHED LINE CURVE (";E$;" NOW)"
6910      PRINT
6920      PRINT "5. END SELECTION"
6930      PRINT
6940      PRINT "ENTER SELECTION NUMBER:";
6950      INPUT M5
6960      IF M5<1 OR M5>5 THEN 6740
6970      PAGE
6980      HOME
6990      GO TO M5 OF 7000,7070,7210,14530,7480
+++1+++ 7000      REM ***ALTER SYMBOL SIZE***
7010      PRINT "ENTER SYMBOL SIZE MULTIPLIER:";
7020      INPUT M3
7030      IF M3=0 THEN 6740
7040      M1=M1*M3
7050      M2=M2*M3
7060      GO TO 6740
+++1+++ 7070      REM*** OUTPUT DEVICE ***
7080      PRINT "1.SCREEN"
7090      PRINT "2.PLOTTER"
7100      PRINT
7110      PRINT "ENTER OUTPUT DEVICE SELECTION:";
7120      INPUT O1
7130      IF O1<1 OR O1>2 THEN 6740
7140      IF O1=1 THEN 7180

```

```

7150      Q9=1
7160      Q$='PLOTTER'
7170      GO TO 6740
+++1+++ 7180      Q9=32
7190      Q$='SCREEN'
7200      GO TO 6740
+++1+++ 7210      REM *** SYMBOL SELECTION ***
7220      PRINT 'J1. TRIANGLE'
7230      PRINT ' 2. SQUARE'
7240      PRINT ' 3. DIAMOND'
7250      PRINT ' 4. '+'
7260      PRINT ' 5. 'X'
7270      PRINT ' 6. '*'
7280      PRINT ' 7. POINT'
7290      IF W9=1 THEN 13330
7300      PRINT 'J ENTER SYMBOL NUMBER: ';
+++1+++ 7310      INPUT M4
7320      IF M4<1 OR M4>7 THEN 6740
7330      GO TO M4 OF 7340,7360,7380,7400,7420,7440,7460
+++1+++ 7340      M$='TRIANGLE'
7350      GO TO 6740
+++1+++ 7360      M$='SQUARE'
7370      GO TO 6740
+++1+++ 7380      M$='DIAMOND'
7390      GO TO 6740
+++1+++ 7400      M$='+'
7410      GO TO 6740
+++1+++ 7420      M$='X'
7430      GO TO 6740
+++1+++ 7440      M$='*'
7450      GO TO 6740
+++1+++ 7460      M$='POINT'
7470      GO TO 6740
+++1+++ 7480      IF N8>1 THEN 4480
7490      RETURN
7500      REM ***END OF SELECTION MENU***

```

```

---1--- 7510      REM*** CARTESIAN COORDINATES***
7520      FOR I=1 TO S1
7530          X(I)=A(I,X7)
7540          Y(I)=A(I,Y7)
7550      NEXT I
7560      IF W9=0 THEN 7610
7570      IF P8=1 THEN 7610
7580      FOR I=1 TO S1
7590          W(I)=A(I,W7)
7600      NEXT I
+++2+++ 7610      PRINT 'JINPUT BOUNDARIES FOR X (MIN,MAX): ';
7620      INPUT X1,X2

```

UNCLASSIFIEDAPPENDIX IV-18

```
7630 PRINT "JINPUT BOUNDARIES FOR Y (MIN,MAX):";
7640 INPUT Y1,Y2
7650 IF W9=0 THEN 7710
7660 IF P8=1 THEN 7710
7670 PRINT "JINPUT BOUNDARIES FOR Z (MIN,MAX):";
7680 INPUT W1,W2
7690 W3=W2-W1
7700 DEF FNW(V)=V
+++2+++ 7710 M2=(Y2-Y1)/100
7720 M1=(X2-X1)/100
7730 X3=X2-X1
7740 Y3=Y2-Y1
7750 DEF FNX(V)=V
7760 DEF FNY(V)=V
7770 RETURN

-----1----- 7780 REM *** SEMILOG ON X AXIS***
7790 I=1
+++1+++ 7800 IF I=S1+1 THEN 7870
7810 IF A(I,X7)=0 THEN 7840
7820 I=I+1
7830 GO TO 7800
+++1+++ 7840 PRINT "GGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE X DATA"
7850 PRINT "IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE"
7860 GO TO 1100
+++1+++ 7870 FOR I=1 TO S1
7880 X(I)=LGT(A(I,X7))
7890 Y(I)=A(I,Y7)
7900 NEXT I
7910 IF W9=0 THEN 7960
7920 IF P8=1 THEN 7960
7930 FOR I=1 TO S1
7940 W(I)=A(I,W7)
7950 NEXT I
+++3+++ 7960 PRINT "JINPUT MINIMUM BOUNDARY FOR X AND NO. OF CYCLES:";
7970 INPUT X1,X3
7980 IF X1>0 THEN 8010
7990 PRINT "GGJIMINIMUM X MUST BE GREATER THAN ZEROJ"
8000 GO TO 7960
+++1+++ 8010 X1=X1+1.0E-3
8020 PRINT "JINPUT BOUNDARIES FOR Y,(MIN,MAX):";
8030 INPUT Y1,Y2
8040 IF W9=0 THEN 8100
8050 IF P8=1 THEN 8100
8060 PRINT "JINPUT BOUNDARIES FOR Z,(MIN,MAX):";
8070 INPUT W1,W2
8080 W3=W2-W1
8090 DEF FNW(V)=V
+++2+++ 8100 Y3=Y2-Y1
```

UNCLASSIFIED

UNCLASSIFIEDAPPENDIX IV-19

```
8110  X1=INT(LGT(X1))
8120  X2=X1+X3
8130  M1=X3/100
8140  M2=(Y2-Y1)/100
8150  DEF FN(X)=LGT(X)
8160  P7=0
8170  DEF FNY(V)=V
8180  RETURN
```

```
-----1----- 8190  REM *** SEMILOG ON Y AXIS ***
8200  I=1
+++1+++ 8210  IF I=S1+1 THEN 8280
8220  IF A(I,Y7)=0 THEN 8250
8230  I=I+1
8240  GO TO 8210
+++1+++ 8250  PRINT "GGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE Y DATA"
8260  PRINT "IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE"
8270  GO TO 1100
+++1+++ 8280  FOR I=1 TO S1
8290  X(I)=A(I,X7)
8300  Y(I)=LGT(A(I,Y7))
8310  NEXT I
8320  IF W9=0 THEN 8450
8330  IF P8=1 THEN 8450
8340  I=1
+++1+++ 8350  IF I=S1+1 THEN 8420
8360  IF A(I,W7)=0 THEN 8390
8370  I=I+1
8380  GO TO 8350
+++1+++ 8390  PRINT "GGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE Z DATA"
8400  PRINT "IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE"
8410  GO TO 1100
+++1+++ 8420  FOR I=1 TO S1
8430  W(I)=LGT(A(I,W7))
8440  NEXT I
+++2+++ 8450  PRINT "JINPUT BOUNDARIES FOR X AXIS,(MIN,MAX):";
8460  INPUT X1,X2
+++1+++ 8470  PRINT "JINPUT MINIMUM BOUNDARY FOR Y AND NO. OF CYCLES:";
8480  INPUT Y1,Y3
8490  IF Y1>0 THEN 8520
8500  PRINT "GGIJ MINIMUM Y MUST BE GREATER THAN ZEROJ"
8510  GO TO 8470
+++1+++ 8520  Y1=Y1+1.0E-3
8530  X3=X2-X1
8540  Y1=INT(LGT(Y1))
8550  Y2=Y1+Y3
8560  M2=Y3/100
8570  M1=(X2-X1)/100
8580  DEF FN(X)=X
```

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UNCLASSIFIEDAPPENDIX IV-20

```
      8590   DEF FNY(V)=LGT(V)
      8600   P5=0
      8610   IF W9=0 THEN 8730
      8620   IF P8=1 THEN 8730
+++1+++  8630   PRINT "JINPUT MINIMUM BOUNDARY FOR Z AND NO. OF CYCLES:";
      8640   INPUT W1,W3
      8650   A9=0
      8660   IF W1>0 THEN 8690
      8670   PRINT "GGIJMINIMUM Z MUST BE GREATER THAN ZEROJ"
      8680   GO TO 8630
+++1+++  8690   W1=W1+1.0E-3
      8700   W1=INT(LGT(W1))
      8710   W2=W1+W3
      8720   DEF FNW(V)=LGT(V)
+++2+++  8730   RETURN

-----1-----  8740   REM ***LOG-LOG COORDINATES***
      8750   I=1
+++1+++  8760   IF I=S1+1 THEN 8840
      8770   IF A(I,X7)=0 THEN 8810
      8780   IF A(I,Y7)=0 THEN 8810
      8790   I=I+1
      8800   GO TO 8760
+++2+++  8810   PRINT "GGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE DATA"
      8820   PRINT "IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE"
      8830   GO TO 1100
+++1+++  8840   FOR I=1 TO S1
      8850       X(I)=LGT(A(I,X7))
      8860       Y(I)=LGT(A(I,Y7))
      8870   NEXT I
      8880   IF W9=0 THEN 9000
      8885   IF P8=1 THEN 9000
      8890   I=1
+++1+++  8900   IF I=S1+1 THEN 8970
      8910   IF A(I,W7)=0 THEN 8940
      8920   I=I+1
      8930   GO TO 8900
+++1+++  8940   PRINT "GGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE Z DATA"
      8950   PRINT "IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE"
      8960   GO TO 1100
+++1+++  8970   FOR I=1 TO S1
      8980       W(I)=LGT(A(I,W7))
      8990   NEXT I
+++3+++  9000   PRINT "JINPUT MINIMUM BOUNDARY FOR X AND NO. OF CYCLES:";
      9010   INPUT X1,X3
      9020   IF X1>0 THEN 9050
      9030   PRINT "GGIJMINIMUM X MUST BE GREATER THAN ZEROJ"
      9040   GO TO 9000
+++1+++  9050   X1=X1+1.0E-3
```

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```
+++1+++ 9060 PRINT "JINPUT MINIMUM BOUNDARY FOR Y AND NO. OF CYCLES:";
          9070 INPUT Y1,Y3
          9080 IF Y1>0 THEN 9110
          9090 PRINT "GGIJMINIMUM Y MUST BE GREATER THAN ZEROJ"
          9100 GO TO 9060
+++1+++ 9110 Y1=Y1+1.0E-3
          9120 IF W9=0 THEN 9250
          9130 IF P8=1 THEN 9250
+++1+++ 9140 PRINT "JINPUT MINIMUM BOUNDARY FOR Z AND NO. OF CYCLES:";
          9150 INPUT W1,W3
          9160 IF W1>0 THEN 9190
          9170 PRINT "GGIJMINIMUM Z MUST BE GREATER THAN ZEROJ"
          9180 GO TO 9140
+++1+++ 9190 W1=W1+1.0E-3
          9200 W1=INT(LGT(W1))
          9210 W2=W1+W3
          9220 DEF FNW(V)=LGT(V)
          9230 M6=W3/100
          9240 A9=0
+++2+++ 9250 Y1=INT(LGT(Y1))
          9260 X1=INT(LGT(X1))
          9270 X2=X1+X3
          9280 Y2=Y1+Y3
          9290 DEF FNX(V)=LGT(V)
          9300 DEF FNY(V)=LGT(V)
          9310 M1=X3/100
          9320 M2=Y3/100
          9330 P5=0
          9340 P7=0
          9350 RETURN
```

```
---2--- 9360 REM***SYMBOL PLOTTING ROUTINE***
          9370 REM *** M1=SYMBOL WIDTH, M2=SYMBOL HEIGHT***
          9380 GO TO M4 OF 9390,9450,9520,9590,9650,9710,9760
```

```
---3--- 9390 REM ***TRIANGLE***
          9400 RMOVE @Q9:0,M2
          9410 RDRAW @Q9:M1,-2*M2
          9420 RDRAW @Q9:-2*M1,0
          9430 RDRAW @Q9:M1,2*M2
          9440 RETURN
```

```
---3--- 9450 REM*** SQUARE***
          9460 RMOVE @Q9:M1,M2
          9470 RDRAW @Q9:0,-2*M2
          9480 RDRAW @Q9:-2*M1,0
          9490 RDRAW @Q9:0,2*M2
```

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9500 RDRAW @Q9:2*M1,0
9510 RETURN

---3--- 9520 REM***DIAMOND***
9530 RMOVE @Q9:0,M2
9540 RDRAW @Q9:M1,-M2
9550 RDRAW @Q9:-M1,-M2
9560 RDRAW @Q9:-M1,M2
9570 RDRAW @Q9:M1,M2
9580 RETURN

---4--- 9590 REM ***"+"***
9600 RMOVE @Q9:0,M2
9610 RDRAW @Q9:0,-2*M2
9620 RMOVE @Q9:M1,M2
9630 RDRAW @Q9:-2*M1,0
9640 RETURN

---3--- 9650 REM ***"X"***

---1--- 9660 RMOVE @Q9:M1,M2
9670 RDRAW @Q9:-2*M1,-2*M2
9680 RMOVE @Q9:2*M1,0
9690 RDRAW @Q9:-2*M1,2*M2
9700 RETURN

---3--- 9710 REM ***"*"
9720 GOSUB 9590
9730 RMOVE M1,0
9740 GOSUB 9660
9750 RETURN

---3--- 9760 REM *** POINT***
9770 RDRAW @Q9:0,0
9780 RETURN
9790 REM*** END SYMBOL PLOTTING ROUTINE***
+++1+++ 9800 REM *** DATA SORT ROUTINE***
9810 PRINT 'LI SORTING ROUTINE (HIGH VALUES FIRST)'
9820 PRINT 'JJ';S\$;'JJ'
9830 PRINT 'J INPUT THE COLUMN THAT IS TO BE SORTED: '
9840 INPUT S4
9850 IF S4>1 OR S4<V1 THEN 9880
9860 PRINT 'J COLUMN IS OUT OF RANGE'
9870 GO TO 10080

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```

+++2+++ 9880   F4=0
          9890   FOR I=1 TO S1-1
          9900     IF A(I,S4)=>A(I+1,S4) THEN 9970
          9910     F4=1
          9920     FOR J=1 TO V1
          9930       T1=A(I,J)
          9940       A(I,J)=A(I+1,J)
          9950       A(I+1,J)=T1
          9960     NEXT J
+++2+++ 9970   NEXT I
          9980   IF F4=1 THEN 9880
          9990   PRINT "JISORTED VALUES"
          10000  PRINT
          10010  FOR I=1 TO S1
          10020    PRINT I;" ";
          10030    FOR J=1 TO V1
          10040      PRINT USING 1220;A(I,J)
          10050    NEXT J
          10060  PRINT
          10070  NEXT I
+++1+++ 10080  END
          10090  REM ***END SORTING ROUTINE***
+++1+++ 10100  REM **COLUMN GENERATED FROM EXISTING DATA**
          10110  PRINT "LICOLUMN GENERATED FROM EXISTING DATA"
          10120  PRINT "JJ";S$;"JJ"
          10130  IF V1<V2 THEN 10160
          10140  PRINT "JJNO MORE COLUMNS ALLOWEDGGGG"
          10150  GO TO 10310
+++1+++ 10160  PRINT "J1. COLUMN TO BE TRANSFORMED IS WRITTEN IN ARRAY FORMAT"
          10170  PRINT "      i.e.A(I,n) WHERE n IS THE COLUMN NUMBER."
          10180  PRINT "2. THE TRANSFORMATION IS INPUT BY RECALLING LINE 10260,"
          10190  PRINT "      AND CHANGING THE EQUATION"
          10200  PRINT "3. ONLY THE RIGHT HAND SIDE OF THE EQUATION IS CHANGED"
          10210  PRINT "      i.e. FOR Y=1/X, INPUT 1/A(I,3), IF USING COLUMN 3"
          10220  PRINT "4. RECALL 10260, MAKE ANY CHANGES, PRESS USER KEY #13"
          10230  PRINT "JJ ONLY ";V2-V1;" MORE COLUMNS ARE ALLOWED!"
          10240  END
+++1+++ 10250  FOR I=1 TO S1
          10260    A(I,V1+1)=A(I,5)*10
          10270  NEXT I
          10280  V1=V1+1
          10290  Z=1
          10300  GO TO 1090
+++1+++ 10310  END
+++1+++ 10320  REM *** LIST ON PRINTER WITH VARIABLE E FORMAT***
          10330  DELETE M
          10340  DIM M(V1)
          10350  M=0
          10360  PRINT "IS SCIENTIFIC NOTATION FORMAT REQUIRED (Y OR N)?";
          10370  INPUT Z$

```

```
10380 IF Z$='Y' THEN 10410
10390 PRINT @Q9:'LJJI';S$;'JJ'
10400 IF Z$='N' THEN 1150
+++1+++ 10410 PRINT 'JINPUT NUMBER OF SIGNIFICANT FIGURES (3 TO 6)'
10420 FOR I=1 TO V1
+++1+++ 10430 PRINT 'JFOR COLUMN ";I;" =';
10440 INPUT Z
10450 IF Z<3 OR Z>6 THEN 10430
10460 M(I)=Z-2
10470 NEXT I
10490 PRINT @Q9:'L'
10500 PRINT @Q9:'JJJJJJJJJJ'
10510 FOR I=1 TO S1
10520 PRINT @Q9:' ';
10530 FOR J=1 TO V1
10540 IF A(I,J)<1.0E-9 THEN 10760
10550 GO TO V1-1 OF 10560,10580,10600,10620,10620
+++1+++ 10560 PRINT @Q9: USING '12X,S';
10570 GO TO 10630
+++1+++ 10580 PRINT @Q9: USING '6X,S';
10590 GO TO 10630
+++1+++ 10600 PRINT @Q9: USING '2X,S';
10610 GO TO 10630
+++2+++ 10620 PRINT @Q9: USING '1X,S';
+++3+++ 10630 GO TO M(J) OF 10640,10670,10700,10730
+++1+++ 10640 PRINT @Q9: USING 10650:A(I,J)
10650 IMAGE 2E,S
10660 GO TO 10780
+++1+++ 10670 PRINT @Q9: USING 10680:A(I,J)
10680 IMAGE 3E,S
10690 GO TO 10780
+++1+++ 10700 PRINT @Q9: USING 10710:A(I,J)
10710 IMAGE 4E,S
10720 GO TO 10780
+++1+++ 10730 PRINT @Q9: USING 10740:A(I,J)
10740 IMAGE 5E,S
10750 GO TO 10780
+++1+++ 10760 PRINT @Q9: USING 10770:
10770 IMAGE 5X,' - ',S
+++4+++ 10780 NEXT J
10790 PRINT @Q9:
10800 NEXT I
10810 PRINT @Q9:
10820 Q9=32
10830 END
+++1+++ 10840 REM *** CALCULATION OF Y FROM X AFTER L.S.***
10850 PRINT 'L I CALCULATION OF Y FROM X'
10860 PRINT 'J THIS CAN ONLY BE USED AFTER A PLOT HAS BEEN MADE'
10870 PRINT ' STOP CALCULATIONS WITH A CARRIAGE RETURN'
10880 PRINT 'J THE CALCULATIONS ASSUME A STRAIGHT LINE, AND'
```

```
10890 PRINT " USE THE LEAST SQUARES PARAMETERS."
10895 Z=1
10900 IF W9=0 THEN 10930
10910 PRINT "JJCALCULATE Y (1) OR Z (2) FROM X?";
10920 INPUT Z
+++1+++ 10930 PRINT "JLIST ON SCREEN (1) OR PRINTER (2)?";
10940 INPUT I
10950 IF I=2 THEN 10980
10960 Q9=32
10970 GO TO 10990
+++1+++ 10980 Q9=41
10985 PRINT @Q9:"LIJJ";S$;"JJJ"
+++1+++ 10990 IF Z=1 THEN 11040
11000 A3=A5
11010 B1=B3
11020 Z$="Z EST"
11030 GO TO 11070
+++1+++ 11040 A3=A6
11050 B1=B4
11060 Z$="Y EST"
+++2+++ 11070 PRINT "JINPUT X:";
11080 INPUT F$
11090 IF F$="" THEN 11270
11100 F2=VAL(F$)
11110 IF Z=1 THEN 11140
11120 IF P8=0 THEN 11140
11130 GO TO E4+N4 OF 11150,11170,11190,11220
+++2+++ 11140 GO TO P1 OF 11150,11170,11190,11220
+++2+++ 11150 G2=A3+B1*F2
11160 GO TO 11240
+++2+++ 11170 G2=A3+B1*LGT(F2)
11180 GO TO 11240
+++2+++ 11190 G2=A3+B1*F2
11200 G2=10^G2
11210 GO TO 11240
+++2+++ 11220 G2=A3+B1*LGT(F2)
11230 G2=10^G2
+++3+++ 11240 PRINT @Q9:"I X=";F2;"II";Z$;"=";G2
11250 PRINT
11260 GO TO 11070
+++1+++ 11270 Q9=32
11280 END
+++1+++ 11290 REM *** CALCULATE X FROM Y AFTER L.S.***
11300 PRINT "L I CALCULATION OF X FROM Y"
11310 PRINT "J THIS CAN BE USED ONLY AFTER A PLOT HAS BEEN MADE"
11320 PRINT " STOP CALCULATIONS WITH A CARRIAGE RETURN "
11330 PRINT "J THE CALCULATIONS ASSUME A STRAIGHT LINE, AND"
11340 PRINT "USE THE LEAST SQUARES PARAMETERS."
11345 Z=1
11350 IF W9=0 THEN 11380
```

```
11360 PRINT 'JCALCULATE X FROM Y (1) OR Z (2)?'
11370 INPUT Z
+++1+++ 11380 PRINT 'JLIST ON SCREEN (1) OR PRINTER (2)?';
11390 INPUT I
11400 IF I=2 THEN 11430
11410 Q9=32
11420 GO TO 11440
+++1+++ 11430 Q9=41
11435 PRINT @Q9:'LIJJ';S$;'JJJ'
+++1+++ 11440 IF Z=1 THEN 11490
11450 A3=A5
11460 B1=B3
11470 Z$='Z'
11480 GO TO 11520
+++1+++ 11490 Z$='Y'
11500 A3=A6
11510 B1=B4
+++2+++ 11520 PRINT 'INPUT ';Z$;': ';
11530 INPUT G$
11540 IF G$='' THEN 11730
11550 G2=VAL(G$)
11560 IF Z=1 THEN 11590
11570 IF P8=0 THEN 11590
11580 GO TO N4+E4 OF 11600,11630,11660,11680
+++2+++ 11590 GO TO P1 OF 11600,11630,11660,11680
+++2+++ 11600 F2=(G2-A3)/B1
11610 GO TO 11700
11620 F2=(G2-A3)/B1
+++2+++ 11630 F2=(G2-A3)/B1
11640 F2=10^F2
11650 GO TO 11700
+++2+++ 11660 F2=(LGT(G2)-A3)/B1
11670 GO TO 11700
+++2+++ 11680 F2=(LGT(G2)-A3)/B1
11690 F2=10^F2
+++3+++ 11700 PRINT @Q9:'I';Z$;''=';G2;'IIX EST=';F2
11710 PRINT
11720 GO TO 11520
+++1+++ 11730 Q9=32
11740 END
+++1+++ 11750 REM*** ADDING TWO FILES OF DATA (SAME NUMBER OF COLUMNS)***
11760 PRINT 'LI ADDING TWO SETS OF DATA (WITH SAME # OF COLUMNS)'
+++1+++ 11770 PRINT 'J ADD MAG TAPE FILE TO CURRENT FILE (Y OR N)?';
11780 INPUT Z$
11790 IF Z$='Y' THEN 12390
11800 PRINT 'J ADD TWO MAG TAPE FILES (Y OR N)?';
11810 INPUT Z$
11820 IF Z$='Y' THEN 11770
11830 PRINT 'IJADDITION OF TWO MAG TAPE FILES (SAME # OF COLUMNS)'
11840 PRINT 'JJ INSERT DATA TAPE NOWGGG'
```

```
11850 PRINT "J INPUT NUMBER OF FIRST FILE:";
11860 INPUT Q1
11870 FIND Q1
11880 READ @33:S1
11890 READ @33:V1
11900 DELETE A
11910 DIM A(S1,V1)
11920 FOR I=1 TO S1
11930   FOR J=1 TO V1
11940     READ @33:A(I,J)
11950   NEXT J
11960 NEXT I
11970 PRINT "JJ INSERT NEXT TAPE, IF NECESSARY GGG"
11980 PRINT "J INPUT NUMBER OF SECOND FILE:";
11990 INPUT Q2
12000 FIND Q2
+++1+++ 12010 READ @33:T2,V2
12020 IF V2=V1 THEN 12050
12030 PRI "INCOMPATABLE DATA:";V2;" COLUMNS IN FILE 2;"V1;" IN FILE 1"
12040 GO TO 12380
+++1+++ 12050 IF S2=>S1+T2 THEN 12130
12055 Z=S2-S1
12060 PRINT "JGGGGGT00 MANY DATA POINTS!"
12070 PRINT "J ONLY ";Z;" OF ";T2;" WILL BE READ INJ"
12080 T2=Z
+++1+++ 12130 V2=V1+2
12140 FOR I=S1+1 TO S1+T2
12150   FOR J=1 TO V1
12160     READ @33:A(I,J)
12170   NEXT J
12180 NEXT I
12270 S1=S1+T2
12280 PRINT "INPUT NEW DATA IDENTIFICATION (<72 CHARACTERS)"
12290 INPUT S$
12300 FOR I=1 TO S1
12310   PRINT I;" ";
12320   FOR J=1 TO V1
12330     PRINT A(I,J);" ";
12340   NEXT J
12350   PRINT
12360 NEXT I
12370 DELETE Q
+++1+++ 12380 END
+++1+++ 12390 REM *** ADDITION OF MAG TAPE DATA TO CURRENT DATA***
12400 PRI "JJADDITION OF MAG TAPE DATA TO CURRENT DATA("V1;" COLUMNS)"
12410 PRINT "JJINSERT DATA TAPE NOWGGG"
12420 PRINT "JINPUT FILE NUMBER:";
12430 INPUT Q1
12440 FIND Q1
12450 GO TO 12010
```

```
12460 END
+++1+++ 12470 REM ***REPEAT PLOT ***
12480 PRINT 'LIREPEAT THE LAST PLOT'
12490 PRINT 'JJTHE PLOT WILL BE IDENTICAL TO THE LAST PLOT;'
12500 PRINT ' ONLY THE SIZE, SYMBOL AND OUTPUT DEVICE CAN BE CHANGED'
12510 PRINT 'JJ CONFIRM IDENTICAL PLOT NEEDED (Y OR N):'
12520 INPUT Z$
12530 P9=0
12540 IF Z$<>'Y' THEN 3650
12550 IF H6<>2 THEN 12570
12560 H6=3
+++1+++ 12570 GO TO 4460
12580 END
+++1+++ 12590 REM ***PLOTING Z AXIS***
12600 GOSUB E4+1 OF 12860,12860,12610
```

```
-----1----- 12610 REM ***LOG AXIS AND TIC MARKS FOR Z AXIS
12620 WINDOW X1,X2,W1,W2
12630 T7=W3
12640 T9=-T9
12650 MOVE @Q9:X2,W1
12660 FOR I=1 TO T7
12670 Z8=0
12680 FOR J=2 TO 10
12690 Z9=LGT(J)
12700 RDRAW @Q9:T8,Z9-Z8
12710 RDRAW @Q9:T9,T8
12720 RDRAW @Q9:-T9,T8
12730 Z8=Z9
12740 NEXT J
12750 NEXT I
12760 REM *** NUMBERING THE Z AXIS
12770 P0=W1
12780 FOR I=0 TO W3
12790 MOVE @Q9:X2,W1+I
12800 PRINT @Q9:' 10K':P0
12810 P0=P0+1
12820 NEXT I
12830 WINDOW X1,X2,Y1,Y2
12840 GO TO 4730
12850 END
```

```
-----2----- 12860 REM*** DRAW CARTESIAN AXIS AND TIC MARKS FOR Z
12870 WINDOW Y1,X2,W1,W2
12880 MOVE @Q9:X2,W1
12890 T7=W3
12900 T9=-T9
12910 Z8=0
```

```

12920   Z9=(W2-W1)/10
12930   FOR J=1 TO 10
12940     RDRAW @Q9:T8,Z9
12950     RDRAW @Q9:T9,T8
12960     RDRAW @Q9:-T9,T8
12970   NEXT J
12980   REM ***NUMBERING Z AXIS (CARTESIAN)
12990   T9=X2
13000   P0=W1
13010   Z9=(W2-W1)/5
13020   A9=INT(LGT(ABS(W1)+ABS(Z9))+1.0E-8)
13030   FOR I=1 TO 4
13040     MOVE @Q9:T9,P0
13050     P6=P0/10^A9
13060     IF W1=>0 THEN 13080
13070     PRINT @Q9:" ";
13080     PRINT @Q9: USING "-2D.2D":P6
13090     P0=W1+Z9*I
13100   NEXT I
13110   WINDOW X1,X2,Y1,Y2
13120   GO TO 4730
+++1+++ 13130   REM ***TITLE FOR Z AXIS
13140   MOVE @Q9:X2,Y1+Y3/2
13150   IF P1=3 OR P1=4 THEN 13180
+++1+++ 13180   PRINT @Q9:" ";
13190   SET DEGREES
13200   PRINT @Q9,25:-90
13210   IF P9=0 THEN 13260
13220   IF A9=0 THEN 13260
13230   P$=STR(A9)
13240   W$=W$&" *10K"
13250   W$=W$&P$
+++2+++ 13260   FOR J=1 TO LEN(W$)/2
13270     PRINT @Q9:"H";
13280   NEXT J
13290   PRINT @Q9:W$
13300   PRINT @Q9,25:0
13310   GO TO 6300
13320   END
+++1+++ 13330   REM **SYMBOL SELECTION FOR X,Z POINTS
13340   PRINT "J ENTER SYMBOL NUMBER FOR X,Z POINTS:";
13350   INPUT A4
13360   GO TO A4 OF 13370,13390,13410,13430,13450,13470,13490
+++1+++ 13370   A$="TRIANGLE"
13380   GO TO 13500
+++1+++ 13390   A$="SQUARE"
13400   GO TO 13500
+++1+++ 13410   A$="DIAMOND"
13420   GO TO 13500
+++1+++ 13430   A$=" '+'

```

```
13440 GO TO 13500
+++1+++ 13450 A$="X"
13460 GO TO 13500
+++1+++ 13470 A$="*"
13480 GO TO 13500
+++1+++ 13490 A$="POINT"
+++o+++ 13500 PRINT "ENTER SYMBOL NUMBER FOR X,Y POINTS:";
13510 GO TO 7310
13520 END
+++1+++ 13530 REM *** DRAWING X,Z POINTS
13535 IF Q3=0 OR Q4=0 THEN 14110
13540 B4=B1
13550 A6=A3
13560 WINDOW X1,X2,W1,W2
13580 W5=4
13590 M2=W3/100
13600 M7=M4
13610 M4=A4
13620 FOR I=Q3 TO Q4
13630 X6=X(I)
13640 IF X(I)>X8 OR X(I)<X9 THEN 13690
13650 L=W(I)
13660 G1=0
13670 MOVE @Q9:X6,L
13680 GOSUB 9360
+++1+++ 13690 NEXT I
13700 REM ***CALC OF LEAST SQUARES
13710 P=0
13720 G=0
13730 F=0
13740 F1=0
13750 N1=0
13760 FOR I=Q3 TO Q4
13770 X6=X(I)
13780 IF X(I)<X9 OR X(I)>X8 THEN 13860
13790 Y6=W(I)
13800 P=P+X6*Y6
13810 G=G+Y6
13820 F=F+X6
13830 F1=F1+X6^2
13840 N1=N1+1
13850 G1=G1+Y6^2
+++1+++ 13860 NEXT I
13870 HOME
13880 PRINT "JJJJJJ"
13890 GO TO 5100
+++1+++ 13900 REM PRINT OUT OF COEF FOR X,Z DATA
13910 PRINT "JJJJJJ"
13912 IF P8=1 THEN 13920
13914 GO TO P1 OF 13930,13960,13990,14020
```

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```
+++1+++ 13920 GO TO N4+E4 OF 13930,13960,13990,14020
+++2+++ 13930 PRINT USING 13940:A3,B1
13940 IMAGE 'Z=',+4E,X,+4E,'*X'
13950 GO TO 14040
+++2+++ 13960 PRINT USING 13970:A3,B1
13970 IMAGE 'Z=',+4E,X,+4E,'* LOG X'
13980 GO TO 14040
+++2+++ 13990 PRINT USING 14000:A3,B1
14000 IMAGE 'LOG Z=',+4E,X,+4E,'* X'
14010 GO TO 14040
+++2+++ 14020 PRINT USING 14030:A3,B1
14030 IMAGE 'LOG Z=',+4E,X,+4E,'* LOG X'
+++3+++ 14040 PRINT 'COEF OF DETERMINATION (R^2)= 'R2
+++1+++ 14050 WINDOW X1,X2,Y1,Y2
14060 M2=Y3/100
14070 B3=B1
14080 A5=A3
14090 M4=M7
14100 W5=1
+++1+++ 14110 GO TO 5520
14120 END
+++1+++ 14130 REM ***ROUTINE FOR Z AXIS DIFFERENT FROM Y AXIS (P8=1)***
14140 PRINT 'JCARTESIAN (1) OR LOG (2) COORDINATES ON Z AXIS?';
14150 INPUT E4
14160 IF E4=2 THEN 14180
14170 E4=0
+++1+++ 14180 IF P1=2 OR P1=4 THEN 14210
14190 N4=1
14200 GO TO 14220
+++1+++ 14210 N4=2
+++1+++ 14220 IF E4=2 THEN 14310
14230 FOR I=1 TO S1
14240 W(I)=A(I,W7)
14250 NEXT I
14260 PRINT 'INPUT BOUNDARIES FOR Z(MIN, MAX):';
14270 INPUT W1,W2
14280 W3=W2-W1
14290 DEF FNW(V)=V
14300 GO TO 4190
+++1+++ 14310 I=1
+++1+++ 14320 IF I=S1+1 THEN 14390
14330 IF A(I,W7)=0 THEN 14360
14340 I=I+1
14350 GO TO 14320
+++1+++ 14360 PRINT 'GGGGGGGERROR: A ZERO VALUE HAS BEEN FOUND IN THE Z DATA'
14370 PRINT ' IT MUST BE REMOVED BEFORE A LOG PLOT CAN BE MADE'
14380 GO TO 1100
+++1+++ 14390 FOR I=1 TO S1
14400 W(I)=LGT(A(I,W7))
14410 NEXT J
```

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```

+++1+++ 14420 PRINT "JINPUT MINIMUM BOUNDARY FOR Z AND NO. OF CYCLES:";
14430 INPUT W1,W3
14440 A9=0
14450 IF W1>0 THEN 14480
14460 PRINT "MINIMUM Z MUST BE GREATER THAN ZERO GGGGJ"
14470 GO TO 14420
+++1+++ 14480 W1=W1+0.01
14490 W1=INT(LGT(W1))
14500 W2=W1+W3
14510 DEF FNW(V)=LGT(V)
14520 GO TO 4190
+++1+++ 14530 REM ***DASHED LINES ON A PLOT***
14540 PRINT "LIDASHED LINES ON PLOTJ"
14550 PRINT " 1. NO DASHED LINE"
14560 PRINT " 2. DASHED LINE ON X,Y PLOT"
14570 IF W9=0 THEN 14590
14580 PRINT " 3. DASHED LINE ON X,Z PLOT"
+++1+++ 14590 PRINT " JJ ENTER SELECTION NUMBER:";
14600 INPUT N8
14610 GO TO N8 OF 14620,14640,14660
+++1+++ 14620 E$="SET OFF"
14630 GO TO 6740
+++1+++ 14640 E$="SET ON X,Y PLOT"
14650 GO TO 14670
+++1+++ 14660 E$="SET ON X,Z PLOT"
+++1+++ 14670 PRINT "JJSELECT DASH PATTERN (FOR PLOTTER ONLY) --"
14680 PRINT "I1. -----"
14690 PRINT "I2. ....-.-"
14700 PRINT "I3. ...."
14710 PRINT "JINPUT SELECTION:";
14720 INPUT N5
14730 REM ***INPUTING THE EQUATION FOR THE DASHED LINE
14740 PRINT "JINPUT THE EQUATION IN LINE 14890"
14750 PRINT "INSTRUCTIONS"
14760 PRI "I1. THE EQUATION IS WRITTEN IN TERMS OF R(I), (X COMPONENT)
14770 PRINT "I AS A FUNCTION OF N(I), (THE Y COMPONENT)"
14780 PRINT "I2. ONLY N(I) SHOULD BE ON THE LEFT SIDE OF THE EQUATION"
14790 PRINT "I3. RECALL LINE 14890 AND INPUT THE EQUATION"
14800 PRINT "I4. THEN PRESS USER KEY #18"
14810 END

-----1--- 14820 REM ***PLOTTING THE DASHED LINE ***
14830 DELETE N,R
14840 DIM N(S1),R(S1)
14850 N=0
14860 R=0
14870 FOR I=1 TO S1
14880 R(I)=A(I,X7)
14890 N(I)=F(I)*0.01

```

```
14900 NEXT I
14910 IF N8=2 THEN 14940
14920 WINDOW X1,X2,W1,W2
14930 GO TO 14950
+++1+++ 14940 WINDOW X1,X2,Y1,Y2
+++1+++ 14950 IF P8=0 THEN 14970
14960 GO TO N4+E4 OF 14980,15020,15060,15100
+++1+++ 14970 GO TO P1 OF 14980,15020,15060,15100
+++2+++ 14980 REM***CARTESIAN
14990 DEF FNR(V)=V
15000 DEF FNN(V)=V
15010 GO TO 15140
+++2+++ 15020 REM***SEMILOG ON X
15030 DEF FNR(V)=V
15040 R=LGT(R)
15050 GO TO 15140
+++2+++ 15060 REM *** SEMILOG ON Y
15070 DEF FNR(V)=V
15080 N=LGT(N)
15090 GO TO 15140
+++2+++ 15100 REM*** LOG-LOG
15110 R=LGT(R)
15120 N=LGT(N)
15130 REM***DRAWING DASHED LINE ***
+++3+++ 15140 IF Q9=1 THEN 15220
15150 MOVE @Q9:R(1),N(1)
15160 DASH 85
15170 DRAW @Q9:R,N
15180 DASH 0
15190 WINDOW X1,X2,Y1,Y2
15200 RETURN
15210 END
+++1+++ 15220 REM DASHED LINE FOR PLOTTER
15230 GOSUB N5 OF 15330,15380,15430
15240 MOVE @Q9:R(1),N(1)
15250 FOR I=1 TO S1
15260 DRAW @Q9:R(I),N(I)
15270 MOVE @Q9:R(I),N(I)
15280 NEXT I
15290 PRINT @1,32:'BL':0
15300 WINDOW X1,X2,Y1,Y2
15310 RETURN
15320 END
```

```
-----1----- 15330 REM*** ----- ****
15340 PRINT @1,32:'BL':1
15350 PRINT @1,32:'BD':1,1,1,1,1,1,1,1,1,1
15360 PRINT @1,32:'BS':10
15370 RETURN
```

```
---1--- 15380 REM*** -.-.-.-.***  
15390 PRINT @1,32:"BL";1  
15400 PRINT @1,32:"BD";1,1,0,1,1,1,0,1,1,1,0,1,1  
15410 PRINT @1,32:"BS";10  
15420 RETURN
```

```
---1--- 15430 REM*** .....***  
15440 PRINT @1,32:"BL";1  
15450 PRINT @1,32:"BD";0,0,0,1,0,1,0,1,0,1,0,1,0  
15460 PRINT @1,32:"BS";5  
15470 RETURN  
15480 END
```

```
---1--- 15490 REM POINTER FUNCTION  
15500 VIEWPORT 10,95,0,30  
15510 WINDOW 0,20,-0.6,5  
15520 MOVE 0,0  
15530 DRAW 0,2.5  
15540 DRAW 20,2.5  
15550 DRAW 20,0  
15560 DRAW 0,0  
15570 FOR I=1 TO 5  
15572 MOVE 0,I/2  
15574 DRAW 20,I/2  
15576 NEXT I  
15578 VIEWPORT 20,85,80,110  
15580 WINDOW 0,20,-0.5,5  
15582 MOVE 0,0  
15584 DRAW 0,2.5  
15586 DRAW 20,2.5  
15588 DRAW 20,0  
15590 DRAW 0,0  
15592 FOR I=1 TO 5  
15594 MOVE 0,I/2  
15596 DRAW 20,I/2  
15598 NEXT I  
15610 VIEWPORT 5,100,0,98  
15620 WINDOW X1-0.23*X3,X2+0.15*X3,Y1-0.54*Y3,Y2  
15630 H=0  
+++1+++ 15640 L$=""  
15650 H4=1  
15660 I=1  
15670 CHARSIZE 3  
+++3+++ 15680 POINTER H1,H2,H$  
15690 MOVE @Q9:H1,H2  
15700 IF H$="?" THEN 16320
```

```

15710 IF H$='8' THEN 15810
15720 IF H$='0' THEN 15840
15730 IF H$='1' THEN 16030
15740 IF H$='2' THEN 16070
15750 IF H$='3' THEN 16110
15760 IF H$='4' THEN 16150
15770 IF H$='5' THEN 16190
15780 IF H$='6' THEN 16230
15790 IF H$='7' THEN 16270
15800 GO TO 15680
+++1+++ 15810 REM H$='8', CORRECT LAST ENTRY
15820 IF I=1 THEN 15640
15830 I=I-1
15840 MOVE @Q9:H(I,3),H(I,4)
15850 GO TO 15680
+++1+++ 15860 REM H$='0', WRITING ONLY, NO SYMBOL
15870 H(I,1)=0
+++7+++ 15880 H(I,4)=H1
15890 H(I,5)=H2
15900 IF H$='0' THEN 15940
15910 H(I,2)=H4
15920 H(I,3)=0
15930 GO TO 16010
+++1+++ 15940 PRINT @Q9:": ";
15950 INPUT K$
15960 H3=LEN(K$)
15970 L$=L$&K$
15980 H(I,2)=H4
15990 H(I,3)=H3
16000 H4=H4+H3
+++1+++ 16010 I=I+1
16020 GO TO 15680
+++1+++ 16030 REM H$='1', TRIANGLE SYMBOL
16040 H(I,1)=1
16050 GOSUB 9390
16060 GO TO 15880
+++1+++ 16070 REM H$='2', SQUARE
16080 H(I,1)=2
16090 GOSUB 9450
16100 GO TO 15880
+++1+++ 16110 REM H$='3', DIAMOND
16120 H(I,1)=3
16130 GOSUB 9520
16140 GO TO 15880
+++1+++ 16150 REM H$='4', +
16160 H(I,1)=4
16170 GOSUB 9590
16180 GO TO 15880
+++1+++ 16190 REM H$='5', X
16200 H(I,1)=5

```

```
16210 GOSUB 9650
16220 GO TO 15880
+++1+++ 16230 REM H$='6', *
16240 H(I,1)=6
16250 GOSUB 9710
16260 GO TO 15880
+++1+++ 16270 REM H$='7', DOT
16280 H(I,1)=7
16290 GOSUB 9760
16300 GO TO 15880
16310 END
+++1+++ 16320 H7=I
16330 VIEWPORT 20,85,34,99
16340 WINDOW X1,X2,Y1,Y2
16350 CHARSIZE 2
16360 RETURN
16370 END

-----1----- 16380 REM PRINT LEGEND AND TITLE
16390 CHARSIZE 3
16400 VIEWPORT 5,100,0,97
16410 WINDOW X1=0.23*X3,X2=0.15*X3,Y1=0.54*Y3,Y2
16420 IF Q9=32 THEN 16450
16430 VIEWPORT 2,97,15,115
16440 WINDOW X1=0.23*X3,X2=0.15*X3,Y1=0.54*Y3,Y2
+++1+++ 16450 FOR I=1 TO H7
16460 MOVE @Q9:H(I,4),H(I,5)
16470 IF H(I,1)=0 THEN 16490
16480 GOSUB H(I,1) OF 9390,9450,9520,9590,9650,9710,9760
+++1+++ 16490 PRINT @Q9:' ';
16500 K$=SEG(L$,H(I,2),H(I,3))
16510 PRINT @Q9:K$
16520 NEXT I
16530 VIEWPORT 20,85,34,99
16540 WINDOW X1,X2,Y1,Y2
16550 CHARSIZE 2
16560 RETURN
16570 END
```

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DATAKOM 1220 PRINTER SET-UP

Appendix V

1. Turn the Datacable knob to position 1 (4054).
2. Install 8½ x 11" paper in printer.
3. Turn the printer parameters as follows:
 - a. Depress the SETUP key. Keep it depressed while doing steps b-d
 - b. set M to 1
 - c. set W to 3
 - d. for 8½ x 11" paper, set F to 66
4. Manually position the top of the paper so it is ~ ¼" above the printer head.

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TEKTRONIX 4663 PLOTTER SET-UP

Appendix VI

The settings below are for an 8½ x 11" sheet of paper, as shown in Figure 1 of the text.

- 1) Turn the Plotter ON
- 2) Position the paper with the bottom right hand corner at the arrow mark on the platten. Push Media Change button to hold the paper in place.
- 3) Install a fiber tip pen in the Pen 1 holder.
- 4) Set the pullout Parameter Entry card as follows:
 - a. Parameter Set Up Select Set Up 2
 - b. Media Form Sheet
 - c. Initial Page Size A
 - d. Initial Page Format Drafting
 - e. Page Orientation Vertical
 - f. Initial Aspect Ratio Full Page
 - g. Initial Axis Orientation #2 X ↔Y
 - h. Line Quality Enhanced 2
 - i. Pen Parameter Access Pen 1
 - j. Pen Type Fiber Tip
 - k. Pen Pressure 5 gm
 - l. Pen Velocity Full speed axial
 - m. Alpha Character Quality Enhanced
 - n. Interface Select #2 (GPIB)

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13. ABSTRACT A BASIC plotting routine for the Tektronix 4054 terminal and 4663 plotter has been developed. It is named PLOT. The program is capable of plotting in a variety of coordinate systems - Cartesian, semilog on X, semilog on Y or log-log. Two separate Y axes can be used. The user can input the axes boundaries, axes titles, the block of data to be plotted, legends for the data, and a figure caption. Model equations can be represented by dashed lines on the plot. The program will accommodate up to 100 data sets, and a total of seven data columns. The data can be manipulated by changing data points or sets, adding sets and columns, deleting sets or columns, sorting data in a column, generating columns from existing data and adding two data files together. This report is a working manual for the PLOT program.			

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KEY WORDS

BASIC program
Tektronix 4054 terminal
plotting routine
log-log plots
semi-log plots
cartesian plots

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