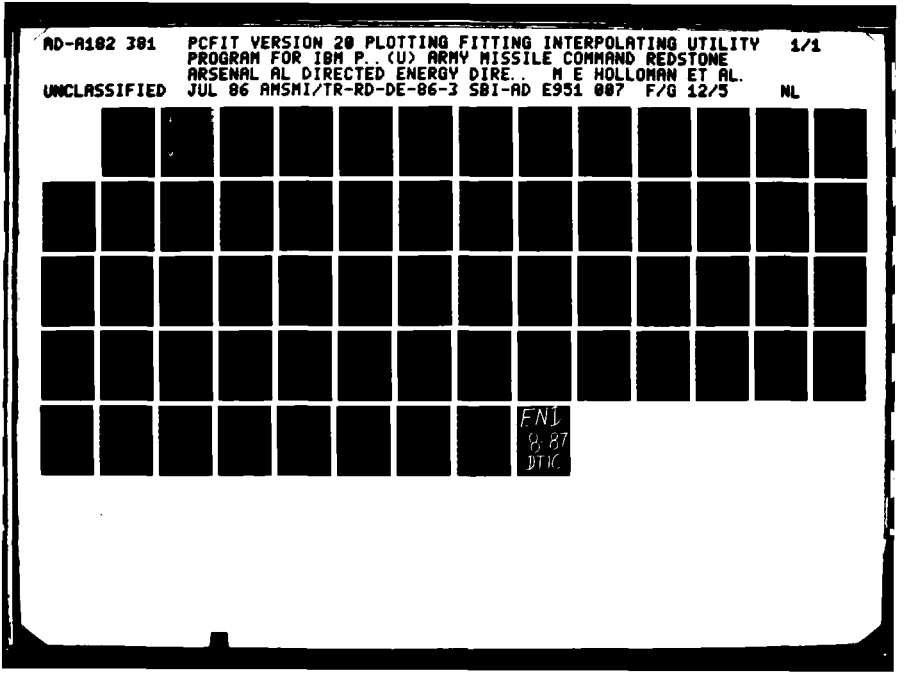
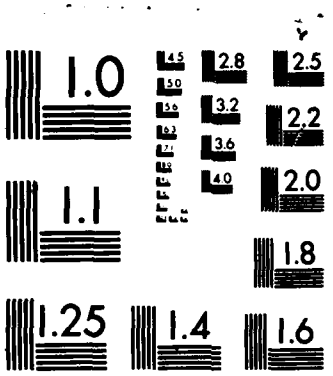

AD-A182 381
PCFIT VERSION 20 PLOTTING FITTING INTERPOLATING UTILITY PROGRAM FOR IBM P.. (U) ARMY MISSILE COMMAND REDSTONE ARSENAL AL DIRECTED ENERGY DIRE.. M E HOLLOMAN ET AL.
1/1
UNCLASSIFIED
JUL 86 AMSMI/TR-RD-DE-86-3 SBI-AD E951 007 F/G 12/5
NL
FNL
8-87
DTIC



TECHNICAL REPORT RD-DE-86-3

PCFIT VERSION 2.0 PLOTTING, FITTING, INTERPOLATING UTILITY PROGRAM FOR IBM PC

Miles E. Holloman,
William F. Otto,
Jerry D. Smith
Directed Energy Directorate
Research, Development and Engineering Center

JULY 1986

U.S. ARMY MISSILE COMMAND
Redstone Arsenal, Alabama 35898-5000

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp. Date Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3. DISTRIBUTION / AVAILABILITY OF REPORT
Approved for public release; distribution is unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
TR-RD-DE-86-3

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
Directed Energy
Res, Dev and Eng Ctr

6b. OFFICE SYMBOL (If applicable)
AMSMI-RD-DE

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code)
Commander
US Army Missile Command
ATTN: AMSMI-RD-DE
Redstone Arsenal, AL 35898

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING / SPONSORING ORGANIZATION

8b. OFFICE SYMBOL (If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS (City, State, and ZIP Code)

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO	WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
PCFIT VERSION 2.0 PLOTTING, FITTING, INTERPOLATING UTILITY PROGRAM FOR IBM PC

12. PERSONAL AUTHOR(S)
Miles E. Holloman, William F. Otto, and Jerry D. Smith

13a. TYPE OF REPORT	13b. TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final	FROM _____ TO _____		

16. SUPPLEMENTARY NOTATION

17 COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Minicomputer, Curve-fit, Graphics

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

PCFIT is a user-friendly, menu-driven, curve-fitting utility for minicomputer application. Eleven common functions in addition to data smoothing and data plotting are included. This document is a user's guide to the use of the code, complete with example cases.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS

21 ABSTRACT SECURITY CLASSIFICATION

22a NAME OF RESPONSIBLE INDIVIDUAL

22b TELEPHONE (Include Area Code)

22c OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

1/(11 blank)

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

I. INTRODUCTION

PCFIT Ver. 2.0 is an improved version of the previously reported PCFIT computer code developed for the IBM and IBM compatible series of microcomputers, see MICOM Technical Report TR-RH-85-2. The original code, having been in use within the Directed Energy Directorate for approximately one year, was found to have shortcomings that have been corrected in this version. The upgrading of the code takes several forms. As originally written, PCFIT was not a single code, but rather three separate but similar codes, each utilizing somewhat different hardware. PCFITM, the simplest of the codes, required no graphics hardware, PCFITG provided screen graphics and PCFITP provided plotter graphics. The maintenance of three separate codes with only two, PCFITG and PCFITP, used most often, prompted the elimination of PCFITM and its associated software. Additionally, the fall in the cost of memory chips has, for the most part, eliminated the desire to keep the code size within the 256K bounds of the more austere microcomputers. This consideration has led to the combining of both the screen graphics and plotter graphics options into a single code now referred to as PCFIT ver. 2.0 or simply PCFIT. It was also found that the previous 200 data point limit was a handicap that was corrected by expanding the code to accommodate 1000 data points in the current version. Finally, it was found that the Lahey F77L FORTRAN Compiler provided a more rapid compilation and hence more expedient code development, thus the current version of PCFIT is compiled in Lahey FORTRAN rather than Microsoft FORTRAN, as was the previous version. This change is not without complication, however. The Lahey F77L compiler requires a 8087 math coprocesser (alternatively the 80287 math coprocesser as appropriate). The PCFIT code continues to interface graphically with the monitor through the Microcompatibles GRAPHMATICS routines. The Lahey compatible version of this code is now required. Since no Lahey compatible version of the Microcompatibles PLOTMATICS routines were available at the time of this code development, it was necessary to write the equivalent. These routines were written in Lahey FORTRAN rather than in assembly code, as is the PLOTMATICS package and suffers somewhat in speed. The development of this plotting package proved to be more difficult than originally anticipated. Due to the nature of this development and the limited "beta" testing to date, problems may arise with use. To date however, the package has performed the required tasks well.

PCFIT provides the options shown in Table 1 and requires the hardware/software in Table 2.

TABLE 1. PCFIT Available Options.

DATA POINTS ONLY
DATA SMOOTHING
Y = A + BX
YU = A exp(BX)
Y = A X**B

TABLE 1. PCFIT Available Options. (Cont)

Y = A + B/X

Y = 1/A + BX)

Y = X/(A + BX)

Y - POLYNOMIAL

Y = LAGRANGE INTERPOLATION

Y = SPLINE FIT

Y = FOURIER SERIES

Y = NATURAL CUBIC SPLINE

TABLE 2. Hardware Requirements.

348 MEMORY

8087 MATH COPROCESSER

GRAPHICS BOARD

GRAPHICS MONITOR

PRINTER (FOR HARDCOPY)

HEWLETT-PACKARD PLOTTER

SOFTWARE REQUIREMENTS

GRAPHMATICS (MICROCOMPATIBLES)

The graphics provided either on the screen or on the plotter are generally considered adequate but no attempt has been made to provide "professional graphics" in any case. An option is provided to allow curves once generated to be stored in data files for future import to professional plotting programs or other analysis programs.

II. FORMAT FOR DATA FILES

The data input to the PCFIT is from data files with the following form:

LINE	CONTENT
1	TITLE (up to 50 characters)
2	X-AXIS LABEL (up to 50 characters)
3	Y-AXIS LABEL (up to 50 characters)
4	X(1),Y(1) - list directed format
.	.
.	.
.	.
.	.
.	.
N	X(N),Y(N)(up to 1000 data pairs)

NOTE: It is recommended that the labels used for the axes be limited to approximately ten characters.

III. THE COEFFICIENT OF DETERMINATION, RSQ

The only statistical information involved in the PCFIT program is the coefficient of determination. The program is only intended to give a quick visual look at the abilities of the various options, not a comprehensive statistical "look" at those abilities. RSQ is given by the following equation:

$$RSQ = 1. - \frac{SSE}{\sum_{i=1}^{N} (Yi - Y)^2}$$

where: (xi,yi) are a set of N data points

y - arithmetic average of the yi values

SSE - sum of squares for error

$$SSE = \sum_{i=1}^{N} (yi - \text{ycalculated at } xi)^2$$

If the curve passes through all points, then

$$RSQ = 1.00$$

If the curve misses the data points by large deviations and the data is quite scattered, the RSQ will be small. Thus, RSQ for some options, gives an indication of which curves fit the data points "best". Caution - Even if RSQ=1., the curve may behave wildly between data points and/or outside the given data range.

IV. AVAILABLE OPTIONS

Table 1 summarizes the options available in the PCFIT series of programs. Options 3 - 10 are common functions and will not be discussed further.

Data Smoothing, Option 2 - this option performs the user's choice of first or third degree five point smoothing of the current Y array. Each Y value is replaced by the value given by a local least squares curve at corresponding X. This curve is determined by using the original Y value plus the two original Y values on either side. For the end and next-to-end points, the choice is skewed so as to give a total of five points as close to the end as possible. Data points must be equally spaced in X. Therefore, caution must be shown in using this option. First degree smoothing is commonly referred to as a moving average. It may be necessary to call the smoothing option several times in succession, smoothing the smoothed data, to yield values acceptable to the user. It is recommended that gross data outliers be corrected or removed before using least squares smoothing.

The Spline Fit, Option 11, uses knots, juncture points at which the polynomials' derivatives are matched, selected automatically by the routine to be such that the data set is divided into five equal subsets. Each subset must contain at least seven data points. Third degree polynomials are calculated and plotted in each spline segment, with first and second derivatives being matched at the common points. The Y array can be multiple valued. The X array must be in ascending order for correct assignment of points to the spline segments. Reordering is performed by the program, routine XREOD, if necessary.

The Fourier Series Representation, Option 12 - any single-valued function that is continuous, except possibly for a finite number of discontinuities in the interval of length 2L, and that has a finite number of maxima and minima in this interval may be represented by a convergent Fourier series of the form:

$$Y = 0.5Ao + (An \cos(n\ x/L) + Bn \sin(n\ x/L))$$

The program essentially forms such a single-valued function from the (X,Y) data by joining the points with straight lines. The user selects the number of terms to be used in the finite series approximation of the above equation. The program uses a numerical integration technique to calculate the coefficients An and Bn. The resultant curve is then superimposed on the data points and Fourier coefficients displayed. A maximum of 10 values of An and Bn are displayed. The parameter L in the above equation is given by L = 0.5(X(data upper limit) - X(data lower limit)). The more points used, the better, due to the method of forming the single valued function.

Natural Cubic Spline Interpolation, Option 13 - during the past decade spline functions have gained widespread use in numerical analysis. Briefly, splines are piece-wise polynominals with continuity in derivatives through one less than the polynominal order, and with the juncture points between different polynominals (knots), usually at the data points. End conditions can be prescribed on the derivatives at these end points. The natural cubic spline employs third degree polynominals, knots at the data points, with second derivatives vanishing at the end data points. The theory of splines is fairly involved and deals mainly with establishing various existence, uniqueness, and convergence properties. However, perhaps the most important practical results for data fitting establish splines as one of the best approximations, in various mathematical senses, to tabular data. Of particular importance is the result that for a given set of X-Y data in the interval (a,b), of all functions f(x) with continuous second derivative and such that f(xi)=yi, the spline function with knots at data points and second derivatives equal to zero at an "a" "b" minimizes the integral

$$f''(x)\ dx$$

Note that f"(x) is often a good approximation to curvature.

V. INPUT GUIDES FOR THE PCFIT PROGRAM

The following contain detailed input guides for PCFIT. The reader is encouraged to review the appendix that contains sample runstreams for typical examples of the programs for further clarification.

PCFIT provides adequate representation of the data and resulting fitted or interpolated curves on a graphics monitor and at the option of the user plots the information of a Hewlett-Packard pen plotter. The minimum system must have 348K of memory, a color graphics or monochrome graphics board and correspondingly a graphics or monochrome monitor. Additionally, the program utilizes the GRAPHMATIC library (Lahey version) routines, available from MICROCOMPATIBLES, that must be supplied by the user. The resolution of the monitor limits the detail of the graphics output.

VI. INPUT GUIDE FOR PCFIT

For PCFIT, the inputs are menu driven prompts with an attempt made to make the selections somewhat self evident for the user. To run PCFIT, the user is presented with six menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU, (5) PLOTTING MENU and (6) PLOTTER MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options or scaling options without rentering the data. For the purposes of this report a sample data set will be used and will be referred to as DATA1.DAT; Table 3 contains this data set for reference.

TABLE 3. DATA1.DAT.

TITLE

X-AXIS

Y-AXIS

1.0 , 2.0

1.2 , 2.2

1.4 , 2.0

1.6 , 2.4

1.8 , 2.1

2.0 , 2.3

2.2 , 2.5

2.4 , 2.3

2.6 , 2.8

2.8 , 2.4

3.0 , 2.7

3.2 , 3.1

3.4 , 2.6

3.6 , 3.0

3.8 , 2.9

TABLE 3. DATA1.DAT. (Cont)

4.0 , 3.0

4.2 , 3.2

4.4 , 3.1

4.8 , 3.2

5.0 , 3.4

5.2 , 3.2

5.4 , 3.0

5.6 , 2.9

5.8 , 2.5

6.0 , 2.2

A. DATA INPUT MENU - STARTING THE PROGRAM

The program is started by typing the command PCFIT, following the DOS prompt. The program enters the "DATA INPUT MENU" initially and prompts the user whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or suppresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computation times involved, thus suppression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the data file name; the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step, the user is prompted whether additional data files are to be read, thus allowing combining data from more than one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation.

B. LOG MENU

The second menu section is now entered allowing the user the option of performing the plotting, fitting or interpolations using the logarithm of X and/or logarithm of Y, and independent of this choice, plotting the results in normal, semi-log, or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y" or "XY" will cause the program to take the log(10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculation or the plotting of the graphics output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This is analogous to the previous and allows selection of options associated with the plotted output.

C. DATA SCALING MENU

The data scaling options menu allows the scaling of the data for plotting purposes; the form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA X - ORIGIN IS AT X=0

Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN

E - END(STOP) N - NOTHING

Prior to plotting the data, it must be scaled to provide scaling parameters/factors to assure that all data will appear within the range of the graphics plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY" or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0 or X=Y=0 respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "SO" option. If the "SO" option is selected, the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

```
ORIGIN AT X =     .80000 STEPS OF   .80000

ENTER NEW VALUES, OTHERWISE ENTER,,
```

At this time the user may elect to use these scaling parameters by entering ",,", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each major tic mark. *It should be noted that the user must select these* parameters such that all data is contained within the resulting plot. The graphics output is such that there are eight(8) divisions along the X axis and five(5) along the Y axis. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphics output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

```
SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER
```

At this time the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by:

```
STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER
```

At which time the user can adjust the increments associated with each major tic mark.

D. OPTION SELECTION MENU

Initially the program exercises the first six of the possible options automatically and provides as guidance to the user a measure of the "goodness" of the fit in terms of the coefficient of determination, RSQ, previously discussed. The following form of information is then provided the user with the prompt allowing the user to specify the option of his choice.

OPTION#	FUNCTION	RSQ
1	DATA POINTS ONLY	
2	DATA SMOOTHING	
3	Y = A + BX	0.4163
4	Y = A * E**BX	0.4224
5	Y = A * X**B	0.5390
6	Y = A + B/X	0.5358
7	Y = 1/(A+B*X)	0.4255
8	Y = X/(A+B*X)	0.5911
9	POLYNOMIAL	
10	LAGRANGE INTERPOLATION	
11	SPLINE FIT	
12	FOURIER SERIES	
13	NATURAL CUBIC SPLINE	

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1-13, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 3-13. The first two options provide for the plotting of the input data and two options involving smoothing of the data. For the options 3-8, the user is provided with some with some indication of the appropriateness of these function to represent the data; a high degree of "fit" is indicated by a RSQ value near unity. It is recommended that the form of the function be examined particularly for the more non-linear options 9-13 for a RSQ value near unity simply means the curve nearly passes through all data points. The behavior of the curve between data points or the slope of the curve at the data points may not represent the physics of the data.

Option 2 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated or smoothed as the user desires.

Option 9, the polynominal, may be up to 14th order; if this option is selected the user will be prompted to select the desired order. If an order is selected that is not supported by the data, i.e., larger order than there are data points, the program will correct the choice of order to a more appropriate value.

Option 10 will prompt the user to select the appropriate number of data points to be used in the polynominal interpolating formula; usually between 2 and 4. Additionally a brief help menu is provided for this option. Option 11 will automatically divide the data range into three subranges for fitting by third degree polynominals in each subrange.

Option 12 will also prompt the user to select the appropriate number of series terms to be used.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve or the current input data. Saving of the input data only is used after smoothing, otherwise it is the simple duplication of the input file. Assuming one of the eleven options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. When this option is selected the user will be prompted to specify a file name in which to store the data:

ENTER THE FILE NAME TO BE USED

followed by a prompt whether the title and axes labels are to be stored also.

SAVE TITLE AND AXES LABELS? (Y/N)

Depending on the purpose of selecting this option the answer may be either "Y" or "N". If, for example, the purpose of saving the data is to allow import into a different program, one might not want to save the title and labels, only the X and Y values. Alternatively if the purpose of selection of this option is to use it as input data to PCFIT the title and labels would be desired. The next prompt is for the selection of either input data or fitted data to be stored and is of the form:

SAVE INPUT OR OUTPUT DATA? (I/O)

If input data is selected all of the current input data is stored in the specified file. In the case of saving output or fitted curve data the curves generated in any of the PCFIT programs consist of one hundred X-Y data

pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50 or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning, allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program. Assuming one of the eleven function was selected as the form of the data analysis the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

```
    OPTION NO.  9

  Y=POLYNOMINAL

    DEGREE = 5

    RSQ = 8893

    C0 =   .246761E+01

    C1 =  -.128385E+01

    C2 =   .125361E+-01

    C3 =  -.470453E+00

    C4 =   .863621E-01

    C5 = - .617910E-02
```

E. PLOTTING MENU

Following the display of the coefficients the user is presented with the PLOTTING MENU. This menu is for the selection of options associated with the

plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

```
              **** PLOTTING OPTIONS ****

    ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E

    P - PLOT DATA AS + SYMBOLS      A - PLOT AXES

    L - connect DATA POINTS         B - BROKEN LINE

    D -  USE DIAMOND                + - USE +

    X - USE X                       * - USE *

    .--USEE..                      OO--USEEOO

    H - HIGH RESOLUTION(DEF)        M - MEDIUM RES

    N - NOTHING                     E - END(STOP)
```

The user may enter up to ten of the letters in a string to specify the selection of options; however, there are not in general ten options to be selected at any one time.

In order that the input data is plotted the "P" option must be selected. This option will then plot each data point as a "+" symbol.

The selection of the "A" or axis option includes the axes and axes labels and graph title in the graphics output.

The "L" option connects the data points by solid lines, the "B" option connects the data points by broken or dotted lines. These options may be used either independently of or in conjunction with the "P" option. If the combination "PL" or "PB" is used, the data points, "+" symbols, are connected by solid or broken lines. If only "L" or "B" option selected, no symbols will appear on the graph.

The "D", "+", "X", "*", "." and "O" options must be used in conjunction with the "P" option and specify alternate symbols to be used to represent the data points. The "D" option represents a diamond, ASCII symbol 004, "+" option is a plus sign somewhat larger than the default plus symbol, "X" option is the symbol X, "*" is the symbol *, "." option is a period recommended if there is a large amount of data and "O" is the symbol O. These options can also be used in conjunction with either option "L" or "B" to connect data point symbols with either solid or broken lines.

The "H" and "M" options specify the resolution of the graphics display. The default value is "H" and is 640 x 200 resolution in black and white. The medium resolution, "M" option, is 320 x 200 resolution with color if a color monitor is used.

The "N" option returns the program to the previous menu and the "E" option terminates the program.

Once the graphics display has been formed on the monitor the user is then prompted whether a hard copy of the plot is desired.

HARD COPY? (NO/PR/PL)

Providing the user has a dot matrix printer with graphics capability the screen can be "dumped" to the printer by specifying "PR".

The selection of the "NO" option causes the program to return to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

The selection of the "PL" option indicates the output is to be plotted on a plotter. Due to significantly different resolutions between the monitor graphics and that available on the plotter an additional menu is provided to allow the selection of options, that if chosen for the screen plot, might confuse the result rather than provide a pleasant display.

F. PLOTTER MENU

This menu is for the selection of options associated with the plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

READY PLOTTER — ENTER G I A F P N D E C Z ANY ORDER

G - PLOT GRIDS	I - GRID INTERSECTION PLOTTED
A - PLOT AXES	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXES
C - ALTERNATE PEN	Z - ALTERNATE LINE TYPE
D - READ ADDITIONAL DATA	E - END(STOP)

The user may enter up to ten of the letters in a string to specify the selection of options; however, there are not in general ten options to be selected at one time.

Specification of the "G" option will result in a plotted output with grid squares; the "I" option will only mark the intersection of the horizontal and vertical bounds of the grid squares with a "+".

Specification of the "A" option will plot a horizontal and vertical axis with the vertical axis located to the left.

The "F" option plots a form around the output.

In order that the input data is plotted, the "P" option must be selected. Specifying this option will cause an addition prompt menu to be displayed to allow specification of the pen, nature of plotting, and symbol to be used. This prompt menu is in the form:

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1- SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2- SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N- SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - YELLOW	1 - LINE AND SYMBOL PLOT	4 - X
6 - ORANGE	2 - LINE AND SYMBOL AT	5 - DIAMOND
	EVERY 2nd POINT	6 - 5% EB
	N - LINE AND SYMBOL AT	7 - 10% EB
	EVERY Nth POINT	8 - 25% EB

The actual colors to be used depend on the arrangement of the pens in the carrousel. Selections under the PLOT OPTION will dictate whether symbols of the type selected under the SYMBOL USED column will be plotted either with or without a line connecting the selected symbol. Options 6, 7 and 8 provide for error bars to be placed around the data on the plotted graph. Each option represents a degree of error in the data of 5, 10 or 25% respectively.

The "N" option does nothing; this option will be used in the plotting of multiple curves to be discussed later.

The "H" option plots only a horizontal axis; the "R" and "L" options plot the vertical axis on either the right or left end of the horizontal axis respectively. The "B" option plots both a horizontal and vertical axis with the vertical axis located on the right of the horizontal.

The "C" and "Z" options allow the selection of an alternate pen and alternate line style. The selection of either of these options will further prompt the user in the form:

SELECT AN ALTERNATE PEN:

and

SELECT AN ALTERNATE LINE STYLE:

In either case, a numerical value is the expected input. In the first case, the number represents the pen number to be used to plot the fitted function, in the latter case the line style is varied from the normal solid line to various degrees of dashed as indicated in the Hewlett-Packard Plotter User's Manual. It should be noted that the primary use of these two options is in the display of multiple curves on a single chart to be discussed later in this report.

The "D" option reenters the program at the INPUT DATA MENU for a new data set; current data will be discarded by specifying this option.

Finally the "E" option terminates the program.

At the completion of the plotted result, the program will return to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

MULTIPLE CURVES

The PCFIT program is not formulated so as to allow internal "storage" of curves for summary plotting of more than one curve on a graph. Nevertheless, the code can be used to display multiple curves by not replacing the paper and plotting a second curve on the same sheet.

Plotting of multiple curves on a single sheet can be divided into two different types depending on whether the values of the Y-variable are in the same general range or whether they are vastly different between the curves to be plotted. In either case the X-variable data must be in the same general range for reasonable plots.

If the data is in the same general range, the approach is to first combine all data into a single data set to allow proper scaling, scale the data to establish the scaling parameters, discard this combined data set and enter the first data set, do not rescale data, plot points, axes, and curve, enter second data set, do not rescale plot points and curves-no axes this time and repeat until complete. Now in somewhat more detail - in the DATA INPUT MENU the first data set is read followed by the prompt:

ADDITIONAL DATA FILES? (Y/N)

To this prompt, the response should be "Y" at which point the second set of data specified by its file name will be entered and appended to the first data set. This process is repeated until all data is entered. The LOG MENU is treated as desired. In the SCALING MENU, the selection is as previously described, depending on the nature of the data. The combined data is thus scaled to fit within the range of the axes. In the PLOTTING MENU, the response should be "D". Specification of the "D" option restarts the program at the INPUT DATA MENU where the first data file is specified. Proceed as before through the LOG MENU. In the SCALING MENU, specify the "N" since rescaling this point will destroy the previous scaling parameters that

encompass all the data sets. In the PLOTTING MENU, specify plotting the axes. The data points may also be plotted, if desired, as may be a curve of the fitted or interpolated data. Having now plotted the first data set, the user is ready to deal with the second data set by entering "DA" in the PLOTTING MENU which then prompts the user for the file name of the second data set. Proceed as before through the LOG MENU and SCALING MENU again specifying "N" in the SCALING MENU. The appropriate function for fitting or interpolating is selected from the OPTION MENU and when presented with the PLOTTING MENU, the user may elect to plot the data points. The screen plot of the data will contain only the current data set under consideration; it is in the plotter option that the multiple curves are to be displayed. Select the "PL" option to enter the PLOTTER MENU. In this menu the user should not specify any option that plots axes since this was done previously and is already on the graph; normally the "N" option is specified. At this point the options for changing the pens or the line styles can be selected as previously discussed. Remaining data sets are processed as data set 2.

For Y-variable data sets that do not lie in the same general range, such that combining on a single axis may suppress one set so as not to allow the desired level of detail, an alternate approach is suggested. The first data set is processed as one would normally handle a single data set. Without changing the paper in the plotter the program is rerun with the second data set. The only difference will be in the PLOTTER MENU where the "R" option is specified to plot the Y-axis for this data on right side of the graph.

APPENDIX

EXAMPLES

APPENDIX

The following examples are provided in an attempt to provide additional instruction in the use of the PCFIT program. Though the examples are limited in the demonstration of the options available an attempt has been made to demonstrate some of the less easily understood modes of operation.

EXAMPLE 1

Example 1 illustrates the use of PCFIT for the data set DATA1.DAT. The logarithm option is not selected for this illustration and the simple scaling option is used. The fifth order polynomial is selected and the resulting graphics output illustrated. At this point the sample problem illustrates the saving of this curve in a file through the selection of of the "SA" option. The curve, along with the title and axes labels, are saved in file DATA2.DAT.

```
PRINTED OUTPUT? (Y/N)

N

ENTER DATA FILE NAME

DATA1.DAT

TITLE

X-AXIS

Y-AXIS
```

DATA1.DAT

1	1.0000	2.0000
2	1.2000	2.2000
3	1.4000	2.0000
4	1.6000	2.4000
5	1.8000	2.1000
6	2.0000	2.3000
7	2.2000	2.5000
8	2.4000	2.3000
9	2.6000	2.8000
10	2.8000	2.4000
11	3.0000	2.7000

DATA1.DAT (Cont)

12	3.2000	3.1000
13	3.4000	2.6000
14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.0000
24	5.6000	2.9000
25	5.8000	2.5000
26	6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS = 26

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

```
SCALE DATA - ENTER S X Y O E N  IN ANY ORDER
S - SCALE DATA              X - ORIGIN IS AT X=O
Y - ORIGIN IS AT Y=O        O - USER SPECIFIED ORIGIN
E - END(STOP)               N - NOTHING
SXY
OPTION#      FUNCTION                    RSQ
  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX                  0.4163
  4          Y = A * E**BX               0.4224
  5          Y = A * X**B                0.5390
  6          Y = A + B/X                 0.5358
  7          Y = 1/(A+B*X)               0.4255
  8          Y = X/(A+B*X)               0.5911
  9          POLYNOMINAL
 10          LAGRANGE INTERPOLATION
 11          SPLINE FIT
 12          FOURIER SERIES
 13          NATURAL CUBIC SPLINE
ENTER:  # L  SA  ST  DA  RS  RP  EX
 # - EQUATION NUMBER          L - LIST DATA
SA - SAVE CURVE ON FILE      ST - STOP
DA - READ NEW DATA SET       RS - RESTART
RP - REPLOT DATA             EX - EXIT(STOP)
9
ENTER:  DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 and 14  5
0.000 % DATA SPACING ERROR
```

```
OPTION NO.  9

Y=POLYNOMIAL

 DEGREE = 5

 RSQ = 0.8934

 CO = 0.246761E+01

 C1 = -.128385E+01

 C2 = 0.125361E+01

 C3 = -.470453E+00

 C4 = 0.863621E-01

 C5 = -.617910E-02

    **** PLOTTING OPTIONS ****

ENTER:  P A L B D + X * . O H M N E

P - PLOT DATA AS + SYMBOLS     A - PLOT AXES

L - CONNECT DATA POINTS        B - BROKEN LINE

D - USE DIAMOND                + - USE +

X - USE X                      * - USE *

. - USE .                      O - USE O

H - HIGH RESOLUTION(DEF)       M - MEDIUM RES

N - NOTHING                    E - END

PAL

HARD COPY? (NO/PR, PL) PL

READY PLOTTER -- ENTER:  G  I  A  F  P  N  D  E  C  Z  ANY ORDER

G - PLOT GRID                  I - GRID INTERSECTIONS PLOTTED

A - PLOT AXIS                  F - DRAW FORM

P - PLOT POINTS                N - NOTHING

H - PLOT HORIZONTAL AXIS       R - PLOT RIGHT AXIS

L - PLOT LEFT AXIS             B - PLOT REVERSE AXIS
```

```
C - ALTERNATE PEN                Z - ALTERNATE LINE TYPE

D - READ ADDITIONAL DATA         E - END(STOP)

PAF

ENTER:  PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN                  PLOT OPTION                                  SYMBOL USED
-------------------------------------------------------------------------------

1 - BLACK            -1 - SYMBOL AT EVERY POINT                   0 - SQUARE

2 - RED              -2 - SYMBNOL AT EVERY 2nd POINT              1 - CIRCLE

3 - GREEN            -N - SYMBOL AT EVERY Nth POINT               2 - TRIANGLE

4 - BLUE              0 - LINE PLOT ONLY                          3 - +

5 - BLACK             1 - LINE AND SYMBOL PLOT                    4 - X

6 - RED               2 - LINE AND SYMBOL AT                      5 - DIAMOND

                          EVERY 2nd POINT                         5 - 5% EB

                      N - LINE AND SYMBOL AT                      6 - 10% EB

                              EVERY Nth POINT                     7 - 25% EB

1,0,1

OPTION#          FUNCTION                      RSQ

  1          DATA POINTS ONLY

  2          DATA SMOOTHING

  3          Y = A + BX                    0.4163

  4          Y = A * E**BX                 0.4224

  5          Y = A + X**B                  0.5390

  6          Y = A + B/X                   0.5358

  7          Y = 1/(A+B*X)                 0.4255

  8          Y = X/(A+B*X)                 0.5911

  9          POLYNOMIAL

 10          LAGRANGE INTERPOLATION

 11          SPLINE FIT
```

```
 12          FOURIER SERIES

 13          NATURAL CUBIC SPLINE

ENTER:  # L  SA  ST  DA  RS  RP  EX

  # - EQUATION NUMBER                    L - LIST DATA

 SA - SAVE CURVE ON FILE                 ST - STOP

 DA - READ NEW DATA SET                  RS - RESTART

 RP - REPLOT DATA EX -                   EXIT(STOP)

 SA

ENTER THE FILE NAME TO BE USED

DATA2.DAT

SAVE TITLE AND AXIS LABELS? (Y/N) Y

TITLE

X-AXIS

Y-AXIS

SAVE INPUT OR OUTPUT DAT? (I/O) O

SAVE 25, 50 or 100 POINTS ON CURVE?  25

      1       1.00000         2.23388

      5       1.20202         2.26166

      9       1.40404         2.29014

     13       1.60606         2.31935

     17       1.80808         2.34931

     21       2.01010         2.38006

     25       2.21212         2.41162

     29       2.41414         2.44402

     33       2.61616         2.47732
```

```
    37        2.81818         2.51153
    41        3.02020         2.54670
    45        3.22222         2.58286
    49        3.42425         2.62007
    53        3.62627         2.65837
    57        3.82829         2.69781
    61        4.03031         2.73843
    65        4.23233         2.78029
    69        4.43435         2.82346
    73        4.63637         2.86798
    77        4.83839         2.91393
    81        5.04041         2.96138
    85        5.24243         3.01040
    89        5.44445         3.06107
    93        5.64647         3.11347
    97        5.84849         3.16770

ENTER: #  L  SA  ST  DA  RS  RP  EX

  # - EQUATION NUMBER        L - LIST DATA
SA  - SAVE CURVE ON FILE    ST - STOP
DA  - READ NEW DATA SET     RS - RESTART
RP  - REPLOT DATA           EX - EXIT(STOP)
EX
```

EXAMPLE 2

Example 2 illustrates the handling of two different data sets. The first of which is DATA1.DAT; the second, DATA3.DAT, is a data set with larger Y values to illustrate scaling of the combined data. The second data set is combined with the first by specifying "Y" to the prompt relative to additional data files. The logarithm options are not used and the combined data sets are scaled using the "SXY" option as in Example 1.

At this point the combined data is discarded and the first data set, DATA1.DAT, is processed taking care not to rescale the data. The second data set is then processed accordingly.

```
PRINTED OUTPUT? (Y/N)

N

ENTER DATA FILE NAME

DATA1.DAT


TITLE

X-AXIS

Y-AXIS

          1          1.0000          2.0000

          2          1.2000          2.2000

          3          1.4000          2.0000

          4          1.6000          2.4000

          5          1.8000          2.1000

          6          2.2000          2.3000

          7          2.2000          2.5000

          8          2.4000          2.3000

          9          2.6000          2.8000

         10          2.8000          2.4000

         11          3.0000          2.7000

         12          3.2000          3.1000

         13          3.4000          2.6000
```

14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.0000
24	5.6000	2.9000
25	5.8000	2.5000
26	6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

Y

ENTER DATA FILE NAME

DATA3.DAT

TITLE3

X-AXIS

Y-AXIS

27	0.4000	3.4000
28	0.5000	4.0000
29	0.7000	4.2000
30	0.8000	4.5000
31	0.9000	4.9000
32	1.3000	4.9000
33	1.5000	5.2000

34	1.6000	5.3000
35	2.0000	5.2000
36	2.2000	5.0000
37	2.6000	4.8000
38	2.8000	4.5000
39	3.0000	4.0000
40	3.4000	3.4000

```
ADDITIONAL DATA FILES? (Y/N)
   N
NUMBER OF DATA POINTS = 40
CALCULATE WITH LOGS? X Y XY N NN EX
   X - LOG(X DATA)
   Y - LOG(Y DATA)
  XY - LOG(X DATA) AND LOG(Y DATA)
   N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
  NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
  EX - STOP
  NN
SCALE DATA - ENTER S X Y O E N  IN ANY ORDER
 S - SCALE DATA            X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0      O - USER SPECIFIED ORIGIN
 E - END(STOP)             N - NOTHING
SXY
```

```
OPTION#          FUNCTION                    RSQ

  1          DATA POINTS ONLY

  2          DATA SMOOTHING

  3          Y = A + BX                  0.0925

  4          Y = A * E**BX               0.0578

  5          Y = A * X**B                0.0588

  6          Y = A + B/X                 0.0545

  7          Y = 1/(A+B*X)               0.0269

  8          Y = X/(A+B*X)               0.0366

  9          POLYNOMIAL

 10          LAGRANGE INTERPOLATION

 11          SPLINE FIT

 12          FOURIER SERIES

 13          NATURAL CUBIC SPLINE

ENTER:  #  L  SA  ST  DA  RS  RP  EX

  # -  EQUATION NUMBER                  L - LIST DATA

 SA -  SAVE CURVE ON FILE               ST - STOP

 DA -  RED NEW DATA SET                 RS - RESTART

 RP -  REPLOT DATA                      EX - EXIT(STOP)

 DA

ENTER DATA FILE NAME

DATA1.DAT
```

TITLE

X-AXIS

Y-AXIS

1	1.0000	2.0000
2	1.2000	2.2000
3	1.4000	2.0000
4	1.6000	2.4000
5	1.8000	2.1000
6	2.0000	2.3000
7	2.2000	2.5000
8	2.4000	2.3000
9	2.6000	2.8000
10	2.8000	2.4000
11	3.0000	2.7000
12	3.2000	3.1000
13	3.4000	2.6000
14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.0000

```
        24          5.6000          2.9000
        25          5.8000          2.5000
        26          6.0000          2.2000

ADDITIONAL DATA FILES? (Y/N)
N

NUMBER OF DATA POINTS =   26

CALCULATE WITH LOGS? X Y XY N NN EX
  X - LOG(X DATA)
  Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
  N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP
 NN

SCALE DATA - ENTER S X Y O E N  IN ANY ORDER
 S - SCALE DATA           X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0     O - USER SPECIFIED ORIGIN
 E - END(STOP)            N - NOTHING
 N

OPTION#              FUNCTION                  RSQ
  1             DATA POINTS ONLY
  2             DATA SMOOTHING
  3             Y = A + BX                0.4163
  4             Y = A * E**BX             0.4224
```

```
OPTION#              FUNCTION                    RSQ
  5              Y = A * X**B                 0.5390
  6              Y = A + B/X                  0.5358
  7              Y = 1/(A+B*X)                0.4255
  8              Y = X/(A+B*X)                0.5911
  9              POLYNOMIAL
 10              LAGRANGE INTERPOLATION
 11              SPLINE FIT
 12              FOURIER SERIES
 13              NATURAL CUBIC SPLINE
ENTER:  #  L  SA  ST  DA  RS  RP  EX

 # - EQUATION NUMBER            L - LIST DATA
SA - SAVE CURVE ON FILE        ST - STOP
DA - READ NEW DATA SET         RS - RESTART
RP - REPLOT DATA               EX - EXIT(STOP)
9

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14 5

    0.000 % DATA SPACING ERROR

 OPTION NO. 9
Y=POLYNOMIAL
 DEGREE = 5
 RSQ = 0.8934
 CO = 0.246761E+01
```

```
 C1 = -.128385E+01

 C2 = 0.125361E+01

 C3 = -.470453E+00

 C4 = 0.863621E-01

 C5 = -.617910E-02

     ****PLOTTING OPTIONS ****

ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E

P - PLOT DATA AS + SYMBOLS      A - PLOT AXES

L - CONNECT DATA POINTS         B - BROKEN LINE

D - USE DIAMOND                 + - USE +

X - USE X                       * - USE *

. - USE .                       O - USE O

H - HIGH RESOLUTION (DEF)       M - MEDIUM RES

N - NOTHING                     E - END

PAL

HARD COPY? (NO/PR, PL)  PL

READY PLOTTER -- ENGER G I A F P N D E C Z  ANDY ORDER

G - PLOT GRID                   I - GRID INTERSECTIONS PLOTTED

A - PLOT AXIS                   F - DRAW FORM

P - PLOT POINTS                 N - NOTHING

H - PLOT HORIZONTAL AXIS        R - PLOT RIGHT AXIS

L - PLOT LEFT AXIS              B - PLOT REVERSE AXIS

C - ALTERNATE PEN               Z - ALTERNATE LINE TYPE

D - READ ADDITIONAL DATA        E - END(STOP)

PAF
```

```
ENTER :  PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN              PLOT OPTION                        SYMBOL USED
-------------------------------------------------------------------------

1 - BLACK        -1 - SYMBOL AT EVERY POINT         0 - SQUARE
2 - RED          -2 - SYMBOL AT EVERY 2nd POINT     1 - CIRCLE
3 - GREEN        -N - SYMBOL AT EVERY Nth POINT     2 - TRIANGE
4 - BLUE          0 - LINE PLOT ONLY                3 - +
5 - BLACK         1 - LINE AND SYMBOL PLOT          4 - X
6 - RED           2 - LINE AND SYMBOL AT            5 - DIAMOND
                      EVERY 2nd POINT               5 - 5% EB
                  N - LINE AND SYMBOL AT            6 - 10% EB
                      EVERY Nth POINT               7 - 25% EB

1,1,0

OPTION#          FUNCTION            RSQ

  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX            0.4163
  4          Y = A * E**BX         0.4224
  5          Y = A * X**B          0.5390
  6          Y = A + B/X           0.5358
  7          Y = 1/(A+B*X)         0.4255
  8          Y = X/(A+B*X)         0.5911
  9          POLYNOMIAL
 10          LAGRANGE INTERPOLATION
 11          SPLINE FIT
 12          FOURIER SERIES
```

```
13          NATURAL CUBIC SPLINE

ENTER:  #  L  SA  ST  DA  RS  RP  EX

 # - EQUATION NUBMER              L - LIST DATA

SA - SAVE CURVE ON FILE          ST - STOP

DA - RED NEW DATA SET            RS - RESTART

RP - REPLOT DATA                 EX - EXIT(STOP)

DA

ENTER DATA FILE NAME

DATA3.DAT

TITLE3

X-AXIS

Y-AXIS

          1          0.4000          3.4000

          2          0.5000          4.0000

          3          0.7000          4.2000

          4          0.8000          4.5000

          5          0.9000          4.9000

          6          1.3000          4.9000

          7          1.5000          5.2000

          8          1.6000          5.3000

          9          2.0000          5.2000

         10          2.2000          5.0000

         11          2.6000          4.8000

         12          2.8000          4.5000

         13          3.0000          4.0000

         14          3.4000          3.4000
```

```
NUMBER OF DATA POINTS =     14

CALCULATE WITH LOGS?  X Y XY N NN EX
  X - LOG(X DATA)
  Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
  N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP
 NN

SCALE DATA - ENTER S X Y O E N  IN ANY ORDER
 S - SCALE DATA              X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0        O - USER SPECIFIED ORIGIN
 E - END(STOP)               N - NOTHING
 N
OPTION#          FUNCTION              RSQ
  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX              0.0004
  4          Y = A * E**BX           0.0006
  5          Y = A * X**B            0.0533
  6          Y = A + B/X             0.2027
  7          Y = 1/(A+B*X)           0.0010
  8          Y = X/(A+B*X)           0.1972
  9          POLYNOMIAL
 10          LAGRANGE INTERPOLATION
 11          SPLINE FIT
```

```
 12          FOURIER SERIES
 13          NATURAL CUBIC SPLINE

ENTER:  #  L  SA  ST  DA  RS  RP  EX

  # - EQUATION NUMBER              L - LIST DATA
 SA - SAVE CURVE ON FILE          ST - STOP
 DA - READ NEW DATA SET           RS - RESTART
 RP - REPLOT DATA                 EX - EXIT(STOP)
 9

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 and 14  5

UNEQUALLY SPACED DATA
  OPTION NO. 9
Y=POLYNOMIAL
  DEGREE = 5
  RSQ = 0.9678
  CO = 0.870954E+00
  C1 = 0.947178E+00
  C2 = -.916723E+01
  C3 = 0.480459E+01
  C4 = -.128377E+01
  C5 = 0.129861E+00

     ****PLOTTING OPTIONS ****
ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E
P - PLOT DATA AS + SYMBOLS      A - PLOT AXES
L - CONNECT DATA POINTS         B - BROKEN LINE
```

```
D - USE DIAMOND                 + - USE +
X - USE X                       * - USE *
. - USE .                       O - USE O
H - HIGH RESOLUTION (DEF)       M - MEDIUM RES
N - NOTHING                     E - END
PAL

HARD COPY? (NO/PR, PL)  PL
READY PLOTTER -- ENGER G I A F P N D E C Z  ANY ORDER

G - PLOT GIRD                   I - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS                   F - DRAW FORM
P - PLOT POINTS                 N - NOTHING
H - PLOT HORIZONTAL AXIS        R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS              B - PLOT REVERSE AXIS
C - ALTERNATE PEN               Z - ALTERNATE LINE TYPE
D - READ ADDITIONAL DATA        E - END(STOP)
PCZ

ENTER :  PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:
PEN             PLOT OPTION                     SYMBOL USED
-------------------------------------------------------------------------
1 - BLACK       -1 - SYMBOL AT EVERY POINT      0 - SQUARE
2 - RED         -2 - SYMBOL AT EVERY 2nd POINT  1 - CIRCLE
3 - GREEN       -N - SYMBOL AT EVERY Nth POINT  2 - TRIANGE
4 - BLUE         0 - LINE PLOT ONLY             3 - +
5 - BLACK        1 - LINE AND SYMBOL PLOT       4 - X
```

```
6 - RED          2 - LINE AND SYMBOL AT        5 - DIAMOND
                     EVERY 2nd POINT           5 - 5% EB
                 N - LINE AND SYMBOL AT        6 - 10% EB
                     EVERY Nth POINT           7 - 25% EB

1,1,1
SELECT A NEW PEN NUMBER 2
SELECT A NEW LINE TYPE 2
OPTION#          FUNCTION            RSQ
  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX            0.0004
  4          Y = A * E**BX         0.0006
  5          Y = A * X**B          0.0533
  6          Y = A + B/X           0.2027
  7          Y = 1/(A+B*X)         0.0010
  8          Y = X/(A+B*X)         0.1972
  9          POLYNOMIAL
 10          LAGRANGE INTERPOLATION
 11          SPLINE FIT
 12          FOURIER SERIES
 13          NATURAL CUBIC SPLINE
ENTER:  #  L  SA  ST  DA  RS  RP  EX
  # - EQUATION NUMBER              L - LIST DATA
 SA - SAVE CURVE ON FILE          ST - STOP
 DA - READ NEW DATA SET           RS - RESTART
 RP - REPLOT DATA                 EX - EXIT(STOP)
 EX
```

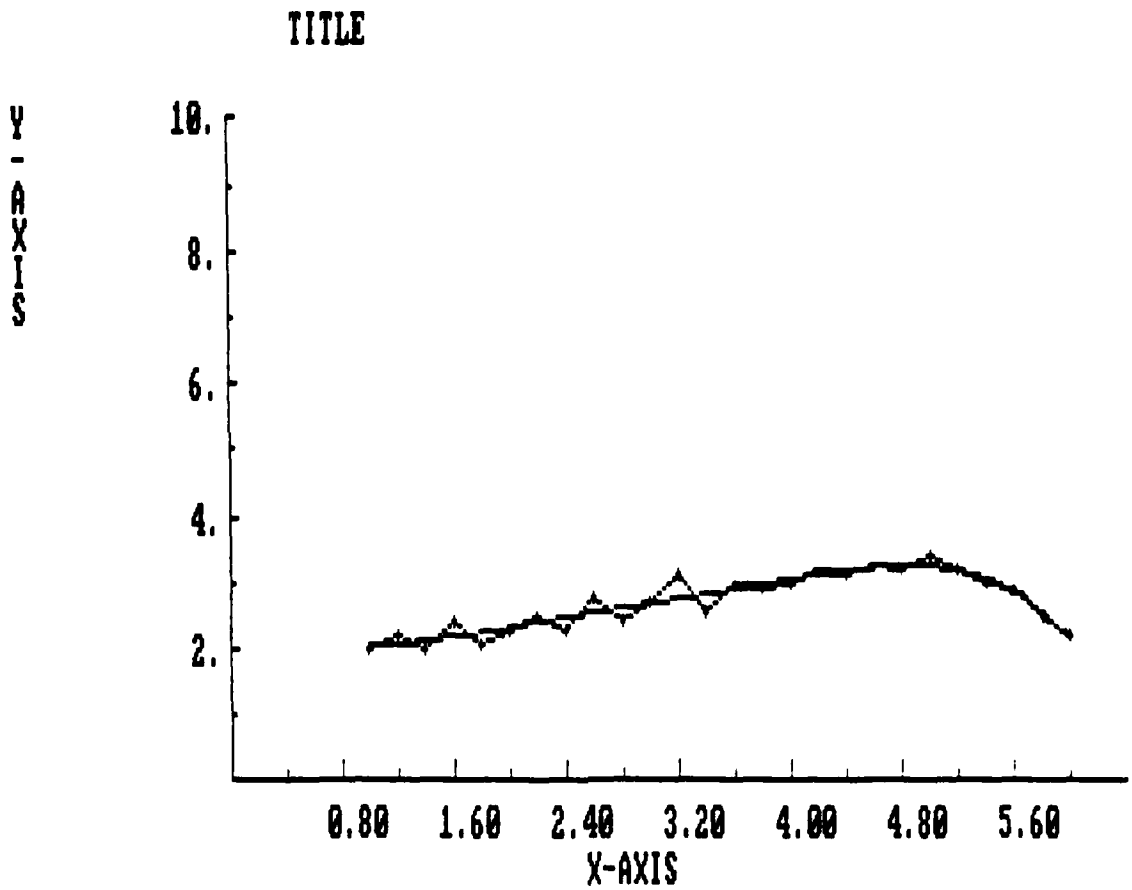


Figure A-1. Plot of DATA1.DAT Data Set.

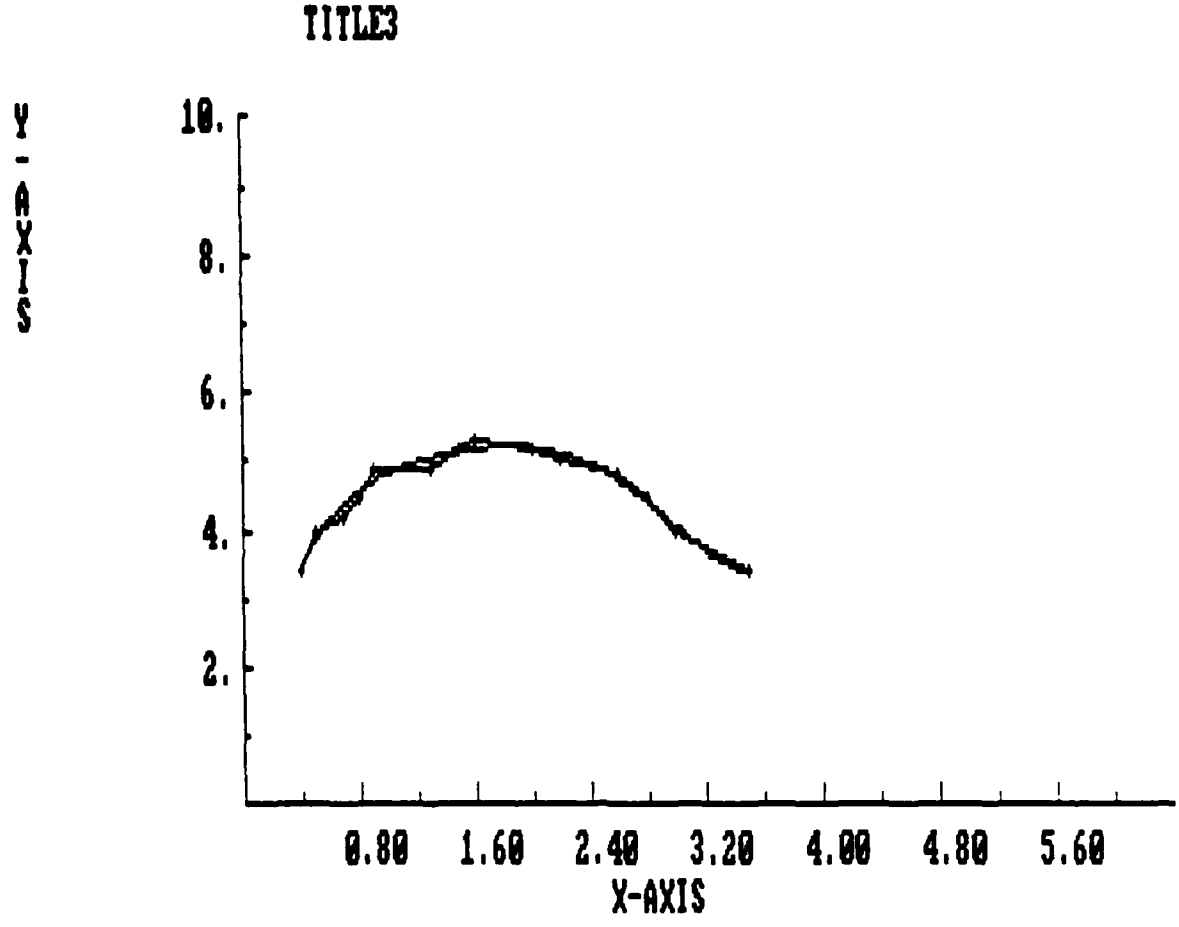


Figure A-2. Plot of DATA3.DAT Data Set.

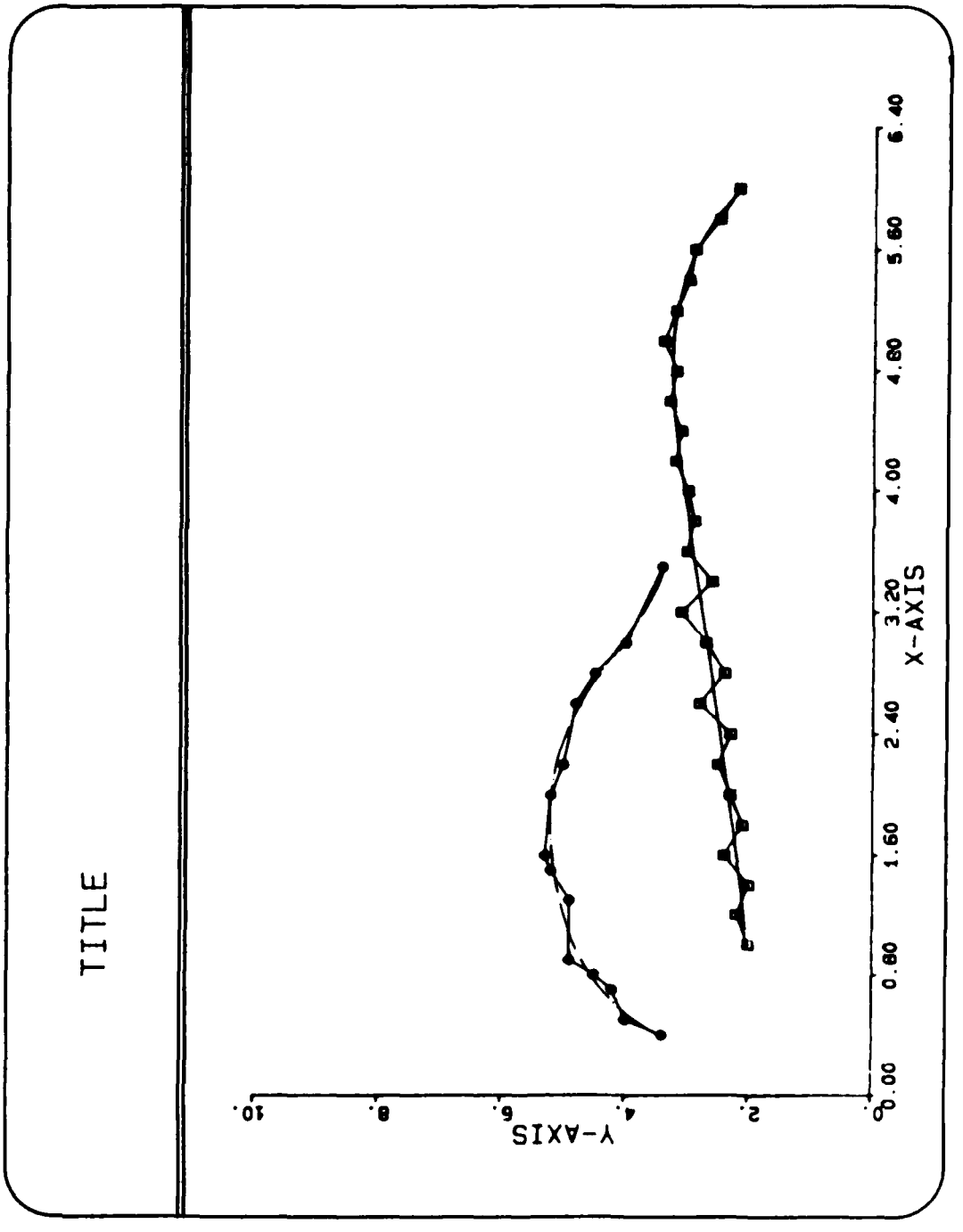


Figure A-3. Plot of Combined DATA;DATA1.DAT, DATA3.DAT.

EXAMPLE 3

Example 3 illustrates the processing of two different data sets that differ significantly in range such that to combine the data sets for scaling would suppress one in an undesirable fashion. The first data set is processed as in Example 2 followed by the processing of the second data set. Note in particular that the second data set, DATA4.DAT, not only is approximately two orders of magnitude larger than DATA1.DAT in the Y-direction but does not have the range in the X-dimension as DATA1.DAT either. It is therefore necessary to impose on the second data set the same X axis as for the first. This is accomplished by determining the scaling factors for the first data set by use of the SXYO option and noting the starting value and increment size, then as the second data set is processed, again specifying the SXYO option and entering the previously noted values at this

PRINTED OUTPUT? (Y/N)

N

ENTER DATA FILE NAME

DATA1.DAT

TITLE

X-AXIS

Y-AXIS

1	1.0000	2.0000
2	1.2000	2.2000
3	1.4000	2.0000
4	1.6000	2.4000
5	1.8000	2.1000
6	2.0000	2.3000
7	2.2000	2.5000
8	2.4000	2.3000
9	2.6000	2.8000
10	2.8000	2.4000

11	3.0000	2.7000
12	3.2000	3.1000
13	3.4000	2.6000
14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.000
24	5.6000	2.9000
25	5.8000	2.5000
26	6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) and LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

```
SCALE DATA - ENTER S X Y O E N IN  ANY ORDER
 S - SCALE DATA              X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0        O - USER SPECIFIED ORIGIN
 E - END(STOP)               N - NOTHING
SXYO
    ORIGIN AT X =     0.00000 STEPS OF     0.80000
          ENTER NEW VALUES, ELSE ,,,,
    ORIGIN AT Y =     0.00000 STEPS OF     0.80000
          ENTER NEW VALUES, ELSE ,,,,
OPTION#          FUNCTION              RSQ
  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX            0.4163
  4          Y = A * E**BX         0.4224
  5          Y = A * X**B          0.5390
  6          Y = A + B/X           0.5358
  7          Y = 1/(A+B*X)         0.4255
  8          Y = X/(A+B*X)         0.5911
  9          POLYNOMIAL
 10          LAGRANGE INTERPOLATION
 11          SPLINE FIT
 12          FOURIER SERIES
 13          NATURAL CUBIC SPLINE

 ENTER:  #  L  SA  ST  DA  RS  RP  EX
```

```
 # - EQUATION NUMBER                L - LIST DATA
SA - SAVE CURVE ON FILE            ST - STOP
DA - READ NEW DATA SET             RS - RESTART
RP - REPLOT DATA                   EX - EXIT(STOP)
9
ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14 5

     0.000 % DATA SPACING ERROR

  OPTION NO.  9
Y=POLYNOMIAL
  DEGREE = 5
  RSQ = 0.8934
  C0 =  0.246761E+01
  C1 =  -.128385E+01
  C2 =  0.125361E+01
  C3 =  -.470453E+00
  C4 =  0.863621E-01
  C5 =  -.617910E-02

     **** PLOTTING OPTIONS ****

ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E

P - PLOT DATA AS + SYMBOLS      A - PLOT AXES
L - CONNECT DATA POINTS         B - BROKEN LINE
D - USE DIAMOND                 + - USE +
```

```
X - USE X                          * - USE *
. - USE .                          0 - USE 0
H - HIGH RESOLUTION (DEF)          M - MEDIUM RES
N - NOTHING                        E - END
PAL

HARD COPY? (NO/PR, PL)  PL


READY PLOTTER -- ENTER G I A F P N D E C Z  ANY ORDER

G - PLOT GIRD                      I - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS                      F - DRAW FORM
P - PLOT POINTS                    N - NOTHING
H - PLOT HORIZONTAL AXIS           R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS                 B - PLOT REVERSE AXIS
C - ALTERNATE PEN                  Z - ALTERNATE LINE TYPE
D - READ ADDITIONAL DATA           E - END(STOP)
PAF

ENTER :  PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:
PEN              PLOT OPTION                       SYMBOL USED
-------------------------------------------------------------------------
1 - BLACK        -1 - SYMBOL AT EVERY POINT        0 - SQUARE
2 - RED          -2 - SYMBOL AT EVERY 2nd POINT    1 - CIRCLE
3 - GREEN        -N - SYMBOL AT EVERY Nth POINT    2 - TRIANGE
4 - BLUE          0 - LINE PLOT ONLY               3 - +
5 - BLACK         1 - LINE AND SYMBOL PLOT         4 - X
```

6 - RED	2 - LINE AND SYMBOL AT	5 - DIAMOND
	EVERY 2nd POINT	5 - 5% EB
	N - LINE AND SYMBOL AT	6 - 10% EB
	EVERY Nth POINT	7 - 25% EB

1,1,0

OPTION #	FUNCTION	REQ
1	DATA POINTS ONLY	
2	DATA SMOOTHING	
3	Y = A + BX	0.4163
4	Y = A * E**BX	0.4224
5	Y = A * X**B	0.5390
6	Y = A + B/X	0.5358
7	Y = 1/(A+B*X)	0.4255
8	Y = X/(A+B*X)	0.5911
9	POLYNOMIAL	
10	LAGRANGE INTERPOLATION	
11	SPLINE FIT	
12	FOURIER SERIES	
13	NATURAL CUBIC SPLINE	

ENTER # L SA ST DA RS RP EX

```
 # - EQUATION NUMBER                L - LIST DATA
SA - SAVE CURVE ON FILE             ST - STOP
DA - READ NEW DATA SET              RS - RESTART
RP - REPLOT DATA                    EX - EXIT(STOP)
DA

ENTER DATA FILE NAME
DATA4.DAT

TITLE4
X-AXIS
Y-AXIS

          1          0.4000          340.0000
          2          0.5000          400.0000
          3          0.7000          420.0000
          4          0.8000          450.0000
          5          0.9000          490.0000
          6          1.3000          490.0000
          7          1.5000          520.0000
          8          1.6000          530.0000
          9          2.0000          520.0000
         10          2.2000          500.0000
         11          2.6000          480.0000
         12          2.8000          450.0000
         13          3.0000          400.0000
         14          3.4000          340.0000

NUMBER OF DATA POINTS - 14
```

```
CALCULATE WITH LOGS/  X Y XY N NN EX

  X - LOG(X DATA)

  Y - LOG(Y DATA)

 XY - LOG(X DATA) AND LOG(Y DATA)

  N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

 NN - DO NOT USE LOGS EITHER AS INPUT OR POLTTING OF DATA

 EX - STOP

 NN

SCALE DATA - ENTER S X Y O E N  IN ANY ORDER

 S - SCALE DATA              X - ORIGIN IS AT X=0

 Y - ORIGIN IS AT Y=0        O - USER SPECIFIED ORIGIN

 E - END(STOP)               N - NOTHING

 SXYO

ORIGIN AT X =    0.00000 STEPS OF    0.50000

       ENTER NEW VALUES, ELSE,,0.0,0.8

ORIGIN AT Y =    0.00000 STEPS OF  200.00000

       ENTER NEW VALUES, ELSE ,,,,

OPTION#          FUNCTION            RSQ

  1          DATA POINTS ONLY

  2          DATA SMOOTHING

  3          Y = A + BX            0.0004

  4          Y = A * E**BX         0.0006

  5          Y = A * X**B          0.0533

  6          Y = A + B/X           0.2027
```

```
 7          Y = 1/(A+B*X)          0.0010
 8          Y = X/(A+B*X)          0.1972
 9          POLYNOMIAL
10          LAGRANGE INTERPPOLATION
11          SPLINE FIT
12          FOURIER SERIES
13          NATURAL CUBIC SPLINE

ENTER:  #  L  SA  ST  DA  RS  RP  EX

 # - EQUATION NUMBER              L - LIST DATA
SA - SAVE CURVE ON FILE          ST - STOP
DA - READ NEW DATA SET           RS - RESTART
RP - REPLOT DATA                 EX - EXIT(STOP)
9

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 and 14  6

UNEQUALLY SPACED DATA

OPTION NO. 9
Y=POLYNOMIAL
 DEGREE = 5
 RSQ = 0.9678
 CO = 0.124740E+03
 C1 = 0.747477E+03
 C2 = -.531554E+03
 C3 = 0.128816E+03
 C4 = 0.352845E+02
```

```
 C5 = -.244896E+02

 C6 = 0.334440E+01

     ****PLOTTING OPTIONS ****

ENTER:  P  A  L  B  D  +  X  *  .  O  H  M  N  E

P - PLOT DATA AS + SYMBOLS      A - PLOT AXES

L - CONNECT DATA POINTS         B - BROKEN LINE

D - USE DIAMOND                 + - USE +

X - USE X                       * - USE *

.- USE .                        O - USE O

H - HIGH RESOLUTION (DEF)       M - MEDIUM RES

N - NOTHING                     E - END

PAL

HARD COPY? (NO/PR, PL)  PL


READY PLOTTER -- ENGER G I A F P N D E C Z  ANY ORDER

G - PLOT GIRD                   I - GRID INTERSECTIONS PLOTTED

A - PLOT AXIS                   F - DRAW FORM

P - PLOT POINTS                 N - NOTHING

H - PLOT HORIZONTAL AXIS        R - PLOT RIGHT AXIS

L - PLOT LEFT AXIS              B - PLOT REVERSE AXIS

C - ALTERNATE PEN               Z - ALTERNATE LINE TYPE

D - READ ADDITIONAL DATA        E - END(STOP)

PRZ
```

```
ENTER :  PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN              PLOT OPTION                        SYMBOL USED
-------------------------------------------------------------------

1 - BLACK        -1 - SYMBOL AT EVERY POINT         0 - SQUARE
2 - RED          -2 - SYMBOL AT EVERY 2nd POINT     1 - CIRCLE
3 - GREEN        -N - SYMBOL AT EVERY Nth POINT     2 - TRIANGLE
4 - BLUE          0 - LINE PLOT ONLY                3 - +
5 - BLACK         1 - LINE AND SYMBOL PLOT          4 - X
6 - RED           2 - LINE AND SYMBOL AT            5 - DIAMOND
                      EVERY 2nd POINT               5 - 5% EB
                  N - LINE AND SYMBOL AT            6 - 10% EB
                      EVERY Nth POINT               7 - 25% EB

1,1,1


  SELECT A NEW LINE TYPE 2

OPTION#          FUNCTION            RSQ
  1          DATA POINTS ONLY
  2          DATA SMOOTHING
  3          Y = A + BX            0.0004
  4          Y = A * E**BX         0.0006
  5          Y = A * X**B          0.0533
  6          Y = A + B/X           0.2027
  7          Y = 1/(A+B*X)         0.0010
  8          Y = X/(A+B*X)         0.1972
  9          POLYNOMIAL
```

```
10          LAGRANGE INTERPOLATION

11          SPLINE FIT

12          FOURIER SERIES

13          NATURAL CUBIC SPLINE

ENTER:  #  L  SA  ST  DA  RS  RP  EX

  # - EQUATION NUMBER              L - LIST DATA

 SA - SAVE CURVE ON FILE          ST - STOP

 DA - READ NEW DATA SET           RS - RESTART

 RP - REPLOT DATA                 EX - EXIT(STOP)

 EX
```

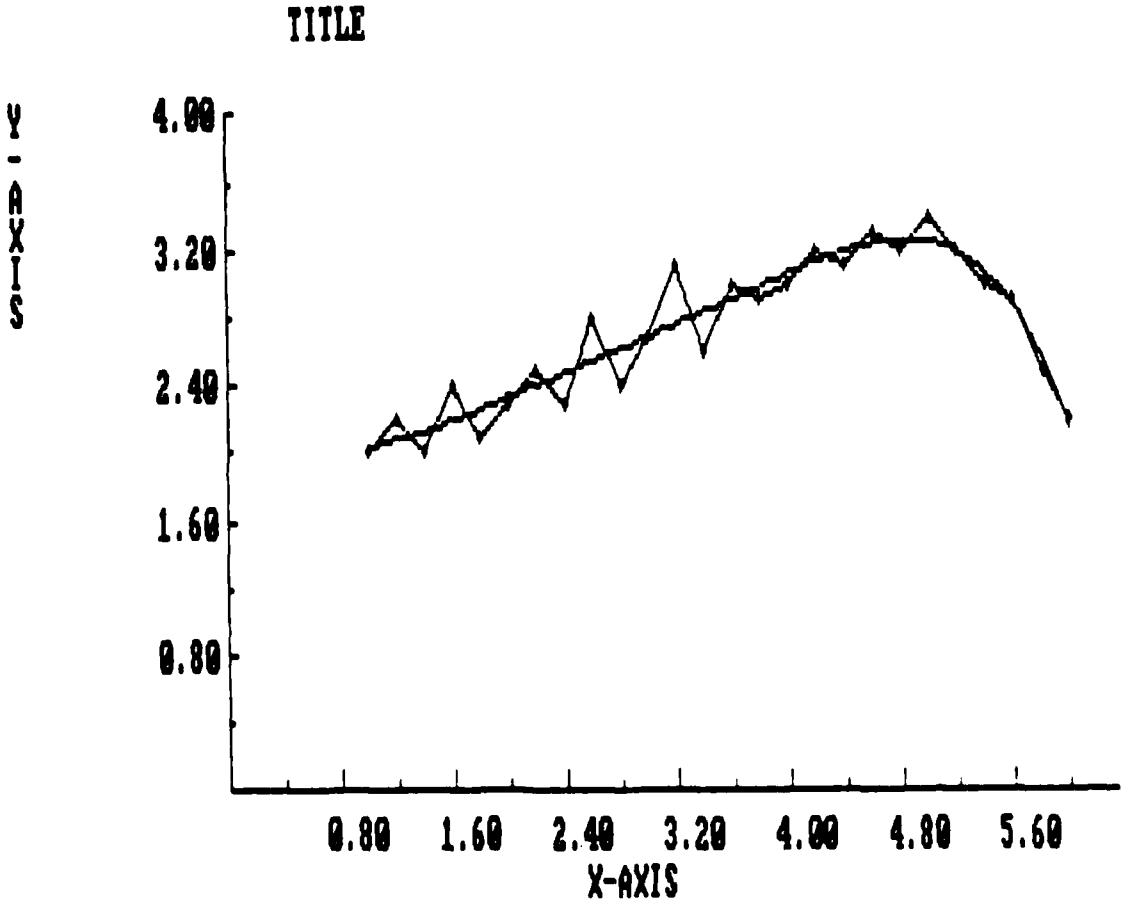


Figure A-4. Plot of DATA1.DAT Data Set.

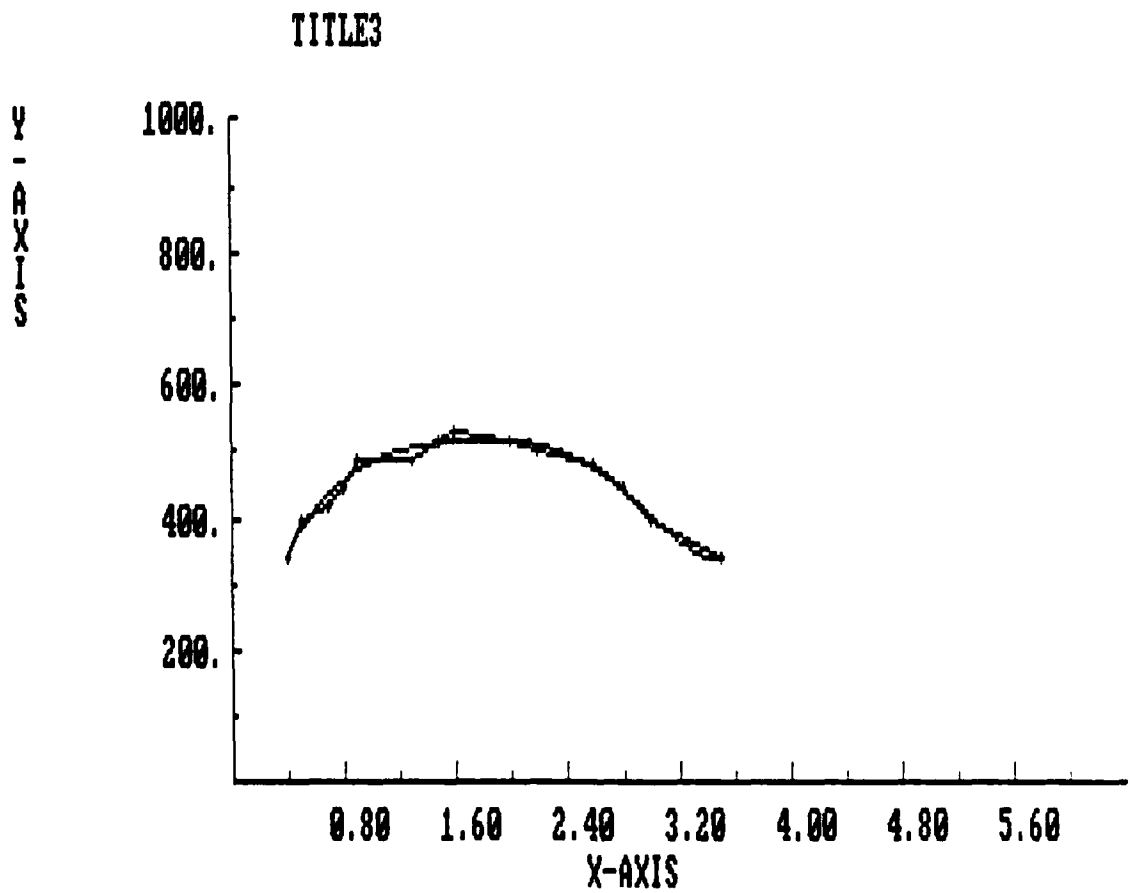


Figure A-5. Plot of DATA4.DAT Data Set.

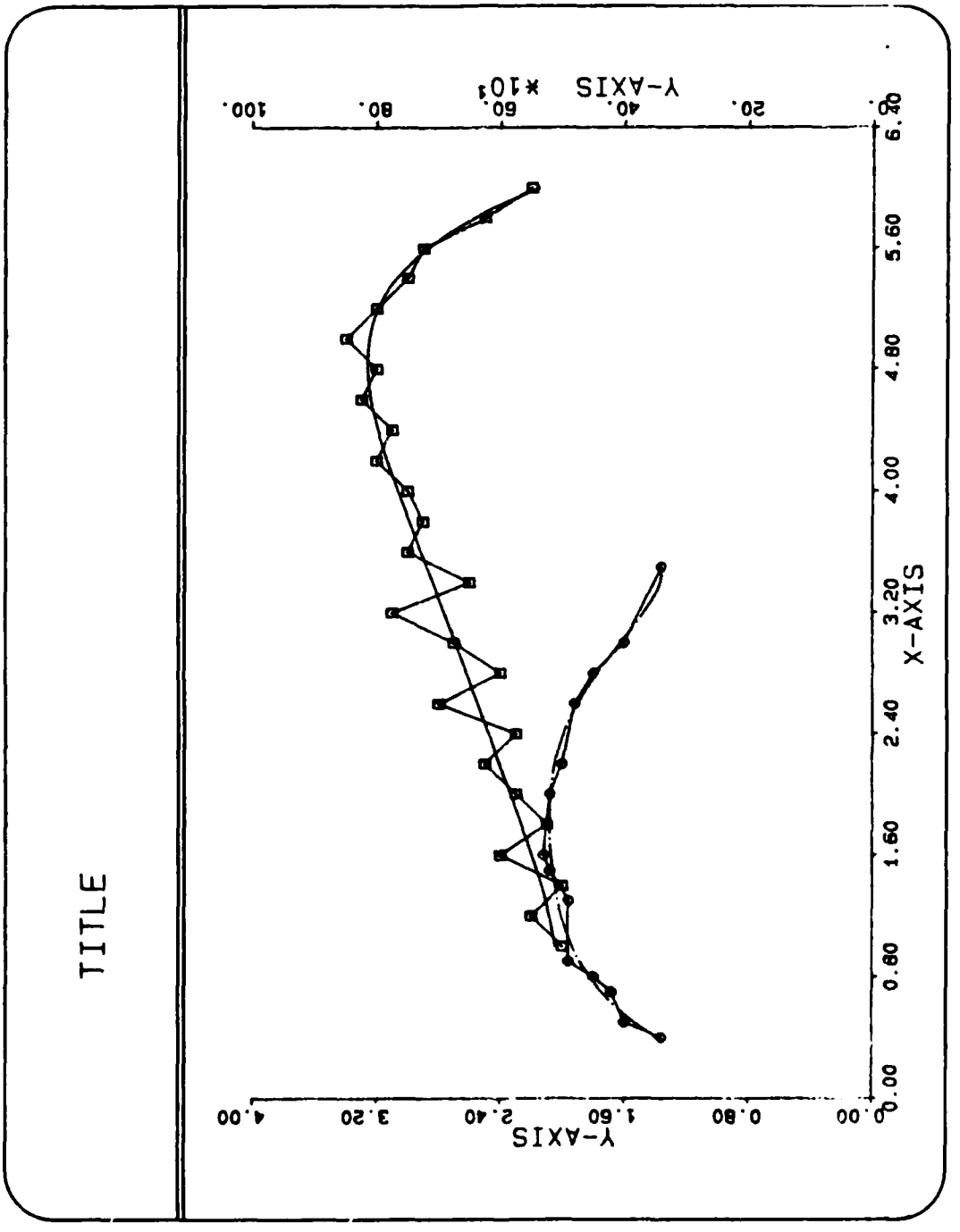


Figure A-6. Plot of Combined DATA;DATA1.DAT, DATA4.DAT.

DISTRIBUTION

	No. Copies
ITT Research Institute Attn: GACIAC 10 W. 35th Street Chicago, IL 60616	1
US Army Materiel System Analysis Activity Attn: AMXSY-MP Aberdeen Proving Ground, MD 21005	1
AMSMI-RD, Dr. McCorkle Dr. Rhoades	1
AMSMI-RD-CS-T, Record Copy	1
AMSMI-RD-CS-R, Reference	15
AMSMI-RD-DE, Miles Holloman	50
AMSMI-GC-IP, Mr. Bush	1

END

8-87

DTIC