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HEWLETT PACKARD

TIME-SHARED BASIC/2000 PROGRAM DOCUMENTATION

VOLUME II

(300) MATH AND NUMERICAL ANALYSIS
(400) PROBABILITY AND STATISTICS
(500) SCIENTIFIC AND ENGINEERING APPLICATIONS

36000-91002

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HEWLETT hp PACKARD

TIME-SHARED BASIC/2000 CONTRIBUTED LIBRARY HANDBOOK

VOLUME II

(300) MATH AND NUMERICAL ANALYSIS

(400) PROBABILITY AND STATISTICS

(500) SCIENTIFIC AND ENGINEERING APPLICATIONS

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36000-91002 6/74 Volume II

CLASSIFICATION CODE CATEGORY

(Not all categories have programs. Please refer to the INDEX to HP BASIC Program Library for available programs in HP BASIC)

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300 MATH AND NUMERICAL ANALYSIS

CONTRIBUTED PROGRAM **BASIC**

TITLE: BASE CALCULATOR

BASCAL
36847

DESCRIPTION:

Given two numbers and their respective bases, the computer will add them, subtract them, multiply or divide them and put the answer into a specified base.

INSTRUCTIONS:

User must give the computer one of the four commands (add, subtract, multiply, or divide) the two numbers and their respective bases, and the base in which the answer is to be printed.

300

SPECIAL CONSIDERATIONS:

The program will only work for bases 2 to 10. Negative numbers are acceptable but not decimals or fractions. In division, the quotient is rounded off to the nearest whole number, .5 and up is rounded to 1. The program cannot figure out a division problem whose quotient is less than .5.

ACKNOWLEDGEMENTS:

Peter Katz
Ravenswood High School

```
RUN

RUN

BASCAL

DO YOU WANT INSTRUCTIONS?YES
THIS PROGRAM IS A BASE CALCULATOR
FIRST YOU TELL THE COMPUTER YOUR COMMAND;
EITHER ADD, SUBTRACT, MULTIPLY, OR DIVIDE,
THEN INPUT ANY TWO NUMBERS AND THEIR RESPECTIVE BASES (2-10),
AND THE BASE IN WHICH YOU WANT THE ANSWER PRINTED.
THE COMPUTER WILL FIGURE OUT THE ANSWER AND PRINT IT
IN THAT BASE.
NEGATIVE NUMBERS ARE ACCEPTABLE, BUT NOT FRACTIONS
OR DECIMALS.
IN DIVISION, THE QUOTIENT IS ROUNDED OFF TO THE NEAREST
WHOLE NUMBER.  (.5 AND UP IS ROUNDED TO 1)

ENTER YOUR COMMAND?ADD
ENTER FIRST NUMBER?-23
AND ITS BASE?5
INPUT THE SECOND NUMBER?78
AND ITS BASE?9
ENTER DESIRED BASE?6

THE SUM IN BASE  6      IS  134


ENTER YOUR COMMAND?S
ENTER FIRST NUMBER?99
AND ITS BASE?10
INPUT THE SECOND NUMBER?34
AND ITS BASE?7
ENTER DESIRED BASE?3

THE DIFFERENCE IN BASE  3      IS  2202


ENTER YOUR COMMAND?M
ENTER FIRST NUMBER?1234
AND ITS BASE?2
INPUT THE SECOND NUMBER?67
AND ITS BASE?9
ENTER DESIRED BASE?5

SOMETHING IS WRONG, START OVER

ENTER YOUR COMMAND?M
ENTER FIRST NUMBER?12
AND ITS BASE?4
INPUT THE SECOND NUMBER?12
AND ITS BASE?5
ENTER DESIRED BASE?6

THE PRODUCT IN BASE  6      IS  110


ENTER YOUR COMMAND?DIVIDE
ENTER FIRST NUMBER?144
AND ITS BASE?10
INPUT THE SECOND NUMBER?2
AND ITS BASE?6
ENTER DESIRED BASE?7

THE QUOTIENT IN BASE  7      IS  132


ENTER YOUR COMMAND?
DONE
```

BESSEL
36019

TITLE: CALCULATES BESSEL FUNCTION OF FIRST KIND

DESCRIPTION: This program calculates Bessel functions of the first kind (J).

It uses an integration routine based on Simpson's Rule to integrate the function given in Handbook of Mathematical Functions, N.B.S. Applied Math Series #55, Section 4.1.22.

INSTRUCTIONS: The program will request the order (N), the argument (Z) and the acceptable error (E). It will return the computed value (J).

To use this program as a subroutine delete lines 9003 through 9008 and change statement 9067 to RETURN. The calling program must supply N, Z and E as defined above. The program will return the value of the Bessel Function, J. To avoid printout delete line 9066.

Variables used: E,FØ,F1,F2,F3,F4,F9,H7,H8,H9,
I9,J,N,T8,T9,X8,X9,Z.

SPECIAL CONSIDERATIONS: It is meaningless if $E < 10^{-5}$.

ACKNOWLEDGEMENTS:

RUN

```
GET-$BESSEL
RUN
BESSEL

WHAT IS THE ORDER?3
WHAT IS THE ARGUEMENT?12
WHAT IS THE ACCEPTABLE ERROR?.001
N= 3     Z= 12    J= .195137

DONE
```

Documentation Date 3/75

MATH AND NUMERICAL ANALYSIS (300)

CONTRIBUTED PROGRAM **BASIC**

BINO
36888-18029

TITLE: BINOMIAL FUNCTION EXPANSION

DESCRIPTION: This program expands any binomial of form $(AX + BY)^N$, where N can range from 1 to 15.

INSTRUCTIONS: Instructions are contained in program.

ACKNOWLEDGEMENTS: Clifford E. Cuellar, Jr.
Reichhold Chemicals Inc.

RUN

```
RUN
BINO

PROGRAM COMPUTES COEFFICIENTS FOR POLYNOMIALS OF FORM
(AX+BY)↑N, WHERE A & B ARE +- NUMBERS AND N IS A
POSITIVE INTEGER BETWEEN 1 AND 15
YES   IS CORRECT RESPONSE TO LAST QUESTIONS

INPUT A,B,N?3,2,3
 27   X↑ 3     + 54   X↑ 2     Y↑ 1     + 36   X↑ 1     Y↑ 2     + 8      Y↑
 3
NEXT HIGHER DEGREE?YES
 81   X↑ 4     + 216  X↑ 3     Y↑ 1     + 216  X↑ 2     Y↑ 2     + 96     X↑
 1    Y↑ 3     + 16   Y↑ 4
NEXT HIGHER DEGREE?NO
NEW VALUES?YES
INPUT A,B,N?4,2,2
 16   X↑ 2     + 16   X↑ 1     Y↑ 1     + 4    Y↑ 2
NEXT HIGHER DEGREE?YES
 64   X↑ 3     + 96   X↑ 2     Y↑ 1     + 48   X↑ 1     Y↑ 2     + 8      Y↑
 3
NEXT HIGHER DEGREE?NO
NEW VALUES?NO

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CALCOM
36131

TITLE: CALCULATOR PROGRAM WITH OPTIONAL PLOTTER OUTPUT

DESCRIPTION:

CALCOM and CALPLT allow the user to perform immediate mode calculations and other functions. The two programs are identical other than for the GRAPH command, which utilizes the HP 7200A Plotter with CALPLT, or the printing terminal with CALCOM.

The sample run utilized CALPLT (and the HP 7200A Plotter).

INSTRUCTIONS:

See Page 2.

SPECIAL CONSIDERATIONS:

There is a heirarchy of operators with factorialization being performed first followed by the min and max functions, then exponentiation, multiplication and division, and finally addition and subtraction. Paranthesis may be used at any time to override the order in which the operations are performed.

In addition to performing direct calculations, the user may retain the results of a calculation as a variable consisting of a single letter.

Variables may be used in later calculations once they have been defined. Undefined variables are set to zero.

By using a backslash \ (shift L) the user may perform more than one calculation per line. The different calculations are performed from left to right in the command string.

ACKNOWLEDGEMENTS:

Steve Poulsen
OMSI

INSTRUCTIONS

The following symbols, commands, and functions are available:

SYMBOL	MEANING	EXAMPLE
+	Addition	2+5=7
-	Subtraction	5-2=3
*	Multiplication	2*5=10
/	Division	2/5=.4
↑ or ^	Exponentiation	2↑5=32
%	Root function A%B=B↑(1/A)	2%5=2.236
<	MIN function. Value is lesser number on either side	2<5=2
>	MAX function. Value is greater number on either side	2>5=5
!	Factorialization of number preceding !	5!=120
?	Value is supplied by user	W=?+3*?/2
\	Allows more than one command per line	2+5\FACTOR 314*W
← or _	Deletes preceding character	2+3_5=7

COMMAND	MEANING
BASE n	Changes input and output to base n
BASE	Changes input and output back to base 10
DEGREES	Allow trig functions to be evaluated in degrees
FACTOR	Prime factors number following command
GRAPH	Graphs functions following command on teleprinter (or plotter)
LIST	Lists variables not equal to zero
RADIANS	Allows trig functions to be evaluated in radians
SAME	Repeats last command string
SCRATCH	Sets all variables equal to zero
STOP	Stops the running of CALC
ZERO	Approximates the points at which the equation following the command is equal to zero

FUNCTION NAME	MEANING
ABS	Absolute value of number
COS	Cosine of angle
COT	Cotangent of angle
CSC	Cosecant of angle
EXP	"e" raised to a real power
INT	Integer part of number
LOG	Natural logarithm of number
RND	Random number between 0 and 1
SEC	Secant of angle
SIN	Sine of angle
TAN	Tangent of angle

Arc functions are called by placing the prefix ARC in front of the function such as: ARCSIN, ARCCOT, or ARCCSC.

Hyperbolic functions are called with the prefix HYP such as: HYPSIN, HYPCOS, HYPSEC, ARCHYPCOT, ARCHYPCSC, HYPARCTAN, or HYPARCCOS.

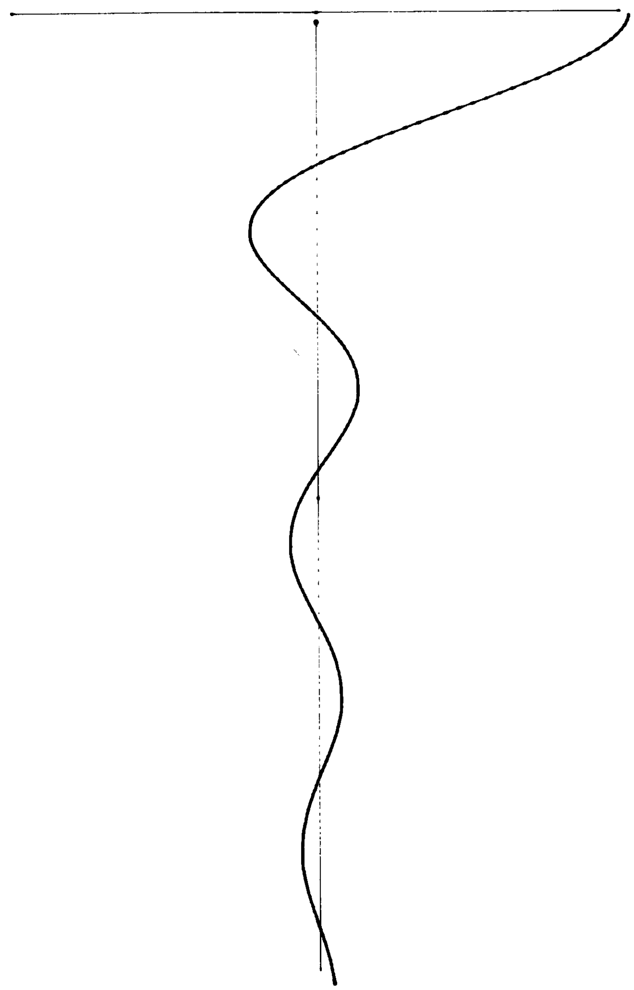
```
RUN

RUN
CALPLT

INTERPRETIVE CALCULATOR



0  2+3*(5/2)
 9.5
0  Q=2+3*(5/2)
0  Q*2
 19
0  2+3*(5/2)\Q*2
 9.5
 19
0  ?+3*(5/2)
INPUT DATA?2
 9.5
0  ?+3*(?/2)
INPUT DATA?2
INPUT DATA?5
 9.5
0  INT(2+3*(5/2))
 9
0  ABS(2-3*(5/2))
 5.5
0  COS(3.14159
COS(3.14159
           ↑
MISSING RIGHT PARENTHESIS
 3.14159
0  COS(3.14159)
-1.
0  ARCTAN(-1)
-.785398
0  FACTOR (52/2)
 2     * 13
0  Q=1024
0  BASE 2\Q
10000000000
0  10010*1001
10100010
0  BASE
0  A=2+2\B=2*3\C=2/5
0  LIST
A                 4
B                 6
C                 .4
Q                 1024
0  SCRATCH
0  LIST
0  2*?+?↑2
INPUT DATA?2
INPUT DATA?3
 13
0  SAME

INPUT DATA?1
INPUT DATA?2
 6
0  ZERO Y=X↑3-X↑2-10*X-8
LOWER LIMIT OF SEARCH?-8
UPPER LIMIT OF SEARCH?8
-2     -1      4
0  GRAPH Y=(SIN(X))/X
LOWER LIMIT OF X?0
UPPER LIMIT OF X?20
X INCREMENT?.1
X OFFSET?0
Y SCALING FACTOR?10
PLTL
 100   5000
 5000      5000
 9900      5000
PLTT
```

```
PLTL
 0      100
 0      5000
 0      9900
PLTT
PLTL
 0      4.99950E+33
 49     9991
 99     9966
 149    9924
 199    9867
 249    9793
 299    9704
 349    9601
 399    9483
 449    9351
 499    9206
 549    9050
 599    8883
 649    8705
 699    8519
 749    8324
 799    8123
 849    7916
 899    7704
 949    7490
 999    7273
 1049      7055
 1099      6837
 1149      6620
 1199      6407
 1249      6196
 1299      5991
 1349      5791
 1399      5598
 1449      5412
 1499      5235
 1549      5067
 1599      4908
 1649      4761
 1699      4624
 1749      4498
 1799      4385
 1849      4284
 1899      4195
 1949      4118
 1999      4054
 2049      4002
 2099      3962
 2149      3934
 2199      3918
 2249      3913
 2299      3920
 2349      3936
 2399      3962
 2449      3997
 2499      4041
 2549      4092
 2599      4150
 2649      4214
 2699      4284
 2749      4358
 2799      4436
 2849      4516
 2899      4599
 2949      4683
 2999      4767
 3049      4850
 3099      4933
 3149      5013
 3199      5091
 3249      5165
 3299      5235
 3349      5302
 3399      5363
 3449      5419
 3499      5469
 3549      5513
```

3599	5551
3649	5582
3699	5607
3749	5625
3799	5636
3849	5641
3899	5640
3949	5632
3999	5618
4049	5598
4099	5573
4149	5543
4199	5508
4249	5469
4299	5426
4349	5380
4399	5332
4449	5281
4499	5228
4549	5175
4599	5121
4649	5066
4699	5013
4749	4960
4799	4909
4849	4859
4899	4813
4949	4768
4999	4728
5049	4690
5099	4656
5149	4627
5199	4602
5249	4581
5299	4564
5349	4553
5399	4545
5449	4543
5499	4545
5549	4552
5599	4562
5649	4577
5699	4596
5749	4619
5799	4645
5849	4674
5899	4706
5949	4740
5999	4776
6049	4814
6099	4853
6149	4893
6199	4933
6249	4973
6299	5013
6349	5052
6399	5090
6449	5126
6499	5161
6549	5194
6599	5224
6649	5251
6699	5276
6749	5297
6799	5315
6849	5330
6899	5341
6949	5349
6999	5353
7049	5354
7099	5351
7149	5344
7199	5335
7249	5322
7299	5306
7349	5287
7399	5266
7449	5242
7499	5216
7549	5189
7599	5159
7649	5129
7699	5098
7749	5066
7799	5034
7849	5002
7899	4970
7949	4939
7999	4910
8049	4881
8099	4854
8149	4828
8199	4805
8249	4784
8299	4765
8349	4749
8399	4735
8449	4725
8499	4717
8549	4712
8599	4710
8649	4711
8699	4714
8749	4721
8799	4730
8849	4742
8899	4756
8949	4772
8999	4791
9049	4811
9099	4833
9149	4857
9199	4881
9249	4907
9299	4933
9349	4960
9399	4986
9449	5013
9499	5039
9549	5064
9599	5089
9649	5112
9699	5134
9749	5155
9799	5173
9849	5190
9899	5205
9948	5217
9998	5228

PLTT
0 STOP

DONE



CONTRIBUTED PROGRAM **BASIC**

CDETER
36025

TITLE: COMPUTES VALUE OF COMPLEX DETERMINANT

DESCRIPTION: This program computes the value of a complex determinant using the Crout method.

INSTRUCTIONS: Before running the program supply the following data beginning in line 9900:

9900 DATA N
9901 $R_{11}, I_{11}, \ldots, R_{1N}, I_{1N}$
—
—
—
—
99-- $R_{N1}, I_{N1}, \ldots, R_{NN}, I_{NN}$

where:

N = = Order of the Determinant
R_{ij} = Real part of the element in the ith row and jth column
I_{ij} = Imaginary part of the element in the ith row and jth column

SPECIAL CONSIDERATIONS: The maximum value of N is 23.

F. B. Hildebrand, Introduction to Numerical Analysis; McGraw-Hill, 1956, pp. 429-439.

ACKNOWLEDGEMENTS:

RUN

```
GET-$CDETER
9900 DATA 2
9901 DATA 1,1,0,0
9902 DATA 0,0,1,-1
RUN
CDETER

COMPLEX DETERMINANT EVALUATOR

 1       1       0       0

 0       0       1      -1


REAL C             IMAGINARY C

 2                  0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CROUT1
36027

TITLE: SOLVES SIMULTANEOUS LINEAR EQUATIONS

DESCRIPTION: Solves M sets of N by N Linear Equations. Uses the Crout Algorithm with row interchange,

$$A_{11}X_1+A_{12}X_2+\dots+A_{1N}X_N = B_{11},B_{12},\dots,B_{1M}$$
$$A_{21}X_1+A_{22}X_2+\dots+A_{2N}X_N = B_{21},B_{22},\dots,B_{2M}$$
. . . .
$$A_{N1}X_1+A_{N2}X_2+\dots+A_{NN}X_N = B_{N1},B_{N2},\dots,B_{NM}$$

INSTRUCTIONS: Data Requirements are:

N = No. of Coefficients
M = No. of Sets
A_{ij} = Coefficient of the ith Row and jth variable

Data should be entered starting with line 9900 as follows:

9900 DATA N,M
9902 DATA $A_{11},A_{12},\dots,A_{1N}$
9904 DATA $A_{21},A_{22},\dots,A_{2N}$
. . . .
99-- DATA $A_{N1},A_{N2},\dots,A_{NN}$
99-- DATA $B_{11},B_{12},\dots,B_{1M}$
. . . .
99-- DATA $B_{N1},B_{N2},\dots,B_{NM}$

In case N or M has a value greater than 10 change the dim statements in line 9003,9004.

SPECIAL CONSIDERATIONS: "MATRIX OF COEFFICIENTS IS SINGULAR.", message means the set of equations designated by the A_N's is linearly dependent. Thus the set of equations has no solution.

An explanation of the Crout algorithm can be found in: Hildebrand, Introduction To Numerical Analysis; McGraw-Hill, or in most texts on linear equations.

ACKNOWLEDGEMENTS:

RUN

```
GET-$CROUT1
9900 DATA 4,2,1,1,1,1,5,1,2,1,1,-6,9,-1,3,2,1,-1,100,220,190,150
9901 DATA 100,160,-130,130
RUN
CROUT1


ANSWER SET   1
 20          30.          40          10
ANSWER SET   2
 10          50           20.         20
DONE
```

CONTRIBUTED PROGRAM **BASIC**

CRVFT
36633

TITLE: LEAST-SQUARES CURVEFITTING

DESCRIPTION:

This is a program to perform least-square fits to several useful functions. It allows storage and manipulation of up to 100 data points of x, y, and Δy, the error in y. The fitting functions are linear in the unknown coefficients. The values of coefficients and their associated error are returned.

INSTRUCTIONS:

The COMMANDS are logically broken into four categories:

1. Data Manipulation

CLEAR	clears out the arrays, resets the default options,
DELETE	deletes a given datum,
ENTER	allows entering of new data, either to replace old data or to extend the numbers of points,
INSERT	allows inserting of new datum at a given index,
LIST	lists the data,
READ	reads the data from a previously written file,
REPLACE	replaces a given datum with a new one,
SORT	sorts the data into ascending order,
TITLE	allows entry of an alpha title for the data,
WRITE	stores the data on a disc file; the data file should be named DATFIL and should be five records long; if a different file is desired, the user may change the files statement - which is statement 1003.

2. Fit options

FIT	instructs the program to do a fit-DEGREE requests the degree of the fit-and prints the results,
FUNCTION	selects the functional form for the fit; choices are: Polynomial, SINe, COSine, CSN-alternate cos and sin, and EXP; the default option is POLY,
UNWEIGHT	gives the data points equal weights; the default option is WEIGHT,
WEIGHT	computes weights on the basis of the absolute errors; the default option is WEIGHT.

continued on following page

SPECIAL CONSIDERATIONS:

The algorithm for fitting is based on:
A Practical Guide to the Method of Least Squares by P. Cziffra and M. Moravesik, UCRL-8523 Rev. 1959.

FOR INSTRUCTIONAL PURPOSES
Suitable Courses: Physics Lab

Student Background Required: Familiarity with least squares

This program is used in the introductory Physics lab course to perform weighted least squares fits to experimental data.

ACKNOWLEDGEMENTS:

Lawrence E. Turner
Pacific Union College

INSTRUCTIONS continued

3. Print options

TABLE	in addition to printing the coefficients, a table of the data is given, the default option is TABLE,
NOTABLE	eliminates the data table from the results; the default option is TABLE,

4. General

HELP	produces a listing of COMMANDS,
SHOW	prints important parameters of the data and the state of various option flags.

For all commands the first three characters are sufficient.

RUN

```
OPE-DATFIL,5
RUN
CRVFT

                LEAST SQUARES ANALYSIS


COMMAND ?HELP

      CRVFT COMMANDS:

1. DATA MANIPULATION

CLEAR
DELETE
ENTER
INSERT
LIST
READ
REPLACE
SORT
TITLE
WRITE

2. FIT OPTIONS

FIT
FUNCTION
UNWEIGHT
WEIGHT

3. PRINT OPTIONS

TABLE
NOTABLE

4. GENERAL

HELP
SHOW
STOP


COMMAND ?CLEAR


COMMAND ?ENTER

NUMBER OF POINTS?5


ENTER:  X, Y, AND DY

 1     ?0,0,.1
 2     ?1,2,.1
 3     ?2,5,.3
 4     ?3,10,.2
 5     ?4,16,.1


COMMAND ?TITLE
```

```
ENTER TITLE:  ?TEST DATA *********

COMMAND ?SHOW


TITLE:  TEST DATA *********

 5    POINTS STORED
WEIGHTED
TABLE
FUNCTION:  POLY


COMMAND ?WRITE


COMMAND ?FIT

DEGREE?2



               TEST DATA *********

FIT OF DEGREE 2        FUNCTION:  POLY

 5    DATA POINTS


 K                 A(K)           DA(K)

 0                1.10321E-02    .070468
 1                1.27618        .111699
 2                .680237        2.63165E-02


DEG OF FREE:  2     ,  CHISQ =  1.05314    ,     VAR =  .526568

   X               Y              DY              F(X)            R

 0                0              .1              1.10321E-02    -1.10321E-02
 1                2              .1              1.96745         .032547
 2                5              .3              5.28435        -.284348
 3                10             .2              9.96172         3.82843E-02
 4                16             .1              15.9996         4.42505E-04



-

COMMAND ?
DONE
```

TITLE: COMPLEX TO REAL FAST FOURIER TRANSFORM

DESCRIPTION:

This program will find the time function, f(i), given a complex line spectrum F(n), i.e., the inverse Fourier transform. The mathematical relationship is:

$$f(i) = \sum_{n=o}^{N-1} F(n)e^{jin\frac{2\pi}{N}}$$

where F(n) are complex numbers. There are some special requirements on the set of F(n) such that f(i) comes out real for all values of i. It is necessary and sufficient that F(n)=F*(N-n) for this to be true. Almost half of the line spectrum F(n) is therefore redundant and can be eliminate This is done in this program--only F(0) through F(N/2) are read as input. F(N/2+1) through F(N-1) are inferred by the complex conjugate relationship One more condition must be adhered to. F(0) and F(N/2) must be pure real. If this condition is not met, the output will be erroneous. The user specifies the number of data points to be read, and gives the complex values of F(n) at each of these points. The program, using a specialized version of the Cooley-Tukey algorithm, computes and prints the corresponding time function f(i).

INSTRUCTIONS:

Line 100 must be changed to read 100 LET G=(g) where g is an integer representing the size of the transformation to be made. It is desired to transform a data set of F(n) consisting of N complex elements (almost half of which are redundant and are not included as data). g is simply ($\log_2(N)-1$), an integer. Thus, if we knew 16 harmonic values of a function we would specify 9 of them (F(0) through F(8)) and we would set G equal to 3.

The complex values F(n) are written in data statements in the order:

(line numbers) DATA $F(0)_{real}$, $F(0)_{imag}$, $F(1)_{real}$, $F(1)_{imag}$, etc.

The output of the program consists of a set of time interval numbers and the value of the time function at each interval. N such values are given (The time function is periodic and repeats after this interval.)

Line numbers #1 to #99 are reserved for data statements.

SPECIAL CONSIDERATIONS:

The initial data are read into a matrix. This matrix is operated on to yield the final data, so that the original data is lost.

ACKNOWLEDGEMENTS:

Peter K. Bice
Hewlett-Packard/Microwave

RUN

```
TAPE

10  DATA 8.50001,0
11  DATA -.5,2.51367
12  DATA -.5,1.20711
13  DATA -.5,.748303
14  DATA -.5,.500001
15  DATA -.5,.33409
16  DATA -.500001,.207107
17  DATA -.5,9.94568E-02
18  DATA -.500001,0
100  LET G=3

RUN
CTRFFT

 0      1.00001
 1      2.
 2      3.
 3      4.00001
 4      5.00001
 5      6.00002
 6      7.00002
 7      8.00002
 8      9.00001
 9      10.
 10     11.
 11     12.
 12     13.
 13     14.
 14     15.
 15     16.

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CXARTH
36118

TITLE: VECTOR ARITHMETIC

DESCRIPTION:

This program allows a user-to perform the four basic arithmetic operations (addition, subtraction, multiplication, and division) on vectors (complex numbers). The operands may be entered in either polar coordinates with the angle in degrees or cartesian coordinates. The resultant of the operation is expressed in both polar and cartesian coordinates. The program may be repeated at will without leaving the RUN mode.

INSTRUCTIONS:

Follow the instructions given by the program. After the mode, data, and operation are entered, the operation is executed and the result printed. The user may then specify that he wants to do another operation, or stop execution of the program.

SPECIAL CONSIDERATIONS:

NONE

ACKNOWLEDGEMENTS:

Dennis I. Smith
Montana State University

```
RUN

RUN
CXARTH

THIS PROGRAM WILL PERFORM ARITHMETIC OPERATIONS
ON VECTORS EXPRESSED IN EITHER POLAR OR CARTESIAN SYSTEMS

WHEN ASKED 'MODE?' TYPE 1 FOR POLAR COORDINATES
                   TYPE 2 FOR CARTESIAN COORDINATES
WHEN ASKED 'OPERATION?' TYPE 1 FOR ADDITION
                        TYPE 2 FOR SUBTRACTION
                        TYPE 3 FOR MULTIPLICATION
                        TYPE 4 FOR DIVISION
WHEN ASKED 'AGAIN?' TYPE 0 TO STOP THE PROGRAM
                    TYPE 1 TO CONTINUE THE PROGRAM
ALL ANGLES INPUT AND OUTPUT ARE IN DEGREES
ANSWERS ARE GIVEN IN BOTH POLAR AND CARTESIAN FORMS

MODE?2
X #1?3
Y #1?6
X #2?4
Y #2?8
OPERATION?1

RESULTANT X =  7
RESULTANT Y =  14
RESULTANT MAGNITUDE =  15.6525
RESULTANT ANGLE =  63.435

AGAIN?1
MODE?1
MAGNITUDE #1?13.65
ANGLE #1?37.5
MAGNITUDE #2?3.456
ANGLE #2?5.67
OPERATION?4

RESULTANT X =  3.35569
RESULTANT Y =  2.08305
RESULTANT MAGNITUDE =  3.94965
RESULTANT ANGLE =  31.83

AGAIN?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CXEXP
36119

TITLE: VECTOR EXPONENTIATION

DESCRIPTION:

This program will raise a complex number expressed in cartesian coordinates to a real power or a complex power (also in cartesian coordinates). The operands are entered and the operation is executed. The resultant is typed in cartesian coordinates. The program may be repeated at will without leaving the RUN mode.

INSTRUCTIONS:

Follow the instructions given by the program. After the type of exponent and the operands have been entered, the operation is executed and the result printed. The user may then specify that he wants to do another operation, or stop execution of the program.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Dennis I. Smith
Montana State University

```
RUN

RUN
CXEXP

THIS PROGRAM WILL RAISE A COMPLEX NUMBER
TO ANY REAL OR COMPLEX POWER.

WHEN ASKED 'POWER?' TYPE 1 FOR REAL EXPONENTS
                    TYPE 2 FOR COMPLEX EXPONENTS
WHEN ASKED 'AGAIN?' TYPE 0 TO STOP THE PROGRAM
                    TYPE 1 TO CONTINUE THE PROGRAM

POWER?1
REAL PART?92
IMAGINARY PART?93
EXPONENT?16

RESULTANT REAL PART =  7.32797E+33
RESULTANT IMAGINARY PART =  6.35338E+32

AGAIN?1
POWER?2
REAL PART?38
IMAGINARY PART?72
EXPONENT REAL PART?2
EXPONENT IMAGINARY PART?5.3

RESULTANT REAL PART =  19.7511
RESULTANT IMAGINARY PART =  7.32445

AGAIN?0

DONE
```

DBLFIT
36252

TITLE: LEAST SQUARES FIT TO POINTS WITH UNCERTAINTIES IN BOTH VARIABLES

DESCRIPTION:

This program does a 1st degree least square fit where there are uncertainties in both the dependent and independent variables. This differs from POLFIT (HP 36023) and CURFIT (HP 36038) which assume that there are only uncertainties in the dependent variable. The equations were derived using the least-squares method in the following manner. The desired set of N points were assumed to be of the following form:

$$(P_o + i\Delta X, Q_o + i\Delta Y) \quad i = 1 \text{ to } N$$

where $(P_o + i\Delta x,\ Q_o + i\Delta y)$ is the calculated point corresponding to the measured point $(X_i,\ Y_i)$. Taking the sum of the squares of the distances from the calculated points to the measured points yields the following equation which should be minimized:

$$\sum_{i=1}^{N} (P_o + i\,\Delta X - X_i)^2 + (Q_o + i\,\Delta Y - Y_i)^2$$

Differentiating with respect to P_o, ΔX, Q_o, ΔY and setting the derivitives equal to zero yields two independent pairs of simultaneous equations:

$$d/dP_o = \sum_{i=1}^{N} (P_o + i\,\Delta X - X_i) = 0$$

$$d/d\,\Delta X = \sum_{i=1}^{N} i\,(P_o + i\,\Delta X - X_i) = 0$$

continued on following page

INSTRUCTIONS:

To use, enter data on line 400 as follows:

```
400  DATA N (where N = number of data points to be read)
401  DATA (X(1), Y91), X(2), Y(2),...., X(N), Y(N).
```

The output of the program provides the coefficients for calculating the desired set of points and a table providing the measured X and Y coordinates, the difference of the measured and calculated values and the distances from the measured to the calculated points.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Frank Phelan
University of California at San Diego

DESCRIPTION continued

$$d/dQ_o = \sum_{i=1}^{N} (Q_o + i\Delta Y - Y_i) = 0$$

$$d/d\Delta Y = \sum_{i=1}^{N} (Q_o + i\Delta X - Y_i) = 0$$

Solving for ΔX and P_o yields:

$$\Delta X = \frac{N\sum_{i=1}^{N}(iX_i) - \sum_{i=1}^{N}(X_i)\sum_{i=1}^{N}(i)}{N\sum_{i=1}^{N}(i^2) - \sum_{i=1}^{N}(i)\sum_{i=1}^{N}(i)}$$

$$P_o = \frac{\sum_{i=1}^{N}(X_i) - \Delta X \sum_{i=1}^{N}(i)}{N}$$

Similarly:

$$\Delta Y = \frac{N\sum_{i=1}^{N}(iY_i) - \sum_{i=1}^{N}(Y_i)\sum_{i=1}^{N}(i)}{N\sum_{i=1}^{N}(i^2) - \sum_{i=1}^{N}(i)\sum_{i=1}^{N}(i)}$$

$$Q_o = \frac{\sum_{i=1}^{N}(Y_i) - \Delta Y \sum_{i=1}^{N}(i)}{N}$$

Note:

$$\sum_{i=1}^{N}(i) = \frac{N(N+1)}{2}$$

$$\sum_{i=1}^{N}(i^2) = \frac{N(N+1)(2N+1)}{6}$$

RUN

```
400  DATA 10
410  DATA 4,5,7,9,5,8,8,9,10,12,11,14,13,15,14,18,15,19
415  DATA 16,19,17,19
500  END

RUN
DBLFIT


CALCULATED POINTS I=1 TO 10

X-CALC. (I) =  2.8          + I *  1.36364

Y-CALC. (I) =  3.93333      + I *  1.61212

X-ACTUAL      DIFFERENCE     Y-ACTUAL      DIFFERENCE     DISTANCE
-----------------------------------------------------------------
 4            -.163636        5            -.545455        .569472
 7             1.47273        9             1.84242        2.3587
 5            -1.89091        8            -.769698        2.04156
 8            -.254545        9            -1.38182        1.40507
 10            .381819        12            6.05965E-03    .381867
 11            1.81828E-02    14            .393938        .394358
 13            .654547        15           -.218182        .689953
```

```
 14            .290911       18           1.1697        1.20533
 15           -7.27253E-02   19            .557575       .562298
 16           -.436361       19          -1.05455       1.14126

               AVERAGE       STD.
----------------------------------------
X-DIFF         8.82149E-07   .862226
Y-DIFF        -7.15256E-07   1.01038
DISTANCE       1.07499       .693047

DONE
```

CONTRIBUTED PROGRAM **BASIC**

DCZOC
36747

TITLE: DECIMAL-TO-OCTAL CONVERTER

DESCRIPTION:

This program converts decimal integers in the range of Ø to plus or minus 262143 to their corresponding octal equivalents.

Attempted conversion of a number that is out of range or not an integer will cause an error diagnostic message to be printed followed by program termination.

INSTRUCTIONS:

Load and run program. When "DECIMAL?" is printed, enter the decimal number to be converted and press the RETURN key.

The program will perform the conversion and print the word "OCTAL" followed by the octal equivalent of the decimal number entered.

Following this, "DECIMAL?" will be printed again, allowing another decimal number to be entered as described in first paragraph.

To terminate the program, enter Ø when "DECIMAL?" is printed.

SPECIAL CONSIDERATIONS:

To use this program as a subroutine to another BASIC program, delete lines 8930 through 8990; the variable Z will now have to be defined by the main program.

The main program uses the subroutine by first setting Z to the decimal number to be converted followed by a GOSUB 9ØØØ. On return, Z will have been replaced by the octal equivalent of the decimal number originally in Z.

ACKNOWLEDGEMENTS:

Carl Davidson
HP, Automatic Measurement Division

```
RUN

RUN
DC2OC


DECIMAL ?1024
OCTAL  2000

DECIMAL ?32768
OCTAL  100000.

DECIMAL ?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

DE-10R
DE-1OR
36032

TITLE: FIRST ORDER DIFFERENTIAL EQUATION

DESCRIPTION:

This program solves the initial value problem for a first order differential equation by the second order Runge-Kutta method.

The initial value problem is of the form:

$$Y' = F(X,Y)$$
$$Y(X_0) = Y_0$$

INSTRUCTIONS:

Enter the differential equation $Y' = F(X,Y)$ in line 8900 as follows:

8900 DEF FNF(Y) = F(X,Y)

and enter the data in line 9900 as follows:

9900 DATA X_0, Y_0, B, H, L

where: X_0 = the initial X value

Y_0 = the value of Y evaluated at X_0

B = the upper limit of integration

H = the integration of step size

L = the step size of X for print out

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

RUN DE-10R

```
GET-$DE-10R
8900 DEF FNF(Y)=-X/Y
9900 DATA 0,1,.01,.10,1
RUN
DE-10R

VALUE OF X      VALUE OF Y

 0               1
 .1              .994988
 .2              .979796
 .3              .95394
 .4              .916516
 .5              .866027
 .6              .800002
 .7              .714145
 .8              .600004
 .9              .435896
 1               3.64845E-02

DONE
```

CONTRIBUTED PROGRAM **BASIC**

DE220R
DE-2OR
36033

TITLE: SECOND ORDER DIFFERENTIAL EQUATION

DESCRIPTION: This program solves the initial value problem for a second order differential equation by the second order Runge-Kutta method.

The initial value problem is of the form:

$$Y'' = F(X,Y,Y')$$

$Y(X_0) = Y_0$

$Y'(X_0) = Y_0'$

INSTRUCTIONS: The function Y'' must be entered in line 8900 by

DEF FNF(X) = f(X,Y,Z)

where Z = Y'.

Enter the data in line number 9900 as follows:

9900 DATA X_0,Y_0,Y_0',B,H,L

where: X_0 = the initial X value
Y_0 = the value of Y evaluated at X_0
Y_0' = the value of Y' evaluated at X_0
B = the upper limit of integration
H = the integration step size
L = the step size of X for print out

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

RUN
DE-20R
DE+20R

VALUE OF X	VALUE OF Y	VALUE OF Y'
0	0	1
.1	9.59594E-02	.928758
.2	.187501	.910593
.3	.27965	.94011
.4	.376964	1.01333
.5	.483667	1.1275
.6	.603758	1.28089
.7	.741113	1.4727
.8	.899566	1.70292
.9	1.08299	1.9723
1	1.29537	2.28224
1.1	1.54085	2.63478
1.2	1.82382	3.0326
1.3	2.14897	3.47897
1.4	2.52134	3.97778
1.5	2.94641	4.53356
1.6	3.43011	5.15146
1.7	3.97895	5.83737
1.8	4.60005	6.59788
1.9	5.30124	7.4404
2	6.09111	8.37317
2.1	6.97914	9.40539
2.2	7.97577	10.5473
2.3	9.09255	11.8101
2.4	10.3422	13.2066
2.5		

STOP

CONTRIBUTED PROGRAM **BASIC**

DETER4
36263

TITLE: DETERMINANTS, CHARACTERISTIC POLYNOMIALS AND INVERSES OF MATRICES

DESCRIPTION:

This program will generate the determinant of an n by n matrix, as well as the characteristic polynomial and the inverse of the matrix. The determinant is equal to the constant term of the characteristic polynomial.

INSTRUCTIONS:

The first input called for is the order (size) of the matrix, i.e. if the matrix is 4x4 you would input a 4. This number must be less than or equal to 20. Then input the elements of the matrix itself, first the elements in order of the first row of the matrix (separated by commas), then the elements of the second row, and so on. There may be a slight delay before the determinant is printed out if the order is larger than four, or if the system is heavily loaded. Then, after the characteristic polynomial is printed, the user is asked if he wants the inverse of the matrix. The response to this question (YES or NO) may be abbreviated to the first letter. Again there may be a delay before the inverse (if any) is printed.

SPECIAL CONSIDERATIONS:

Matrix Z is the input matrix, Y and X are used for intermediate calculations, W is used to store the traces of the powers of Z and the coefficients of the characteristic polynomial, and V is used to store the inverse of Z. (These are all matrices.) Common variables used: Z, Z0, Z1, Z2, Z3, Z7, Z8, and Z9. String variable used: Z$.

Reference:

Finkbeiner, Daniel T., II, Introduction to Matrices and Linear Transformations. San Francisco: W. H. Freeman and Company, 2nd ed., 1966., pp 173-176.

ACKNOWLEDGEMENTS:

Phillip Short
Burnsville Senior High School

```
RUN

RUN
DETER4


          THE DETERMINANT, CHARACTERISTIC POLYNOMIAL
                 AND THE INVERSE OF MATRICES


WHAT IS THE ORDER OF THE MATRIX?3

NOW ENTER THE MATRIX.

 ?1,0,2,3,4,5,5,6,7

THE DETERMINANT OF :

 1              0              2

 3              4              5

 5              6              7


IS -6

THE COEFFICIENTS OF ITS CHARACTERISTIC POLYNOMIAL ARE


          -1      12     1     -6


DO YOU WANT THE INVERSE OF THIS MATRIX : ?YES


THE INVERSE IS

 .333333       -2              1.33333

-.666667        .5            -.166667

 .333333        1             -.666667


VERIFICATION - THE PRODUCT OF THE MATRIX AND ITS INVERSE IS :

 .999999        0              0

 0              1              0

 0              0              1.


DONE
RUN
DETER4

          THE DETERMINANT, CHARACTERISTIC POLYNOMIAL
                 AND THE INVERSE OF MATRICES


WHAT IS THE ORDER OF THE MATRIX?5

NOW ENTER THE MATRIX.

 ?1,-2,3,-2,-2,2,-1,1,3,2,1,1,2,1,1,1,-4,-3,-2,-5,3,-2,2,2,-2

THE DETERMINANT OF :

 1             -2              3              -2              -2

 2             -1              1               3               2

 1              1              2               1               1
```

1	-4	-3	-2	-5
3	-2	2	2	-2

IS 118

THE COEFFICIENTS OF ITS CHARACTERISTIC POLYNOMIAL ARE

-1 -2 -30 83 204 118

DO YOU WANT THE INVERSE OF THIS MATRIX : ?Y

THE INVERSE IS

-.101695	.237288	1.69492	.711864	-.59322
-.237288	-.279661	.788136	.161017	-5.08475E-02
.186441	-.101695	-.440678	-.305085	.254237
-.152542	-.144068	-.957627	-.432203	.610169
.118644	.38983	.355932	.169491	-.474576

VERIFICATION - THE PRODUCT OF THE MATRIX AND ITS INVERSE IS :

1	0	0	0	0
0	1	0	0	0
0	0	1.	0	0
0	0	0	1.	0
0	0	0	0	1

DONE
RUN
DETER4

THE DETERMINANT, CHARACTERISTIC POLYNOMIAL
AND THE INVERSE OF MATRICES

WHAT IS THE ORDER OF THE MATRIX?4

NOW ENTER THE MATRIX.

?1,1,1,1,3,4,5,6,1,2,3,4,10,0,-1,-2

THE DETERMINANT OF :

1	1	1	1
3	4	5	6
1	2	3	4
10	0	-1	-2

IS 0

THE COEFFICIENTS OF ITS CHARACTERISTIC POLYNOMIAL ARE

1 -6 -17 -27 0

DO YOU WANT THE INVERSE OF THIS MATRIX : ?Y
THE MATRIX IS SINGULAR, AND THEREFORE HAS NO INVERSE.
DONE

EXTADD
36888-18040

TITLE: 40 DIGIT PRECISION STRING ADDITION

DESCRIPTION:

EXTADD is an extraction from EXTPRE, 40 DIGIT PRECISION STRING ARITHMETIC. It has been found from several users of EXTPRE that 90% of the programs written to utilize EXTPRE need only the part which does addition, and that Z8, which returns the number of digits in the result, is not needed. This subroutine has been written to fulfill that need, and runs about 7% to 9% faster than EXTPRE.

INSTRUCTIONS:

Variables used are: A, A1, A2, A3, A4, A5, A6, A9
B, C, D, A(*), B(*), C(*)
D$, Y$, Z$

This subroutine begins at statement number 9000. It is intended to be appended to a user's program. The subroutine performs arithmetic operations on the contents of two strings, Y$ and Z$. The result is returned in Z$. Leading or embedded blanks, a minus sign, commas, and a decimal point may or may not be contained in Y$ and/or Z$ when they are passed to the subroutine.

When the subroutine is called, the variable D must contain a number between 0 and 6 which indicates the largest number of digits to the right of the decimal point which the user desires.

An example of a calling sequence for this subroutine is as follows:

```
211  Y$ = "36243163.123"
212  Z$ = "1234567.89"
213  D = 3
214  Z9 = 2
215  GOSUB 9000
216  PRINT Z$
```

Statement 216 will cause 361188595.233 to be printed on the user's terminal.

SPECIAL CONSIDERATIONS:

A marginal increase in subroutine execution speed may be achieved by removing line 9001 D$="0123456789" and inserting it at the top of the calling program (it need only be done once, instead of for each call, as is now done, if the user does not use it anywhere else in his program.)

It is not necessary to set Z9 to indicate the type of operation as in EXTPRE, since EXTADD does only addition. This instructions are eliminated in both the subroutine and its calling program.

If more than addition is to be done, use EXTPRE.

ACKNOWLEDGEMENTS:

Stephen S. MacKenzie
Hewlett-Packard/Atlanta, Georgia

EXTPRE
36144

TITLE: 40-DIGIT PRECISION MATHEMATICS

DESCRIPTION:

This time-shared BASIC subroutine is designed to be appended to a time-shared BASIC program to enable a user to do calculations with up to 40 digits of precision.

INSTRUCTIONS:

Variables used are:

A, A1, A2, A3, A4, A5, A6, A9
B, B1, B2, B3, B4, B5
C, C1
D, Z8; Z9
A(*), B(*), C(*)
D$, Y$, Z$

A marginal increase in subroutine execution speed may be achieved by removing line 9001 D$="0123456789" and inserting it at the top of the calling program (it need only be done once, if the user does not use it anywhere else in his program.)

An additional 5% to 7% improvement in speed can be achieved by deleting lines 9032-9036 and changing line 9031 to REM. This should be done only if the variable Z8, which returns the number of digits in the result, is not needed by the user.

INSTRUCTIONS continued on page 2

SPECIAL CONSIDERATIONS:

If only addition is to be done, the user should use the subroutine EXTADD.

ACKNOWLEDGEMENTS:

David Sanders (Original)
Hewlett-Packard/Cupertino
Stephen MacKenzie (Modification, Rev. B)
Hewlett-Packard/Atlanta, Georgia

CONTRIBUTED PROGRAM BASIC

EXTPRE
36144

TITLE: 40-DIGIT PRECISION MATHEMATICS

DESCRIPTION: This time-shared BASIC subroutine is designed to be appended to a time-shared BASIC program to enable a user to do calculations with up to 40 digits of precision.

INSTRUCTIONS: See Page 2

SPECIAL CONSIDERATIONS: The subroutine uses the following variables:

Array Variables: A(16), B(16), C(16)
Strings: Y$(72), Z$(72), D$(10)
Simple Variables: A, A1, A2, A3, A4, A5, A6, A8, A9, B, B1, B2, B3, B4, B5, C, D, R, W, C1, Z8, Z9

All necessary arrays and strings are dimensioned within the subroutine, and should not be dimensioned by the user.

ACKNOWLEDGEMENTS: David Sanders
Hewlett-Packard/Cupertino

INSTRUCTIONS

This subroutine begins at statement number 9000. It is intended to be appended to a user's program. The subroutine performs arithmetic operations on the contents of two strings, Y$ and Z$. The result is returned in Z$. Leading or embedded blanks, a minus sign, commas, and a decimal point may or may not be contained in Y$ and/or Z$ when they are passed to the subroutine.

When the subroutine is called, the variable Z9 must contain the value 1, 2, 3, or 4. These values indicate to the routine to perform the following operations:

1 - Addition (Y$ + Z$)

2 - Subraction (Y$ - Z$)

3 - Multiplication (Y$ * Z$)

4 - Division (Y$ / Z$)

Any other value of Z9 will cause a diagnostic to be issued.

When the subroutine is called, the variable D must contain a number between 0 and 6 which indicates the largest number of digits to the right of the decimal point which the user desires.

An example of a calling sequence for this subroutine is as follows:

```
211  Y$ = "36243163.123"

212  Z$ = "1234567.89"

213  D =  3

214  Z9 = 2

215  GOSUB 9000

216  PRINT Z$
```

Statement 216 will cause 361188595.233 to be printed on the user's terminal.

The subroutine returns the variable Z8, which contains the number of digits in the result (Z$). If the result is negative, a minus sign is the first character of Z$.

```
RUN

211 Y$="234567812345.432"
212 Z$="111111111111.1"
213 D=5
214 Z9=1
215 GOSUB 9000
216 PRINT Z$
217 STOP
APPEND-EXTPRE
RUN
EXTPRE

345678923456.53200

DONE
```

CONTRIBUTED PROGRAM **BASIC**

FACTOR
36037

TITLE: FINDS PRIME FACTORS OF POSITIVE INTEGERS

DESCRIPTION: This program will find the prime factors of a number.

INSTRUCTIONS: The program will request the number to be factored and print out all prime factors and their multiplicity.

Input a zero (Ø) or negative number to terminate execution.

SPECIAL CONSIDERATIONS: The number to be factored must be a positive integer less than 32768.

ACKNOWLEDGEMENTS:

RUN

```
RUN
FACTOR

PROGRAM TO FIND PRIME FACTORS OF A POSITIVE INTEGER.
TO TERMINATE EXECUTION INPUT A 'Ø'.

WHAT NUMBER IS TO BE FACTORED?77

THE PRIME FACTORS OF 77   ARE:
PRIME            MULTIPLICITY
-----            ------------
 7                1
 11               1

WHAT NUMBER IS TO BE FACTORED?147

THE PRIME FACTORS OF 147  ARE:
PRIME            MULTIPLICITY
-----            ------------
 3                1
 7                2

WHAT NUMBER IS TO BE FACTORED?Ø

DONE
```

CONTRIBUTED PROGRAM **BASIC**

FNCTS
36017

TITLE: COMPUTES TRIG FUNCTIONS FOR COMPLEX ARGUMENTS

DESCRIPTION: This program computes the values of SIN, COS, TAN, SINH, COSH, TANH for a complex argument.

INSTRUCTIONS: The argument has the form

$$Z = A + iB$$

The program will request the values of A and B (in radians) during execution, then print out the real and imaginary parts of each function.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

```
GET-$FNCTS
RUN
FNCTS

ENTER THE REAL AND IMAGINARY PARTS OF THE ARGUMENT
RE(Z)= ?3
IM(Z)=
?2

SIN(Z):  RE= .530921           IM=-3.59057
COS(Z):  RE=-3.72455           IM=-.511822
TAN(Z):  RE=-9.88436E-03       IM= .965386
SINH(Z):  RE=-4.16891          IM= 9.1545
COSH(Z):  RE=-4.18963          IM= 9.10923
TANH(Z):  RE= 1.00324          IM=-3.76402E-03

DONE
```

CONTRIBUTED PROGRAM BASIC

GFFT
36030

TITLE: GENERAL FAST FOURIER TRANSFORM

DESCRIPTION:

This program is an efficient algorithm for finding the Fourier transform of a function. The expression which is evaluated is:

$$F(n) = \frac{1}{N} \sum_{i=o}^{N-1} F(i)e^{-jin\frac{\alpha\pi}{N}}$$

where the f(i) are in general complex.

The Cooley-Tukey algorithm is used, which allows dramatic savings in time and storage over conventional methods.

INSTRUCTIONS:

The user first specifies in line 100 how many (complex) data input there are by letting G = $\log_2$ of this number. i.e., LET G=3 implies that there are 8 complex input values. There must be an integer power of two input values.

The program reads the input values from a DATA tape in the order: Real(1), Imag(1), Real(2), Imag(2), ...,etc. The transform is then taken and printed out as:

Harmonic Number	Real Part	"J"	Imag Part

Line numbers #1 to #99 are available from data statements.

SPECIAL CONSIDERATIONS:

The number of input data must be an integer power of two. The input data are complex. If they are pure real, another routine is available which will find the transform more efficiently.

Inverse transforms can also be taken with this routine. The inverse transform is:

$$f(i) = \sum_{n=o}^{N-1} F(n)e^{jin\frac{2\pi}{N}}$$

To take such a transform, merely (1) remove lines 150 and 160, and (2) change the sign on line 250.

ACKNOWLEDGEMENTS:

Peter K. Bice
Hewlett-Packard/Microwave

RUN

```
GET-GFFT

TAPE
10  DATA 28,28
11  DATA 5.65686,-13.6569
12  DATA 0,-8.00001
13  DATA -2.34315,-5.65686
14  DATA -4,-4
15  DATA -5.65686,-2.34315
16  DATA -8.00001,0
17  DATA -13.6569,5.65686
100  LET G=3

RUN
GFFT

 0     -9.29832E-06                +J-8.10623E-06
 1      .999991                    +J .99999
 2      2.                         +J 1.99999
 3      3.                         +J 3.
 4      4.00001                    +J 4.00001
 5      5.00001                    +J 5.00001
 6      6.00001                    +J 6.00001
 7      7.                         +J 7.00001

DONE
```

CONTRIBUTED PROGRAM **BASIC**

GSIMEQ
36547

TITLE: SIMULTANEOUS LINEAR EQUATIONS

DESCRIPTION:

This program allows the user to specify a set of simultaneous linear equations in standard algebraic format. Some of the variables may be exogeneous (i.e., determined outside the system of equations). There must be as many endogeneous variables (i.e., those determined within the system of equations) as there are linear equations.

INSTRUCTIONS:

Each variable must be represented by a simple alphabetic character. As many as 20 variables can be included. All parameters must be specified explicitly. The program solves the system then prints the solution equations.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Graduate School of Business
Stanford University

```
RUN
GSIMEQ

DO YOU WANT INSTRUCTIONS?YES

I WILL ASK YOU FOR EXOGENEOUS VARIABLES AND
ENDOGENEOUS VARIABLES. EACH VARIABLE CONSISTS
OF A SINGLE ALPHABETIC CHARACTER. YOU MAY SEPARATE
VARIABLES WITH COMMAS OR BLANKS -- FOR EXAMPLE:
  EXOGENOUS VARIABLES: G,I
IF THERE ARE NO EXOGENEOUS VARIABLES, ANSWER --
   EXOGENEOUS VARIABLES: NONE
I WILL THEN ASK YOU FOR YOUR EQUATIONS.
YOU MAY USE ANY LINEAR EQUATION WITH CONSTANTS
(NOT VARIABLES) AS PARAMETERS.
MULTIPLICATION MAY BE EXPLICIT (*) OR IMPLICIT.
DO NOT PLACE A MINUS SIGN IMMEDIATELY AFTER '='.
HERE ARE SOME EXAMPLES --
  C+I+G=Y
  C=.9Y
  I=100-.2*Y
HERE GOES --

EXOGENEOUS VARIABLES: G
ENDOGENEOUS VARIABLES: C,I,Y

I AM GOING TO ASK YOU FOR  3     EQUATIONS

EQUATION: C=.7Y+50
EQUATION: I=.1Y-10
EQUATION: C+I+G=Y

C   =   190.00 +     3.50*G
I   =    10.00 +     0.50*G
Y   =   200.00 +     5.00*G

DONE
```

CONTRIBUTED PROGRAM **BASIC**

INTGR
36698

TITLE: COMPUTES A DEFINITE INTEGRAL BY MEANS OF THE THREE POINT GAUSSIAN INTEGRATION FORMULA

DESCRIPTION:

This program computes a definite integral by means of the three point Gaussian integration formula.

INSTRUCTIONS:

Enter the integrand, FUNC (Q), in line number 9100 using Z as the dependent variable. For example:

```
9100  LET Z = FUNC (Q)
```

Enter the input data in line number 9200, as follows:

```
9200  DATA A, B, K
```

where A = the lower limit of integration
B = the upper limit of integration
K = the number of intervals desired between A and B for the computation

Note: The larger K is, the smaller the interval size, and, hence, the more accurate the resulting answer will be.

The program begins at line number 9000.

The following variable are used in the routine:

Z, Q, Z1, Z2, Z3, Z4, Z5, Q1, Q2, Q3

Q, W are array names

I, J are used for internal looping

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9100  LET Z=EXP(Q)
9200  DATA 0,1,10
RUN
INTGR


THE INTEGRAL FROM 0     TO 1     FOR 10    INTERVALS IS 1.71828

DONE
```

INTGRS
36699

TITLE: COMPUTES THE AREA UNDER A CURVE

DESCRIPTION:

This program computes the area under a curve, its movement, its center of gravity along the y-axis, and its center of gravity along the x-axis, using Simpson's rule for numerical integration.

INSTRUCTIONS:

Enter data beginning in line number 9900, as follows:

9900 DATA S, F
9901 DATA X_1, Y_1, X_2, Y_2, ...X_n, Y_n

where: S = a spacing factor applied to all the x-values giving the distance between points on the x-axis
F = a weighting factor applied to all the y-values
X_k= the value of X in the kth data pair
Y_k- the value of Y in the kth data pair

The spacing factor permits integers to be input for the X values. For example, with a spacing factor of 100, input data values of X can be entered as 2, 4, and 6 to represent values 200, 400 and 600.

This program integrates with the original y-values, and then applies the weighting factor to the integrated values. This procedure allows the weighting factor to be used for such purposes as that of computing a total area by applying a factor of 2 to a half area.

Note that data line numbers must not exceed 9997.

Note: The integration algorithm is found as a subroutine between lines 9058 and 9100 of the program and can be extracted for use as a subroutine for other programs.

The program begins at line number 9000.

The following variables are used in the program:

A, F, G, H, I1, I2, M, R, S
A, S are array names
I is used for internal looping

SPECIAL CONSIDERATIONS:

There is an important restriction to the program which requires every interval to have at least one adjacent interval of equal length. Also, the program is limited to 40 pairs of data. The latter restriction can be changed by altering the DIM statement.

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

```
RUN

9900  DATA 1,1.59894
9901  DATA 0,.02
9902  DATA 2,.3091
9903  DATA 4,.4882
9904  DATA 6,.7123
9905  DATA 8,.8918
9906  DATA 10,1
9907  DATA 12,.8949
9908  DATA 14,.7326
9909  DATA 16,.5096
9910  DATA 18,.2404
9911  DATA 20,.0017

RUN
INTGRS


X-VALUE SPACING FACTOR    = 1
Y-VALUE WEIGHTING FACTOR = 1.59894

X VALUE         Y VALUE         WEIGHTED Y VALUE
 0                .02             3.19788E-02
 2                .3091           .494232
 4                .4882           .780602
 6                .7123           1.13892
 8                .8918           1.42593
 10               1               1.59894
 12               .8949           1.43089
 14               .7326           1.17138
 16               .5096           .81482
 18               .2404           .384385
 20               .0017           2.71820E-03


AREA UNDER CURVE = 18.7271
MOMENT OF AREA UNDER CURVE ABOUT THE Y-AXIS = 185.366

CENTER OF GRAVITY OF AREA UNDER CURVE FROM Y-AXIS = 9.89826
CENTER OF GRAVITY/DISTANCE ALONG X-AXIS = 9.89826    / 20    = .494913

DONE
```

CONTRIBUTED PROGRAM **BASIC**

LOGICK
36888-18015

TITLE: BOOLEAN ALGEBRA EVALUATOR

DESCRIPTION:

This program analyzes Boolean algebraic expressions, checks for proper syntax, and creates a truth table for any legal expression. If it finds an error in the syntax, it exits to an internal error routine that prints an appropriate error message, and returns to statement entry mode.

The program operates by translating the Boolean statement into a psuedo-machine-language program, stored in matrix P, and then running it for every combination of truth-values possible. Once this 'mini-program' is compiled, execution is very fast.

INSTRUCTIONS:

Legal variables are the letters A to Z. Legal operators are:

+ 'OR' inclusive or
* 'AND' and
- 'NOT' not

The program will accept any statement that is a legal combination of variables and operators. The types of errors that will generate error messages are shown in the sample RUN. The program will accept any number of levels of parentheses, and will evaluate the statement in the hierarchal order of those levels. However, within any level, evaluation is <u>strictly from left to right</u>.

Other than the above considerations, the program should be self-explanatory.

SPECIAL CONSIDERATIONS:

Truth table output of '0' and '1' may be changed to 'F' and "T" by changing D$ to "FT" (line 80). The logical operator * + - may be changed by altering the appropriate characters of B$ in line 90.

FOR INSTRUCTIONAL PURPOSES
Suitable Course(s): Intro Logic, Intro Programming, Digital Circuit Design, Boolean Algebra

Student Background Required: Boolean algebra.

The program was written as part of a directed study in Elementary Logic. It was used to quickly check elaborate theorems. The program could be used in conjunction with most any modern text on symbolic logic or Boolean algebra.

ACKNOWLEDGEMENTS:

A. B. Jensen
MacMurray College

RUN

```
RUN
LOGICK

THIS PROGRAM WILL PRODUCE A TRUTH TABLE FOR ANY BOOLEAN
ALGEBRA EXPRESSION THAT WILL FIT ON A 72-CHARACTER LINE.
 - = NOT
+ = IOR
* = AND
EVALUATION IS FROM LEFT TO RIGHT.



YOUR LOGICAL STATEMENT IS:
?A&B
ILLEGAL CHARACTER
      '&'
YOUR LOGICAL STATEMENT IS:
?A B
OPERATION ERROR: TWO ADJACENT SYMBOLS
YOUR LOGICAL STATEMENT IS:
?A*+B
OPERATION ERROR: TWO ADJACENT OPERATORS
YOUR LOGICAL STATEMENT IS:
?A-B
OPERATION ERROR: MISPLACED NOT
YOUR LOGICAL STATEMENT IS:
?A*((B+C)*D
UNEQUAL NUMBER OF RIGHT AND LEFT PARENTHESES
YOUR LOGICAL STATEMENT IS:
?A-+B
OPERATION ERROR: MISPLACED NOT
YOUR LOGICAL STATEMENT IS:
?A+A

TRUTH TABLE FOR A+A   :
 A    T/F
----------
 0      0
 1      1

YOUR LOGICAL STATEMENT IS:
?A+B

TRUTH TABLE FOR A+B   :
 A B    T/F
------------
 0 0      0
 0 1      1
 1 0      1
 1 1      1

YOUR LOGICAL STATEMENT IS:
?A*B

TRUTH TABLE FOR A*B   :
 A B    T/F
------------
 0 0      0
 0 1      0
 1 0      0
 1 1      1

YOUR LOGICAL STATEMENT IS:
?-(A*B)

TRUTH TABLE FOR -(A*B)   :
 A B    T/F
------------
 0 0      1
 0 1      1
 1 0      1
 1 1      0
```

```
YOUR LOGICAL STATEMENT IS:
?A*(B+C)

TRUTH TABLE FOR A*(B+C)   :
 A B C     T/F
--------------
 Ø Ø Ø      Ø
 Ø Ø 1      Ø
 Ø 1 Ø      Ø
 Ø 1 1      Ø
 1 Ø Ø      Ø
 1 Ø 1      1
 1 1 Ø      1
 1 1 1      1

YOUR LOGICAL STATEMENT IS:
?
DONE
```

NEWTON
36652

TITLE: INTERPOLATION OF NONLINEAR FUNCTIONS BY NEWTON'S FORMULA

DESCRIPTION:

NEWTON provides a simple means of interpolating tabulated functions. It uses Newton's Interpolation Formula:

$$B_{(T)} = B_{o'} + p\, d_{o'} + \frac{p(p-1)}{2}\, d_{o''}$$

where

$$p = \frac{T-T_o}{T_1-T_o} \qquad d_{o'} = B_1 - B_o \qquad d_{o''} = (B_o + B_2) - 2B_1$$

This program performs well on exponential and other functions where linear interpolation techniques are unsatisfactory. It has been used with good results on thermocouple calibration tables, blackbody radiation tables, and various exponential functions.

INSTRUCTIONS:

If large portions of a table are to be interpolated it is better to run the program several times than to attempt interpolation over too broad a range.

1. The program first asks for three equidistant arguments. These should be as close together as possible, and centered upon the region in which the interpolation is to be done.
2. The program will then ask for function values for these three arguments.
3. Next, respond with the limits between which you wish the interpolated table to be printed.
4. Finally, the program will ask for the size of the increments in the interpolated table.

SPECIAL CONSIDERATIONS:

This program is generally not suitable for interpolation of factorial functions.

Variables used: B,BO,B1,B2,K,K1,K2,T,TO,T1,T2,X

ACKNOWLEDGEMENTS:

Richard A. Milewski
Raytek Inc.

RUN

INTERPOLATION OF CUBE ROOT TABLE

```
RUN
NEWTON

INPUT THREE EQUIDISTANT ARGUMENTS
?8,10,12
INPUT FUNCTION VALUES FOR THE THREE ARGUMENTS
?2,2.15444,2.28943
INPUT TABLE INCREMENT SIZE
?.25
INPUT TABLE LIMITS (BETWEEN 8      &  12    )
?8,12



 8              2
 8.25           2.02037
 8.5            2.04043
 8.75           2.06019
 9              2.07965
 9.25           2.0988
 9.5            2.11765
 9.75           2.1362
 10             2.15444
 10.25          2.17238
 10.5           2.19001
 10.75          2.20734
 11             2.22437
 11.25          2.24109
 11.5           2.25751
 11.75          2.27362
 12             2.28943



DONE
```

INTERPOLATION OF TEMPERATURE CONVERSION TABLE

```
RUN
NEWTON

INPUT THREE EQUIDISTANT ARGUMENTS
?0,10,20
INPUT FUNCTION VALUES FOR THE THREE ARGUMENTS
?32,50,68
INPUT TABLE INCREMENT SIZE
?.5
INPUT TABLE LIMITS (BETWEEN 0      &  20    )
?5,15
```

```
5                41
5.5              41.9
6                42.8
6.5              43.7
7                44.6
7.5              45.5
8                46.4
8.5              47.3
9                48.2
9.5              49.1
10               50
10.5             50.9
11               51.8
11.5             52.7
12               53.6
12.5             54.5
13               55.4
13.5             56.3
14               57.2
14.5             58.1
15               59



DONE
```

CONTRIBUTED PROGRAM **BASIC**

OCZQC
OC-DC
36712

TITLE: OCTAL-TO-DECIMAL CONVERTER

DESCRIPTION:

This program converts octal integers in the range of Ø to plus or minus 777777 to their corresponding decimal equivalents.

Attempted conversion of a number that is out of this range or not octal will cause an error diagnostic message to be printed followed by program termination.

INSTRUCTIONS:

Load and run program. When "OCTAL ?" is printed, enter the octal number to be converted and press the RETURN key.

The program will perform the conversion and print the word "DECIMAL" followed by the decimal equivalent of the octal number entered.

Following this, "OCTAL ?" will be printed again, allowing another octal number to be entered as described in first paragraph.

To terminate the program, enter Ø when "OCTAL ?" is printed.

SPECIAL CONSIDERATIONS:

To use this program as a subroutine to another BASIC program, delete lines 8930 through 8990; the variable Z will now have to be defined by the main program.

The main program uses the subroutine by first setting Z to the octal number to be converted followed by a GOSUB 9ØØØ. On return, Z will have been replaced by the decimal equivalent of the octal number originally in Z.

ACKNOWLEDGEMENTS:

Carl Davidson
HP, Automatic Measurement Division

```
RUN

RUN
OC-DC
OC2DC

OCTAL ?2000
DECIMAL  1024

OCTAL ?100000
DECIMAL  32768.

OCTAL ?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

PARABO
36702

TITLE: FINDS THE EQUATION OF THE PARABOLA PASSING THROUGH 3 GIVEN POINTS

DESCRIPTION: This program finds the equation of the parabola passing through 3 given points.

INSTRUCTIONS: The coordinates X and Y of the three points will be required by the program.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

```
RUN

RUN
PARABO


THIS PROGRAM FINDS THE EQUATION OF A PARABOLA PASSING THROUGH
THREE POINTS.  YOU ENTER THE X AND Y COORDINATES OF EACH POINT.

FIRST POINT?2,9
SECOND POINT?9,0
THIRD POINT?14,9

THE EQUATION IS:  Y = .257143    X↑2 +-4.11429    X + 16.2


DO YOU WISH TO RUN AGAIN?YES

FIRST POINT?-1,1
SECOND POINT?0,0
THIRD POINT?1,1

THE EQUATION IS:  Y = 1    X↑2 + 0    X + 0


DO YOU WISH TO RUN AGAIN?YES

FIRST POINT?-1,-1
SECOND POINT?0,0
THIRD POINT?1,-1

THE EQUATION IS:  Y =-1    X↑2 + 0    X + 0


DO YOU WISH TO RUN AGAIN?YES

FIRST POINT?1,1
SECOND POINT?0,0
THIRD POINT?1,-1

THE EQUATION FOR THESE POINTS IS NOT A FUNCTION
AND THE COEFFICIENTS CANNOT BE DETERMINED BY THIS PROGRAM.


DO YOU WISH TO RUN AGAIN?NO

DONE
```

CONTRIBUTED PROGRAM **BASIC**

POLFTE
36246

TITLE: FITS LEAST-SQUARES POLYNOMIALS

DESCRIPTION:

This program fits least-squares polynomials to bivariate data, using an orthogonal polynomial method. Limits are 11-th degree fit and a maximum of 100 data points. Program allows user to specify the lowest degree polynomial to be fit, and then fits the polynomials in order of ascending degree.

INSTRUCTIONS:

At each stage, the index of determination is printed, and the user has the choice of going to the next higher degree fit, seeing either of two summaries of fit at that stage, or of stopping the program.

To use, enter data in line 9900 as follows:

```
9900 DATA N, D
      (Where N = Number of data points to be read
          and D = Initial (lowest) degree to be fit)

9901 Data X(1), Y(1), X(2), Y(2),...,X(N), Y(N)
               ..........
```

SPECIAL CONSIDERATIONS:

This program previously existed in the BASIC library as POLFIT, HP 36023A, and is now being reinstated in its original form under this new name. Another "POLFIT" program was submitted in March 1972 and a subsequent need for both versions became apparent.

ACKNOWLEDGEMENTS:

RUN

```
9900  DATA 6,2
9901  DATA 1,2,3,4,5,6,7,8,9,10,11,12
RUN
POLFTE

L E A S T - S Q U A R E S  P O L Y N O M I A L S

     NUMBER OF POINTS = 6
      MEAN VALUE OF X = 6
      MEAN VALUE OF Y = 7
       STD ERROR OF Y = 3.74166

  NOTE:  CODE FOR 'WHAT NEXT?' IS:

     0 = STOP PROGRAM
     1 = COEFFICIENTS ONLY
     2 = ENTIRE SUMMARY
     3 = FIT NEXT HIGHER DEGREE


POLYFIT OF DEGREE 2    INDEX OF DETERM = 1       WHAT NEXT?2


TERM           COEFFICIENT

 0              1
 1              1
 2              0

X-ACTUAL       Y-ACTUAL       Y-CALC         DIFF           PCT-DIFF

 1              2              2              0              0
 3              4              4              0              0
 5              6              6              0              0
 7              8              8              0              0
 9              10             10             0              0
 11             12             12             0              0

          STD ERROR OF ESTIMATE FOR Y = 0

   WHAT NEXT?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

POLY
36188

TITLE: POLYNOMIAL APPROXIMATION

DESCRIPTION:

This is a BASIC program which accepts X-Y data pairs and a polynomial degree, and approximates a function to fit the data. After the coefficients have been printed, the user has the option of going to the next higher degree, entering more data, or changing the degree entirely.

INSTRUCTIONS:

Input is conversational. The user is asked to give the degree of the polynomial, an x,y value to signal termination of input data, and the data pairs.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Susan Temple
Montana State University

RUN

```
POLY

PROGRAM TO FIND POLYNOMIAL TO APPROXIMATE A TABLE
OF X-Y DATA IN A MINIMUM RMS ERROR MANNER

DEGREE OF POLYNOMIAL N=?1
TYPE TERMINATOR VALUES
?0,0
TYPE X-Y PAIRS. 0     , 0      TERMINATES INPUT.
?-6,-6
?-5.2,-5
?-4.1,-4
?-3,-3
?-2,-2
?8,8
?15,15
?25,25
?150,150
?0,0

POLYNOMIAL OF DEGREE 1
COEFFICIENTS OF POLYNOMIAL SUMMATION A(I)*X↑I
I               A(I)
------------------
 0              3.88747E-02
 1              .995928


TYPE 1 TO GO TO NEXT HIGHER DEGREE
TYPE 2 TO ENTER MORE DATA
TYPE 3 TO CHANGE DEGREE
?1

POLYNOMIAL OF DEGREE 2
COEFFICIENTS OF POLYNOMIAL SUMMATION A(I)*X↑I
I               A(I)
------------------
 0              1.20597E-02
 1              .990747
 2              5.98444E-04


TYPE 1 TO GO TO NEXT HIGHER DEGREE
TYPE 2 TO ENTER MORE DATA
TYPE 3 TO CHANGE DEGREE
?
DONE
```

POLYGN
36703

TITLE: COMPUTES THE AREA ENCLOSED IN ANY POLYGON

DESCRIPTION: Computes the area enclosed in any polygon.

INSTRUCTIONS: After each question mark, type the X,Y coordinates of points on the perimeter in clockwise sequence. The last point entered must be the same as the first.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

```
RUN

RUN
POLYGN

AFTER EACH ? TYPE THE X,Y COORDINATES OF POINTS ON THE
PERIMETER IN CLOCKWISE SEQUENCE.
THE LAST POINT MUST BE THE SAME AS THE FIRST.
?2,3
?6,8
?9,11
?2,3
THE AREA IS 1.5

DONE
```

POWER2
36888-18009

TITLE: POWERS OF TWO TABLES

DESCRIPTION: This program is intended to be used when a Powers of Two Table is needed (as is often the case for an Assembler programmer). It also demonstrates extended precision integer arithmetic through the use of arrays. The 'RUN' is paginated for 11 inch sheets (a header line is printed every 66 lines).

INSTRUCTIONS: Just GET and RUN program.

SPECIAL CONSIDERATIONS: Array B and String B$ have dimensions corresponding to the accuracy limits. One can have more precision through the manipulation of the dimensions and certain counters. As the program is written it will print up to 2^{162}.

ACKNOWLEDGEMENTS: Mr. Leslie Citrome (Student)
West Hill High School of Montreal

RUN

```
RUN
POWER2




                              POWERS OF TWO TABLE

 1      2
 2      4
 3      8
 4      16
 5      32
 6      64
 7      128
 8      256
 9      512
10      102 4
11      204 8
12      409 6
13      819 2
14      163 84
15      327 68
16      655 36
17      131 072
18      262 144
19      524 288
20      104 8576
21      209 7152
22      419 4304
23      838 8608
24      167 7721 6
25      335 5443 2
26      671 0886 4
27      134 2177 28
28      268 4354 56
29      536 8709 12
30      107 3741 824
31      214 7483 648
32      429 4967 296
33      858 9934 592
34      171 7986 9184
35      343 5973 8368
36      687 1947 6736
37      137 4389 5347 2
38      274 8779 0694 4
39      549 7558 1388 8
40      109 9511 6277 76
41      219 9023 2555 52
42      439 8046 5111 04
43      879 6093 0222 08
44      175 9218 6044 416
45      351 8437 2088 832
46      703 6874 4177 664
47      140 7374 8835 5328
48      281 4749 7671 0656
49      562 9499 5342 1312
50      112 5899 9068 4262 4
51      225 1799 8136 8524 8
52      450 3599 6273 7049 6
53      900 7199 2547 4099 2
54      180 1439 8509 4819 84
55      360 2879 7018 9639 68
56      720 5759 4037 9279 36
57      144 1151 8807 5855 872
```

POWERS OF TWO TABLE

58	288	2303	7615	1711	744				
59	576	4607	5230	3423	488				
60	115	2921	5046	0684	6976				
61	230	5843	0092	1369	3952				
62	461	1686	0184	2738	7904				
63	922	3372	0368	5477	5808				
64	184	4674	4073	7095	5161	6			
65	368	9348	8147	4191	0323	2			
66	737	8697	6294	8382	0646	4			
67	147	5739	5258	9676	4129	28			
68	295	1479	0517	9352	8258	56			
69	590	2958	1035	8705	6517	12			
70	118	0591	6207	1741	1303	424			
71	236	1183	2414	3482	2606	848			
72	472	2366	4828	6964	5213	696			
73	944	4732	9657	3929	0427	392			
74	188	8946	5931	4785	8085	4784			
75	377	7893	1862	9571	6170	9568			
76	755	5786	3725	9143	2341	9136			
77	151	1157	2745	1828	6468	3827	2		
78	302	2314	5490	3657	2936	7654	4		
79	604	4629	0980	7314	5873	5308	8		
80	120	8925	8196	1462	9174	7061	76		
81	241	7851	6392	2925	8349	4123	52		
82	483	5703	2784	5851	6698	8247	04		
83	967	1406	5569	1703	3397	6494	08		
84	193	4281	3113	8340	6679	5298	816		
85	386	8562	6227	6681	3359	0597	632		
86	773	7125	2455	3362	6718	1195	264		
87	154	7425	0491	0672	5343	6239	0528		
88	309	4850	0982	1345	0687	2478	1056		
89	618	9700	1964	2690	1374	4956	2112		
90	123	7940	0392	8538	0274	8991	2422	4	
91	247	5880	0785	7076	0549	7982	4844	8	
92	495	1760	1571	4152	1099	5964	9689	6	
93	990	3520	3142	8304	2199	1929	9379	2	
94	198	0704	0628	5660	8439	8385	9875	84	
95	396	1408	1257	1321	6879	6771	9751	68	
96	792	2816	2514	2643	3759	3543	9503	36	
97	158	4563	2502	8528	6751	8708	7900	672	
98	316	9126	5005	7057	3503	7417	5801	344	
99	633	8253	0011	4114	7007	4835	1602	688	
100	126	7650	6002	2822	9401	4967	0320	5376	
101	253	5301	2004	5645	8802	9934	0641	0752	
102	507	0602	4009	1291	7605	9868	1282	1504	
103	101	4120	4801	8258	3521	1973	6256	4300	8
104	202	8240	9603	6516	7042	3947	2512	8601	6
105	405	6481	9207	3033	4084	7894	5025	7203	2
106	811	2963	8414	6066	8169	5789	0051	4406	4
107	162	2592	7682	9213	3633	9157	8010	2881	28
108	324	5185	5365	8426	7267	8315	6020	5762	56
109	649	0371	0731	6853	4535	6631	2041	1525	12
110	129	8074	2146	3370	6907	1326	2408	2305	024
111	259	6148	4292	6741	3814	2652	4816	4610	048
112	519	2296	8585	3482	7628	5304	9632	9220	096
113	103	8459	3717	0696	5525	7060	9926	5844	0192
114	207	6918	7434	1393	1051	4121	9853	1688	0384

POWERS OF TWO TABLE

```
115    415 3837 4868 2786 2102 8243 9706 3376 0768
116    830 7674 9736 5572 4205 6487 9412 6752 1536
117    166 1534 9947 3114 4841 1297 5882 5350 4307 2
118    332 3069 9894 6228 9682 2595 1765 0700 8614 4
119    664 6139 9789 2457 9364 5190 3530 1401 7228 8
120    132 9227 9957 8491 5872 9038 0706 0280 3445 76
121    265 8455 9915 6983 1745 8076 1412 0560 6891 52
122    531 6911 9831 3966 3491 6152 2824 1121 3783 04
123    106 3382 3966 2793 2698 3230 4564 8224 2756 608
124    212 6764 7932 5586 5396 6460 9129 6448 5513 216
125    425 3529 5865 1173 0793 2921 8259 2897 1026 432
126    850 7059 1730 2346 1586 5843 6518 5794 2052 864
127    170 1411 8346 0469 2317 3168 7303 7158 8410 5728
128    340 2823 6692 0938 4634 6337 4607 4317 6821 1456
129    680 5647 3384 1876 9269 2674 9214 8635 3642 2912
130    136 1129 4676 8375 3853 8534 9842 9727 0728 4582 4
131    272 2258 9353 6750 7707 7069 9685 9454 1456 9164 8
132    544 4517 8707 3501 5415 4139 9371 8908 2913 8329 6
133    108 8903 5741 4700 3083 0827 9874 3781 6582 7665 92
134    217 7807 1482 9400 6166 1655 9748 7563 3165 5331 84
135    435 5614 2965 8801 2332 3311 9497 5126 6331 0663 68
136    871 1228 5931 7602 4664 6623 8995 0253 2662 1327 36
137    174 2245 7186 3520 4932 9324 7799 0050 6532 4255 472
138    348 4491 4372 7040 9865 8649 5598 0101 3064 8530 944
139    696 8982 8745 4081 9731 7299 1196 0202 6129 7061 888
140    139 3796 5749 0816 3946 3459 8239 2040 5225 9412 3776
141    278 7593 1498 1632 7892 6919 6478 4081 0451 8824 7552
142    557 5186 2996 3265 5785 3839 2956 8162 0903 7649 5104
143    111 5037 2599 2653 1157 0767 8591 3632 4180 7529 9020 8
144    223 0074 5198 5306 2314 1535 7182 7264 8361 5059 8041 6
145    446 0149 0397 0612 4628 3071 4365 4529 6723 0119 6083 2
146    892 0298 0794 1224 9256 6142 8730 9059 3446 0239 2166 4
147    178 4059 6158 8244 9851 3228 5746 1811 8689 2047 8433 28
148    356 8119 2317 6489 9702 6457 1492 3623 7378 4095 6866 56
149    713 6238 4635 2979 9405 2914 2984 7247 4756 8191 3733 12
150    142 7247 6927 0595 9881 0582 8596 9449 4951 3638 2746 624
151    285 4495 3854 1191 9762 1165 7193 8898 9902 7276 5493 248
152    570 8990 7708 2383 9524 2331 4387 7797 9805 4553 0986 496
153    114 1798 1541 6476 7904 8466 2877 5559 5961 0910 6197 2992
154    228 3596 3083 2953 5809 6932 5755 1119 1922 1821 2394 5984
155    456 7192 6166 5907 1619 3865 1510 2238 3844 3642 4789 1968
156    913 4385 2333 1814 3238 7730 3020 4476 7688 7284 9578 3936
157    182 6877 0466 6362 8647 7546 0604 0895 3537 7456 9915 6787 2
158    365 3754 0933 2725 7295 5092 1208 1790 7075 4913 9831 3574 4
159    730 7508 1866 5451 4591 0184 2416 3581 4150 9827 9662 7148 8
160    146 1501 6373 3090 2918 2036 8483 2716 2830 1965 5932 5429 76
161    292 3003 2746 6180 5836 4073 6966 5432 5660 3931 1865 0859 52
162    584 6006 5493 2361 1672 8147 3933 0865 1320 7862 3730 1719 04
```

DONE

CONTRIBUTED PROGRAM **BASIC**

QUADRA
36704

TITLE: ANALYZES A QUADRATIC EQUATION

DESCRIPTION:

This program analyzes a quadratic equation:

$$ax^2+bxy+cy^2+dx+ey+f=0$$

where: a,b,c,d,e and f are the coefficients.

INSTRUCTIONS:

Enter the coefficients when required.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

RUN
QUADRA

THIS PROGRAM ANALYZES A QUADRATIC EQUATION IN X AND Y.
THE EQUATION IS:  AX↑2+BXY+CY↑2+DX+EY+F=0  .

TYPE YOUR COEFFICIENTS IN ORDER:  A,B,C,D,E,F
SEPARATED BY COMMAS.

WHAT IS YOUR EQUATION?1,0,1,-4,8,-16

THE EQUATION IS A CIRCLE WITH ECCENTRICITY 0.
THE CENTER IS ( 2     ,-4     )
THE RADIUS IS  6.
THE AREA IS  113.097




DO YOU WANT TO RUN AGAIN?Y

TYPE YOUR COEFFICIENTS IN ORDER:  A,B,C,D,E,F
SEPARATED BY COMMAS.

WHAT IS YOUR EQUATION?9,0,16,0,0,-144

THE EQUATION IS AN ELLIPSE WITH ECCENTRICITY  .661438
THE CENTER IS ( 0     , 0     )
THE ANGLE FROM THE X-AXIS TO THE MAJOR AXIS
IS  0      DEGREES.
THE FOCI ARE ( 2.64575     , 0     )
         ARE ( 2.64575     , 0     )
THE SUM OF THE FOCAL RADII IS 8.
THE MAJOR AXIS HAS A LENGTH OF 8.
THE MINOR AXIS HAS A LENGTH OF 6.
THE FOCAL CHORD HAS A LENGTH OF 1.5
THE MAJOR AXIS IS A LINE:
 0     X+ 1.         Y= 0
THE MINOR AXIS IS THE LINE:
 1.          X+ 0    Y= 0
THE DIRECTRICES ARE THE LINES:
 1.          X+ 0    Y= 6.04743
AND
 1.          X+ 0    Y=-6.04743
THE AREA IS  37.6991



DO YOU WANT TO RUN AGAIN?N

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ROMINT
36022

TITLE: INTEGRATES A FUNCTION (ROMBERG METHOD)

DESCRIPTION: This program will integrate a given function by the Romberg Method.

INSTRUCTIONS: Define the integrand in line 100 by a "DEF FNF(X)=..." statement i.e.,

100 DEF FNF(X)=X↑2"

The lower and upper limits of integration will be requested during execution. The output is the sequence of the first five approximations which should converge to the value of the integral. The number of approximations may be increased by changing the value of N in line 107.

SPECIAL CONSIDERATIONS: Specifying an order of integration greater than 5 can result in excessive running time and usually will not improve accuracy.

ACKNOWLEDGEMENTS: B. Gateley
Colorado College

RUN

```
GET-$ROMINT
8900 DEF FEN←←NF(X)=SIN(X)
9900 DATA Ø,3.14158,3
RUN
ROMINT

INTEGRAL= 2.

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ROOTER
36024

TITLE: FINDS THE ROOTS OF POLYNOMIALS

DESCRIPTION: This program finds the roots of a polynomial using Barstow's Method.

INSTRUCTIONS: Before running the program supply data as follows:

9900 DATA N,A_N,A_{N-1},...,A_1,$A_Ø$

99xx DATA Ø

where N is the order of the polynomial

A_i is the coefficient of the ith term of the polynomial of the form

$$A_N X^N + A_{N-1} X^{N-1} + \ldots + A_1 X + A_Ø$$

This program will solve for the roots of as many polynomials as desired, and will terminate execution when reading a value for N of zero (Ø).

In cases where the program is not converging to a solution the user will be asked if he wishes to continue or go to the next polynomial.

SPECIAL CONSIDERATIONS: There are some forms of polynomials for which this program cannot find the roots. If this condition occurs the program will indicate this and continue to the next polynomial.

For high order polynomials the running time may be excessive since many iterations may be required.

ACKNOWLEDGEMENTS:

RUN

```
GET-$ROOTER
9900 DATA 3
9901 DATA 1,6,11,6
9902 DATA 2
9903 DATA 1,0,1
9904 DATA 0
RUN
ROOTER

POLYNOMIAL NUMBER 1     IS OF ORDER 3

   COEFFICIENTS (IN DESCENDING ORDER) ARE:

        1       6       11      6

   THE ROOTS ARE:

      -3.
      -.999998      AND  -2.


POLYNOMIAL NUMBER 2     IS OF ORDER 2

   COEFFICIENTS (IN DESCENDING ORDER) ARE:

        1       0       1

   THE ROOTS ARE:

        0    + J * 1      AND    0     - J * 1


DONE
```

CONTRIBUTED PROGRAM **BASIC**

ROOTNL
36697

TITLE: FINDS THE ROOTS OR FIXED POINTS OF A NON-LINEAR FUNCTION

DESCRIPTION:

This program finds the roots or fixed points of a non-linear function, F(X), using Wegstein's acceleration of the standard iteration procedure.

INSTRUCTIONS:

The function, F(X), whose root is to be found is entered in line 9050 as follows:

```
9050  LET Y = F(X)
```

If one desires to find the fixed points of a function (i.e., the roots of the equation "X-F(X) + 0"), enter line 9050 as follows:

```
9050  LET Y = X-F(X)
```

Convergence or divergence of the process can be determined from the values of F(X) that are printed out.

Division by zero may indicate that the process is close to a root.

The program begins at line number 9000.

The following variables are used in the program:

X, X1, X2, Y, Y1, W
I is used for internal looping

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9050  LET Y=SIN(X)-COS(X)
RUN
ROOTNL

SUPPLY STARTING VALUE.
?0

 X                F(X)

-1.              -1.38177
 2.61936          1.36552
 .820382          4.94643E-02
 .752767         -4.61392E-02
 .785399          9.53674E-07
 .785398         -3.57628E-07
 .785398          0
 .785398          0

DIVISION BY 0.
SUPPLY A NEW STARTING VALUE OR TYPE 999999 TO STOP.
?-1

 X                F(X)

-1.38177         -1.17009
-3.49202          1.28252
-2.38852          4.57134E-02
-2.34774         -.011959
-2.3562           1.43051E-06
-2.35619          1.19209E-07
-2.35619          1.19209E-07

DIVISION BY 0.
SUPPLY A NEW STARTING VALUE OR TYPE 999999 TO STOP.
?999999

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ROOTNR
36696

TITLE: LOCATES A ROOT OF A FUNCTION WHOSE DERIVATIVE IS KNOWN

DESCRIPTION:

This program locates a root of a function whose derivative is known by means of the Newton-Raphson iteration method.

INSTRUCTIONS:

Enter the function, F(X), whose root is to be found, and its derivative, DERIV(X), in lines 9002 and 9018 as follows:

```
9002  DEF FNX(X) = "F(X)"
9018  LET Y1 = "DERIV(X)"
```

Enter data in line 9900 as follows:

```
9900  DATA X0, A
```

where: X0 = the initial approximation for the root
A = the maximum difference allowed between F(X) and 0 for an acceptable root.

The program begins at line number 9000.

The following variables are used in the program:

A, N, X, Y, Y1
I is used for internal looping
FNX is a user defined function

Example: Input

```
9002  DEF FNX(X)=X↑2-2*SQR(X)+1
9018  LET Y1=2*X-1/SQR(X)
```

Output

```
F(X)           X

 2.17157       2
 .481891       1.34053
 8.27429E-02   1.07564
 5.98431E-03   1.00594
 4.00922E-05   1.00004
 0             1

DONE
```

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9002 DEF FNX(X)=X↑2-2*SQR(X)+1
9018 LET Y1=2*X-1/SQR(X)



RUN
ROOTNR


F[X]                X

 2.17157            2
 .481391            1.34053
 8.27429E-02        1.07564
 5.98431E-03        1.00594
 4.33922E-05        1.00004
 0                  1

DONE
```

CONTRIBUTED PROGRAM **BASIC**

RTCFFT
36029

TITLE: REAL TO COMPLEX FAST FOURIER TRANSFORM

DESCRIPTION:

This program is an algorithm for computing a set of F(n) such that

$$F(n) = \frac{1}{N} \sum_{i=0}^{N-1} f(i)e^{-jin.\frac{2\pi}{N}}$$

which is a discrete Fourier transform. The Cooley-Tukey algorithm is used, which gives a tremendous saving in time and core space over conventional methods for computing this function.

Restrictions on the application of this algorithm are: (1) the number of initial data points, f(i), must be an integer power of two; and (2) these data points must be real. These data points are listed in DATA statements, and the variable "G" is given the integer value of $\log_2$ (# of data points, N) in line 100. When the program is run, it prints N/2+1 complex values of F(n), starting with F(0) and ending with F(N/2). Note that this is a complete set. The input data are real--this is sufficient to guarantee that F(n)=F(N-n) and F(n)+F(N+n) for all n.

INSTRUCTIONS:

Input data is listed in DATA statements #1 to #99.

Line 100 must be rewritten "LET G = (Log_2 of the number of data points)".

Output data consists of the harmonic number followed by the real and imaginary parts of the function at that harmonic number.

SPECIAL CONSIDERATIONS:

The initial data are read into a matrix. This matrix is operated on to yield the final data, so the original data is lost.

ACKNOWLEDGEMENTS:

Peter K. Bice
Hewlett-Packard/Microwave

RUN

```
TAPE

10  DATA 64
11  DATA -66.4929
12  DATA 19.3137
13  DATA -15.2127
14  DATA 7.99999
15  DATA -6.7919
16  DATA 3.31371
17  DATA -2.63087
18  DATA -7.62939E-06
19  DATA .551735
20  DATA -3.31371
21  DATA 3.89897
22  DATA -8
23  DATA 8.73302
24  DATA -19.3137
25  DATA 13.9446
100  LET G=4


RUN
RTCFFT

 0    -5.72205E-06    +J 0
 1     .999997     +J 1.
 2    2.           +J 2.
 3    3      +J 3.
 4    4.           +J 4.
 5    5      +J 5.00001
 6    6.           +J 6.
 7    7.           +J 7.
 8    8.           +J 0

DONE
```

SIMPLX
36888-18030

TITLE: SOLVES LINEAR PROGRAMS (CONDENSED TABLEAU METHOD)

DESCRIPTION:

This program solves linear programs and matrix games and finds the best uniform solution for linear equation.

For linear programs, the data consists of

(1) greater than inequalities of the form

$$a_1 x_1 + \ldots + a_n x_n + b \geq 0,$$

(2) less than inequalities of the form

$$a_1 x_1 + \ldots + a_n x_n + b \geq 0,$$

(3) equalities of the form

$$a_1 x_1 + \ldots + a_n x_n + b = 0,$$

and

(4) a linear function of the form

$$c_1 x_1 + \ldots + c_n x_n + d = w$$

INSTRUCTIONS:

After the user has entered the coefficients of the linear constraints and the coefficients of the linear function, the computer finds the solution of the linear program as well as the solution to the dual program.

To avoid cycling problems, the computer randomly chooses pivot spots when two or more coordinates satisfy the rules of the simplex algorithm.

For matrix games, the user enters his matrix and the computer converts the problem into a linear program and solves it. The optimal strategy for the row and columns players are then printed.

The maximum possible size of the input data is a 20 x 20 matrix for the linear programs and a 19 x 19 matrix for the matrix games.

The program will find integer solutions if the constraints are given with integer coefficients.

Instructions continued on following page.

ACKNOWLEDGEMENTS: Donald E. Ramirez
University of Virginia

INSTRUCTIONS continued

PROBLEM: (See first sample RUN)

Maximize $x_1 + x_2 + x_3 + x_4 + 0$

Subject to

$$\begin{cases} 3x_1 + 4x_2 + 5x_3 + 6x_4 - 7 \geq 0 \\ 4x_1 + 5x_2 + 6x_3 + 7x_4 - 8 \geq 0 \\ x_1 + 2x_2 + 3x_3 + 4x_4 - 5 \geq 0 \\ 2x_1 + 3x_2 + 4x_3 + 5x_4 - 6 = 0 \\ x_1, x_2, x_3, x_4, \geq 0 \end{cases}$$

PROBLEM: (See second sample RUN)

Maximize $2x_1 + 5x_2 + x_3 - 1000 \geq 0$

Subject to

$$\begin{cases} x_1 + 2x_2 + 4x_3 - 3000 \geq 0 \\ 3x_1 + x_2 + 6x_3 - 2000 = 0 \\ x_1, x_2, x_3 \geq 0 \\ x_1, x_2, x_3 \ \underline{\text{INTEGRAL}} \end{cases}$$

PROBLEM: (See third sample RUN)

Find the optional strategies for the matrix game

$$\begin{bmatrix} 2 & 4 & -5 & 6 \\ -3 & 4 & 4 & 6 \\ 0 & 1 & 3 & 2 \end{bmatrix}$$

PROBLEM: (See fourth sample RUN)

Find the best uniform solution of

$$\begin{aligned} x_1 + x_2 &= 3 \\ x_1 - x_2 &= 1 \\ x_1 + 2x_2 &= 7 \\ 2x_1 + 4x_2 &= 11.1 \\ 2x_1 + x_2 &= 6.9 \\ 3x_1 + x_2 &= 7.2 \end{aligned}$$

RUN

```
RUN

SIMPLX

THIS PROGRAM SOLVES LINEAR PROGRAMS AND MATRIX GAMES
AND FINDS THE BEST UNIFORM SOLUTION FOR LINEAR EQUATIONS
TYPE LP OR MG OR BS?LP
A PROGRAM TO MAXIMIZE OR MINIMIZE A LINEAR FUNCTION
SUBJECT TO LINEAR CONSTRAINTS
ENTER MAX OR MIN ?MAX
DO YOU WANT TO SEE THE PIVOT STEPS (Y OR N)?N
ENTER NUMBER OF VARIABLES, EQUALITIES (=0) ?4,1
ENTER NUMBER OF INEQUALITIES OF THE FORM >=0,<=0?2,1
ENTER THE SIMPLEX TABLEAU ROW BY ROW - GREATER THAN'S FIRST,
LESS THAN'S NEXT, EQUALITIES NEXT, AND THE LINEAR FUNCTION LAST
?3,4,5,6,-7
??4,5,6,7,-8
??1,2,3,4,-5
??2,3,4,5,-6
??1,1,1,1,0
INITIAL TABLEAU (Y OR N)?N
THE MAXIMUM OF THE LINEAR FUNCTION IS  3.

THE SOLUTION OCCURS AT
( 3.          , 0     , 0     , 0     )

THE DUAL SOLUTION OCCURS AT
( 0     , 0     , 0     , 0     )

DO YOU WANT SOLUTIONS TO BE MORE INTEGRAL (Y OR N)?N


DONE




RUN
SIMPLX

THIS PROGRAM SOLVES LINEAR PROGRAMS AND MATRIX GAMES
AND FINDS THE BEST UNIFORM SOLUTION FOR LINEAR EQUATIONS
TYPE LP OR MG OR BS?LP
A PROGRAM TO MAXIMIZE OR MINIMIZE A LINEAR FUNCTION
SUBJECT TO LINEAR CONSTRAINTS
ENTER MAX OR MIN ?MIN
DO YOU WANT TO SEE THE PIVOT STEPS (Y OR N)?N
ENTER NUMBER OF VARIABLES, EQUALITIES (=0) ?3,1
ENTER NUMBER OF INEQUALITIES OF THE FORM >=0,<=0?1,1
ENTER THE SIMPLEX TABLEAU ROW BY ROW - GREATER THAN'S FIRST,
LESS THAN'S NEXT, EQUALITIES NEXT, AND THE LINEAR FUNCTION LAST
?2,5,1,-1000
??1,2,4,-3000
??3,1,6,-2000
??16,32,23,0
INITIAL TABLEAU (Y OR N)?N
THE MINIMUM OF THE LINEAR FUNCTION IS  9666.67

THE SOLUTION OCCURS AT
( 444.444     , 0     , 111.111     )

THE DUAL SOLUTION OCCURS AT
( 3     , 0     , 0     )

DO YOU WANT SOLUTIONS TO BE MORE INTEGRAL (Y OR N)?Y

PROGRAM ASSUMES ALL VARIABLES ARE INTEGER VARIABLES AND ADDS
A CUTTING PLANE ON THE VARIABLE WITH THE LARGEST FRACTIONAL PART.
```

```
THE MINIMUM OF THE LINEAR FUNCTION IS  9694

THE SOLUTION OCCURS AT
( 438.         , 1.99988     , 114.        )

THE DUAL SOLUTION OCCURS AT
( 0     , 0     , 0     , 8.99999     , 35.         )
SOLUTION IS NEARLY INTEGRAL.

DONE


RUN
SIMPLX

THIS PROGRAM SOLVES LINEAR PROGRAMS AND MATRIX GAMES
AND FINDS THE BEST UNIFORM SOLUTION FOR LINEAR EQUATIONS
TYPE LP OR MG OR BS?MG
A PROGRAM TO SOLVE MATRIX GAMES
DO YOU WANT TO SEE THE PIVOT STEPS (Y OR N)?N
ENTER THE NUMBER OF ROWS,COLUMNS?3,4
ENTER THE MATRIX ROW BY ROW
?2,4,-5,6
??-3,4,4,6
??0,1,3,2
MATRIX IS
 2      4      -5      6

-3      4       4      6

 0      1       3      2

THE VALUE OF THE MATRIX GAME IS  .6

THE OPTIMAL STRATEGY FOR THE ROW PLAYER IS
( .3           , 0     , .7          )

THE OPTIMAL STRATEGY FOR THE COLUMN PLAYER IS
( .8           , 0     , .2           , 0     )

DONE


RUN
SIMPLX

THIS PROGRAM SOLVES LINEAR PROGRAMS AND MATRIX GAMES
AND FINDS THE BEST UNIFORM SOLUTION FOR LINEAR EQUATIONS
TYPE LP OR MG OR BS?BS
ENTER NUMBER OF EQUATIONS, VARIABLES?6,2
ENTER THE EQUATIONS IN THE FORM A*X1+B*X2=C
?1,1,3,1,-1,1,1,2,7,2,4,11.1,2,1,6.9,3,1,7.2
MINIMAX DEVIATION IS  1
THE SOLUTION OCCURS AT
( 2     , 2     )

DEVIATIONS ARE
 1     -1     -1      .9          -.9           .8
DONE
```

CONTRIBUTED PROGRAM **BASIC**

SOLVIT
36196

TITLE: SIMULTANEOUS LINEAR EQUATIONS USING GAUSSIAN REDUCTION

DESCRIPTION:

SOLVIT solves simultaneous linear equations using Gaussian reduction with positioning for size.

INSTRUCTIONS:

The first data input is the number of equations in the set. This is followed by the coefficients fed in by rows including the right side (the driving functions).

For example if the equations 9X+4Y=1 and 3X+5Y=Ø are to be solved the data would be

```
1 DATA 2
2 DATA 9,4,1
3 DATA 3,5,Ø
```

The data lines should be numbered consecutively starting with one. This insures that no data left over from another problem are read in place of your new data.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Dr. Edward J. White
University of Virginia

RUN

```
SOLVIT

SOLVIT SOLVES SIMULTANEOUS EQUATIONS USING GAUSSIAN
REDUCTION WITH POSITIONING FOR SIZE. THE FIRST DATA INPUT
IS THE NUMBER OF EQUATIONS IN THE SET.  THIS IS FOLLOWED
BY THE COEFFICIENTS FED IN BY ROWS INCLUDING THE RIGHT
SIDE (THE DRIVING FUNCTIONS).
FOR EXAMPLE IF THE EQUATIONS 9X+4Y=1 AND 3X+5Y=0 ARE TO
BE SOLVED THE DATA WOULD BE
1 DATA 2
2 DATA 9,4,1
3 DATA 3,5,0
THE DATA LINES SHOULD BE NUMBERED CONSECUTIVELY STARTING
WITH ONE. THIS INSURES THAT NO DATA LEFT OVER FROM ANOTHER
PROBLEM ARE READ IN PLACE OF YOUR NEW DATA.
 IF YOU DO NOT WANT THESE INSTRUCTIONS REPEATED THE
 NEXT TIME YOU GET SOLVIT, JUST FEED IN YOUR DATA BEFORE
 CALLING FOR A RUN.
NOW FEED IN YOUR DATA AND CALL FOR A RUN.

DONE


1  DATA 2
2  DATA 9,4,1
3  DATA 3,5,0
RUN
SOLVIT



V 1, V 2, ETC. STAND FOR VARIABLE 1, VARIABLE 2 ETC.

V 1     =        .151515

V 2     =       -9.09091E-02

DONE
```

CONTRIBUTED PROGRAM **BASIC**

SPHERE
36034

TITLE: SOLVES SPHERICAL TRIANGLES

DESCRIPTION: SPHERE solves spherical triangles having the apex at the north pole and the two other corners defined by their respective latitude and longitude.

INSTRUCTIONS: Input data in the following format:

9900 DATA LLA°,LLA",LLO°,LLO",RLA°,RLA",RLO°,RLO"
9901 DATA AL°,AL"

LLA°,LLA" = Local Latitude in degrees, and minutes.
LLO°,LLO" = Local Longitude in degrees, and minutes.
RLA°,RLA" = Remote Latitude in degrees, and minutes.
RLO°,RLO" = Remote Longitude in degrees and minutes.
AL°,AL" = Observed altitude (if available).

If the observed altitude is not available enter Ø,Ø for AL°,AL".

Enter negative degree values for South Latitudes and East Longitudes.

As many triangles may be solved as desired by entering new data statements after the preceding triangle has been solved. Begin all data statements at 9900.

SPECIAL CONSIDERATIONS: "OUT OF DATA IN LINE 9010" is compatible with normal program termination.

ACKNOWLEDGEMENTS:

RUN

```
9900 DATA 27,42,15,3,86,1,-2,5,0,0
RUN
SPHERE
   S P H E R I C A L   T R I A N G L E   S O L U T I O N
CASE NUMBER 1
LOCAL POSITION:

 27    DEG     42    MIN   NORTH LATITUDE
 15    DEG     3     MIN   WEST LONGITUDE


REMOTE POSITION:

 86    DEG     1     MIN   NORTH LATITUDE
 2     DEG     5     MIN   EAST LONGITUDE


LOCAL HOUR ANGLE (AT NORTH POLE):

 17.1          DEG
 17    DEG     8     MIN
 1     HRS     8     MIN      32     SEC


ZENITH (GREAT CIRCLE) DISTANCES:

 58.5          DEG
 58    DEG     30    MIN
 3510     NAUTICAL MILES
 4042       STATUTE MILES


TRUE BEARINGS (GREAT CIRCLE COURSES):

 REMOTE POSITION FROM LOCAL POSITION:
 1.4           DEG
 1     DEG     22.5          MIN

 LOCAL POSITION FROM REMOTE POSITION:
 197.8         DEG
 197   DEG     48.8          MIN


ALTITUDE (REMOTE CELESTIAL POSITION
   ABOVE LOCAL POSITION HORIZON):

 31.5          DEG
 31    DEG     30    MIN
```

TITLE: COMPLEX NUMBER CALCULATOR

UHCX
36888-18005

DESCRIPTION:

UHCX is a calculator program which permits the operator to obtain functions of complex numbers and to perform complex arithmetic operations using numbers of the form '*a + bi*'. In the calculator the form of the numbers is described in the more common engineering terminology of 'R + JX' where 'R' is <u>the</u> real portion of the argument, 'X' is the imaginary portion and 'J' = $\sqrt{-1}$. The user may type functions and/or arithmetic operations with parentheses and functions nested as deeply as desired. The answer is outputted both in rectangular form (R + JX) and in polar form with 'Z' equal to the absolute value of the magnitude and the angle is expressed in both radians and degrees. In construction, the calculator program consists of syntax error check routines followed by a reverse Polish conversion program which results in the real and imaginary arguments being placed in push-up stacks and a Polish execution stack being generated for the operators. This is followed by an interpreter which executes from the Polish stack in accordance with the hierarchy of priorities assigned to the operators and functions. Instructions are provided in the program for use including a list of the functions implemented and sample inputs. Blanks are ignored in the input string, however, the input string length is restricted to 72 characters. Only complex arguments are permitted, but either portion of the argument may be made zero.

INSTRUCTIONS:

Highest priority is assigned to the unary operator. Parentheses may be used to modify priority as operations with the parenthesis are evaluated as the second priority. The next priority level is assigned to conversion instructions. 'CONR' (convert from polar to rectangular using radians for the angle argument) uses the general form CONR <magnitude> , < angle > . COND < magnitude >, < angle > also converts from polar to rectangular form, however the argument of the angle must be in degrees. Conversion from rectangular to polar may be accomplished simply by typing the complex numbers such as '3 + J4' or using the conversion command CONP < magnitude >, < angle > .

The next priority of execution is assigned to functions including the vertical arrow ' ' (power/root). These functions are sine (SIN), cosine (COS), tangent (TAN), hyperbolic sine (HSIN), hyperbolic cosine (HCOS), hyperbolic tangent (HTAN), square root (SQR), log base e (LOG), epsilon to the power of a complex number (EXP). Multiplication and division of complex numbers is assigned the next lower priority level with the least priority being assigned to addition and subtraction. All inputs containing operations of equal priority are evaluated from left to right. Implied multiplication is not permitted nor is the use of '-J' to indicate that the imaginary argument is negative, therefore, 2 - J7 is not a permitted input and will result in an error message being outputted. The correct input for that quantity should be 2 + J - 7. The sign of the number must be immediately adjacent to the number itself. In running the program, the user has the option of obtaining instructions by typing 'YES' or 'Y' or refusing them by typing 'NO' or 'N'. The user is next asked to, "Input your expression followed by carriage return:" Sample inputs are attached which indicate how to input various functions.

Continued on following page.

SPECIAL CONSIDERATIONS:

See following page.

ACKNOWLEDGEMENTS:

Professor George C. McKay, Jr.
University of Houston
Electrical-Electronics Technology

INSTRUCTIONS continued

Functions may call additional functions - that is they may be nested. The answer is typed as noted previously in both polar and rectangular form. The notes in script on the attached computer print-outs explain in greater detail the limitations on entering data. Among the syntax errors checked are illegal functions or characters, unequal number of left and right parentheses, illegal format of the complex number such as the use of -J instead of +J, implied multiplication, and use of an arithmetic operator between complex numbers without the second complex number being enclosed in parentheses (this was found to be necessary in order to separate addition or subtraction from a unary operator function).

SPECIAL CONSIDERATIONS

This calculator will perform all the functions of the following programs currently in the contributed library: FNCTS (A 303), SQR (Z) (A 303), CXARTH (A 303), CXEXP (A 303). The writer utilized the work of generating the necessary equations for the functions implemented in the calculator from these programs. In addition, a modified version of the program ALFTOV is used in the calculator as a subroutine. The user of the calculator should be aware of the round off errors which will occur in functions as complex as those implemented. All functions have been checked with a number of sets of data using complex functions in FORTRAN and the results have compared favorably to a minimum of four digits accuracy.

RUN

```
RUN
UHCX


U OF H TECH COMPLEX CALCULATOR; INSTRUCTIONS?YES
FUNCTIONS IMPLEMENTED ARE SIN,COS,TAN,HSIN (HYPERBOLIC SINE)
HCOS, & HTAN (ARGUMENTS IN RADIANS);SQR(Z), '↑' (POWER/ROOT)
LOG (BASE E), EXP (EPSILON TO THE POWER OF R+JX), AND THE
ARITHMETIC OPERATIONS ARE *, /, +, -. SAMPLE INPUTS:
'SIN 2+J-5' OR SIN(2+J-5)..'(2+J5)↑(-3+J-7)'..SIGN MUST
BE NEXT TO THE NUMBER.. 2-J7 IS NOT PERMITTED...
TO CONVERT FROM RECTANGULAR-TO-POLAR FORM TYPE 'CONP'
FOLLOWED BY  ''R' +J 'X'' WHERE 'R' IS THE 'REAL' & 'X' IS
THE IMAGINARY ARGUMENT. FOR EXAMPLE: 'CONP 3+J4' OR '3,4'
WILL RESULT IN Z=5 AT AN ANGLE OF .927295 RADIANS (53.1301
DEGREES). TO CONVERT FROM POLAR-TO-RECTANGULAR FORM:
TYPE 'CONR <MAGNITUDE>, <ANGLE>' I.E. CONR 5, .927295
IF THE ANGLE IS IN RADIANS - OR COND 5, 53.1301 IF THE
ANGLE IS IN DEGREES..
INPUT YOUR EXPRESSION FOLLOWED BY A CARRIAGE RETURN:
SQR 625+J0

ANSWER =  25    +J  0
Z =  25
ANGLE =  0     RADIANS ( 0     DEGREES)
NEXT:
EXP 0 +J 3.14159

ANSWER = -1.          +J  2.24704E-06
Z =  1.
ANGLE = -2.24704E-06   RADIANS (-1.28746E-04   DEGREES)
NEXT:
((((2+J7E1)↑(2+J0)/(1.2345E-2+J1.786))*(2+J3))+(3+J4))

ANSWER = -7948.18    +J  5902.01
Z =  9899.87
ANGLE = -.638723    RADIANS (-36.5962    DEGREES)
NEXT:
SQR (-2+J-67)

ANSWER =  5.70219    +J -5.87494
Z =  8.18718
ANGLE = -.800319    RADIANS (-45.8549    DEGREES)
NEXT:
```

```
HTAN SIN LOG 2.12345E1 +J -.--3.1298E-1

ANSWER =  8.55689E-02   +J -.014578
Z =  8.68019E-02
ANGLE = -.168745     RADIANS (-9.66841     DEGREES)
NEXT:
EXP LOS 2.12345 +J -8.98765
ILLEGAL CHARACTER OR OPERATION
NEXT:
EXP LOG 2.12345 +J -8.98765

ANSWER =  2.12345     +J -8.98765
Z =  9.23509
ANGLE = -1.33879     RADIANS (-76.7069     DEGREES)
NEXT:
COS 3+J4(4+J6)
IMPLIED '*'
NEXT:
COS 3+J4 *(4+J6)

ANSWER =  38.5219     +J  7.71781
Z =  39.2874
ANGLE =  .197731     RADIANS ( 11.3292     DEGREES)
NEXT:
2+J5 SIN 3+J4
IMPLIED '*'
NEXT:
3+J4

ANSWER =  3     +J  4
Z =  5
ANGLE =  .927295     RADIANS ( 53.1301     DEGREES)
NEXT:
CONR 5, .927295

ANSWER =  3.           +J  4
Z =  5.
ANGLE =  .927295     RADIANS ( 53.1301     DEGREES)
NEXT:
SIN COND 5, 53.1301

ANSWER =  3.85363     +J -27.0168
Z =  27.2902
ANGLE = -1.42911     RADIANS (-81.8822     DEGREES)
NEXT:
SIN 3+J4

ANSWER =  3.85374     +J -27.0168
Z =  27.2903
ANGLE = -1.42911     RADIANS (-81.882      DEGREES)
NEXT:
2-J8
ILLEGAL CHARACTER OR OPERATION
NEXT:
2+J8

ANSWER =  2     +J  8
Z =  8.24621
ANGLE =  1.32582     RADIANS ( 75.9638     DEGREES)
NEXT:
4+J4 ↑5+J0
ILLEGAL CHARACTER OR OPERATION
NEXT:
4+J4↑(5+J0)

ANSWER = -4096.        +J -4096.
Z =  5792.62
ANGLE =  .785398     RADIANS ( 45.          DEGREES)
NEXT:
((2+J5)+(3+J8)
UNEQUAL # OF '(' & ')'
NEXT:

DONE
```

VOLUME II
CONTENTS (Continued)

400 PROBABILITY AND STATISTICS

VOLUME II
CONTENTS (Continued)

400 PROBABILITY AND STATISTICS (Continued)

ANCOV
36294

TITLE: ANALYSIS OF COVARIANCE

DESCRIPTION:

This program computes an analysis of covariance table, F-ratio and adjusted means for groups of unequal size.

INSTRUCTIONS:

Enter data in line 400 in the following manner:

- first enter observation one for the first subject of group one, followed by observation two of the same subject. Observations for the second through nth subjects of group one follows the first subject. Each additional group follows the first group, one at a time. For example:

```
400  DATA X(1), Y(1), X(2), Y(2), ... X(n1), Y(n1)
401  DATA X(1), Y(1), X(2), Y(2), ... X(n2), Y(n2)
```

where:

- $X(n_1)$ - the first observation of the last subject in group one.
- $Y(n_1)$ - the second observation of the last subject in group one.
- $X(n_2)$ - the first observation of the last subject in group two.
- $Y(n_2)$ - the second observation of the last subject in group two.

SPECIAL CONSIDERATIONS:

For further reference, check STATISTICAL METHODS, by George W. Snedecor, pp. 318-320.

FOR INSTRUCTIONAL PURPOSES
Suitable Courses: Tests and Measurements, Statistics and Student Seminars.

Student Background Required: An understanding of the meaning of an F-ratio.

The analysis of covariance program computes the difference between two or more groups of any size that were not matched groups before the beginning of the experimental period.

ACKNOWLEDGEMENTS:

Dr. John Ingold
Goshen College

```
RUN

RUN
ANCOV

ANALYSIS OF COVARIANCE                    NO. GROUPS?4

GROUP    1      NO. OBSERV.?3

GROUP    2      NO. OBSERV.?4

GROUP    3      NO. OBSERV.?5

GROUP    4      NO. OBSERV.?6


                  BETWEEN         THIN          TOTAL

  DF              3               14            17
SUM SQRS X        8.86108         124.75        133.611
SUM  XY           4.0835          106.083       110.167
SUM SQRS Y        39.4502         125.05        164.5
ADJ SS Y          38.8237         34.8401       73.6639
ADJ  DF           3               13            16
MEAN SQR          12.9412         2.68001       4.60399

F                 4.8288


MEAN ADJ Y( 1     ) 8.71391
MEAN ADJ Y( 2     ) 9.65156
MEAN ADJ Y( 3     ) 12.8142
MEAN ADJ Y( 4     ) 11.0302

DONE
```

CONTRIBUTED PROGRAM **BASIC**

TITLE: FACTORIAL ANALYSIS OF VARIANCE (FIVE-WAY, FOR ANY BALANCED DESIGN)

ANØVA
36870

DESCRIPTION:

This program performs up to a five way analysis of variance for any balanced design. The maximum number of subjects the program can handle is 1000. Input may be either through DATA statements or a data file.

INSTRUCTIONS:

The system consists of two programs: ANØVA and TANØV2 at statement 940. This statement may have to be changed depending on whether the programs are stored on a private library, a group library, or the public library.

If file input is used, the data must be stored on a sequential file. For very large problems, the program may take several minutes to run.

ACKNOWLEDGEMENTS:

Dr. William Terris, Robert Rosellini, Nestor Dyhdalo
De Paul University
Chicago, IL

```
RUN

RUN
ANOVA


A N A L Y S I S   O F   V A R I A N C E   P R O G R A M

2000F VERSION: MODIFIED ON 06/30/73


DO YOU WANT INSTRUCTIONS (1=YES, 0=NO)?1

*** INSTRUCTIONS ***
THIS PROGRAM COMPUTES UP TO A FIVE-WAY FACTORIAL ANOVA
WITH A MAX. OF 1000 SUBJECTS IN THE DESIGN. THE PROGRAM WILL
WORK FOR ANY BALANCED (EQUAL # OF SUBJ. PER CELL) DESIGN
THAT HAS AT LEAST ONE SUBJECT PER CELL. SINCE NO F-RATIOS
ARE PRINTED, ONE MUST CALCULATE THEM FROM THE SUMMARY TABLE.
DATA MAY BE ENTERED IN DATA STATEMENTS BEGINNING ON LINE 5000
OR FROM DATA FILES STORED ON DISC.
ENTER DATA SO THAT SUBJECTS ARE INCREMENTED FIRST (IF MORE THAN
ONE PER CELL) AND VARIABLE 'A' IS INCREMENTED LAST.
FOR EXAMPLE, IN A 2 X 2 DESIGN WITH TWO SUBJECTS PER CELL,
THE 8 DATA POINTS SHOULD BE ENTERED IN THIS ORDER:

      A       B       S
      1       1       1
      1       1       2
      1       2       1
      1       2       2
      2       1       1
      2       1       2
      2       2       1
      2       2       2

RUNNING THE PROGRAM DESTROYS DATA IN DATA STATEMENTS. IF YOU
WANT TO SAVE YOUR DATA, PUNCH ON PAPER TAPE BY TYPING PUN-5000
AND TURNING ON THE TAPE PUNCH BEFORE RUNNING. IF MORE THAN ONE
PROBLEM IS TO BE RUN AT A SINGLE TERMINAL SESSION, IT WILL BE
NECESSARY TO TYPE GET-$ANOVA BEFORE ENTERING DATA FOR ADDITIONAL
PROBLEMS. GET-$ANOVA MUST ALSO BE TYPED BEFORE RUNNING ADDITIONAL
PROBLEMS USING DATA FILES. NOW GET-$ANOVA, ENTER YOUR DATA,
AND RUN.

DONE


GET-ANOVA
5000  DATA 34,23,41,33,28,29
5010  DATA 12,14,15,17,13,10
5020  A-DATA 12,18,17,15,15,12
5030  DATA 22,23,26,27,29,21
PUN-5000
ANOVA

5000  DATA 34,23,41,33,28,29
5010  DATA 12,14,15,17,13,10
5020  DATA 12,18,17,15,15,12
5030  DATA 22,23,26,27,29,21
9999  END


RUN
ANOVA


A N A L Y S I S   O F   V A R I A N C E   P R O G R A M

2000F VERSION: MODIFIED ON 06/30/73


DO YOU WANT INSTRUCTIONS (1=YES, 0=NO)?0
```

```
1= DATA ON FILE, 0= DATA IN DATA STATEMENTS. WHICH?0
NUMBER OF VARIABLES?2
NUMBER OF REPLICATES (# OF SUBJ. PER CELL)?6
# OF LEVELS FOR VARIABLE A?2
# OF LEVELS FOR VARIABLE B?2

DO YOU WANT THE MEANS & SUMS OF SQUARES PRINTED FOR
POST-HOC COMPARISONS (1=YES, 0=NO)?1


GRAND MEAN= 21.08


VARIABLES        A      B
L E V E L        1      0     MEAN= 22.42
L E V E L        2      0     MEAN= 19.75
FOR VARIABLE:  A                     RAW SS= 128530.        CODE= 1

VARIABLES        A      B
L E V E L        0      1     MEAN= 23.08
L E V E L        0      2     MEAN= 19.08
FOR VARIABLE:  B                     RAW SS= 129170.        CODE= 2

VARIABLES        A      B
L E V E L        1      1     MEAN= 31.33
L E V E L        1      2     MEAN= 13.5
L E V E L        2      1     MEAN= 14.83
L E V E L        2      2     MEAN= 24.67
FOR VARIABLE:  A X B                 RAW SS= 71730.         CODE= 3

                      ***** SUMMARY TABLE *****
----------------------------------------------------------------------
SOURCE OF                   CODE  SUM OF      DEGREES OF      MEAN
VARIANCE                          SQUARES     FREEDOM        SQUARES
----------------------------------------------------------------------
A                            1     42.67        1              42.67
B                            2     96           1              96
A X B                        3     1148.16      1              1148.16
ERROR                              299          20             14.95
-------------------------------------------------
TOTAL                              1585.83      23

DONE



GET-ANOVA
TAP
5000  DATA 34,23,41,33,28,29
5010  DATA 12,14,15,17,13,10
5020  DATA 12,18,17,15,15,12
5030  DATA 22,23,26,27,29,21
9999  END

RUN
ANOVA


A N A L Y S I S   O F   V A R I A N C E   P R O G R A M

2000F VERSION: MODIFIED ON 06/30/73


DO YOU WANT INSTRUCTIONS (1=YES, 0=NO)?0

1= DATA ON FILE, 0= DATA IN DATA STATEMENTS. WHICH?0
NUMBER OF VARIABLES?3
NUMBER OF REPLICATES (# OF SUBJ. PER CELL)?1
# OF LEVELS FOR VARIABLE A?2
# OF LEVELS FOR VARIABLE B?2
# OF LEVELS FOR VARIABLE C?6
```

```
DO YOU WANT THE MEANS & SUMS OF SQUARES PRINTED FOR
POST-HOC COMPARISONS (1=YES, 0=NO)?0


GRAND MEAN= 21.08
```

***** SUMMARY TABLE *****

SOURCE OF VARIANCE	CODE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES
A	1	42.67	1	42.67
B	2	96	1	96
A X B	3	1148.16	1	1148.16
C	4	121.33	5	24.27
A X C	5	66.83	5	13.37
B X C	6	45.5	5	9.1
A X B X C	7	65.34	5	13.07
TOTAL		1585.83	23	

DONE

CONTRIBUTED PROGRAM **BASIC**

ANOVA3
36271

TITLE: THREE FACTORIAL ANALYSIS OF VARIANCE

DESCRIPTION:

This program computes an analysis of variance for an experiment with three factors. Each factor may have up to 8 levels. The number of observations for each cell must be the same.

The printout consists of a table listing sum of squares, mean squares, and F-ratios, for Rows, Columns, Layers, and the various interactions.

INSTRUCTIONS:

Enter data beginning in line 9000. The first four items must be the number of rows, then the number of columns, then the number of layers, and finally the number of observations in each cell (n).

Then enter the observations by cell, starting with Layer 1, Row 1, Column 1; the Layer 1, Row 1, Column 2; etc.

SPECIAL CONSIDERATIONS:

This program will handle up to an 8x8x8 analysis. To increase the number of levels allowed for any factor, change line 70 to read:

70 DIM X(R+1, (C+1)*(L+1)) , where R, C, L are the numbers of Rows, Columns, and Layers.

ACKNOWLEDGEMENTS:

A. B. Jensen
MacMurray College

RUN

ANOVA3

```
9000  DATA 2,3,2,6
9001  DATA 27,22,45,18,76,33
9002  DATA 31,37,52,45,86,66
9003  DATA 55,62,76,85,104,126
9004  DATA 55,40,81,50,36,70
9005  DATA 77,76,98,68,42,104
9006  DATA 132,104,96,70,89,142
9007  DATA 61,39,76,60,46,59
9008  DATA 61,71,82,92,103,105
9009  DATA 140,122,99,92,68,101
9010  DATA 88,92,95,103,51,73
9011  DATA 100,120,120,131,89,76
9012  DATA 142,150,96,105,80,125
```

RUN
ANOVA3

SOURCE TABLE

	SUM OF SQUARES	DF	MEAN SQUARE	F
ROW	7667.31	1	7667.31	15.9905
COLUMN	23630.1	2	11815.	24.6408
LAYER	9730.19	1	9730.19	20.2928
R*C	136.25	2	68.125	.142078
R*L	8.6875	1	8.6875	1.81182E-02
C*L	751.625	2	375.812	.783774
R*C*L	223.75	2	111.875	.233321
W/GROUP	28769.4	60	479.491	
TOTAL	70917.3	71		

DONE

CONTRIBUTED PROGRAM **BASIC**

TITLE: ONE-WAY ANALYSIS OF VARIANCE USING MEANS AND STANDARD DEVIATIONS AS INPUT — ANVA1 36871

DESCRIPTION:

This program does a one-way analysis of variance for up to 30 groups using sample sizes, means, and standard deviations for the individual groups as input.

INSTRUCTIONS:

Program asks for number of groups and number of cases, means, and standard deviation for each group. It then prints the ANOVA table.

ACKNOWLEDGEMENTS:

Bill Jarosz
DePaul University

```
RUN

RUN
ANVA1

ONE-WAY ANALYSIS OF VARIANCE USING SAMPLE MEANS AND STD. DEVS.


DO YOU NEED INSTRUCTIONS (1=YES,0=NO)?1

ALL DATA IS ENTERED WHILE THE PROGRAM IS RUNNING.
THE PROGRAM WILL ASK FOR NO. OF GROUPS, THEN FOR
THE NO. OF CASES, MEAN, AND STD. DEV. FOR EACH GROUP.
WHEN ALL DATA HAS BEEN ENTERED, THE ANOVA TABLE WILL BE
PRINTED.

DONE
RUN
ANVA1

ONE-WAY ANALYSIS OF VARIANCE USING SAMPLE MEANS AND STD. DEVS.


DO YOU NEED INSTRUCTIONS (1=YES,0=NO)?0

NO. OF GROUPS (30 MAX.)?3

FOR EACH GROUP ENTER NO. OF CASES, MEAN, STD. DEV.
GROUP 1     ?20,32.45,5.45
GROUP 2     ?20,34.4,3.85
GROUP 3     ?18,31.22,5.53


                    ANALYSIS OF VARIANCE TABLE

               S.S.          D.F.           M.S.          F

BETWEEN         98.3812       2              49.1906       1.98081

WITHIN          1365.85       55             24.8336

TOTAL           1464.23       57

     GRAND MEAN 32.7407

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ANVAR1
36039

TITLE: ANALYSIS OF VARIANCE FOR A RANDOMIZED ONE-WAY DESIGN

DESCRIPTION: This program computes an analysis of variance table for a completely randomized one-way design.

INSTRUCTIONS: Enter data beginning in line 9900 in the following manner: ~~first enter A, the total number of observations;~~ then M, the number of different treatments; then the N's, where N_j is the number of observations in the jth treatment; and lastly the observations themselves by first entering the observations of treatment 1, then the observations of treatment 2, and so on. For example:

```
9900 DATA M
9901 DATA N1,N2,...Nm
9902 DATA P(1),P(2),...P(N1)
9903 DATA Q(1),Q(2),...Q(n1)
9910 DATA Z(1),Z(2),...Z(Nm)
```

where:

M = the number of different treatments $\leq$ 20

N_k = the number of observations in the kth treatment $\leq$ 50

P_k = the value of the kth observation of treatment one

Q_k = the value of the kth observation of treatment two

Z_k = the value of the kth observation of the mth treatment

SPECIAL CONSIDERATIONS: The maximum number of different treatments is 20 and the maximum number of observations per treatment is 50. These restrictions can be changed by altering the DIM statement.

C,E,F,M,R,U,V,W

N,S,T,X are array names

I,J are used for internal looping

ACKNOWLEDGEMENTS: Jerry L. Mulcahy
Raychem Corporation

```
RUN
9900  DATA 5
9901  DATA 2,6,11,4,2
9902  DATA 83,85
9903  DATA 84,85,86,86,87,86
9904  DATA 87,87,87,88,88,88,88,88,85,88,90
9905  DATA 89,90,90,91
9906  DATA 90,92
9999  END

RUN
ANVAR1

ANALYSIS OF VARIANCE TABLE

GRAND TOTAL= 2188     NO. OBS.= 25    MEAN= 87.52


SOURCE            SS              DF              MS

TREATMENTS       94.375          4               23.5937
ERROR            25.875          20              1.29375

TOTAL            120.25          24


F = 18.2367     ON 4     AND 20    DEGREES OF FREEDOM.
PROBABILITY OF F>= 18.2367     WITH 4     AND 20    D.F. IS 0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ANVAR2
36040

TITLE: ANALYSIS OF VARIANCE (LATIN SQUARE DESIGN)

DESCRIPTION: This program computes an analysis of variance table and F-ratios for a simple Latin square design.

INSTRUCTIONS: Enter data in line 9900 in the following manner: first enter the number of treatments N (rows and columns); then the treatment assignments, Mij, by rows; and lastly, the observations, Xij, by rows. For example:

9900 DATA N
9901 DATA $M_{11}, M_{12}, \ldots, M_{1n}, M_{21}, \ldots, M_{n1}, M_{n2}, \ldots, M_{nn}$
9902 DATA $X_{11}, X_{12}, \ldots, X_{1n}$
9903 DATA $X_{21}, X_{22}, \ldots, X_{2n}$
⋮ ⋮
9910 DATA$X_{n1}, X_{n2}, \ldots X_{nn}$

where: N = the number of treatments in the matrix $\leq$ 10
Mij = the treatment assignment for the ith row and jth column
Xij = the value of the observation at the ith row and jth column.

SPECIAL CONSIDERATIONS: The maximum number of treatments is 10. In order to increase the number of allowable data elements, add a DIM statement in line 8999 for the variables M,R,C and T, with the required number of subscripts for each,

where: M = the matrix of treatment assignments with n rows and columns
R = an accumulator used to sum the observations for each row
C = an accumulator used to sum the observations for each column
T = an accumulator used to sum the observations for each treatment

ACKNOWLEDGEMENTS: Jerry L. Mulcahy
Raychem Corporation

```
RUN

LIST-9890
ANVAR2

9899  DATA 4
9900  DATA 1,2,3,4,4,1,2,3,3,4,1,2,2,3,4,1
9901  DATA 81,41,44,53
9902  DATA 38,97,42,49
9903  DATA 31,43,67,36
9904  DATA 57,33,43,81
9999  END


RUN
ANVAR2

ITEM            SUM-SQR         DEG. FREE.      MEAN-SQR        F-RATIO
----            -------         ----------      --------        -------
ROWS             359.5           3               119.833         1.18549
COLS             74.5            3               24.8333         .245672
TREATS           4626.5          3               1542.17         15.2564
ERROR            606.5           6               101.083

PROBABILITY OF F>= 1.18549     WITH 3    AND 6    D.F. IS .391361

PROBABILITY OF F>= .245672     WITH 3    AND 6    D.F. IS .861666

PROBABILITY OF F>= 15.2564     WITH 3    AND 6    D.F. IS 3.25394E-03

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ANVAR3
36172

TITLE: ANALYSIS OF VARIANCE FOR A TWO VARIABLES OF CLASSIFICATION FACTORIAL DESIGN.

DESCRIPTION:

This program computes an analysis of variance table for a two-way classification of variables design in which a single observation is made for each combination of levels.

The print out includes the analysis of variance level and a statement of the probability of the "F" values arising by chance.

The program is self documenting.

INSTRUCTIONS:

Enter data beginning in line 9900: First enter R, the number of rows; then C, the number of columns. In lines 9901 and succeeding lines, enter the data in row order from the design. For Example:

```
9900 Data R,C
9901 Data X(1,1),S(1,2),X(1,3)....X(1,C)
9902 Data X(2,1),X(2,2),X(2,3)....X(2,C)
       .      .      .      .         .
       .      .      .      .         .
       .      .      .      .         .
       .      .      .      .         .
99CR Data X(R,1),X(R,2),X(R,3)....X(R,C)
```

Where:

R = The Number of Rows $\leq$ 20

C = The Number of Rows $\leq$ 20

X(i,j) = The Observation in Row i and Column j

SPECIAL CONSIDERATIONS:

Maximum number of rows and columns is 20. This is established in line 9008. To change this size, change 9008 to read: 9008 Dim X(R,C) Where R and C are the number of Rows and Columns respectively.

Uses all letters except H,K,L,V and Y

ACKNOWLEDGEMENTS:

J. L. Mulcahy
Raychem Corporation

```
RUN

9900  DATA 3,4
9901  DATA 7,6,8,7
9902  DATA 2,4,4,4
9903  DATA 4,6,5,3
9999  END

RUN
ANVAR3

INSTRUCTIONS?- 1=YES, 2=NO
?1
THIS PROGRAM CALCULATES A TWO WAY ANALYSIS OF VARIANCE
TABLE. DATA IS ENTERED USING DATA STATEMENTS AT LINE
9900. ENTER THE NUMBER OF ROWS AND COLUMNS AT 9900 AND
THE OBSERVATIONS IN ROW ORDER STARTING AT LINE 9901.

                              ANOVA TABLE
SOURCE          SUM SQ        DEG FREE      MEAN SQ       F RATIO
ROWS             26            2             13            11.7
COLS             3.33331       3             1.1111        .999991
RESID            6.66669       6             1.11111
TOTAL            36            11


PROBABILITY OF F>= 11.7       WITH 2    AND 6    D.F. IS 8.49998E-03


PROBABILITY OF F>= .999991    WITH 3    AND 6    D.F. IS .454728

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ANVAR4
36173

TITLE: ANALYSIS OF VARIANCE FOR A TWO-WAY EXPERIMENT WITH REPEATED OBSERVATIONS

DESCRIPTION: This program computes a set of analysis of variance tables for a two-way classification of variables factorial design with replicated observations.

Two analyses of variance tables are included with an option for a third.

Table 1: Test of difference between means treating each combination of classifications as a separate population.

Table II: Test of difference between columns and between rows with a test for interaction effects.

Table III: Optional test combining interaction effects with the "within effect." Used if the interaction effect from Table II is not significant.

INSTRUCTIONS: Enter data beginning in line 9900: First enter R, the number of rows; then C, the number of columns; then P, the number of replications or repeated observations. In lines 9901 and succeeding lines, enter the observations by replications in row order. For example:

```
9900 R,C,P
9901 X(1,1,1),X(1,1,2),X(1,1,3) . . . X(1,1,P)
9902 X(1,2,1),X(1,2,2),X(1,2,3) . . . X(1,2,P)
  .      .         .         .              .
  .      .         .         .              .
  .      .         .         .              .
  .      .         .         .              .
     X(2,1,1),X(2,1,2),X(2,1,3) . . . X(2,1,P)
  .      .         .         .              .
  .      .         .         .              .
  .      .         .         .              .
  .      .         .         .              .
     X(R,C,1),X(R,C,2),X(R,C,3) . . . X(R,C,P)
```

Where: R = The Number of Rows ≤ 20
C = The Number of Columns ≤ 20
P = The Number of Replications ≤ 40
X(i,j,k) = The K th repeated observation in row i and column j

SPECIAL CONSIDERATIONS: Maximum number of rows and columns is 20; replications is 40. This is established in line 9000. To change modify 9000 to:

9000 Dim X(R,P),Y(R,C),D(C),E(R) Where R,C and P are rows, columns and replications as discussed above.

Uses all letters except L,U, and V

ACKNOWLEDGEMENTS: J. L. Mulcahy
Raychem Corporation

ANVAR4 PROBLEM:

From Dixon & Massey "Introduction to Statistical Analysis-2nd Ed."

McGraw Hill 1957 p. 164

Categories

		A	B	C
Treatments	a	4	2	6
		7	3	6
		5	2	4
	b	9	8	10
		8	7	8
		8	5	7

Number of Rows, R = 2 (a and b)

Number of Columns C = 3 (A,B, and C)

Number of Replications = 3 (3 values in each box)

```
RUN

9900  DATA 2,3,3
9901  DATA 4,7,5,2,3,2,5,6,4
9902  DATA 9,8,8,8,7,5,10,8,7
9999  END

RUN
ANVAR4
                                 ANOVA TABLE I
SOURCE          SUM SQ          DEG. FREE.      MEAN SQ         F RATIO
MEANS            78.6666         5                15.7333         10.8923
WITHIN           17.3334         12               1.44445
TOTAL            96              17

PROBABILITY OF F>= 10.8923    WITH 5    AND 12    D.F. IS 0

                                ANOVA TABLE II
SOURCE          SUM SQ          DEG. FREE.      MEAN SQ         F RATIO
ROWS             56.8889         1                56.8889         39.3845
COLS             20.3334         2                10.1667         7.03846
INTER            1.44434         2                .722168         .499961
SUBTOT           78.6666         5
WITHIN           17.3334         12               1.44445
TOTAL            96              17

PROBABILITY OF F>= 39.3845    WITH 1    AND 12    D.F. IS 0
```

```
PROBABILITY OF F>= 7.03846    WITH 2    AND 12    D.F. IS 9.49597E-03


PROBABILITY OF F>= .499961    WITH 2    AND 12    D.F. IS .618647

IF THE INTERACTION EFFECT IS NOT SIGNIFICANT AND
IF YOU WISH TO POOL INTERACTION AND WITHIN SUMS OF
SQUARES TO FORM RESIDUAL SUM OF SQUARES TYPE THE
NUMBER 1 OTHERWISE TYPE NUMBER 0.
?1
                            ANOVA TABLE III
SOURCE          SUM SQ          DEG. FREE.      MEAN SQ         F RATIO
ROWS             56.8889         1               56.8889         42.4144
COLS             20.3334         2               10.1667         7.57992
RESID            18.7777         14              1.34126
TOTAL            96              17

PROBABILITY OF F>= 42.4144    WITH 1    AND 14    D.F. IS 0


PROBABILITY OF F>= 7.57992    WITH 2    AND 14    D.F. IS 5.88048E-03

DONE
```

CONTRIBUTED PROGRAM **BASIC**

BICONF
36691

TITLE: CONFIDENCE LIMITS

DESCRIPTION:

Determines the confidence limits for a population proportion based on the exact binomial distribution.

INSTRUCTIONS:

Enter values for X, N, and C when requested.

Note: X = successes
N = sample size
C = confidence coefficient in percent

Sample Problem:

A polling agency makes a sample of 200 voters in a certain city and it is found that 110 of these people intend to vote for Candidate A. Therefore, the best estimate that can be made from this sample is that 55 percent of the entire population intend to vote for Candidate A.

If the agency wants to publish a prediction, with a 95 percent chance that they will be correct that the actual percentage of the entire population will be within certain bounds, what limits should they choose? Results are found in the sample RUN.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN
BICONF


CONFIDENCE LIMITS FOR A POPULATION PROPORTION BASED ON
THE EXACT BINOMIAL DISTRIBUTION.  WHAT ARE THE VALUES
OF X(SUCCESSES), N(SAMPLE SIZE), C(CONFIDENCE COEFF-
ICIENT IN PERCENT)?110,200,95
PLEASE WAIT...........


   BEST ESTIMATE OF POPULATION PROPORTION (PCT) =  55

   THE  95   PERCENT CONFIDENCE LIMITS ON THE POPULATION
   PROPORTION (PCT) ARE  47.8241    AND  62.0248


DONE
```

CONTRIBUTED PROGRAM **BASIC**

BINOPO
36041

TITLE: PROBABILITY DISTRIBUTION COMPARISONS

DESCRIPTION: This program is a comparison of probability distribution. It compares the exact binomial probabilities with approximations given by the normal and the Poisson distribution.

INSTRUCTIONS: Data requested will be:

N = Number of binomial trials

P = Probability $\leq$ 1 of occurrence

The output will show a tabulation of the probability of J-occurrences in N trials as given by the binomial theorem, as well as approximations given by the normal and Poisson distribution.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

```
GET-$BINOPO
RUN
BINOPO

PLEASE INPUT THE NUMBER OF TRIALS - N?1000
PLEASE INPUT THE PROBABILITY - P?.002
N= 1000         P= .002

J           EXACT          NORMAL          POISSON
 0           .1351          .1058           .1353
 1           .2707          .2175           .2707
 2           .271           .2766           .2707
 3           .1806          .2175           .1804
 4           .0902          .1058           .0902
 5           .036           .0318           .0361
 6           .012           .0059           .012
 7           .0034          .0007           .0034
 8           .0008          .0001           .0009
 9           .0002          0               .0002
 10          0              0               0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

BITEST
36692

TITLE: BINOMIAL PROPORTION

DESCRIPTION: This program performs a statistical test of a binomial proportion.

INSTRUCTIONS: Enter values for X, N, and P when requested, where

X = successes in sample
N = sample size
P = population proportions

Additional instructions in listing.

Sample Problem:

Consider a city in which 75% of the population intend to vote for Candidate A (and the rest for some other candidate). From a survey of 200 people picked at random, what is the probability that 60% or less (i.e., 120 people) are planning to vote for Candidate A?

Let a "success" be a person in the sample who intends to vote for Candidate A. Therefore, the input to the program will be:

X (number of successes in sample) = 120
N (sample size) = 200
P (true proportion of population intending to vote for A) = .75

As can be imagined, the accuracy of a smaller sample (say 20 people instead of 200) is much less. This is demonstrated by the second of the 2 sample RUN's.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
RUN
BITEST


THIS PROGRAM MAKES THE NECESSARY CALCULATION FOR A
STATISTICAL TEST OF A BINOMIAL PROPORTION.  WHAT
ARE X(SUCCESSES IN SAMPLE), N(SAMPLE SIZE), AND  P(THE
POPULATION PROPORTION)?120,200,.75

IN SAMPLES OF SIZE  200  RANDOMLY SELECTED FROM A
BINOMIAL POPULATION HAVING A TRUE PROPORTION OF .75
THE PROBABILITY OF A SAMPLE HAVING  120  OR LESS
SUCCESSES IS .000002

DONE


RUN
BITEST


THIS PROGRAM MAKES THE NECESSARY CALCULATION FOR A
STATISTICAL TEST OF A BINOMIAL PROPORTION.  WHAT
ARE X(SUCCESSES IN SAMPLE), N(SAMPLE SIZE), AND  P(THE
POPULATION PROPORTION)?12,20,.75

IN SAMPLES OF SIZE  20   RANDOMLY SELECTED FROM A
BINOMIAL POPULATION HAVING A TRUE PROPORTION OF .75
THE PROBABILITY OF A SAMPLE HAVING  12   OR LESS
SUCCESSES IS .101812

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CHISQ
36042

TITLE: COMPUTES PROBABILITY OF CHI-SQUARE VALUES

DESCRIPTION: This program computes the exact probability of a chi-square value with specified degrees of freedom.

INSTRUCTIONS: The program will request:

the chi-square value
degrees of freedom

The output will give the exact probability of the chi-square.

SPECIAL CONSIDERATIONS: Error halts and messages:

The message "YOU HAVE ERRED--INPUT THE TWO VALUES AGAIN" means the chi-square was zero.

ACKNOWLEDGEMENTS:

RUN

```
GET-$CHISQ
RUN
CHISQ

ENTER THE CHI-SQUARE VALUE AND THE DEGREES OF FREEDOM.
?5,1

EXACT PROBABILITY OF CHI-SQUARE= 5    WITH   1    D.F.

    IS  .024

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CHISQS
36043

TITLE: CHI-SQUARE STATISTICS FOR M*N CONTINGENCY TABLE

DESCRIPTION:

This program computes chi-square statistics for an M by N contingency table. It allows for application of Yates correction when the degrees of freedom is 1.

INSTRUCTIONS:

Enter data at line 9900.

9900 Data R,C,X_{11},X_{12},...X_{1C},X_{21},X_{22},...X_{2C},...X_{R1},X_{R2},...X_{RC}

Where: R = Number of Rows $\leq$ 10
C = Number of Columns $\leq$ 10
Xij = The observed frequency in the ith row, jth column

For Rows or Columns greater than 10, add a DIM Statement as follows:

8999 DIM O(R,C),R(M),C(N)

Where: M is the Maximum number of rows in the problem set.
N is the Maximum number of columns in the problem set.

To solve more than one problem, set change line 9036 to read:

9036 GOTO 9003

and set the additional data statements beginning at 9901 as above.

SPECIAL CONSIDERATIONS:

Yates correction is applied when the Degrees of Freedom is equal to one. See Dixon-Massey 3rd Edition, Pg. 240, 242.

When multiple problems are run, Out of Data in Line 9001 indicates a normal End of Job.

Variables Used: C,E,M,N,O,S,S1
C,O,R Are Array Names
I,J Are Used For Internal Looping

ACKNOWLEDGEMENTS: J. L. Mulcahy
Raychem Corporation

RUN

```
9900  DATA 2,2,37,20,2-15,6
RUN
CHISQS


 37               20
 15               6
CHI-SQUARE EQUALS 7.33083E-02   ON 1     DEGREES OF FREEDOM.

DONE
```

Reference: Dixon and Massey ."Introduction to Statistical Analysis Third Ed."
McGraw-Hill 1969 P. 242

```
9900 DATA 3,2,32,12,14,22,6,9
RUN
CHISQS


 32               12
 14               22
 6                9
CHI-SQUARE EQUALS 10.7122    ON 2     DEGREES OF FREEDOM.

)ONE
```

Reference: Dixon and Massey "Introduction to Statistical Analysis Third Ed."
McGraw-Hill 1969 P. 240

CONTRIBUTED PROGRAM **BASIC**

COFTAB
36888-18020

TITLE: CONVERSATIONAL FREQUENCY AND CROSS TABULATOR

DESCRIPTION:

COFTAB (COnversational Frequency and cross TABulator) is a Time-Shared BASIC program which, under the direction of commands entered from a remote teletype terminal, recodes data and outputs frequency counts or n-dimensional cross tabulations using data that the user has stored on files in the time-shared system.

INSTRUCTIONS:

1.0 GENERAL OVERVIEW

COFTAB is a multi-segment program and only those segments which the user needs reside in the user memory space at any time. The segments are:

1. COFTAB - the main routine which initializes the system and prints the current date, time and program version; calls COFTA1.

2. COFTA1 - the heart of the system, it accepts commands from the keyboard or command file, checks the commands for syntax and sets parameters for the various command routines; transfers control to one of COFTA2, COFTA3, COFTA5, COFTA8, or COFTA9.

3. COFTA2 - the utility processor (i.e., handles listing, punching, editing, etc. of the different files); transfers control back to COFTA1.

4. COFTA3 - does the frequency counts on the data; transfers control to COFTA4.

INSTRUCTIONS: continued on following page.

SPECIAL CONSIDERATIONS:

This program was written for an HP 2000B. If you are using an HP 2000 Series System, create the files limiting the word/record size to 64 words/record; e.g., CRE-VARBLE,128,64.

Do not abort (with the BREAK key) any EDIT or RECODE command. These commands alter the variable, command, and data files and an abort may cause file destruction.

It is recommended that users not attempt to collapse multiple column variables into single column variables since user errors here may quickly destroy the data. For example; if one were recoding the two column variable AGE into the values 1, 2, and 3, it would be best to recode into the two column values 01, 02, and 03.

Several user errors are not detected by the program logic and cause system program halts. In these cases, restart processing by getting and running the main program.

When several users are sharing one account for COFTAB usage or one user has several sets of data, paper tapes of the variable and command files can be punched out on paper tape using the PUNCH command. These may be reloaded into the files by mounting them in the paper tape reader and pushing the reader start switch.

ACKNOWLEDGEMENTS:

J. G. Allan,
University of Lethbridge

INSTRUCTIONS: continued

5. COFTA4 - prints out the tables generated by COFTA3; transfers control to COFTA1.

6. COFTA5 - does the cross tabulations on the data; transfers control to COFTA6 to print out the tables.

7. COFTA6 - prints out the tables generated by COFTA5; transfers control to COFTA7.

8. COFTA7 - calculates the statistics; transfers control back to COFTA1.

9. COFTA8 - recodes the data; transfers control back to COFTA1.

10. COFTA9 - handles the initial input of data; transfers control back to COFTA1.

The program has two modes of operation:

1. keyboard mode
2. programmable mode

In the keyboard mode, commands are singly entered on the teletype and are executed immediately following the input of a carriage return.

In the programmable mode, the commands are stored in a command file and executed following the input of a RUN command. The same commands are used in either mode.

The user must familiarize himself with the following files:

1. variable file - containing the definitions of the variables (i.e., labels and column numbers).

2. command file - containing commands which are to be used as input to the program when a RUN command is entered on the keyboard.

3. data file - containing card images of the data to be tabulated.

2.0 Files Used In The Program (The casual user need not concern himself with this section.)

A total of twelve files may be used in the program, three of which are special files, the remaining nine are available for data. If the user is familiar with the TSB system, he may wish to change the names of the files, remembering of course that the first three are special purpose files. The file declarations appear in the programs as follows:

1. COFTA1 - statement 2000 - 3 special files.

2. COFTA2 - statement 2000 - 3 special files.
   statement 3000 - data files.

3. COFTA3 - statement 2000 - 3 special files.
   statement 3000 - data files.

4. COFTA4 - statement 2000 - 3 special files.

5. COFTA5 - statement 2000 - 3 special files.
   statement 3000 - data files.

6. COFTA6 - statement 2000 - 3 special files.

7. COFTA8 - statement 2000 - 3 special files.
   statement 3000 - data files.

8. COFTA9 - statement 2000 - 3 special files.
   statement 3000 - data files.

In addition to changing the FILES statement, the user must do the following:

1. The second and third of the three special files must be <u>at least</u> as large (in sectors) as
   MAX(INT((length of file#1)/2),MAX(length of data files))

2. The user must also change statement numbers 5050,5030 of COFTA1 and COFTA2 respectively to
   F7 = length of special file #1

The standard file names and their usage are:

1. VARBLE - divided into two parts, the first half is used for the variable definitions, and the last half is used for the commands, which the user has saved, which can be executed by the RUN command.

INSTRUCTIONS: continued

2. WORK1 - temporary work file.
3. WORK2 - temporary work file.
4. F1 thru F10 - data files.

3.0 Documentation Conventions

3.1 Underlined characters are the characters necessary for the recognition of a keyword e.g., VARIABLE - only the first three characters are recognized (i.e., VARYING, VARMIT, VARCOSE are equivalent, since only VAR is used for decoding the keyword).

3.2 Blanks and carriage returns separate command keywords and statement numbers. All other blanks are ignored (except for blanks in an edit field of the EDIT command).

Example:
```
LIS VAR 10
   ↑   ↑
```
These blanks are necessary to separate LIS (LIST command) and VAR (indicating variable file) and 10 (statement number).

3.3 Keywords in braces { } mean that one of the keywords in the braces must be used.

Example:
```
LIS  {VARIABLE}  st. range., st. range.,...
     {COMMAND }
```
means that the command can take the form of
LIST VARIABLE st. range., st. range,...

or

LIST COMMAND st. range., st. range,...

3.4 Abbreviations
st. no. → statement number between 0 and 50000

st. no. range → statement number range of the form

1. n- → from st. no. n on
2. -m → up to st. no. m
3. n → st. no. n
4. n-m → from st. no. n thru st. no. m.

st. range → st. no. range

3.5 Square brackets [] are used to denote optional fields (i.e., items in square brackets are not necessary for the syntax of the command but may contain some options which the user would want).

4.0 Data Preparation

There are two ways in which data may be entered in to the system for analysis by COFTAB, (1) direct entry via keyboard and (2) direct entry via paper tape.

Direct Entry Via Keyboard

In this method of data entry, the data is typed on the keyboard after the entering of the OBSERVATION command (see sec. 2.9). Each line typed is a card image, with the position of each character on a line very important. A line is typed followed by a carriage return. The very last line typed must be EOT in columns 1-3 indicating that no more data is to be entered.

Direct Entry Via Paper Tape

This method is similar to that described in sec. 1.1 except that the data is punched on to paper tape at the keyboard in the off-line mode. Each card image must be followed by X-OFF carriage return, line feed. Again, the last line of the data must be EOT followed by X-OFF, carriage return and line-feed. After the user has punched the data on to tape, he enters it into the system by entering the OBSERVATION putting the tape into the paper tape reader and turning the tape reader on.

5.0 Commands

5.1 VARIABLE command

INSTRUCTIONS: continued

Syntax

VARIABLE st. no. or VARIABLE st. no. label, starting column no., final column no.[,comments]

where:

st. no. - indicates the position in the variable file where the variable definition is to be put.

label - variable name.

starting column no. - indicates the first column no. that the variable occupies.

final column no. - indicates the last column no. that the variable occupies. May not be larger than 72.

NOTE: For one column variables, starting column no. = final column no.

[,comments] - an optional, identification field, if used, the comments will be printed on the top of each table referencing the variable.

Description

This command defines a variable (card columns), thus allowing the user to reference his variables by name rather than by card columns. The first form of the command in the syntax section is equivalent to clearing (deleting) the st. no. for the variable file. The second form defines a new variable in the variable file.

NOTE: If there already exists a corresponding st. no. in the variable file it will be replaced by this new one.

Examples

VAR 10 SEX,5,5,1=FEMALE 2=MALE

St. no. 10 of the variable file has SEX,5,5,1=FEMALE 2=MALE as its entry after command has been processed. This statement defines column 5 of the data to be the variable SEX and any reference to column 5 (in XTAB, COUNT or RECODE commands) should be by the label SEX. The comment "1=FEMALE 2=MALE" will be printed at the top of the frequency or cross tabulation tables dealing with SEX.

VAR 20 AGE,6,7

St. no. 20 of the variable file has AGE,6,7 as its entry after the command has been processed. This defines column 6 and column 7 of the data to be the variable AGE. Note that the comments field is not used.

5.2 COMMAND command

Syntax

COMMAND st. no. or COMMAND st. no. command

where:

st. no. - indicates the position in the command file where the command is to be put.

command - any command described in this documentation except for OBSERVATION and APPEND.

Description

This command is used for setting up a program to be run under the direction of the RUN command. The first form of the command in the syntax section is equivalent to clearing (deleting) the st. no. from the command file. The second form enters a new command in to the command file (or replaces an existing command if a corresponding statement no. exists in the command file). The command that is entered in to the command file is not checked for syntax at this time and any error in construction of the command will appear when the st. no. is executed.

Examples

COM 10 COUNT SEX

St. no. 10 of the command file has COUNT SEX as its entry after the command has been processed. This command (COUNT SEX) can be executed by entering the following command at the keyboard:

RUN 10 (see RUN command)

5.3 LIST and PUNCH commands

Syntax

{LIST | PUNCH*} [(N)] {COMMAND | VARIABLE} [st. range$_1$, st. range$_2$,111]

*NOTE: When PUNCH is selected, the user has one minute to punch some leader with the HERE IS key both prior to punching and when punching is completed.

INSTRUCTIONS: continued

where:

[(N)] - optional parameter for listing and punching.

N - specifies a listing or punching without the st. nos. (default option - st. nos. are listed or punched).

{COMMAND / VARIABLE} - necessary field specifying which file is to be listed or punched.

[st. $range_1$, st. $range_2$,...] - optional field specifying which st. nos. are to be listed or punched. If this field is omitted, the entire file is listed or punched.

Description
This command allows the user to list or punch all or part of the command or variable files.

Examples
LIS COM
The entire command file is listed with st. nos.

LIS N COM
The entire command file is listed without the st. nos.

PUN N VAR
The entire variable file is punched without st. nos. and an X-OFF at the end of each line.

LIS VAR 20-
Statements 20 to the end of the variable file are listed.

LIS N COM 30-40,70,75
Statements 30 through 40, 70 and 75 of the command file are listed without st. nos.

5.4 CLEAR command

Syntax

CLEAR {COMMAND / VARIABLE} [st. $range_1$, st. $range_2$,...]

where:

{COMMAND / VARIABLE} - necessary field specifying which file is to be cleared.

[st. $range_1$, st. $range_2$,...] - optional field specifying which st. nos. are to be cleared. If this field is omitted, the entire file is cleared.

Description
This command allows the user to clear (delete) all or part of the command or variable files.

Examples
CLE COM
The entire command file is cleared.

CLE VAR 10
St. no. 10 of the variable file is cleared.

CLE COM 10, 30-40, 70-
Statements 10, 30 through 40 and from 70 to the end of the command file are cleared.

CLE VAR -50, 64
All statements up to and including 50 and st. no. 64 are cleared from the variable file.

5.5 EDIT command

Syntax
EDIT [LIST] {COMMAND / VARIABLE} [st. $range_1$, st. $range_2$,...]
[c]; [f]

INSTRUCTIONS: continued

where:
[LIST] - optional field allowing the listing of the edited line.

{COMMAND / VARIABLE} - necessary field specifying which file is to be edited.

[st. $range_1$, st. $range_2$,...] - optional field specifying which st. nos. are to be edited. If this field is omitted, the entire file is edited.

[c] - optional field containing the character string to be edited. If a ; appears in this field, it must be enclosed by apostrophies (i.e., ';'). If this field is omitted, the [f] field will be appended to each specified statement of the file.

[f] - optional field containing the character string which replaces the character string in the [c] field. If this field is omitted, the character string of the [c] field will be deleted from the specified statements of the file.

Description
This command allows the user to edit entries in the variable and command files without reentering the entire line.

Examples
EDI VAR;A;B
The entire variable file is edited, with all occurrences of A being changed to B. The edited statements are not listed.

EDI VAR 10-50;VAR;LAB
Statements 10 through 50 of the variable file are edited by changing any occurrences of VAR to LAB. The edited statements are not listed.

EDI LIS COM 10-50, 65, 90-;T;THE TIME IS
Statements 10 through 50, 65 and from 90 to the end of the command file are edited by changing any occurrences of T to THE TIME IS. The edited statements are listed on the teletype.

EDI COM;;TIME
The entire command file is edited by appending TIME to the end of each line. The edited statements are not listed.

EDI COM;TIME;
The entire command file is edited by removing any occurrences of TIME. The edited lines are not listed.

5.6 COUNT command

Syntax
COUNT ALL or COUNT $label_1$[(constraints)], $label_2$[(constraints)],...

where:
ALL is a keyword specifying that all defined variables are to be counted.

NOTE: The program is set up to allow only a maximum of 60 responses per variable to be counted. This may be changed (by the system operator only) as described below. Also only 5 variables may be defined when using this option.

$label_i$ - label of variable to be counted.

[(constraints)] - optional field specifying which responses are to be counted (i.e., counting only specific responses or response ranges). If this field is omitted, every response is counted. Constraints have the form:

alpha constant e.g. 5
alpha constant- e.g. 5-
-alpha constant e.g. -5
alpha constant - alpha constant e.g. ' 5'-10

or any combination of the above separated by commas.

NOTE: Leading and trailing blanks of multi-column variables must be enclosed by apostrophes. For example, ' 5' or ' 5'-10, etc.

Description
This command specifies the variables and observations of which frequency counts and percentages are needed. The standard form of the program allows for a maximum of 5 variables with at most

INSTRUCTIONS: continued

60 responses for any variable. The operator can still obtain frequency counts of continuous variables such as age by doing the following:

```
GET-COFTA3
1001 COM F(1,300)*
PUR-COFTA3
SAVE
GET-COFTA4
1001 COM F(1,300)
PUR-COFTA4
SAVE
```

*300 is the maximum value allowed in this change (i.e., only a maximum of 300 different responses are allowed per variable). This could also have been F(2,150) allowing a maximum of 150 different responses for 2 variables, etc.

The user can now get COFTAB and run it again and do frequency counts on his continuous variables.

Examples
Shown in sample RUN.

5.7 XTAB command

Syntax
XTAB $label_1$[(constraints)], $label_2$[(constraints)],...

where:
$label_i$ - labels of variables to be cross tabulated.

[(constraints)] - same as those for COUNT.

Description
This command specifies the variables to be used in the cross tabulations. The number of labels in the command specify the dimension of the table, thus allowing n-dimensional tables.

Examples
Shown in sample RUN.

5.8 RECODE command

Syntax
RECODE $label_1$ (new $value_{11}$=old value $range_{11}$, old value $range_{12}$,...; new $value_{12}$=old value range $_{21}$,...), $label_2$ (new $value_{21}$=old value $range_{11}$,...; new $value_{22}$=old value $range_{21}$,...)...

where:
$label_i$ - label of variable to be recoded.

new $value_{ij}$ - new value to be assigned to the variable specified by the $label_i$ field for each case when a response falls into a value range specified by the old value $range_{ij}$.
NOTE: Leading and trailing blanks must be enclosed by apostrophes.

old value $range_{jk}$ - criteria for recoding the data. If a response of $label_i$ falls into this range, the new response for the case is assigned the value of new $value_{ij}$. These ranges have the same form as the constraints in 5.6 and 5.7 syntax.

Description
This command allows the user to recode data for specified variables. It is useful when ranges such as age and income level are to be grouped into certain categories such as high, low, medium or under twenty, over twenty.

CAUTION: This is an irreversible process (i.e., once data is recoded, the original data cannot be returned unless it is input back into the system as described in Data Preparation, 4.0). When recoding multi-column variables into single column variables the card image is accordingly "shrunk" that many columns and the column fields of the variable file must be readjusted accordingly by use of the EDIT command (see 5.5).

Examples
REC AGE (1=-20;2=21-50;3=51-)
The two column variable AGE is recoded into a one column variable by the following criteria:

INSTRUCTIONS: continued

1 if an observation is less than 20,
2 if an observation is between 21 and 50,
3 if an observation is greater than 50.

REC VAR7(1=1,2,5;2=3,7-9)
The one column variable VAR7 is recoded into a one column variable by the following criteria:
1 if a response is a 1 or 2 or 5, and
2 if a response is a 3 or between 7 and 9.

REC VAR7(1=1,2,5;2=3,7-9),AGE(1=-20;2=21-50;3=51-)
This is equivalent to entering each of the first two examples.

5.9 OBSERVATIONS command

Syntax
OBSERVATIONS

Description
This command allows the user to input data into the data files. The data follows immediately after after the command has been entered by one of the methods described in Data Preparation, 4.0.

5.10 APPEND command

Syntax
APPEND

Description
This command allows the user to add more data to an existing data file. The data follows immediately after the command has been entered by one of the methods described in Data Preparation, 4.0.

5.11 RUN command

Syntax
RUN [st. range$_1$, st. range$_2$,...]

where:
[st. range$_1$, st. range$_2$,...] - optional field specifying the order, and which statements of the command file are to be executed. If this field is omitted, the entire command file is executed sequentially.

Description
This command initiates the programmable mode of COFTAB and allows the user to execute some or all of the commands in the command file.

Examples
RUN
Every command stored in the command file is executed sequentially.

RUN 10, 20
Only statements 10 and 20 of the command file are executed.

RUN 10,20-30,70-
Statements 10, 20 through 30 and from 70 to the end of the command file are executed.

5.12 STOP command

Syntax
STOP

Description
This command stops execution of the COFTAB program.

6.0 AN EXAMPLE CASE STUDY

The sample RUN following illustrates this case study.

Description
This study deals with a researcher who circulates fifty questionnaires to a sample of the community. Each questionnaire has ten questions to be answered:

1. Sex of the respondent
VALUES: Blank - missing
1 - male
2 - female

INSTRUCTIONS: continued

2. Age
   VALUES: Blank - missing
   01-99 - actual age of respondent

3. Marital status
   VALUES: Blank - missing
   1 - single
   2 - married
   3 - other

4. Education
   VALUES: Blank - missing
   1 - university
   2 - no university

5-10. Questions
   VALUES: Blank - missing
   1 - yes
   2 - no
   3 - maybe

The data files F1 to F10 and the work files VARBLE,WORK1, and WORK2 must exist in the user account. Unless COFTAB is changed as indicated in section 2.0, VARBLE, WORK1, and WORK2 must be 128 sectors long.

The CLEAR command removes any information which may be remaining in the files from the previous user.

With the small amount of data shown in the sample RUN most of the data files will be unused. Create files F1 to F10 so that the total number of sectors opened will accommodate the data stored as sequential strings. All unused files must be opened to at least 1 sector.

DEFINING THE VARIABLES FOR PROCESSING

The following names are assigned:

Variable (Question #)	Label	Column Field
1.	SEX	1
2.	AGE	2-3
3.	MSTAT	4
4.	ED	5
5.	VAR5	6
6.	VAR6	7
7.	VAR7	8
8.	VAR8	9
9.	VAR9	10
10.	VAR10	11

These variables are defined by using the VARIABLE command.

CROSS TABULATIONS

The following cross tabulations are used in the sample RUN:

1. Sex versus question 6 (including missing values).

2. Sex versus question 6 (excluding missing values).

3. Sex versus marital status (exluding missing values).

4. Males versus question 7 versus question 8 (excluding missing values).

5. Males versus education versus question 7 versus question 9 (including missing values for question 7 and question 9).

This is done by entering the commands into the command file and executing them with a RUN command.

```
CRE-F1,20
CRE-F2,20
CRE-F32-,20
CRE-F4,20
CRE-F5,20
CRE-F6,20
CRE-F7,20
CRE-F8,20
CRE-F9,20
CRE-F10,20
CRE-VARBLE,128
CRE-WORK1,128
CRE-WORK2,128

GET-COFTAB
RUN
COFTAB
```

```
***** COFTAB *****
VERSION - 06/06/73

15:59    WEDNESDAY    DECEMBER 19    1973



**?CLE VAR
**?OBS
13921231232
276211221 3
1893213232
19131112232
127111322 2
112 1121313
12912 3 132
10721313221
1313 333331
13931222222
 5211323213
2333 312322
19112122113
22831233233
2833122 113
137323113 1
237 2231211
11631231231
28812212331
1551 211233
2042 123321
 502213311
22511332 1
 971 1132 1
26022313133
111122321 1
21412233322
 3432332331
149321   32
186122223 3
20912222313
251 2223333
12712311131
11121211 12
13312312 21
27722313211
1902133 212
16722313131
22111111   1
2781 231111
12511233131
```

```
296 2112231
16731211223
17022121 31
16012223121
2681 312122
1161232223
10911 32211
20111123332
152113 233
EOT

 50   DATA RECORDS STORED


**?
   VARIABLE 10 SEX,1,1,BLANK=MISSING 1=MALE 2=FEMALE
**?VAR 20 AGE,2,3
**?VAR 30 MSTAT,4,4,BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER
**?VAR 40 EED,5,5,BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY
**?VAR 50 VAR5,6,6
**?VAR 60 VAR6,7,7
**?VAR 70 VAR7,8,8
**?VAR 80 VAR8,9,9
**?VAR 90 VAR9,10,10
**?VAR 100 VAR10,11,11
**?LIS VAR
 10    SEX,1,1,BLANK=MISSING 1=MALE 2=FEMALE
 20    AGE,2,3
 30    MSTAT,4,4,BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER
 40    EED,5,5,BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY
 50    VAR5,6,6
 60    VAR6,7,7
 70    VAR7,8,8
 80    VAR8,9,9
 90    VAR9,10,10
 100   VAR10,11,11
**?EDI VAR 40;EED;ED
**?LIS VAR
 10    SEX,1,1,BLANK=MISSING 1=MALE 2=FEMALE
 20    AGE,2,3
 30    MSTAT,4,4,BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER
 40    ED,5,5,BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY
 50    VAR5,6,6
 60    VAR6,7,7
 70    VAR7,8,8
 80    VAR8,9,9
 90    VAR9,10,10
 100   VAR10,11,11
**?EDI VAR 50-;;,BLANK=MISSING 1=YES 2=NO 3=MAYBE
**?LIS VAR
 10    SEX,1,1,BLANK=MISSING 1=MALE 2=FEMALE
 20    AGE,2,3
 30    MSTAT,4,4,BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER
 40    ED,5,5,BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY
 50    VAR5,6,6,BLANK=MISSING 1=YES 2=NO 3=MAYBE
 60    VAR6,7,7,BLANK=MISSING 1=YES 2=NO 3=MAYBE
 70    VAR7,8,8,BLANK=MISSING 1=YES 2=NO 3=MAYBE
 80    VAR8,9,9,BLANK=MISSING 1=YES 2=NO 3=MAYBE
 90    VAR9,10,10,BLANK=MISSING 1=YES 2=NO 3=MAYBE
 100   VAR10,11,11,BLANK=MISSING 1=YES 2=NO 3=MAYBE
**?COUNT SEX,MSTAT,ED,VAR5,VAR6


VARIABLE:  SEX            BLANK=MISSING 1=MALE 2=FEMALE


 SYMBOL     FREQUENCY     PER CENTAGE

      1            28          56.00
      2            18          36.00
  BLANK             4           8.00

  TOTAL            50         100.00
```

VARIABLE: MSTAT   BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER

SYMBOL	FREQUENCY	PER CENTAGE
1	23	46.00
3	12	24.00
2	11	22.00
BLANK	4	8.00
TOTAL	50	100.00

VARIABLE: ED   BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY

SYMBOL	FREQUENCY	PER CENTAGE
2	23	46.00
1	20	40.00
BLANK	7	14.00
TOTAL	50	100.00

VARIABLE: VAR5   BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
2	18	36.00
3	16	32.00
1	14	28.00
BLANK	2	4.00
TOTAL	50	100.00

VARIABLE: VAR6   BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
3	17	34.00
1	17	34.00
2	14	28.00
BLANK	2	4.00
TOTAL	50	100.00

```
**?COU VAR7,VAR8,VAR9,VAR10,VAR11
*****VAR11 IS NOT DEFINED AS A VARIABLE
**?COU VAR7,VAR8,VAR9,VAR10
```

VARIABLE: VAR7   BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
2	19	38.00
3	15	30.00
1	12	24.00
BLANK	4	8.00
TOTAL	50	100.00

VARIABLE: VAR8 BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
2	17	34.00
3	15	30.00
1	13	26.00
BLANK	5	10.00
TOTAL	50	100.00

VARIABLE: VAR9 BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
3	19	38.00
1	13	26.00
2	11	22.00
BLANK	7	14.00
TOTAL	50	100.00

VARIABLE: VAR10 BLANK=MISSING 1=YES 2=NO 3=MAYBE

SYMBOL	FREQUENCY	PER CENTAGE
1	21	42.00
3	12	24.00
2	11	22.00
BLANK	6	12.00
TOTAL	50	100.00

**?COU AGE

VARIABLE: AGE

SYMBOL	FREQUENCY	PER CENTAGE
39	2	4.00
91	2	4.00
27	2	4.00
52	2	4.00
33	2	4.00
37	2	4.00
16	2	4.00
25	2	4.00
60	2	4.00
11	2	4.00
09	2	4.00
67	2	4.00
83	1	2.00
12	1	2.00
29	1	2.00
88	1	2.00
55	1	2.00
04	1	2.00
50	1	2.00
07	1	2.00
97	1	2.00
31	1	2.00
76	1	2.00
14	1	2.00
34	1	2.00
49	1	2.00
86	1	2.00
89	1	2.00
51	1	2.00
77	1	2.00
90	1	2.00
28	1	2.00
21	1	2.00
78	1	2.00
96	1	2.00
70	1	2.00
68	1	2.00
01	1	2.00
TOTAL	50	100.00

```
**?RECODE AGE(01=' 0'-30;02=31-50;03=51-99)
**?LIS VAR 20
 20   AGE,2,3
**?EDI LIS VAR 20;;,1=YOUNGER THAN 30 2=31 TO 50 3=OVER 50
 20   AGE,2,3,1=YOUNGER THAN 30 2=31 TO 50 3=OVER 50
**?COUNT AGE
```

VARIABLE: AGE   1=YOUNGER THAN 30 2=31 TO 50 3=OVER 50

SYMBOL	FREQUENCY	PER CENTAGE
03	22	44.00
01	18	36.00
02	10	20.00
TOTAL	50	100.00

```
**?COM 10 XTAB SEX,VAR6
**?COM 20 XTAB SEX(1,2),VAR6(1,2,3)
**?COM 30 XTAB SEX)1,2),MSTAT(1,2,3),ED(1,2)
**?COM 40 XTAB SEX(1),VAR7(1,2,3),VAR8(1,2,3)
**?COM 50 XTAB VAR6,SEX
**?LIS COM
```

```
 10    XTAB SEX,VAR6
 20    XTAB SEX(1,2),VAR6(1,2,3)
 30    XTAB SEX)1,2),MSTAT(1,2,3),ED(1,2)
 40    XTAB SEX(1),VAR7(1,2,3),VAR8(1,2,3)
 50    XTAB VAR6,SEX
**?COM 30 XTAB SEX(1,2),MSTAT(1,2,3),ED(1,2)
**?COM 50 XTAB SEX(1),ED(1,2),VAR7,VAR9
**?COM 15 XTAB VAR6,SEX
**?LIS COM
 10    XTAB SEX,VAR6
 15    XTAB VAR6,SEX
 20    XTAB SEX(1,2),VAR6(1,2,3)
 30    XTAB SEX(1,2),MSTAT(1,2,3),ED(1,2)
 40    XTAB SEX(1),VAR7(1,2,3),VAR8(1,2,3)
 50    XTAB SEX(1),ED(1,2),VAR7,VAR9
**?RUN
!!? 10    XTAB SEX,VAR6



SEX:  ROWS                BLANK=MISSING 1=MALE 2=FEMALE

VAR6:  COLUMNS            BLANK=MISSING 1=YES 2=NO 3=MAYBE


 CODE BLANK      1      2      3 TOTAL

BLANK      0      1      1      2     4
         0.0   25.0   25.0   50.0 100.0
         0.0    2.0    2.0    4.0   8.0

    1      2      9      7     10    28
         7.1   32.1   25.0   35.7 100.0
         4.0   18.0   14.0   20.0  56.0

    2      0      7      6      5    18
         0.0   38.9   33.3   27.8 100.0
         0.0   14.0   12.0   10.0  36.0

TOTAL      2     17     14     17    50
         4.0   34.0   28.0   34.0 100.0
         4.0   34.0   28.0   34.0 100.0


DEGREES OF FREEDOM:   6
CHI-SQUARE:   2.638
EXACT PROBABILITY OF CHI-SQUARE:  0.853
CONTINGENCY COEFFICIENT:  0.224
CORRECTED CONTINGENCY COEFFICIENT:  0.265
CRAMER'S V:  0.162
GOODMAN-KRUSKAL'S TAU-C:  0.012


!!? 15    XTAB VAR6,SEX



VAR6:  ROWS               BLANK=MISSING 1=YES 2=NO 3=MAYBE

SEX:  COLUMNS             BLANK=MISSING 1=MALE 2=FEMALE
```

CODE	BLANK	1	2	TOTAL
BLANK	0	2	0	2
	0.0	100.0	0.0	100.0
	0.0	4.0	0.0	4.0
1	1	9	7	17
	5.9	52.9	41.2	100.0
	2.0	18.0	14.0	34.0
2	1	7	6	14
	7.1	50.0	42.9	100.0
	2.0	14.0	12.0	28.0
3	2	10	5	17
	11.8	58.8	29.4	100.0
	4.0	20.0	10.0	34.0
TOTAL	4	28	18	50
	8.0	56.0	36.0	100.0
	8.0	56.0	36.0	100.0

DEGREES OF FREEDOM: 6
CHI-SQUARE: 2.638
EXACT PROBABILITY OF CHI-SQUARE: 0.853
CONTINGENCY COEFFICIENT: 0.224
CORRECTED CONTINGENCY COEFFICIENT: 0.265
CRAMER'S V: 0.162
GOODMAN-KRUSKAL'S TAU-C: 0.035

!!? 20 XTAB SEX(1,2),VAR6(1,2,3)

SEX: ROWS BLANK=MISSING 1=MALE 2=FEMALE

VAR6: COLUMNS BLANK=MISSING 1=YES 2=NO 3=MAYBE

CODE	1	2	3	TOTAL
1	9	7	10	26
	34.6	26.9	38.5	100.0
	20.5	15.9	22.7	59.0
2	7	6	5	18
	38.9	33.3	27.8	100.0
	15.9	13.6	11.4	40.9
TOTAL	16	13	15	44
	36.4	29.5	34.1	100.0
	36.4	29.5	34.1	100.0

DEGREES OF FREEDOM: 2
CHI-SQUARE: 0.557
EXACT PROBABILITY OF CHI-SQUARE: 0.761
CONTINGENCY COEFFICIENT: 0.112
CORRECTED CONTINGENCY COEFFICIENT: 0.145
CRAMER'S V: 0.113
GOODMAN-KRUSKAL'S TAU-C: 0.006

!!? 30 XTAB SEX(1,2),MSTAT(1,2,3),ED(1,2)

```
SEX:  1                     BLANK=MISSING 1=MALE 2=FEMALE

MSTAT:  ROWS                BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER

ED:  COLUMNS                BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY


 CODE      1      2 TOTAL

    1      4      8    12
        33.3   66.7 100.0
        16.0   32.0  48.0

    2      4      2     6
        66.7   33.3 100.0
        16.0    8.0  24.0

    3      4      3     7
        57.1   42.9 100.0
        16.0   12.0  28.0

TOTAL     12     13    25
        48.0   52.0 100.0
        48.0   52.0 100.0


DEGREES OF FREEDOM:    2
CHI-SQUARE:    2.106
EXACT PROBABILITY OF CHI-SQUARE:   0.350
CONTINGENCY COEFFICIENT:   0.279
CORRECTED CONTINGENCY COEFFICIENT:   0.360
CRAMER'S V:  0.290
GOODMAN-KRUSKAL'S TAU-C:   0.084


SEX:  2                     BLANK=MISSING 1=MALE 2=FEMALE

MSTAT:  ROWS                BLANK=MISSING 1=SINGLE 2=MARRIED 3=OTHER

ED:  COLUMNS                BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY


 CODE      1      2 TOTAL

    1      3      3     6
        50.0   50.0 100.0
        27.3   27.3  54.5

    2      1      2     3
        33.3   66.7 100.0
         9.1   18.2  27.2

    3      2      0     2
       100.0    0.0 100.0
        18.2    0.0  18.1

TOTAL      6      5    11
        54.5   45.5 100.0
        54.5   45.5 100.0


DEGREES OF FREEDOM:    2
CHI-SQUARE:    2.261
EXACT PROBABILITY OF CHI-SQUARE:   0.323
CONTINGENCY COEFFICIENT:   0.413
CORRECTED CONTINGENCY COEFFICIENT:   0.533
CRAMER'S V:  0.453
GOODMAN-KRUSKAL'S TAU-C:   0.206


!!? 40    XTAB SEX(1),VAR7(1,2,3),VAR8(1,2,3)
```

```
SEX:  1                        BLANK=MISSING 1=MALE 2=FEMALE

VAR7:  ROWS                    BLANK=MISSING 1=YES 2=NO 3=MAYBE

VAR8:  COLUMNS                 BLANK=MISSING 1=YES 2=NO 3=MAYBE


 CODE      1      2      3 TOTAL

    1      1      4      2     7
        14.3   57.1   28.6 100.0
         4.5   18.2    9.1  31.8

    2      2      5      3    10
        20.0   50.0   30.0 100.0
         9.1   22.7   13.6  45.4

    3      3      1      1     5
        60.0   20.0   20.0 100.0
        13.6    4.5    4.5  22.7

TOTAL      6     10      6    22
        27.3   45.5   27.3 100.0
        27.3   45.5   27.3 100.0


DEGREES OF FREEDOM:    4
CHI-SQUARE:    3.688
EXACT PROBABILITY OF CHI-SQUARE:   0.548
CONTINGENCY COEFFICIENT:   0.379
CORRECTED CONTINGENCY COEFFICIENT:   0.464
CRAMER'S V:   0.290
GOODMAN-KRUSKAL'S TAU-C:   0.083


!!? 50    XTAB SEX(1),ED(1,2),VAR7,VAR9


SEX:  1                        BLANK=MISSING 1=MALE 2=FEMALE

ED:  1                         BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY

VAR7:  ROWS                    BLANK=MISSING 1=YES 2=NO 3=MAYBE

VAR9:  COLUMNS                 BLANK=MISSING 1=YES 2=NO 3=MAYBE


 CODE BLANK      1      2      3 TOTAL

BLANK     0      1      0      0     1
        0.0  100.0    0.0    0.0 100.0
        0.0    7.7    0.0    0.0   7.6

    1     0      2      1      2     5
        0.0   40.0   20.0   40.0 100.0
        0.0   15.4    7.7   15.4  38.4

    2     1      1      1      2     5
       20.0   20.0   20.0   40.0 100.0
        7.7    7.7    7.7   15.4  38.4

    3     0      0      1      1     2
        0.0    0.0   50.0   50.0 100.0
        0.0    0.0    7.7    7.7  15.3

TOTAL     1      4      3      5    13
        7.7   30.8   23.1   38.5 100.0
        7.7   30.8   23.1   38.5 100.0
```

DEGREES OF FREEDOM: 9
CHI-SQUARE: 5.460
EXACT PROBABILITY OF CHI-SQUARE: 0.793
CONTINGENCY COEFFICIENT: 0.544
CORRECTED CONTINGENCY COEFFICIENT: 0.628
CRAMER'S V: 0.374
GOODMAN-KRUSKAL'S TAU-C: 0.141

SEX: 1 BLANK=MISSING 1=MALE 2=FEMALE

ED: 2 BLANK=MISSING 1=UNIVERSITY 2=NO UNIVERSITY

VAR7: ROWS BLANK=MISSING 1=YES 2=NO 3=MAYBE

VAR9: COLUMNS BLANK=MISSING 1=YES 2=NO 3=MAYBE

CODE	BLANK	1	2	3	TOTAL
BLANK	0	0	1	1	2
	0.0	0.0	50.0	50.0	100.0
	0.0	0.0	7.7	7.7	15.3
1	1	0	0	2	3
	33.3	0.0	0.0	66.7	100.0
	7.7	0.0	0.0	15.4	23.0
2	2	1	2	1	6
	33.3	16.7	33.3	16.7	100.0
	15.4	7.7	15.4	7.7	46.1
3	0	0	1	1	2
	0.0	0.0	50.0	50.0	100.0
	0.0	0.0	7.7	7.7	15.3
TOTAL	3	1	4	5	13
	23.1	7.7	30.8	38.5	100.0
	23.1	7.7	30.8	38.5	100.0

DEGREES OF FREEDOM: 9
CHI-SQUARE: 5.417
EXACT PROBABILITY OF CHI-SQUARE: 0.797
CONTINGENCY COEFFICIENT: 0.542
CORRECTED CONTINGENCY COEFFICIENT: 0.626
CRAMER'S V: 0.373
GOODMAN-KRUSKAL'S TAU-C: 0.155

**?STOP

DONE

CONTRIBUTED PROGRAM **BASIC**

CONLM1
36694

TITLE: COMPUTES CONFIDENCE LIMITS FOR AN UNKNOWN POPULATION MEAN

DESCRIPTION:

This program computes confidence limits for an unknown population mean, based on the random sample data entered. The output includes the mean, variance and standard deviation for the data supplied, the standard error of the mean and the estimated standard deviation, as well as a table of upper and lower confidence limits for eight confidence levels.

INSTRUCTIONS:

Enter data beginning in line number 9900 as follows:

```
9900 DATA S
9901 DATA X(1), X(2), ...........X(N)
```

where: S = the size of the population (Enter the value '1E20' if this is infinite.)
X(I) = the Ith sample observation
N = the number of observations

Note that data line numbers must not exceed 9997.

The program begins at line number 9000.

The following variables are used in the program:

A1, A2, D, D1, D2, D3, E1, H, I, N, M, P, Q, S, S1, S2, S5, S6, S8, U, Z

X is an array name

I is used for internal looping

FNB, FND, FNQ, FNZ are user defined functions

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9900  DATA 1E20
9901  DATA 84,36,17,93,22,46,72,91,65,81,37,44,79,53

RUN

CONLM1

VALUES OF SAMPLE STATISTICS:

   SIZE OF SAMPLE              14
   SAMPLE MEAN VALUE           58.5714
   VARIANCE OF SAMPLE          604.817
   SAMPLE STD DEVIATION        24.593
   ESTIMATED POPN STD DEV      25.5214
   STANDARD ERROR OF MEAN      6.82088


CONFIDENCE LIMITS ON POPULATION MEAN:

CONF LEVEL      LOWER LIM      UPPER LIM

 50              53.8389        63.304
 75              50.3586        66.7843
 90              46.4953        70.6476
 95              43.8441        73.2988
 99              38.0656        79.0772
 99.9            29.97          87.1728
 99.99           21.5335        95.6093
 99.999          12.7635        104.379

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CONLM2
36693

TITLE: COMPUTES CONFIDENCE LIMITS FOR AN UNKNOWN POPULATION MEAN

DESCRIPTION:

This program computes confidence limits for the difference between two population means, based on data supplied for two samples, one from each population. The output includes a summary of the input data, the variance of the two samples, the estimated standard deviation for each population, the difference between the means, the standard error of the differences and the upper and lower confidence limits for the eight standard confidence levels.

INSTRUCTIONS:

Enter data beginning in line number 9900 as follows:

```
9900 DATA S1, N1, M1, D1
9901 DATA S2, N2, M2, D2
```

where: SI = the size of the Ith population (Enter the value '1E20' if the population is infinite.)
NI = the size of the Ith sample
MI = the arithmetic mean of the Ith sample
DI = the standard deviation of the Ith sample
I = 1 or 2

Note that data line numbers must not exceed 9997.

The program begins at line number 9000.

The following variables are used in the program:

A1, A2, D, D1, D2, D3, E1, H1, H2, M1, M2, M3
N1, N2, P, Q, R1, R2, R3, R5, R6, S1, S2
T1, T2, U, W, Z

X is an array name

I is used for internal looping

FNB, FND, FNQ, FNZ are user defined functions

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

RUN

```
9900  DATA 1E20,18,28,26.2
9901  DATA 1E20,23,33,29.6

RUN
CONLM2


      STATISTIC                    SAMPLE 1        SAMPLE 2

SAMPLE MEAN                         28              33
SAMPLE VARIANCE                     686.44          876.16
SAMPLE STD DEVIATION                26.2            29.6
SAMPLE SIZE                         18              23
POPULATION SIZE                    INFINITE        INFINITE
ESTIM POPN STD DEV                  26.9596         30.2653
STD ERROR OF MEAN                   6.35443         6.31074

DIFF BETWEEN MEANS                          -5
STD ERROR OF DIFF                            8.95568
DEGR OF FEEDOM (DIFF)                        38.3


CONFIDENCE LIMITS ON DIFFERENCE BETWEEN MEANS:

CONF LEVEL      LOWER LIM       UPPER LIM

 50             -11.0983         1.09835
 75             -15.4608         5.46077
 90             -20.0957         10.0957
 95             -23.1248         13.1248
 99             -29.2721         19.2721
 99.9           -36.9012         26.9012
 99.99          -43.8499         33.8499
 99.999         -50.2538         40.2538

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CORREL
36689

TITLE: CORRELATION COEFFICIENT

DESCRIPTION:

Computes the correlation coefficient for two sets of data having an equal number of elements in each set.

INSTRUCTIONS:

Enter the data beginning in line number 9900 as follows: first input N, the number of data elements in each set (i.e., the number of X, Y pairs); then enter the X and Y values in pairs.

9900 DATA N
9901 DATA X_1, Y_1, X_2, Y_2, ...X_n, Y_n

where: N = the number of data elements in each set of data.
X_k = the value of the kth data element of the first set.
X_k = the value of the kth data element of the second set.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

RUN

```
9900  DATA 5
9901  DATA 1,5,2,3,3,0,4,-5,5,-11

RUN
CORREL

THE CORRELATION COEFFICIENT = -.978

DONE
```

CONTRIBUTED PROGRAM **BASIC**

CROSS2
36860

TITLE: CROSSTABULATION AND CHI-SQUARE

DESCRIPTION: The program will cross tabulate up to 500 observations on a pair of variables with up to six categories per variable and calculate a chi-square statistic for the resulting contingency table. The row and column sums and the expected frequency matrix are printed. Any null rows or columns are excluded from the calculation of chi-square and Yates' correction is made for 2X2 tables.

INSTRUCTIONS: See sample RUN.

SPECIAL CONSIDERATIONS: If file input is used, the data must be on a sequential file accessible by the account.

ACKNOWLEDGEMENTS: Bill Jarosz, Nestor Dyhdalo, Joann Preston
DePaul University

```
RUN

RUN
CROSS2


                     C R O S S T A B S   P R O G R A M

DO YOU WANT INSTRUCTIONS (1=YES, 0=NO)?1

***INSTRUCTIONS***
THIS PROGRAM PERFORMS A TWO-WAY FREQUENCY COUNT ON
RAW DATA. THE FREQUENCIES ARE USED TO CALCULATE A CHI-SQUARE STATISTIC.
THE PROGRAM WILL TAKE A MAXIMUM OF 500 SUBJECTS AND WILL CROSS-CLASSIFY
THEM INTO A MAX. OF 6 INTERVALS PER VARIABLE.
THE EXPECTED FREQUENCIES ARE ROUNDED TO WHOLE NUMBERS
AND THE CHI-SQUARE STATISTIC IS ROUNDED TO THREE DECIMAL
PLACES. ENTER DATA STARTING WITH STATEMENT 3000. ENTER ALL DATA FOR THE
FIRST VARIABLE BEFORE STARTING THE SECOND.
DATA MAY OPTIONALLY BE READ FROM A FILE INSTEAD OF FROM DATA STATEMENTS.
WHEN RUNNING, THE PROGRAM ASKS FOR THE # OF OBS., THE MIN. AND MAX. FOR
EACH VAR. AND THE # OF INTERVALS FOR EACH VAR. IF THE MIN. AND MAX.
ARE BOTH ENTERED AS 1 FOR EITHER OR BOTH VARS., THE PROGRAM WILL
CALCULATE THE MIN AND MAX FROM THE DATA. IF A MIN LARGER THAN THE
SMALLEST VALUE IS ENTERED, ALL DATA BELOW THIS VALUE WILL BE IGNORED.
SIMILARLY, MAX VALUES SMALLER THAN THE LARGEST DATA VALUE MAY BE USED.
THE MIN AND MAX MAY ALSO BE SMALLER THAN THE SMALLEST VALUE OR LARGER
THAN THE LARGEST VALUE. SINCE THE MIN AND MAX ARE USED TO DETERMINE THE
END POINTS FOR EACH INTERVAL, THIS FEATURE MAY BE USEFUL FOR CONTROLLING
INTERVAL SIZE. THERE IS NO LIMIT TO THE RANGE OF THE DATA, BUT THE NO.
OF INTERVALS MUST NOT EXCEED 6. BOTH VARIABLES NEED NOT HAVE THE SAME
NUMBER OF INTERVALS.

DONE



3000  DATA 1,2,3,4,5,6,7,8,9,10,1,2,3,4,5,6,7,8,9,10


3010  DATA 1,2,3,4,5,6,7,8,9,10,1,2,3,4,5,6,7,8,9,10
3020  DATA 1,2,3,4,5,6,7,8,9,10,1,2,3,4,5,6,7,8,9,10
3030  DATA 1,2,3,4,5,6,7,8,9,10,1,2,3,4,5,6,7,8,9,10
RUN
CROSS2


                     C R O S S T A B S   P R O G R A M

DO YOU WANT INSTRUCTIONS (1=YES, 0=NO)?0
1= DATA ON FILE, 0= DATA IN DATA STATEMENTS. WHICH?0
ENTER # OF OBS. PER VARIABLE?40
ENTER THE MIN. VALUES FOR EACH VAR.?1,1
ENTER THE MAX. VALUES FOR EACH VAR.?1,1
ENTER THE # OF INTERVALS FOR EACH VAR.?5,5

FOR VAR. A, CALCULATED MIN.= 1     CALCULATED MAX.= 10
FOR VAR. B, CALCULATED MIN.= 1     CALCULATED MAX.= 10
```

OBSERVED FREQUENCY TABLE

					ROW SUMS
8	0	0	0	0	8
0	8	0	0	0	8
0	0	8	0	0	8
0	0	0	8	0	8
0	0	0	0	8	8
8	8	8	8	8	COL SUMS

GRAND TOTAL= 40

EXPECTED FREQUENCY TABLE

2	2	2	2	2
2	2	2	2	2
2	2	2	2	2
2	2	2	2	2
2	2	2	2	2

****

CHI-SQUARE FOR A 5 BY 5 MATRIX, WHERE DF= 16
IS EQUAL TO 160

****

DONE

CONTRIBUTED PROGRAM **BASIC**

CURFIT
36038

TITLE: PERFORMS LEAST-SQUARES FIT

DESCRIPTION:

This program performs a least squares curve fit to the following functions:

1. Y = A + B(X)
2. Y = A exp (B * X)
3. Y = A (X^B)
4. Y = A + B/X
5. Y = 1/(A + B * X)
6. Y = X/(A + B * X)
7. Y = A + B * Log(X)

INSTRUCTIONS:

Before running the program enter the following data beginning in line 9900:

9900 DATA N

9901 DATA X_1, Y_1, X_2, Y_2...

—
—
—
—

99--DATA......X_n, Y_n

Where: N = Number of Data Pairs

X_i, Y_i = the ith Data Pair

Where X_i is the independent variable and Y_i is the dependent variable.

The program will print summary data for the curve fits for the seven functions and request the user to indicate which function he wishes detailed information about (Input a Ø, 1,2,3,4,5,6 or 7). A zero (Ø) will terminate the program.

SPECIAL CONSIDERATIONS:

If there are more than 200 data pairs, change the dimension of variables X, Y, U, V in statement 9003 to this number.

If data is made up of multiple observations in the dependent variable for each independent variable, use MULTX, 36186, as a calling program and APPend CURFIT.

ACKNOWLEDGEMENTS:

Jerry L. Mulcahy
Raychem Corporation

```
9900 DATA 7
9901 DATA 8.32,12.78
9902 DATA 8.34,12.53
9903 DATA 83←.36,12.08
9904 DATA 8.38,11.7←57
9905 DATA 8.4,11.19
9906 DATA 8.42,10.91
9907 DATA 8.44,10.73
```

RUN

```
RUN
CURFIT


                LEAST SQUARES CURVES FIT

CURVE TYPE        INDEX   OF        A              B
                DETERMINATION

1. Y=A+(B*X)     .979167         165.023        -18.2981
2. Y=A*EXP(B*X) .981411          5.64762E+06    -1.56211
3. Y=A*(X↑B)     .937287         5.35430E+12    -12.6316
4. Y=A+(B/X)     .988257        -142.787         1294.44
5. Y=1/(A+B*X)   .985601        -1.03558         .133832
6. Y=X/(A+B*X)   .991327        -9.45113         1.21377
7. Y=A+B*LOG(X) .935615          326.308        -148


                STANDARD ERROR ESTIMATES


CURVE TYPE      REGRESSION         A              B


1. Y=A+(B*X)     .126494         10.0028        1.19363
2. Y=A*EXP(B*X) 1.01889E-02      2.23828        9.61452E-02
3. Y=A*(X↑B)    1.87146E-02      22.3387        1.46122
4. Y=A+(B/X)    9.49684E-02      7.5304         63.1026
5. Y=1/(A+B*X)  7.66646E-04      .060624        7.23429E-03
6. Y=X/(A+B*X)  5.94971E-04      .395333        4.71774E-02
7. Y=A+B*LOG(X) .222375          36.9108        17.3629


DETAILS FOR CURVE TYPE?6
   6. Y=X/(A+B*X)  IS A HYPERBOLIC FUNCTION.  THE RESULTS
      OF A LEAST-SQUARES FIT OF ITS LINEAR TRANSFORM
      (SORTED IN ORDER OF ASCENDING VALUES OF X)
      ARE AS FOLLOWS:

X-ACTUAL          Y-ACTUAL          Y-CALC          PCT DIFFER

 8.32              12.78            12.8503        -.5
 8.34              12.53            12.4156                 .9
 8.36              12.08            12.0113                 .5
 8.38              11.57            11.6343        -.5
 8.4               11.19            11.2819        -.8
 8.42              10.91            10.9516        -.3
 8.44              10.73            10.6417                 .8


DETAILS FOR CURVE TYPE?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

EVPI
36688

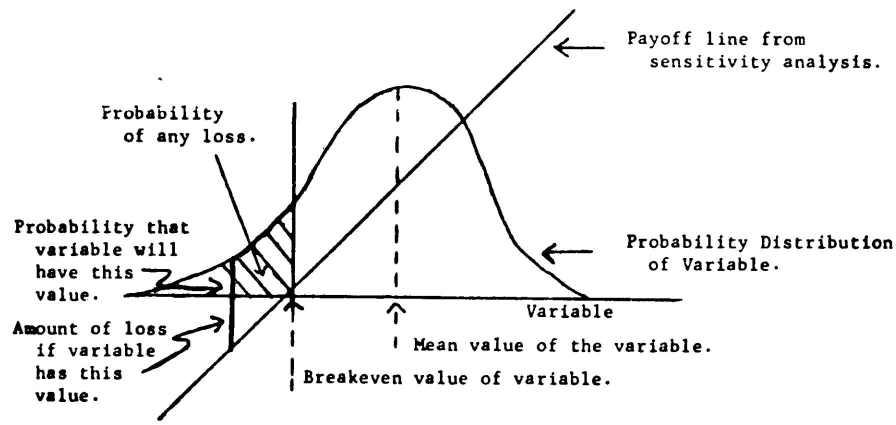
TITLE: COMPUTES THE EXPECTED VALUE OF PERFECT INFORMATION

DESCRIPTION:

Computes the expected value of perfect information.

Assumptions: .'. the variable of interest is normally distributed.
.. the payoff has a linear relationship with respect to the variable of interest.

A graphical representation of the problem is as follows:



The expected value of perfect information is the sum of the products of all possible losses times the probabilities of those losses.

INSTRUCTIONS:

The user must enter data in line 2.

```
2 DATA B, L, M, X, Y
```

where: B = the breakeven value of the variable
L = the slope of payoff line
M = mean value of the variable
X...If Y = 0: standard deviation of estimate of value of variable.
...If Y = 1: probability of actual value on the loss side of the breakeven
Y = 0 or 1
0 means that X is the standard deviation
1 means that X is the value on the loss side of the breakeven.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

2  DATA 50,40000.,66,20,0



RUN
EVPI


BREAKEVEN VALUE 50   SLOPE OF PAYOFF LINE 40000.
MEAN VALUE 66   STANDARD DEVIATION 20
EXPECTED VALUE OF PERCENT INFORMATION 96160.

DONE
```

CONTRIBUTED PROGRAM **BASIC**

FC
36120

TITLE: ANALYSIS OF LOG TAPE

DESCRIPTION:

Each piece of data furnished by the LOGON-LOGOFF tape is read, compiled and stored. At the end of the tape, the program prints:

1. number of calls per user per hour,
2. average length of the calls
3. total number of calls received by the computer each hour
4. total number of minutes for each hour.

The total number of calls and the total number of minutes for the day are printed at the end.

INSTRUCTIONS:

The tape, which has been generated by the computer console, has to be placed in the paper tape reader of the teletype terminal.

SPECIAL CONSIDERATIONS:

There is a built-in test to stop the program at the first call placed after midnight. Therefore, the remainder of the tape has to be saved for the following day's analysis. To explain how the program stops reading the tape, let's take an example:

```
**LOGON  B001 2342 #01
**LOGON  D021 2345 #02
**LOGOFF D021 0027 #02
```

The time '0027' contained in the current entry is smaller than the time '2345' contained in the previous entry. Since, in a single day, time always increases, midnight has been reached. The program stops reading the paper tape and prints the results.

To stop the reading of the paper tape from the TTY, a '*' can be inputted.

If the system crashes, the word 'CRASH' has to be inputted, in order to clear the previous information.

If the first entry is a 'LOGOFF', the program acts as if the corresponding 'LOGON' was at midnight. If the last entry before midnight is a 'LOGON', the program acts as if the corresponding 'LOGOFF' is at midnight.

How to Adapt "FC" for a Specific User

Line 20 is the definition of a string of characters that contains the first letter of all user numbers. For example:

```
20 C$="ABCDEFGHJNR"
```

If there are less than 11 letters in use, some letters have to be made up. If there are more than 11 letters, the program "FC" cannot be used. The number is restricted to 11 because of print format limitations.

The printout has 12 columns of values. The first 11 are 11 different user number codes. The 12th is the total.

Two lines of values are printed for each hour of the day. The first line is the number of calls in the hour per user. The second line is the average length of each call per user.

In the 'total' column the value in the first line is the total number of calls in the hour. The value in the second line is the total number of minutes of connect time in the hour.

The number printed following 'MAX' is the maximum number of terminals on line at any one time during the hour.

ACKNOWLEDGEMENTS:

Francois Carlhian
Babson College

RUN

```
RUN
FC

INSERT THE PAPER TAPE
?**LOGOFF B560 1502 #14
 902
?
 **LOGON  B560 1504 #14
?
 **LOGOFF B560 1508 #14
 4
?
 **LOGON  C000 1508 #14
?
 **LOGOFF D000 1508 #31
 908
?
 **LOGON  D012 1508 #31
?
 **LOGOFF C000 1509 #14
 1
?
 **LOGON  B078 1510 #14
?
 **LOGOFF B078 1512 #14
 2
?
 **LOGOFF C000 1515 #13
 915
?
 **LOGOFF A422 1516 #18
 916
?
 **LOGOFF A455 1518 #17
 918
?
 **LOGOFF B073 1518 #23
 918
?
 **LOGOFF C700 1521 #03
 921
?
 **LOGOFF D019 1527 #04
 927
?
 **LOGON  D016 1527 #04
?
 **LOGON  A422 1529 #18
?
 **LOGOFF C701 1529 #00
 929
?
 **LOGON  C000 1529 #14
?
 **LOGOFF A422 1530 #18
 1
?
 **LOGON  B078 1535 #00
?
 **LOGON  A455 1540 #17
?
 **LOGOFF C701 1541 #26
 941
?
 **LOGOFF D012 1544 #31
 36
?
 **LOGOFF D016 1544 #04
 17
?
 **LOGOFF C000 1555 #14
 26
?
 **LOGON  C000 1555 #14
?
```

```
 **LOGON  C700 1558 #13
?
 **LOGOFF A455 1558 #17
 18
?
 **LOGON  A422 1558 #18
?
 **LOGON  A810 1606 #31
?
 **LOGOFF A810 1609 #31
 3
?
 **LOGON  A000 1609 #31
?
 **LOGOFF H122 1610 #19
 970
?
 **LOGON  A422 1611 #19
?
 **LOGON  I006 1627 #01
?
 **LOGOFF A422 1629 #19
 18
?
 **LOGON  A205 1629 #19
?
 **LOGOFF C000 1629 #14
 34
?
 **LOGON  A455 1629 #17
?
 **LOGON  C000 1629 #14
?
 **LOGOFF C000 1630 #14
 1
?
 **LOGOFF A205 1631 #19
 2
?
 **LOGOFF B078 1631 #00
 56
?
 **LOGON  C701 1634 #24
?
 **LOGOFF A000 1635 #31
 26
?
 **LOGON  A810 1635 #31
?
 **LOGOFF A455 1638 #17
 9
?
 **LOGON  B061 1638 #17
?
 **LOGOFF C701 1642 #24
 8
?
 **LOGOFF C700 1654 #13
 56
?
 **LOGOFF B061 1655 #17
 17
?
 **LOGON  A455 1656 #17
?
 **LOGON  I018 1657 #19
?
 **LOGOFF A455 1657 #17
 1
?
 **LOGON  I018 1659 #17
?
 **LOGOFF A920 1716 #02
 1036
?
 **LOGOFF A810 1718 #31
 43
?
```

```
 **LOGOFF I006 1729 #01
 62
?
 **LOGOFF I018 1729 #19
 32
?
 **LOGOFF A422 1734 #18
 96
?
 **LOGOFF B063 1800 #30
 1080
?
 **LOGON  B063 1803 #01
?
 **LOGOFF B063 1813 #01
 10
?
 **LOGON  B063 1830 #01
?
 **LOGON  A001 1855 #02
?
 **LOGOFF A001 1906 #02
 11
?
 **LOGOFF B063 1956 #01
 86
?
 **LOGOFF I018 2043 #17
 224
?
 **LOGON  E111 2048 #01
?
 **LOGOFF E111 2058 #01
 10
?
 **LOGON  A600 0018 #17
```

```
FIRST LINE  : NUMBER OF CALLS IN THE HOUR
SECOND LINE : AVERAGE LENGTH OF EACH CALL

         *********USER IDENTIFICATION**********

 B    C    D    E    F    G    J    K    N    P    S

FROM MIDNIGHT TO 6 AM
 13   0    0    0    0    0    0    0    0    0    0    13
 945  0    0    0    0    0    0    0    0    0    0
 12281
HOUR #  7     MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  8     MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  9     MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  10    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  11    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  12    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  13    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  14    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  15    MAX :  5
 12   0    0    0    0    0    0    0    0    0    0    12
 29   0    0    0    0    0    0    0    0    0    0    347
HOUR #  16    MAX :  8
 13   0    0    0    0    0    0    0    0    0    0    13
 34   0    0    0    0    0    0    0    0    0    0    446
HOUR #  17    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  18    MAX :  3
 3    0    0    0    0    0    0    0    0    0    0    3
 36   0    0    0    0    0    0    0    0    0    0    107
HOUR #  19    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  20    MAX :  1
 1    0    0    0    0    0    0    0    0    0    0    1
 10   0    0    0    0    0    0    0    0    0    0    10
HOUR #  21    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  22    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0
HOUR #  23    MAX :  0
 0    0    0    0    0    0    0    0    0    0    0    0
 0    0    0    0    0    0    0    0    0    0    0    0

TOTAL NUMBER OF CALLS DURING THE DAY :  42    ****************
TOTAL CONNECTION TIME DURING THE DAY :  13191    ****************

DONE
```

CONTRIBUTED PROGRAM **BASIC**

FISHER
36606

TITLE: FISHER'S EXACT PROBABILITY TEST

DESCRIPTION: This program analyzes discrete data from two independent small random samples which fall into one or another of two mutually exclusive classes. The printout includes a summary table with marginal frequencies and the probability of occurence by chance of the distribution under examination.

INSTRUCTIONS: Instructions for the use of this program are given at run-time for the entry of data into a 2 x 2 table of the following format:

```
+----------+---------+
      A         B
+----------+---------+
      C         D
+----------+---------+
```

Reference: Siegel, Sidney NON-PARAMETRIC STATISTICS, McGraw-Hill; New York 1956, Page 96

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Robert M. Smith
University of Alabama School of Medicine

```
RUN


RUN
FISHER

FISHER'S EXACT PROBABILITY TEST
===============================
ENTER THE FREQUENCY IN CELL 'A'
?10
ENTER THE FREQUENCY IN CELL 'B'
?0
ENTER THE FREQUENCY IN CELL 'C'
?4
ENTER THE FREQUENCY IN CELL 'D'
?5

          SUMMARY TABLE
          =============

+----------+----------+
    10          0            10
+----------+----------+
     4          5             9
+----------+----------+
    14          5            19

P =     0.01084


DONE



RUN
FISHER

FISHER'S EXACT PROBABILITY TEST
===============================
ENTER THE FREQUENCY IN CELL 'A'
?1
ENTER THE FREQUENCY IN CELL 'B'
?6
ENTER THE FREQUENCY IN CELL 'C'
?4
ENTER THE FREQUENCY IN CELL 'D'
?1

          SUMMARY TABLE
          =============

+----------+----------+
     1          6             7
+----------+----------+
     4          1             5
+----------+----------+
     5          7            12

P =     0.04419


DONE
```

```
RUN
FISHER

FISHER'S EXACT PROBABILITY TEST
===============================
ENTER THE FREQUENCY IN CELL 'A'
?0
ENTER THE FREQUENCY IN CELL 'B'
?7
ENTER THE FREQUENCY IN CELL 'C'
?5
ENTER THE FREQUENCY IN CELL 'D'
?0

     SUMMARY TABLE
     =============

+----------+----------+
    0          7          7
+----------+----------+
    5          0          5
+----------+----------+
    5          7          12

P =     0.00126


DONE
```

CONTRIBUTED PROGRAM **BASIC**

FREQ1
36864

TITLE: FAST FREQUENCY DISTRIBUTIONS

DESCRIPTION: The program does a frequency distribution for up to 900 scores. The range of the data must not exceed 800. Input may be either through data statements or from a previously prepared data file.

INSTRUCTIONS: Enter data in DATA statements beginning on line 1000 or be sure data is on a sequential file. Program will ask for number of scores, whether data is on file or in data statements, and the desired interval size.

SPECIAL CONSIDERATIONS: If file input is used, the data must be on a sequential file accessible by the account.

ACKNOWLEDGEMENTS: Bernard Drzazga
DePaul University

```
RUN

RUN
FREQ1

FAST FREQUENCY DISTRIBUTIONS FOR TEST SCORES

DO YOU WANT INSTRUCTIONS(1=YES,0=NO)?1

THIS PROGRAM CAN TAKE UP TO 900 SCORES.
FRACTIONS ARE ROUNDED TO THE NEAREST WHOLE NUMBER.
NEGATIVE NUMBERS ARE ALLOWED.  THE HIGHEST MINUS THE
LOWEST (RANGE OF THE DATA) CANNOT EXCEED 800.

ENTER DATA STARTING ON LINE 1000, SEPARATE SCORES WITH COMMAS.
WHEN FINISHED, TYPE RUN.
THIS PROGRAM HAS AN OPTION TO USE DATA FILE INPUT
INSTEAD OF DATA STATEMENTS.

DONE


1000  DATA 5,10,15,3,6,9,12,1,4,2,7,8,11,13,14,16,17,18
RUN
FREQ1

FAST FREQUENCY DISTRIBUTIONS FOR TEST SCORES

DO YOU WANT INSTRUCTIONS(1=YES,0=NO)?0

NUMBER OF SCORES?18
1= DATA ON FILE, 0= DATA IN DATA STATEMENTS. WHICH?0

INTERVAL SIZE?3

CLASS
INTERVAL          FREQ

 18   -    20    1
 15   -    17    3
 12   -    14    3
 9    -    11    3
 6    -    8     3
 3    -    5     3
 0    -    2     2

NUMBER OF SCORES = 18

MAXIMUM SCORE IS 18

MINIMUM SCORE IS 1

SUM= 171
SUM SQR = 2109
MEAN = 9.5
STDEV = 5.33854

DONE
```

CONTRIBUTED PROGRAM **BASIC**

FRQ
36191

TITLE: FREQUENCY BETWEEN BOUNDRIES

DESCRIPTION:

The program finds the number of data points (frequency) within a set of limits. Data may come from a file or the terminal. Three (3) options are provided to set the limits. It handles 150 rows of data with a maximum of 5 data items per row.

INSTRUCTIONS:

The program is self-explanatory. However, if data is to come from a file one must remember to first declare a file on line(s) one (1) to nine (9). For example:

```
1 FILES MYFILE
```

VARIABLE NAMES --

"A" RAW DATA VALUES
"M" INTERVAL BOUNDRY POINTS
"R" NUMBER OF ROWS IN MATRIX "A"
"C" NUMBER OF COLUMNS IN MATRIX "A" = NUMBER OF VARIABLES
"E" INTERVAL WIDTHS CALCULATED FROM MAX AND MIN VALUES
"M1" and "M2" MAX AND MIN DATA VALUES
"Q1" and "Q2" FREQUENCY COUNTERS

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

A. Kozlowski and J. Kramp
GTE Automatic Electric Laboratories, Inc.

RUN

```
RUN
FRQ

FREQUENCY BETWEEN BOUNDARIES


THIS PROGRAM FINDS THE NUMBER OF DATA POINTS FALLING
BETWEEN GIVEN BOUNDRIES. INPUT OF UP TO 150 VALUES
OF EACH OF UP TO 5 VARIABLES FROM A DATA FILE OR
THE TERMINAL. THE DATA MAY BE SORTED INTO UP TO 200
INTERVALS.

DATA MANY BE ENTERED FROM A FILE IF THIS PROGRAM HAS
HAS HAD A 'FILES' STATMENT ADDED. DO YOU WISH TO
INPUT FROM A FILE (YES OR NO)?NO

ENTER NUMBER OF ROWS AND COLUMNS IN YOUR DATA SET?5,1

ENTER DATA ONE ELEMENT AT A TIME
ENTER ALL DATA FOR ONE ROW IN THE ORDER OF THE COLUMNS
STARTING WITH COLUMN ONE (1)

ROW   1

?3.6

ROW   2

?5

ROW   3

?6.8

ROW   4

?7.888

ROW   5

?9

WHICH VARIABLE DO YOU WISH TO WORK WITH?2

ERROR 02--DATA HAS  1      VARIABLES

WHICH VARIABLE DO YOU WISH TO WORK WITH?1

MAX. AND MIN VALUES FOR VARIABLE 1
 ARE            9               AND             3.6

DO YOU WISH TO SPECIFY DIFFERENT MAX. AND MIN.
VALUES. (YES OR NO)
?NO

THREE INTERVAL OPTIONS ARE AVAILABLE, THEY ARE:

   1            SPECIFY THE NUMBER OF INTERVALS
                (PROGRAM WILL CALCULATE END-POINTS)
   2            SPECIFY THE END-POINTS OF EACH INTERVAL
                (OTHER THAN THE MAX. AND MIN.)
   3            SPECIFY THE WIDTHS OF THE INTERVALS

ENTER INTERVAL OPTION
?1

ENTER THE NUMBER OF INTERVALS (200 MAX.)
?3
```

```
INTERVAL          FOR THE REGION          THE FREQUENCY IS

 1              3.6            5.4               2

 2              5.4            7.2               1

 3              7.2            9                 2

THE TOTAL NO. OF POINTS CLASSIFIED IS            5


DO YOU WISH TO DO MORE CLASIFYING (YES OR NO)
?NO

**END OF RUN**


DONE


GET-FILIST
8900 FILES F1
RUN
FILIST

IS T/S AN HP 2000 'A', 'B', OR 'C'?C

STOP LISTING FILE 1    AT THE FIRST EOF (Y OR N OR Q)?Y


FILE 1    RECORD 1

 10    350200.    422505.    100   1

FILE 1    RECORD 2

 12    350300.    422503.    200   2

FILE 1    RECORD 3

 12    350100.    422505.    300   3

FILE 1    RECORD 4

 10    350500.    422502.    400   4

FILE 1    RECORD 5

 11    350100.    422506.    500   5

FILE 1    RECORD 6

 11    350500.    422505.    600   6

FILE 1    RECORD 7

 11    350500.    422502.    700   7

FILE 1    RECORD 8

 10    350200.    422505.    800   8

FILE 1    RECORD 9

 10    350400.    422505.    900   9

FILE 1    RECORD 10

 10    350200.    422506.    1000      10

FILE 1    RECORD 11

 10    350500.    422504.    1100      11

FILE 1    RECORD 12

 12    350100.    422502.    1200      12
```

```
FILE 1     RECORD 13

 10    350100.     422505.     1300      13

FILE 1     RECORD 14

 10    350100.     422506.     1400      14

FILE 1     RECORD 15

 12    350200.     422504.     1500      15

FILE 1     RECORD 16

 10    350100.     422501.     1600      16

FILE 1     RECORD 17

 12    350400.     422502.     1700      17

FILE 1     RECORD 18

 11    350300.     422505.     1800      18

FILE 1     RECORD 19

 11    350100.     422503.     1900      19

FILE 1     RECORD 20

 11    350200.     422504.     2000      20

FILE 1     RECORD 21

END OF FILE 1

STOP LISTING FILE 2    AT THE FIRST EOF (Y OR N OR Q)?Q

DONE

GET-FRQ
1 FILES F1
RUN
FRQ

FREQUENCY BETWEEN BOUNDARIES


THIS PROGRAM FINDS THE NUMBER OF DATA POINTS FALLING
BETWEEN GIVEN BOUNDRIES. INPUT OF UP TO 150 VALUES
OF EACH OF UP TO 5 VARIABLES FROM A DATA FILE OR
THE TERMINAL. THE DATA MAY BE SORTED INTO UP TO 200
INTERVALS.

DATA MANY BE ENTERED FROM A FILE IF THIS PROGRAM HAS
HAS HAD A 'FILES' STATMENT ADDED. DO YOU WISH TO
INPUT FROM A FILE (YES OR NO)?YES

ENTER NUMBER OF ROWS AND COLUMNS IN YOUR DATA SET?20,5
WHICH VARIABLE DO YOU WISH TO WORK WITH?2

MAX. AND MIN VALUES FOR VARIABLE 2
 ARE            350500.         AND             350100.

DO YOU WISH TO SPECIFY DIFFERENT MAX. AND MIN.
VALUES. (YES OR NO)
?NO

THREE INTERVAL OPTIONS ARE AVAILABLE, THEY ARE:

   1            SPECIFY THE NUMBER OF INTERVALS
                (PROGRAM WILL CALCULATE END-POINTS)
   2            SPECIFY THE END-POINTS OF EACH INTERVAL
                (OTHER THAN THE MAX. AND MIN.)
   3            SPECIFY THE WIDTHS OF THE INTERVALS

 ENTER INTERVAL OPTION
 ?1
```

CONTRIBUTED PROGRAM **BASIC**

FVALUE
36720

TITLE: COMPUTES EXACT PROBABILITY OF AN F-RATIO WITH DEGREES OF FREEDOM (M,N)

DESCRIPTION: This program computes exact probability of an F-Ratio with degrees of freedom (M,N).

INSTRUCTIONS: The F-Value, numerator degrees of freedom, and denominator degrees of freedom must be provided.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
RUN
FVALUE

THERE IS A DISCONTINUITY IN THE APPROXIMATION FORMULA USED IN THIS
PROGRAM.  HOWEVER, THIS DISCONTINUITY WILL NOT AFFECT VALUES IN
THE CRITICAL RANGE.

ENTER F-VALUE, NUMERATOR D. F., AND DENOMINATOR D. F.
?6.7,5,11


EXACT PROBABILITY OF F= 6.7          WITH  (  5     ,    11    )  D.F.

    IS  .00464

DONE
```

CONTRIBUTED PROGRAM **BASIC**

GANOVA
36501

TITLE: ANALYSIS OF VARIANCE (2-WAY)

DESCRIPTION:

This program performs two way analysis of variance and provides a table of output containing degrees of freedom, sum of squares, and F ratios for columns, rows, interactions, error (no F ratio) and total (no mean square or F ratio). The program is dimensioned to allow a maximum of 20 rows and 20 columns. Cells may have any number of observations, but each cell must have the same number.

INSTRUCTIONS:

Data are entered cell by cell, down columns starting at line number 3000. Hence, each data statement will contain the values for a cell, and the statements will be ordered such that the first statement contains the values for the first cell in the first columns, the second statement contains the values for the second cell in the first column, etc.

Three user prompts are issued to give the program the dimensions of the data table. The sample run* illustrates the use of the program.

HOW MANY OBSERVATIONS PER CELL DO YOU HAVE?

Answer the number of replications per cell.

HOW MANY COLUMNS DO YOU HAVE?

Answer the number of column treatments in the analysis.

HOW MANY ROWS DO YOU HAVE?

Answer the number of row treatments in the analysis.

* The sample run is from Statistics, Volume II, W.L. Hays and R.L. Winkler, (Holt, Rinehart & Winston, Inc., p. 153).

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Graduate School of Business
Stanford University

RUN

```
3000 DATA 52,48,43,50,43,44,46,46,43,49
3001 DATA 38,42,42,35,33,38,39,34,33,34
3002 DATA 28,35,34,32,34,27,31,27,29,25
3003 DATA 43,34,33,42,41,37,37,40,36,35
3004 DATA 15,14,23,21,14,20,21,16,20,14
3005 DATA 23,25,18,26,18,26,20,19,22,17
RUN
GANOVA


HOW MANY OBSERVATIONS PER CELL DO YOU HAVE?10
HOW MANY COLUMNS DO YOU HAVE?3
HOW MANY ROWS DO YOU HAVE?2


                                  ***  ANOVA TABLE  ***
SOURCE            DF              SUM OF SQ      VARIANCE        F RATIO
ROW               1                4.26562        4.26562         .35812
COLUMN            2                4994.13        2497.07         209.641
INTERACTION       2                810.133        405.066         34.0073
ERROR             54               643.203        11.9112
TOTAL             59               6451.73


DONE
```

CONTRIBUTED PROGRAM **BASIC**

GEOMEN
36045

TITLE: STATISTICS OF GEOMETRIC DISTRIBUTION

DESCRIPTION: This program computes the geometric mean and standard deviation for a geometrically normal set of data.

INSTRUCTIONS: Enter data in line 9900 as follows:

9900 DATA N

9901 DATA $A_1, A_2, \ldots . . A_n$

where N = the number of data elements

A_k = the value of the kth data element in the set of data.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

```
GET-$GEOMEN
9900 DATA 10
9901 DATA 1←2,4,2,4,2,4,2,4,2,4
RUN
GEOMEN

GEOMETRIC MEAN IS 2.82843
GEOMETRIC STANDARD DEVIATION IS 1.44097

DONE
```

CONTRIBUTED PROGRAM **BASIC**

GRANK
36541

TITLE: RANKING STATISTICS

DESCRIPTION:

This program calculates three ranking statistics on from 2 to 10 different rank orderings of up to 20 ranks each. The statistics calculated are the Spearman R's for each pair, the average R's, and the Kendall W (for more than 2 orderings).

INSTRUCTIONS:

Data are entered via data statements beginning with line 3000. Begin with the first set of ranks, then the second, etc. The program will ask for the number of rankings and the number of ranks.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Graduate School of Business
Stanford University

RUN

```
3000 DATA 8,7,5,6,1,3,2,4,10,9
3010 DATA 7,6,8,3,2,1,5,4,9,10
3020 DATA 5,4,7,6,3,2,1,8,10,9
3030 DATA 8,6,7,4,1,3,5,2,10,9
3040 DATA 5,4,3,2,6,1,9,10,7,8
3050 DATA 4,5,6,3,2,1,9,10,8,7
3060 DATA 8,6,7,5,1,2,3,4,10,9
RUN
GRANK

HOW MANY RANKINGS DO YOU HAVE?7
HOW MANY RANKS DO YOU HAVE?10


RANKINGS
   1    2    3    4    5    6    7

   8    7    5    8    5    4    8
   7    6    4    6    4    5    6
   5    8    7    7    3    6    7
   6    3    6    4    2    3    5
   1    2    3    1    6    2    1
   3    1    2    3    1    1    2
   2    5    1    5    9    9    3
   4    4    8    2   10   10    4
  10    9   10   10    7    8   10
   9   10    9    9    8    7    9

SPEARMAN R(S) MATRIX
1.000  0.782  0.733  0.867  0.018  0.224  0.952
       1.000  0.673  0.915  0.333  0.539  0.915
              1.000  0.552  0.273  0.455  0.770
                     1.000  0.079  0.321  0.939
                            1.000  0.818  0.115
                                   1.000  0.370
                                          1.000

AVERAGE R(S)=  .554401        KENDALL W=  .618059

DONE
```

CONTRIBUTED PROGRAM **BASIC**

GRGPLT
36542

TITLE: SIMPLE REGRESSION AND PLOT

DESCRIPTION:

GRGPLT performs a simple regression and provides a plot of the data points. Data may be entered from the terminal or via data statements. Up to 500 observations may be used. The program computes maximum, minimum, and average values of the two variables, as well as the standard deviations.

In addition to the equation of the regression line, the standard errors and T-values of the two coefficients are printed, along with the unadjusted and adjusted values of R-squared (i.e., the coefficient of determination).

INSTRUCTIONS:

The user may specify the size of the graph (up to 7 inches by 7 inches). The graph will be square, with a resolution of 10 positions per inch on the horizontal axis and 6 positions per inch on the vertical axis.

An asterisk (*) in the diagram indicates one data point; a digit between 2 and 8 indicates the corresponding number of data points; a "9" indicates 9 or more data points. An axis will be provided whenever zero lies within the range of values plotted.

The letter "M" indicates the mean value of a variable. The letter "L" indicates the approximate intercept of the regression line. The user may specify the range of values plotted, or allow the program to do so automatically. In the latter case, the user may have both axes the same (i.e., from the lowest data value to the highest) or different (i.e., the X-axis will run from the lowest X-value to the highest X-value, and the Y-axis will run from the lowest Y-value to the highest).

If data statements are to be used, enter them between lines 2000 and 2999, as follows: first, the number of observations, then the observations, one at a time, with the y-variable followed by the x-variable.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Graduate School of Business
Stanford University

RUN

```
RUN
GRGPLT

DATA FROM TERMINAL OR DATA STATEMENTS?TERMINAL

HOW MANY POINTS DO YOU HAVE?10
FOR EACH POINT, TYPE TWO VALUES
  THE Y-VARIABLE FIRST, THEN THE X-VARIABLE
  SEPARATE THEM WITH A COMMA
FOR EXAMPLE --
  PAIR 1? 34, 56.7

PAIR  1?2,6
PAIR  2?1,8
PAIR  3?4,2
PAIR  4?3,9
PAIR  5?5,1
PAIR  6?3,10
PAIR  7?7,2
PAIR  8?3,9
PAIR  9?5,1
PAIR 10?2,2


NAME OF Y-VARIABLE?PRICE
NAME OF X-VARIABLE?QUANTITY
DO YOU WANT A LIST OF THE DATA?YES

PRICE           QUANTITY
-----           --------
 2               6
 1               8
 4               2
 3               9
 5               1
 3               10
 7               2
 3               9
 5               1
 2               2

DO YOU WANT A GRAPH?YES
DO YOU WANT TO SELECT THE AXES?YES
HOW LONG SHOULD EACH SIDE BE (IN INCHES)?5


               PRICE           QUANTITY
               -----           --------
 MAXIMUM        7               10
 MINIMUM        1               1
 AVERAGE        3.5             5
 STD DEV        1.68819         3.54965
(UNADJUSTED)

REGRESSION LINE --
     PRICE           =        4.88889       -0.27778*QUANTITY

STANDARD ERRORS:              0.83692        0.13649
T-VALUES:                     5.84150       -2.03519

R-SQUARED -- UNADJUSTED:  .341131       ADJUSTED:  .258772
```

```
Y-AXIS -- BOTTOM?0
             TOP?10
X-AXIS --   LEFT?0
           RIGHT?10


PRICE

 !
 !
 !
 !
 !
 !
 !
 !
 !         *
 !
 !
 !
 !
 !
 !    2
L!
 !
 !         *
 !
M!
 !                                            2   *
 !
 !
 !         *                   *
 !
 !
 !                                       *
 !
 !
 +-------------------------------------------------

                          M                        QUANTITY


DONE
```

CONTRIBUTED PROGRAM **BASIC**

GTASPD
36549

TITLE: SUBJECTIVE PROBABILITY DISTRIBUTION

DESCRIPTION: GTASPD allows the user to determine a subjective probability distribution which represents his state of knowledge about some random variable. Three values are provided:

A. The minimum possible value
B. The maximum possible value, and
C. The most likely value (the mode)

GTASPD fits a truncated, modified Weibull distribution (reference GWBULL, HP #36551) to the three values and prints an initial histogram showing the relative likelihood that the true value is contained in an interval.

INSTRUCTIONS: The user is asked to modify the histogram so that it will more accurately reflect his own feelings; then a new histogram is printed. This cycle is repeated until he is satisfied with the relative likelihood in each interval. Finally the histogram is normalized to determine the probability mass per interval, and a cumulative distribution function (piecewise linear approximation) is printed.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Graduate School of Business
Stanford University

RUN

```
RUN
GTASPD




TECHNIQUE FOR ASSESSMENT OF SUBJECTIVE PROBABILITY DISTRIBUTIONS



FOR ALL YES-NO RESPONSES, USE '1' FOR YES, 'Ø' FOR NO.



DO YOU WANT AN EXPLANATION OF THE PROGRAM?1




THIS PROGRAM WILL ASSIST YOU IN DETERMINING A SUBJECTIVE
PROBABILITY DISTRIBUTION WHICH WILL REPRESENT YOUR STATE
OF KNOWLEDGE ABOUT SOME RANDOM VARIABLE.  YOU PROVIDE THREE
VALUES:  A)  THE MINIMUM POSSIBLE VALUE,
         B)  THE MAXIMUM POSSIBLE VALUE, AND
         C)  THE MOST LIKELY VALUE (THE MODE).
THE PROGRAM FITS A TRUNCATED, MODIFIED WIEBULL DISTRIBUTION
(SEE $GWBULL) TO THE THREE VALUES AND PRINTS AN INITIAL
HISTOGRAM SHOWING THE RELATIVE LIKELIHOOD THAT THE TRUE
VALUE IS CONTAINED IN AN INTERVAL.  YOU ARE ASKED TO MODIFY
THE HISTOGRAM SO THAT IT WILL MORE ACCURATELY REPLECT YOUR
OWN FEELINGS;  THEN A NEW HISTOGRAM IS PRINTED.  THIS CYCLE
IS REPEATED UNTIL YOU ARE SATISFIED WITH THE RELATIVE LIKE-
LIHOOD IN EACH INTERVAL.  FINALLY THE HISTOGRAM IS NORMAL-
IZED TO DETERMINE THE PROBABILITY MASS PER INTERVAL, AND A
CUMULATIVE DISTRIBUTION FUNCTION (PIECEWISE LINEAR APPROXI-
MATION) IS PRINTED.




SCALE THE RANDOM VARIABLE SO THAT
     A)  MIN >= 1, MAX < 1ØØØØ,
     B)  (MAX - MIN) > 1, AND
     C)  MIN < MODE < MAX.



MINIMUM POSSIBLE VALUE?15



MAXIMUM POSSIBLE VALUE?43



MOST LIKELY VALUE (MUST BE BETWEEN THE MIN AND MAX VALUES) ?31
```

```
                                                RELATIVE LIKELIHOOD / INTERVAL
                                          0         10        20        30        40
                                          !         !         !         !         !
                                          +---------+---------+---------+---------+
                                          !
 1         BELOW     12.00               -!**********
                                          !
 2      12.00 TO     15.99               -!**********
                                          !
 3      16.00 TO     19.99               -!****************
                                          !
 4      20.00 TO     23.99               -!**********************
                                          !
 5      24.00 TO     27.99               -!***************************
                                          !
 6      28.00 TO     31.99               -!******************************
                                          !
 7      32.00 TO     35.99               -!*****************************
                                          !
 8      36.00 TO     39.99               -!*************************
                                          !
 9      40.00 TO     43.99               -!******************
                                          !
10      44.00 AND ABOVE                  -!******************
                                          !
                                          +---------+---------+---------+---------+
```

INTERPRET THE HISTOGRAM AS FOLLOWS: IF, FOR EXAMPLE, THERE ARE 12 *'S IN INTERVAL 5 AND 4 *'S IN INTERVAL 9, THEN IT IS THREE TIMES AS LIKELY THAT THE TRUE VALUE IS IN INTERVAL 5 THAN IN INTERVAL 9. MAKE SIMILAR PAIRWISE COMPARISONS WITH THE OTHER INTERVALS.

DO YOU WANT TO MODIFY THE HISTOGRAM?1

FOLLOWING EACH '?' TYPE THE NUMBER OF THE INTERVAL YOU WANT TO MODIFY, COMMA, AND THE NUMBER OF *'S YOU WANT DELETED (-) OR ADDED. FOR EXAMPLE, '7,-3' MEANS DELETE 3 *'S FROM INTERVAL 7. '4,9' MEANS ADD 9 *'S TO INTERVAL 4. TYPE '0,0' WHEN YOU HAVE COMPLETED THE DESIRED MODIFICATIONS; THEN A REVISED HISTOGRAM WILL BE PRINTED.

```
?1,-3
?5,1
?6,3
?10,-4
?0,0
```

```
                                       RELATIVE LIKELIHOOD / INTERVAL
                                  0         10        20        30        40
                                  !         !         !         !         !
                                  +---------+---------+---------+---------+
                                  !
 1          BELOW    12.00       -!*******
                                  !
 2       12.00 TO    15.99       -!**********
                                  !
 3       16.00 TO    19.99       -!****************
                                  !
 4       20.00 TO    23.99       -!**********************
                                  !
 5       24.00 TO    27.99       -!****************************
                                  !
 6       28.00 TO    31.99       -!*********************************
                                  !
 7       32.00 TO    35.99       -!*****************************
                                  !
 8       36.00 TO    39.99       -!*************************
                                  !
 9       40.00 TO    43.99       -!******************
                                  !
10       44.00 AND ABOVE         -!**************
                                  !
                                  +---------+---------+---------+---------+



DO YOU WANT TO MODIFY THE HISTOGRAM?1



AS BEFORE, TYPE INTERVAL NUMBER, COMMA,
AND NUMBER OF *'S TO BE CHANGED.

?1,-7
?2,-3
?3,-2
?4,-1
?5,1
?8,-1
?9,-2
?10,-4
?0,0


                                       RELATIVE LIKELIHOOD / INTERVAL
                                  0         10        20        30        40
                                  !         !         !         !         !
                                  +---------+---------+---------+---------+
                                  !
 1          BELOW    12.00       -!
                                  !
 2       12.00 TO    15.99       -!*******
                                  !
 3       16.00 TO    19.99       -!**************
                                  !
 4       20.00 TO    23.99       -!*********************
                                  !
 5       24.00 TO    27.99       -!*****************************
                                  !
 6       28.00 TO    31.99       -!*********************************
                                  !
 7       32.00 TO    35.99       -!*****************************
                                  !
 8       36.00 TO    39.99       -!************************
                                  !
 9       40.00 TO    43.99       -!****************
                                  !
10       44.00 AND ABOVE         -!**********
                                  !
                                  +---------+---------+---------+---------+
```

DO YOU WANT TO MODIFY THE HISTOGRAM?0

			PROBABILITY MASS
1	BELOW	12.00	0.000
2	12.00 TO	15.99	0.038
3	16.00 TO	19.99	0.077
4	20.00 TO	23.99	0.115
5	24.00 TO	27.99	0.158
6	28.00 TO	31.99	0.180
7	32.00 TO	35.99	0.158
8	36.00 TO	39.99	0.131
9	40.00 TO	43.99	0.087
10	44.00 AND ABOVE		0.055

CUMULATIVE PROBABILITY

```
              0    .1   .2   .3   .4   .5   .6   .7   .8   .9   1.0
             -+----+----+----+----+----+----+----+----+----+----+
              !
    12.00    -!*
              !*
    16.00    -! *
              !   *
    20.00    -!     *
              !        *
    24.00    -!           *
              !               *
    28.00    -!                   *
              !                       *
    32.00    -!                            *
              !                                *
    36.00    -!                                    *
              !                                       *
    40.00    -!                                          *
              !                                             *
    44.00    -!                                               *
              !
             -+----+----+----+----+----+----+----+----+----+----+
```

DONE

CONTRIBUTED PROGRAM **BASIC**

GWBULL
36551

TITLE: SUBJECTIVE PROBABILITY - RANDOM VALUES

DESCRIPTION: This subroutine can be used to fit a three-parameter representation of the Weibull distribution to judgmental data on the likelihood of events and/or to generate random values from such a distribution.

INSTRUCTIONS: The use of the subprogram is described in GSB Technical Report #1, "A Flexible Stochastic Generator for Judgment-Based Simulations" by W. F. Massy, which follows:

The generation of pseudo-random numbers according to a distribution of specified shape is often a problem in the development of simulation models. This may be done easily, of course, when the parameters of the appropriate probability law are known and the law possesses a closed-form distribution function. Alternatively, the desired law may be approximated by another more tractable one, or by a piece-wise linear function. These techniques often suffice in cases where the model is being parameterized by "experts."

Instructions continued on next page.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Graduate School of Business
Stanford University

More serious difficulties arise when a general model is to be used in a wide variety of situations, and the individual parameterizations are to be provided directly to the model by persons not trained in probability theory. An example of this is in PERT models where the time to complete a task is subject to uncertainty. The user of the model is asked to provide a minimum, most likely, and maximum value for each time, where the extremes may be defined as (say) the 10% and 90% probability limits. Ideally, the computer program should accept this information as an input and determine the parameters of an appropriate probability distribution before proceeding. A similar situation arises in "risk analysis" programs.[1] Here managers may be asked to give minimum, most likely, and maximum values for quantities like sales, unit costs, and so on; then the model translates these into a distribution for net discounted profit or rate of return on investment.

Three general considerations should be kept in mind when defining an algorithm for processing the kind of inputs described above. (1) The procedure must be able to handle a wide variety of data. For example, a manager may believe that one distribution is highly skewed in a positive direction, the next one skewed negatively, and that still another is symmetric. Similarly, certain distributions may be constrained to be positive, others negative, while still others may span the origin. (2) The procedure must be simple to use and require no technical expertise on the part of the manager who provides the inputs. For example, the user should not have to choose from among a number of different probability laws -- which are probably all Greek to him -- in order to adequately represent the data he is providing. Similarly, he should be able to respond to questions like the ones illustrated above rather than being forced to provide unnatural (to him) statistics like standard deviations on higher moments. (3) The process by which individual random numbers are generated in the computer should be fairly efficient, which implies that a closed form distribution function should be sought. However, a reasonable amount of "setup time" can be afforded in the course of having the machine translate the user's inputs into a processable form.

The exact form of the probability law utilized is not of great importance in judgment-based simulations. The important thing is that whatever function is chosen can fit the set of data points provided by the user with an acceptable degree of accuracy. These data usually represent "beliefs" or "attitudes" which the user is hard-pressed to precisely quantify (that is to say, the data are "judgments"). Therefore, it is hard to believe that one probability law can ever be shown to be more "valid" than another, provided that both fit whatever data points are provided by the user.

The algorithm described in this paper provides a flexible, convenient, and fairly efficient way to fit judgmental data on the likelihood of events. It is based on a three-parameter representation of the Weibull distribution. It was constructed during the author's development of MARKETPLAN, an interactive model for evaluating alternative marketing mixes under uncertainty about market conditions and response factors.

<u>The Distribution and Its Parameterization</u>

The Weibull distribution can be written as follows:

$$F(z) = 1 - \exp\left\{ -\frac{\mu}{\lambda+1} z^{\lambda+1} \right\},\ z \geq 0.$$

where μ and λ are parameters.[2] The density function is:

$$f(z) = \mu z^{\lambda} \exp\left\{ -\frac{\mu}{\lambda+1} z^{\lambda+1} \right\}.$$

It is apparent that μ must be greater than zero and λ greater than -1 in order for $f(z)$ to be a proper density function. If $\lambda=0$ we have an exponential distribution, whereas for $\lambda>0$ the Weibull has a unique mode for $z>0$. This is easily seen by maximizing the density function with respect to z.

$$f(z) = -\mu^2 z^{2\lambda} \exp\left\{ -\frac{\mu}{\lambda+1} z^{\lambda+1} \right\} + \mu\lambda z^{\lambda-1} \exp\left\{ -\frac{\mu}{\lambda+1} z^{\lambda+1} \right\} = 0$$

$$z_{mode} = \left(\frac{\lambda}{\mu}\right)^{\frac{1}{\lambda+1}}$$

The mode is not defined for $\lambda<0$.

1) See for example David B. Hertz, "Risk Analysis in Capital Investment," <u>Harvard Business Review</u>, (January-February, 1964), pp. 95-106.

2) For a discussion of the Weibull distribution and the broader class of Polya frequency functions of which it is a member, see R.E. Barlow, A.W. Marshall, and F. Proschaw, "Properties of Probability Distributions with Monotone Hazard Rates," Annuals of Mathematical Statistics, vol. 34 (1963), pp. 375-389.

It is common to use the most likely value of the probability distribution as one of the judgmental inputs obtained prior to a simulation. For the Weibull this allows the distribution function to be reparameterized as follows:

$$F(z) = 1 - \exp\{-\frac{\lambda}{\lambda+1}(\frac{z}{z_{mode}})^{\lambda+1}\}, \quad (1)$$

where $\mu = \lambda z_{mode}^{-(\lambda+1)}$ is implied. Thus the Weibull depends only on one parameter, λ, once the most likely value of z has been specified. And of course the value of λ must be greater than zero if the mode is to be specified in this way.

Unfortunately, this representation of the Weibull distribution is rather restrictive. The values of z are constrained to be positive, negatively skewed data cannot be fit, and the distribution becomes approximately symmetric only when z_{mode} is large. These problems can be handled by introducing two new parameters. Let:

- x be the random variable to which the distribution is to be fit.
- $\emptyset$ be an origin shift or location parameter.
- δ be a reflection and scaling parameter, which is positive if the data are positively skewed or symmetric and negative if the data are negatively skewed.

Our original random variable is now defined to be:

$$z = (x - \emptyset)\delta. \quad (2)$$

Random values of x can be obtained from a rectangularly distributed psuedo-random variable (r) by solving equation (1) for F(z) and inverting equation (2).

$$z = z_{mode} - [\frac{(\lambda+1)}{\lambda} \log(1-r)]^{\frac{1}{\lambda+1}}$$

where of course $z_{mode} = (X_{mode} - \emptyset)\delta$ according to equation (2).

We will show that a Weibull distribution on z provides a good approximation to a wide variety of single-humped, skewed and symmetric data on x, given X_{mode} as an input and suitable choices for λ, $\emptyset$, and δ.[3] First, however, we will briefly describe an algorithm for making these choices.

Estimation of Parameters

We assume that the data inputs to a judgment-based simulation take the following form. (1) The most likely value (X_{mode}). (2) A series of pairs of values (X_k and $P_k, k=1,\ldots,N$) giving x-values for different probability points on the cumulative distribution function. The only restrictions on these values are as follows: $N \geq 2$, $X_1 < X_2 < \ldots < X_N$, $P_1 < P_2 < \ldots < P_N$, $X_1 < X_{mode} < X_N$, and $P_N = 1 - P_1$. The first restriction insures that there are enough data points to identify the parameters λ and $\emptyset$. The second and third restrictions simplify the algorithm, but do not reduce the generality of the procedure. The last two restrictions are usually met by the normal procedures for defining judgmental inputs -- the need for them will become apparent shortly.

The parameter estimation process proceeds in several steps. First, the sign of the reflection parameter δ is determined by sensing the direction in which the extreme points in the data are skewed. That is:

$$\delta > 0 \quad \text{if } (X_N - X_{mode}) \geq (X_{mode} - X_1)$$

$$\delta < 0 \quad \text{if } (X_N - X_{mode}) < (X_{mode} - X_1).$$

The facts that $P_N = 1 - P_1$ and X_{mode} lies between X_1 and X_N insure that the above criterion represents a meaningful measure of the direction of skewness.

Second, a tentative value for the origin parameter $\emptyset$ is determined. It is set slightly outside the "short side" of the distribution -- i.e. just below X_1 if $\delta>0$, or above X_N if $\delta<0$. (For the results to be presented here, the starting value of $\emptyset$ was 0.01 $(X_N - X_1)$ away from the appropriate extreme value.)

[3] Additional information, about the alternative shapes taken by the distribution can be found in W. Grant Ireson (Ed.) Reliability Handbook (New York: McGraw-Hill Book Company, 1966), pp. 2-6 to 2-10. Also, the information on X_{mode} supplied by the user is incorporated in λ, $\emptyset$, and δ by the fitting procedure, making this a three-parameter distribution.

Third, the distribution is rescaled so that the origin is at Ø and all z-values are positive. If $\delta<\emptyset$ this implies a reflection as well as an origin shift, in which case all values of P_k are subtracted from one. Since the scaling at this stage is arbitrary, the numerical value of δ is set so that $z_{mode} = 1$.

Next, the best value of λ is determined by means of a Fibonacci search over the positive range. (Our results are based on a starting value of 0.1.) A search based on linear increments is conducted between the best three points found by the Fibonacci search. The criterion function which is minimized at this stage is:

$$C = \sum_{k=1}^{N} \frac{(P_k - F(z_k))^2}{P_k(1-P_k)} ,$$

where z_k is given by equation (2) and $F(z_k)$ by (1). This is analogous to a modified chi-square function, which has been shown to be an efficient parameter estimation procedure.[4] While the usual assumptions of parameter estimation probably do not apply in this case, it is very likely that this weighted-sum-of-squared-error procedure has desirable properties.

A measure of the goodness of fit of the distribution is provided by the proportion of the weighted variance of P_k (taken through the origin) that is "explained" by $F(z_t)$. That is:

$$R^2 = 1 - C_{min} \sum_{k=1}^{N} \frac{P_k^2}{P_k(1 - P_k)}$$

Once the best value of λ has been determined for the trial value of Ø, the latter parameter is shifted in the direction away from the nearest extreme value, the distribution is rescaled (step 3), and a new optimum for λ determined. (For our results, the increments to Ø follow a Fibonacci series starting with the value mentioned in step two.) This process continues until the optimal value for Ø has been found.[5] If desired, an inequality constraint on the value of Ø can be introduced at this stage. This has the effect of bounding the short side of the distribution as, for example, when the distribution is known to be skewed to the right (left) and strictly positive (negative). (No bound is possible for the long side of the distribution, but it is doubtful whether the need for such a constraint would ever arise in practice.) The constraint is programmed into the search procedure by setting C to $+\infty$ whenever Ø strays outside the feasible region.

Test Results

The fitting program was run for several sets of test data. Table 1 shows two sets of results for N=2, (X_1,P_1) = (- 1.0, 0.1), and (X_2,P_2) = (+ 0.1, 0.9). The first one is based on X_{mode} = -0.7, in which case the distribution is positively skewed. The second is the mirror image of the first, where X_{mode} = -0.2. The table presents parameter values and coefficients of determination, as well as the values of the density and distribution functions. The scaled values (z) are also shown; note that they are the same regardless of the direction in which the distribution is skewed.

Table 2 presents some comparisons of results for a set of data ranging from perfectly symmetric (run A) to very highly skewed (run F). (All the runs are based on N=2 and have the same P_1 and modal values.) The degree of fit is always very good, with the small variations probably being due to the fact that the sum of squares is not minimized with equal precision in all runs. (A fairly good fit is to be expected with only two data points, providing that the function is capable of representing both symmetric and skewed distributions.) The value of Ø tends to become more negative (i.e. get further from the lower extreme point in the data) and λ declines with the degree of skewness -- both results are in accordance with the known properties of the Weibull distribution.

---

[4]For a discussion of estimation procedures see C.R. Rao, Linear Statistical Inference and Its Applications (New York: John Wiley & Sons, Inc., 1965).

[5]The sequential procedure just described is direct but probably somewhat inefficient. It is possible that a type of pattern search would yield quicker convergence, though the necessity to rescale the distribution after every change in Ø complicates the picture somewhat. For a discussion of pattern searching methods see Douglas Wilde, Optimal Seeking Methods (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964).

Table 1. SAMPLE PAIR OF FITTED WEIBULL FUNCTIONS*

Cumulative Probability	f(z)	z	X: Mode = -.7	X: Mode = -.2
.001	0.054	0.033	-1.20	-2.14
.01	0.148	0.119	-1.16	-1.64
.10	0.375	0.449	-0.99	-1.01
.20	0.462	0.685	-0.86	-0.76
.30	0.497	0.892	-0.76	-0.60
.40	0.498	1.092	-0.65	-0.47
.50	0.474	1.297	-0.54	-0.35
.60	0.428	1.518	-0.43	-0.25
.70	0.362	1.771	-0.30	-0.14
.80	0.274	2.085	-0.14	-0.04
.90	0.160	2.552	+0.11	+0.09
.99	0.217	3.771	+0.74	+0.26
.999	0.003	4.738	+1.24	+0.30
δ (scale parameter)			+1.92	-1.92
∅ (origin parameter)			-1.22	+0.32
λ (shape parameter)			0.775	+0.775
R^2			0.998	0.998

* P [X < - 1.0] = 0.1; P [X < + 0.1] = 0.9

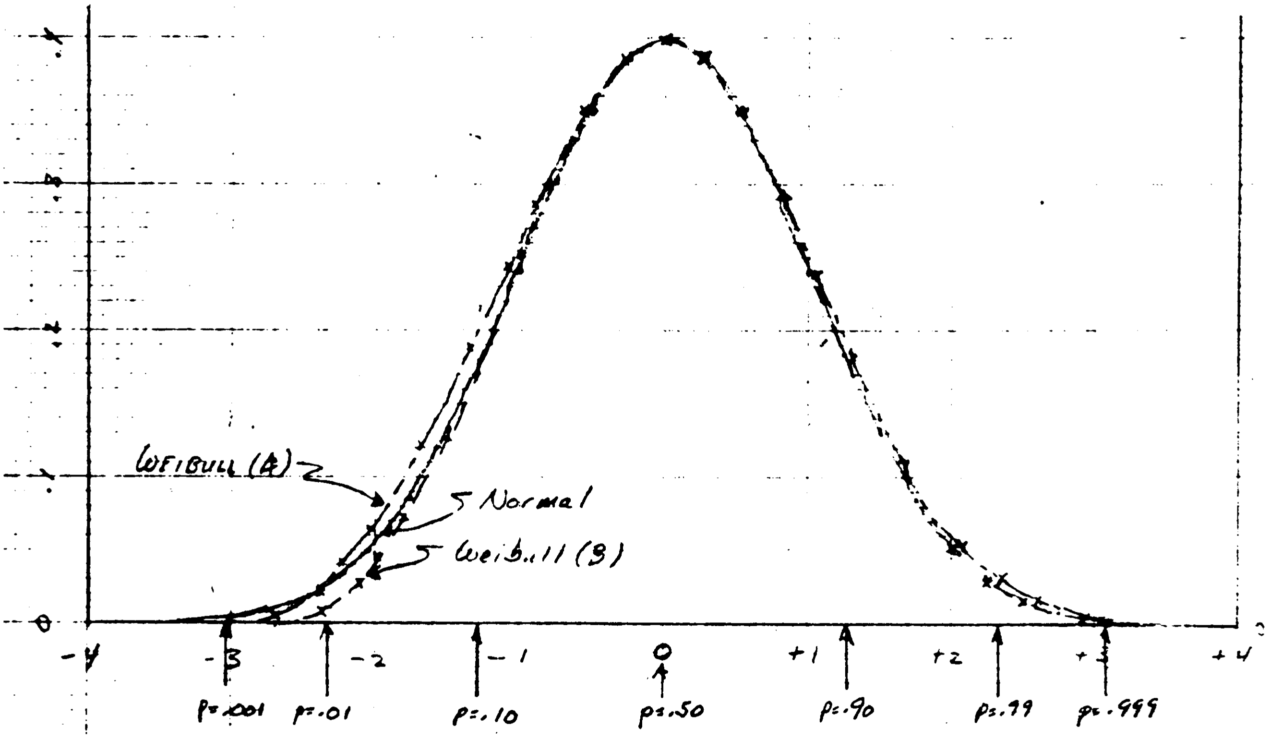
Table 2. COMPARISON OF FITTED PARAMETERS FOR SYMMETRIC AND SKEWED DISTRIBUTIONS

X-values for:	RUN A	B	C	D	E	F
P = .1	-1	-1	-1	-1	-1	-1
Mode	0	0	0	0	0	0
P = .9	+1	+2	+5	+10	+50	+100
δ	0.481	0.503	0.581	0.431	0.140	0.124
∅	-2.080	-1.990	-1.720	-2.32	-7.120	-8.070
λ	2.025	1.150	0.475	0.325	0.225	0.125
R^2	.9959	.9963	.9949	.9979	.9704	.9891

Finally, Figure 1 compares the density functions fitted to two different sets of data with the normal density function having the same mean and variance. The run labeled "Weibull (A)" was estimated with N=7 and X_{mode} = E(x) = 0. The seven data points were based on cumulative probabilities of 0.001, 0.01, 0.10, 0.50, 0.90, 0.99, and 0.999, with X-values taken from a table of the unit normal distribution. The run labeled "Weibull (B)" was similar except that only two probability values were used: for p = 0.1 and 0.9. The fit of the Weibull distribution to the data was excellent in both cases, with R^2 of 0.9985 and 0.9997 respectively. The correspondence with the normal distribution is also quite good except for a slight tendency to undershoot in the left-hand tail. This effect is greater for the (B) estimation, where data for P = .01 and P = .001 were not included in the fitting process.

These results suggest that the three-parameter Weibull distribution described in this paper can provide a reasonable approximation to a wide variety of judgmental data pertaining to unimodal probability assessments. In particular, the parameterization and fitting algorithm described here can handle either skewed or symmetric distributions, including the normal distributions. (We conjecture that it will easily handle a skewed distribution like the gamma as well.) The procedure is completely insensitive to the location of the origin or the direction of skewness. We hope these results will be helpful to builders of judgment-based simulation models.

Figure 1. COMPARISON OF THE STANDARDIZED NORMAL AND FITTED WEIBULL DISTRIBUTIONS



Appendix: Program Description

The Weibull program has two entry points, as follows:

GOSUB 9010. The fitting procedure: called once for each distribution to be initialized.

GOSUB 9840. The stochastic generator, called each time a random variable is desired.

The first entry is by far the largest part of the program (approximately 80 statements), and may need to be chained. (This would also serve to isolate the local variables used in the fitting procedure.) The random number generator portion of the program is self-contained, and consists of only 8 statements. A flow chart of the program is presented in Figure A-1.

Variable definitions

Inputs to the fitting program:

NO	Number of data points to be fit, excluding the most likely value.
P(k)	The probability level associated with the k^{th} data point.
X(k)	The value of the k^{th} data point.
MO	The value of the mode (most likely value).

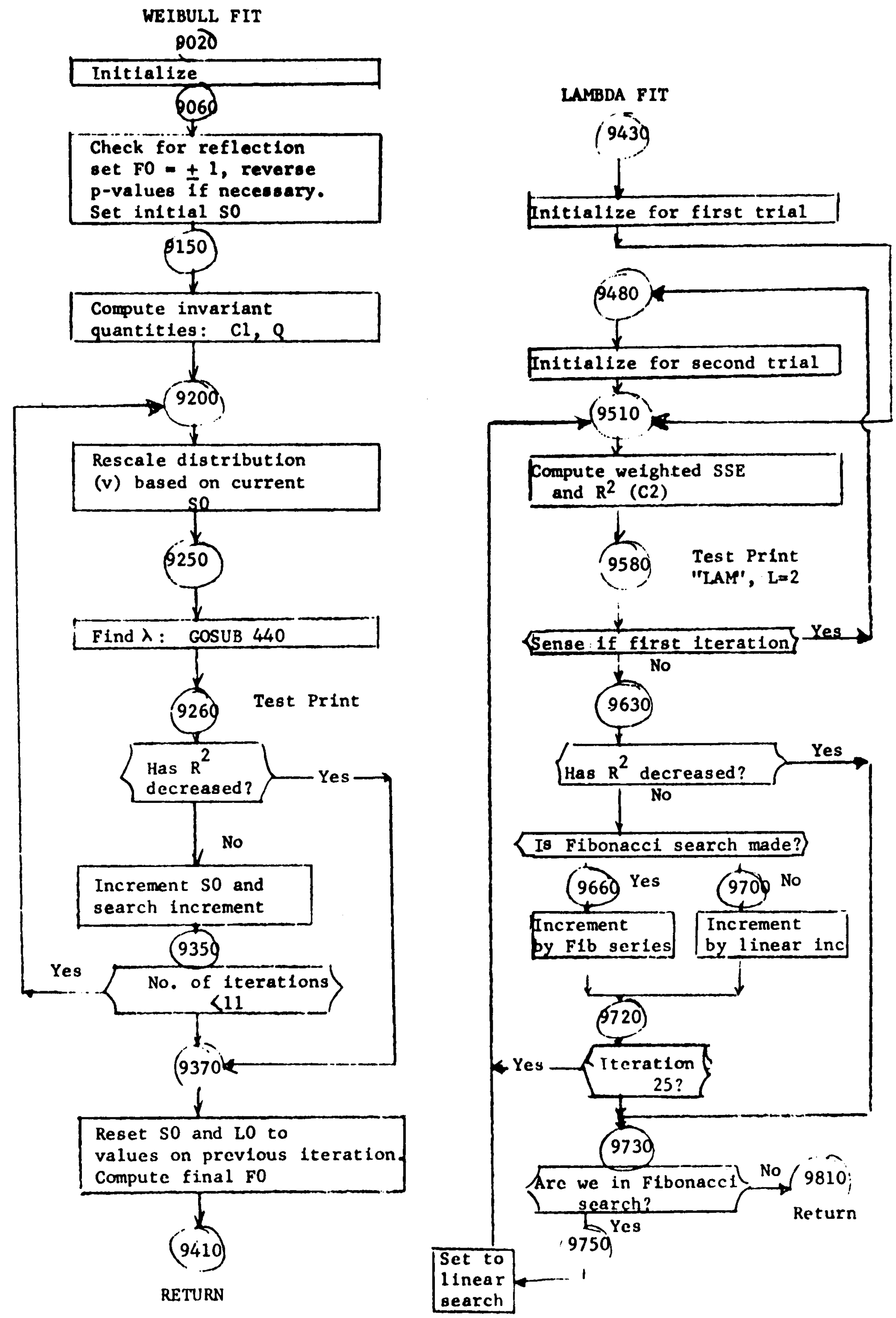
Parameters (outputs of the fitting program, inputs to the stochastic generator).

FO	The scale factor (δ in the text)
SO	The origin shift (Ø in the text)
LO	The shape parameter (λ in the text)

Output of stochastic generator.

RO	The Weibull-distributed pseudo-random number.

Figure A-1. FLOWCHART FOR WEIBULL FITTING PROGRAM



Local variables used in the fitting program.

V(k)	The rescaled value of X(k) (Z_k in the text)
Q(k)	The inverse of the weighting factor in the sum-of-squared error function (equal to P_k $(1-P_k)$).
S1,S2	Increments to S0 used in the Fibonacci search for Ø.

R0,R1	Coefficients of determination used at various points in the program. (C2, is also used this way at one point.)
R2	A flag which determines whether the λ-search is in Fibonacci mode (=0) or linear mode (=1).
L1,L2,L4	Temporary values of L0 and increments to L0 used in the Fibonacci search and linear searches for
L3	Always L1 +1.
C1	The weighted sum of squares of P_k.
C2,C3	Accumulators used in calculating the sum of squared error.
M1	A temporary variable used in rescaling.
N1	The number of iterations for S0.
N2	The number of iterations for L0 (for the current value of S0).
Z	Controls the printing of test output (=0 for no output; =1 for output on S0-search only; =2 for output on both S0 and L0 search).

Local variables used in the stochastic generator:

R1,R2	Temporary variables.

CONTRIBUTED PROGRAM **BASIC**

HISTOG
36055

TITLE: A HISTOGRAM FORMED FROM A SET OF NUMBERS

DESCRIPTION:

This program calculates the mean, median, mode, standard deviation and prints a standardized histogram on the teletype from a set of data. After the histogram is complete, the user has the option of testing the data set against the normal or Gaussian distribution using the Chi square test for goodness of fit.

INSTRUCTIONS:

Before running the program, enter the following in line 9900:

9900 DATA S,L,N
9901 DATA X_1,X_2,...X_N

Where:

S = the cell size or number of units of X desired in each Histogram bar.
L = Lower bound of lowest Histogram bar.
N = Number of data points.
X_i= Data points.

Warning: First Line Number of X Data Set MUST be 9901.

SPECIAL CONSIDERATIONS:

The maximum number of data points this program will handle is 100. For a larger number, change statement 9003 to

9003 DIM G (# of data points), DIM F (100)

and statement 9004 to

9004 N = # of data points

The mean, median, and standard deviation are calculated using the raw data. The formula for standard deviation uses N-1 in the denominator. The frequency statistics are gathered on the blocked data, once the histogram bar sizes have been determined. When sample size is greater than 1 bar, numbers are noted with a "+" following them. This means the bar represents data points in the range of the bar number to the bar number plus the sample size minus 1. i.e., 20 + with sample size of 5 means the bar represents all points in the region 20-24.

The theoretical distribution values are determined by integrating the standardized normal function from -6 SIGMA to (X-Mean)/SIGMA) using Simpsons's Rule.

ACKNOWLEDGEMENTS:

J. L. Mulcahy
Raychem Corporation

RUN

```
9900  DATA 2.-,0,25
9901  DATA 1,2,3,4,5,6,7,8,9,2,3,4,5,6,7,8,3,4,5,6,7,4,5,6,5
RUN
HISTOG


-----------------------------------------------------------------------

                       ***  HISTOGRAM  ***

-----------------------------------------------------------------------

      25   DATA POINTS TOTAL          CELL SIZE= 2

      MEAN= 5                         MEDIAN= 5

      STANDARD DEVIATION= 2.04124

      MAXIMUM FREQUENCY= 9

      MAXIMUM FREQUENCIES AT: 4     +

-----------------------------------------------------------------------

                                   % OF MAXIMUM
          0         20         40         60         80         100
          !          !          !          !          !          !
          +----------+----------+----------+----------+----------+
 0     +  -!*****
          -!***************************
          -!**************************************************
          -!**************************************
          -!****************
 10    +  -!

DO YOU WISH TO TEST FOR NORMALITY IN THIS DATA SET?
YES=1,NO=0
?1
               THEORETICAL    OBSERVED
MID-POINT      FREQUENCY      FREQUENCY

 1              1.77047        1
 3              6.03199        5
 5              9.39479        9
 7              6.03198        7
 9              1.77077        3

CALCULATED VALUE OF CHI SQUARE IS 1.53709    WITH 2    D.F.

DONE
```

TITLE: INTERACTIVE DATA ANALYSIS

IDA
36755

DESCRIPTION:

IDA is an interactive system for statistical analysis that has been developed at the Graduate School of Business of the University of Chicago for implementation on HP 2000C and C'/F mini-computers. The system is fully conversational, permitting a statistical analysis to be implemented flexibly by a series of commands that can be accomplished in almost any sequence, according to the user's choice after seeing the results of previous commands. IDA is virtually self-documenting, and has a number of convenience features for the user, including multi-level prompts, data-editing, automatic updating, and recovering from errors. IDA has been used in teaching of statistics courses at different levels with gratifying response from students. It has also proved valuable as a tool for research.

INSTRUCTIONS:

Get and RUN program. Type "YES" in response to query, "DO YOU NEED HELP?"

Complete user instructions are included in material published by the HP Computer Curriculum Project: HP 5951-5606 CONVERSATIONAL STATISTICS $13.50. For further information contact:

HP Computer Curriculum Project
11000 Wolfe Road
Cupertino, CA 95014

Get and RUN "IDAFIL" for a list of data files included in the IDA package.
Get and RUN "IDAPRO" for a list of programs included in the IDA package.

ACKNOWLEDGEMENTS: Robert Ling/Harry Roberts
Graduate School of Business
University of Chicago

RUN

```
GET-IDA
RUN
IDA

14 JUN 74 VERSION

GOOD MORNING.  NEED HELP ?YES

IDA  (AN ACRONYM FOR 'INTERACTIVE DATA ANALYSIS')

IS A SYSTEM OF PROGRAMS CHAINED TO THE CONTROL PROGRAM $IDA.

IN USING IDA, YOU ISSUE A COMMAND FOR THE TASK YOU WANT DONE,
IDA DOES IT, YOU EXAMINE THE RESULTS, AND ON THE BASIS OF THE
RESULTS YOU DECIDE WHICH TASK YOU WISH IDA TO EXECUTE NEXT AND
ISSUE THE APPROPRIATE COMMAND.
WHEN YOU DO NOT WANT TO DO MORE, YOU TYPE THE COMMAND 'QUIT'.

CURRENTLY THERE ARE OVER 100 IDA COMMANDS.

>    IS THE SYMBOL INDICATING THAT IDA IS READY FOR YOU TO ISSUE
       A COMMAND WORD INDICATING WHICH TASK IS TO BE EXECUTED NEXT.

PROMPTS ARE GIVEN BY IDA WHEN MORE INFORMATION IS NEEDED TO EXECUTE
       THE TASK INDICATED BY THE COMMAND.
       THE PROMPTS ARE DETAILED (LEVEL 1), LESS DETAILED (LEVEL 2)
       OR BRIEF (POSSIBLY CRYPTIC) IN LEVEL 3.
       PROMPT LEVEL 1 IS IN EFFECT UNLESS YOU ISSUE THE COMMAND
       CHGP  TO CHANGE THE PROMPT LEVEL.
       IT IS SUGGESTED YOU USE PROMPT LEVEL 1 THE FIRST TIME YOU
       ISSUE A COMMAND IN ORDER TO TAKE ADVANTAGE OF THE
       ADDITIONAL EXPLANATIONS AVAILABLE AT THAT LEVEL.

*  WILL PRECEDE A PROMPT IF FURTHER INFORMATION WILL BE
   FORTHCOMING IF YOU
   (1)  TYPE  ?   OR
   (2)  JUST SIT AND WAIT A BIT.

*  WANT MORE DETAILS ? YES
YOU CAN GET MORE INFORMATION ABOUT IDA
   (1)  FROM 'CONVERSATIONAL STATISTICS' AND ITS 'COMPUTER
        PREFACE', OR
   (2)  IF YOU GET-$IDA, RUN IT, AND
        ISSUE THE IDA COMMANDS:
          EXPL  TO GET AN EXPLANATION FOR A SPECIFIC COMMAND
          INFO  TO GET EXPLANATIONS OF ALL THE COMMANDS IN A
                GROUP--SUCH AS TRANSFORMATION COMMANDS
        OR, IN SOME CASES,
        ISSUE THE COMMAND AT PROMPT LEVEL 1.

IN ORDER TO ANALYSE DATA WITH IDA,
DATA MUST FIRST BE ENTERED IN THE IDA DATA MATRIX.
YOU CAN THINK OF THE DATA MATRIX AS A TABLE WITH NUMBER OF ROWS
EQUAL TO THE NUMBER OF OBSERVATIONS (QUESTIONNAIRES) AND NUMBER
OF COLUMNS EQUAL TO THE NUMBER OF VARIABLES.

YOU MAY ENTER DATA IN THE IDA DATA MATRIX BY
    (1)  USING DATA FILE(S) AND ONE OF THE FOLLOWING COMMANDS:
         ENTER, ENTS, ENRA, CRSP, OR EOBR;

    (2)  INPUTTING DATA DIRECTLY FROM THE TERMINAL WITH TAPE OR
         KEYBOARD, USING 'ENTER';

    (3)  ENTERING DATA GENERATED BY IDA, USING 'RAND' OR 'INDX'.
```

```
AFTER DATA IS ENTERED, YOU MAY EXECUTE OTHER COMMANDS TO:
DESIGNATE VARIABLES FOR ANALYSIS OF CROSS-SECTIONAL AND TIME-SERIES
   DATA BY SIMPLE AND MULTIPLE REGRESSION AND RELATED TECHNIQUES;
TRANSFORM THE DATA AND PLACE THE RESULTS IN THE DATA MATRIX;
ADD OTHER VARIABLES TO THE DATA MATRIX;
DELETE OBSERVATIONS;
RETRIEVE DELETED OBSERVATIONS;
SORT THE DATA INTO ASCENDING ORDER;
SAVE PART OR ALL OF THE DATA MATRIX OR FITTED OR RESIDUAL
   VALUES IN ONE OF YOUR FILES;
EXAMINE THE DATA OR FITTED OR RESIDUAL VALUES BY DISPLAYING
   THEM IN PLOTS OR HISTOGRAMS;
PRINT TABLES OF DATA VALUES AND CROSS TABULATIONS OF FREQUENCIES
   AND OF MEANS;
ANALYSE THE DATA IN VARIOUS WAYS;
COMPUTE AND PRINT OUT SUMMARY AND ONE SAMPLE STATISTICS,
PERFORM OTHER TASKS BY USING THE IDA COMMAND 'NEWC' AND A PROGRAM
   WRITTEN BY YOU TO BE USED WITH IDA.

OR, YOU CAN USE IDA TO:
CREATE NEW DATA FILES BY SAVING AN EDITED VERSION OF SOME OR ALL
   COLUMNS OF THE IDA DATA MATRIX WITH 'SAVF' OR BY USING 'CRFI'
   FOR LARGER SETS OF DATA;
LIST THE CONTENTS OF FILES WITH 'FILE';
COMPUTE NORMAL PROBABILITES WITH 'GAUS';
SELECT RANDOM SAMPLES WITH 'PSAM'.

YOU CAN NORMALLY ENTER A MAXIMUM OF 100 ROWS (OR OBSERVATIONS)
AND A MAXIMUM OF 19 COLUMNS (OR VARIABLES) OF DATA IN THE IDA
DATA MATRIX, BUT YOU CAN USE THE IDA COMMAND 'RDIM'  TO RE-
DIMENSION THE DATA MATRIX TO MORE ROWS (A MAX. OF 563) AT
THE EXPENSE OF FEWER COLUMNS (A MIN. OF 1).

YOU CAN STOP THE NORMAL EXECUTION OF IDA BY
    (1)  USING C-CONTROL IF IT IS AWAITING INPUT BY YOU, OR,
         OTHERWISE,
    (2)  USING THE 'BRK', 'BREAK', OR 'INTERRUPT' KEY.

IF YOU THEN WISH TO GET BACK TO THE COMMAND LEVEL, TYPE
'RUN-9998', THEN CARRIAGE RETURN
AND IDA WILL RESPOND WITH
                               >
                                THE COMMAND READINESS SYMBOL.

TO STOP USING IDA, TYPE THE IDA COMMAND
                                        QUIT.
TO GET A LIST OF IDA COMMANDS, TYPE THE IDA COMMAND,
                                                 COMM
TO GET ADDITIONAL DETAILS, TYPE THE IDA COMMAND,
                                              INFO

> QUIT

DONE
```

CONTRIBUTED PROGRAM **BASIC**

IDA
F404-36755A

TITLE: INTERACTIVE DATA ANALYSIS

DESCRIPTION:

IDA is an interactive system for statistical analysis that has been developed at the Graduate School of Business of the University of Chicago for implementation on HP 2000C and C'/F mini-computers. The system is fully conversational, permitting a statistical analysis to be implemented flexibly by a series of commands that can be accomplished in almost any sequence, according to the user's choice after seeing the results of previous commands. IDA is virtually self-documenting, and has a number of convenience features for the user, including multilevel prompts, data-editing, automatic updating, and recovery from errors. IDA has been used in teaching of statistics courses at different levels with gratifying response from students. It has also proved valuable as a tool for research.

There are 56 programs in this package. Program NAMes are: IDA, IDA01, IDA02, IDA03, IDA04, IDA05, IDA06, IDA07, IDA08, IDA09, IDA10, IDA11, IDA12, IDA12A, IDA13, IDA13A, IDA13B, IDA14, IDA21, IDA22, IDA23, IDA24, IDA25, IDA26, IDA27, IDA28, IDA29, IDA30, IDA31, IDA32, IDA33, IDA34, IDA35, IDA36, IDA37, IDA38, IDA39, IDA40, IDA41, IDA42, IDA43, IDA45, IDA46, IDA47, IDA48, IDA49, IDA50, IDA51, IDA52, IDA903, IDA95, IDA98, IDA99, IDAARC, IDACOM, IDAVAR.

INSTRUCTIONS:

Get and RUN program. Type "YES" in response to query, "DO YOU NEED HELP?"

Complete user instructions are included in material published by the HP Computer Curriculum Project which will be available in Spring 1974. For information on ordering this material contact:

HP Computer Curriculum Project
11000 Wolfe Road
Cupertino, California 95014

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Robert Ling/Harry Roberts
Graduate School of Business
University of Chicago

```
RUN
RUN
IDA

* HOW MANY CATEGORIES ?

YOU CAN HAVE HELP ON ANY OR ALL OF THE FOLLOWING :

 1. GENERAL COMMENTS ABOUT IDA
 2. DATA DEFINITION
 3. DATA EDITING
 4. DATA DISPLAY (PRINT)
 5. DATA DISPLAY (PLOT)
 6. TRANSFORMATIONS
 7. SUMMARY STATISTICS
 8. ONE SAMPLE STATISTICS
 9. REGRESSION ANALYSIS
10. MISCELLANEOUS COMMANDS

HOW MANY OF THE ABOVE CATEGORIES DO YOU NEED HELP ?1
WHICH 1 ?  GIVE NUMBERS, SEPARATED BY COMMAS :
?1


GENERAL COMMENTS :

1.  MAXIMUM SIZE OF DATA MATRIX IS 100 BY 19
    COLUMNS OF THE DATA MATRIX ARE REFERRED TO AS
    VARIABLES; ROWS, OBSERVATIONS.  UNIVARIATE DATA
    SHOULD BE STORED AS A COLUMN VECTOR.
    IF YOU HAVE MORE THAN 100 ROWS IN YOUR
    MATRIX, YOU MAY RE-DIMEMSION THE SIZE
    BY EXECUTING THE COMMAND 'RDIM'.
2.  COMMAND STRUCTURE :  THE SYSTEM PRINTS THE SYMBOL
    '>' WHEN IT WAITS FOR THE USER TO TYPE A COMMAND
    WORD FOR A TASK.  ONLY THE FIRST 4 CHARACTERS OF
    A COMMAND WORD ARE CHECKED BY THE SYSTEM.  FOR
    EXAMPLE, ONE OF THE COMMANDS ABAILABLE IS 'EXPLAIN'.
    THIS TASK WILL BE EXECUTED WHETHER THE USER TYPES
    'EXPLAIN' OR ANY WORD THAT BEGINS WITH 'EXPL'.
    SOME COMMAND WORDS ARE CONTRACTIONS, SUCH AS 'PARC'
    FOR THE COMPUTATION OF 'PARTIAL CORRELATIONS'.  TO
    OBTAIN THE ENTIRE LIST OF VALID COMMAND WORDS, YOU
    MAY ISSUE THE COMMAND 'LIST'.
3.  PROMPTS :  IN ALMOST ALL CASES, ONCE A COMMAND IS
    ISSUED BY THE USER, IDA WILL NEED ADDITIONAL INFOR-
    MATION BEFORE THE TASK CAN BE EXECUTED.  THE USER
    WILL BE PROMPTED FOR THE INFORMATION.  IDA HAS THREE
    LEVELS OF PROMPTS WHICH THE USER CAN CHOOSE DEPENDING
    ON HIS FAMILIARITY WITH THE SYSTEM.  UNLESS OTHERWISE
    INSTRUCTED BY THE COMMAND 'CHGP' (FOR CHANGING THE
    LEVEL OF PROMPTS), IDA WILL GIVE 1ST LEVEL PROMPTS
    WHICH ARE MEANT TO BE USED BY THE NOVICE -- THESE
    PROMPTS ARE GENERALLY DETAILED AND LENGTHY.  2ND
    LEVEL PROMPTS ARE MORE CONCISE AND ABBREVIATED, AND
    3RD LEVEL PROMPTS ARE VERY BRIEF, POSSIBLY CRYPTIC.
    WHEN A PROMPT IS PRECEDED BY THE SYMBOL '*', THE USER
    WILL AUTOMATICALLY OBTAIN FURTHER EXPLANATION IF HE
    WAITS A CERTAIN AMOUNT OF TIME (USUALLY 30 SECONDS)
    WITHOUT RESPONDING, OR IF HE TYPES 'HELP' OR ANY
    ALPHAMERIC CHARACTERS WHEN NUMERIC INPUT IS CALLED
    FOR.
4.  IDA HAS A NUMBER OF BUILT IN CHECKS FOR ERRORS IN
    THE USER'S INPUT.  HOWEVER, ERRORS WILL OCCASIONALLY
    CAUSE YOU TO BE KICKED OUT OF THE SYSTEM IDA.  ALSO
    HITTING THE 'BREAK' KEY DURING EXECUTION WILL SURELY
    GET YOU OUT OF IDA.  IN EITHER CASE, YOU CAN GET BACK
    TO IDA (WITHOUT LOSING YOUR ACTIVE DATA) BY TYPING :
    RUN-9998
    AND YOU'LL BE BACK AT THE IDA COMMAND LEVEL AND CAN
    PROCEED FROM WHERE YOU LEFT OFF.
```

5. ACTIVE DATA : WHEN YOU ENTER YOUR DATA MATRIX, IT BECOMES ACTIVE. ALL COMMANDS WILL REFER TO THIS MATRIX. WHEN YOU DELETE A ROW (BY 'DELO') OR A BLOCK OF ROWS (BY 'DELB'), THE ROWS ARE NOT PHYSICALLY DELETED. THEY ONLY BECOME INACTIVE IN SUBSEQUENT COMPUTATIONS UNLESS YOU RETRIEVE THEM LATER VIA COMMANDS SUCH AS 'RECOUP' OR 'RETO' (RETRIEVE OBSERVATION). IF YOU CHANGE A COLUMN OF YOUR ORIGINAL DATA MATRIX BY TRANSFORMATION, YOU CANNOT RECOVER THE ORIGINAL BY THE COMMAND 'RECOUP'. YOU CAN DO SO ONLY BY AN INVERSE TRANSFORMATION (IF ONE IS AVAILABLE) OR BY RE-ENTERING THE ORIGINAL DATA MATRIX FROM FILE. IF YOU WANT TO RETAIN THE ORIGINAL COLUMN IN THE FIRST PLACE, AT THE TIME OF TRANSFORMATION YOU MUST PLACE THE TRANSFORMED COLUMN IN A DIFFERENT (FREE) COLUMN OF THE DATA MATRIX.
6. UPDATING : AS SOON AS THE USER ENTERS HIS DATA, IDA COMPUTES THE MEANS, STANDARD DEVIATIONS AND THE CORRELATION MATRIX OF ALL THE VARIABLES. AS THE USER EDITS HIS DATA MATRIX OR MAKES TRANSFORMATIONS, THESE STATISTICS ARE AUTOMATICALLY UPDATED. THE SAME IS TRUE FOR REGRESSION ANALYSIS COMPUTATIONS. THUS IF THE USER EXECUTES IN SUCCESSION THE FOLLOWING COMMANDS : REGR, COEF, DELO, COEF, ..., THE FIRST COMMAND DEFINES THE REGRESSION EQUATION, THE SECOND COMPUTES AND PRINTS THE REGRESSION COEFFICIENTS, THE THIRD DELETES AN OBSERVATION VECTOR TO BE SPECIFIED BY THE USER, AND THE FOURTH WILL COMPUTE AND PRINT THE NEW REGRESSION COEFFICIENTS, AND SO ON.
7. FORMAT OF DATA FILES: THEN YOU USE THE COMMANDS

```
     'FILE'  OR  'SAVF'
THE FOLLOWING FORMAT IS IMPLICITLY ASSUMED :
ELEMENTS OF THE DATA MATRIX ARE SEQUENTIALLY STORED
BY ROWS.  THE FIRST TWO ELEMENTS OF THE FILE
SPECIFIES THE SIZE OF THE DATA MATRIX.  THUS, IF
THE MATRIX CONSISTS OF
1.2   3.1
2.5   4.1
1.1   2.9
IT WILL BE SAVED (WHEN YOU EXECUTE 'SAVF') AS
3  2  1.2  3.1  2.5  4.1  1.1  2.9
BUT WHEN YOU ENTER DATA VIA 'ENTER', 'APPV', OR
'APPS', YOU MAY USE A FILE WITHOUT THE TWO LEADING
ELEMENTS DESCRIBED ABOVE; THAT IS, THE FILE MAY
CONSIST OF DATA ALONE, STORED BY ROWS.  YOU WILL
BE PROMPTED FOR THE VALUES OF N AND K IN THAT CASE.
```

```
>

DONE
RUN
IDA39

* HOW MANY CATEGORIES ? 9

WHICH 9 ?  GIVE NUMBERS, SEPARATED BY COMMAS :
?2,3,4,5,6,7,8,9,10


DATA DEFINITION :

ENTE   TO ENTER DATA FROM FILE, TAPE, OR TERMINAL
ENTS   TO ENTER SELECTED DATA FROM A SERIAL DATA FILE
ENRA   TO ENTER SELECTED DATA FROM A RANDOM ACCESS FILE
       WHICH CONTAINS DATA, VARIABLE NAMES AND FILE
       STRUCTURE INFORMATION
INDX   TO CREATE AN INDEX VECTOR (SUCH AS 1,2,...,N)
       IN A COLUMN OF THE DATA MATRIX
RAND   TO GENERATE RANDOM DATA FROM SOME MODEL
SAVF   TO SAVE DATA MATRIX ON FILE (NOTE:  FILE MUST
       HAVE BEEN OPENED ALREADY)
SAVR   TO SAVE THE RESIDUALS FROM THE CURRENT REGRESSION
     . INTO A COLUMN OF THE DATA MATRIX
```

DATA EDITING :

APPO TO APPEND AN OBSERVATION VECTOR TO THE DATA MATRIX. YOU MAY USE THIS TO ADD A ROW TO THE EXISTING DATA MATRIX OR TO CHANGE A ROW IN IT
APPS TO APPEND A SUBMATRIX TO THE DATA MATRIX. YOU MAY USE THIS TO ADD OR CHANGE A BLOCK OF DATA
APPV TO APPEND A VARIABLE (COLUMN) TO THE DATA MATRIX
CHGO TO CHANGE THE VALUE OF A SINGLE ENTRY IN THE DATA MATRIX
DELB TO DELETE A BLOCK OF OBSERVATIONS FROM THE DATA MATRIX. YOU CAN RECOVER THE DELETED BLOCK BY THE COMMAND 'RETB' OR 'RECO'
DELO TO DELETE AN OBSERVATION VECTOR FROM THE DATA MATRIX. DELETED VECTOR CAN BE RETRIEVED BY 'RETO' OR 'RECO'
RECO TO RECOUP ALL THE DELETED OBSERVATIONS
RETB TO RETRIEVE A BLOCK OF DELETED OBSERVATIONS
RETO TO RETRIEVE A DELETED ROW OF OBSERVATIONS

DATA DISPLAY (PRINT) :

FILE TO PRINT ONE OR MORE ROWS OF A DATA MATRIX ON FILE. THIS ALLOWS YOU TO TAKE A LOOK AT THE DATA BEFORE DECIDING WHETHER THAT'S THE MATRIX YOU WANT TO ENTER
FPRF FORMATTED PRINT OF FITTED VALUES (IN REGRESSION)
FPRO FORMATTED PRINT OF AN OBSERVATION (VECTOR)
FPRR FORMATTED PRINT OF RESIDUALS (IN REGRESSION)
FPRS FORMATTED PRINT OF A SUBMATRIX
FPRV FORMATTED PRINT OF A VARIABLE (COLUMN)
IN THE ABOVE FIVE COMMANDS, THE USER WILL BE ASKED TO SUPPLY THE FORMAT FOR PRINTING
NAME TO LIST THE NAMES OF THE VARIABLES (IF THE USER SUPPLIED THEM). TO BE USED WHEN YOU HAVE FORGOTTEN WHICH VARIABLE IS IN WHICH COLUMN OF THE DATA MATRIX. IF NO NAME HAS BEEN GIVEN TO THE VARIABLES, THE COMMAND WILL CAUSE THE FIRST ACTIVE ROW OF THE DATA MATRIX TO BE PRINTED
PRTF PRINT FITTED VALUES
PRTO PRINT OBSERVATION
PRTR PRINT RESIDUALS
PRTS PRINT SUBMATRIX
PRTV PRINT VARIABLE

THE COMMANDS BEGINNING WITH 'PRT' WILL AUTOMATICALLY GIVE VALUES IN THE FORM DDDDD.DDDDD, UP TO FIVE VALUES PER LINE. IF ANY OF YOUR DATA VALUES IS GREATER THAN 99999, YOU SHOULD USE THE CORRESPONDING 'FPR' COMMANDS, SUPPLYING THE FORMAT YOU CHOOSE. BECAUSE OF FLOATING POINT CONVERSION OF NUMBERS, YOU MAY GET GARBAGE FOR CERTAIN TRAILING DIGITS WHEN 'PRT' COMMANDS ARE USED. FOR EXAMPLE, THE NUMBER 12345 IS PRINTED AS 12344.99989 BECAUSE THE MACHINE DOES NOT CARRY AN EXACT REPRESENTATION OF 12345.

WHEN YOU GIVE A FORMAT FOR PRINT, THE SAME FORMAT MUST BE APPLIED TO ALL OF THE VARIABLES; THAT IS, YOU DO NOT HAVE THE OPTION OF SPECIFYING DIFFERENT FORMATS FOR DIFFERENT VARIABLES AS CAN BE DONE IN 'FORTRAN'. FOR EXAMPLE, IF A ROW OF DATA CONSISTS OF
1.2, 2.3456, 3500
THE 'FPR' COMMANDS WILL NOT ENABLE YOU TO PRINT IT AS

```
  1.2    2.3456   3500.
```

IF YOU USE THE FORMAT #,4D.4D,2X YOU WILL GET:

```
   1.2000     2.3456  3500.0000
```

WHICH IS NOT MUCH DIFFERENT FROM THE FORMAT YOU WOULD HAVE OBTAINED BY 'PRT'. THE 'FPR' COMMANDS ARE USEFUL WHEN ALL THE VARIABLES ARE ROUGHLY COMPARABLE IN MAGNITUDE; OR WHEN ALL THE DATA VALUES ARE INTEGERS.

DATA DISPLAY (PLOT) :

```
FREQ   TABLE OF RELATIVE FREQUENCIES
HIST   HISTOGRAM OF ABSOLUTE FREQUENCIES
NORM   NORMAL PROBABILITY PLOT
PLTS   TO PLOT A VARIABLE IN SEQUENCE
RVSF   A TINY PLOT OF RESIDUALS VERSUS FITTED VALUES
       FOR A QUICK LOOK.  FOR DETAILS, USE
SCAT   TO SCATTER PLOT ANY VARIABLE VERSUS ANY OTHER.
       VARIABLES 'FITTED' AND 'RESIDU' ARE ALWAYS
       AVAILABLE AFTER A REGRESSION
```

TRANSFORMATIONS :

```
ABSO   ABSOLUTE VALUE
ADDC   ADD A CONSTANT TO A COLUMN
ADDV   ADD TWO COLUMNS OF DATA MATRIX
       NOTE THE DIFFERENCE OF TWO COLUMNS CAN
       BE OBTAINED BY FIRST MULTIPLYING A COLUMN
       BY -1 AND THEN ADDING TO ANOTHER COLUMN
DIFF   DIFFERENCING TRANSFORMATION
       LET J BE THE COLUMN TO PLACE THE TRANSFORMED
       VARIABLE, I BE THE VARIABLE TO BE TRANSFORMED,
       AND K BE THE GAP FOR DIFFERENCING.  THEN
       X(L,J) = X(L,I) - X(L-K,I), L=K+1,...
       THE FIRST K ROWS OF THE ACTIVE DATA MATRIX BECOME
       INACTIVE IN THE PROCESS
DOTP   DIRECT PRODUCT OF TWO COLUMNS
EXPO   EXPONENTIAL TRANSFORMATION
LAGG   LAG TRANSFORMATION X(L,J) = X(L-K,I), L=K+1,...
       THE FIRST K ROWS OF THE ACTIVE DATA MATRIX BECOME
       INACTIVE IN THE PROCESS
LOGE   NATURAL LOG (LN) TRANSFORMATION
LOG1   COMMON LOG (BASE 10) TRANSFORMATION
MULC   MULTIPLY A COLUMN OF DATA MATRIX BY A CONSTANT
MULV   MULTIPLY TWO COLUMNS OF DATA MATRIX
POWE   POWER TRANSFORMATION.  NOTE VALUE OF POWER =
       -1    FOR RECIPROCAL TRANSFORMATION
       .5    FOR SQUARE ROOT TRANSFORMATION, ETC.
MSOR   SORTS ONE VARIABLE (COLUMN) IN ASCENDING ORDER
       AND ALL OTHER COLUMNS ACCOMPANY IT. RESULTS
       PLACED IN SAME COLUMNS
PSOR   PAIRED SORT OF ONE VARIABLE (COLUMN) AND
       ACCOMPANYING VARIABLE (COLUMN) INTO TWO
       OTHER COLUMNS
RANK   ASSIGNS RANKS TO THE OBSERVATIONS (ROWS) OF A
       VARIABLE (COLUMN) AND PLACES THE RANKS IN ANOTHER
       COLUMN
SORT   SORTS THE VALUES OF ONE VARIABLE (COLUMN) INTO
       ASCENDING ORDER AND PLACES RESULTS IN ANOTHER
       COLUMN
STAN   STANDARDIZATION TRANSFORMATION--SUBTRACT MEAN
       FROM EACH OBSERVATION, DIVIDE THE DEVIATION BY
       THE STANDARD DEVIATION
```

SUMMARY STATISTICS :

```
CORR   CORRELATION MATRIX OF VARIABLES
COVA   COVARIANCE MATRIX OF VARIABLES
MEAN   MEANS AND STANDARD DEVIATIONS OF VARIABLES
PARC   PARTIAL CORRELATION MATRIX OF ONE SET OF
       VARIABLES GIVEN ANOTHER SET OF VARIABLES
```

ONE SAMPLE STATISTICS :

```
AUTO   AUTOCORRELATION (BOX-JENKINS ESTIMATES)
DURB   DURBIN-WATSON STATISTIC (FOR RESIDUALS ONLY)
RUNS   EXPECTED AND OBSERVED NUMBER OF RUNS ABOVE
       AND BELOW THE MEAN.  NORMAL APPROXIMATION
SERC   SERIAL CORRELATION (MAXIMUM LIKELIHOOD
       ESTIMATE OF AUTOCORRELATION)
```

```
REGRESSION ANALYSIS :

1.  SIMPLE OR MULTIPLE REGRESSION
    REGR  ORDINARY REGRESSION
    WLSR  WEIGHTED LEAST SQUARES
2.  FOR SELECTING INDEPENDENT VARIABLES
    BACK  BACKWARD SELECTION PROCEDURE (AUTOMATIC)
    FORW  FORWARD SELECTION PROCEDURE (AUTOMATIC)
    STEP  STEPWISE PROCEDURE (USER TO SPECIFY STEPS)
    SWEE  SWEEP OPERATION.  USED TO DELETE A VARIABLE
          FROM OR TO ADD A VARIABLE TO THE CURRENT
          REGRESSION EQUATION
    ALLS  TO PERFORM REGRESSIONS USING ALL POSSIBLE
          SUBSETS OF A SET OF INDEPENDENT VARIABLES
    SUBS  TO REGRESS THE DEPENDENT VARIABLE ON ALL
          POSSIBLE COMBINATIONS OF A GIVEN SIZE OF
          A SET OF INDEPENDENT VARIABLES
3.  FOR PRINTING REGRESSION RESULTS :
    ANOV  ANALYSIS OF VARIANCE TABLE
    BCOR  CORRELATION MATRIX OF REGRESSION COEFFICIENTS
    BCOV  COVARIANCE MATRIX OF REGRESSION COEFFICIENTS
    COEF  REGRESSION COEFFICIENTS, STANDARD ERRORS, T
    SUMM  SUMMARY STATISTICS -- MULTIPLE R, STANDARD
          ERROR OF RESIDUALS, ETC.
4.  FOR EXAMINATION OF RESIDUALS :
    AUTO  TO COMPUTE AUTOCORRELATION COEFFICIENTS
          (BOX-JENKINS ESTIMATES)
    DURB  DURBIN-WATSON STATISTIC
    NORM  TO OBTAIN NORMAL PROBABILITY PLOT OF RESIDUALS
    PLTC  TO PLOT CONFIDENCE BAND OF FITTED VALUES
    PLTS  TO PLOT SEQUENCE OF RESIDUALS
    RVSF  MINIPLOT OF RESIDUALS VERSUS FITTED VALUES
    RUNS  RUNS TEST FOR RESIDUALS
    SAMP  TO PERFORM REGRESSION USING RANDOM SUBSAMPLES
          OF DATA.  FOR ERROR ANALYSIS
    SEPR  TO COMPUTE STANDARD ERRORS OF PREDICTED VALUES


MISCELLANEOUS COMMANDS :

CALC   A CALCULATOR FOR ARITHMETIC OPERATIONS
CHGP   TO CHANGE THE LEVEL OF PROMPTS
EXPL   TO EXPLAIN INDIVIDUAL COMMAND WORDS
HELP   TO OBTAIN HELP ON VARIOUS CATEGORIES OF COMMANDS
LIST   TO OBTAIN THE COMPLETE LIST OF COMMAND WORDS
NEWC    TO DEFINE A NEW COMMAND NAME
NEWS    TO PRINT NEWS ABOUT $IDA
PAUS   TO PAUSE AT THE COMMAND LEVEL.  OTHERWISE IDA
       WILL ASK YOU IF YOU NEED HELP IF NO COMMAND IS
       ISSUED WITHIN ONE MINUTE
QUIT   TO EXIT FROM IDA TO HP SYSTEM CONTROL
RDIM    TO RE-DIMENSION MAX SIZE OF DATA MATRIX

> QUIT

DONE
```

CONTRIBUTED PROGRAM **BASIC**

KR20
36137

TITLE: ITEM ANALYSIS AND KUDER-RICHARDSON FORMULA 20 RELIABILITY

DESCRIPTION:

This program may be used to do an item analysis on teacher-constructed tests to determine the difficulty, discrimination index, and PQ value for each item, and the average difficulty, average discrimination index, and Kuder-Richardson Formula 20 Reliability for the test.

INSTRUCTIONS:

After determining the number of students in the upper 27% and the number in the lower 27% of all the students who took the test, the teacher tabulates the number of correct responses to each item on the test for each of these two groups.

DATA: line 350: number of items on the test, number of people in either the high or low group (27% of all those taking the test).

in following data lines, list the number of correct responses for the high group on item #1, no. of correct responses for the low group on item no. 1; then correct responses for the high group on item no. 2, no. of correct responses for the low group on item no. 2, etc.

last data line (line 400) must be the variance (standard deviation squared) for the test obtained previously using all test scores.

SPECIAL CONSIDERATIONS:

NONE

ACKNOWLEDGEMENTS:

Donald E. Gettinger
Stillwater Senior High School

RUN

RUN
KR20

TEST ITEM	HIGH	LOW	DIFFICULTY	DISCR. INDEX	PQ
1	44	27	.622807	.298246	.234918
2	52	42	.824561	.175439	.14466
3	50	11	.535088	.684211	.248769
4	49	32	.710526	.298246	.205679
5	18	2	.175439	.280702	.14466
6	22	12	.298246	.175439	.209295
7	56	26	.719298	.526316	.201908
8	56	29	.745614	.473684	.189674
9	54	32	.754386	.385965	.185288
10	56	29	.745614	.473684	.189674
11	41	13	.473684	.491228	.249307
12	54	37	.798246	.298246	.16105
13	57	47	.912281	.175439	8.00246E-02
14	57	36	.815789	.368421	.150277
15	55	35	.789474	.350877	.166205
16	55	48	.903509	.122807	8.71807E-02
17	51	27	.684211	.421053	.216066
18	52	15	.587719	.649123	.242305
19	50	18	.596491	.561404	.240689
20	15	8	.201754	.122807	.16105
21	57	52	.95614	8.77193E-02	.041936
22	53	31	.736842	.385965	.193906
23	55	40	.833333	.263158	.138889
24	56	21	.675439	.614035	.219221
25	55	21	.666667	.596491	.222222
26	47	14	.535088	.578947	.248769
27	54	9	.552632	.789474	.24723
28	45	18	.552632	.473684	.24723
29	27	11	.333333	.280702	.222222
30	55	10	.570175	.789474	.245075
31	48	16	.561404	.561404	.24623
32	51	22	.640351	.508772	.230302
33	19	14	.289474	8.77193E-02	.205679
34	22	10	.280702	.210526	.201908

SUM OF PQ= 6.6195 VARIANCE= 29.963
AVERAGE DIFFICULTY IS .619969
AVERAGE DISCRIMINATION INDEX IS .398865
KUDER-RICHARDSON FORMULA 20 RELIABILITY= .802686

DONE

CONTRIBUTED PROGRAM **BASIC**

LOGRAM
36001

TITLE: LOG-ON TAPE ANALYZER

DESCRIPTION:

The LOGRAM program is designed to analyze the Log Tape produced by the Time-Share System and also to check if more than one user is signed on the computer with the same I.D. Two graphs can be printed -- one showing how many users have accessed the system during each thirty minute period; the other illustrates how many users were on the Time-Share System on the hour and on the half hour during the day in which the Log Tape was punched.

If an error is detected while inputting the Log Tape the TTY bell will ring to attract the operator's attention and a message will be printed telling the operator to deactivate the tape reader and to type in the correct log on or log off statement.

After the tape has been inputted, the program will ask for the data of the Log Tape. After this has been inputted the program will ask which of the two graphs you want printed out.

After the graphs have been printed out the program checks all the I.D.'s for duplicate sign ons and prints them out along with the time when it happended. The program also prints out any new I.D.'s that were added to the system but were not added to this program.

INSTRUCTIONS:

The three files used, STRNG1, STRNG2, and STRNG3, are opened to 128 sectors to allow maximum usage of the system.

Open - STRNG1, 128　　Open - STRNG2, 128　　Open - STRNG3, 128

It is helpful if the Log listing from the Time-Share ASR35 corresponding to the Log Tape is saved until the tape is processed.

The I.D.'s for the system are stored in strings C$, D$, E$, F$, G$, H$. After graph 1 (accumulative usage graph) is printed out, the matrix of values used for the graph is printed out. This is done to show how many more than 32 (max for TTY printout) users, if any, used the system in a half hour period.

1. Type in GET-LOGRAM
2. Place the Log Tape in the TTY Tape Reader.
3. Type in RUN
4. End input by "* CR"
5. After the Log Tape has been read in the program will type: INPUT THE DATE OF THE LOG TAPE.
6. Type in the date (m/d/y).
7. The program will then type: TYPE IN A Ø FOR BOTH TABLES, A 1 FOR ACC. TABLE, A 2 FOR TIME TABLE.
8. Type in the appropriate response.

SPECIAL CONSIDERATIONS:

The ASR35 TTY must have the X-ON, X-OFF FEATURE.
Modify statements #60, 70, 80, 90, 100, 110, and 120 to match the I.D.'s for the system.

ACKNOWLEDGEMENTS:

TIES
St. Paul, Minnesota

RUN

```
OPEN-STRNG1,128
OPEN-STRNG2,128
OPEN-STRNG3,128

GET-LOGRAM
RUN
LOGRAM

?OGON  B550 1046 #29

RE-INPUT THE LAST DATA ITEM!IT WAS RECEIVED INCORRECTLY!!
DURING THE FOLLOWING TIME DELAY, DEACTIVATE THE TAPE READER UNTIL
THE DATA HAS BEEN INPUTED CORRECTLY!!
?G  B550 1047 #28

RE-INPUT THE LAST DATA ITEM!IT WAS RECEIVED INCORRECTLY!!
DURING THE FOLLOWING TIME DELAY, DEACTIVATE THE TAPE READER UNTIL
THE DATA HAS BEEN INPUTED CORRECTLY!!

?<<<TPZ00 1058 #03

RE-INPUT THE LAST DATA ITEM!IT WAS RECEIVED INCORRECTLY!!
DURING THE FOLLOWING TIME DELAY, DEACTIVATE THE TAPE READER UNTIL
THE DATA HAS BEEN INPUTED CORRECTLY!!
?
 **LOGON  A400 1059 #03
?
 **LOGOFF A412 1101 #18
?
 **LOGOFF A001 1104 #01
?
 **LOGON  B008 1104 #01
?
 **LOGON  R031 1105 #19
?
 **LOGOFF R031 1105 #19
?
 **LOGOFF B008 1107 #01
?
 **LOGOFF C701 1109 #29
?
 **LOGOFF D012 1109 #31
?
 **LOGON  D000 1109 #31
?
 **LOGOFF D000 1109 #31
?
 **LOGON  D000 1109 #31
?
 **LOGOFF D018 1109 #04
?
 **LOGON  D019 1109 #04
?
 **LOGOFF D019 1110 #04
?
 **LOGON  D016 1110 #04
?
 **LOGOFF D000 1110 #31
?
 **LOGON  D012 1110 #31
?
 **LOGOFF D012 1116 #31
?
 **LOGON  D019 1116 #31
?
 **LOGOFF D019 1124 #31
?
 **LOGON  D012 1124 #31
?
 **LOGOFF B008 1133 #23
?
 **LOGOFF D016 1133 #04
?
 **LOGON  D012 1133 #04
?
```

```
 **LOGOFF D012 1140 #04
?
 **LOGON  W100 1140 #12
?
 **LOGON  D012 1141 #04
?
 **LOGOFF D012 1141 #04
?
 **LOGON  D019 1141 #04
?
 **LOGOFF D019 1141 #04
?
 **LOGON  D012 1142 #04
?
 **LOGOFF D012 1145 #04
?
 **LOGON  D012 1146 #04
?
 **LOGOFF W100 1147 #12
?
 **LOGON  B560 1152 #26
?
 **LOGOFF B063 1154 #14
?
 **LOGOFF D012 1156 #31
?
 **LOGON  D023 1156 #31
?
 **LOGON  A411 1156 #18
?
 **LOGOFF D012 1157 #04
?
 **LOGON  D022 1157 #04
?
 **LOGOFF D022 1159 #04
?
 **LOGON  D012 1159 #04
?
 **LOGOFF D012 1201 #04
?
 **LOGON  D022 1201 #04
?
 **LOGOFF A411 1201 #18
?
 **LOGOFF A400 1205 #03
?
 **LOGON  A920 1208 #01
?
 **LOGOFF D022 1212 #04
?
 **LOGON  D012 1212 #04
?
 **LOGOFF D012 1216 #04
?
 **LOGON  D022 1216 #04
?
 **LOGON  A400 1222 #12
?
 **LOGOFF A400 1228 #12
?
 **LOGOFF D022 1231 #04
?
 **LOGON  D012 1231 #04
?
 **LOGOFF D012 1236 #04
?
 **LOGON  D018 1236 #04
?
 **LOGOFF D018 1236 #04
?
 **LOGON  D012 1236 #04
?
 **LOGOFF D023 1237 #31
?
 **LOGON  D019 1237 #31
?
 **LOGOFF D019 1237 #31
?
```

```
 **LOGON  DØ12 1237 #31
?
 **LOGOFF DØ12 1238 #31
?
 **LOGON  DØ12 1239 #31
?
 **LOGOFF A92Ø 1246 #Ø1
?
 **LOGOFF B56Ø 1247 #26
?
 **LOGON  B56Ø 1248 #28
?
 **LOGON  BØØ8 1248 #23
?
 **LOGOFF DØ12 1248 #Ø4
?
 **LOGON  DØ22 1248 #Ø4
?
 **LOGOFF DØ22 1248 #Ø4
?
 **LOGON  DØ12 1248 #Ø4
?
 **LOGOFF B56Ø 1249 #28
?
 **LOGON  B56Ø 1253 #12
?
 **LOGON  A4ØØ 1253 #Ø1
?
 **LOGOFF DØ12 1256 #31
?
 **LOGON  DØ12 1257 #31
?
 **LOGON  B55Ø 1257 #28
?
 **LOGON  C7Ø1 13ØØ #24
?
 **LOGOFF B56Ø 13ØØ #12
?
 **LOGON  B55Ø 13ØØ #12
?
 **LOGON  RØ37 13Ø2 #19
?
 **LOGOFF RØ37 13Ø3 #19
?
 **LOGOFF DØ12 13Ø4 #31
?
 **LOGON  DØ18 13Ø4 #31
?
 **LOGOFF C7Ø1 13Ø5 #24
?
 **LOGOFF DØ18 13Ø5 #31
?
 **LOGON  DØ12 13Ø5 #31
?
 **LOGON  C7Ø1 131Ø #29
?
 **LOGOFF C7Ø1 1311 #29
?
 **LOGON  W1ØØ 1312 #19
?
 **LOGON  BØ63 1312 #14
?
 **LOGON  C7Ø1 1313 #ØØ
?
 **LOGOFF BØ63 1317 #14
?
 **LOGON  IØ18 1318 #29
?
 **LOGOFF B55Ø 1318 #28
?
 **LOGON  B55Ø 132Ø #26
?
 **LOGOFF B55Ø 132Ø #26
?
 **LOGON  C7Ø1 1321 #28
?
 **LOGON  B55Ø 1323 #26
?
```

```
 **LOGOFF C701 1324 #28
?
 **LOGOFF B550 1324 #26
?
 **LOGOFF C701 1327 #00
?
 **LOGON  B550 1329 #26
?
 **LOGOFF I018 1330 #29
?
 **LOGON  C701 1330 #00
?
 **LOGOFF B550 1332 #12
?
 **LOGON  C701 1332 #29
?
 **LOGON  B550 1333 #12
?
 **LOGOFF C701 1334 #00
?
 **LOGON  C002 1335 #03
?
 **LOGOFF C701 1335 #29
?
 **LOGOFF B063 1341 #17
?
 **LOGOFF C002 1344 #03
?
 **LOGON  C002 1345 #03
?
 **LOGON  A610 1357 #18
?
 **LOGON  W100 1358 #14
?
 **LOGON  C701 1359 #00
?
 **LOGON  I016 1359 #06
?
 **LOGOFF W100 1402 #14
?
 **LOGOFF A610 1403 #18
?
 **LOGON  C701 1403 #14
?
 **LOGOFF W100 1407 #19
?
 **LOGON  W100 1407 #19
?
 **LOGOFF I016 1407 #06
?
 **LOGOFF W100 1410 #19
?
 **LOGON  C002 1411 #06
?
 **LOGON  A422 1411 #19
?
 **LOGOFF B550 1412 #12
?
 **LOGON  B550 1412 #12
?
 **LOGOFF C002 1413 #06
?
 **LOGOFF C002 1413 #03
?
 **LOGOFF A422 1413 #19
?
 **LOGOFF C701 1413 #00
?
 **LOGON  A001 1414 #19
?
 **LOGOFF D012 1416 #04
?
 **LOGON  D016 1416 #04
?
 **LOGON  C002 1416 #29
?
 **LOGOFF C002 1416 #29
?
```

```
 **LOGOFF D016 1417 #04
?
 **LOGON  D012 1417 #04
?
 **LOGOFF C701 1418 #14
?
 **LOGON  W100 1419 #03
?
 **LOGOFF W100 1425 #03
?
 **LOGOFF A001 1425 #19
?
 **LOGON  C701 1427 #28
?
 **LOGON  A920 1427 #18
?
 **LOGOFF A920 1429 #18
?
 **LOGOFF C701 1429 #28
?
 **LOGON  I016 1430 #03
?
 **LOGOFF A400 1431 #01
?
 **LOGON  C701 1433 #28
?
 **LOGON  C701 1435 #29
?
 **LOGON  R031 1436 #19
?
 **LOGOFF B008 1438 #23
?
 **LOGOFF C701 1439 #29
?
 **LOGON  A400 1439 #14
?
 **LOGOFF R031 1440 #19
?
 **LOGOFF A400 1443 #14
?
 **LOGOFF D012 1448 #04
?
 **LOGON  D000 1448 #04
?
 **LOGOFF C701 1448 #28
?
 **LOGON  C701 1448 #28
?
 **LOGON  C701 1449 #00
?
 **LOGON  A001 1451 #18
?
 **LOGON  C002 1451 #01
?
 **LOGOFF C701 1453 #00
?
 **LOGOFF A001 1453 #18
?
 **LOGON  D003 1453 #23
?
 **LOGON  I019 1454 #14
?
 **LOGON  C701 1454 #00
?
 **LOGOFF D012 1455 #31
?
 **LOGOFF D000 1456 #04
?
 **LOGON  C701 1459 #29
?
 **LOGOFF C701 1501 #29
?
 **LOGON  A455 1502 #19
?
 **LOGOFF C701 1503 #00
?
 **LOGOFF C002 1510 #01
?
```

```
 **LOGON   C002 1511 #01
?
 **LOGOFF A455 1511 #19
?
 **LOGON   C002 1515 #29
?
 **LOGOFF C002 1517 #29
?
 **LOGON   C002 1518 #29
?
 **LOGON   I018 1520 #00
?
 **LOGOFF C701 1525 #28
?
 **LOGOFF C002 1525 #01
?
 **LOGON   C002 1525 #01
?
 **LOGOFF C002 1526 #01
?
 **LOGON   C002 1527 #28
?
 **LOGOFF C002 1529 #29
?
 **LOGON   C002 1531 #29
?
 **LOGOFF D003 1531 #23
?
 **LOGOFF I018 1531 #00
?
 **LOGON   C002 1531 #00
?
 **LOGOFF I019 1531 #14
?
 **LOGON   I019 1531 #14
?
 **LOGOFF C002 1531 #00
?
 **LOGON   C002 1539 #00
?
 **LOGOFF I016 1540 #03
?
 **LOGOFF C002 1541 #28
?
 **LOGOFF C002 1541 #29
?
 **LOGON   C002 1542 #01
?
 **LOGOFF C002 1545 #00
?
 **LOGOFF I019 1548 #14
?
 **LOGOFF C002 1551 #01
?
 **LOGON   C002 1602 #01
?
 **LOGON   C002 1603 #29
?
 **LOGON   I019 1605 #14
?
 **LOGOFF C002 1605 #29
?
 **LOGON   C002 1606 #29
?
 **LOGON   C002 1607 #03
?
 **LOGOFF I019 1608 #14
?
 **LOGON   D002 1610 #23
?
 **LOGON   C701 1614 #00
?
 **LOGOFF C701 1615 #00
?
 **LOGOFF C002 1617 #29
?
```

```
 **LOGON   A400 1625 #19
?
 **LOGOFF C002 1626 #01
?
 **LOGOFF A400 1629 #19
?
 **LOGOFF D002 1631 #23
?
 **LOGON   D016 1631 #23
?
 **LOGOFF C002 1643 #03
?
 **LOGOFF D016 1647 #23
?
 **LOGON   C002 1709 #01
?
 **LOGON   N311 1711 #19
?
 **LOGOFF N311 1723 #19
?
 **LOGON   C603 1724 #29
?
 **LOGOFF C603 1729 #29
?
 **LOGON   I006 1731 #06
?
 **LOGON   C603 1732 #29
?
 **LOGOFF C603 1733 #29
?
 **LOGOFF C002 1742 #01
?
 **LOGON   C800 1743 #19
?
 **LOGOFF C800 1743 #19
?
 **LOGON   C002 1746 #01
?
 **LOGOFF I006 1748 #06
?
 **LOGOFF C002 1758 #01
?
 **LOGON   A920 1905 #01
?
 **LOGOFF B550 1909 #26
?
 **LOGON   B550 1913 #19
?
 **LOGOFF B550 1913 #12
?
 **LOGOFF B550 1917 #19
?
 **LOGON   B550 1921 #26
?
 **LOGOFF A920 1924 #01
?
 **LOGON   B550 1927 #28
?
 **LOGOFF B550 1932 #28
?
 **LOGON   B550 1932 #28
?
 **LOGOFF B550 1938 #28
?
 **LOGON   B550 1941 #28
?
 **LOGON   I006 1948 #14
?
 **LOGOFF B550 1956 #28
?
 **LOGON   B550 1958 #29
?
 **LOGOFF B550 1959 #29
?
 **LOGON   B550 2001 #29
?
 **LOGOFF I006 2014 #14
?
```

```
 **LOGON  I006 2015 #14
?
 **LOGOFF I006 2028 #14
?
 **LOGOFF B550 2035 #29
?
 **LOGOFF B550 2103 #26
?
 **LOGON  B550 2107 #26
?

 *
IF THE INPUT ERRORS DETECTED WERE NOT RE-INPUTED CORRECTLY
THE USAGE COUNT WILL BE OFF BY 1 OR MORE USERS DEPENDING
UPON HOW MANY INPUT ERRORS WERE NOT CORRECTED.


INPUT THE DATE OF THE LOG TAPE.
?4/9/72
TYPE A 0 FOR BOTH TABLES,A 1 FOR ACC. TABLE,A 2 FOR TIME TABLE.
?0


                              4/9/72


  630-*
  700-*
  730-*
  800-*
  830-*
  900-*
  930-*
 1000-*
 1030-*
 1100-*X
 1130-*XXXXXXXXXXXXXXXXXXX
 1200-*XXXXXXXXXXXXXXXXXXXXX
 1230-*XXXXXXXXX
 1300-*XXXXXXXXXXXXXXXXXXXXXXXXXXX
 1330-*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 1400-*XXXXXXXXXXXXXXXXXXXXXXXXX
 1430-*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 1500-*XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 1530-*XXXXXXXXXXXXXXXXXXXXX
 1600-*XXXXXXXXXXXXX
 1630-*XXXXXXXXXXXXXXX
 1700-*XXXXX
 1730-*XXXXX
 1800-*XXXXXXXXX
 1830-*
 1900-*
 1930-*XXXXXXX
 2000-*XXXXXXX
 2030-*XXX
 2100-*
 2130-*X
 2200-*
 2230-*
 2300-*
 2330-*
      ****************************************************************
       1 2 3 4 5 6 7 8 9 1011121314151617181920212223242526272829303132

THIS IS MATRIX T
 0     0     0     0     0     0     0     0     0     0     1     10
 11    5     14    16    13    19    15    11    7     8     3     3
 5     0     0     4     4     2     0     1     0     0     0     0
 0     0     0     0


                              4/9/72
```

```
 630-*
 700-*
 730-*
 800-*
 830-*
 900-*
 930-*
1000-*
1030-*
1100-*X
1130-*
1200-*
1230-*
1300-*XXX
1330-*XXXXXXX
1400-*XXXXXXXXXXXXX
1430-*X
1500-*XXXXXXX
1530-*XXX
1600-*
1630-*XXX
1700-*
1730-*X
1800-*
1830-*
1900-*
1930-*
2000-*
2030-*
2100-*
2130-*
2200-*
2230-*
2300-*
2330-*
      ****************************************************************
       1 2 3 4 5 6 7 8 9 1011121314151617181920212223242526272829303132


ID A400  WAS NOT FOUND IN THE ID STRING!
ID A412  WAS NOT FOUND IN THE ID STRING!
ID B008  WAS NOT FOUND IN THE ID STRING!
ID R031  WAS NOT FOUND IN THE ID STRING!
ID R031  WAS NOT FOUND IN THE ID STRING!
ID B008  WAS NOT FOUND IN THE ID STRING!
ID C701  WAS NOT FOUND IN THE ID STRING!
ID D012  WAS NOT FOUND IN THE ID STRING!
ID D018  WAS NOT FOUND IN THE ID STRING!
ID D019  WAS NOT FOUND IN THE ID STRING!
ID D019  WAS NOT FOUND IN THE ID STRING!
ID D016  WAS NOT FOUND IN THE ID STRING!
ID D012  WAS NOT FOUND IN THE ID STRING!
ID D012  WAS NOT FOUND IN THE ID STRING!
ID D019  WAS NOT FOUND IN THE ID STRING!
ID D019  WAS NOT FOUND IN THE ID STRING!
ID D012  WAS NOT FOUND IN THE ID STRING!
ID B008  WAS NOT FOUND IN THE ID STRING!
DONE
```

CONTRIBUTED PROGRAM **BASIC**

TITLE: CALCULATES BASIC STATISTICS FOR GROUPED AND/OR UNGROUPED DATA — MANDSD 36748

DESCRIPTION:

MANDSD will find the mean, standard deviation, sample variance, estimated true variance and standard error of the mean for individual or grouped set of data. Sample values are entered through DATA statements.

INSTRUCTIONS:

Enter data for each set of individual values as follows:

```
1  DATA N, X(1), X(2), X(3), ......, X(N)
```

Where the N values of the set are X(1) thru X(N). If needed, additional DATA statements may be used to give the entire list of values. Additional cases may be given in subsequent DATA statements in the same format.

The input for grouped values has the following format:

```
1  DATA 0, N, X(1), F(1), X(2), F(2),..., X(N), F(N)
```

Where the initial zero signals grouped data, the N is the number of different values to be given, and the F(1) are the number of times the X(I) occur. DATA statements following may be used to extend the list as necessary, and blocks of grouped data may be intermixed freely with straight lists described above.

Note the statement numbers 1 thru 250 are available for continuation of the data field.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

W. Y. Gateley
Colorado College

```
RUN

RUN
MANDSD

DO YOU WANT INSTRUCTIONS?YES

THIS PROGRAM CALCULATES THE MEAN, VARIANCE, AND STANDARD
DEVIATION FOR EACH OF SEVERAL SETS OF INDIVIDUAL VALUES
OR FREQUENCY DISTRIBUTIONS.

DATA FOR EACH SET OF INDIVIDUAL VALUES IS ENTERED INTO
THE PROGRAM AS FOLLOWS:

   1 DATA  N, X(1), X(2), X(3),......, X(N)

WHERE THE N VALUES OF THE SET ARE X(1) THRU X(N).  IF
NEEDED, ADDITIONAL DATA STATEMENTS MAY BE USED TO GIVE
THE ENTIRE LIST OF VALUES.   ADDITIONAL CASES MAY BE
GIVEN IN SUBSEQUENT DATA STATEMENTS IN THE SAME FORMAT.

THE INPUT FOR GROUPED VALUES HAS THE FOLLOWING FORMAT:

   1 DATA 0, N, X(1), F(1), X(2), F(2),...., X(N), F(N)

WHERE THE INITIAL ZERO SIGNALS GROUPED DATA, THE N IS
THE NUMBER OF DIFFERENT VALUES TO BE GIVEN, AND THE F(I)
ARE THE NUMBER OF TIMES THE X(I) OCCUR.  DATA STATEMENTS
FOLLOWING MAY BE USED TO EXTEND THE LIST AS NECESSARY,
AND BLOCKS OF GROUPED DATA MAY BE INTERMIXED FREELY
WITH STRAIGHT LISTS DESCRIBED ABOVE.

AS AN EXAMPLE, SUPPOSE WE WERE INTERESTED IN THE MEAN
AND STANDARD DEVIATION OF THE NUMBERS 1,5,4,2,6,7,4,7
AND ALSO FOR THE DISTRIBUTION CONSISTING OF 5-1'S,
3-4'S, 6-7'S, AND 2-11'S.  THESE TWO CASES COULD BE RUN
BY TYPING THE FOLLOWING:

   1 DATA 8,1,5,4,2
   2 DATA 6,7,4,7
   3 DATA 0,4,5,1,3,4
   4 DATA 6,7,2,11
   RUN

OR EQIVALENTLY:

   1 DATA 8,1,5,4,2,6,7,4,7,0,4,5,1,3,4,6,7,2,11
   RUN

NOTE THAT STATEMENT NUMBERS 1 THRU 250 ARE AVAILABLE
FOR CONTINUATION OF THE DATA FIELD.

DONE



1  DATA 8,1,5,4,2,6,7,4,7,0,4,5,1,3,4,6,7,2,11
RUN
MANDSD

DO YOU WANT INSTRUCTIONS?N


ARITHMETIC MEAN, VARIANCE, AND
      STANDARD DEVIATION



INDIVIDUAL SET NUMBER 1

INPUT VALUES:   1     5     4     2     6     7     4     7

      NUMBER OF VALUES =  8
       ARITHMETIC MEAN =  4.5
    STANDARD DEVIATION =  2.20389
       SAMPLE VARIANCE =  4.25
     EST TRUE VARIANCE =  4.85714
         ST ERROR MEAN =  .779194
```

```
FOR GROUPED DATA SET 2

X-VALUE         FREQUENCY

 5               1
 3               4
 6               7
 2               11

      NUMBER OF VALUES =  23
       ARITHMETIC MEAN =  3.52174
    STANDARD DEVIATION =  1.80579
       SAMPLE VARIANCE =  3.11909
     EST TRUE VARIANCE =  3.26087
         ST ERROR MEAN =  .376533


DONE
```

MARKOV
36701

TITLE: COMPUTES FOR AN ERGODIC MARKOV CHAIN

DESCRIPTION:

This program computes for an ergodic Markov chain the following basic quantities: limiting probabilities, fundamental matrix, potential operator, mean first passage times, first passage times in equilibrium, variances of first passage times, limiting variances, and the transition matrix of the reverse chain.

INSTRUCTIONS:

Enter data beginning in line number 9900, as follows:

9900 DATA N
9901 DATA P_{11}, P_{12}, ...P_{1n}
9902 DATA P_{21}, P_{22}, ...P_{2n}
. .
. .
. .
9910 DATA P_{n1}, P_{n2}, ...P_{nn}

where: N = the number of states (i.e., the number of rows and columns) ($N \leq 20$)

P_{ij} = the transitional probability of moving from state I to state J

SPECIAL CONSIDERATIONS:

The number of rows (and columns) in the matrix cannot exceed 20.

The program begins at line number 9000.

The following variable is used in the program: N
A, B, K, M, P, W, Z are array names
I, J are used for internal looping

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9900  DATA 3
9901  DATA .5,.25,.25
9902  DATA .5,0,.5
9903  DATA .25.-,.25,.5
RUN
MARKOV

TRANSITION PROBABILITIES
 .5              .25             .25

 .5              0               .5

 .25             .25             .5



LIMITING PROBABILITIES
 .4              .2              .4



FUNDAMENTAL MATRIX
 1.14667         .04             -.186667

 .08             .84             .08

-.186667         .04             1.14667



POTENTIAL OPERATOR
 0               .533333         1.33333

 1.06667        -.266667         1.06667

 1.33333         .533333         0



MEAN FIRST PASSAGE TIMES
 0               4.              3.33333

 2.66667         0               2.66667

 3.33333         4.              0



FIRST PASSAGE TIMES IN EQUILIBRIUM
 1.86667         3.2             1.86667



VARIANCES OF FIRST PASSAGE TIMES

 0               12.             6.88889

 6.22223         0               6.22223

 6.88889         12.             0



LIMITING VARIANCES

 .357333         .096            .357333
```

TRANSITION MATRIX OF REVERSE CHAIN

.5	.25	.25
.5	0	.5
.25	.25	.5

DONE

CONTRIBUTED PROGRAM **BASIC**

MLREG
36661

TITLE: MULTIPLE REGRESSION

DESCRIPTION: A multiple regression program. Using:

$$t = \frac{X_1 - X_2}{T\sqrt{1/N_1 + 1/N_2}} \quad \text{where} \quad T = \sqrt{\frac{N_1 S_1^2 + N_2 S_2 2}{N_1 + N_2 - 2}}$$

The program checks to see if there is a significant difference between each column.

The beta test is a pure number whose size is a measure of final contribution to the regression equation.

INSTRUCTIONS: The data is read in by first specifying the number of variables (columns) and the number of pieces of data in each column. Then the data is fed in reading down each column starting with the dependent variable.

The actual data presently in the program is from Schaum's Outline Series, Statistics, Chap. 15, p. 273.

NOTE: The program is not limited to a certain number of variables nor a certain number of pieces of data for each variable.

ACKNOWLEDGEMENTS: William C. Lucas
University of Virginia

```
RUN

RUN
MLREG

COLUMN          MEAN            CHI-SQUARE      STANDARD DEVIATION
 1               62.75           14.1554         8.9861
 2               53.5833         7.25816         5.9461
 3               8.83333         4.49057         1.89896

PARTIAL CORRELATIONS            STUDENT'S T AT  11   D.F.
R 1     2     .819645                 2.8215
R 1     3     .769817                 19.4698
R 2     3     .798407                 23.7776

THE BETA TEST
 2               .565495
 3               .318321

STANDARD ERROR OF THE ESTIMATE IS  4.64468
COEFFICIENT OF LINEAR MULTIPLE CORRELATION .841757
COEFFICIENT OF MULTIPLE DETERMINATION IS .708555

THE F DISTRIBUTION              DEGREES OF FREEDOM              DENOMINATOR
 250.28                         2                                33

THE REGRESSION EQUATION IS
X1 =  3.65117
            +  .854611     X 2
            +  1.50633     X 3

DONE
```

CONTRIBUTED PROGRAM **BASIC**

MULREG
36178

TITLE: Multiple Regression/Correlation

DESCRIPTION:

This program performs multiple linear correlation and regression on data using the model $Y=B_0+B_1X_1 + B_2X_2 + \ldots + B_nX_n$.

INSTRUCTIONS:

Data should be entered:

```
9900 Data N,V,R
9901 Data M1,N1,P1 .... W1
9902 Data M2,N2,P2 .... W2
 .    .    .  .  .      .
 .    .    .  .  .      .
990N Data Mn,Nn,Pn .... Wn
99XX Data 1,G1,Q1,Q2,X1,X2,X3 ...XG1,Y
99XY Data 2,G2,Q1,Q2,X1,X2,X3 ...XG2,Y
 .    .   .  .  .  .  .  .      . .
 .    .   .  .  .  .  .  .      . .
99ZZ Data R,Gr,Q1,Q2,X1,X2,X3 ...XGr,Y
```

WHERE:
N=No. of Data Sets
V=No. of Variables Per Data Set
R=No. of Regression Models to be Solved in this Run.
$M_{n1}, N_{n1}, P_n \ldots W_n$ = The Complete Data Set, Including Both Dependent and Independent Variables, for the Nth Observation.
G_r=The Number of Independent Variables in the Rth Regression Model.
Q1=Control Variable for Variance-Covariance Matrix 1 to Print Ø to Omit
Q2=Control Variable for Calculated vs. Actual with Residuals Table Print Out: 1 to Print, Ø to Omit.
Xi=The Index of Position in the Data Matrix (Lines 9901 through 990n) for the ith Independent Variable in the Model.
Y= The Index of Position in the Data Matrix for the Dependent Variable.

SPECIAL CONSIDERATIONS:

Uses All Variables Except F.

I and J are Used for Internal Looping.

Literature Reference on the Durbin-Watson Statistic BIOMETRIKA, Vol. 38 #1 and 2, 1951, pp 159-177.

"Testing for Serial Correlation in Least Squares Regression II."

ACKNOWLEDGEMENTS: J. L. Mulcahy
Raychem Corporation

SAMPLE PROBLEM:

Experiment on the effect of composition of Portland Cement on heat evolved during hardening. *

DATA CODE

M= Amount of Tricalcium Aluminate, %

N= Amount of Tricalcium Silicate, %

O= Amount of Calcium Aluminum Ferrate, %

P= Amount of Dicalcium Silicate, %

Q= Heat Evolved in Calories per gram, the dependent variable.

VARIABLE

Observation	M	N	O	P	Q
1	7	26	6	60	78.5
2	1	29	15	52	74.3
3	11	56	8	20	104.3
4	11	31	8	47	87.6
5	7	52	6	33	95.9
6	11	55	9	22	109.2
7	3	71	17	6	102.7
8	1	31	22	44	72.5
9	2	54	18	22	93.1
10	21	47	4	26	115.9
11	1	40	23	34	83.8
12	11	66	9	12	113.3
13	10	68	8	12	109.4

The Desired Models to be Tried are:

1. The effect of all variables on the dependent variable (#5=Q)

2. The effect of variable No. 1 (M) on the dependent variable (#5=Q)

3. The effect of variable No's. 1 and 2 (M and N) on the dependent variable (No. 5 or Q).

Structure Of The Data Set:

Line No.	
9900	Size of the data matrix and number of models to be tried
9901 Through 9913	The Data Set Of Observations M,N,O,P,Q
9914 Through 9916	Description of the models and calculation options

* Draper, N.R. and Smith, H. Applied Regression Analysis, John Wiley & Sons: New York 1968, Page 365

Model 1. ibid page 395

Model 2. ibid page 367

Model 3. ibid page 375

For Analysis of the Durbin Watson Statistics, see Durbin, J., and G.S. Watson, Testing for Serial Correlation in Least Squares Regression, Biometrika, Vol. 38, nos. 1-2, 1951, pp. 159-177.

```
RUN

9900  DATA 13,5,3
9901  DATA 7,26,6,60,78.5
9902  DATA 1,29,15,52,74.3
9903  DATA 11,56,8,20,104.3
9904  DATA 11,31,8,47,87.6
9905  DATA 7,52,6,33,95.9
9906  DATA 11,55,9,22,109.2
9907  DATA 3,71,17,6,102.7
9908  DATA 1,31,22,44,72.5
9909  DATA 2,54,18,22,93.1
9910  DATA 21,47,4,26,115.9
9911  DATA 1,40,23,34,83.8
9912  DATA 11,66,9,12,113.3
9913  DATA 10,68,8,12,109.4
9914  DATA 1,4,1,0,1,2,3,4,5
9915  DATA 2,1,0,0,1,5
9916  DATA 3,2,0,1,1,2,5
9999  END


RUN
MULREG

**REGRESSION NUMBER 1     :DEPENDENT VARIABLE IS 5

INDEX           MEANS           STANDARD DEVIATIONS
 1               7.46154         5.88239
 2               48.1538         15.5609
 3               11.7692         6.40513
 4               30              16.7382
 5               95.4231         15.0437


CORRELATION COEFFICIENTS
 1.              .22858          -.824133        -.245445        .730719

 .22858          1.              -.139242        -.972956        .816254

-.824133        -.139242          .999999         .029537       -.534672

-.245445        -.972956          .029537         1.            -.821311

 .730719         .816255         -.534672        -.821311        1.00001


VARIANCE-COVARIANCE MATRIX
 4911.1         -50.5187         -50.6145        -51.6721       -49.6089

-50.5186         .554809          .512775         .554371        .505407

-50.6146         .512776          .523994         .525825        .512252
```

-51.672	.554372	.525824	.569716	.516999
-49.6089	.505408	.512252	.516999	.502875

INDEX	B	STD. ERROR	T-RATIO
0	62.5736	70.0793	.892897
1	1.54939	.744855	2.08012
2	.50843	.723874	.702373
3	.100156	.754796	.132693
4	-.145764	.709137	-.205552

R-SQUARED= .982371 R= .991146

STAND. ERROR OF EST.= 2.44632 D.F.= 8

DURBIN-WATSON STAT.= 2.05135

**REGRESSION NUMBER 2 :DEPENDENT VARIABLE IS 5

INDEX	MEANS	STANDARD DEVIATIONS
1	7.46154	5.88239
5	95.4231	15.0437

CORRELATION COEFFICIENTS

1.	.730719
.730719	1.00001

INDEX	B	STD. ERROR	T-RATIO
0	81.4794	4.92735	16.5362
1	1.86875	.526408	3.54999

R-SQUARED= .533944 R= .730715

STAND. ERROR OF EST.= 10.7267 D.F.= 11

DURBIN-WATSON STAT.= 1.71579

**REGRESSION NUMBER 3 :DEPENDENT VARIABLE IS 5

INDEX	MEANS	STANDARD DEVIATIONS
1	7.46154	5.88239
2	48.1538	15.5609
5	95.4231	15.0437

CORRELATION COEFFICIENTS

1.	.22858	.730719
.22858	1.	.816254
.730719	.816255	1.00001

INDEX	B	STD. ERROR	T-RATIO
0	52.5775	2.28652	22.9946
1	1.46831	.121319	12.1028
2	.662248	4.58616E-02	14.4401

R-SQUARED= .978672 R= .989279

STAND. ERROR OF EST.= 2.4067 D.F.= 10

ACTUAL	PREDICTED	RESIDUAL
78.5	80.0741	-1.57406
74.3	73.251	1.04903
104.3	105.815	-1.51471
87.6	89.2585	-1.65852
95.9	97.2925	-1.39251
109.2	105.152	4.04753
102.7	104.002	-1.30199
72.5	74.5755	-2.07547
93.1	91.2755	1.82454
115.9	114.538	1.36245
83.8	80.5357	3.26431
113.3	112.437	.862816
109.4	112.293	-2.89339

DURBIN-WATSON STAT.= 1.92106

*****PROBLEM COMPLETED*****

DONE

CONTRIBUTED PROGRAM **BASIC**

MULTX
36186

TITLE: LEAST-SQUARES FIT, MULTIPLE Y's PER X

DESCRIPTION:

This program builds a data matrix to be used by CURFIT, 36038.

INSTRUCTIONS:

GET - MULTX

APP - CURFIT

Enter data beginning in line 9900 in the following manner: First enter K, the number of different X values or groups. Then for each of the K groups enter NO, the number of elements in that group; then the common X value; and lastly the Y values for that group. For example:

9900 DATA K

9901 DATA $NO_1, X_1, Y_{11}, Y_{12}, \ldots Y_{1n}$

9902 DATA $NO_2, X_2, Y_{21}, Y_{22}, \ldots Y_{2n}$

. .
. .
. .

Where:

K = the number of different X values or groups

NOj = the number of data elements in the ith group

Xj = the common X value in the ith group

Yij = the value of the jth data element in the ith group

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

J. L. Mulcahy
Raychem Corporation

RUN

```
GET-MULTX
APP-CURFIT
9900  DATA 4
9901  DATA 3,60,110,135,120
9902  DATA 4,62,2-120,140,130,135
9903  DT-ATA 2,62-4,150,145
9904  DATA 3,70,170,185,160

MULTX

                LEAST SQUARES CURVES FIT

CURVE TYPE          INDEX  OF          A               B
                  DETERMINATION

1. Y=A+(B*X)       .824384       -179.359          5.02913
2. Y=A*EXP(B*X)    .800551        15.6465          3.43485E-02
3. Y=A*(X↑B)       .804422        .012423          2.24597
4. Y=A+(B/X)       .827907        477.589         -21371.
5. Y=1/(A+B*X)     .76408         2.23924E-02     -2.37859E-04
6. Y=X/(A+B*X)     .774062        1.01519         -8.74825E-03
7. Y=A+B*LOG(X)    .826723       -1223.18          328.516


MEAN AND STANDARD DEVIATION OF RAW DATA

                  MEAN            STANDARD DEVIATION
X                 63.8333          3.95042
Y                 141.667          21.8812

DETAILS FOR CURVE TYPE?4
   4. Y=A+(B/X) IS A HYPERBOLIC FUNCTION.  THE RESULTS
      OF A LEAST-SQUARES FIT OF ITS LINEAR TRANSFORM
      (SORTED IN ORDER OF ASCENDING VALUES OF X)
      ARE AS FOLLOWS:

X-ACTUAL        Y-ACTUAL          Y-CALC          PCT DIFFER

 60              110              121.406         -9.3
 60              135              121.406                   11.1
 60              120              121.406         -1.1
 62              120              132.896         -9.7
 62              140              132.896                   5.3
 62              130              132.896         -2.1
 62              135              132.896                   1.5
 64              150              143.667                   4.4
 64              145              143.667                   .9
 70              170              172.289         -1.3
 70              185              172.289                   7.3
 70              160              172.289         -7.1

DETAILS FOR CURVE TYPE?7
   7. Y=A+B*LOG(X) IS A LOGARITHMIC FUNCTION.  THE RESULTS
      OF A LEAST-SQUARES FIT OF ITS LINEAR TRANSFORM
      (SORTED IN ORDER OF ASCENDING VALUES OF X)
      ARE AS FOLLOWS:

X-ACTUAL        Y-ACTUAL          Y-CALC          PCT DIFFER

 60              110              121.882         -9.7
 60              135              121.882                   10.7
 60              120              121.882         -1.5
 62              120              132.654         -9.5
 62              140              132.654                   5.5
 62              130              132.654         -2
 62              135              132.654                   1.7
 64              150              143.083                   4.8
 64              145              143.083                   1.3
 70              170              172.522         -1.4
 70              185              172.522                   7.2
 70              160              172.522         -7.2


DETAILS FOR CURVE TYPE?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

PMSD
36863

TITLE: POOLED MEAN AND STANDARD DEVIATION

DESCRIPTION: The program calculates the pooled mean and standard deviation for up to 30 groups using the mean and standard deviation of the individual groups as input.

INSTRUCTIONS: When running, the program will ask for the number of groups, then for the number of cases, mean, and standard deviation for each group.

ACKNOWLEDGEMENTS: Bill Jarosz
DePaul University

```
RUN

RUN
PMSD

POOLED MEANS AND STANDARD DEVIATIONS


DO YOU NEED INSTRUCTIONS (1=YES,0=NO)?1

ALL DATA IS ENTERED WHILE THE PROGRAM IS RUNNING.
THE PROGRAM WILL ASK FOR NO. OF GROUPS, THEN FOR
THE NO. OF CASES, MEAN, AND STD. DEV. FOR EACH GROUP.
WHEN ALL DATA HAS BEEN ENTERED, THE TOTAL NUMBER OF CASES,
THE POOLED MEAN, AND THE POOLED STANDARD DEVIATION WILL BE
PRINTED.

DONE



RUN
PMSD

POOLED MEANS AND STANDARD DEVIATIONS


DO YOU NEED INSTRUCTIONS (1=YES,0=NO)?0

NO. OF GROUPS (30 MAX.)?5

FOR EACH GROUP ENTER NO. OF CASES, MEAN, STD. DEV.
GROUP 1     ?20,32.5,5.67
GROUP 2     ?15,28.6,4.98
GROUP 3     ?22,33.8,5.42
GROUP 4     ?25,29.1,5.11
GROUP 5     ?18,30.7,4.88

TOTAL CASES       100
POOLED MEAN       31.027
POOLED STD. DEV.  5.23799

DONE
```

CONTRIBUTED PROGRAM **BASIC**

POLFIT
36023

TITLE: FITS LEAST-SQUARES POLYNOMIALS

DESCRIPTION: This program is a calling program to modify MULREG, 36178, to calculate Bivariate Polynominal curves. The maximum fit is 9th degree.

INSTRUCTIONS:

GET - POLFIT
APP - MULREG
Enter date beginning at line 9900:

9900 Data N,V,R

9901 Data X_1,Y_1

9902 Data X_2,Y_2

9903 Data X_3,Y_3

: : : :

990N Data X_n,Y_n

99XX Data 1,G1,Q1,Q2,P1,P2...P_{G1},V

99XY Data 2,G2,Q1,Q2,P1,P2...P_{G2},V

: : : : : : : : :

99ZZ Data R,GR,Q1,Q2,P1,P2...P_{GR},V

Where:
N = No. of Data Sets
V = Maximum Power of Interest (No Larger Than 9)V+1
R = No. of Models to be Tested or Solved in This Run
X,Y = The Data Sets of X,Y Pairs
G = The Number of Independent Variables in the Model
Q1 = Control Variable for Variance - Covariance Matrix 1,to Print, Ø to Omit
Q2 = Control Variable for Calculated Vs. Actual Table, 1 to Print, Ø to Omit
P = Power(s) to be Included in the Model
V = Location in The Data Matrix of the Dependent Variable (Y)

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Jerry L. Mulcahy
Raychem Corporation

RUN

```
GET-POLFIT
APPEND-$MULREG
 PUN-9900
 POLFIT

 9900  DATA 7,6,2
 9901  DATA 8.32,12.78
 9902  DATA 8.34,12.53
 9903  DATA 8.36,12.08
 9904  DATA 8.38,11.57
 9905  DATA 8.4,11.19
 9906  DATA 8.42,10.91
 9907  DATA 8.44,10.73
 9908  DATA 1,1,0,0,3,6
 9909  DATA 2,1,0,1,4,6
 9999  END
RUN
POLFIT

**REGRESSION NUMBER 1     :DEPENDENT VARIABLE IS 6

 INDEX          MEANS          STANDARD DEVIATIONS
  3              588.521        9.09327
  6              11.6843        .800028


CORRELATION COEFFICIENTS
 1.0009          -.992081

-.992081          .999961



 INDEX          B              STD. ERROR      T-RATIO
  0              63.015         2.95326         21.3374
  3             -8.72199E-02    5.01759E-03    -17.3828

R-SQUARED= .983725             R= .991829

STAND. ERROR OF EST.= .111803                  D.F.= 5

DURBIN-WATSON STAT.= 1.37114

**REGRESSION NUMBER 2     :DEPENDENT VARIABLE IS 6

 INDEX          MEANS          STANDARD DEVIATIONS
  4              4932.14        101.686
  6              11.6843        .800028


CORRELATION COEFFICIENTS
 .99976          -.990996

-.990997          .999961

 INDEX          B              STD. ERROR      T-RATIO
  0              50.1371        2.31561         21.6518
  4             -7.79638E-03    4.69408E-04    -16.609

R-SQUARED= .982199             R= .99106

STAND. ERROR OF EST.= .116927                  D.F.= 5


ACTUAL          PREDICTED      RESIDUAL
 12.78           12.7789        1.09863E-03
 12.53           12.4184        .11161
 12.08           12.0553        2.47345E-02
 11.57           11.6896       -.11956
 11.19           11.3212       -.131187
 10.91           10.9502       -.040184
 10.73           10.5765        .153473

DURBIN-WATSON STAT.= 1.26539

     *****PROBLEM COMPLETED*****
```

CONTRIBUTED PROGRAM **BASIC**

PROB
36718

TITLE: COMPUTES BINOMIAL, POISSON AND HYPERGEOMETRIC PROBABILITIES

DESCRIPTION: This program computes binomial, poisson and hypergeometric probabilities.

INSTRUCTIONS: The instructions for using this program are contained within the program. Type "RUN" at the console, and type in the data as it is requested by the teletype printout. This program will compute binomial, poisson, or hypergeometric probabilities depending upon which distribution is requested.

The program begins at line number 9000.

The following variables are used in the programs:

D, K, K9, N, N1, P, P1, P2, S1, T, X, Z1

F, N are array names

I, J, L are used for internal looping

FND is a user defined function

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
RUN
PROB


DISTRIBUTION CODES:

0 = HYPERGEOMETRIC
1 = BINOMIAL
2 = POISSON

WHICH DISTRIBUTION ARE YOU ASSUMING?0

M = LOT SIZE
K = NUMBER DEFECTIVES IN THE LOT
N = SAMPLE SIZE
X = NUMBER DEFECTIVES IN THE SAMPLE


TYPE VALUES OF M, K, N, X AND RETURN?1000,10,100,2

PROBABILITIES ARE:

EXACTLY X      X OR LESS      X OR MORE
---------      ---------      ---------
 .19483         .93198         .26285



TYPE 0 IF YOU WISH TO HALT THE PROGRAM
TYPE 1 IF YOU WISH TO CONTINUE COMPUTING PROBABILITIES
?0

DONE
```

CONTRIBUTED PROGRAM **BASIC**

PSRC
36793

TITLE: POWER SERIES REGRESSION CURVE WITH X AXIS OFFSET

DESCRIPTION:

One of the most popular forecasting methods involves the extension of past trends by regression analysis. A mathematical curve which closely matches the observed data is determined by the least squares method. The formula for this curve is then used to calculate future values.

The power function is a particularly useful regression analysis formula for forecasting growth trends. It represents a logical growth curve because its growth rate decreases as its magnitude increases. It produces a simple mathematical approximation to the 'Gompertz' or 'S' curve, often used by statisticians to portray growth. The power function plots as a straight line on log-log coordinate graph paper. A straight line projection is very desirable because it is easy to visualize.

The data for most forecasting applications is represented by a time series in which the X axis values are expressed in years, quarters, months, weeks or days. The observed data often begins at a later time than the actual beginning of the series. When this is the case, the closest fit between observed data and the power series curve can usually be obtained by offsetting the X axis so that the initial value approximates the actual beginning of the time series. Program 'PSRC' automates the process for doing this.

INSTRUCTIONS:

The sample RUN demonstrates how X offset works. The objective is to forecast the future sales of an electronics company for which observed data are available for the years 1967 through 1972. Sales data are first entered. The program next calculates the various least squares regression coefficients. Since this company's first year of operation was earlier than 1967, it is logical to offset the X axis accordingly. Coefficient values for various X offsets are calculated. The index of determination (measure of closeness of fit) increases to a maximum for an offset value of 4, then decreases for larger offset values.

This particular company commenced operation in 1962 and had its first significant sales in 1963. The chart shows how these data are plotted on log-log coordinates. Curve 1 corresponds to zero X axis offset. The curved line fits the input data. The straight line is the calculated power series regression. The difference between the two curves demonstrates the imperfect fit at zero X axis offset.

With an X offset of four units, as shown by Curve 2, perfect correlation between input data and the calculation is obtained. In this case, the program adjusts the X values to range from 5 to 10 instead of from 1 to 6 as input originally.

(continued on next page)

SPECIAL CONSIDERATIONS:

A special case arises when it is desired to plot two curves on one graph. The same value for X offset must be used in both cases. This can usually be satisfactorily accomplished by compromising on an X offset value midway between the two which produce the highest index of determination for each time series. A graph which demonstrates this is shown on Page 2.

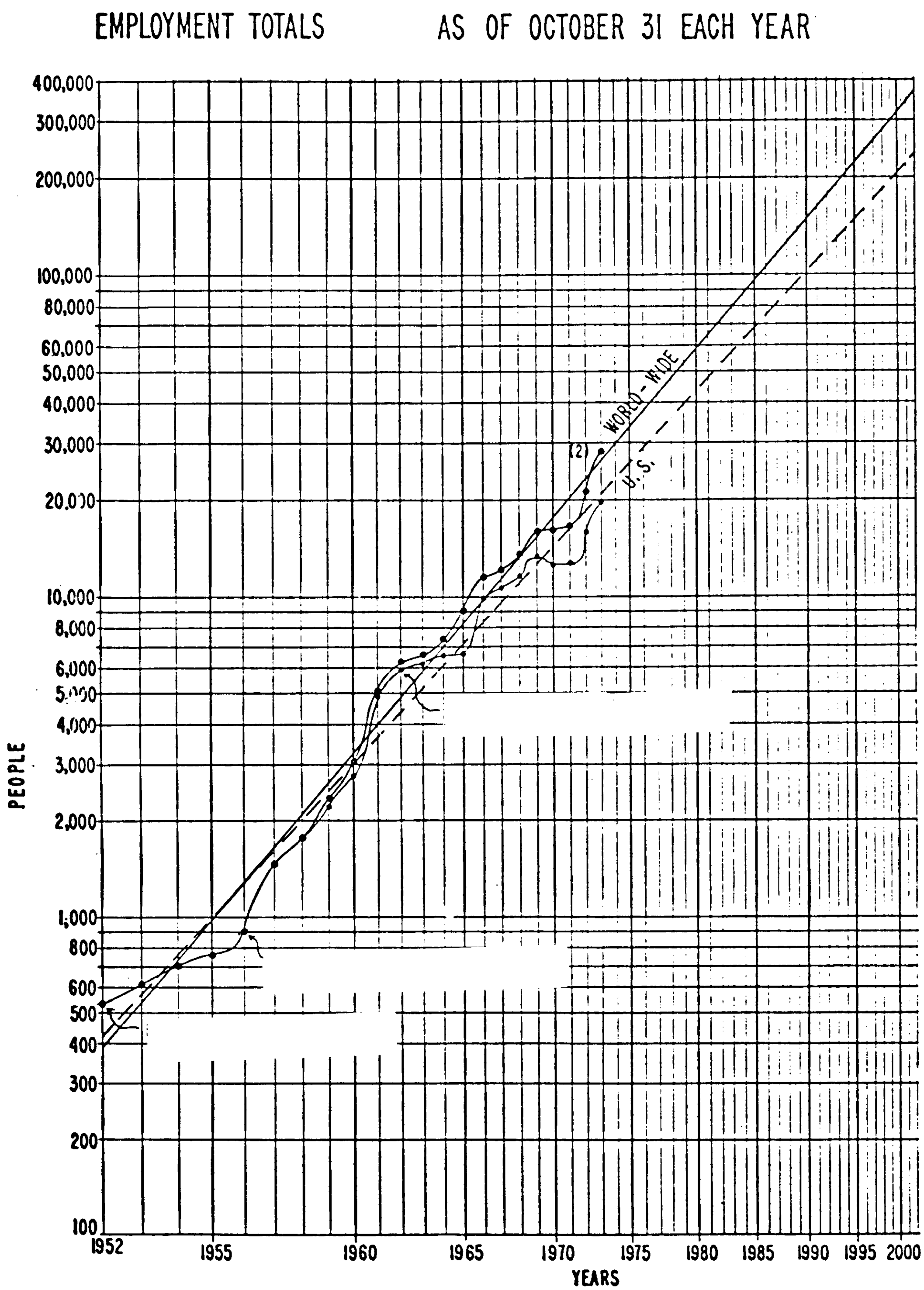
ACKNOWLEDGEMENTS:

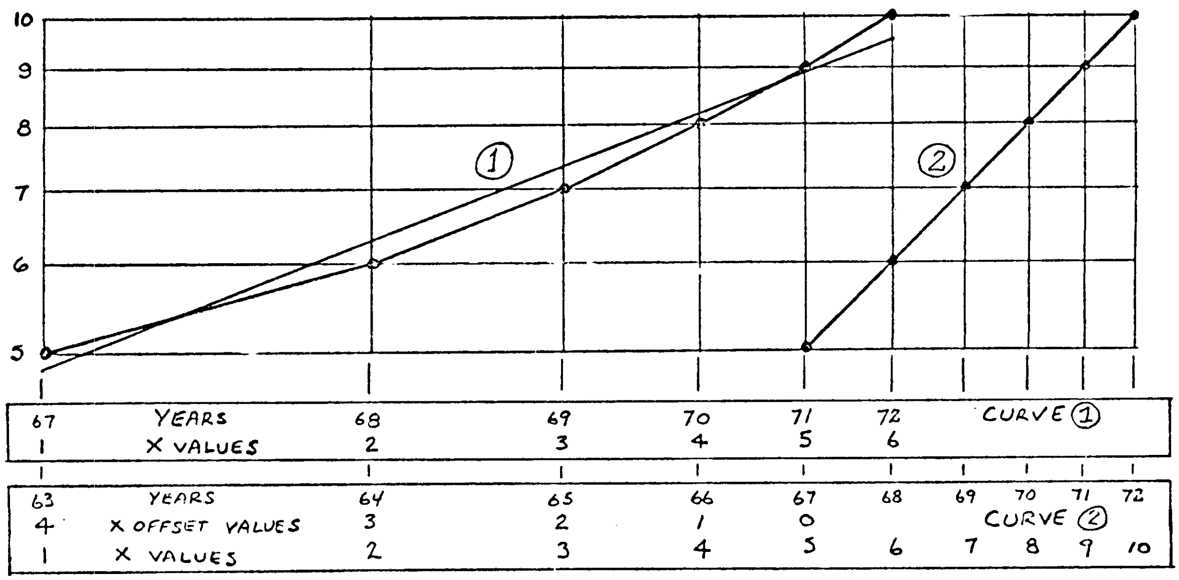
Cort Van Rensselaer
Hewlett-Packard

INSTRUCTIONS: (Cont'd)

A result of offsetting the X values is to compress the horizontal axis of the plotted data. It is necessary to expand the X axis grid lines and to plot them manually in order to compensate for this. (Y axis grid lines can be obtained from regular multi-cycle logarithmic graph paper.) X axis linear dimensions are calculated by the program.

The operator of the program must make sure that the X offset value selected by the program is logical. If it does not closely approximate the actual beginning of the time series, a second calculation for the data to be plotted should be made using an operator selected value.





POWER SERIES REGRESSION CURVE
WITH X AXIS OFFSET

RUN

```
RUN
PSRC

WANT EXPLANATION?YES


ONE OF THE MOST POPULAR FORECASTING METHODS INVOLVES THE
EXTENSION OF PAST TRENDS BY REGRESSION ANALYSIS. A MATHE-
MATICAL CURVE WHICH CLOSELY MATCHES THE OBSERVED DATA IS
DETERMINED BY THE LEAST SQUARES METHOD. THE FORMULA FOR
THIS CURVE IS THEN USED TO CALCULATE FUTURE VALUES.

THE POWER FUNCTION IS A PARTICULARLY USEFUL REGRESSION
ANALYSIS FORMULA FOR FORECASTING GROWTH TRENDS. IT REP-
RESENTS A LOGICAL GROWTH CURVE BECAUSE ITS GROWTH RATE
DECREASES AS ITS MAGNITUDE INCREASES. IT PRODUCES A SIM-
PLE MATHEMATICAL APPROXIMATION TO THE 'GOMPERTZ' OR 'S'
CURVE, OFTEN USED BY STATISTICIANS TO PORTRAY GROWTH. THE
POWER FUNCTION PLOTS AS A STRAIGHT LINE ON LOG-LOG COOR-
DINATE GRAPH PAPER. A STRAIGHT LINE PROJECTION IS VERY
DESIRABLE BECAUSE IT IS EASY TO VISUALIZE.

THE DATA FOR MOST FORECASTING APPLICATIONS IS REPRESENTED
BY A TIME SERIES IN WHICH THE X AXIS VALUES ARE EXPRESSED
IN YEARS, QUARTERS, MONTHS, WEEKS OR DAYS. THE OBSERVED
DATA OFTEN BEGINS AT A LATER TIME THAN THE ACTUAL BEGIN-
NING OF THE SERIES. WHEN THIS IS THE CASE, THE CLOSEST FIT
BETWEEN OBSERVED DATA AND THE POWER SERIES CURVE CAN USU-
ALLY BE OBTAINED BY OFFSETTING THE X AXIS SO THAT THE INI-
TIAL VALUE APPROXIMATES THE ACTUAL BEGINNING OF THE TIME
SERIES. PROGRAM 'PSRC' AUTOMATES THE PROCESS FOR DOING
THIS.

THE PROGRAM CALCULATES THE INDEX OF DETERMINATION (MEAS-
URE OF THE CLOSENESS OF THE FIT) FOR EACH INCREASING VALUE
OF X OFFSET, THEN DETERMINES THE VALUES AND DIMENSIONS FOR
PLOTTING THE OBSERVED DATA AND THE FORECAST PROJECTION.
```

A RESULT OF OFFSETTING THE X VALUES IS TO COMPRESS THE HORIZONTAL AXIS OF THE PLOTTED DATA. IT IS NECESSARY TO EXPAND THE X AXIS GRID LINES AND TO PLOT THEM MANUALLY IN ORDER TO COMPENSATE FOR THIS. (Y AXIS GRID LINES CAN BE OBTAINED FROM REGULAR MULTICYCLE LOGARITHMIC GRAPH PAPER.) X AXIS LINEAR DIMENSIONS ARE CALCULATED BY THE PROGRAM.

THE FIRST STEP IN RUNNING THE PROGRAM IS TO INPUT THE X AND Y VALUES FOR THE DATA. THEN AN AUTOMATIC OR MANUAL COEFFICIENT CALCULATION MODE IS SELECTED. IN THE AUTOMATIC MODE THE PROGRAM PROCEEDS TO THE END WITHOUT OPERATOR INTERVENTION, EXCEPT FOR ENTERING TWO CONSTANTS. THE MANUAL MODE PERMITS ANY DESIRED NUMBER OF X OFFSET VALUES TO BE CALCULATED AND THEIR COEFFICIENTS EXAMINED.

THE OPERATOR OF THE PROGRAM MUST MAKE SURE THAT THE AUTOMATICALLY SELECTED X OFFSET VALUE IS LOGICAL. IF IT DOES NOT CLOSELY APPROXIMATE THE ACTUAL BEGINNING OF THE TIME SERIES A SECOND CALCULATION FOR THE DATA TO BE PLOTTED SHOULD BE MADE USING THE MANUAL MODE OF OPERATION.

SINCE A POWER FUNCTION HAS A DECREASING RATE OF GROWTH AS ITS MAGNITUDE INCREASES, IT IS OFTEN USEFUL TO KNOW THE GROWTH RATE FOR SPECIFIC X AXIS VALUES. THESE DATA ARE CALCULATED AND PRINTED BY PROGRAM 'PSRC'.

```
                    POWER SERIES REGRESSION CURVE
                         WITH  X AXIS OFFSET

                          12 DECEMBER 1973

REPRESENTATION OF X VALUES   (BY DAY - 'D',
WEEK-'W', MONTH-'M', QUARTER-'Q', YEAR-'Y')?Y
X VALUE OF FIRST DATA SET - '1960'?1967

INPUT '-1' FOR Y VALUE FOLLOWING LAST DATA SET

 X VALUE    Y VALUE

   1967       ?5
   1968       ?6
   1969       ?7
   1970       ?8
   1971       ?9
   1972       ?10
   1973       ?-1

MANUAL-'M', OR AUTOMATIC-'A' COEFFICIENT CALCULATION MODE?M


                    COEFFICIENT CALCULATION

   X       INDEX OF        DIFFERENCE     A COEF-       B COEF-    STD ERROR
 OFFSET  DETERMINATION                    FICIENT       FICIENT     OF EST

   0       0.97564         +.97564     4.78192E+00    0.38565      0.05
   1       0.99348         +.01783     3.32208E+00    0.55399      0.02
   2       0.99826         +.00479     2.26786E+00    0.70760      0.01
   3       0.99971         +.00145     1.51921E+00    0.85533      0.00
   4       1.00000         +.00029     1.00000E+00    1.00000      0.00
   5       0.99985         -.00015     6.47819E-01    1.14286      0.00
   6       0.99951         -.00034     4.13684E-01    1.28448      0.01
   7       0.99909         -.00042     2.60675E-01    1.42534      0.01
   8       0.99868         -.00041     1.62311E-01    1.56553      0.01
   9       0.99821         -.00047     9.99245E-02    1.70535      0.01
MORE?N
```

X OFFSET VALUE WITH HIGHEST INDEX OF DETERMINATION - '29'?4
A COEFFICIENT?1
B COEFFICIENT?1
NUMBER OF TIME INTERVALS TO BE PROJECTED - '8'?0
WIDTH OF GRAPH IN MILLIMETERS - '160'?100

X AND Y VALUES AND DIMENSIONS FOR GRAPH

X VALUE	X DIM (MM)	Y ACTUAL	Y CALCULATED	RATE OF GROWTH
1967	0.0	5.0	5.0	.20
1968	26.3	6.0	6.0	.17
1969	48.5	7.0	7.0	.14
1970	67.8	8.0	8.0	.12
1971	84.8	9.0	9.0	.11
1972	100.0	10.0	10.0	.10

ANOTHER CALCULATION?NO

DONE

CONTRIBUTED PROGRAM **BASIC**

REGCOR
36054

TITLE: REGRESSION/CORRELATION

DESCRIPTION:

Regression/Correlation performs simple regression and correlation analyses on a series of observations of the values of two variables. The correlation coefficient between the variables is computed, and up to four regression equations are estimated, using the method of least-squares. The four equations are:

1. Variable 2=a+b (variable 1)
2. Variable 2=a+b (natural log of variable 1)
3. Natural log of variable 2=a+b (variable 1)
4. Natural log of variable 2=a+b (natural log of variable 1)

If any observation contains a negative or zero value of one of the variables, the equations using the natural log of that variable are not estimated.

Coefficients for each equation are chosen to minimize the deviations of the actual values of the quantity to the left of the equal sign (above) from the estimated values. However, the extent to which the equation fits the data is indicated by the percentage of the variation in variable 2 that is explained by the equation. Equations 3 and 4 are presented both in the form shown above and in alternate forms in which variable 2 is the dependent variable. The program also gives the average value and standard deviation of values for each variable.

Inputs: Number of observations (< = 500)
Variable 1) First observation
Variable 2)
:
Variable 1) Last observation
Variable 2)

Several problems may be resolved; the inputs described above are simply repeated for each problem.

The program uses the standard method of least-squares. The regression analysis is performed in subroutine 500, which regresses values of B(I) on values of A(I). The main program uses the values of the actual variables stored in X(I) and Y(I) to prepare the values in A(I) and B(I) before calling in subroutine 500. The remainder of the program performs input and output and supplementary calculations.

INSTRUCTIONS:

1. Load
2. Enter the number of observations into data statement 1ØØØ.
3. Enter the observation number, variable 1, and variable 2 into data statements 1Ø11.....10??.
4. RUN.

SPECIAL CONSIDERATIONS:

"Basic, An Introduction to Computer Programming Using the Basic Language", William F. Sharpe, University of Washington, The FREE Press, New York, 1967, L/C 67-25334.

ACKNOWLEDGEMENTS:

Walt Nichols
Woods Hole Oceanographic Institute

```
RUN

RUN
REGCOR

                   DATA

 OBSERVATION    VARIABLE 1    VARIABLE 2

 1              1             12.9
 2              2             12.4
 3              3             11.2
 4              4             9.1
 5              5             7.2
 6              6             5.2
 7              7             4.3
 8              8             4.3
 9              9             4.2
 10             10            4.1
 11             11            2.3
 12             12            .6
 13             13            .3

THE AVERAGE VALUE OF VARIABLE 1 IS            7
THE AVERAGE VALUE OF VARIABLE 2 IS            6.00769
THE STANDARD DEVIATION OF VARIABLE 1 IS       3.89444
THE STANDARD DEVIATION OF VARIABLE 2 IS       4.23546
THE CORRELATION COEFFICIENT BETWEEN VARIABLES 1 AND 2 IS    -.970511

EQUATION 1
VARIABLE 2 =    13.3962           +       -1.05549       * VARIABLE 1
 94.1892       PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 2
VARIABLE 2 =    15.2143           +       -5.30709
*LOG OF VAR 1
 91.9888       PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 3
LOG(VAR 2) =    3.23493        +          -.262097       * VARIABLE 1
ALTERNATE FORM --
VARIABLE2 = 25.4047            * .769436                 ↑VAR 1
 70.9538       PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 4
LOG(VAR 2) =    3.39234        +          -1.14832       *LOG(VAR 1)
ALTERNATE FORM --
VARIABLE 2 = 29.7355        *(VAR 1↑      -1.14832       )
-50.3798       PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

OUT OF DATA  IN LINE 201


1011  DATA 1,.3
1012  DATA 2,.6
1013  DATA 3,2.3
1014  DATA 4,4.1
1015  DATA 5,4.2
1016  DATA 6,4.3
1017  DATA 7,4.3
1018  DATA 8,5.2
1019  DATA 9.7.2←←←←,7.2
1020  DATA 10,9.1
1021  DATA 11,11.2
1022  DATA 12,12.4
1023  DATA 13,12.9
RUN
REGCOR
```

```
                    DATA

  OBSERVATION     VARIABLE 1      VARIABLE 2

  1               1               .3
  2               2               .6
  3               3               2.3
  4               4               4.1
  5               5               4.2
  6               6               4.3
  7               7               4.3
  8               8               5.2
  9               9               7.2
  10              10              9.1
  11              11              11.2
  12              12              12.4
  13              13              12.9

THE AVERAGE VALUE OF VARIABLE 1 IS            7
THE AVERAGE VALUE OF VARIABLE 2 IS            6.00769
THE STANDARD DEVIATION OF VARIABLE 1 IS       3.89444
THE STANDARD DEVIATION OF VARIABLE 2 IS       4.23546
THE CORRELATION COEFFICIENT BETWEEN VARIABLES 1 AND 2 IS     .970511

EQUATION 1
VARIABLE 2 =    -1.38077          +         1.05549        * VARIABLE 1
 94.1892        PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 2
VARIABLE 2 =    -2.45933          +         4.88074
*LOG OF VAR 1
 77.8025        PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 3
LOG(VAR 2) =    -.434432       +            .262097        * VARIABLE 1
ALTERNATE FORM --
VARIABLE2 = .647633             * 1.29965                  ↑VAR 1
 70.954         PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

EQUATION 4
LOG(VAR 2) =    -1.10635       +            1.44491        *LOG(VAR 1)
ALTERNATE FORM --
VARIABLE 2 = .330765        *(VAR 1↑        1.44491        )
 95.8351        PERCENT OF THE VARIANCE IN VARIABLE 2 EXPLAINED

OUT OF DATA  IN LINE 201
```

CONTRIBUTED PROGRAM **BASIC**

REGRES
36738

TITLE: STEP-WISE REGRESSION

DESCRIPTION:

This program performs a step-wise regression analysis for a dependent variable X_j (for j = 1 to M). Independent variables are selected in order of importance and entered into a multiple linear regression model of the form:

$$X_j = A+B_1*X_1+ ....+B_k*X_k + ...+B_m*X_m \text{ (for } k \neq j)$$

INSTRUCTIONS:

Enter data beginning in line 5000 as follows:

5000 DATA N, M
5001 DATA X_{11}, X_{12}, ... X_{1m}
5002 DATA X_{21}, X_{22}, ... X_{2m}
5003 DATA X_{31}, X_{32}, ... X_{3m}
.
.
.
5900 DATA X_{n1}, X_{n2}, ... X_{nm}

where: N = the number of observations of a variable
M = the number of variables
X_{jk} = the jth observation of the kth variable

Only statement numbers 5000-9998 may be used for DATA.

No more than 10 variables may be specified.

No more than 50 observations per variable may be entered.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

RUN
REGRES

STEP-WISE REGRESSION

ANSWER ALL QUESTIONS WITH N FOR NO, Y FOR YES , OR E FOR EXPLAIN.

TYPE THE NUMBER OF THE COLUMN CORRESPONDING TO THE
DEPENDENT VARIABLE(Y).?1

DO YOU WISH TO OMIT A VARIABLE(XK) FROM THE ANALYSIS?N



STEP  1

VARIABLE SELECTED IS ... X 2
SUM OF SQUARES REDUCED IN THIS STEP.... 622.249
PROPORTION OF VARIANCE OF Y REDUCED.... .315265
PARTIAL F (D.F. =) 13   ............... 5.98544

CUMULATIVE SUM OF SQUARES REDUCED...... 622.249
CUMULATIVE PROPORTION REDUCED.......... .315265    (OF 1973.73    )

MULTIPLE CORRELATION COEFFICIENT....... .561485
F FOR ANALYSIS OF VAR. (D.F. = 1    , 13    ) 5.98544
STANDARD ERROR OF ESTIMATE............. 10.1961

VARIABLE        REG. COEFF.     STD. ERR-COEFF.     COMPUTED T
 2               .923674         .377547             2.44652

INTERCEPT(A) -9.76983


STEP  2

VARIABLE SELECTED IS ... X 4
SUM OF SQUARES REDUCED IN THIS STEP.... 250.484
PROPORTION OF VARIANCE OF Y REDUCED.... .126909
PARTIAL F (D.F. =) 12   ............... 2.73007

DO YOU WISH TO ENTER THIS VARIABLE IN THE REGRESSION?Y

CUMULATIVE SUM OF SQUARES REDUCED...... 872.733
CUMULATIVE PROPORTION REDUCED.......... .442174    (OF 1973.73    )

MULTIPLE CORRELATION COEFFICIENT....... .664961
F FOR ANALYSIS OF VAR. (D.F. = 2    , 12    ) 4.75603
STANDARD ERROR OF ESTIMATE............. 9.57862

VARIABLE        REG. COEFF.     STD. ERR-COEFF.     COMPUTED T
 2               .74815          .37025              2.02066
 4               1.09415         .662202             1.65229

INTERCEPT(A) -23.2627


STEP  3

VARIABLE SELECTED IS ... X 3
SUM OF SQUARES REDUCED IN THIS STEP.... 74.9895
PROPORTION OF VARIANCE OF Y REDUCED.... 3.79937E-02
PARTIAL F (D.F. =) 11   ............... .803972

DO YOU WISH TO ENTER THIS VARIABLE IN THE REGRESSION?N

DO YOU WISH TO PRINT THE TABLE OF RESIDUALS?Y

OBS. NO.      Y OBSERVED     Y ESTIMATED     RESIDUAL       STD. RESID.
 1              32            29.0608         2.93922        .306852
 2              36            18.9327         17.0673        1.78181
 3              3             13.0036        -10.0036       -1.04437
 4              12            25.4976        -13.4976       -1.40914
 5              36            28.434          7.56596        .78988
```

6	24	24.4596	-.459579	-4.79797E-02
7	19	22.3836	-3.38358	-.353243
8	20	17.8385	2.16147	.225656
9	27	28.8362	-1.83619	-.191696
10	15	6.32642	8.67358	.905514
11	45	38.506	6.49401	.677969
12	9	16.2861	-7.28608	-.76066
13	11	20.3728	-9.37283	-.978515
14	33	22.9633	10.0367	1.04782
15	21	30.0988	-9.09879	-.949905

DO YOU WISH TO COMPUTE MORE REGRESSION?N

DONE

CONTRIBUTED PROGRAM **BASIC**

RNDORD
36264

TITLE: PLACING INTEGERS IN RANDOM ORDER

DESCRIPTION: This program will place the counting numbers from one to N in random order. It sets up two matrices, one of which has as its elements the numbers from 1 to N in order. It also sets two counters, M=N and N=1 (in that order). It then picks at random a number between 1 and M+1-N, and places this value from the first matrix into the Nth spot in the other matrix. The value of element in the first matrix where this number was originally located is given the value of the M+1-Nth element of this same matrix. N is incremented by one and the cycle continues. So in effect we choose a number stored in the first matrix, place it in the second matrix, and replace it in the first matrix with the last value stored in this first matrix, thereby avoiding the chance that it will be picked again.

INSTRUCTIONS: User inputs how many random lists he wants, then the number of numbers in each list.

SPECIAL CONSIDERATIONS: If the user wishes a list to be longer than 200 numbers, he will have to redimension line 80.

ACKNOWLEDGEMENTS: Phillip Short
Burnsville Senior High School

```
RUN

RUN
RNDORD

     THIS PROGRAM WILL LIST THE NUMBERS FORM 1 TO M IN RANDOM ORDER.

HOW MANY DIFFERENT LISTS DO YOU DESIRE?2


WHAT DO YOU WANT YOUR M TO BE?24

HERE ARE 2    LISTS OF THE NUMBERS FORM 1 TO 24   IN RANDOM ORDER.

 13     22     17     19     9      6      11     2      10     21     18     4
 15     24     8      16     12     1      3      5      14     20     7      23




 24     9      11     4      5      12     20     15     23     16     18     14
 1      13     2      6      21     8      22     17     7      10     19     3



DONE
```

SCOREF
36888-18035

TITLE: COMPUTES MEAN, STANDARD DEVIATION and STANDARD SCORES FOR TEST SCORES

DESCRIPTION:

This program finds the mean and standard deviation for a set of scores and the deviation, Z-score, and T-score for each of the individual scores.

INSTRUCTIONS:

Enter data starting in line 500. Data can be entered in any order except the number of scores must be first.

This is a modified version of the program "SCORES" to sort the scores entered in DATA statements.

ACKNOWLEDGEMENTS:

Donald E. Gettinger (original program)
Modified by Dr. L. Winrich and E. Schroeder
University of Wisconsin - La Crosse

```
RUN
SCOREF

MEAN =   61.8182
STANDARD DEVIATION =   19.0127

SCORE            DEVIATION        Z-SCORE          T-SCORE
-----            ---------        -------          -------
  99               37.2            1.96             69.56
  99               37.2            1.96             69.56
  89               27.2            1.43             64.30
  89               27.2            1.43             64.30
  87               25.2            1.32             63.24
  85               23.2            1.22             62.19
  75               13.2            0.69             56.93
  74               12.2            0.64             56.41
  73               11.2            0.59             55.88
  70                8.2            0.43             54.30
  69                7.2            0.38             53.78
  67                5.2            0.27             52.73
  66                4.2            0.22             52.20
  64                2.2            0.11             51.15
  64                2.2            0.11             51.15
  64                2.2            0.11             51.15
  62                0.2            0.01             50.10
  62                0.2            0.01             50.10
  61               -0.8           -0.04             49.57
  59               -2.8           -0.15             48.52
  58               -3.8           -0.20             47.99
  57               -4.8           -0.25             47.47
  54               -7.8           -0.41             45.89
  49              -12.8           -0.67             43.26
  48              -13.8           -0.73             42.73
  47              -14.8           -0.78             42.21
  44              -17.8           -0.94             40.63
  44              -17.8           -0.94             40.63
  39              -22.8           -1.20             38.00
  37              -24.8           -1.31             36.95
  34              -27.8           -1.46             35.37
  29              -32.8           -1.73             32.74
  22              -39.8           -2.09             29.06

DONE
```

CONTRIBUTED PROGRAM **BASIC**

SCORES
36136

TITLE: COMPUTES MEAN, STANDARD DEVIATION, AND STANDARD SCORES FOR TEST SCORES

DESCRIPTION: Program finds the mean and standard deviation for a set of scores, and the deviation, Z-score, and T-score for each of the individual scores.

INSTRUCTIONS: DATA: First line (line 370) is number of scores.

List the scores on the following data line(s).

SPECIAL CONSIDERATIONS: Program assumes a normal distribution of scores.

ACKNOWLEDGEMENTS: Donald E. Gettinger
Stillwater Senior High School

```
RUN

RUN
SCORES

MEAN =  41.3333
STANDARD DEVIATION =   7.66522

SCORE          DEVIATION      Z-SCORE        T-SCORE
-----          ---------      -------        -------
 50             8.66666        1.13065        61.3065
 50             8.66666        1.13065        61.3065
 50             8.66666        1.13065        61.3065
 48             6.66666        .869729        58.6973
 48             6.66666        .869729        58.6973
 44             2.66666        .347891        53.4789
 43             1.66666        .217432        52.1743
 42             .666664       8.69726E-02     50.8697
 42             .666664       8.69726E-02     50.8697
 42             .666664       8.69726E-02     50.8697
 41            -.333336      -4.34868E-02     49.5651
 35            -6.33334      -.826243         41.7376
 30            -11.3333      -1.47854         35.2146
 29            -12.3333      -1.609           33.91
 26            -15.3333      -2.00038         29.9962

DONE
```

CONTRIBUTED PROGRAM **BASIC**

TITLE: CHI-SQUARE TEST

SEVPRO
36719

DESCRIPTION:

This program applies a CHI-SQUARE test to several sample proportions.

INSTRUCTIONS:

Supply values for N and S as follows:

```
100  DATA N1, S1, N2, S2, N3, S3, .....
```

where:

N1 = size of sample
S1 = the number of success in sample 1.

Repeat for the total number of samples

Sample Problem:

Statistically test the following data for significance.

In response to heavy demand for a particular model portable radio, four separate assembly lines have been in operation for the last two weeks. While all are identical operations for all intents and purposes, there are unavoidable differences in equipment, operator experience and so on. The reject rate has been running fairly high, and each line is blaming it on the others. The Quality Engineer decided to check all rejects for one day to discover whether the quality was significantly different for the four lines.

Assembly Line	Total Units Assembled	Number Rejected	Percent Rejected
1	1217	45	3.7
2	948	49	5.2
3	1165	33	2.8
4	1121	44	3.9

Line 2 seemed higher, and line 3 lowest in reject rate, but such a difference could be the result of just chance. The engineer decided to make a statistical test for significance.

Analysis of Result: It looks as though the 4 lines are not alike on quality. Lines 1 and 4 are much alike, but Line 2 seems to have problems. The test of the four proporations simply tells us that it's rather improbable (only 1 chance in 24 or so) that chance could account for this much variability, assuming the quality level was actually the same on all lines.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

RUN

```
100  DATA 1217,45,948,49,1165,33,1121,44
RUN
SEVPRO

CHI-SQUARE TEST OF SEVERAL PROPORTIONS:

 SAMPLE     SUCCESSES / TOTAL     PCT SUCCESSES

    1           45   / 1217          3.698
    2           49   / 948           5.169
    3           33   / 1165          2.833
    4           44   / 1121          3.925

CHI-SQUARED FOR THESE DATA    =  7.81994
CORRESPONDING NORMAL DEVIATE =  1.65456

 BEING EXCEEDED BY CHANCE ALONE IS 6.00001E-02

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STATØ6
36724

TITLE: CALCULATES THE SIGN TEST CONFIDENCE INTERVAL USING FRACTIONAL COUNTS

DESCRIPTION: This program calculates the Sign Test confidence interval using fractional counts.

INSTRUCTIONS: Enter the data beginning in line number 9900 in the following manner: first input N, the number of data elements; then C, the critical value; and then the data itself. For example:

9900 DATA N, C, X_1, X_2, ...X_n

where: N = the number of data elements to be entered ≤ 1000
C = the critical value
X_k = the value of the kth data element

The maximum number, N, of data elements is 1000.

The program begins at line number 9000.

The following variables are used in the program:

C, L, N, T, U, X
D is an array name
I is used for internal looping

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
9900  DATA 12,2.2,20.1,21,20.4,18.1,19,17.8
9901  DATA 20.3,19.2,21.5,19.7,20,18.2

RUN
STATØ6

CONFIDENCE INTERVAL BY SIGN TEST, FRACTIONAL COUNT.

LOWER LIMIT IS  18.36          UPPER LIMIT IS  20.38

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STATØ7
36725

TITLE: CALCULATES THE CONFIDENCE LIMITS FOR A SET OF DATA

DESCRIPTION:

This program calculates the confidence limits for a set of data using the Wilcoxon signed rank sum procedure with fractional counts.

INSTRUCTIONS:

Enter the data beginning in line number 9900 in the following manner: first input N, the number of data elements; then C, the critical value; and then the data itself. For example:

9900 DATA N, C, X_1, X_2, ...X_n

where: N = the number of data elements to be entered $\leq$40.
C = the critical value
X_k = the value of the kth data element

The maximum number, N, of data elements is 40.

The program begins at line number 9000.

The following variables are used in the program:

B, C, K, L, N, U, X
A, D are array names
I, J are used for internal looping

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

```
RUN

9900  DATA 12,13.8,20.1,21,20.4,18.1,19,17.8
9901  DATA 20.3,19.2,21.5,19.7,20,18.2

RUN
STAT07

CONFIDENCE INTERVAL BY SIGNED RANK SUM, FRACTIONAL COUNT

LOWER LIMIT     UPPER LIMIT
 18.9            20.35

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STATØ8
36732

TITLE: COMPARES TWO GROUPS OF DATA USING THE MEDIAN TEST

DESCRIPTION:

This program compares two groups of data using the Median Test. The Chi-square value of the 2 by 2 table on 1 degree of freedom is printed out.

INSTRUCTIONS:

Enter data beginning in line number 9900 as follows:

9900 DATA M, N

9901 DATA X_1, X_2, ...X_m

9902 DATA Y_1, Y_2, ...Y_n

where: M = the number of data elements in the first group

N = the number of data elements in the second group

X_k = the value of the kth data elements in the first group

Y_k = the value of the kth data element in the second group

There can be no more than 1000 data elements; that is, $M + N \leq 1000$.

The program begins at line number 9000.

The following variables are used in the program:

C2, I, J, L, M, M1, M2, N, Q, T, U, V, X, Y, Z

A is an array name

K is used for internal looping

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

RUN

```
9900  DATA 4,6
9901  DATA 160,160,140,190
9902  DATA 117,145,147,120,150,120

RUN
STATØ8

TWO SAMPLE MEDIAN TEST.

GROUP 1        1       3
GROUP 2        4       2

CHI-SQUARE =   .416667

DONE
```

STAT1

TITLE: A HISTOGRAM, STANDARD DEVIATION, AND PLOT OF A SET OF NUMBERS 36881-18003

DESCRIPTION:

This program provides a selection of any or all of the following:

1. A statistical analysis giving standard deviation, normalized deviation, the mean and, as an option, the median.
2. A histogram of the set of numbers.
3. A plot of the numbers with the mean indicated.
4. Automatic or manual selection of scale factors for the histogram and the plot.

INSTRUCTIONS:

Before running the program enter the following data beginning with line 1000:

1000 DATA X_1, X_2, X_3, X_4 ....

where X_i = DATA POINTS (limit 1000 points)

SPECIAL CONSIDERATIONS:

If more than 1000 data points are required, redimension G(N) in line 6.

The median is sorted with a technique requiring less than a third of the time of other methods thereby saving considerable terminal time for large groups of numbers.

If numbers are outside the limit of the plot they have indicated by an "O" at the edge of the plot. Valid numbers are indicated by "*".

If more than one histogram bar contains "Maximum Frequency" each is printed separately giving the limits of their occurence.

Automatic scale selection is based on standard deviation of the number set. Positive, negative and decimal numbers are acceptable.

Provisions are made for removing a fixed offset or "TARE" from the set of data.

The end of each run is identified with the date and time.

ACKNOWLEDGEMENTS:

A. E. Brown
Saratoga Systems, Inc.

RUN

```
GET-STAT1
1000  DATA 0,.5,.86603,1,.86603,.5,0,-.5,-.86603,-1,-.86603,-.5,0
RUN
STAT1

DO YOU WANT AN HISTOGRAM    1=YES    0=NO ?1
DO YOU WANT A PLOT          1=YES    0=NO ?1
DO YOU WANT THE MEDIAN      1=YES    0=NO ?1
AUTOMATIC SCALE FACTOR      1=YES    0=NO ?1
THIS IS AN ANALYSIS OF WHAT
?OFFSET SINE WAVE
WHAT ARE THE DIMENSIONS  ?UNITS
WHAT IS THE TARE READING ?.5
-



                    THIS IS A STATISTICAL ANALYSIS OF
                             OFFSET SINE WAVE
                                 (UNITS)


   NUMBER OF POINTS      =  13
   TARE OF DATA          =  .5
   MEAN OF DATA          = -.5
   MEDIAN OF DATA        = -.5
   STANDARD DEVIATION    =  .707109
   NORMALIZED DEVIATION  = -1.41422
   SAMPLE SIZE           =  .2
   MAXIMUM FREQUENCY     =  3
     OCCURS BETWEEN -.6          AND -.4



                                 % OF MAXIMUM
             0        20        40        60        80        100
             I         I         I         I         I         I
             +----.----+----.----+----.----+----.----+----.----+
-3          -I
             I
             I
             I
             I
-2          -I
             I
             I****************
             I*********************************
             I
-1          -I*********************************
             I
             I**************************************************
             I
             I
0           -I*********************************
             I*********************************
             I****************
             I
             I
1           -I
```

```
                                 UNITS
-3                     -1                      1                       3
!           !           !           !           !           !           !
+-----.-----+-----.-----+-----.-----+-----.-----+-----.-----+-----.-----+
                             -M-
                              *
                                    *
                                        *
                                          *
                                        *
                                    *
                              *
                        *
                   *
                 *
                   *
                        *
                              *
```

1/14/75   18:36

DONE

CONTRIBUTED PROGRAM **BASIC**

STAT14
36730

TITLE: ANALYSIS OF VARIANCE AND F-RATIOS (RANDOMIZED COMPLETE BLOCK DESIGN)

DESCRIPTION:

This program produces the analysis of variance and F-ratios for treatments and blocks of a randomized complete block design.

INSTRUCTIONS:

Enter data beginning in line number 9900 in the following manner: first enter N, the number of treatments; then M the number of blocks, and lastly enter the observations, X_{ij}, by block, where the treatments are columns and the blocks are rows of the input matrix. (This means the first observation will be entered for each treatment, followed by the second observation for each treatment, and so on.) For example,

```
9900  DATA N, M
9901  DATA X11,X12,...X1n
9902  DATA X21,X22,...X2n
  .      .
  .      .
  .      .
9910  DATA Xm1,Xm2,...Xmn
```

where: N = the number of treatments $\leq$ 10
M = the number of blocks $\leq$ 10
X_{ij} = the value of the observation in the ith block (row) and the jth treatment (column)

The maximum number of treatments and blocks is 10. In order to increase the number of allowable treatments and blocks, add a DIM statement for the variables X, S, and G, with the required number of subscripts for each.

where: X = the matrix of observations with M rows and N columns
S = an accumulator used to sum the observations for each treatment (column)
G = an accumulator used to sum the observations for each block (row)

The program begins at line number 9000.

The following variables are used in the program:

A, A1, A2, A3, B, C, D, F, F1
T, U, W, W1

G, S, X are array names

I, J are used for internal looping

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
9900  DATA 4,4
9901  DATA 4,1,-1,0
9902  DATA 1,1,-1,-1
9903  DATA 0,0,-3,-2
9904  DATA 0,-5,-4,-4


RUN
STAT14

ANALYSIS OF VARIANCE TABLE

ITEM            SUM-SQR         DEG. FREE.      MEAN-SQR

GRAND TOTAL      92              16
GRAND MEAN       12.25           1
TREATMENTS       28.75           3                9.58333
BLOCKS           40.25           3                13.4167
ERROR            10.75           9                1.19444


F-RATIO FOR TREATMENTS = 8.02326     , ON 3     AND 9
DEGREES OF FREEDOM.
F-RATIO FOR BLOCKS = 11.2326     , ON 3     AND 9     DEGREES OF FREEDOM.

DONE
```

STAT16
36729

TITLE: COMPUTES AN ANALYSIS OF VARIANCE TABLE AND F-RATIOS

DESCRIPTION:

This program computes an analysis of variance table and F-ratios for a simple Graeco-Latin square design.

INSTRUCTIONS:

Enter data beginning in line number 9900 in the following manner: first enter N, the number of treatments; then the Latin treatment assignments, M_{ij}, by rows; then the Graeco treatment assignments, N_{ij}, by rows; and lastly the data, X_{ij}, by rows. For example,

9900 DATA N

9901 DATA $M_{11}, M_{12}, \ldots M_{1n}, M_{21}, M_{22}, \ldots M_{2n}, \ldots M_{n1}, M_{n2}, \ldots M_{nn}$

9902 DATA $N_{11}, N_{12}, \ldots N_{1n}, N_{21}, N_{22}, \ldots N_{2n}, \ldots N_{n1}, N_{n2}, \ldots N_{nn}$

9903 DATA $X_{11}, X_{12}, \ldots X_{1n}$

9904 DATA $X_{21}, X_{22}, \ldots X_{2n}$

. .

. .

. .

9910 DATA $X_{n1}, X_{n2}, \ldots X_{nn}$

where: N = the number of treatments ≤ 10
M_{ij} = the Latin treatment assignment for the ith row and jth column
N_{ij} = the Graeco treatment assignment for the ith row and the jth column
X_{ij} = the value of the data element at the ith row and jth column

The maximum number of treatments is 10. In order to increase the number of allowable data elements, add a DIM statement for the variables M, N, R, C, T, and G with the required number of subscripts for each.

where: M = the matrix of Latin treatment assignments with N rows and columns
N = the matrix of Graeco treatment assignments with N rows and columns
R = an accumulator used to sum the observations for each row
C = an accumulator used to sum the observations for each column
T = an accumulator used to sum the observations for the Latin treatments
G = an accumulator used to sum the observations for the Graeco treatments

continued on following page

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

INSTRUCTIONS continued

The program begins at line number 9000.

The following variables are used in the program:

C, D1, D2, N, S, S0, S3, S4, S5, S6, S7, S8, X

C, G, M, N, R, T are array names

I, J are used for internal looping

```
RUN

9900  DATA 4
9901  DATA 1,2,3,4,4,1,2,3,3,4,1,2,2,3,4,1
9902  DATA 4,3,2,1,3,2,1,4,2,1,4,3,1,4,3,2
9903  DATA 24,47,35,42
9904  DATA 47,85,23,47
9905  A←DATA 65,49,23,62
9906  DATA 12,14,19,23


RUN
STAT16

ITEM       SUM-SQR        DEG. FREE.      MEAN-SQR       F-RATIO
----       -------        ---------       --------       -------
ROWS       2940.19           3            980.062        5.07202
COLS       1258.19           3            419.396        2.17046
TREAT L    39.6875           3            13.2292        6.84636E-02
TREAT G    1564.19           3            521.396        2.69833
ERROR      579.687           3            193.229

DONE
```

STAT17
36728

TITLE: COMPUTES AN ANALYSIS OF VARIANCE TABLE FOR A BALANCED INCOMPLETE BLOCK DESIGN

DESCRIPTION:

This program computes an analysis of variance table for a balanced incomplete block design. The sum of squares for treatments is adjusted because of incompleteness.

INSTRUCTIONS:

Enter data beginning in line number 9900. First enter the number of blocks, B, followed by the number of treatments, T, the number of treatments per block, K, and the number of replications, R, for each treatment in the experiment. The next input is a matrix, N, where the value for each N_{ij} is one if a treatment appears in the matrix of observations, and zero if there is no treatment. This data is followed by the matrix of observations, X_{ij}, where X_{ij} is entered as zero when no treatment is available. When the value of the treatment X_{ij} is actually zero, N_{ij} for that treatment should be one. For example,

9900 DATA B, T, K, R

9901 DATA $N_{11},N_{12},\ldots N_{1t}$

9902 DATA $N_{21},N_{22},\ldots N_{2t}$

: :

9910 DATA $N_{b1},N_{b2},\ldots N_{bt}$

9911 DATA $X_{11},X_{12},\ldots X_{1t}$

9912 DATA $X_{21},X_{22},\ldots X_{2t}$

: :

9920 DATA $X_{b1},X_{b2},\ldots X_{bt}$

where:
- B = the number of blocks ≤ 10
- T = the number of treatments ≤ 10
- K = the number of treatments per block
- R = the number of replications for each treatment in the experiment

Continued on following page.

SPECIAL CONSIDERATIONS:

The maximum number of blocks or treatments is 10. This restriction can be changed by adding a DIM statement to increase the size of the arrays used in the program.

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

INSTRUCTIONS continued

N_{ij} = a code value which represents the existence of a treatment in the ith row and jth column of the matrix of observations. (The value of N_{ij} is one when a value appears in the matrix of observations; otherwise, N_{ij} is zero.)
X_{ij} = the value of the treatment at the ith row and the jth column of the observation matrix. (A value of zero should be entered for X_{ij} where no treatment appears.)

NOTE: Data line numbers must not exceed 9997.

The program begins at line number 9000.

The following variables are used in the program:

A, A1, A2, A3, B, C, D, F, K, L, L1, R, T, U, W, W1

G, N, P, Q, S, X are array names

I, J are used for internal looping

RUN

```
9900  DATA 4,4,3,3
9901  DATA 1,0,1,1
9902  DATA 0,1,1,1
9903  DATA 1,1,1,0
9904  DATA 1,1,0,1
9905  DATA 2,0,20,7
9906  DATA 0,32,14,3
9907  DATA 4,13,31,0
9908  DATA 0,23,0,11


RUN
STAT17

ANALYSIS OF VARIANCE TABLE

ITEM            SUM-SQR         DEG. FREE.      MEAN-SQR

GRAND TOTAL     3478            12
GRAND MEAN      2133.33         1
TREATMENTS      880.833         3                  293.611
BLOCKS          100.667         3         ...BLOCK MEAN-SQR NOT ADJUSTED...
ERROR           363.167         5                  72.6333


F-RATIO = 4.04238     , ON 3     AND 5     DEGREES OF FREEDOM.

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STAT18
36727

TITLE: COMPUTES AN ANALYSIS OF VARIANCE TABLE AND F-RATIO FOR TREATMENTS FOR A YOUDEN SQUARE DESIGN

DESCRIPTION:

This program computes an analysis of variance table and F-ratio for treatments for a Youden square design. The sums of squares for treatments is adjusted because of incompleteness of the experimental data.

INSTRUCTIONS:

Enter data beginning in line number 9900. First enter the number of rows and treatments, N; then the number of columns and replications of each treatment, K. Next the matrix, M, for assigning treatments is entered. This is followed by the Youden treatments entered as matrix, N. The observations, X_{ij}, are entered last in matrix form where X_{ij} is set equal to zero when no treatment is available. For example,

9900 DATA N, K

9901 DATA $M_{11}, M_{12}, \ldots M_{1k}$

9902 DATA $M_{21}, M_{22}, \ldots M_{2k}$

⋮ ⋮

9910 DATA $M_{n1}, M_{n2}, \ldots M_{nk}$

9911 DATA $N_{11}, N_{12}, \ldots N_{1n}$

9912 DATA $N_{21}, N_{22}, \ldots N_{2n}$

⋮ ⋮

9920 DATA $N_{n1}, N_{n2}, \ldots N_{nm}$

9921 DATA $X_{11}, X_{12}, \ldots X_{1k}$

9922 DATA $X_{21}, X_{22}, \ldots X_{2k}$

⋮ ⋮

9930 DATA $X_{n1}, X_{n2}, \ldots X_{nk}$

Continued on following page.

SPECIAL CONSIDERATIONS:

The maximum number of rows and treatments is 10. This restriction can be changed by adding a DIM statement to increase the size of the arrays used in the program.

ACKNOWLEDGEMENTS:

Babson College
Babson Park, Massachusetts

INSTRUCTIONS continued

where: N = the number of rows and treatments ≤ 10
K = the number of columns and replications
M_{ij} = an integer value representing the treatment row number to be entered in the ith row and the jth column of the treatment matrix
N_{ij} = a code value which equals 1 if treatment j appears in row i of the matrix M, and equals 0 otherwise.
X_{ij} = the value of the observation at the ith row and jth column of the observation matrix

The program begins at line number 9000.

The following variables are used in the program:

C, C1, C2, D, D1, E2, F, K, L, N, R, R2, S, S2, T1, T2

C, M, N, P, Q, R, T, X are array names

H, I, J are used for internal looping

RUN

```
9900  DATA 4,3
9901  DATA 1,2,3
9902  DATA 4,1,2
9903  DATA 2,3,4
9904  DATA 3,4,1
9905  DATA 1,1,1,0
9906  DATA 1,1,0,1
9907  DATA 0,1,1,1
9908  DATA 1,0,1,1
9909  DATA 2,1,0
9910  DATA -2,2,2
9911  DATA -1,-1,-3
9912  DATA 0,-4,2

RUN
STAT18

ANALYSIS OF VARIANCE TABLE

ITEM            SUM-SQR        DEG. FREE.      MEAN-SQR

GRAND TOTAL      48             12
GRAND MEAN       .333333        1
TREATMENTS       31.0833        3                 10.3611
ROWS             13.6667        3             ...SS NOT ADJUSTED...
COLUMNS          1.16667        2                 .583333
ERROR            1.75001        3                 .583336


TREATMENT F-RATIO = 17.7618     , ON 3     AND 3     DEGREES OF FREEDOM.

IF MSC/MSE = .999996     IS NOT SIGNIFICANT, IT MAY BE
DESIRABLE TO POOL COLUMN AND ERROR SS TO OBTAIN AS AN
ERROR MS ESTIMATE .583335     WITH 5     DEGREES OF FREEDOM.

DONE
```

STAT19
36607

TITLE: KRUSKAL - WALLIS ONE WAY ANALYSIS OF VARIANCE

DESCRIPTION:

The Kruskal-Wallis one way analysis of variance by ranks is an extremely useful non-parametric test for deciding whether K independent samples are from different populations. The Kruskal-Wallis technique tests the null hypothesis that the K samples came from the same population or from identical populations with respect to averages.

The data is present in a table having K columns (maximum of 10) each column representing one set, or sample, from a total of N observations.

INSTRUCTIONS:

Enter the data in lines 2000-9998. Data should be entered by sample (or column) and each sample should be preceded by the number of observations in that sample. Type 'RUN' and answer the questions as they appear. The computer will print out the value of H to be compared to Chi-Square. If H is less than or equal to the value of Chi-Square at the given degrees of freedom then the null hypothesis should be rejected.

SPECIAL CONSIDERATIONS:

There may only be up to 500 observations in 10 samples. (Maximum - 50 per sample).

ACKNOWLEDGEMENTS:

Larry Robbins
Babson College

```
RUN

2000  DATA 10,2,2.8,3.3,3.2,4.4,3.6,1.9,3.3,2.8,1.1
2010  DATA 8,3.5,2.8,3.2,3.5,2.3,2.4,2,1.6
2020  DATA 10,3.3,3.6,2.6,3.1,3.2,3.3,2.9,3.4,3.2,3.2

2030  DATA 8,3.2,3.3,3.2,2.9,3.3,2.5,2.6,2.8
2040  DATA 6,2.6,2.6,2.9,2,2,2.1
2050  DATA 4,3.1,2.9,3.1,2.5
2060  DATA 6,2.6,2.2,2.2,2.5,1.2,1.2
2070  DATA 4,2.5,2.4,3,1.5
9999  END

RUN
STAT19

TOTAL NUMBER OF OBSERVATIONS    ?56
NUMBER OF SAMPLES   ?8


  YOUR ANSWER WILL TAKE A FEW MINUTES...
          PLEASE WAIT...........


DO YOU WANT TO SEE THE RANKED SCORES????YES


                                         RANKED SCORES


  1.0      2.0      3.0      4.0      5.0      6.0      7.0      8.0
-----------------------------------------------------------------------

  8.5     52.5     47.5     41.0     23.0     36.0     23.0     18.5
 27.5     27.5     54.5     47.5     23.0     31.5     12.5     15.5
 47.5     41.0     23.0     41.0     31.5     36.0     12.5     34.0
 41.0     52.5     36.0     31.5      8.5     18.5     18.5      4.0
 56.0     14.0     41.0     47.5      8.5      0.0      2.5      0.0
 54.5     15.5     47.5     18.5     11.0      0.0      2.5      0.0
  6.0      8.5     31.5     23.0      0.0      0.0      0.0      0.0
 47.5      5.0     51.0     27.5      0.0      0.0      0.0      0.0
 27.5      0.0     41.0      0.0      0.0      0.0      0.0      0.0
  1.0      0.0     41.0      0.0      0.0      0.0      0.0      0.0

NO. OF NO'S IN COLUMN
 10.0      8.0     10.0      8.0      6.0      4.0      6.0      4.0

SUM OF NO'S IN COLUMN
 317.0    216.5    414.0    277.5    105.5    122.0     71.5     72.0

THE VALUE OF H TO BE COMPARED TO CHI SQUARE IS 18.4639
DEGREES OF FREEDOM ARE  7

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STAT2
36052

TITLE: MANN-WHITNEY 2 SAMPLE RANK TEST

DESCRIPTION: This program compares two groups of data by means of the Mann-Whitney two sample rank test.

INSTRUCTIONS: Enter data beginning in line 9900 in the following manner: first enter M, the number of data elements in the first group; then N, the number of data elements in the second group; then C, the critical value; and lastly the data elements. For example:

9900 DATA M, N, C, X_1, X_2, ... Y_n

where M = the number of data elements in the first group <30
N = the number of data elements in the second group <30
C = the critical value (fractional count)
X_k = the value of the kth data element in the first group
Y_k = the value of the kth data element in the second group

SPECIAL CONSIDERATIONS: The maximum number of data elements in either group is 30; that is, M <30 and N <30.

Variables used: C, L, M, N, P, Q, R, T, U, X
A, B, D are array names
I, J are used for internal looping

ACKNOWLEDGEMENTS:

RUN

```
GET-$STAT2
9900 DATA 4,6,2.5,190,160,2-160,140,117,120,120,145,147,150
RUN
STAT2

CONFIDENCE INTERVAL BY RANK SUM TEST.
LOWER LIMIT =    2.5            UPPER LIMIT =    57.5

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STAT2Ø
36608

TITLE: THE FRIEDMAN TWO-WAY ANALYSIS OF VARIANCE

DESCRIPTION:

The Friedman two-way analysis of variance is a non-parametric test. When the data from K matched samples are in at least an ordinal scale, it is useful for testing the null hypothesis that all samples are drawn from the same population. The data is presented in a table having N rows (subject groups) and K columns (conditions). If the data are scores of subjects serving under all conditions then each row gives the scores for one subject under the K conditions. If the data are ranks then the scores of each row are ranked separately.

The XR-squared value calculated by the program is to be compared to a chi-square table for an accept-reject decision of the null hypothesis. If the value XR-squared is less than or equal to chi-square reject the null hypothesis.

INSTRUCTIONS:

Enter the data, (raw or ranked scores) in line 1000-9000. Data should be entered by groups, entering all K conditions for each group before the next group. The order of conditions is not relevant as long as it remains constant.

There may be up to 50 sets of data with 5 conditions in each set.

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

Larry Robbins
Babson College

```
RUN

1Ø1Ø  DATA 1,8,7
1Ø2Ø  DATA 6,8,4
1Ø3Ø  DATA 3,9,5
1Ø4Ø  DATA 1,7,9
1Ø5Ø  DATA 7,3,4
1Ø6Ø  DATA 6,7,5
1Ø7Ø  DATA 4,3,2
1Ø8Ø  DATA 1,5,3
1Ø9Ø  DATA 6,2,4
11ØØ  DATA 5,2,4
111Ø  DATA 4,7,3
112Ø  DATA 4,6,2
113Ø  DATA 9,6,4
114Ø  DATA 7,9,4
115Ø  DATA 6,6,5
116Ø  DATA 4,2,1
117Ø  DATA 6,5,4
118Ø  DATA 6,9,3


RUN
STAT2Ø

NEED INSTRUCTIONS
?NO
WHAT IS THE VARIABLE NAME    ?SAMPLE RUN
WHAT IS THE NUMBER OF SETS OF DATA  ?18
WHAT IS THE NUMBER OF CONDITIONS IN EACH SET  ?3
DO YOU WANT THE RANK MATRIX PRINTED    ?YES
```

RANKED SCORES FOR SAMPLE RUN

SET # 1	1	3	2
SET # 2	2	3	1
SET # 3	1	3	2
SET # 4	1	2	3
SET # 5	3	1	2
SET # 6	2	3	1
SET # 7	3	2	1
SET # 8	1	3	2
SET # 9	3	1	2
SET # 1Ø	3	1	2
SET # 11	2	3	1
SET # 12	2	3	1
SET # 13	3	2	1
SET # 14	2	3	1
SET # 15	2.5	2.5	1
SET # 16	3	2	1
SET # 17	3	2	1
SET # 18	2	3	1
TOTALS	39.5	42.5	26

```
STATISTICS FOR SAMPLE RUN


THE VALUE XR↑2 FOR COMPARISON TO CHI SQ. IS =  8.58
DEGREES OF FREEDOM SHOULD BE  2

DONE
```

CONTRIBUTED PROGRAM **BASIC**

STAT3
36053

TITLE: SPEARMAN RANK CORRELATION COEFFICIENTS

DESCRIPTION: This program computes the Spearman rank correlation coefficient for two series of data.

INSTRUCTIONS: Enter data beginning in line 9900 in the following manner: the first input N, the number of data pairs; then enter the data in pairs. For example:

9900 DATA N, X_1, Y_1, X_2, Y_2,...., X_n, Y_n

where: N = the number of data pairs, such as X_k, Y_k, that are to be entered < 100.

X_k = the value of the X variable of the kth pair of data

Y_k = the value of the Y variable of the kth pair of data

If the number of data pairs is greater than 100 make the following change:

9003 DIM A(N), B(N)

where N = the number of data pairs.

SPECIAL CONSIDERATIONS:

Variables used: D, D1, D2, N, P, Q, R, S, S1, S2, S3, T, X, Y, Z

A, B are array names

I, J, K are used for internal looping

ACKNOWLEDGEMENTS:

RUN

```
GET-$STAT3
9900 DATA 5,480,56,500,61,520,78,540,71,560,82
RUN
STAT3
SPEARMAN RANK CORRELATION COEFFICIENT
  R =   .9
DONE
```

CONTRIBUTED PROGRAM **BASIC**

T-2TEST
T-TEST
36170

TITLE: TEST OF HYPOTHESES USING STUDENTS T DISTRIBUTION

DESCRIPTION:

This program calculates the mean and standard deviation for each of two samples. The program compares the two means using the assumption of equal variance, unequal variance or pairing of data as desired. The comparison of a single sample to a desired or target value is provided for.

INSTRUCTIONS:

Enter data beginning in line 9900 entering Q, the option desired, N1, the number of observations in sample 1, and N2, the number of observation in Sample 2. In lines 9901, and in the following lines, insert the observations in the sample.

For example:

```
9900 DATA Q; N1,N2
9901 DATA X(1),X(2),X(3). . . . X(N1)
9902 DATA Y(1),Y(2),Y(3). . . . Y(N2)
```

Option Code Q: 1 = Compare Means, Assume Equal Variance
2 = Compare Means, Assume Unequal Variance
3 = Pair Observations, Test Difference Between Pairs = Ø

NOTE: To test a sample against a desired value set N2=1 and insert the desired value for the single observation in set 2.

SPECIAL CONSIDERATIONS:

Variables not used in this program are:

C,E,H,J,K,L,O,R,U,V: and W.

I is used for internal looping

ACKNOWLEDGEMENTS:

J. L. Mulcahy
Raychem Corporation

I. COMPARISON OF TWO SAMPLES ASSUMING EQUAL VARIANCE

Problem From DIXON And MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS 2nd Ed., McGraw-Hill, Page 122

TYPE A:	31	34	29	26	32	35	38	34	30	29	32	31
TYPE B:	26	24	28	29	30	29	32	26	31	29	32	28

RUN

```
9900  DATA 1,12,12
9901  DATA 31,34,29,26,32,35,38,34,30,29,32,31
9902  DATA 26,24,28,29,30,29,32,26,31,29,32,28
9999  END

RUN
T-TEST

SAMPLE          SAMPLE SIZE    MEAN           STANDARD DEVIATION
 1               12              31.75          3.19446
 2               12              28.6667        2.46182

 THE POOLED DEVIATION IS 2.85176    AND THE STUDENTS T
VALUE IS 2.64839    AT 22    DEGREES OF FREEDOM.

PROBABILITY OF T>= TO 2.64839    WITH 22    DEGREES OF FREEDOM
IS 7.33960E-03

DONE
```

II. COMPARISON OF TWO SAMPLES, UNEQUAL VARIANCE

Problem From NATRELLA, EXPERIMENTAL STATISTICS; NBS Handbook 91, Page 3-26

A	B
3128	1939
3219	1697
3244	3030
3073	2424
	2020
	2909
	1815
	2020
	2310

```
T-TEST

9900  DATA 2,4,9
9901  DATA 3128,3219,3244,3073
9902  DATA 1939,1697,3030,2424,2020,2909,1815,2020,2310
9999  END
RUN
T-TEST

SAMPLE          SAMPLE SIZE    MEAN            STANDARD DEVIATION
 1               4              3166            79.5655
 2               9              2240.44         470.81

 THE STUDENTS T VALUE IS 5.71682    AT 9.23372    DEGREES OF FREEDOM.

PROBABILITY OF T>= TO 5.71682    WITH 9.23372    DEGREES OF FREEDOM
IS .00025

DONE
```

III. COMPARISON OF TWO SAMPLES USING PAIRED DATA

Problem From DIXON And MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS 2nd Ed.,

	Pair Number									
	1	2	3	4	5	6	7	8	9	10
Boys	28	18	22	27	25	30	21	21	20	27
Girls	19	38	42	25	15	31	22	37	30	24

```
T-TEST

9900  DATA 3,10,10
9901  DATA 28,18,22,27,25,30,21,21,20,27
9902  DATA 19,38,42,25,15,31,22,37,30,24
9999  END
RUN
T-TEST

SAMPLE          SAMPLE SIZE    MEAN            STANDARD DEVIATION
 1               10             23.9            4.01249
 2               10             28.3            8.8198

 THE MEAN DIFFERENCE BETWEEN SETS OF OBSERVATIONS IS-4.4
,THE STANDARD DEVIATION OF THIS DIFFERENCE IS 11.3451
THE STUDENTS T TEST VALUE IS-1.22644    AT 9    D.F.

PROBABILITY OF T>= TO-1.22644    WITH 9    DEGREES OF FREEDOM
IS .12515

DONE
```

IV. COMPARISON OF A SAMPLE TO A STANDARD

Problem From DIXON And MASSEY, INTRODUCTION TO STATISTICAL ANALYSIS 2nd Ed., McGraw-Hill, Pages 117, 118

Sample: 55, 62, 54, 58, 65, 64, 60, 62, 59, 69, 62, 61

Standard: 65

```
T-TEST

9900  DATA 1,12,1
9901  DATA 55,62,54,58,65,64,60,62,59,67,62,61
9902  DATA 65
9999  END


RUN
T-TEST


THE SAMPLE MEAN IS 60.75       ,THE STANDARD DEVIATION IS 3.84057
AND THE T TEST VALUE IS-3.83339    WITH 11   DEGREES
OF FREEDOM WHEN COMPARED WITH A STANDARD OF 65

PROBABILITY OF T>= TO-3.83339    WITH 11   DEGREES OF FREEDOM
IS .0015

DONE
```

CONTRIBUTED PROGRAM **BASIC**

TESTUD
36722

TITLE: TEST UNKNOWN POPULATION MEAN

DESCRIPTION: This program tests an unknown population mean using sample statistics.

INSTRUCTIONS: To use this program simply supply values for the 5 variables N, M, S, W, and X.

where: N = sample size
M = sample mean
S = sample standard deviation
W = population size (0 if infinite)
X = the population mean to be tested

Sample Problem:

Determine the probability that the annual fallout will exceed or equal a critical amount.

During the early stages of a project to develop high-energy fuels for gas turbine engines, the question of liability for damages to agricultural crops in the vicinity of the outdoor test site arose. As the exhaust products were toxic to plant growth if applied in concentrations exceeding about 20 pounds per acre, a sampling experiment was established to measure the fallout at various distances from the test site. The greatest potential liability seemed to be from the farmland located about a mile and a half downwind from the prevailing direction of local winds, since crop losses for any reason would doubtless be blamed on the "poison gases" which the local people were already grumbling about. By annualizing the results from the first eight test runs, a sample of eight readings averaging 13.4 pounds per acre with a standard deviation of 5.1 p.p.a was available for the lawyers' consideration. Their question was simply this: is this evidence sufficient to deny a claim that the fallout actually will equal or exceed the critical value of p.p.a?

Analysis of Result

In terms of the statistical model, we conclude that such sample results as we observed would be extremely rare if the population mean were 20 p.p.a. It seems fairly safe to say that the annual fallout will be less than this critical amount.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
RUN
TESTUD


THIS PROGRAM PERFORMS CALCULATIONS NECESSARY FOR
TESTING AN UNKNOWN POPULATION MEAN USING SAMPLE
STATISTICS. WHAT ARE N (THE SAMPLE SIZE), M (THE
SAMPLE MEAN), S (THE SAMPLE STANDARD DEVIATION),
W (POPULATION SIZE, ZERO IF INFINITE), AND X (THE
POPULATION MEAN TO BE TESTED)?8,13,-.4,5.1,0,20

  BASED ON THE STUDENT'S T-DISTRIBUTION WITH 7
  DEGREES OF FREEDOM, THE PROBABILITY OF FINDING
  A SAMPLE MEAN THIS MUCHLESS THAN THE POPUL-
  ATION MEAN IS  .00085

DONE
```

CONTRIBUTED PROGRAM **BASIC**

TVALUE
36721

TITLE: COMPUTES THE EXACT PROBABILITY OF A T-VALUE WITH A TWO-TAILED TEST

DESCRIPTION: This program computes the exact probability of a T-value with a two-tailed test.

INSTRUCTIONS: The T-value and the degree of freedom must be entered when requested by the program.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Babson College
Babson Park, Massachusetts

RUN

```
RUN
TVALUE

THERE IS A DISCONTINUITY IN THE APPROXIMATION FORMULA USED
IN THIS PROGRAM.  HOWEVER, THIS DISCONTINUITY WILL NOT AFFECT
VALUES IN THE CRITICAL RANGE.

ENTER THE T-VALUE AND THE D. F.
?5,1


EXACT PROBABILITY OF T= 5      (TWO-TAILED TEST) WITH  1      D.F.

    IS  .13185

DONE
```

CONTRIBUTED PROGRAM **BASIC**

UNLETH
36888-18021

TITLE: UNILETH STATISTICS PACKAGE

DESCRIPTION:

A set of related statistical analysis program modules designed for interactive use from a common data base. Package contains modules for: 1. Data Matrix Loading, 2. Factor Analysis, 3. Multiple Descriminant Analysis, 4. Two and Three Factor Analysis of Variance, and 5. Cross Tabulations. Subset of modules is selectable by user by initial commands.

Program names are: MATIN, EDITM, MDRS, CORS, SEVS, VORS, DISCRM, AEVS, DISC2, AVAR23, AVR23+, STRGIN, and COUNTS.

INSTRUCTIONS:

I. MATRIX DATA LOADING

MATIN

This program will transfer numeric data from paper tape or keyboard entry to random access file(s) in matrix form.

Before running the program, open files of sufficient length to accomodate the data. As each row of the matrix requires two records, there must be twice the number of records of file space available as there are rows in the matrix.

For example: If a matrix with 140 rows is to be entered into file, 140 X 2 = 280 records are required. A 2000B file has a maximum of 128 records, thus open two files of 128 records each and one of 24 records (128 X 2 + 24 = 280). NOTE: If more than one file is required then all but the last file must be of length 128 records. Be sure to declare the file(s) into which the data is to be read by:

```
10 FILES  FILE 1, FILE 2, FILE 3, ...
```

As a BASIC program can access only 16 files and each of these may have a maximum of 128 records, the matrix is restricted to 16 X 128/2 = 1024 rows or fewer. As each row takes up 2 records, the number of columns is restricted to 32 X 2 = 64.

INSTRUCTIONS: Continued On Next Page.

SPECIAL CONSIDERATIONS:

These programs are written for use on an HP 2000B. HP 2000C/F users should open files limited to 64 words per record; e.g., OPE-FILE 1, 128, 64. Limitations -- Number of variables = number of columns of data matrix $\leqslant$ 64. Number of subjects limited only by file space.

The major reference for this package is "Fortran Programming for the Behavioral Sciences" by D.J. Veldman published by Holt, Rinehart and Winston in 1967. Most of the programs are BASIC translations of the FORTRAN routines presented in this text (slight modifications were made where deemed necessary; these are noted in the individual program documentation).

ACKNOWLEDGEMENTS:

Warren Nelson
University of Lethbridge

INSTRUCTIONS: Continued

If data is to be read in from paper tape:

1. Each data item on a line is to be separated from the next item by a comma.
2. An X-OFF character must appear at the end of each line.
3. Each row of the matrix must begin on a new line.
4. A row of the matrix may take more than one line.
5. No line should end in a comma.

EXAMPLE: To input the following matrix of 4 rows and 5 columns:

Row #1	1	2	3	4	5
Row #2	6	7	8	9	10
Row #3	11	12	13	14	15
Row #4	16	17	18	19	20

The data tape may appear as:

```
1, 2, 3 (X-OFF)
4, 5 (X-OFF)
6, 7, 8, 9, 10 (X-OFF)
11, 12, 13, 14 (X-OFF)
15 (X-OFF)
16, 17, 18, 19, 20 (X-OFF)
```

EDITM

This program will edit data stored by MATIN or a similar routine. Data may be listed, changed, added, deleted, or dumped to paper tape.

Before running, declare the files of data by:

```
10 FILES    FILE 1, FILE 2, FILE 3, ...
```

If data is to be added, then additional space must be opened and declared. Two records must be opened for each row added.

COMMAND	FUNCTION
LIST	Causes listing of a specified portion of the matrix.
CHANGE	Allows one row of data to be changed.
ADD	Allows one row to be inserted into the matrix.
DELETE	Causes a specified row to be deleted from the matrix.
DUMP	Causes the matrix to be output onto paper tape in a form acceptable to MATIN.

INSTRUCTIONS: Continued

II. FACTOR ANALYSIS

CODING OF DATA

The general form of the data is a matrix with NS rows and NV columns (where NS is the number of subjects and NV is the number of variables). Missing data must be coded with a constant that is not a valid observation (e.g., 999); blanks are not an acceptable means of indicating missing data as the BASIC language ignores these. As the data is to be entered by the program MATIN, the data tape must conform to the standards as given.

RUNNING THE FACTOR ANALYSIS CHAIN

The factor analysis chain requires a number of standard files to be opened before running. Do this by typing:

OPEN-CORR,128
OPEN-CORR1,128
OPEN-VEC,128
OPEN-S,128 (Required only if there is missing data.)

FACTOR ANALYSIS CHAIN

This chain consists of 4 separate BASIC programs linked together by the chain command. As well as the mean and standard deviation of each variable, the correlation matrix, the trace of the correlation matrix, eigenroots, percentage of total variance for each component, the unrotated principal axis factor loadings, percentage of total variance for each factor, the percentage of variance of each variable extracted and the V load matrix is output.

The number of variables is restricted to 64 or fewer.
The number of subjects is restricted to 768 or fewer.

CORS

This program is one of two alternative programs in the factor analysis chain. CORS computes means, sigmas and intercorrelations from data stored in file by MATIN or a similar routine; no missing data is allowed.

MDRS

This program is one of two alternative programs in the factor analysis chain. MDRS computes means, sigmas and intercorrelations from data stored in file by MATIN or a similar routine; missing data is allowed.

SEVS

This program, the third in the factor analysis chain, extracts eigenroots and denormal vectors from a symmetric matrix.

The logic of this program has been changed slightly from that given by Veldman. Instead of a fixed number of iterations (25) to compute an eigen vector, the iteration will continue until 59 is less than .0001.

$$S9 = \sqrt{\sum_{i=1}^{NV} (U_i - V_i)^2}$$

Where U and V are successive vectors. This method will eliminate unnecessary calculations and will also increase accuracy.

VORS

This program, the fourth in the factor analysis chain, does orthogonal Verimax rotation of factor axes.

INSTRUCTIONS: Continued

MEANS, STANDARD DEVIATIONS AND CORRELATIONS (CORS OR MDRS)

A. No Missing Data Allowed.

a. Mean $\mu_j = \frac{\Sigma X_{kj}}{N}$

b. Standard Deviation $\sigma_j^2 = \frac{\Sigma X^2_{kj}}{N} - \mu_j^2$

c. Correlation $r_{ij} = \frac{\Sigma X_{ki} X_{kj}/N - \mu_i \mu_j}{\sigma_i \sigma_j}$

B. Missing Data Allowed.

a. Mean $\mu_i = \frac{\Sigma X_{ki}}{N}$

b. Standard Deviation $\sigma_i^2 = \frac{\Sigma X^2_{ki}}{N} - \mu_i^2$

c. Correlation $r_{ij} = \frac{\Sigma X_{ki} Y_{kj}/N_{ij} - \mu_{i(j)} \mu_{j(i)}}{\sigma_{i(j)} \sigma_{j(i)}}$

where

1. $\mu_{i(j)}$ is the mean of the i^{th} variable taken over those subjects with valid data in the j^{th} variable.
2. $\sigma_{i(j)}$ is the standard deviation of the i^{th} variable taken over those subjects with valid data in the j^{th} variable.
3. N_{ij} is the number of subjects with valid data in the i^{th} variable and the j^{th} variable.

EXTRACTION OF EIGENROOTS AND DENORMAL VECTORS (SEVS)

This routine is based upon a procedure originally outlined by Hotelling. If in a given problem M is the number of variables and K is the number of factors extracted, then the trace (T) of the correlation matrix (R) is given by:

$$T = U'_M R_{\Delta M} U_M$$

When all the factors are extracted, the trace will also equal the sum of the eigenvalues (E) thus:

$$T = U'_K E_K \quad \text{when } K = M$$

If K < M the percentage of the variance in R extracted by the K factors is given by:

$$P = U'_K E_K T^{-1} 100$$

If V_{MK} is the matrix of factor loadings:

$$E_{\Delta K} = V'_{KM} V_{MK}$$

The column vectors of V may be normalized by:

$$F_{MK} = V_{MK} E_{\Delta K}^{-1/2}$$

INSTRUCTIONS: Continued

If all M possible factors are extracted from R then:

$$R_{MM}V_{MK} = V_{MK}E_{\Delta K}$$

and

$$R_{MM}F_{MK} = F_{MK}E_{\Delta K}$$

If K < M then the outer products of V and F may only approximate R:

$$\hat{R}_{MM} = V_{MK}V'_{KM} = F_{MK}E_{\Delta K}F'_{KM}$$

As recommended by R. Kaiser only those eigenvalues exceeding 1.0 are retained. Unlike Veldman's version which utilizes a fixed number iterations to obtain the eigenvectors, this program requires the square root of the sum of the squares of the differences of successive vectors be less than .0001.

VARIMAX ROTATION OF FACTOR AXES (VORS)

The computational procedure used was derived from a formula suggested by Kaiser.

$$Y_{NK} = Z_{NM}V_{MK}E^{-2}_{\Delta K}V'_{KM}W_{MK}$$

where
V is a matrix of unrotated loadings.
E is a diagonal matrix of roots.
W is the Varimax rotated matrix of loadings.

III. MULTIPLE DISCRIMINANT ANALYSIS

CODING OF DATA

The general form of the data is a matrix with NS rows and NV columns (where NS is the number of subjects and NV is the number of variables). No missing data is allowed. As the data is to be entered by the program MATIN, the data tape must conform to the standards as given in that program's documentation.

RUNNING THE MULTIPLE DISCRIMINANT ANALYSIS CHAIN

The multiple discriminant analysis chain requires a number of standard files to be opened before running. Do this by typing:

```
OPEN-A,128
OPEN-W,128
OPEN-C,128
OPEN-S,128
```

MULTIPLE DISCRIMINANT ANALYSIS CHAIN

This chain consists of 3 separate BASIC programs linked together by the chain command. The general procedure is based on "Multivariate Procedures for the Behavioral Sciences" by W.W. Cooley and P.R. Lohnes with major modifications by Veldman. The direct factoring of $W^{-1}A$ and the internal computation of correlations between original variables and discriminant functions are the responsibility of Veldman. Discriminant score weights are followed by the correlations between the original variables and discriminant functions. Wilks' Lambda is computed and tested for significance. Chi-square tests are performed for each discriminant function. Group centroids and univariate analysis of variance are calculated for the original variables.

The number of subjects is restricted to 768 or fewer.
The number of variables is restricted to 64 or fewer.

DISCRM

This program, the first of three in the Multiple Discriminant Analysis Chain, reads the raw data from file, accumulates sums and cross products, and computes covariance.

INSTRUCTIONS: Continued

AEVS

This program, the second of three in the Multiple Discriminant Analysis Chain, extracts roots and vectors from a square asymmetric matrix.

This routine is much like the program SEVS included in the Factor Analysis Chain, except that both "right" and "left" eigenvectors are extracted and their outer product is used to deflate the A matrix after extraction of each root.

DISC2

This program, the last of three in the Multiple Discriminant Analysis Chain, computes discriminant-score weights, correlations of discriminant and original variables, Wilks' Lambda, F-ratio and probability as well as performing chi-square tests and univariate analysis of variance.

For each group of subjects the matrices P, T and W are formed from the raw scores X by:

$P_{MM} = X'_{MN}X_{NM}$ raw cross products

$T_M = X'_{MN}U_N$ raw sums

$W_{MM} = P_{MM} - T_M T'_M N^{-1}$ deviation cross products

where: N = the number of subjects in the group
M = the number of variables.

These matrices and the total N are accumulated over all groups and the following matrices are developed:

$C_{MM} = N^{-1}(P_{MM} - T_M T'_N N^{-1})$ covariance matrix

$A_{MM} = NC_{MM} - W_{MM}$ among-groups matrix

where P, T, W and N refer to the accumulated matrices.

Note that even though W^{-1} and A are symmetric matrices, $W^{-1}A$ is not and thus cannot be factored by the method used in the factor analysis chain.

IV. DOUBLE OR TRIPLE FACTOR ANALYSIS OF VARIANCE

CODING OF DATA

The general form of the data is a matrix with NS rows and NV columns (where NS is the number of subjects and NV is the number of variables). Missing data must be coded with a constant that is not a valid observation (e.g., 999); blanks are not an acceptable means of indicating missing data as the BASIC language ignores these. As the data is to be entered by the program MATIN, the data tape must conform to the standards as given.

RUNNING DOUBLE OR TRIPLE FACTOR ANALYSIS OF VARIANCE

Double or triple factor analysis of variance requires a number of standard files to be opened before running. Do this by typing:

```
OPEN-M,128
OPEN-L,128
OPEN-SX,128
OPEN-G,128
```

DOUBLE OR TRIPLE FACTOR ANALYSIS OF VARIANCE

This chain of two separate BASIC programs extends single classification analysis of variance to permit classification of subjects into "levels" on two or three independent variables simultaneously. Tests of significance are computed for each of the two or three "factors" as well as for their interactive effect upon the dependent variable.

INSTRUCTIONS: Continued

The number of subjects is restricted to 768 or fewer.

The method used is outlined by B.J. Winer in "Statistical Principles in Experimental Design" published in 1962 by McGraw-Hill. This method, unlike the usual routines, allows unequal numbers of subjects to be used in each cell of the design.

AVAR23

This program, the first of two in the Double or Triple Factor Analysis of Variance Chain, reads the raw data from file and computes cell variances and means as well as the number of valid observations for each variable.

"FORTRAN Programming for the Behavioral Sciences" by D.J. Veldman is the reference.

AVR23+

This program, the second in the Double or Triple Factor Analysis of Variance Chain, computes analysis of cell means, F-ratio and produces a source table and relevant cell means. The same reference is used as in AVAR23.

V. CROSS TABULATIONS

STRGIN

This program will transfer string data from paper tape to sequential file(s).

Before running the program declare the files into which the data is to be read by:

```
10 FILES    FILE 1, FILE 2, ...
```

in the order they are to be filled. Make certain that there is sufficient file space to contain all the data and that an X-OFF character ends each line of the paper tape. A string containing "EOT" as the first three letters will cause program completion.

The characters "Control Q", "Control Shift N", and "Control Shift O" are special control characters and should be avoided.

COUNTS

This program is designed to simulate the counting function of a card sorter. String data is read from file(s) and counts are performed on columns specified by the user. In addition, the user has the option of distribution(s) on:

1. Single columns
2. Two columns simultaneously
3. Three columns simultaneously

Before running, declare the files of data by:

```
10 FILES    FILE 1, FILE 2, ...
```

Make certain the files are ordered correctly (i.e., in such a manner that the last string of the last file begins with the letters EOT as this will cause completion of the count).

The maximum number of strings of data is limited to 99,999 while the maximum number of strings with a specific character in a given column is limited to 9,999.

RUN

I. MATRIX DATA LOADING

```
OPE-A,128
OPE-W,128
OPE-C,128
OPE-S,128

OPE-INPT,128
GET-MATIN
RUN\
10 FILES INPT
RUN
MATIN

HAVE YOU ENTERED THE FILES STATEMENT?YES
HOW MANY ROWS ARE THERE?16
HOW MANY COLUMNS ARE THERE?8

PLEASE MOUNT DATA TAPE AND MOVE READER CONTROL LEVER TO
START.

ROW # 1
?25,21,22,20,26,261←,19,23

ROW # 2
?260,30,30,26,28,20,24,28

ROW # 3
?20,25,20,23,18,24,21,29

ROW # 4
?30,28,29,29,28,23,28,30

ROW # 5
?23,25,29,19,20,27,28,28

ROW # 6
?28,27,30,22,19,25,30,26

ROW # 7
?28,24,27,27,17,21,30,26

ROW # 8
?25,29,29,27,26,25,26,25

ROW # 9
?26,30,30,24,29,24,14,29

ROW # 10
?28,29,30,26,25,28,30,28

ROW # 11
?24,28,30,29,27,23,21,28

ROW # 12
?26,29,26,27,28,19,30,27

ROW # 13
?30,27,26,24,25,21,28,25

ROW # 14
?29,29,29,28,25,19,30,27

ROW # 15
?29,25,28,26,24,21,30,29

ROW # 16
?29,26,30,20,25,20,30,28


MATRIX ENTERED INTO FILE(S).

DONE
```

```
GET-EDITM
10 FILES1← INPT
RUN
EDITM

HOW MANY ROWS ARE THE IN THE MATRIX?16
HOW MANY COLUMNS?8
DO YOU WISH A LISTING OF THE COMMANDS?YES

          COMMAND   FUNCTION

          ...............................................
          LIST      CAUSES A LISING OF SPECIFIED ROWS OF THE MATRIX

          CHANGE    ALLOWS ONE ROW OF DATA TO BE CHANGED

          ADD       ALLOWS ONE ROW TO BE INSERTED INTO THE MATRIX

          DELETE    CAUSES A SPECIFIED ROW TO BE DELETED

          DUMP      CAUSES THE MATRIX TO BE OUTPUT ONTO PAPER
                    TAPE IN A FORM ACCEPTABLE TO 'MATIN'
COMMAND?LIST
FROM WHICH ROW TO WHICH ROW DO YOU WANT LISTED (EG.4,6)?2,2

ROW # 2
 260            30              30              26              28
 20             24              28
MORE EDITING?YES
COMMAND?CHANGE
WHICH ROW DO YOU WISH TO CHANGE?2
PRESENT STATUS OF ROW 2

 260            30              30              26              28
 20             24              28
DO YOU STILL WISH TO CHANGE THE ROW?YES
INPUT NEW DATA (EG. 3,4,5,6,7)

?26,30,30,26,28,20,24,28
MORE EDITING?NO

DONE
```

II. FACTOR ANALYSIS

```
OPE-CORR,128
OPE-C←VEC,128
OPE-CORR1,128

GET-CORS
120 FILES INPT
RUN
CORS

HOW MANY SUBJECTS ARE THERE?16
HOW MANY VARIABLES ARE THERE?8
MAXIMUM NUMBER OF FACTORS?3
MEANS

 26.625         27              27.8125         24.8125         24.375
 22.875         26.1875         27.25

SIGMAS

 2.6897         2.4238          2.9202          3.1269          3.6891
 2.7585         4.8117          1.7854
```

CORRELATION MATRIX

1	.1821	.4685	.2666	.2409	-.3938	.556	-.0325
.1821	1	.6181	.5525	.5452	-.215	.0161	.39
.4685	.6181	1	.2631	.3198	-.0495	.2694	.3087
.2666	.5525	.2631	1	.3529	-.3723	.1394	.2547
.2409	.5452	.3198	.3529	1	-.2104	-.3032	.1091
-.3938	-.215	-.0495	-.3723	-.2104	1	-.2808	-.1079
.556	.0161	.2694	.1394	-.3032	-.2808	1	-.0127
-.0325	.39	.3087	.2547	.1091	-.1079	-.0127	1

PRINCIPAL AXIS ANALYSIS OF CORRELATION MATRIX

TRACE = 8

70.57 PCT OF TRACE WAS EXTRACTED BY 3 ROOTS

EIGENROOTS

1	2	3	4	5
2.9197	1.662	1.0637		

PCT OF TOT VAR FROM EACH COMPONENT

1	2	3	4	5
36.5	20.8	13.3		

UNROTATED PRINCIPAL AXIS FACTOR LOADINGS

1	2	3	4	5
.6125	-.5974	-.0757		
.8054	.3802	.1163		
.7276	-.0058	.4891		
.701	.0999	-.2479		
.5851	.4818	-.3937		
-.5045	.3246	.5502		
.3156	-.8384	.2481		
.4228	.3318	.4737		

VARIMAX ROTATION ANALYSIS

PCT. OF TOT. VAR. FROM EACH FACTOR

1	2	3	4	5
24.548	23.688	22.3313		

PCT. OF VAR OF EACH VARIABLE EXTRACTED

1	2	3	4	5
73.77	80.67	76.87	56.28	72.95
66.26	86.42	51.33		

V LOAD

1	2	3	4	5
.3032	-.7969	.104		
.5719	-.015	.6924		
.1591	-.354	.7861		
.672	-.1966	.2692		
.7976	.2069	.2247		
-.628	.4722	.2127		
-.185	-.9073	.0815		
.0554	.0825	.7095		

```
DONE
KIL-INPT
KIL-CORR
KIL-VEC
KIL-CORR1
```

III. MULTIPLE DISCRIMINANT ANALYSIS

```
OPE-A,128
OPE-W,128
OPE-C,128
OPE-S,128

OPE-INPT,128
GET-MATIN
10 FILES INPT
RUN
MATIN

HAVE YOU ENTERED THE FILES STATEMENT?YES
HOW MANY ROWS ARE THERE?16
HOW MANY COLUMNS ARE THERE?8

PLEASE MOUNT DATA TAPE AND MOVE READER CONTROL LEVER TO
START.

ROW # 1
?25,21,22,20,26,26,19,23

ROW # 2
?20,25,20,23,18,24,21,29

ROW # 3
?26,30,30,26,28,20,24,28
```

```
ROW # 4
?30,28,29,29,28,23,28,30

ROW # 5
?25,29,29,27,262-,25,26,25

ROW # 6
?2
  26,30,30,24,29,24,14,29

ROW # 7
?28,29,30,26,25,28,30,28

ROW # 8
?24,28,30,29,27,23,21,28

ROW # 9
?26,29,26,27,28,19,30,27

ROW # 10
?30,27,26,24,25,21,28,25

ROW # 11
?29,29,29,28,25,19,30,27

ROW # 12
?29,25,28,26,24,21,30,29

ROW # 13
?29,26,30,20,25,20,30,28

ROW # 14
?23,25,29,19,20,27,28,28

ROW # 15
?28,27,30,22,19,25,30,26

ROW # 16
?28,24,27,27,17,21,30,26


MATRIX ENTERED INTO FILE(S).

DONE

GET-EDITM
10 FILES INPT
RUN
EDITM

HOW MANY ROWS ARE THE IN THE MATRIX?16
HOW MANY COLUMNS?8
DO YOU WISH A LISTING OF THE COMMANDS?YES

          COMMAND   FUNCTION

          ..................................................
          LIST      CAUSES A LISING OF SPECIFIED ROWS OF THE MATRIX

          CHANGE    ALLOWS ONE ROW OF DATA TO BE CHANGED

          ADD       ALLOWS ONE ROW TO BE INSERTED INTO THE MATRIX

          DELETE    CAUSES A SPECIFIED ROW TO BE DELETED

          DUMP      CAUSES THE MATRIX TO BE OUTPUT ONTO PAPER
                    TAPE IN A FORM ACCEPTABLE TO 'MATIN'
COMMAND?CHANGE
WHICH ROW DO YOU WISH TO CHANGE?6
PRESENT STATUS OF ROW 6

 226            30              30              24              29
 24             14              29
DO YOU STILL WISH TO CHANGE THE ROW?YES
INPUT NEW DATA (EG. 3,4,5,6,7)
```

```
?26,30,30,24,29,24,14,29
MORE EDITING?YES
COMMAND?LIST
FROM WHICH ROW TO WHICH ROW DO YOU WANT LISTED (EG.4,6)?9,9

ROW # 9
 26             29             26             27             28
 19             30             27
MORE EDITING?NO

DONE


GET-DISCRM
70 FILES INPT
RUN
DISCRM

NUMBER OF VARIABLES?8


NUMBER OF GROUPS?3


NUMBER OF SUBJECTS IN GROUP 1     ?2


NUMBER OF SUBJECTS IN GROUP 2     ?11


NUMBER OF SUBJECTS IN GROUP 3     ?3




TRACE = 14.2885


 100  PCT. OF TRACE EXTRACED BY 2    ROOTS.

WILKS LAMBDA = .019

D.F. =  16    AND  12

F-RATIO = 4.665

P = .0055

ROOT          % VARIANCE     CHI-SQUARE     D.F.        P

 1              76.37         26.014        9          .0026
 2              23.63         15.501        7          .0306


CENT.
 38.708         12.3233

 51.6327        10.9154

 47.3464        5.6343
```

```
COREL

 .6235          -.0843

 .7825           .2026

 .8591          -.3633

 .5501           .2559

 .5551           .7362

-.4058          -.2013

 .3773          -.4533

 .3388           .104

UNIVARIATE F-TESTS D.R.B.=  2     DFW=  13

VARIABLE      F-RATIO        P
 1             3.6817       .0531
 2             9.4527       .0032
 3             22.7661      .0002
 4             3.1689       .0746
 5             15.2046      .0006
 6             1.4474       .2703
 7             2.6416       .1078
 8             .8323        .5398

MEAN

 1             2             3

 22.5          27.4545       26.3333
 23            28.1818       25.3333
 21            28.8182       28.6667
 21.5          26            22.6667
 22            26.3636       18.6667
 25            22.0909       24.3333
 20            26.4545       29.3333
 26            27.6364       26.6667

DONE

KIL-A
KIL-W
KIL-C
KIL-S
KIL-INPT
```

IV. DOUBLE OR TRIPLE FACTOR ANALYSIS OF VARIANCE

```
OPE-M,128
OPE-L,128
OPE-G,128
OPE-SX,128
OPE-INPT,128
10 FILES INPT
GET-MATIN
10 FILES INPT
RUN
MATIN
```

```
HAVE YOU ENTERED THE FILES STATEMENT?YES
HOW MANY ROWS ARE THERE?13
HOW MANY COLUMNS ARE THERE?1

PLEASE MOUNT DATA TAPE AND MOVE READER CONTROL LEVER TO
START.

ROW # 1
?30

ROW # 2
?28

ROW # 3
?25

ROW # 4
?27

ROW # 5
?2

ROW # 6
?29

ROW # 7
?29

ROW # 8
?28

ROW # 9
?29

ROW # 10
?27

ROW # 11
?29

ROW # 12
?25

ROW # 13
?26

MATRIX ENTERED INTO FILE(S).

DONE


GET-EDT-ITM
10 FILES INPT
RUN
EDITM

HOW MANY ROWS ARE THE IN THE MATRIX?13
HOW MANY COLUMNS?1
DO YOU WISH A LISTING OF THE COMMANDS?YES

          COMMAND   FUNCTION

          ....................................................
          LIST      CAUSES A LISING OF SPECIFIED ROWS OF THE MATRIX

          CHANGE    ALLOWS ONE ROW OF DATA TO BE CHANGED

          ADD       ALLOWS ONE ROW TO BE INSERTED INTO THE MATRIX

          DELETE    CAUSES A SPECIFIED ROW TO BE DELETED

          DUMP      CAUSES THE MATRIX TO BE OUTPUT ONTO PAPER
                    TAPE IN A FORM ACCEPTABLE TO 'MATIN'
```

```
COMMAND?CHANGE
WHICH ROW DO YOU WISH TO CHANGE?5
PRESENT STATUS OF ROW 5

 2              DO YOU STILL WISH TO CHANGE THE ROW?YES
INPUT NEW DATA (EG. 3,4,5,6,7)

?24
MORE EDITING?NO

DONE


GET-AVAR23
80 FILES INPT
RUN
AVAR23

NUMBER OF DEPENDENT VARIABLES?1
NUMBER OF LEVELS FOR THE A FACTOR?2
NUMBER OF LEVELS FOR THE B FACTOR?2
NUMBER OF LEVELS FOR THE C FACTOR?1
NUMBER OF SUBJECTS PER ABC CELL?9999
MISSING DATA CODED WITH WHAT NUMBER?-999
NUMBER OF SUBJECTS IN GROUP 1     ?2
NUMBER OF SUBJECTS IN GROUP 2     ?4
NUMBER OF SUBJECTS IN GROUP 3     ?3
NUMBER OF SUBJECTS IN GROUP 4     ?4



ANALYSIS OF VARIABLE 1
```

SOURCE	M.S.	D.F.	F-RATIO	P
TOTAL	3.587	12		
BETWEEN	5.625	3		
A	.022	1	.0076	.9302
B	16.334	1	5.6183	.0403
AB	.519	1	.1784	.6842
WITHIN	2.907	9		

```
MEANS FOR ALL EFFECTS.

A MAIN

 27.625         27.7083


B MAIN

 28.8333        26.5


A BY B

ROW # 1
 29             26.25

ROW # 2
 28.6667        26.75

SUBJECTS PER CELL. BLOCKS =C LEVELS.

  AB

 ROW #   1
 2              4
 ROW #   2
 3              4
```

```
DONE
KIL-INPT
KIL-M
KIL-L
KIL-SX
KIL-G




OPE-INPT,128
OPE-M,128
OPE-L,128
OPE-SX,128
OPE-G,128

GET-MATIN
RUN
MATIN

HAVE YOU ENTERED THE FILES STATEMENT?NO
THIS PROGRAM REQUIRES THE ENTERING OF A FILES STA.EMENT
BEFORE RUNNING; PLEASE CHECK THE PROGRAM DOCUMENTATION.

DONE
10 FILES INPT
RUN
MATIN

HAVE YOU ENTERED THE FILES STATEMENT?YES
HOW MANY ROWS ARE THERE?16
HOW MANY COLUMNS ARE THERE?2

PLEASE MOUNT DATA TAPE AND MOVE READER CONTROL LEVER TO
START.

ROW # 1
?25   ,-999

ROW # 2
?26   , 30

ROW # 3
?20   ,-999

ROW # 4
?30   ,28

ROW # 5
?23   , 25

ROW # 6
?28   , 27

ROW # 7
?28   , 24

ROW # 8
?25   , 29

ROW # 9
?26   ,-999

ROW # 10
?28   , 29

ROW # 11
?24   , 28

ROW # 12
?26   , 29

ROW # 13
?30   , 27
```

```
ROW # 14
?29    , 29

ROW # 15
?29    , 29

ROW # 16
?29    , 26


MATRIX ENTERED INTO FILE(S).

DONE

GET-EDITM
10 FILES INPT
RUN
EDITM

HOW MANY ROWS ARE THE IN THE MATRIX?16
HOW MANY COLUMNS?2
DO YOU WISH A LISTING OF THE COMMANDS?YES

           COMMAND   FUNCTION

           .................................................
           LIST      CAUSES A LISING OF SPECIFIED ROWS OF THE MATRIX

           CHANGE    ALLOWS ONE ROW OF DATA TO BE CHANGED

           ADD       ALLOWS ONE ROW TO BE INSERTED INTO THE MATRIX

           DELETE.   CAUSES A SPECIFIED ROW TO BE DELETED

           DUMP      CAUSES THE MATRIX TO BE OUTPUT ONTO PAPER
                     TAPE IN A FORM ACCEPTABLE TO 'MATIN'
COMMAND?LIST
FROM WHICH ROW TO WHICH ROW DO YOU WANT LISTED (EG.4,6)?1,16

ROW # 1
 25            -999

ROW # 2
 26             30

ROW # 3
 20            -999

ROW # 4
 30             28

ROW # 5
 23             25

ROW # 6
 28             27

ROW # 7
 28             24

ROW # 8
 25             29

ROW # 9
 26            -999

ROW # 10
 28             29

ROW # 11
 24             28

ROW # 12
 26             29

ROW # 13
 30             27
```

```
ROW # 14
 29              29

ROW # 15
 29              29

ROW # 16
 29              26
MORE EDITING?YES
COMMAND?DUMP
TURN ON TAPE PUNCH AND PRESS 'HERE IS' FOR LEADER
 25    ,-999
 26    , 30
 20    ,-999
 30    , 28
 23    , 25
 28    , 27
 28    , 24
 25    , 29
 26    ,-999
 28    , 29
 24    , 28
 26    , 29
 30    , 27
 29    , 29
 29    , 29
 29    , 26
MORE EDITING?YES
COMMAND?CHANGE
WHICH ROW DO YOU WISH TO CHANGE?15
PRESENT STATUS OF ROW 15

 29              29              DO YOU STILL WISH TO CHANGE THE ROW?YES
INPUT NEW DATA (EG. 3,4,5,6,7)

?29   , 25
MORE EDITING?NO

DONE



GET-AVAR23
80 FILES INPT
RUN
AVAR23

NUMBER OF DEPENDENT VARIABLES?2
NUMBER OF LEVELS FOR THE A FACTOR?2
NUMBER OF LEVELS FOR THE B FACTOR?2
NUMBER OF LEVELS FOR THE C FACTOR?2
NUMBER OF SUBJECTS PER ABC CELL?2
MISSING DATA CODED WITH WHAT NUMBER?-999
```

ANALYSIS OF VARIABLE 1

SOURCE	M.S.	D.F.	F-RATIO	P
TOTAL	7.717	15		
BETWEEN	6.25	7		
A	16.	1	1.7778	.2177
B	16.	1	1.7778	.2177
C	1.	1	.1111	.745
AB	6.25	1	.6944	.5667
AC	2.25	1	.25	.6342
BC	2.25	1	.25	.6342
ABC	0	1	0	1
WITHIN	9	8		

MEANS FOR ALL EFFECTS.

A MAIN

25.625 27.625

B MAIN

25.625 27.625

C MAIN

26.875 26.375

A BY B

ROW # 1
25.25 26

ROW # 2
26 29.25

A BY C

ROW # 1

25.5 25.75
ROW # 2

28.25 27

B BY C

ROW # 1
26.25 25
ROW # 2
27.5 27.75

CELL MEANS BLOCKS = C LEVELS.

AB

ROW # 1
25.5 25.5
ROW # 2
27 29.5

AB

ROW # 1
25 26.5
ROW # 2
25 29

SUBJECTS PER CELL. BLOCKS =C LEVELS.

AB

ROW # 1
2 2
ROW # 2
2 2

AB

ROW # 1
2 2
ROW # 2
2 2

ANALYSIS OF VARIABLE 2

SOURCE	M.S.	D.F.	F-RATIO	P
TOTAL	3.515	12		
BETWEEN	3.526	7		
A	.045	1	.013	.9098
B	16.409	1	4.6883	.0815
C	3.682	1	1.0519	.3538
AB	.409	1	.1169	.7431
AC	.409	1	.1169	.7431
BC	.045	1	.013	.9098
ABC	3.682	1	1.0519	.3538
WITHIN	3.5	5		

MEANS FOR ALL EFFECTS.

A MAIN

27.625 27.75

B MAIN

28.875 26.5

C MAIN

28.25 27.125

A BY B

ROW # 1
29 26.25

ROW # 2
28.75 26.75

A BY C

ROW # 1

28 27.25
ROW # 2

28.5 27

```
B BY C

ROW # 1
 29.5           28.25
ROW # 2
 27             26


CELL MEANS   BLOCKS = C LEVELS.


AB

ROW # 1
 30             26
ROW # 2
 29             28


AB

ROW # 1
 28             26.5
ROW # 2
 28.5           25.5


SUBJECTS PER CELL. BLOCKS =C LEVELS.

  AB

 ROW #   1
 1              2
 ROW #   2
 1              2


  AB

 ROW #   1
 1              2
 ROW #   2
 2              2


DONE
KIL-INPT
KIL-M
KIL-L
KIL-SC
NO SUCH ENTRY
KIL-SX
KIL-G
```

V. CROSS TABULATIONS

GET-STRGIN

```
10 FILES TEST1,TEST2
RUN
STRGIN

HAVE YOU ENTERED THE FILES STATEMENT ('YES' OR 'NO')?YES
ARE YOU CERTAIN THE FILES ARE IN THE ORDER YOU DESIRE AND
THAT THEY ARE OF SUFFICIENT LENGTH TO ACCOMODATE ALL YOUR DATA
?YES
HOW MANY FILES HAVE YOU DECLARED?2

MOUNT PAPER TAPE AND MOVER TAPE READER CONTROL TO 'START'.
?1234567890
?1234567890
?AAAAAAAAAA
?BBBBBBBBBB
?CCCCCCCCCC
?DDDDDDDDDD
?EEEEEEEEEE
?FFFFFFFFFF
?GGGGGGGGGG
?HHHHHHHHHH
?IIIIIIIIII
?123456789012345
?123456789012345
?ABCDEFGHIJKLMNO
?PQRSTUVWXYZ!#$%
?EOT
?EOT
?EOT
?EOT
?EOT
DATA STORED IN FILE.

DONE
```

GET-COUNTS

```
10 FILES TS←\
10 FILES TEST1,TEST2
RUN
COUNTS

HAVE YOU ENTERED THE FILES STATEMENT ('YES' OR 'NO')?YES
ARE YOU CERTAIN THE FILES ARE NAMED IN THE CORRECT ORDER?YES


HOW MANY FILES OF DATA HAVE YOU USED?2

WHICH OF THE FOLLOWING COUNTS DO YOU WISH
          1. COUNT ON A SINGLE COLUMN
          2. COUNT ON TWO COLUMNS
          3. COUNT ON THREE COLUMNS

TYPE 'SINGLE','TWO' OR 'THREE'?SINGLE
ON HOW MANY COLUMNS DO YOU WISH TO COUNT ?3
WHICH COLUMNS (EG. 1,4,7,10,14,6,34)
?2,6,3


COUNT ON COLUMN  2

CHAR.   1    2    3    4    5    6    7    8    9    0  OTHER  TOT.
.....................................................................

FREQ.   0    4    0    0    0    0    0    0    0    0   11     15

PCT.   0.0 26.7  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0 73.3  100.0
```

COUNT ON COLUMN 6

CHAR.	1	2	3	4	5	6	7	8	9	0	OTHER	TOT.
FREQ.	0	0	0	0	0	4	0	0	0	0	11	15
PCT.	0.0	0.0	0.0	0.0	0.0	26.7	0.0	0.0	0.0	0.0	73.3	100.0

COUNT ON COLUMN 3

CHAR.	1	2	3	4	5	6	7	8	9	0	OTHER	TOT.
FREQ.	0	0	4	0	0	0	0	0	0	0	11	15
PCT.	0.0	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.3	100.0

DO YOU WISH TO DO ANY OTHER COUNTS?YES
PLEASE TYPE 'SINGLE','TWO', OR 'THREE'?TWO
ON WHICH COLUMNS DO YOU WISH TO COUNT (EG. 4,17)?2,5

COL.: COLUMN 5

2 :	1	2	3	4	5	6	7	8	9	0	OTHER	TOTAL
1 :	0	0	0	0	0	0	0	0	0	0	0	0
2 :	0	0	0	0	4	0	0	0	0	0	0	4
3 :	0	0	0	0	0	0	0	0	0	0	0	0
4 :	0	0	0	0	0	0	0	0	0	0	0	0
5 :	0	0	0	0	0	0	0	0	0	0	0	0
6 :	0	0	0	0	0	0	0	0	0	0	0	0
7 :	0	0	0	0	0	0	0	0	0	0	0	0
8 :	0	0	0	0	0	0	0	0	0	0	0	0
9 :	0	0	0	0	0	0	0	0	0	0	0	0
0 :	0	0	0	0	0	0	0	0	0	0	0	0
O :	0	0	0	0	0	0	0	0	0	0	11	11
T :	0	0	0	0	4	0	0	0	0	0	11	15

PERCENTAGE DISTRIBUTION

COL.: COLUMN 5

2 :	1	2	3	4	5	6	7	8	9	0	OTHER	TOTAL
1 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 :	0.0	0.0	0.0	0.0	##.#	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O :	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	##.#	100.0
T :	0.0	0.0	0.0	0.0	26.6	0.0	0.0	0.0	0.0	0.0	73.3	100.0

VOLUME II
CONTENTS (Continued)

500 SCIENTIFIC AND ENGINEERING APPLICATIONS

CONTRIBUTED PROGRAM **BASIC**

ACNODE
36057

TITLE: AC CIRCUIT ANALYSIS PROGRAM

DESCRIPTION: This program computes node voltages by inverting an admittance matrix created from a nodal description of an electronic circuit. Circuit elements allowed include resistors, inductors, transformers, independent current sources, and voltage current sources.

INSTRUCTIONS: Data line numbers 1-999 allowed

Data R$ -- Alpha or numeric designator code
Data M,N, -- # of elements, # of nodes
Data J_5, G_1, G_2,...,G_n -- # of node voltages to be printed out, nodes desired
Data L$, F_1, F_2, S -- Log or Linear frequency step, start frequency, stop frequency, step size or steps/decade
Data-Circuit elements -- statements in any order

Additional information attached.

500

SPECIAL CONSIDERATIONS:

Works with HP 7200A plotter
Limited to 10 nodes (other than ground -- node "0")
Unlimited # of elements
Transformers non-ideal ($.0001 \le k \le .9999$)
Matrix inversion can blow up if all elements connected to a node are lossless and resonant at frequency of interest

ACKNOWLEDGEMENTS: Jim Thomason
Hewlett-Packard/Microwave Division

This program computes node voltages (magnitude and phase), over a given frequency range, from a list of circuit elements. The program gathers the whole circuit into an admittance matrix, based on the element connections and values, and then solves for node voltages at each frequency.

Elements allowed include Resistors, Capacitors, Inductors, Transformers (non-ideal), Independent Current Sources, and Voltage-Dependent Current Sources - (*ACNODE also allows admittance elements).

```
10 DATA R$           where R$ = "A" for alphanumeric
                                element descriptions
                           R$ = "N" for numeric element
                                descriptions

20 DATA M, N         where M  = No. of circuit elements
                           N  = Highest numbered node

30 DATA J,J1,J2,.... where J  = No. of nodes for which
                                output is desired; J1,
                                J2 are the nodes included in J
```

NOTE: J = 0 causes all node voltages to be printed. J1, J2,... are not entered in this case.

```
40 DATA L,F1,F2,S    where L  = "LOG" or "LIN" (1 or 2)
                           F1 = Start frequency
                           F2 = Stop frequency
                           S  = Steps per decade (Log) or
                                frequency increment (Lin)
```

NOTE: Use numeric entry for L where numeric description of circuit elements is used.

NOTE: Frequency increment must be positive.

C. Circuit elements may be entered in any order after the above data is entered. This is possible because all entries are converted to admittance and placed in the circuit admittance matrix according to node numbers.

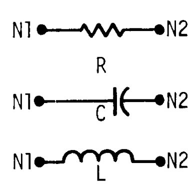
D. Data input form for circuit elements.

RESISTOR

```
100 DATA "R21", N1, N2, X      where N1, N2 are the two
or                             nodes connected to the
100 DATA 1, N1, N2, X          circuit element
                               X = value of the element
                                   (ohms, farads, henries)
```

CAPACITOR

```
100 DATA "CE2", N1, N2, X
or
100 DATA 2, N1, N2, X
```



INDUCTOR

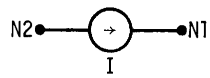
```
100 DATA "L", N1, N2, X
or
100 DATA 5, N1, N2, X
```

INDEPENDENT CURRENT SOURCE

100 DATA "I", N1, N2, X, Y

or

100 DATA 3, N1, N2, X, Y



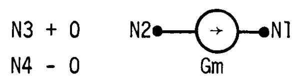
where N1 = "INTO" node
N2 = "OUT OF" node
X = Real part of current (Amps)
Y = Imaginary part of current (Amps)

DEPENDENT CURRENT SOURCE

100 DATA "IV", N1, N2, N3, N4, X

or

100 DATA 4, N1, N2, N3, N4, X



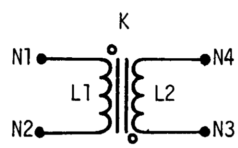
where N1, N2 as above
N3 = Positive control node
N4 = Negative control node
X = Real part of Gm (ohms)

TRANSFORMER

100 DATA "TRF", N1, N2, N3, N4, L1, L2, K

or

100 DATA 7, N1, N2, N3, N4, L1, L2, K



where N1 = Dotted primary node
N2 = Other primary node
N3 = Dotted secondary node
N4 = Other secondary node

<u>NOTE</u>: $0.0001 \leq K \leq 0.9999$
Do <u>not</u> use K=0 or K=1.0

L1 = Primary inductance (Henries)
L2 = Secondary inductance (Henries)
K = Coupling coefficient

PSEUDO VOLTAGE SOURCES

The program does not allow for some useful elements, such as voltage sources or current dependent current sources, but good approximations for these elements are usually possible.

For example, a 1.0 amp current source paralleled with 1.0 ohm makes a reasonable 1.0 volt source for a circuit with input impedance greater than 100 ohms. Also, by putting 1.0 ohm and one extra node in series with the voltage control path, a current-controlled current source may be fashioned.

These values should be fashioned to fit the parameters of the individual circuit. One should be careful to avoid the temptation to use sources such as 1000 amps and .001 ohms = 1.000 volts, because the values may cause resolution errors in the computer.

INPUT AND OUTPUT IMPEDANCE

The impedance looking into any node (from ground) may be found by driving that node with a 1.0 amp current source and removing all other independent sources. The voltage at the driven node will be equal to the impedance looking into the node.

RUNNING THE PROGRAM

A. The data can be merged with the program in several ways.

1) The main program may be loaded into core and then the data entered via the keyboard or punched tape.

2) The data may be stored under a program name. In this case, the data statements should be loaded onto core first and then ACNODE is appended to the data.

For example, suppose the data statements are stored under the name "DATA1". The sequence of commands would be as follows:

```
  (HP)
GET-DATA1
APP-$ACNODE
RUN
```

USING THE HP 7200A PLOTTER

Turn on the plotter and position graph paper before asking for a plot.

The program will ask if you want graphical output and if you respond with (Y), it will ask which quantity (node voltage, dB, or phase) you wish to plot versus frequency. It also asks for the extreme values of that quantity, which will correspond to the top and bottom limits set on the plotter.

As soon as these questions are answered, the plot will begin. The teletype may be muted if desired during the plot, since its output will not normally be meaningful anyway. Disable the muting after the plot is finished to return system control to the teletype.

The horizontal scale, frequency, is plotted in log or linear mode, as requested in the data statement. Be sure that the graph paper you are using corresponds to that scale (i.e., do not use three decade log paper if you have asked for a five decade frequency range).

You may make as many plots or tables (on the terminal) as you like without changing the graph paper (by rerunning the program). The plotter will not respond to anything unless called by the program.

RUN

```
LIST
ACNODE

5  DATA "A"
10  DATA 20,10
20  DATA 3,1,4,10
30  DATA "LOG",1000,1.01E+07,2
40  DATA "I",1,0,1,0
50  DATA "R",1,0,1
60  DATA "R1",1,2,100
70  DATA "REB",2,3,375
80  DATA "RPI",3,5,1625
90  DATA "CPI",3,5,8.3E-11
100  DATA "RMU",3,4,1.4E+07
110  DATA "CMU",3,4,1.5E-12
120  DATA "IVQ1",5,4,3,5,.08
130  DATA "RO",4,5,71000.
140  DATA "R2",5,6,50
150  DATA "R3",6,0,2000
160  DATA "C1",0,6,4.7E-07
170  DATA "TRF1",4,0,7,0,.1,.2,.9999
180  DATA "C2",7,8,.000001
190  DATA "R4",8,0,1000
200  DATA "R5",8,9,1500
210  DATA "C3",9,0,1.E-09
220  DATA "R6",9,10,5000
230  DATA "C4",10,0,3.E-10
STOP

RUN
ACNODE

GRAPHICAL OUTPUT (HP 7200A PLOTTER): (Y OR N)?N
```

NODE	FREQUENCY	VOLTAGE	DB	PHASE
1	1000	.999992	0	0
4	1000	1.21881	1.719	-77.36
10	1000	1.69973	4.608	-69.58
1	3162.28	.999967	0	0
4	3162.28	3.81041	11.619	-113.9
10	3162.28	5.3669	14.594	-114.99
1	10000.	.999908	-.001	0
4	10000.	6.57101	16.353	-153.94
10	10000.	9.14808	19.227	-165.5
1	31622.8	.999887	-.001	0
4	31622.8	6.65723	16.466	179.53
10	31622.8	8.26111	18.341	142.39
1	100000.	.999884	-.001	0
4	100000.	5.34979	14.567	172.54
10	100000.	3.50764	10.9	83.64
1	316228.	.999883	-.001	0
4	316228.	4.65644	13.361	-179.83
10	316228.	.634542	-3.951	33.92
1	1.00000E+06	.999888	-.001	-.01
4	1.00000E+06	4.85668	13.727	-163.75
10	1.00000E+06	7.11578E-02	-22.956	7.15
1	3.16229E+06	.999934	-.001	-.03
4	3.16229E+06	7.93942	17.996	-142.8
10	3.16229E+06	7.64719E-03	-42.33	-11.84
1	1.00000E+07	.998157	-.016	-.14
4	1.00000E+07	26.4475	28.448	167.1
10	1.00000E+07	9.77322E-04	-60.199	-88.04

DONE

CONTRIBUTED PROGRAM **BASIC**

ACTFIL
36293

TITLE: ACTIVE FILTER DESIGN

DESCRIPTION: Designs Butterworth or Tchebyscheff active filters with roll-offs of 12, 24, or 36 db per octave. (48 for Butterworth)

INSTRUCTIONS: The user is asked to enter:

1. Type Butterworth or Tchebyscheff
2. High or low pass
3. Cut-off frequency in hertz
4. Db of attenuation per octave, and
5. The value of C for high pass or R for low pass

If the user wishes a schematic, it is printed out on the graphic display terminal or teletype.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Brian L. Bardsley
Woods Hole Oceanographic Institution

```
RUN
ACTFIL

THIS PROGRAM WILL DESIGN BUTTERWORTH OR TCHEBYSCHEFF ACTIVE
FILTERS WITH A ROLL OFF OF 12,24,36,OR 48 DB PER OCTAVE FOR
BUTTERWORTH OR 12,24,OR 36 DB FOR TCHEBYSCHEFF. IT DOES NOT
ALLOW FOR THE ADDITION OF ANY GAIN IN THE FILTERS
YOU WILL BE REQUIRED TO ENTER THE FOLLOWING INFORMATION:

TCHEBYSCHEFF OR BUTTERWORTH
HIGH OR LOW PASS
CUT-OFF FREQUENCY
DB OF ATTENUATION PER OCTAVÉ
VALUE OF  C  FOR HIGH PASS OR  R  FOR LOW PASS

BE SURE TO PUSH RETURN AFTER EVERY ENTRY

IF YOURE READY,LETS BEGIN


ENTER A  1  FOR TCHEBYSCHEFF,  2  FOR BUTTERWORTH:?2
ENTER  1  FOR LOW PASS,  2  FOR HIGH PASS:?2
ENTER CUT OFF FREQUENCY IN HERTZ:?1000
ENTER  C  IN MICROFARADS:?.001
ENTER DB OF ATTENUATION PER OCTAVE:?48
R1= 31066.9
R2= 816175.
R3= 88471.4
R4= 286601.
R5= 132404.
R6= 191504.
R7= 156178.
R8= 162353.
DO YOU WANT A SCHEMATIC? 1 IF YES, 2 IF NO:?1
IF YOU ARE USING THE TEKTRONIX, ENTER A 1. IF TTY,A 2:?2
                ----------------XXXX----------------
                I               R1                 I
                I               R3                 I
                I               R5                 I
                I               R7                 I
                I                   *              I
                I                   **             I
                I                   * *            I
  IN            I                   *  *           I
                I                   *   *          I
  O------)(------------)(-----------* -  *         I
        C             C     I       *     *        I
                            I       *      *       I
                 -----XXXX-----     *       *-------------O
                 I                  *      *       I
                 I                  *     *        I   OUT
                 I    R2      ------* +  *         I
                 I    R4      I     *   *          I
                 I    R6      I     *  *           I
                 I    R8      I     * *            I
                 I            I     **             I
                 I            I     *              I
             --------         I                    I
               ----           ----------------------
                --


 THIS REPRESENTS ONE 12 DB SECTION.
FOR ONE SECTION, USE R1,R2.
FOR 2 SECTIONS, USE R1,R2 FOR THE FIRST AND R3,R4 FOR
THE SECOND.
FOR 3,USE R1,R2 FOR THE FIRST-R3,R4 FOR THE SECOND-ETC.
 THE VALUE OF C YOU SELECTED AT THE START OF THE
 DESIGN, IS USED FOR BOTH VALUES OF  C
IF YOU HAVE MORE TO DESIGN,ENTER 1. IF NOT, 2:?2

DONE
```

CONTRIBUTED PROGRAM **BASIC**

ANALAD
36056

TITLE: LADDER NETWORK ANALYSIS

DESCRIPTION: This program will analyze circuits with a "ladder" topology, i.e., alternating series and shunt elements. The circuit can be made of R, L, C networks and lossless transmission lines. The size of the circuit is not restricted, only the topology.

INSTRUCTIONS: See attached.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

This program will print tables or graphs on the teletype corresponding to the reflection or transmission characteristics of ladder networks. The program is very easy to use since the network to be analyzed is broken up into circuits identifiable in a stored catalog.

From the catalog of circuits and the example, you can tell if this program suits your problem. The program is written in BASIC so the data input must have the following form, as an example:

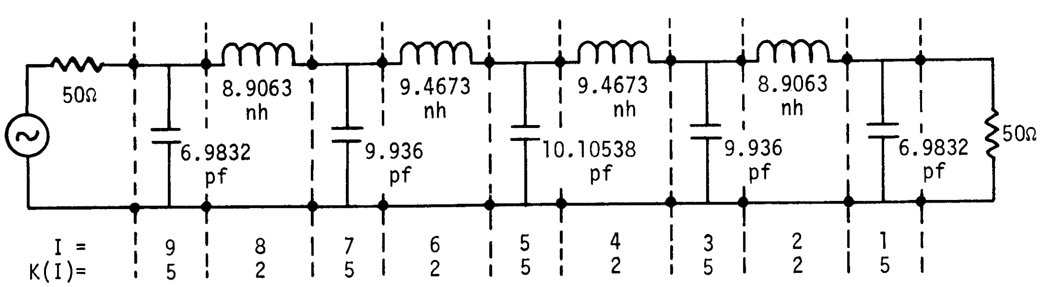
```
2000   DATA  N
2001   DATA  F1,F2,F3
2002   DATA  R1,ZØ,RØ
2003   DATA  Q
```

This shows the first eight numbers required for ANALAD. Each data line must begin with a number, then the word DATA, then the data number(s) set apart with commas. You can put as much or as little data on each line as you wish but after each carriage return, you must begin again as shown. Here is the meaning of the eight numbers shown.

N	The number of times the catalog will be referred to
F1	The lowest frequency wanted
F2	The highest frequency wanted
F3	The frequency interval wanted
R1	The load resistance (real only)
ZØ	The characteristic impedance of a line (real only) for computing VSWR
RØ	The source impedance (real only)
Q	The choice of output option.

If Q = Ø	you get a table of LOSS, DB; INS PH, DEG; REFL MAG; REFL PH, DEG; versus FREQ, GHz
If Q = 1	you get a table of R IN, OHMS; X IN, OHMS; VSWR; REFL, DB DOWN; versus FREQ, GHz
If Q = 2	you get a GRAPH of VSWR on a scale of 1 to 1.6 versus FREQ, GHz
If Q = 3	you get a GRAPH of VSWR on a scale of 1 to 7 versus FREQ, GHz
If Q = 4	you get a GRAPH of INS LOSS, DB on a scale Ø to 6 versus FREQ, GHz
If Q = 5	you get a GRAPH of INS LOSS, DB on a scale of Ø to 6Ø versus FREQ, GHz

For illustration, the nine element, one dB ripple Chebyshev low pass filter with one GHz cutoff. For reference to this program, the circuit is shown below.



As shown the sub-circuits are numbered from the load toward the generator. The numbers K(I) are the catalog numbers, as found in the catalog section following the example. Each catalog entry shows the exact form of the line needed to input that circuit. Below is the complete input information for this example and the various printout options. Parenthetical explanations have been added later.

RUN

```
READY

GET-$ANALAD

2000  DATA 9,.95,1.1,.Ø1,5Ø,5Ø,5Ø
2001  DATA Ø
2002  DAA←TA 5,6.9832          (Correcting a one character error with backspace.)
2003  DATA 2,8.9Ø63
2004  DATA 5,9.936             These nine lines are the references to the catalog
2005  DATA 2,9.4673            circuits corresponding to the filter diagram.  The
2006  DATA 5,1Ø.1Ø538          line numeration in increments of five has no  signi-
2007  DATA 2,9.4673            ficance.  You could even put all data on one line,
2008  DATA 5,9.936             but it would make changes inconvenient since the
2009  DATA 2,8.9Ø63            whole line must be retyped.
2010  DATA 5,6.9832
```

(At this point we have all the data entered. It is a good idea to check the list for errors.)

```
RUN         (There is no perceptible delay here upon execution.)
ANALAD
```

FREQ, GHZ	LOSS, DB	INS PH, DEG	VSWR	REFL PH, DEG
.95	.97939	-166.318	2.63192	-1Ø3.683
.96	.758219	-155.364	2.3347	-114.637
.97	.4Ø9931	-142.269	1.85764	-127.731
.98	6.713Ø8E-Ø2	-125.722	1.28272	-144.279
.99	9.14Ø18E-Ø2	-1Ø4.778	1.33731	14.7783
1	1.Ø112	-81.ØØ5	2.67488	-8.99461
1.Ø1	2.96728	-58.9443	5.7472	-31.Ø555
1.Ø2	5.5Ø716	-41.6643	12.1337	-48.3355
1.Ø3	8.16325	-28.968	24.1642	-61.Ø318
1.Ø4	1Ø.7182	-19.5616	45.1733	-7Ø.4382
1.Ø5	13.11Ø8	-12.3539	79.863	-77.6459
1.Ø6	15.3392	-6.62717	134.763	-83.3726
1.Ø7	17.4193	-1.92992	218.813	-88.Ø698
1.Ø8	19.3698	2.Ø2547	343.976	-92.Ø257
1.Ø9	21.2Ø79	5.42752	526.254	-95.4277
1.1	22.9485	8.4Ø451	786.811	-98.4Ø47

DONE

2001 DATA 1 (Changing one number changes the output.)

RUN

ANALAD

FREQ, GHZ	R IN, OHMS	X IN, OHMS	REFL MAG	REFL DB DOWN
.95	28.2123	-30.8652	.449328	6.94883
.96	28.1079	-24.3534	.400247	7.95355
.97	31.2177	-16.2869	.300121	10.4542
.98	40.473	-5.94442	.123852	18.1422
.99	66.005	4.96297	.144317	16.8139
1	128.867	-23.1797	.455764	6.82529
1.01	87.1978	-125.349	.703581	3.05376
1.02	23.7822	-107.055	.84772	1.43497
1.03	7.98572	-84.2685	.920522	.719325
1.04	3.32471	-70.7249	.956685	.384625
1.05	1.59257	-62.1115	.975267	.217533
1.06	.838793	-56.1386	.985268	.128908
1.07	.472941	-51.711	.990901	7.93928E-02
1.08	.280786	-48.2622	.994202	5.05024E-02
1.09	.173589	-45.4742	.996207	3.30108E-02
1.1	.110899	-43.1553	.997461	2.20778E-02

DONE

2001 DATA 2

RUN

ANALAD

GRAPH: Y = VSWR (This tells us that the Y-axis will be VSWR.)

FOR F: TOP= .95 BOTTOM = 1.1 INCREMENT = .01

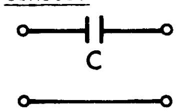
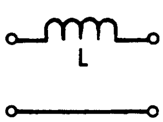
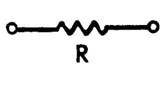
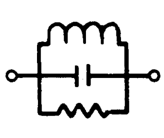
FOR Y: LEFT= 1 RIGHT = 1.5 INCREMENT = .01

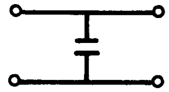
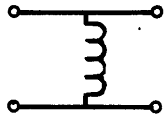
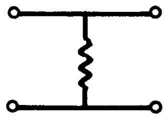
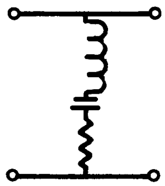
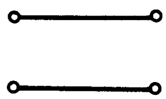
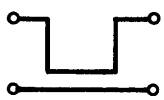
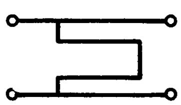
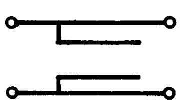
```
   I.........I.........I.........I.........I.........I   (This is Y-Axis.)
 - OFF SCALE (F,Y) =  .95        , 2.63192
 . OFF SCALE (F,Y) =  .96        , 2.3347     (Off-scale data is
 . OFF SCALE (F,Y) =  .97        , 1.85764      printed out.)
 .                              +
 .                                    +
 . OFF SCALE (F,Y) =  1    , 2.67488
 . OFF SCALE (F,Y) =  1.01       , 5.7472
```

STOP (The BREAK key was struck to stop the printing.)

```
2001 DATA 3   (Instruction to change scale.)
RUN
ANALAD

GRAPH: Y = VSWR

FOR F:  TOP=  .95          BOTTOM =   1.1         INCREMENT = .01
FOR Y: LEFT=  1       RIGHT =  6      INCREMENT = .1

   I.........I.........I.........I.........I.........I
 -                 +
 .              +
 .          +
 .    +
 .    +
 .                +
 .                                                 +
 . OFF SCALE (F,Y) =  1.02       ,  12.1337
 . OFF SCALE (F,Y) =  1.03       ,  24.1642
 . OFF SCALE
STOP  (The BREAK key was struck to stop the printing.)


2001 DATA 4
RUN
ANALAD

GRAPH: Y = INS LOSS

FOR F:  TOP=  .95          BOTTOM =   1.1         INCREMENT = .01
FOR Y: LEFT=  0       RIGHT =  5      INCREMENT = .1

   I.........I.........I.........I.........I.........I
 -          +
 .        +
 .    +
 . +
 . +
 .          +
 .                            +
 . OFF SCALE  (F,Y) =  1.02       , 5.50716
 . OFF SCALE  (F,Y) =  1.03       , 8.16325
STOP     (The BREAK key was struck to stop the printing.)
```

```
2001 DATA 5
RUN
ANALAD

GRAPH: Y = INS LOSS

FOR F:  TOP=  .95          BOTTOM =   1.1         INCREMENT = .01
FOR Y: LEFT=  0       RIGHT =  50     INCREMENT = 1

  I.........I.........I.........I.........I.........I
-  +
.  +
. +
. +
. +
.  +
.    +
.       +
.         +
.            +
-              +
.                +
.                  +
.                    +
.                      +
.                        +
.

DONE
```

CATALOG NUMBER	DESCRIPTION	CIRCUIT	LINE	WORD	NUMBER,	NUMBER,	NUMBER,	NUMBER,	NUMBER
					INPUT DATA LINE				
1.	Series C		(____)	DATA	1 ,	(C, pf)			
2.	Series L		(____)	DATA	2 ,	(L, nh)			
3.	Series R		(____)	DATA	3 ,	(R, Ω)			
4.	Series tank		(____)	DATA	4 ,	(L, nh),	(C, PF),	(G, mho)	

					INPUT DATA LINE				
CATALOG NUMBER	DESCRIPTION	CIRCUIT	LINE	WORD	NUMBER,	NUMBER,	NUMBER,	NUMBER,	NUMBER
5.	Shunt C		(___)	DATA	5 ,	(C, pf)			
6.	Shunt L		(___)	DATA	6 ,	(L, nh)			
7.	Shunt G		(___)	DATA	7 ,	(G, mho)			
8.	Shunt tank		(___)	DATA	8 ,	(L, nh),	(C, pf),	(R,ohms)	
9.	Transmission line		(___)	DATA	9 ,	(Zo, Ω),	(L, in),	($\sqrt{\varepsilon}$ ___)	
10.	Series shorted stub		(___)	DATA	10 ,	(Zo, Ω),	(L, in),	($\sqrt{\varepsilon}$ ___)	
11.	Series open stub		(___)	DATA	11 ,	(Zo, Ω),	(L, in),	($\sqrt{\varepsilon}$ ___)	
12.	Shunt shorted stub		(___)	DATA	12 ,	(Zo, Ω),	(L, in),	($\sqrt{\varepsilon}$ ___)	
13.	Shunt open stub		(___)	DATA	13 ,	(Zo, Ω),	(L, in),	($\sqrt{\varepsilon}$ ___)	

CONTRIBUTED PROGRAM **BASIC**

BEMDES
36109

TITLE: RECOMMENDS CORRECT STEEL BEAM USE

DESCRIPTION:

This program will recommend the correct steel beam to use for a number of common applications.

INSTRUCTIONS:

Respond to the questions about the application according to the following code:

L = 1 for uniformly distributed load
  = 2 for single midpoint load
  = 3 for uniform load & single midpoint load
  = 4 for two equal symmetric loads

B = 1 for beam supported at both ends
  = 2 for one end fixed, other end supported
  = 3 for beam fixed at both ends
  = 4 for one end fixed (cantilever)

S = Length of the span in feet

W = Distributed load in pounds per foot

P = Each concentrated load in pounds

A = Location of load(s) in feet from end

SPECIAL CONSIDERATIONS:

None

ACKNOWLEDGEMENTS:

RUN

```
GET-$BEMDES
RUN
BEMDES

DO YOU WANT INSTRUCTIONS (YES OR NO)?YES

THIS PROGRAM WILL RECOMMEND THE CORRECT STEEL BEAM
TO USE FOR A NUMBER OF COMMON APPLICATIONS.  TO USE,
RESPOND TO THE QUESTIONS ABOUT THE APPLICATION
ACCORDING TO THE FOLLOWING CODE:

   L = 1 FOR UNIFORMLY DISTRIBUTED LOAD
     = 2 FOR SINGLE MIDPOINT LOAD
     = 3 FOR UNIFORM LOAD + SINGLE MIDPOINT LOAD
     = 4 FOR TWO EQUAL SYMMETRIC LOADS

   B = 1 FOR BEAM SUPPORTED AT BOTH ENDS
     = 2 FOR ONE END FIXED, OTHER END SUPPORTED
     = 3 FOR BEAM FIXED AT BOTH ENDS
     = 4 FOR ONE END FIXED (CANTILEVER)

   S = LENGTH OF THE SPAN IN FEET

   W = DISTRIBUTED LOAD IN POUNDS PER FOOT

   P = EACH CONCENTRATED LOAD IN POUNDS

   A = LOCATION OF LOAD(S) IN FEET FROM END


WHAT IS THE LOAD CODE (L)?2

WHAT IS THE SUPPORT CODE (B)?3

WHAT IS THE SPAN IN FEET (S)?37

WHAT IS EACH CONCENTRATED LOAD (P)?298

   RECOMMENDED BEAM IS A    3    U 5

ARE YOU FINISHED (YES OR NO)?YES

DONE
```

CONTRIBUTED PROGRAM **BASIC**

DEBYE
36059

TITLE: COMPUTES DEBYE OR EINSTEIN FUNCTION

DESCRIPTION: This program calculates the Debye or Einstein Function. Given two of three variables (temperature, specific heat, and theta), the program will calculate the third, then the normalized energy function at the given temperature.

INSTRUCTIONS: Enter data beginning with Line 9900. First data is the function type, either Debye or Einstein, in quotes. Second is the number of data sets to be evaluated. Remaining data is entered as triplets, with the first number temperature, the second specific heat and the third theta. Enter zero for the unknown variable.

Format:

```
9900 DATA "DEBYE",N   no. of data sets (or Einstein)
9901 DATA T,CV,Ø      (calculates Theta)
9902 DATA T,Ø, θ      (calculates Specfic Heat)
9903 DATA Ø,DV,θ      (calculates temperature)
```

SPECIAL CONSIDERATIONS:

Temperature $\geq$ 0

0 $\leq$ Specific Heat < 5.96151

θ > 0

Error halts and messages:

"It is not clear whether the Debye or Einstein functions are wanted..."

The first data item is not "DEBYE" or "EINSTEIN" (including quotes). Retype data statement.

"Not defined for T = ..."
One or more parameters is not allowed. (See above.)

ACKNOWLEDGEMENTS:

RUN

```
GET-$DEBYE
9900 DATA "DEBYE",3
9902 DATA 1000,0,1,100,0,1,10,0,1
RUN
DEBYE

   DEBYE FUNCTION

 TEMPERATURE      CV              THETA         Q            CV/3R

 1000            5.9598          1             .999625      .999713
 100             5.96129         1             .996255      .999962
 10              5.95854         1             .963         .999501

DONE
```

FORCST
36750

TITLE: WEATHER FORECASTING PROGRAM

DESCRIPTION:

This program will forecast the weather to 77% accuracy. The program will also print out

- A Temperature At Various Heights [(000-10000')]
- B High At Which Cumulus Clouds Could Form
- C Present Weather -- From Input Data
- D Forecast

INSTRUCTIONS:

No files are used in this program.

1. BARometric PRESSURE INPUT

   Input the current barometric pressure. This will normally be a number from 29.50 to 30.27. Other numbers will work (unless they are $> 10^{35}$).

2. TEMPERATURE INPUT

   Input temperature to nearest degree Fahrenheit. Example: 25 or even 25.7251.

3. WIND DIRECTION

   Input a number between 1-8. The number should be an integer. This number if not an integer or between 1-8 will be treated as a north wind.

4. WIND SPEED

   Input current wind speed in MPH. No number limitations.

5. DEWPOINT

   Input current dewpoint. If dewpoint is not known, input is Ø. However, if the input is Ø the height of cumulus clouds will be off. Rest of forecast is not affected.

SPECIAL CONSIDERATIONS:

The forecast print out will be 77% accurate.

ACKNOWLEDGEMENTS:

Michael R. Barnes

```
RUN

RUN
FORCST

THIS IS THE HEWLETT-PACKARD WEATHER FORECASTER
DO YOU WANT INSTRUCTIONS (1=YES,0=NO)?1
THIS FORECAST INFORMATION DEPENDS ON VARIOUS
FACTORS,AMONG THE MAIN FACTORS ARE BAROMETRIC
PRESSURE AND WIND DIRECTION. YOU WILL BE ASKED
TO INPUT THE ABOVE,AND WIND SPEED,DEWPOINT,AND
TEMPERATURE.THESE HAVE TO DO WITH OTHER FEATURES
OF THIS FORECAST.THIS FORECAST IS 77% ACCURATE.

WHAT IS THE BAROMETRIC PRESSURE TO THE NEAREST TENTH
EXAMPLE(30.01=30.0)?30.2
WHAT IS THE TEMPERATURE IN DEGREES F?89
WHAT IS THE WIND DIRECTION(SEE WIND CODE BELOW)
N=1,NE=2,E=3,SE=4,S=5,SW=6,W=7,NW=8?8
WHAT IS THE WIND SPEED?3
WHAT IS THE DEWPOINT?68


                PRESENT WEATHER

  WIND NORTHWEST AT 3    MPH

  TEMPERATURE 89   DEWPOINT 68

  WIND CHILL FACTOR IS 86   DEGREES

  BAROMETRIC PRESSURE 30.2

HEIGHT     TEMPERATURE
 1000           85.5
 2000           82
 3000           78.5
 4000           75
 5000           71.5
 6000           68
 7000           64.5
 8000           61
 9000           57.5
 10000          54

CUMULUS CLOUDS COULD FORM AT 4666.67    FEET


               FORECAST

SUMMER;LIGHT TO MODERATE WINDS,GOOD CHANCE OF RAIN.
WINTER;RAIN OR SNOW,WITH INCREASING WINDS,OFTEN WILL
SET IN WHEN BAROMETER BEGINS TO FALL AND THE WIND SETS
IN FROM THE N OR NE


THANK YOU

DONE
```

CONTRIBUTED PROGRAM **BASIC**

GENFIL
36784

TITLE: DESIGNS PASSIVE FILTER

DESCRIPTION: This program calculates the element values in henries and farads for matched Butterworth or Chebishev filters. Will operate for lowpass, high-pass, or Cohn structure bandpass.

INSTRUCTIONS: Inputs requested are:

A) All cases:

1. Butterworth or Chebishev? Requests filter response required.
2. Number of elements? Requests number of branches required in filter, or number of resonators for a Cohn structure bandpass.
3. Defines answers for 3 types of filters available and requests which is required.
4. Center or cut-off frequency? Requires values, in Hc, of the center frequency of a band-pass filter, or the cut-off frequency of any other type. The cut-off frequency required is the 3db frequency for a Butterworth or the ripple cut-off frequency for a Chebishev.
5. Terminating impedance? Requests value of equal terminating resistance, in ohms.

B) Chebishev only:

1. Requests value of ripple to be permitted, in db.

C) Bandpass only:

1. Requests the required bandwidth, in Hz.
2. Requests a choice of resonator inductance, in henries.

SPECIAL CONSIDERATIONS: This program handles up to 20 elements for low-pass or high-pass filters. It will also do this for Cohn structure bandpass (although note that in this case, this is 20 resonators) but owing to certain assumptions made, the accuracy deteriorates markedly above 5 resonators. Also notice in the bandpass case it is possible to make a bad choice of inductor. This reveals itself in negative values for the end capacitors.

Reference: Cohn S. B., Direct Coupled Resonator Filters Proc. Inst. Radio Engrs. (Feb. 1957); Brown, K. E., Systematic Development of Cohn Structure for H. F. Band-Pass Filters. Electronic Engineering, July 1964.

ACKNOWLEDGEMENTS: Alastair Sharp
HP, Scotland

RUN

```
RUN
GENFIL

 BUTTERWORTH (0) OR CHEBISHEV (1) ?1
NO. OF ELEMENTS ?9
WHAT IS ALLOWED RIPPLE ?1.3
LOW-PASS = 0, HIGH-PASS = 1, COHN BAND-PASS = 2
TYPE OF FILTER ?0
CENTRE OR CUT-OFF FREQ. ?5E6
TERMINATING IMPEDANCE ?75

LOW-PASS FILTER
C INPUT                              L INPUT
     C              L                  L              C
 1.01924E-09     2.50317E-06      5.73322E-06     4.45008E-10
 1.42825E-09     2.64897E-06      8.03392E-06     4.70928E-10
 1.45073E-09     2.64895E-06      8.16035E-06     4.70924E-10
 1.42822E-09     2.50293E-06      8.03372E-06     4.44965E-10
 1.01820E-09                      5.72736E-06

 BUTTERWORTH (0) OR CHEBISHEV (1) ?0
NO. OF ELEMENTS ?5
LOW-PASS = 0, HIGH-PASS = 1, COHN BAND-PASS = 2
TYPE OF FILTER ?1
CENTRE OR CUT-OFF FREQ. ?5E6
TERMINATING IMPEDANCE ?500
HIGH-PASS FILTER

C INPUT                              L INPUT
     C              L                  L              C
 1.02981E-10     9.83417E-06      2.57452E-05     3.93367E-11
 3.18269E-11     9.83708E-06      7.95672E-06     3.93483E-11
 1.03110E-10                      2.57776E-05

 BUTTERWORTH (0) OR CHEBISHEV (1) ?1
NO. OF ELEMENTS ?3
WHAT IS ALLOWED RIPPLE ?1
LOW-PASS = 0, HIGH-PASS = 1, COHN BAND-PASS = 2
TYPE OF FILTER ?2
CENTRE OR CUT-OFF FREQ. ?5E6
TERMINATING IMPEDANCE ?75
REQUIRED BANDWIDTH ?5E5
INTENDED INDUCTANCES ?1E-6

COHN STRUCTURE BAND-PASS FILTER
RESONATOR INDUCTANCE = .000001
RESONATOR CAPACITIES             SERIES CAPACITIES
 6.70341E-10                      3.15693E-10
 8.76833E-10                      7.18646E-11
 6.70341E-10                      7.18772E-11
                                  3.15693E-10

 BUTTERWORTH (0) OR CHEBISHEV (1) ?
DONE
```

CONTRIBUTED PROGRAM **BASIC**

HTXFR
36058

TITLE: TWO-DIMENSIONAL HEAT TRANSFER IN A THIN PLATE

DESCRIPTION:

This program is designed to determine the temperature at each segment in a flat plate (a 2 dimensional array is used in the program) where:

A. There is given heat input for each segment (given in BTU/HR thermal energy).

B. There is a given thermal resistance in the plate between each segment (given in (°F-HR)/BTU).

C. There is a given temperature on one side of the plate such as outdoor temperature (given in °F).

D. There is a given thermal resistance from each segment to the outdoor temperature (given in (°F-HR)/BTU).

E. There is a given temperature on the other side of the plate such as indoor temperature (given in °F).

F. There is a given thermal resistance from each segment to the indoor temperature (given in (°F-HR)/BTU).

G. There is a given thermal resistance from the edge segments to a temperature adjacent to the plate and assumed to be the average of indoor and outdoor temperature (given in (°F-HR)/BTU).

The maximum number of segments for rows and columns is 29 which makes a maximum of 841 segments. Special heat inputs (other than given in the general input statement) may be introduced to any single or adjacent segments of a given row and column. The program will ask you questions in which you should answer YES or NO. It will also tell you when and how to input your data. The printout will be the steady state temperature distribution of the plate at each segment.

INSTRUCTIONS:

Input Variables include the maximum segment for columns, the maximum segment for rows, resistance between segments, heat input per segment, outdoor temperature (TO), resistance to TO, indoor temperature (TI), resistance to TI and resistance to outside edge.

SPECIAL CONSIDERATIONS:

WARNING: Some data may take a long time for a printout. May I suggest that you leave it for awhile. When the bell on the teletype starts ringing you will know that the printout has been typed up and the program is waiting for an answer to a question.

ACKNOWLEDGEMENTS:

Richard H. Nelson
Bloomington, Minnesota

RUN

```
RUN
HTXFT

PRINT IN THE MAXIMUM SEGMENT FOR COLUMNS, THE MAXIMUM
SEGMENT FOR ROWS, RESISTANCE BETWEEN SEGMENTS, HEAT INPUT
PER SEGMENT, OUTDOOR TEMP. (TO), RESISTANCE TO TO, INDOOR
TEMP. (TI), RESISTANCE TO TI AND RESISTANCE TO OUTSIDE EDGE



?34,56,2,1.31,-30,2,72,2,1
THE MAXIMUM MUST BE BETWEEN (AND INCLUDING) 2 AND 29
PRINT IN A NEW MAXIMUM FOR ROWS
?5
PRINT IN A NEW MAXIMUM FOR COLUMNS
?12
IS THERE ANY SPECIAL HEAT INPUT ?YES
IS THERE A PATTERN IN ROWS OR COLUMNS ?NO
HOW MANY ITEMS ARE TO BE INPUTED ?3
INPUT THE HEAT AS FOLLOWS: ROW, COLUMN, HEAT
PUSH RETURN AFTER EACH HEAT
?1,1,0
?6,1,1
 6    IS GREATER THAN 5    WHICH IS YOUR MAXIMUM FOR ROWS
INPUT THOSE FIGURES AGAIN !
?5,1,0
?3,12,4
IS THERE ANY MORE DATA TO BE INPUTED ?NO

            1        2        3        4        5        6        7        8
     1      *        *        *        *        *        *        *        *
          24.53    35.17    37.15    37.51    37.58    37.59    37.59    37.58

     2      *        *        *        *        *        *        *        *
          35.07    28.04    26.81    26.58    26.54    26.53    26.52    26.52

     3      *        *        *        *        *        *        *        *
          36.68    26.97    24.86    24.42    24.33    24.31    24.3     24.31

     4      *        *        *        *        *        *        *        *
          35.13    28.07    26.83    26.6     26.56    26.55    26.55    26.56

     5      *        *        *        *        *        *        *        *
          24.47    35.24    37.22    37.58    37.65    37.66    37.66    37.66



            9        10       11       12
     1      *        *        *        *
          37.5     37.17    35.33    24.86

     2      *        *        *        *
          26.56    26.84    28.23    35.44

     3      *        *        *        *
          24.43    24.96    27.33    37.99

     4      *        *        *        *
          26.64    26.93    28.3     35.54

     5      *        *        *        *
          37.62    37.21    35.38    24.9

IS THERE ANY MORE DATA TO BE INPUTED ?NO


DONE
```

CONTRIBUTED PROGRAM **BASIC**

KSWEEP
36771.

TITLE: FREQUENCY PLOT OF POLES & ZEROS IN A COMPLEX PLANE

DESCRIPTION:

This program lists and plots the frequency response of the poles and zeros in the complex plane. The poles and zeros may be that of a transfer, driving point, or system function.

The plot routine scales the gain and phase for an optimum plot. The resolution of the graph can be improved to .001db by changing the sweep range.

INSTRUCTIONS:

The numerator and denominator of the function must first be reduced to simple, multiple, and complex roots. The program is written with sufficient "HELP" for the inexperienced user. The "HELP" routines give detailed information to answer the question asked by the program.

If an incorrect entry is accepted by the program, the user will be able to make the change at a later point in the program.

SPECIAL CONSIDERATIONS:

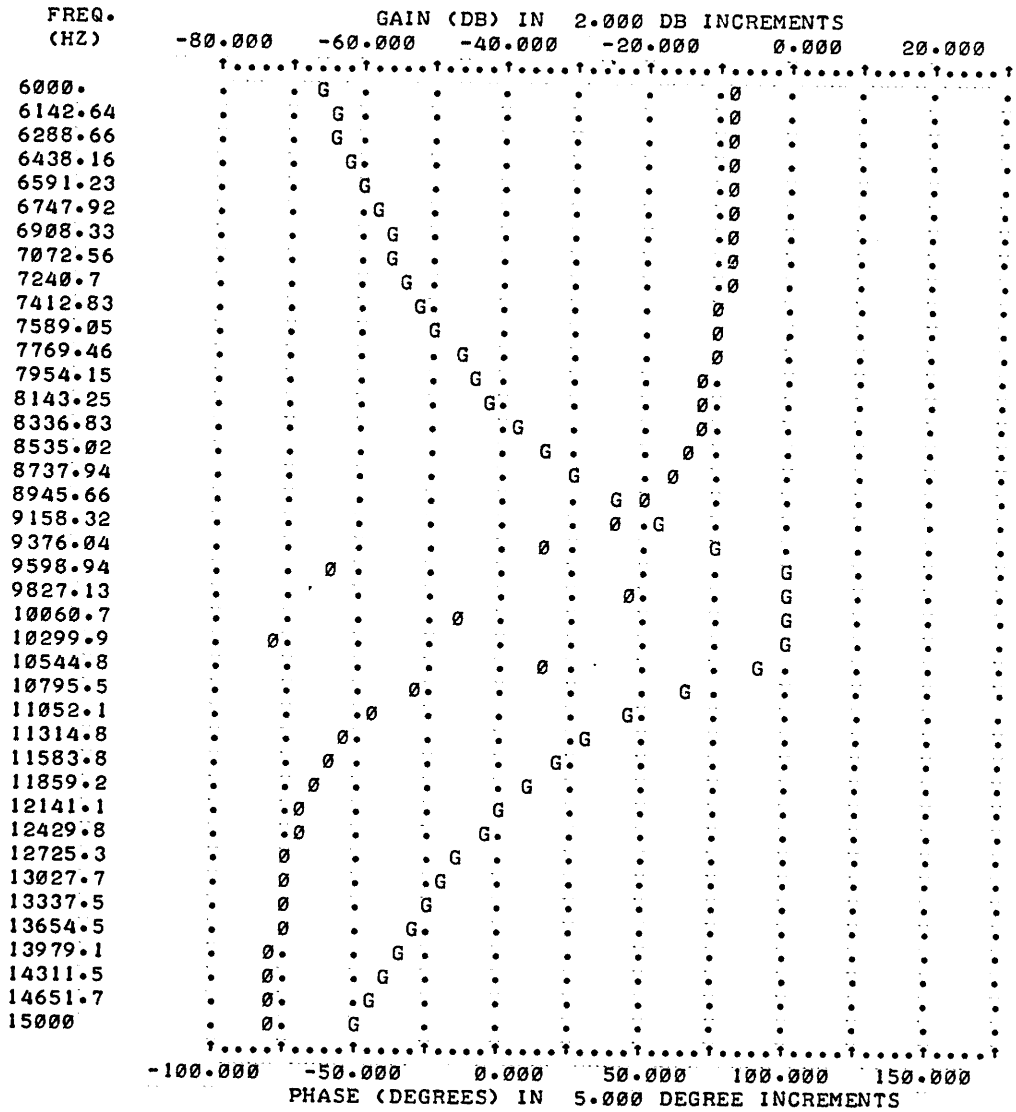
The student needs exposure to Transfer Functions, or Filter theory, or automatic control theory, (in general, courses where the response of a network is represented as a ratio of two polynomials). This program is especially useable when the sensitivity of a response as a function of the movements of the poles and zeros is of interest. The efect on the gain and phase of a not-dominant pole or zero, which is usually disregarded, can easily be determined by listing or plotting the response with and without the pole or zero of interest.

ACKNOWLEDGEMENTS:

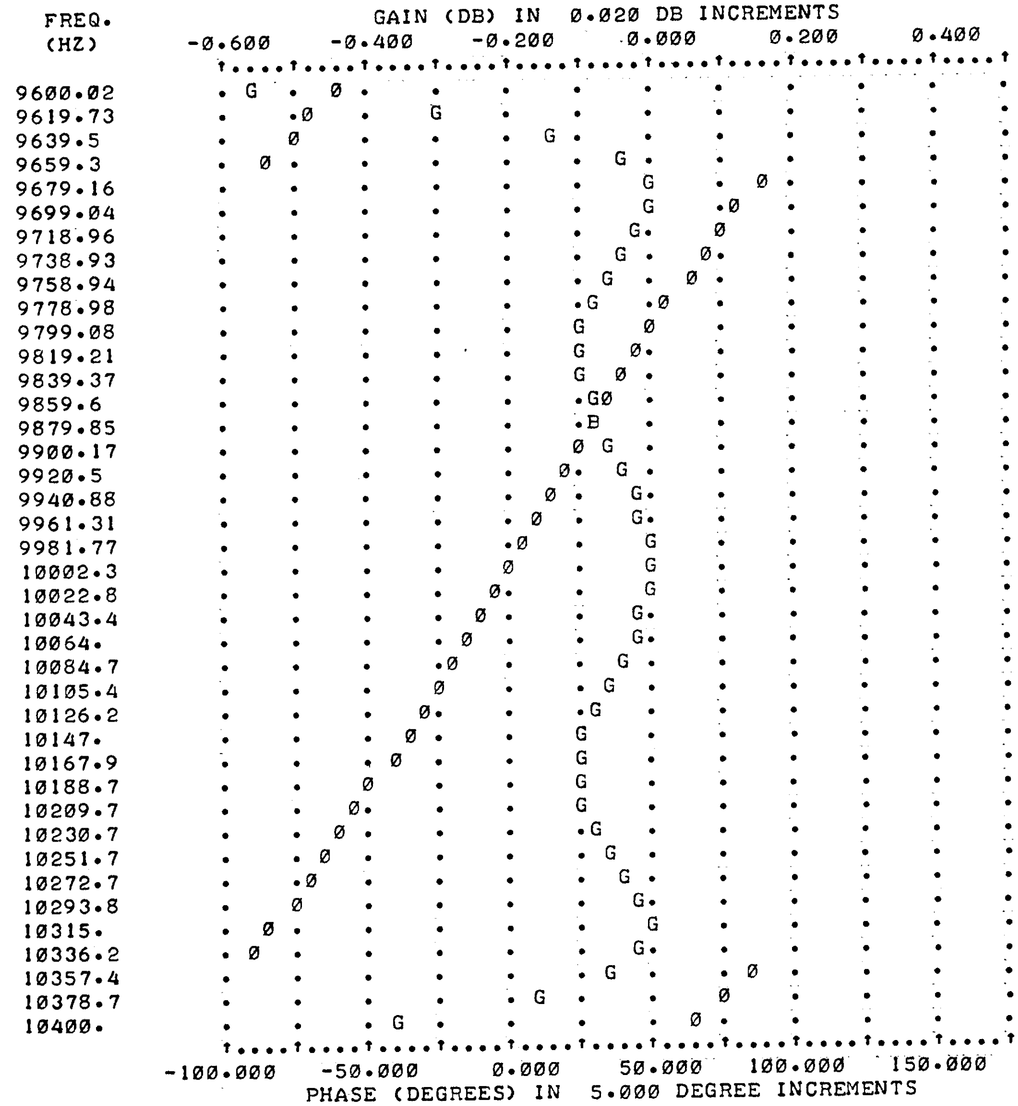
Erhard Ketelsen
HP, Delcon Division

RUN

```
RUN
KSWEEP

EXPLANATIONS ?    YES(1)  NO(0)  ?1

THIS PROGRAM LISTS AND PLOTS THE FREQUENCY
RESPONSE OF POLES AND ZEROS IN THE COMPLEX PLANE.
THE NUMERATOR AND DENOMINATOR OF THE FUNCTION MUST BE
REDUCED TO SIMPLE, MULTIPLE, OR COMPLEX ROOTS.
THE ROOTS MAY BE OBTAINED BY USING THE B.A.E.D.P.
TIME SHARE $ROOTER PROGRAM.

HZ(1) OR RADIANS(2)  HELP(8)  ?2

POLE(1)  ZERO(0)  STOP(5)  HELP(8)
POLE OR ZERO ?0
REAL PART?0
IMAGINARY PART?0
POLE OR ZERO ?0
REAL PART?0
IMAGINARY PART?0
POLE OR ZERO ?0
REAL PART?0
IMAGINARY PART?0
POLE OR ZERO ?1
REAL PART?-2192.5
IMAGINARY PART?62793.6
POLE OR ZERO ?1
REAL PART?-1143.65
IMAGINARY PART?65609.4
POLE OR ZERO ?1
REAL PART?-1048.55
IMAGINARY PART?60153.7
POLE OR ZERO ?5

SWEEP SELECTION
LINEAR(1)  QUASI LOG(2)  TRUE LOG(3)
SPECIFIC FREQUENCIES(4)  HELP(8)   ?3
ENTER THE LOWEST AND HIGHEST FREQUENCIES IN HZ. ?6000,15000
IN HOW MANY STEPS ?40

ENTER THE FREQUENCY AT WHICH THE GAIN SHALL BE 0 DB.  ?10000

THE POLES & ZEROS IN RADIANS ARE:

 1    ZERO AT  0       +-J  0
 2    ZERO AT  0       +-J  0
 3    ZERO AT  0       +-J  0
 4    POLE AT -2192.5        +-J  62793.6
 5    POLE AT -1143.65       +-J  65609.4
 6    POLE AT -1048.55       +-J  60153.7

TRUE LOG SWEEP FROM 6000    TO 15000   HZ IN 40   STEPS.

THE 0 DB REFERENCE FREQUENCY IS 10000   HZ.

MODIFY PARAMETER ?   HELP(8)  ?0

LIST(1)  PLOT(2)  HELP(8)  ?2
```




```
FOR ANY CHANGES(1)  FOR A LIST(2)  STOP(0)  ?1

MODIFY PARAMETER ?   HELP(8)  ?2

SWEEP SELECTION
LINEAR(1)  QUASI LOG(2)  TRUE LOG(3)
SPECIFIC FREQUENCIES(4)  HELP(8)   ?3
ENTER THE LOWEST AND HIGHEST FREQUENCIES IN HZ. ?9600,10400
IN HOW MANY STEPS ?40
TRUE LOG SWEEP FROM 9600    TO 10400   HZ IN 40    STEPS.

MODIFY PARAMETER ?   HELP(8)  ?0

LIST(1)  PLOT(2)  HELP(8)  ?2
```



FOR ANY CHANGES(1) FOR A LIST(2) STOP(0) ?2

FREQUENCY (HZ)	GAIN (DB)	PHASE (DEGREES)
9600.02	-0.562	-60.633
9619.73	-0.305	-68.844
9639.5	-0.140	-76.798
9659.3	-0.047	-84.396
9679.16	-0.006	88.391
9699.04	0.000	81.571
9718.96	-0.015	75.112
9738.93	-0.038	68.965
9758.94	-0.062	63.087
9778.98	-0.082	57.421
9799.08	-0.095	51.917
9819.21	-0.100	46.536
9839.37	-0.097	41.239
9859.6	-0.088	35.991
9879.85	-0.073	30.774
9900.17	-0.056	25.560
9920.5	-0.039	20.351
9940.88	-0.023	15.134
9961.31	-0.010	9.902
9981.77	-0.002	4.665
10002.3	0.000	-0.578
10022.8	-0.004	-5.822
10043.4	-0.013	-11.058
10064.	-0.026	-16.284
10084.7	-0.043	-21.503
10105.4	-0.060	-26.710
10126.2	-0.077	-31.918
10147.	-0.090	-37.143
10167.9	-0.098	-42.397
10188.7	-0.099	-47.709
10209.7	-0.093	-53.116
10230.7	-0.078	-58.649
10251.7	-0.057	-64.357
10272.7	-0.033	-70.292
10293.8	-0.011	-76.500
10315.	0.000	-83.040
10336.2	-0.012	-89.943
10357.4	-0.062	82.762
10378.7	-0.169	75.077
10400.	-0.353	67.061

FOR ANY CHANGES(1)   FOR A PLOT(2)   STOP(0)   ?0

DONE

CONTRIBUTED PROGRAM **BASIC**

LPFLTR
36060

TITLE: DESIGNS LOW-PASS FILTERS

DESCRIPTION: This program uses constant K prototype T section and M derived (M = .6) termination L section to design low pass filters. The program will give high attenuation at specified frequencies in the stop band by adding up to nine additional M derived T sections.

INSTRUCTIONS: Enter the following information when requested by the program:

1. Characteristic impedance.
2. Cutoff frequency in H_z.
3. Number of stop band attenuators.
4. Frequency (in H_z) for attenuators.

The program will then diagram the filter and indicate maximum attenuation.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

```
GET-$LPFLTR
RUN
LPFLTR

PROGRAM FOR THE DESIGN OF A LOW PASS FILTER

WHAT IS THE DESIRED CHARACTERISTIC IMPEDANCE IN OHMS ?50

WHAT IS THE DESIRED CUTOFF FREQUENCY IN HZ ?1E+06

HOW MANY ATTENUATORS ARE DESIRED IN THE STOP BAND ?1

WHAT IS THE FREQUENCY FOR ATTENUATOR NUMBER  1    ?1.5E+06


0<------------- 50             OHM LINE       ------------->0
I                                                           I
I                                                           I
+-------- 8.48827E-03   MH +   1.90986E-03   MFD ----------+
I                                                           I
I                                                           I
>               1.27324E-02   MH                            I
I                                                           I
I                                                           I
+-------------- 6.36620E-03     MFD  ----------------------+
I                                                           I
I                                                           I
>               1.38891E-02   MH                            I
I                                                           I
I                                                           I
+-------- 2.37254E-03   MH +   4.74509E-03   MFD ----------+
I                                                           I
I                                                           I
>               .010706       MH                            I
I                                                           I
I                                                           I
+-------- 8.48827E-03   MH +   1.90986E-03   MFD ----------+
I                                                           I
I                                                           I
0<------------- 50             OHM LINE       ------------->0

TERMINATING SECT'S GIVE MAX. ATTEN. AT 1.25000E+06   HZ
IN ADDITION TO THOSE SPECIFIED AT:
 1.50000E+06   HZ

DONE
```

METRIC
36635

TITLE: CONVERTS ENGLISH TO METRIC, METRIC TO ENGLISH

DESCRIPTION: This program converts 19 metric measurements into their equivalent English measurements and vice versa.

INSTRUCTIONS: If the user responds "Y" or "YES" to the prompt, INSTRUCTIONS?, the program prints out a table of the 19 metric measurements, and assigns each conversion a number. The user then enters his choice. An entry of "20" to the "choice" prompt terminates execution of the program.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Terry Von Gease
HP, Data Systems

```
RUN


RUN
METRIC


INSTRUCTIONS ?Y

+ TO CONVERT FROM                    TO
- TO CONVERT TO                      FROM

 1          INCHES                   MILLIMETERS
 2          FEET                     METERS
 3          YARDS                    METERS
 4          MILES                    KILOMETERS
 5          SQUARE INCHES            SQUARE CENTIMETERS
 6          SQUARE FEET              SQUARE METERS
 7          SQUARE YARDS             SQUARE METERS
 8          ACRES                    HECTARES
 9          CUBIC INCHES             MILLILITERS
10          CUBIC FEET               CUBIC METERS
11          CUBIC YARDS              CUBIC METERS
12          QUARTS                   LITERS
13          GALLONS                  LITERS
14          OUNCES                   GRAMS
15          POUNDS (MASS)            KILOGRAMS
16          POUNDS (FORCE)           NEWTONS
17          P.S.I.                   KILOPASCALS
18          HORSEPOWER               KILOWATTS
19          BTU                      KILOJOULE
20          END THE PROGRAM

YOUR CHOICE ?1

ENTER THE VALUE IN INCHES ?12

    12.0000 INCHES =     304.8000 MILLIMETERS

YOUR CHOICE ?-1

ENTER THE VALUE IN MILLIMETERS ?304.8000

   304.8000 MILLIMETERS =      12.0000 INCHES

YOUR CHOICE ?16

ENTER THE VALUE IN POUNDS (FORCE) ?56

    56.0000 POUNDS (FORCE) =     249.0880 NEWTONS

YOUR CHOICE ?-9

ENTER THE VALUE IN MILLILITERS ?10

    10.0000 MILLILITERS =      0.6102 CUBIC INCHES

YOUR CHOICE ?20

DONE
```

CONTRIBUTED PROGRAM **BASIC**

MICRO
36062

TITLE: MICROWAVE PARAMETERS CONVERSION

DESCRIPTION: MICRO is a series of seven short programs for converting microwave parameters.

INSTRUCTIONS: The user, after entering the program and typing RUN, selects the program he desires by first asking for a listing of the program catalog and then typing in the appropriate code number to retrieve that program.

After calling for the desired program, that program will then ask for the necessary input(s) to be typed in.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

RUN

```
GET-$MICRO
RUN
MICRO

TYPE 1 IF YOU WANT PROGRAM CATALOG.
TYPE 0 IF YOU DO NOT.
?1
1=CALCULATE MISMATCH UNCERTAINTY IN DB BASED ON TWO VSWRS.
2= CONVERT RHO, VSWR, OR RETURN LOSS TO OTHER TWO PARAMETERS.
3= DB TO PERCENT ERROR CONVERSION OR VISA VERSA.
4=SIGNAL SEPARATION.
5=THEORETICAL NOISE LEVEL.
6=CONVERT Z AND THETA TO:
   1.RESISTANCE AND REACTANCE
   2.NORMALIZED R AND X
   3.REFLECTION COEFFICIENT AND ANGLE
   4.REFLECTION COEFFICIENT (RHO)
     VOLTAGE STANDING WAVE RATIO
     RETURN LOSS
7=SMITHCHART - CONVERT RHO AND ANGLE TO R AND X.
PROGRAM NUMBER?1
VSWR1?1.1
VSWR2?1.5
PLUS DB= .0823
MINUS DB=-.0831

PROGRAM NUMBER?2
TYPE 1,2, OR 3 IF INPUT IS RHO, VSWR, OR R.L.
?3
R.L.?60
RHO= .001        VSWR= 1.002      R.L.= 60

PROGRAM NUMBER?3
TYPE 1 OR 2 IF INPUT IS DB OR PERCENT?1
DB?3
PERCENT VOLTAGE +  41.2539    PERCENT POWER + 99.5265
                  -29.2055                   -49.8813

PROGRAM NUMBER?4
FIRST VECTOR QTY (DB)?6
SECOND VECTOR QTY (DB)?10
DB(A)= 20.6789    DB(B)= 7.7717

PROGRAM NUMBER?5
BANDWIDTH (HZ) VALUE?1E+06
S(DBM)=-113.843

PROGRAM NUMBER?6
Z?50
ANGLE?36.9
R= 39.9846    X= 30.0206
CHARACTERISTIC IMPEDANCE?50
R(N)= .799692    X(N)= .600412
REFLECTION COEFF.        ANGLE              VSWR            RETURN LOSS
        .3336            90                 2.0013              9.5349

PROGRAM NUMBER?7
RHO?.33
ANGLE?90
R(N)= .8036      X(N)= .5952
CHARACTERISTIC IMPEDANCE?50
R= 40.1804     X= 29.7593

PROGRAM NUMBER?99

DONE
```

CONTRIBUTED PROGRAM **BASIC**

MIXSPR
36064

TITLE: MIXER SPURIOUS RESPONSE PROGRAM

DESCRIPTION: This program was written to aid in the identification and source of residual responses. The program applies the general equation for mixing to each converter and calculates the frequency where the spurious response will occur on the tuning dial. In addition, the harmonic numbers and frequencies involved are printed so that filter requirements can be determined.

INSTRUCTIONS: See Attached

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS:

MIXER SPURIOUS RESPONSE PROGRAM

TO USE MIXSPR:

1) All DATA statements should be entered, in the order shown below, with line numbers below (less than) 500.

2) First of all, decide how many mixers in a chain of conversions you wish to analyze. Generally this will be for one mixer, but up to three cascaded mixers can be checked automatically.

10 DATA X X = NO. OF MIXERS

3) Next, the frequencies (GHz, MHz or kHz units) of the signal LO and IF are entered with harmonic numbers as integers:

20 DATA S1, J1

S1 = Input signal to mixer

J1 = Highest harmonic of input signal

30 DATA F3, F4, K1, I1

F3 = Lowest first LO frequencey

F4 = Highest first LO frequency

K1 = Highest harmonic of first LO

I1 = First intermediate frequency

4. If more than one mixer, enter the following:

40 DATA F5, K2, I2

50 DATA F7, F8, K3, I3

F5 = Second LO frequency

K2 = Highest harmonic of second LO

I2 = Second intermediate frequency

F7 = Lowest third LO frequency

F8 = Highest third LO frequency

K3 = Highest harmonic of third LO

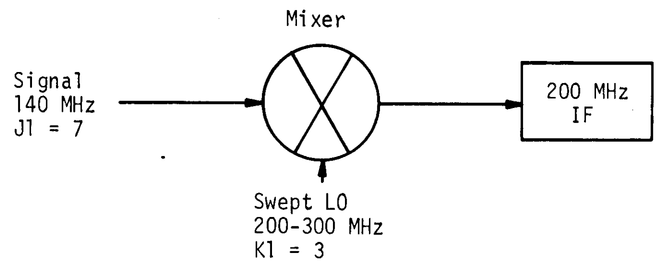
I3 = Third intermediate frequency

5) The program will ask for which frequency units (GHz, MHz, kHz) you are using. The units you respond with should be consistent with your input data and will be used in printing the output.

RUN

EXAMPLE 1

The residual responses are desired for the following case where a 140 MHz LO signal is present in a mixer in addition to the normal swept LO. The usual receiver band for signals is from 0 to 100 MHz. Harmonic numbers are represented by J1 and K1.



The input data is entered:

```
10 DATA 1 (no. of mixers)

20 DATA 140, 7 (signal)

30 DATA 200, 300, 3, 200 (swept LO and IF)
```

Or data may be entered in a more compact form:

```
10 DATA 1, 140, 7, 200, 300, 3, 200
```

NOTE: An upper frequency of 300.1 MHz is used in the example following to prevent computer round-off error from masking the spurious response at 100 MHz.

```
GET-$MIXSPR
10 DATA 1,140,7,200,300.1,2,200
RUN
MIXSPR

UNITS? (GHZ,MHZ,KHZ)?MHZ

NUMBER OF MIXERS = 1
S1= 140          J1= 7           F3= 200          F4= 300.1
K1= 3            I1= 200

 LO    SIG       LO MHZ          SIG MHZ          SPUR MHZ

 1      3         220             420              20
 2      2         480             280              40
 2      5         500             700              50
 3      3         620.            420              6.66669
 3      4         760             560              53.3333
 3      5         900.            700              100.
 3      6         640.            840              13.3334
 3      7         780.            980              60.0001

DONE
```

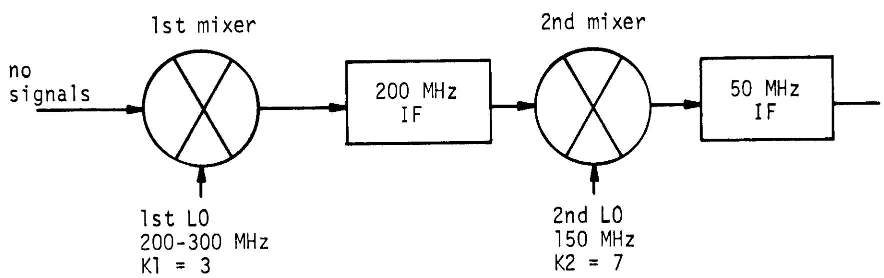
The output shows that responses were calculated for one mixer with an input signal, S1 = 140 MHz (highest harmonic = 7), a swept LO from 200 MHz to 300 MHz (highest harmonic = 3), and an IF at 200 MHz.

Spurious responses will occur on the receiver dial over a 0 to 100 MHz range. The first line in the table indicates that a residual response (SPUR) will occur at 20 MHz if the LO and signal (SIG) frequencies of 220 MHz and 420 MHz are allowed to mix (420 MHz - 220 MHz = 200 MHz IF). These frequencies correspond to the fundamental and third harmonic of the LO and SIG, respectively, and are printed in the left two columns.

The spurious responses are printed out in the order of ascending harmonic numbers of the LO and SIG. This corresponds approximately to the amplitude order of the responses, since higher harmonic products generally have greater conversion loss. These responses are suppressed in a receiver through careful filter and mixer design.

EXAMPLE 2

Two mixers are analyzed in the following:



Input the data as:

```
10 DATA   2, 0, 0, 200, 300, 3, 200, 150, 7, 50
```

- Two mixers — 2
- No input signal — 0, 0
- 1st LO lowest frequency — 200
- 1st LO highest frequency — 300
- Max. 1st LO harmonic — 3
- 1st IF frequency — 200
- 2nd LO frequency — 150
- Max. 2nd LO harmonic — 7
- 2nd IF frequency — 50

RUN!

```
10 DATA 2,0,0,0,200,300.1,3,200,150,7,50
RUN
MIXSPR

UNITS? (GHZ,MHZ,KHZ)?MHZ

NUMBER OF MIXERS = 2
S1= 0          J1= 0          F3= 200          F4= 300.1
K1= 3          I1= 200
F5= 150        K2= 7          I2= 50
```

RESIDUAL SPURIOUS RESPONSES

FIRST MIXER

1ST LO	2ND LO	1ST LO MHZ	2ND LO MHZ	SPUR MHZ
1	3	250	450	50
2	2	500	300	50
2	4	400	600	0
2	5	550	750	75
3	3	650.	450	16.6667
3	4	800.	600	66.6667
3	6	700.	900	33.3334
3	7	850.	1050	83.3334

SECOND MIXER

1ST LO	2ND LO	1ST LO MHZ	2ND LO MHZ	SPUR MHZ
1	1	200	150	0
1	2	250	300	50
2	3	500	450	50
2	3	400	450	0
2	4	550	600	75
3	4	650.	600	16.6667
3	5	800.	750	66.6667
3	5	700	750	33.3333
3	6	850.	900	83.3333

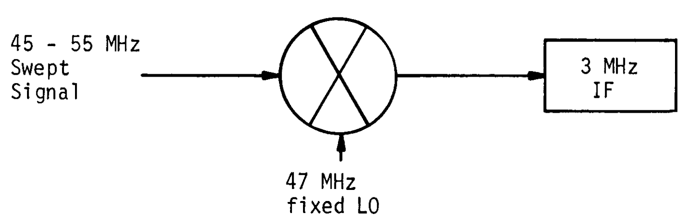
DONE

Although the response frequencies at first look redundant, you will notice that they come from different harmonics of the LO's. For example, a residual at 50 MHz can come from any of four separate mixing processes.

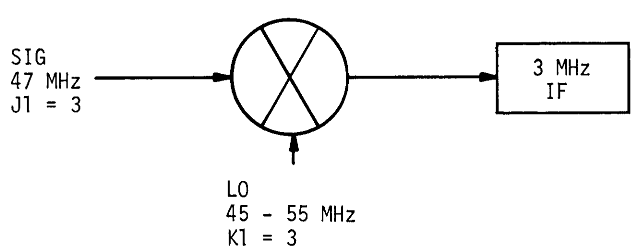
The first line in the second mixer output shows the zero frequency response generated by 1st LO feed-through into the 200 MHz IF.

EXAMPLE 3

Consider the case of a converter where a mixer is operated with a fixed 47 MHz LO which sees a swept input signal from 45 to 55 MHz.



As far as the mixing products are concerned, signal and LO ports may be reversed.



The spurious response readout is always referred to the lower edge of the receiver band. In this case, the signal is swept from 45 MHz to 55 MHz, so that the lower band edge is 45 MHz. Add this to line 776 in the program as shown and proceed as before:

```
776 R = R - A1 + 45

10 DATA 1, 37, 2, 45, 55, 3, 3

RUN

776 R=R-A1+45
10 DATA 1,47,3,45,55,3,3
RUN
MIXSPR

UNITS? (GHZ,MHZ,KHZ)?MHZ

NUMBER OF MIXERS = 1
S1= 47          J1= 3          F3= 45          F4= 55
K1= 3           I1= 3

 LO   SIG       LO MHZ         SIG MHZ         SPUR MHZ

 1     1         50             47              50
 2     2         97             94              48.5
 2     2         91             94              45.5
 3     3         144            141             48
 3     3         138            141             46

DONE
```

The desired response is in the first line of the table at 50 MHz. However, other responses at 48 and 48.5 MHz are very close to the 50 MHz IF and can be troublesome on a spectrum analyzer display if the filtering does not reject these.

CONCLUDING REMARKS

$MIXSPR is completely general in that it will handle any of the six combinations of signal, local oscillator, and intermediate frequencies. Shifted responses, e.g. a 1st LO translated by a 2nd LO and then mixed with 3rd LO, are not handled automatically for the case of three mixers. However, an easy check on a one-mixer-at-a-time basis (as in Example 3) will provide this information.

It is suggested that harmonic numbers for the oscillators be kept to 10 or less on the first run of the program, since the number of residual responses generally increases rapidly with harmonic number. Searching above the harmonic number of 15 for that un-explainable response usually means that it is coming from some other mixing process.

The procedure of injecting all of the oscillators (be sure to include calibration oscillators, etc.) separately in each mixer and checking for shifted responses will locate all of the residual responses. In-band, spurious responses may be checked in a similar manner.

CONTRIBUTED PROGRAM **BASIC**

SUNSET
36180

TITLE: SUNRISE-SUNSET PREDICTOR

DESCRIPTION:

The program computes the Greenwich Mean Time (or as an option, standard zone times) of sunrise and sunset phenomena for each day of a chosen week for a given latitude and longitude. The output for each day gives the morning time of the beginning of astronomical, nautical and civil twilights. The time and azimuth of sunrise are then given. The azimuth angle is given in standard form for astronomy: the angle is measured from the north (zero) through each (90°). The evening line gives the times of the ending of the respective twilights. Thus in the last line, the time and azimuth of sunset appear last. Reading "backwards" we obtain the end of civil twilight, nautical twilight, and astronomical twilight.

INSTRUCTIONS:

It is suggested that the user create his own version of the program by retyping two or three lines:

```
194 LET L3 = (latitude in decimal degrees)
195 LET L4 = (longitude in decimal degrees)
```

If zone time is desired instead of GMT, retype line 193 entering the appropriate value of Z from the table below. For example, to obtain Eastern Standard Time the line becomes

```
193 LET Z = 5
```

Time Zone	Z for Standard Time	Z for Daylight Time
Central European	-1	0
Eastern (U.S.)	5	4
Central (U.S.)	6	5
Mountain (U.S.)	7	6
Pacific (U.S.)	8	7
Alaska (Juneau)	8	7
Alaska (Fairbanks)	10	9
Hawaii	10	9

Data may be provided in lines 9000-9900 as pairs giving the starting day (Sunday's date for the desired week) and the month (1 through 12). If data are not provided, the program will request input. After each execution the program loops back for new data or input. If a DATA statement is used, entering 99,99 for the last data pair will terminate the run.

SPECIAL CONSIDERATIONS:

Astronomical constants in the program are correct for the year 1972 but the program will give times for any year within 50 years of 1972 correct to about two minutes. Execution time without EAU is about 15 seconds per day of output. If single terminal BASIC is used with 8K the matrix package must be deleted.

A row of stars appearing in the output indicates that the event does not exist. At northerly latitudes the various twilights may not occur in summer and above the arctic circle. Neither sunrise nor sunset will occur in late June.

ACKNOWLEDGEMENTS: David E. Laird
Cincinnati Country Day School

RUN

```
LIST-193,195
SUNSET

193  LET Z=5
194  LET L3=39.1849
195  LET L4=84.329

LIST-9000,9900
SUNSET

9000  DATA 19,3,99,99


RUN
SUNSET

     TWILIGHT PHENOMENA FOR WEEK OF MAR 19   TO 25

FOR STATION LATITUDE  39.1849    AND LONGITUDE  84.329     DEGREES
IN TIME ZONE  5

          ASTRONOMICAL  NAUTICAL   CIVIL      RISE/SET      AZIMUTH
            HR    MIN   HR   MIN   HR    MIN    HR    MIN   DEGREES
SUN
MORNING     5     12    5    44    6     15     6     42    89.8
EVENING     20    16    19   45    19    14     18    47    270.3

MON
MORNING     5     15    5    42    6     18     6     40    89.3
EVENING     20    20    19   48    19    17     18    51    270.7

TUE
MORNING     5     12    5    44    6     15     6     42    88.9
EVENING     20    21    19   49    19    18     18    52    271.2

WED
MORNING     5     11    5    43    6     14     6     40    88.4
EVENING     20    22    19   51    19    19     18    53    271.7

THUR
MORNING     5     9     5    41    6     12     6     39    87.8
EVENING     20    23    19   52    19    20     18    54    272.2

FRI
MORNING     5     7     5    39    6     11     6     37    87.3
EVENING     20    25    19   53    19    21     18    55    272.7

SAT
MORNING     5     6     5    38    6     9      6     36    86.8
EVENING     20    26    19   54    19    22     18    56    273.2
```

CONTRIBUTED PROGRAM **BASIC**

TZCPL
T-CPL
36654

TITLE: THERMOCOUPLE TABLE PACKAGE

DESCRIPTION:

This package consists of seven programs:

T-CPL — Produces a table of the ET characteristic for any of the four thermocouple types. The table can be generated for any temperature range and with a correction for any reference junction temperature. The table is generated by applying a cubic spline fit to fixed point data of the International Practical Temperature Scale of 1968. The program also prints the thermopower (first derivative) and second derivative values of the function.

T-CPL2 — Produces a temperature corresponding to the millivoltage input. This program also includes provisions for correcting for any desired reference temperature.

TYPE-E
TYPE-K
TYPE-S
TYPE-T — These programs contain the data for the above programs.

TC-DAT — This program prints the data in a form convenient for editing or checking.

INSTRUCTIONS:

GET the desired program. (T-CPL, T-CPL2, or TC-DAT)

APPend the data program appropriate to the type of thermocouple used. (TYPE-E, TYPE-K, TYPE-S, or TYPE-T)

RUN -- the programs are then self explanatory.

References:
R.K.ADAMS & R.L. SIMPSON Temperature Its Measurement & Control in Science & Industry. (Instrument Society of America, Pittsburgh, 1972) Vol. 4, Part 3, p. 1603.

SPECIAL CONSIDERATIONS:

Attempts to run T-CPL2 for values of thermocouple output very close to zero millivolts may result in underflow warnings.

Step sizes of less than .1 deg. C may result in rounding errors in T-CPL unless some program changes are made.

ACKNOWLEDGEMENTS:

Richard A. Milewski
Raytek Inc.

```
RUN

GET-T-CPL
APP-TYPE-T
RUN
T-CPL

INPUT REFERENCE JUNCTION TEMPERATURE IN DEGREES C
?0
INPUT TABLE START, END, AND STEP
?25,30,0.5
```

CALIBRATION TABLE FOR TYPE T THERMOCOUPLES

REFERENCE JUNCTION AT 0 DEGREES C

DEGREES C	MILLIVOLTS	THERMOPOWER	2ND DERIVATIVE
25	.992385	4.07858E-02	8.57160E-05
25.5	1.01279	4.08286E-02	8.56251E-05
26	1.03321	4.08714E-02	8.55341E-05
26.5	1.05366	4.09141E-02	8.54432E-05
27	1.07413	4.09568E-02	8.53523E-05
27.5	1.09462	4.09995E-02	8.52614E-05
28	1.11513	4.10421E-02	8.51705E-05
28.5	1.13566	4.10847E-02	8.50796E-05
29	1.15621	4.11272E-02	8.49887E-05
29.5	1.17679	4.11697E-02	8.48978E-05
30	1.19738	4.12121E-02	8.48069E-05

DONE

```
GET-T-CPL
APP-TYPE-E
RUN
T-CPL

INPUT REFERENCE JUNCTION TEMPERATURE IN DEGREES C
?0
INPUT TABLE START, END, AND STEP
?-100,300,50
```

CALIBRATION TABLE FOR TYPE E THERMOCOUPLES

REFERENCE JUNCTION AT 0 DEGREES C

DEGREES C	MILLIVOLTS	THERMOPOWER	2ND DERIVATIVE
-100	-5.24003	4.53355E-02	1.64079E-04
-50	-2.78356	5.26479E-02	1.30714E-04
0	0	5.84502E-02	1.01376E-04
50	3.04475	.06325	9.06139E-05
100	6.31603	6.75116E-02	7.98517E-05
150	9.78534	7.11389E-02	6.52407E-05
200	13.4177	7.40357E-02	5.06297E-05
250	17.1768	7.62212E-02	3.82025E-05
300	21.0321	7.79175E-02	2.96468E-05

DONE

```
GET-T2CPL2
APP-TYPE2E
RUN
T2CPL2

INPUT REFERENCE JUNCTION TEMPERATURE IN DEGREES C
?0
INPUT MILLIVOLTAGE
?12.4

 186.186      DEGREES C

INPUT MILLIVOLTAGE
?11.7

 176.603      DEGREES C

INPUT MILLIVOLTAGE
?8.377

 130.014      DEGREES C

INPUT MILLIVOLTAGE
?6.316

 99.9996      DEGREES C

INPUT MILLIVOLTAGE
?-2.31

-41.1021      DEGREES C

INPUT MILLIVOLTAGE
?-11

-11             OUT OF TABLE RANGE
INPUT MILLIVOLTAGE
?-9.2

-216.406      DEGREES C

INPUT MILLIVOLTAGE
?
DONE
```

```
GET-TC2DAT
APP-TYPE2K
RUN
TC2DAT

CUBIC SPLINE PARAMETERS FOR TYPE K THERMOCOUPLES

X               Y               Z

-270            -6.45779         1.79999E-04
-252.87         -6.41667         2.31446E-04
-195.802        -5.82572         1.80462E-04
-78.476         -2.86961         1.09880E-04
 0               0               5.12750E-05
 100             4.0945         -6.56060E-06
 122.37          5.0204         -3.80096E-05
 156.634         6.4096         -1.82532E-05
 231.968         9.4195          2.34117E-05
 327.502         13.3516         6.33419E-06
 419.58          17.2214         6.47652E-06
 660.37          27.4621        -7.81672E-06
 961.93          39.7798        -1.05406E-05
 1064.43         43.757         -1.35854E-05
 1372            54.877         -1.19100E-05

DONE
```

```
GET-TC←DAT
APP-TYPE←E
RUN
TC←DAT
```

CUBIC SPLINE PARAMETERS FOR TYPE E THERMOCOUPLES

X	Y	Z
-270	-9.83527	4.59999E-04
-252.87	-9.74485	3.70183E-04
-195.802	-8.7169	2.38214E-04
-78.476	-4.22751	1.47423E-04
0	0	1.01376E-04
100	6.31603	7.98517E-05
231.968	15.8088	4.12880E-05
327.502	23.1856	2.49409E-05
419.58	30.5142	1.02607E-05
660.37	49.9401	-1.08928E-05
961.93	73.496	-1.99897E-05
1000	76.3581	-1.92700E-05

DONE

CONTRIBUTED PROGRAM **BASIC**

WAVFN
36733

TITLE: COMPUTES AND PLOTS THE RADIAL PART OF HYDROGEN-LIKE WAVE FUNCTIONS

DESCRIPTION: This program computes and plots the radial part of hydrogen-like wave functions.

INSTRUCTIONS: The student inputs the nuclear charge (Z) and the principal (N) and azimuthal (K) quantum numbers.

Scaling limits can be modified by changing lines 101 and 111.

SPECIAL CONSIDERATIONS: None

ACKNOWLEDGEMENTS: Dr. Leonard Soltzberg
Simmons College

```
RUN

 RUN
 WAVFN

MAX. DISTANCE FROM NUCLEUS?4
DESIRED INTERVAL?.15
ENTER Z,N,L
Z=?1
N=?2
L=?0
YMIN= -.248692
YMAX=  1.83781
 .......................................................................
.        2                                                             1
.          2                                           1
.           2                              1
.            2                   1
.           2           1
.          2      1
.         2  1
.        21
.      1  2
.    1     2
.  1        2
. 1           2
.1             2
.1               2
.1                2
.1                  2
.1                   2
. 1                  2
. 1                  2
. 1                  2
.  1                 2
.  1                 2
.   1               2
.   1              2
.   1              2
.    1            2
.    1           2
 .......................................................................

DONE
```