

# GE-400 Series Time-Sharing Library Programs

PROGRAM ABSTRACTS



# GE-400 SERIES TIME-SHARING LIBRARY PROGRAMS

# **PROGRAM ABSTRACTS**





INFORMATION SYSTEMS DIVISION

B

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#### INTRODUCTION

This manual contains descriptions of the programs available in the Time-Sharing Library. Each program is described using a standard format - referred to as a program abstract.

#### Program Abstract

This specifies the purpose of the program, gives instructions for its use, and demonstrates both of these via a sample problem. This is fully stated with the necessary input and output provided as it would appear to a user at a terminal.

#### Locating a Program Abstract

This is a simple procedure. Programs are grouped into broad classes:

B = Business and Financial

E = Engineering

M = Mathematical and Scientific

S = Statistical

T = Tutorial

Within each class the program is given a number in the range 001 - 999. This number simply indicates the point in time when the program was entered in the library. Hence the latest program will have the highest number in its class.

Within the manual, the classes are in separate sections; each section has its class letter printed at the edge of the page. Hence to find a particular program, it is necessary only to go to the relevant section - business, engineering, etc. - and locate the program abstract in its numerical sequence.

The class and number of a program are called the program code. This is printed at the top of each page for easy reference.

For example: The program ANNUIT\*\*\* has the program code B001. To locate the abstract, turn to section (B) and then the first program.



In practice, programs are referred to by their names rather than by program code. To simplify locating a program an index is provided listing both program names and program codes. This is in order by program code, reflecting the chromological sequence of program entries. This also makes updating the index very simple.

#### PROGRAM INDEX:

Note that all program names are assumed to have three asterisks following)

Program <u>Code</u>	Name	Description			
BUSINESS AND FINANCIAL:					
B001 B002 B003	ANNUIT TRUINT SAVING	Computes annuities, loans, mortgages Computes true annual interest on installment loan Computes value of saving plan at Compound interest			
ENGINEERING	:				
E001 E002 E003 E004 E005	LPFILT LCVSIC GCVSIZ SCVSIZ BEMDES	To design lowpass filters To compute liquid value coefficients To compute gas/vapor valve coefficients To compute steam valve coefficients Steel beam design program			
MATHEMATIC	AL AND SCIENTIFIC:				
M001	ZEROES	To find zeroes of a function and relative maxima and minima			
M002 M003 M004 M005	CIRCLE SIMEQN ROOTER NUMINT	To divide a circle into (n) given parts To solve (n) linear equations in (n) unknowns To find roots of polynomial (Bairstow's method) To evaluate definite integral (Gauss' method)			
M006 M007 M008 M009 M010	SPHERE TRIANG CURFIT XYPLOT PLOTTO	To solve spherical triangles To solve for major features of a triangle To determine best fit of 6 curves to data To plot single function of X Plots 1 to 6 functions simultaneously			
M011 M012 M013 M014	TWOPLO LINPRO TMFCEV MULFIT CPMONE	Plots two functions of X simultaneously Maximizes objective function (2-phase method) Evaluates time functions (exp. + sin/cos) Supplies statistical analysis of up to 61 observations (1-6 variables) CPM input edit program (see CPMONX***)			
		, and the property (200 of 11101111 )			



STATISTICAL:		(List program STADES*** for general info on several of programs below)
S001	MANDSD	Computes mean, variance, std. deviation for data
S002	UNISTA	Description of univariate data
S003	STATAN	Gives 34 measures for univariate data
S004	PROVAR	Calculations for normal and Student's distribution
S005	LINREG	Linear regression: three curve types
S006	COLINR	Confidence limits on linear regression
S007	CONBIN	Confidence limits on proportion using normal approximation
S008	CONDIF	Confidence limits on difference between 2 means
S009	CONLIM	Confidence limits on sample mean value
S010	BICONF	Confidence limits on proportion using binomial
		• •
S011	BITEST	Test of binomial proportion
S012	BINDIS	Computes binomial probability distributions
S013	SEVPRO	Applies chi-square test to sample proportions
S014	ONEWAY	A variance analysis with equal sample sizes
S015	TESTUD	Tests population means using sample statistics

#### Note:

The above programs have all been reviewed and tested - however, no responsibility can be assumed.



# **BUSINESS & FINANCIAL**



#### **PURPOSE**

To perform the calculations necessary for determining both payment and withdrawal annuities.

#### **INSTRUCTIONS**

To use this program supply values for the variables as required by the problem.

Variables are denoted as follows:

- N = Number of periods
- P = Original principal amount
- A = Total amount at end of n periods
- I = Interest rate per period, in percent
- R = Amount of payment/withdrawal each period

For a payment annuity, you may give any three of N, A, I, R and find the fourth.

For a withdrawal annuity, you give any three of N, P, I, R and find the fourth.

For loan or mortgage, use the withdrawal annuity option.

After each case, you may choose one of the following alternatives:

- 1 = Another case, same unknown variable
- 2 = Another case, different unknown
- 3 = Another case, other type of annuity
- 4 = Total interest paid over n periods
- 5 = Table of withdrawals, principal, and interest
- 6 = Stop the program

Additional instructions maybe found in the listing.

#### SAMPLE PROBLEM

#### Payment Option:

Assume you intend to deposit \$35 a month in the local bank and want to know how much you would have after four years. The bank pays 4-7/8% a year and compounds quarterly.



```
ANNUIT * * *
B001
Page 2
```

For this program you must convert everything to a quarterly basis.

```
N = 4 . 4 = 16 periods
A = variable of interest
1 = 4.875/4 = 1.21875/period
R = 35 . 4 = 105/period
```

The above values of N, I and R will be entered during the running of the program.

#### NOTE:

You must supply the portions of the printout which are underlined.

The answer (\$1842.65) is printed out after you select the proper options at lines 2 and 3 and enter (in proper sequence) N, I and R at line 4.

The answer does not account for any simple interest that might have been paid on \$35 deposits prior to the first compounding period.

The total interest (4) and table (5) alternatives do not apply to the payment option.

#### Withdrawal Option:

Determines the monthly principal and interest payments on a \$20,900 mortgage for 30 years at 5-1/2% per year.

To use this program you must convert everything to a monthly basis:

The above values of N, P, and I, will be entered during the running of the program.

The complete run will be as shown in the sample solution.

- 1. The answer (\$118.668) is printed out when the proper options at lines 2 and 3 are entered (in proper sequence) N, P, and I, at line 4.
- 2. The total interest and a payments table was obtained by answering 4 and 5 respectively to the "another case" question. The "S" key was used to stop the table print-out at period 13.



#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

RUN

ANNUIT

ANNUITY CALCULATION

WANT INSTRUCTIONS FIRST (1=YES, 2=N0)?2

WHICH ANNUITY TYPE (1=PAYMENT, 2=WITHDRAWAL)?1

WHICH VARIABLE IS UNKNOWN (1=N,2=A,3=I,4=R)?2

WHAT ARE N(INTEGER), I(PCT), R(\$)?16, 1.21875, 105.00

AMOUNT AT END OF N PERIODS = A = 1842.65

ANOTHER CASE (TYPE CODE NUMBER)?6



ANNUIT \* \* \* B001 Page 4

RUN

ANNUIT

ANNUITY CALCULATION

WANT INSTRUCTIONS FIRST (1=YES, 2=NO)? 2

WHICH ANNUITY TYPE [1=PAYMENT, 2=WITHDRAWAL]? 2

WHICH V@RIABLE IS UNKNOWN [1:N,2:P,3:I,4:R]? 4

WHAT ARE N(INTEGER), P(\$), I(PCT)? 360, 20900, .458333333

WITHDRAWAL EACH PERIOD = R = 118.668

ANOTHER CASE [TYPE CODE NUMBER]? 4

TOTAL INTEREST PAID = 21820.5

20900

ANOTHER CASE [TYPE CODE NUMBER]75

PER I ØD	PRINCIPAL	INTEREST	PRINC BAL	INT TO DATE
0			20900	
1	22.88	95.7879	20877.1	95.7879
2	22.98	95.6879	20854.1	191.476
3	23.09	95.5779	20831.1	287.054
4	23.19	95.4779	20807.9	382.532
5	23.3	95.3679	20784.6	477.9
6	23.41	95.2579	20761.2	573.157
7	23.51	95.1579	20737.6	668.315
8	23.62	95.0479	20714.	763.363
9	23.73	94.9379	20690.3	858.301
10	23.84	94.8279	20666.5	953.129
11	23.95	94.7179	20642.5	1047.85
12	24.06	94.6079	20618.4	1142.45
13	24.17	94.4979	20594.3	1236.95
14	24.28	94.3879	20570	1331.34
15	24.39	94.2779	20545.6	1425.62
16	@2.T	2 122 113	200.00	



#### **PURPOSE**

To calculate the true annual interest rate charged on an instalment loan.

#### INSTRUCTIONS

To use this program simply supply values for the four variables:

A = AMOUNT OF LOAN [IN \$].

P = AMOUNT OF EACH PAYMENT [\$].

N = THE TOTAL NUMBER OF PAYMENTS DUE.

K = THE NUMBER OF PAYMENTS DUE IN ONE YEAR.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Determine the true interest charged on these two loans:

Loan 1 is for \$600 for 21 months with a payback of \$31.99 per month. Loan 2 is for \$1400 for 30 months with a payback of \$54.90 per month. The bank's stated rate is 6%. The input data would be:

#### Loan 1

A = Amount of Loan = \$600.00

P = Amount of each payment = \$31.99

N = Total Number of Payments = 21

K = Number of Payments in one year = 12

#### Loan 2

A = \$1400.00

P = \$54.90

N = 30

K = 12



TRUINT \* \* \*
B002
Page 2

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

Note:

All user supplied information is underlined

TRUI NT

THIS PROGRAM WILL CALCULATE THE TRUE ANNUAL INTEREST RATE CHARGED ON AN INSTALLMENT LOAN. YOU SUPPLY THE VALUES OF FOUR VARIABLES: A = AMOUNT OF LOAN [IN \$], P = AMOUNT OF EACH PAYMENT [\$], N = THE TOTAL NUMBER OF PAYMENTS DUE, AND K = THE NUMBER OF PAYMENTS DUE IN ONE YEAR. WHAT ARE A,P,N,K? 600.00, 31.99, 21, 12

THE TRUE ANNUAL INTEREST RATE = 12.61

ANØTHER CASE? [TYPE 'S' TØ STØP NØW]. WHAT ARE A,P,N,K? 1400.00, 54.90, 30, 12

THE TRUE ANNUAL INTEREST RATE = 12.98

ANØTHER CASE? (TYPE 'S' TØ STØP NØW). WHAT ARE A,P,N,K?



#### **PURPOSE**

To calculate the amount of money that would accumulate after N years at an annual interest rate R compounded T times per year, when the initial amount is P and an amount D is added at the beginning of each subsequent year.

#### INSTRUCTIONS

To use this program enter the data as requested.

NOTE:

P and D must be given in dollars, N and T in integers, and R as a percentage.

Additional instructions may be found in the listing.

# SAMPLE PROBLEM

Several cases are used based on the input data underlined in the sample solution.



#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

RUN

SAVI NG

THIS PRØGRAM CALCULATES THE AMOUNT ØF MØNEY THAT WOULD ACCUMULATE AFTER N YEARS AT AN ANNUAL INTEREST RATE R COMPOUNDED T TIMES PER YEAR, WHEN THE INITIAL AMOUNT IS P AND AN AMOUNT D IS ADDED AT THE BEGINNING OF EACH SUBSEQUENT YEAR. NØTE THAT P AND D ARE GIVEN IN DØLLARS, N AND T MUST BE INTEGERS, AND R IS GIVEN AS A PERCENTAGE.

WHAT ARE P,D,N,T,R?6000.00,200.00,20,4,4

AFTER 20 YEARS, 6000 DØLLARS INVESTED AT 4
PERCENT CØMPØUNDED 4 TIMES PER YEAR, WITH THE
ADDITION OF 200 DØLLARS PER YEAR, YIELDS A TOTAL
ØF 19093.4 DØLLARS.

TYPE 'S' TØ STØP NØW, ØR ELSE WHAT ARE P,D,N,T,R?6000.00,0,20,4,4

AFTER 20 YEARS, 6000 DØLLARS INVESTED AT 4 PERCENT CØMPØUNDED 4 TIMES PER YEAR, WITH THE ADDITION OF 0 DØLLARS PER YEAR, YIELDS A TOTAL OF 13300.3 DØLLARS.

TYPE 'S' TØ STØP NØW, ØR ELSE WHAT ARE P,D,N,T,R?6000.00,0,20,1,4

AFTER 20 YEARS, 6000 DØLLARS INVESTED AT 4 PERCENT COMPOUNDED I TIMES PER YEAR, WITH THE ADDITION OF O DØLLARS PER YEAR, YIELDS A TOTAL OF 13146.7 DØLLARS.

TYPE 'S' TØ STØP NØW, ØR ELSE WHAT ARE P,D,N,T,R?7000.00,0,20,4,5.25

AFTER 20 YEARS, 7000 DØLLARS INVESTED AT 5.25 PERCENT CØMPØUNDED 4 TIMES PER YEAR, WITH THE ADDITION OF 0 DØLLARS PER YEAR, YIELDS A TØTAL ØF 19867.4 DØLLARS.

TYPE 'S' TØ STØP NØW, ØR ELSE WHAT ARE P,D,N,T,R?6000,0,3,4,5.50

AFTER 3 YEARS, 6000 DØLLARS INVESTED AT 5.5 PERCENT CØMPØUNDED 4 TIMES PER YEAR, WITH THE ADDITION OF 0 DØLLARS PER YEAR, YIELDS A TOTAL OF 7068.41 DØLLARS.

TYPE 'S' TØ STØP NØW, ØR ELSE WHAT ARE P,D,N,T,R?S



# ENGINEERING

E



#### **PURPOSE**

To design low pass filters using constant K prototype T section and M derived [1=0.6] termination L sections. Up to nine additional M derived T sections may be included to give high attenuation at specified frequencies in the stop band.

#### INSTRUCTIONS

To use this program, enter data as:

10 DATA R, C, N, F[I], F [2],..., F[N]

WHERE R = DESIRED CHARACTERISTIC IMPEDANCE IN OHMS

C = DESIRED CUTOFF FREQUENCY IN CYCLES/SECOND

N = NUMBER OF ATTENUATORS DESIRED IN STOP BAND

F [I] = FREQUENCY FOR ATTENUATOR I

Then Type RUN

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Design a low pass filter with a 50 ohm impedance, 20 kc cut-off frequency. 2 attenuators in stop band, 455KC and 91 KC attenuators in the filter.



LPFILT \* \* \* E001 Page 2

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

10 DATA 50,2E4,2,455000,91E3 RUN WAIT.

LPFILT

DESIGN FOR DESIRED LOW PASS FILTER:

0< 50	OHM LINE	
+424413 MH +	.095493	MFD
.63662	мн	İ
1 +	MFD	
.79539	мн	I I
1 + 3.84758 E-4 MH +	.318002	MFD+
I > .785662	мн	I I
I + 9.85050 E-3 MH +	.310527	MFD+
i > .626891	мн	Ī
I +424413 MH +	.095493	MFD
I 0< 50	OHM LINE	I >0

TERMINATING SECTIONS GIVE MAXIMUM ATTENUATION AT 25000 CPS IN ADDITION TO THE SPECIFIED ATTENUATOR FREQUENCIES.



#### **PURPOSE**

To calculate liquid valve coefficients and the required valve rangeability.

#### INSTRUCTIONS

Enter input data using the following format:

20 DATA ENTER DATA IN ORDER...MIN. PRESS. DROP, MAX. PRESS. DROP, MIN. FLOW AND MAX. FLOW.

TYPE:

25 DATA ENTER ONE OR MORE VALUES OF FLUID SPECIFIC GRAVITY, FOR EXAMPLE, EXPECTED HIGH AND LOW.

Then type RUN

NOTE:

To size more valves, enter new data in lines 20 and 25, then type RUN.

Reference is the voluntary standard (Nov., 1961) of the Fluid Controls Institute, Inc. No viscosity corrections are available yet. Consult valve manufacturers about viscous or non-newtonian fluids.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Determine the valve coefficients which satisfy the data used in the sample solution.



```
LCVSIC * * *
E002
Page 2
```

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

```
20 DATA 30, 70, 3.5, 12.5
25 DATA .9, 1, 1.1
RUN
WAIT.
```

LCVSIC 11:40

\*\*\*THE IDENTITY OF THE VALVE IS

WHEN SPECIFIC GRAVITY = .9

```
FLØW,GPM PRESS.DRØP, PSI VALVE CØEFF.

3.5 30 .606218

12.5 30 2.16506

3.5 70 .396863

12.5 70 1.41737

RATIO ØF HIGH/LØW CØEFFICIENTS= VALVE RANGEABILITY
```

WHEN SPECIFIC GRAVITY = 1

```
FLØW,GPM PRESS.DRØP,PSI VALVE CØEFF.
3.5 30 .63901
12.5 30 2.28218
3.5 70 .41833
12.5 70 1.49404
```

RATIO OF HIGH/LOW COEFFICIENTS= VALVE RANGEABILITY

WHEN SPECIFIC GRAVITY = 1.1

```
FLØW,GPM PRESS.DRØP,PSI VALVE CØEFF.

3.5 30 .670199

12.5 30 2.39357

3.5 70 .438748

12.5 70 1.56696

RATIO ØF HIGH/LØW CØEFFICIENTS=VALVE RANGEABILITY
```

OUT OF DATA IN 40

TIME: 1 SECS.



#### **PURPOSE**

To calculate gas and vapor (but not steam) control valve coefficients and the required valve rangeability.

#### INSTRUCTIONS

Enter input data using the following format:

TYPE: 20 DATA ENTER IN ORDER....MIN. TEMP. IN DEGREES F, MAX. TEMP. IN DEGREES F, MOLECULAR WEIGHT.

TYPE: 25 DATA ENTER DATA IN GROUPS OF 3, AS MANY GROUPS AS YOU NEED, IN THIS ORDER.....PPH FLOW, INLET PSIG, OUTLET PSIG, 2ND FLOW, 2ND PRESS., ETC...

Then type RUN

#### NOTE:

When pressure drop is critical, the program assumes outlet pressure is half the absolute inlet pressure. The program also converts pressure and temperature to absolute.

Reference is equation 4 of the voluntary standard agreed to in Nov., 1961 by the Fluid Controls Institute, Inc.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Determine the control valve coefficients which satisfy the data used in the sample solution.



GCVSIZ \* \* \* E003 Page 2

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

20 DATA 470,870,112.5 25 DATA 1350,145,80,8000,145,80,1350,195,105,8000,195,105 RUN WAIT.

GCVSIZ 11:34

RATIO OF HIGH/LOW COEFF. = REQUIRED VALVE RANGEABILITY.

\*\*\* THE IDENTITY OF THE VALVE IS

WHEN FLOW IN PPH = 1350	FLØW IN SCFH = 4550.53
TEMP IN DEG F INLET PSIG 470 145 870 145	ØUTLET PSIG         PRESS DRØP PSI VALVE CØEFF.           80         65.         2.20719           80         65.         2.63951
WHEN FLOW IN PPH = 8000	FLOW IN SCFH = 26966.1
TEMP IN DEG F INLET PSIG 470 145 870 145	ØUTLET PSIG         PRESS DRØP PSI VALVE CØEFF.           80         65.         13.0796           80         65.         15.6416
WHEN FLOW IN PPH = 1350	FLØW IN SCFH = 4550.53
TEMP IN DEG F INLET PSIG 470 195 870 195	ØUTLET PSIG         PRESS DRØP PSI VALVE CØEFF.           105         90.         1.64843           105         90.         1.97131
WHEN FLOW IN PPH = 8000	FLØW IN SCFH = 26966.1
TEMP IN DEG F INLET PSIG 470 195 870 195 OUT OF DATA IN 45	ØUTLET PSIG         PRESS DRØP PSI VALVE CØEFF.           105         90.         9.76849           105         90.         11.6819

TIME: 1 SECS.

#### **PURPOSE**

To calculate steam control valve coefficients and the required valve rangeability.

#### INSTRUCTIONS

Enter input data using the following format:

TYPE: 20 DATA ENTER DEGREES F OF SUPERHEAT IN THE STEAM OR ENTER ZERO IF IT IS ZERO.

TYPE: 25 DATA ENTER DATA IN GROUPS OF 3, AS MANY GROUPS
AS YOU WISH OR NEED, IN THIS ORDER...FLOW IN PPH,
INLET PSIG, OUTLET PSIG; THEN SECOND FLOW, SECOND
INLET PRESSURE, SECOND OUTLET PRESS., ETC......

Then type RUN

#### NOTE:

When pressure drop is critical, the program assumes outlet pressure is half the absolute inlet pressure. The program also converts pressures to absolute.

Reference is equation 8 of the November, 1961 Fluid Controls Institute, Inc. voluntary standard.

To size more valves, enter new data in 20 and 25 and type RUN. If for saturated steam, zero in 20 need be entered only once. It will stay in.

Additional instructions may be found in the listing.



SCVSIZ \* \* \* E004 Page 2

#### SAMPLE PROBLEM

Determine the valve coefficients which satisfy the data used in the sample solution.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

20 DATA 463 25 DATA 1000,106,104,10000,106,104,1000,66,64,10000,66,64 RUN WAIT.

SCVSIZ 11:17

RATIO OF HIGH/LOW COEFF.=REQUIRED VALVE RANGEABILITY

\*\*\* THE IDENTITY OF THIS VALVE IS

WHEN SUPERHEAT IN DEGREES F = 463

INLET PSIG OUTLET PSIG PR.DROP, PSI FLOW, PPH VAL	
106 104 2 1000 28	.8154
106 104 2 10000 28	8.154
66 64 2 1000 35	.3136
66 64 2 10000 35	3.136

ØUT ØF DATA IN 60

TIME: 1 SECS.



#### PURPOSE

To recommend the correct steel beam to be used in any of the following 13 load and support cases.

CASE 1	Uniform distributed load on simple beam.
<b></b>	Uniform distributed load, beam fixed at one end, supported at other.
CASE 2	Uniform distributed load, beam fixed at one end, supported at officer.
CASE 3	Uniform distributed load, beam fixed both ends.
CASE 4	Uniform distributed load, cantilever beam.
CASE 5	Single midpoint load on simple beam.
CASE 6	Single midpoint load, beam fixed at one end, supported at other.
CASE 7	Single midpoint load, beam fixed both ends.
CASE 8	Single midpoint load, cantilever beam.
CASE 9	Two equal loads, placed symetrically on simple beam.
CASE 10	Uniform load plus midpoint load on simple beam.
CASE 11	Uniform load plus midpoint load, beam fixed one end, supported at other.
CASE 12	Uniform load plus midpoint load, fixed both ends.
CASE 13	Uniform load plus midpoint load, cantilever beam.

#### INSTRUCTIONS

To use this program type RUN, then respond to the following questions:

Which load and support case number properly describes your problem (list lines 1 thru 16 for definitions)?

What is the length of the span in feet?

What is the distributed load in pounds per foot?

What is the amount of each concentrated load in pounds?

What are the locations of the concentrated loads in feet from the end?

Additional instructions may be found in the listing.



# SAMPLE PROBLEM

Determine the type of beam required for each of the 13 cases listed in the following table.

Case No.	PICTURE	Feet Span	Distrib Load	Concen Load	From End
1	DISTRIB	23	1000		
2	<b>3</b> +++++++++++++*	23	100		
3	<u> </u>	23	1000		
4	<u> </u>	23	500		
5	CONC	23		25000	
6	<b>1</b>	23		50000	
7		23		50000	
8	<u></u>	23		25000	
9	FROM DEND	23		10000 10000	(A)4' (B)9'
10	<del>, , , , , , , , , , , , , , , , , , , </del>	23	6000	150000	
11	<del>3</del>	23	15000	400000	
12	<del>Jamin Linnie</del>	23	1000	25000	
13	<u> </u>	23	500	10000	
		CAN NOT B BY THIS P			



#### SAMPLE SOLUTION

The following sample solutions are copies of the printout that will appear at your teletype-writer.

#### NOTE:

All user supplied information is underlined.

RUN

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPORT CASE NUMBER PROPERLY DESCRIBES YOUR PROBLEM (LIST LINES 1 THRU 16 FOR DEFINITIONS) ?  $\frac{1}{2}$  What is the length of the span in feet ?  $\frac{23}{2}$  What is the distributed Load in Pounds per foot ?  $\frac{1000}{2}$ 

USE A 14 WF 30

RUN WAIT.

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPORT CASE NUMBER PROPERLY DESCRIBES YOUR PROBLEM (LIST LINES 1 THRU 16 FOR DEFINITIONS) ? 2 WHAT IS THE LENGTH OF THE SPAN IN FEET ? 23 WHAT IS THE DISTRIBUTED LOAD IN POUNDS PER FOOT ? 100

USE A 8 JR 6.5

RUN

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPORT CASE NUMBER PROPERLY DESCRIBES YOUR PROBLEM (LIST LINES 1 THRU 16 FOR DEFINITIONS) ?  $\frac{3}{2}$  what is the length of the span in feet ?  $\frac{23}{2}$  what is the distributed Load in Pounds per foot ?  $\frac{1000}{2}$ 

USE A 12 WF 27



BEMDES \* \* \* E005 Page 4

> RUN WAIT.

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPØRT CASE NUMBER PRØPERLY DESCRIBES YØUR PRØBLEM (LIST LINES 1 THRU 16 FØR DEFINITIØNS) ? 8 WHAT IS THE LENGTH ØF THE SPAN IN FEET ? 23 WHAT IS THE AMOUNT ØF EACH CONCENTRATED LØAD IN POUNDS ? 25000

USE A 24 WF 84

RUN

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPORT CASE NUMBER PROPERLY DESCRIBES YOUR PROBLEM (LIST LINES 1 THRU 16 FOR DEFINITIONS) ? 9 WHAT IS THE LENGTH OF THE SPAN IN FEET ? 23 WHAT IS THE AMOUNT OF EACH CONCENTRATED LOAD IN POUNDS ? 10000 WHAT ARE THE LOCATIONS OF THE CONCENTRATED LOADS IN FEET FROM THE END ? 4 9

USE A 30 WF 108

RUN

BEMDES

PROGRAM FOR SELECTION OF STEEL BEAMS.

WHICH LØAD AND SUPPORT CASE NUMBER PROPERLY DESCRIBES YOUR PROBLEM (LIST LINES 1 THRU 16 FOR DEFINITIONS) ? 13
WHAT IS THE LENGTH OF THE SPAN IN FEET ? 23
WHAT IS THE AMOUNT OF EACH CONCENTRATED LOAD IN POUNDS ? 10000
WHAT IS THE DISTRIBUTED LOAD IN POUNDS PER FOOT ? 500

USE A 24 WF 76

NOTE:

Solutions for sample problem cases 1, 2, 3, 8, 9, and 13 provide at least one example of each unique data situation.



# MATHEMATICAL + SCIENTIFIC

M



#### **PURPOSE**

To locate "interesting" values of X for any function of X. Specifically to locate the values of X at which relative maximums and minimums of F[X] occur, and the values of X for which F[X] is zero [i.e., the zeroes or roots of the function].

#### INSTRUCTIONS

To use this program, enter data using the following format:

```
100 DATA <XMIN>, <XMAX>, <ACC>, <INCR>
200 LET Y = <A FUNCTION OF X>
RUN
```

#### NOTE:

XMIN and XMAX define the interval in which interesting values of X are to be sought, ACC is the accuracy [in number of significant figures] to which the ZEROES of X and the maximum and minimum values of F[X] are to be estimated, INCR is the number of increments into which the total interval is to be divided for search purposes [try 50 to start], and the function of X is any legitimate basic-language expression involving the variable X.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

To illustrate how this program is used consider the sine function, it crosses the axis at 0 degrees and every 180 degrees thereafter, has maximums at 90 degrees and every 180 degrees thereafter. degrees thereafter and has minimums at 270 degrees and every 180 degrees thereafter.

To use this program to arrive at the same conclusion enter the following data:

```
100 DATA 0, 725, 3, 200
200 LET Y = SIN(X*3.14159265/180)
```



ZERGES \* \* \* M001 Page 2

#### NOTE:

Since BASIC assumes all trig functions are in radians, you must convert degrees to radians by multiplying X by Pi over 180.

The slight errors at the maximums and minimums are due to the binary nature of the machine--Pi could not be represented exactly and it was stepping through the function in fractional steps.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

ZERØES

PØINT-TYPE	F[X]	×
Z ER Ø	0.	0
MAX	1.	90.002
ZERØ	0.	180.004
MIN	-1.	270.006
ZERØ	0.	360.008
MAX	1.	450.01
ZERØ	0.	540.012
MIN	-1.	630.014
ZER Ø	0.	719.987



#### **PURPOSE**

To divide circles into any number of equal parts, giving the angles in Decimal Degrees and Degrees, Minutes, and Seconds, and to calculate the Horizontal and Vertical Distances from the center to the point on the circumference.

#### **INSTRUCTIONS**

To use this program enter the input data in the following format:

NOTE:

N = the number of parts R = the radius of circle

As many cases as desired may be entered in the same way by continuing the data list.

After all the data is entered type RUN.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Divide 3 sheet metal disks of 18.351 inches radius into equal segments of 3, 7, and 15 parts. To use this program enter the following data:

10 DATA 3, 18.351, 7, 18.351, 15, 18.351



CIRCLE \* \* \*
M002
Page 2

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

READY.

10 DATA 3, 18.351, 7, 18.351, 15, 18.351

RUN WAIT.

CIRCLE

DIVISION OF CIRCLE

CAS	E NUMBER	1	NUI	MBER OF PAR	TS: 3	RADIUS:	18.351
	• • • • • • •	.ANGL	E	• • • •		CO-ORD	INATES
INDEX	DECIMAL	DEG	MIN	SEC		HORIZ	VERT
1	120	120	0	0		-9.1755	15.8924
2	240	240	0	0		-9.17551	-15.8924
3	360	360	0	0		18.351	0

CASE NUMBER: 2			NUMBER OF PARTS: 7			RADIUS: 18.351	
	•••••	.ANGL	CO-ORDINATES				
INDEX	DECIMAL	DEG	MIN	SEC		HORIZ	VER T
1	51.4286	51	25	42.9		11.4417	14.3474
2	102.857	102	51	25.7		-4.08348	17.8909
3	154.286	154	17	8.6		-16.5337	7.96221
4	205.714	205	42	51.4		-16.5337	-7.96219
5	257.143	257	8	34.3		-4.08349	-17.8909
6	308.571	308	34	17.1		11.4417	-14.3474
7	360.	360	0	0		18.351	0



C	ASE NUMBER:	3	NU	IBER OF	PARTS:	15	RADIUS:	18.351
		. ANGL	CO-ORDINATES					
INDE	X DECIMAL	DEG	MIN	SEC			HORIZ	<b>VE</b> R <b>T</b>
1	24	24	0	0			16.7645	7.46402
2	48	48	0	0			12.2792	13.6374
3	72	72	0	0			5.67077	17.4528
Ă	96	96	0	0			-1.9182	18.2505
2 3 4 5 6 7	120	120	0	0			-9.1755	15.8924
6	144	144	Ó	0			-14.8463	10.7865
7	168	168	Ö	0			-17.95	3.8154
8	192	192	Õ	0			-17.95	-3.81538
9	216	216	Ŏ	Ō			-14.8463	-10.7864
ĭo	240	240	Ŏ	Ŏ			-9.17551	-15.8924
11	264	264	ō	Ö			-1.91821	-12505
iż	288	288	ŏ	Ŏ			5.67076	-17.4528
i 3	312	312	ŏ	Ŏ			12.2792	-13.6375
14	336	336	ŏ	ŏ			16.7645	-7.46404
13	360	360	ŏ	ŏ			18.351	0



#### **PURPOSE**

To solve systems consisting of N linear equations in N unknowns.

#### INSTRUCTIONS

To use, this program, enter coefficients in the equations in data statements, starting in statement number 1 with the first coefficient of the first equation, and ending with the N-TH coefficient of the N-TH equation. All zero coefficients must be entered in their proper place. The right-side constant terms of the equations are then entered in subsequent data statements. If additional cases with the same coefficient matrix but different right sides are to be run, they may all be run at once by simply entering additional data statements with the right-side values of the other cases. A zeroth data statement [preceding all the above] is used to specify the number of systems to be solved, and the number of equations [and hence variables] in the system. Thus, the two systems:

$$3X + 5Y - 2Z = 9$$
  $3X + 5Y - 2Z = 19$   $7X + Y = -3$   $X - 7Y + 9Z = 14$   $X - 7Y + 9Z = 8$ 

Could be solved by typing:

```
O DATA 2,3
1 DATA 3,5,-2,7,1,0,1,-7,9
2 DATA 9,-3,14,19,-3,8
RIN
```

Solutions are proofed by multiplying the vector by the original coefficient matrix.

Additional instructions may be found in the listing.



```
SIMEQN * * *
M003
Page 2
```

#### SAMPLE PROBLEM

Solve the following sets of simultaneous equations:

The extreme right-hand column of numbers is a second set of right-hand values.

To use this program to solve the two sets, prepare the following data tape:

```
0 DATA 2, 4
1 DATA 25, -2.7, 38.7, 1, 0, 18, -5.8, -3
2 DATA 6, 9, 18, 0, 11, 0, 87, 41
3 DATA 115.76, 11.5, 55, 17, 10, 20, 30, 40
```

In the 0 line, the 2 means two sets of equations and the 4 means each set consists of four equations. In the 1 and 2 lines, the 0's are necessary to represent any missing (zero coefficient) terms in the set. Line 4 contains the right-hand values for both sets.

#### NOTE:

Supply all portions of the print-out which are underlined.

The answers for the first set would be read thus:

$$W = 1.25315$$
  $Y = 2.34878$   $X = .578122$   $Z = -4.90557$ 

The proof lines merely use the calculated values to evaluate the left-hand side of each equation to prove that they give the right-hand value.



#### SAMPLE SOLUTIONS

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

0	D	Α	TΑ	2	• 4	4														
I	D	A	TA	2	5,	-2	2.7	7,	38	3.	7,	1		0.	18		-5,	.8,	, -	3
2	D	A	TA	6	, :	Э,	18	3,	0,	, 1	ll,		٥,	8	7,	4				
3	D	A	TΑ	1	13	.70	5,	T	T.:	5,	3:	5,	1	7,	10	,	<sup>-</sup> 20,	, 3	10,	40
R	UN	<u> </u>																		

#### SIMEQN

SOLUTION FOR LINEAR SYSTEM OF ORDER 4

INDEX:

1 2 3 4

SOLUTION VECTOR FOR CASE I

1.25315 .578122 2.34878 -4.90557

PROOF OF SULUTION FOR CASE I

115.76 11.5 55. 17.

SØLUTIØN VECTØR FØR CASE 2

-1.95156 1.3087 1.66283 -2.02925

PROOF OF SOLUTION FOR CASE 2

10. 20. 30. 40.



#### **PURPOSE**

To find the roots of Polynomials using Bairstow's method.

#### INSTRUCTIONS

To use this program, enter data in data statements as follows:

10 DATA N, 
$$A(N)$$
,  $A(N-1)$ ,....,  $A(1)$ ,  $A(0)$ 

WHERE N IS THE ORDER OF THE POLYNOMIAL AND A(I) IS THE COEFFICIENT OF THE I-TH DEGREE TERM. MORE THAN ONE DATA LINE MAY BE USED TO SUPPLY COEFFICIENTS FOR ONE POLYNOMIAL, AND ADDITIONAL POLYNOMIALS MAY BE SOLVED ON A SINGLE RUN BY SUPPLYING DATA FOR THEM ON SUBSEQUENT DATA LINES (NOT BEYOND LINE 299).

#### NOTE:

There are a few types of polynomials which this program is unable to solve. Program will so indicate and go on to next case. Also, for high order polynomials, program may require many iterations, so running time can be high.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Determine the roots for the following 6 polynomials:

$$6 + 3X = 0$$
  
 $5 - 6X + X^{2} = 0$   
 $4 - 7X^{2} + 3X^{3} = 0$ 

To use this program enter the following data:

```
10 DATA 1, 3, 6
11 DATA 2, 1, -6, 5
12 DATA 3, 3, -7, 0, 4
```



ROOTER \* \* \* M004 Page 2

#### NOTES:

All 3 polynomials are solved in one run.

Each set of coefficients must be preceded by the order of the polynomial.

The coefficients must be entered in descending order, which is just the reverse from how the equations are written above.

There is no need to put each set of coefficients on a separate line. This was done only for readability.

Rooter gives erroneous results for double imaginary roots.

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

## NOTE:

All user supplied information is underlined.



10 DATA 1, 3, 6 11 DATA 2, 1, -6, 5 12 DATA 3, 3, -7, 0, 4 RUN

RØØTER

POLYNOMIAL NUMBER ! IS OF ORDER !

CØEFFICIENTS (IN DESCENDING GRDER) ARE:

3 6

THE ROOTS ARE:

-2

POLYNOMIAL NUMBER 2 IS OF ORDER 2

COEFFICIENTS [IN DESCENDING ORDER] ARE:

1 -6 5

THE ROOTS ARE:

5 AND 1

POLYNOMIAL NUMBER 3 IS OF ORDER 3

CØEFFICIENTS (IN DESCENDING ØRDER) ARE:

3 -7 0 4

THE ROOTS ARE:

2

1. AND -.666667

#### **PURPOSE**

To evaluate definite integrals using Gauss' rule with ten points.

## INSTRUCTIONS

To use this program enter the functions to be integrated thus:

Then type "RUN."

The program will ask for the Integration limits as it runs. If more than one integral of the same function is to be evaluated, just keep supplying limits. To stop the program, make the two limits equal to each other.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Find the value of the following integral between the limits 0 to 7.65 and 7.65 to 1567.

$$\int \frac{x^2}{\log 3x} dx$$

To use this program to get a numerical approximation of the integrals type the following program line:

10 LET 
$$Y = X \uparrow 2/(LOG(3*X)/2.30258509)$$

NOTE:

The division by 2.30258509 was necessary to convert from natural to common logs.



NUMINT \* \* \* M005
Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

10 LET Y = X t2/(LØG(3\*X)/2.30258509)
RUN
WAIT.

NUMI NT

LIMITS [LØWER, UPPER] = ? 0, 7.65

INTEGRAL = 125.535

LIMITS [LØWER, UPPER] = ? 7.65, 1567

INTEGRAL = 3.64278 E 8

LIMITS (LØWER, UPPER) = ? 0,0



#### **PURPOSE**

To solve spherical triangles having the apex at the North Pole and the other two corners defined by their respective latitudes and longitudes.

#### INSTRUCTIONS

Enter data for as many cases as desired successively. Data must be entered in data statements 10 - 99 in the following format:

10 DATA LTD, LTM, LGD, LGM, RLTD, RLTM, RLGD, RLGM, ALD, ALM

#### NOTE:

Each pair of numbers specifies a location in the form Degrees, Minutes as follows:

```
LTD, LTM = LOCAL LATITUDE
LGD, LGM = LOCAL LONGITUDE
RLTD, RLTM = REMOTE LATITUDE
RLGD, RLGM = REMOTE LONGITUDE
ALD, ALM = OBSERVED ALTITUDE [IF ANY]
```

For South latitudes and East longitudes, enter the degree values as negative numbers. If there is no observed altitude, set ALD and ALM equal to zero.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Solve the spherical triangle problem using the following data:

```
Local Latitude - 40 deg. 50 min. North Lat. 73 deg. 30 min. West Long.

Remote Latitude - 23 deg. 26 min. North Lat. Remote Longitude - 133 deg. 30 min. West Long.

Observed Altitude - 37 deg. 20 min.
```



SPHERE \* \* \* M006 Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

10 DATA 40,50,73,30,23,26,133,30,37,20 RUN

SPHERE

SPHERICAL TRIANGLE SØLUTIØN

CASE NUMBER I

LØCAL PØSITIØN:

DEG 40 MIN NØRTH LATITUDE DEG MIN WEST LØNGITUDE 30

REMOTE POSITION:

DEG MIN NØRTH LATITUDE 133 DEG 30 MIN WEST LØNGITUDE

LOCAL HOUR ANGLE (AT NORTH POLE):

60 DEG 59 DEG

60 MIN HRS 59 SEC MIN 60

ZENITH (GREAT CIRCLE) DISTANCES:

52.6 DEG

52 DEG 3157 N 52 DEG 37 MIN 3157 NAUTICAL MILES 3635.5 STATUTE MILES



TRUE BEARINGS [GREAT CIRCLE COURSES]:

REMOTE POSITION FROM LOCAL POSITION: 270.1 DEG 270 DEG 4 MIN

LOCAL POSITION FROM REMOTE POSITION: 55.6 DEG 55 DEG 33 MIN

ALTITUDE (REMOTE CELESTIAL POSITION ABOVE LOCAL POSITION HORIZON):

37.4 DEG 37 DEG 23 MIN

ØBSERVED ALTITUDE:

37 DEG 37.33 DEG 20 MIN

LINE OF POSITION:

3 MILES AWAY ON LINE BEARING 90.1 DEGREES TRUE



#### **PURPOSE**

To find the unknown features of any triangle, given one side and any two other parts.

## **INSTRUCTIONS**

To use this program supply values as required by the selected option.

## NOTE:

Specify angles as 'DEG, MIN. DEC'

Additional instructions may be found in the listing

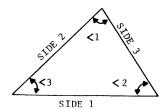
## SAMPLE PROBLEM

Calculate the value of the three enclosed angles of a triangle whose sides are 17, 7.8, and 13.9.

Calculate the value of three enclosed angles.

This program has a specific way for naming the sides and angles of the triangle. Care must be exercised to avoid erroneous answers.

Angle N is the angle opposite the side you choose to call side N, as shown in the following diagram.





TRIANG \* \* \*
M007
Page 2

All angles are entered as two distinct values. The first is the angle degrees and the second is minutes (which can have a fractional part). If one or more of your angles is in the whole degrees only, you must supply 0 for the minutes portion.

Use the following table to select the proper option:

If you have	<u>Use option</u>
Side 1, Side 2, Side 3	1
Side 1, Angle 3, Side 2	2
Side 1, Side 3, Angle 1	3
Angle 1, Side 3, Angle 2	4
Angle 3, Angle 1, Side 3	5

NOTE:

The values calculated by option 1 are used to demonstrate the other options.

## SAMPLE SOLUTION

These sample solutions are copies of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.



#### RUN

#### TRIANG

THIS PROGRAM WILL FIND THE UNKNOWN FEATURES OF ANY TRIANGLE, GIVEN ONE SIDE AND ANY TWO OTHER PARTS.

WHAT WILL BE GIVEN (1=SSS, 2=SAS, 3=SSA, 4=ASA, 5=AAS)?  $\underline{1}$  WHAT ARE SIDE1, SIDE2, SIDE3?17, 7.8, 13.9

	1	2	3
SIDE	17	7.8	13.9
ANGLE (RAD)	1.73268	.469931	.938981
ANGLE (DEG) (MIN)	99 16.519	26 55.5026	53 47.8778
ALT TØ SIDE	6.29426	13.7183	7.69802

RADIUS OF CIRCUMSCR CIRCLE = 8.61261 RADIUS OF INSCRIBED CIRCLE = 2.76492 AREA OF TRIANGLE = 53.5012

## ANOTHER CASE [1=YES]? 1

WHAT WILL BE GIVEN (1=SSS, 2=SAS, 3=SSA, 4=ASA, 5=AAS)?2 [NØTE: SPECIFY ANGLES AS 'DEG, MIN.DEC'] WHAT ARE SIDEI, ANG, LE3, SIDE2? 17, 53, 47.9778, 7.8

	1	2	3
SIDE	17	7.8	13.9
ANGLE [RAD]	1.73268	.469931	.938981
ANGLE [DEG] [MIN]	99 16.5191	26 55.5026	53 47.9777
ALT TØ SIDE	6.29426	13.7183	7.69802

RADIUS ØF CIRCUMSCR CIRCLE = 8.61261 RADIUS ØF INSCRIBED CIRCLE = 2.76492 AREA ØF TRIANGLE = 53.5012

ANOTHER CASE [1=YES]?1



TRIANG \* \* \* M007 Page 4

WHAT WILL BE GIVEN [1=SSS, 2=SAS, 3=SSA, 4=ASA, 5=AAS]?4
[NØTE: SPECIFY ANGLES AS 'DEG, MIN.DEC']

WHAT ARE ANG, LEI, SIDE3, ANG, LE2? 99, 16.519, 13.9, 26, 55.5026

	1	2	3
SIDE	17.	7.8	13.9
ANGLE [RAD]	1.73268	.469931	.938981
ANGLE [DEG] [MIN]	99 16.5188	26 55.5024	53 47 <b>.</b> 9782
ALT TO SIDE	6.29426	13.7183	7.69802

RADIUS OF CIRCUMSCR CIRCLE = 8.61261 RADIUS OF INSCRIBED CIRCLE = 2.76492 AREA OF TRIANGLE = 53.5012

ANØTHER CASE [1=YES]? 1

WHAT WILL BE GIVEN [1=SSS, 2=SAS, 3=SSA, 4=ASA, 5=AAS]75
[NØTE: SPECIFY ANGLES AS 'DEG, MIN.DEC']

WHAT ARE ANG, LE3, ANG, LE1, SIDE3? 53, 47.9778, 99, 16.519, 13.9

	1	2	3
SIDE	17.	7.8	13.9
ANGLE (RAD)	1.73268	.469931	.938981
ANGLE (DEG) (MIN)	99 16.5188	26 55.503	53 47.9776
ALT TØ SIDE	6.29426	13.7183	7.69802

RADIUS OF CIRCUMSCR CIRCLE = 8.61261
RADIUS OF INSCRIBED CIRCLE = 2.76492
AREA OF TRIANGLE = 53.5012



#### **PURPOSE**

To determine which of 6 curves best fits the supplied data.

#### INSTRUCTIONS

Enter data on lines numbered 0-699. All values for 1 variable are given in data statements followed by all data for the second variable. One convenient arrangement might be lines 100-199 for variable 1 and lines 200-299 for variable 2.

## NOTE:

This program accepts up to 200 observations on 2 variables.

Additional instructions may be obtained by listing the program STADES \* \* \*.

## SAMPLE PROBLEM

Find which of 6 curves presents the closest fit to the following data points:

```
1.0
      3.5
            3.0
                  7.0
1.5
      4.0
            4.0
                  6.0
2.0
     4.5
            5.0
                  5.0
2.5
      5.0
            6.0
                  4.0
     5.5
            7.0
                  3.0
      6.0
            8.0
                  2.0
      6.5
```

Supply details for curve number 3.



CURFIT \* \* \*
M008
Page 2

#### SAMPLE SOLUTION

The following sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

100 DATA 1,1.5,2,2.5,3,3.5,4,4.5,5,5.5,6,6.5 200 DATA 3,4,5,6,7,8,7,6,5,4,3,2 RUN

#### CURFIT

PLEASE SPECIFY THE NUMBER OF VALUES [N] GIVEN AS DATA FOR THE TWO INPUT VARIABLES, AND THE OUTPUT CODE [D]. [D=1 IF OUTPUT IS TO BE IN ORDER OF INCREASING VALUES OF THE INDEPENDENT VARIABLE, ELSE D=0]. N,D = 712,0

LEAST-SQUARES CURVEFIT

CURVE TYPE	INDEX	Α	В
1. Y=A+[B*X] 2. Y=A*EXP[B*X]	5.96246 E-2 6.79621 E-3 4.28484 E-2	4.93421 3.34458 3.83113	236842 -4.22812 E-3 102162
3. Y=A*[X†B] 4. Y=A+[B/X] 5. Y=1/[A+B*X] 6. Y=X/[A*X+B]	135872 NEGATIVE NEGATIVE	2.32305 .494583	6.09218 -2.62454 E-2 .148198

FØR WHICH CURVE ARE DETAILS DESIRED [GIVE NUMBER]?4

4. Y=A+[B/X] IS A HYPERBOLIC FUNCTION. THE RESULTS OF A LEAST-SQUARES FIT OF ITS LINEAR TRANSFORM ARE AS FOLLOWS:

X-ACTUAL	Y-ACTUAL	Y-CALC	PCT DIFFER
3	1	4.35378	-77
4	1.5	3.8461	-60.9
5	2	3.54149	-43.5
6	2.5	3.33842	-25.1
7	3	3.19336	-6
8	3.5	3.08457	13.4
7	4	3.19336	25.2
6	4.5	3.33842	34.7
5	5	3.54149	41.1
4	5.5	3.8461	43.
3	6	4.35378	37.8
2	6.5	5.36914	21.



200 DATA 1,2,3,4,5,6,7,8,9,10,11,12 RUN WAIT.

CURFIT

PLEASE SPECIFY THE NUMBER OF VALUES (N) GIVEN AS DATA FOR THE TWO INPUT VARIABLES, AND THE OUTPUT CODE [D]. (D=1 IF OUTPUT IS TO BE IN ORDER OF INCREASING VALUES OF THE INDEPENDENT VARIABLE, ELSE D=0). N,D = ?12,0

#### LEAST-SUARES CURVEFIT

CURVE TYPE	INDEX	A	В
1. Y=A+[B*X]	1	•5	.5
2. Y=A*EXP[B*X]	.914246	1.17857	.157214
3. Y=A*[X+B]	.992535	.905171	.771993
4. Y=A+[B/X]	.612308	5.1356	-5.35806
5. Y=1/{A+B*X}	NEGATIVE	.758901	-6.08532 E-2
6. Y=X/[A*X+B]	.890665	.119643	.942427

FOR WHICH CURVE ARE DETAILS DESIRED [GIVE NUMBER]?]

I. Y=A+(B\*X) IS A LINEAR FUNCTION. THE RESULTS ARE AS FOLLOWS:

X-ACTUAL	Y-ACTUAL	Y-CALC	PCT DIFFER
1	1	1	0.0
2	1.5	1.5	0.0
3	2	2	0.0
4	2.5	2.5	0.0
5	3	3	0.0
6	3.5	3.5	0.0
7	4	4	0.0
8	4.5	4.5	0.0
9	5	5	0.0
10	5.5	5.5	0.0
11	6	6	0.0
12	6.5	6.5	0.0

FØR WHICH CURVE ARE DETAILS DESIRED [GIVE NUMBER]?3

3. Y=A\*(X†B) IS A POWER FUNCTION. THE RESULTS OF A LEAST-SQUARES FIT OF ITS LINEAR TRANSFORM ARE AS FOLLOWS:

X-ACTUAL	Y-ACTUAL	Y-CALC	PCT	DIFFER
1	1	.905171		10.4
2	1.5	1.54569	-2.9	
3	2	2.1138	-5.3	
4	2.5	2.63947	-5.2	
5	3	3.13567	-4.3	
6	3.5	3.60959	-3	
7	4	4.06574	-1.6	
8	4.5	4.50722	1	
9	5	4.93627		1.2
10	5.5	5.35455		2.7
11	6	5.76339		4.1
12	6.5	6.16382		5.4



Name XYPLOT \* \* \*
Code M009

## PROGRAM ABSTRACT

#### **PURPOSE**

To plot single valued functions of X, with X on the vertical axis.

#### INSTRUCTIONS

To use this program type:

During running, the program will ask for YMIN and YMAX [the limits on the horizontal Y-axis], for XMIN and XMAX [the limits on the vertical X-axis], and for DELX, the increment to be used along the X-axis.

#### NOTE:

Lines 11-99 of the program may be used as desired to express complicated functions.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

For illustration purposes, we will use this program to plot a normal curve. In its simplest form, the normal can be represented as:

$$Y = e^{-X^2}$$

From looking at the equation we can see that the Y limits are  $e^{-\infty}=0$  and  $e^{\circ}=1$ . The X limits are  $\pm \infty$ , but Y remains very close to zero if X is less than -2 or greater than  $\pm 2$ . We will use these as our limits and split the X axis into 40 segments ( $\Delta X=.1$ ).

To use this program type in the following program line:

10 LET 
$$Y = EXP(-(X \uparrow 2))$$



XYPLOT \* \* \* M009 Page 2

#### NOTE:

You control both the X and Y axis limits by answering the YMIN, YMAX, XMIN, XMAX, DELX question.

If incorrect values were used for YMIN and/or YMAX, and the plot went off-axis at certain X points, the program would have typed "off-scale" and the actual Y value at those points. If a clean plot is required you must run the program again and modify YMIN and/or YMAX.

By knowing YMIN and YMAX from analyzing the quation, it is possible to get a plot which fills all the available space.

You can use this program to get semi-log or log-log plots by using appropriate transforms at lines 10 through 99. If this is done, though, the plot axis will still be linear and you must properly interpret the result.

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

## NOTE:

All user supplied information is underlined.



10 LET Y = EXP(-(X+2))

RUN WAIT.

XYPLØT

WHAT ARE YMIN, YMAX, XMIN, XMAX, DELX70,1,-2,2,.1

TYPE '0' TØ STØP ØR '1' TØ CHANGE LIMITS. WHICH?



#### **PURPOSE**

To plot 1 to 6 functions of X simultaneously. All functions have the same upper and lower limits for the plot. The functions are called A, B, C, D, E, F and are plotted in that order of priority. Where plots would overlap, the lower priority functions are suppressed. Values exceeding the selected bounds are disregarded.

#### INSTRUCTIONS

To use this program enter information in the following format:

```
100 DATA NUM, XMIN, XMAX, DELX, HMIN, HMAX
200 LET A = ANY 'BASIC' FUNCTION OF X
210 LET B = ANY 'BASIC' FUNCTION OF X AND/OR A
220 LET C = DITTO FOR X AND/OR A AND/OR B
230 [SIMILARLY FOR D]
240 [SIMILARLY FOR F]
RUN
```

Where: NUM is the number of functions given [1-6], XMIN and XMAX are the lower and upper limits for X, DELX is the Increment for X. HMIN and HMAX are the lower and upper limits for the values of the function.

#### NOTE:

The horizontal increment is always [HMAX-MIN]/40.

Additional instructions may be found in the listing.

#### SAMPLE PROBLEM

Plot the same 6 curves twice where the second plot will be an enlarged version of a section of the first graph.

The functions plotted are illustrated in statements 200 - 250 in the sample solutions. The option of plotting all 6 functions is used. Since functions D and E were out of the specified range, they were not shown on the second plot.



PLOTTO \* \* \* M010 Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

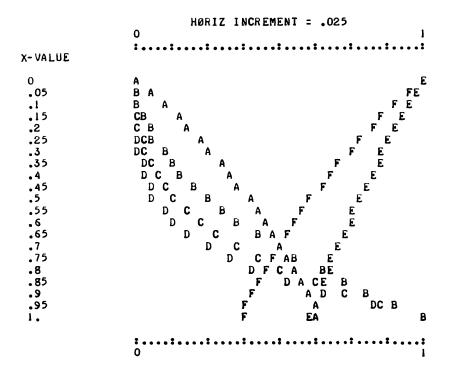
#### NOTE:

All user supplied information is underlined.

100	DA T	۱ (	5,0	0,1,	.05	,0,1
200	LEI	Α	Ξ	1-E	XP(	-X)
210	LET	₿	=	Xt2		
220	LET	С	=	X13		
230	LET	D	=	X*C		
240	LET	Ε	=	EXP	(-x	/2)
250	LET	F	=	EXP	(-X	2
RUN						
WAI	Γ.					

PLØTTØ

## MULTIPLE PLOT OF THE FUNCTIONS A, B, C, D, E, F





TYPE 'S' TØ STØP, ØR GIVE NEW VALUES ØF NUM, XMIN, XMAX, DELX, HMIN, HMAX? 6,0,.5,.025,0,.1

# MULTIPLE PLOT OF THE FUNCTIONS A, B, C, D, E, F

	HØRIZ INCREMENT = .0025
X-VALUE	
0 .025 .05 .075 .1	A A B A A CB A A C B A A C B A A C B A C B B C C B B C C B C C C B C C C C
.175 .175 .2 .225 .275 .3 .325 .35	DC B DC B DC B DC B D C B D C B D C B D C B D C B D C B D C B D C C
.425 .45 .475	D C C C C C D D
	0 .1

TYPE 'S' TO STOP, OR GIVE NEW VALUES OF NUM, XMIN, XMAX, DELX, HMIN, HMAX?  $\underline{\mathbf{S}}$ 



#### **PURPOSE**

To plot simultaneously 2 functions of a single variable, X.

## **INSTRUCTIONS**

To use this program type:

```
10 LET Y= [THE FIRST FUNCTION OF X]
20 LET Z= [THE SECOND FUNCTION OF X AND/OR Y]
```

Then: RUN

The functions Y and Z may be any legitimate 'BASIC' expressions. Intermediate variables may be defined using intermediate lines, if the functions are too complicated to fit on one line.

Additional instructions may be obtained from the listing.

#### SAMPLE PROBLEM

Plot the first 2 curves that were used to illustrate the program PLOTTO \* \* \*.

#### NOTE:

It is advisable to use TWOPLO \* \* \* rather than PLOTTO \* \* \* when only 2 functions are required because of the shorter running time.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

## NOTE:

All information to be supplied by the user is underlined.



```
TWOPLO * * * M011 Page 2
```

10 LET Y=1-EXP(-X)
20 LET Z=X+2
RUN
WAIT.

TWØPLØ

WHAT ARE FMIN, FMAX, XMIN, XMAX, DELX70, 1, 0, 1, .05

[NOTE: Y IS PLOTTED "+", Z IS ".", AND "O" IS COMMON POINT]

TYPE 'S' 10 STOP NOW, OR ELSE SPECIFY NEW VALUES FOR FMIN, FMAX, XMIN, XMAX, DELX?



#### **PURPOSE**

To maximize an objective function using the two-phase method. It automatically supplies slack, surplus, and artificial variables as required for the solution.

#### INSTRUCTIONS

NOTE:

More detailed instructions may be obtained by listing programs LPINST \* \* \* and LPINS2 \* \* \*

Before using this program arrange all constraints (i. e. linear restrictions on the problem variables) as follows:

- 1. The "less than or equal" inequalities.
- 2. The strict equalities.
- 3. The "greater than or equal" inequalities.

To use this program enter the data starting at line 10,000, in this order:

FIRST:

COEFFICIENTS OF EACH OF THE PROBLEM VARIABLES (INCLUDING ZEROES FOR VARIABLES NOT APPEARING) IN EACH RESTRICTION, STARTING WITH THE FIRST RESTRICTION AND PROCEEDING IN ORDER UNTIL ALL COEFFICIENTS OF ALL RESTRICTIONS HAVE BEEN ENTERED IN DATA STATEMENTS,

THEN:

THE ELEMENTS OF THE "B" VECTOR (THE CONSTANTS COMPRISING THE RIGHT SIDE OF ALL RESTRICTIONS) IN THE SAME ORDER AS THE RESTRICTIONS,

LAST:

THE COEFFICIENTS OF THE (LINEAR) OBJECTIVE FUNCTION, IN THE SAME ORDER AS USED IN THE RESTRICTIONS, INCLUDING ZEROES IF NEEDED.

THEN TYPE "RUN."

Additional instructions may be found in the listing.



LINPRO \* \* \*
M012
Page 2

#### SAMPLE PROBLEM

Maximize the function  $30 \times X1 + 45 \times X2$  while satisfying the following constraints:

The data would be entered starting at line number 10000, in the following order:

First: Coefficients of each of the problem variables in each constraint.

Ex : 10000 Data 1, 0, 0, 1, 2.5, 2, 1, 0, 0, 1, 3, -1, 2.5, 2 Then: The values on the right side of the constraints. Ex : 10001 Data 6000, 4000, 24000, 1000, 1000, 0, 10000

Last: The coefficients of the objective function.

Ex: 10002 Data 30, 45

As the program runs, the values "7,2" would be supplied for "M, N." M being the number of constraints and N being the number of variables. When "I, J and K" are called for "3, 0, 4" would be supplied. "I" being the number of < = restrictions, 0 being the number of = restrictions and 4 being the number of > = restrictions.

## NOTE:

The problem solution is X1 = 6000, X2 = 4000

This problem was run 3 times to illustrate all output options.

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.



WAIT. READY.

10000 DATA 1,0,0,1,2.5,2,1,0,0,1,3,-1,2.5,2 10001 DATA 6000, 4000, 24000, 1000, 1000, 0, 10000 10002 DATA 30, 45 RUN WAIT.

## LINPRØ

TYPE '2' FOR OUTPUT OF TABLEAUS AND BASIS AT EACH ITERATION, '1' FOR THE BASIS ONLY, OR 'O' FOR JUST THE SOLUTION. WHICH?2

WHAT ARE M AND N OF THE DATA MATRIX?7,2

HOW MANY 'LESS THANS', 'EQUALS', 'GREATER THANS' ?3,0,4

YØUR VARIABLES I THRØUGH 2 SURPLUS VARIABLES 3 THRØUGH 6 SLACK VARIABLES 7 THRØUGH 9 ARTIFICIAL VARIABLES 10 THRØUGH 13

TABLEAU A I O O	FTER 0 I1 0 I 0 0 I 0 0 I 0 0 I 0 I 0 I 0 I	TERATIONS 0 0	0 0 6000	0
0 0	1 0	0 0 1 0	0 0 4000	0
2.5 0 0	2 0 0	0 0 0	0 ! 24000	0
1 / 0 / 0 /	0 0 0	-1 0 0	0 0 1000	0
0 1	1 0 0	0 0 0	-1 0 1000	0
3 0 0	-1 0 1	0 0 0	0 0 0	-1 0
2.5 -1 0	2 0 0	0 0 1	0 0 10000	0
-30 0 0	-45 0 0	0 0 0	0 0 0	0
-6.5 I 0	-2 0 0	1 0 0	! 0 0	1 0

```
BASIS BEFØRE ITERATION 1
 VARIABLE
                  VALUE
                   6000
  8
                   4000
  9
                   24000
  10
                   1000
  11
                   1000
  12
                   0
  13
                   10000
BASIS BEFØRE ITERATION 2
 VARIABLE
                  VALUE
 7
                   6000
 8
                   4000
 9
                   24000
 10
                   1000
 11
                   1000
                   0
 13
                   10000
BASIS BEFØRE ITERATION 3
VARIABLE
                  VALUE
                   5666.67
 8
                   3000
 9
                   21166.7
 10
                   666.667
 2
                   1000
 1
                   333.333
 13
                   7166.67
BASIS BEFORE ITERATION 4
                  VALUE
VARIABLE
 7
                   5000.
 8
                   1000.
 9
                   15500.
 4
                  2000.
 2
                   3000
                   1000
 13
                   1500
BASIS BEFØRE ITERATION 5
VARIABLE
                  VALUE
                  4823.53
470.588
 8
 9
                  14000.
2529.41
 4
 2
                  3529.41
1176.47
 i
                  176.471
BASIS BEFORE ITERATION 6
VARIABLE
                 VALUE
                  4666.67
 6
                  1333.33
 9
                  12666.7
                  3000.
 2
                  4000.
1333.33
333.333
 ı
 3
```



## ANSWERS:

VARIABLE	VALUE
5	14000.
6	13000.
9	1000.
4	3000.
2	4000.
ī	6000.
3	5000

# DUAL VARIABLES: COLUMN VALUE 3 0 4 0 5 0 6 0 7 30. 8 45 9 0

TABLEAU O O O	AFTER 6 ITERATION  0 3 -1	0 -1 0	0 0 14000.	1 0
0 1 0	0 2.5 0	0 2. -1	0 0 13000.	0
0 0 0	0 -2.5 0	0 -2 0	0 ! 1000.	0 0
0 0 -1	0 0 0	0 1 0	1 0 3000.	0
0 0 0	1 0 0	0 1 0	0 0 4000.	0 0
1 0 0	0 1	0 0 0	0 0 6000.	0
0 0 0	0 1. 0	1 0 0	0 0 5000.	0 -1.
0 0 0	0 30. 8.94070 E-8	0 45 2.98023 E-8	0 0 360000.	0 4.76837 E-7



LINPRO \* \* \* M012 Page 6

> RUN WAIT.

#### LINPRØ

TYPE '2' FOR OUTPUT OF TABLEAUS AND BASIS AT EACH ITERATION, 'I' FOR THE BASIS ONLY, OR 'O' FOR JUST THE SOLUTION. WHICH? 1

WHAT ARE M AND N OF THE DATA MATRIX?7,2

HOW MANY 'LESS THANS', 'EQUALS', 'GREATER THANS' 73,0,4

```
YØUR VARIABLES 1 THRØUGH 2
SURPLUS VARIABLES 3 THRØUGH 6
SLACK VARIABLES 7 THRØUGH 9
ARTIFICIAL VARIABLES 10 THRØUGH 13
```

```
BASIS BEFØRE ITERATION !
VARIABLE
                VALUE
                 6000
 8
                 4000
 9
                 24000
 10
                 1000
 11
                 1000
 12
                 ٥
 13
                 10000
```

BASIS BEFØRE	ITERATION	2
VARIABLE	VALUE	
7	6000	
8	4000	
9	24000	
10	1000	
11	1000	
1	0	
13	1 0000	

BASIS BEFØRE	TTEDATION T
VARIABLE	VALUE
AUVIUDEE	
•	5666.67
8	3000
9	21166.7
10	666.667
2	1000
1	333.333
13	7166.67



```
BASIS BEFØRE ITERATION 4
 VARIABLE
                   VALUE
                    5000.
  7
  8
                    1000.
  9
                    15500.
                    2000.
  4
  2
                    3000
  1
                    1000
  13
                    1500
BASIS BEFØRE ITERATION 5
 VARIABLE
                   VALUE
  7
                    4823.53
470.588
 8
 9
                    14000.
 4 2
                   2529.41
                   3529.41
 1
                    1176.47
 3
                    176.471
BASIS BEFØRE ITERATION 6
VARIABLE VALUE
                   4666.67
 7
 6
 9
                   12666.7
                   3000.
 2
                   4000.
1333.33
333.333
 ı
ANSWERS:
VARIABLE
                  VALUE
                   14000.
 6
                   13000.
 9
                   1000.
                   3000.
 2
                   4000.
                   6000.
 1
                   5000.
DUAL VARIABLES:
CØLUMN
                  VALUE
 3
                   0
 4
                   0
 5
                   0
                   0
 7
                   30.
```

45



8

```
LINPRO * * *
M012
Page 8
```

## RUN

## LINPRØ

TYPE '2' FØR ØUTPUT ØF TABLEAUS AND BASIS AT EACH ITERATION, '1' FØR THE BASIS ØNLY, ØR 'O' FØR JUST THE SØLUTIØN. WHICH?O

WHAT ARE M AND N OF THE DATA MATRIX?7,2

HOW MANY 'LESS THANS', 'EQUALS', 'GREATER THANS'?3,0,4

YØUR VARIABLES I THRØUGH 2
SURPLUS VARIABLES 3 THRØUGH 6
SLACK VARIABLES 7 THRØUGH 9
ARTIFICIAL VARIABLES 10 THRØUGH 13

## ANSWERS:

VARIABLE	VALUE
5	14000.
6	13000.
9	1000.
4	3000.
2	4000.
1	6000.
3	5000.

#### DUAL VARIABLES:

CØLUMN	VALU
3	0
4	0
5	0
6	0
7	30.
8	45
9	0



## **PURPOSE**

To evaluate time functions which are sums of exponentials and exponential sine-cosine terms.

## INSTRUCTIONS

To use this program enter input data in the following format:

20 DATA NP,N1,N2,TO,DELTA-T,SIGMA

#### where:

NP=TOTAL NUMBER OF POINTS TO BE COMPUTED N1=NUMBER OF EXPONENTIAL TERMS N2=NUMBER OF SINE-COSINE EXPONENTIAL TERMS TO=TIME OF FIRST POINT DELTA-T=TIME BETWEEN POINTS SIGMA=STANDARD DEVIATION OF THE NOISE

#### NOTE:

If additive noise is not desired, SIGMA = 0.

Parameters of the function are entered as follows:

- 41 DATA  $C[1], C[2], C[3], \dots, S[1], S[2], S[3], \dots$ 60 DATA  $A[1], A[2], A[3], \dots, B[1], B[2], B[3]$
- 60 DATA A[1],A[2],A[3],...,B[1],B[2],B[3],...
  79 DATA w[1],w[2],w[3],...,G[1],G[2],G[3],...

Only statement numbers between 41 and 79 inclusive may be used.

Maximum number of points permissable is 500 and 2N1+4N2=20.

The computation of  $E_{\uparrow}$ -X, where X is large may result in excessive running time.

Additional instructions may be found in the listing.



TMFCEV \* \* \* M013 Page 2

#### SAMPLE PROBLEM

Evaluate a time function of this form:

C\*EXP(-S\*T)

<u>c</u>	<u>s</u>
-0.0178189	1.5662
0.0166119	16.2565
0.00450666	136.889

FORM: (A\*COS(W\*T)+B\*SIN(W\*T))\*EXP(-G\*T)

<u>A</u>	<u>_B</u>	<u>W</u>	G
15.438	372211	491.834	200.474

Type the following data:

```
20 DATA 30, 3, 1, 0, .001, 0
50 DATA -1.78189E-2, 1.66119E-2, 4.50666E-3, 1.5662, 16.2565, 136.889
60 DATA 15.438, -.37221, 491.834, 200.474
```

#### NOTE:

In the data entered on line 20, 30 is the total number of points desired, 3 is the number of exponential terms, 1 is the number of sine-cosine exponential terms, 0 is the time of the first point, .001 is the time between the points and 0 is the standard deviation of the noise.

The parameters of the functions, which are on lines 50 and 60, can be entered from lines 41-79.

TMFCEV provides for adding random numbers from a uniform distribution (-1/2, 1/2) with a standard deviation  $\sigma$  (standard deviation of the noise). If additive noise is not desired, input  $\sigma$  as zero.



#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

```
READY.
```

ØLD PRØBLEM NAME--IMFCEV\*\*\*
WAIT.
READY.

20 DATA 30.3.1.0..001.0 50 DATA -1.78189E-2.1.66119E-2.4.50666E-3.1.5662.16.2565.136.889 60 DATA 15.438.-.37221.491.834.200.474 WAIT.

TMFCEV 11:24

NOISE SIGMA = 0

TERMS OF FORM C\*EXP[-S+T] ARE:

C S
-1.78189 E-2 1.5662
1.66119 E-2 16.2565
4.50666 E-3 136.889

TERMS OF FORM [A\*COS[W\*T]+B\*SIN[W\*T]]\*EXP[-G\*T] ARE:

A B W G

15.438 -.37221 491.834 200.474

FIRST POINT AT T1.SPACING-T2

FIRST PØINT AT T1, SPACING=T2 T1= 0 T2 = .001

DATA POINTS ARE:

15.4413 10.9947 5.52152 .603037 -2.8276 -4.48323 -4.57445 -3.59741 -2.12686 -.659706 .472038 1.02218 1.30216 .752094 1.12634 .329864 -.028716 -.263328 -.361716 -.346594 -.258936 -.142646 -3.36229 E-2 4.57423 E-2 8.71895 E-2 9.37954 E-2 7.55308 E-2 4.47195 E-2 1.24639 E-2 -.013472

TIME: 4 SECS.



#### **PURPOSE**

To provide a statistical analysis for up to 61 observations on up to 6 variables.

## INSTRUCTIONS

To use this program enter the input data using line numbers 0-699. All values for 1 variable are given in data statements, followed by all data for a second variable, etc. One convenient way to arrange the input variables is as follows:

LINES	VARIABLE
100-199	Til
200-299	First Second
300-399	Third
400-499	Fourth
500-599	Fifth
600-699	Sixth

If no transformed variables are given a linear function is fitted for the first data variable in terms of the subsequent variables. By using transforms, any function of any or all of the input variables may be used as any variable in the analysis. Transforms are entered before the run, at lines 1000-1099, in the following way:

10XX LET X(J) = ANY FUNCTION OF V(1), V(2),.... V(R)

WHERE X(J) IS THE J-TH VARIABLE IN THE ANALYSIS (J=1 IS THE DEPENDENT VARIABLE), AND THE V(I) ARE THE INPUT DATA VARIABLES. THUS, ONE MIGHT ENTER DATA FOR THREE VARIABLES V(I), V(2), AND V(3), BUT RUN THE ANALYSIS WITH X(I)=V(2) AS THE DEPENDENT VARIABLE, AND THREE 'INDEPENDENT' VARIABLES, BY ENTERING TRANSFORMATIONS LIKE THE FOLLOWING AT LINES 1000-1003:

1000 LET X(1)=V(2) 1001 LET X(2)=LOG(V(1)+V(3)) 1002 LET X(3)=V(1)+X(2)\*EXP(-1-V(3)) 1003 LET X(4)=(V(3)-1)+2

Additional instructions may be obtained by listing STADES \* \* \*.



MULFIT \* \* \*
M014
Page 2

#### SAMPLE PROBLEM

Secure a statistical analysis for the observed data consisting of 30 data values for each of 4 variables.

#### NOTE:

This data is identical to that used in the MULREG \* \* \* sample problem.

Commas are not needed after each line because this program is written in BASIC.

The data for the first variable is entered on line 100, the second variable on 200, etc.

The run fits the equation  $Y = A + B \cdot X1 + C \cdot X2 + D \cdot X3$ . The coefficients for the fitted equation are A = .936716, B = -.00142542, C = -.0040351 and D = .193222.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

```
100 DATA .43,.55,.55,.55,.54,.52,.62,.60,.50,.55,.52,.53,.40

101 DATA .46,.57,.59,.49,.45,.48,.47,.46,.61,.59,.60,.57

102 DATA .64,.62,.54,.66,.64

200 DATA 75,66,67,70,64,65,67,.63,70,.65,.73,.73,.88,.75,.90,.77

201 DATA 72,70,63,66,.67,.57,.55,.51,.53,.58,.51,.51,.54,.54

300 DATA 9.4,7.8,8.1,8.3,8.6,8.0,8.8,8.7,8.7,8.9,8.8,8.0,8.8,8.7

301 DATA 8.6,8.7,8.1,8.5,8.6,8.3,8.9,8.9,8.6,8.7,8.4,1.2,8.4

302 DATA 8.3,7.8,8.5

400 DATA 2.04,1.36,1.36,1.36,1.36,1.36,1.36,1.59,1.59,1.59

401 DATA 1.59,1.59,1.59,1.13,1.13,1.59,1.59,1.59,1.59,1.59,1.02
```

RUN

MULFIT

PLEASE SPECIFY THE NUMBER OF VALUES (N) GIVEN AS DATA FOR THE INPUT VARIABLES, THE NUMBER OF INPUT VARIABLES (R) GIVEN, THE NUMBER OF VARIABLES (S) TO BE INCLUDED IN THE ANALYSIS (AFTER TRANSFORMS, IF ANY), AND A CODE VALUE (D). (D=1 IF TRANSFORMS HAVE BEEN SPECIFIED, OR D=0 OTHERWISE.) N,R,S,D = ? 30,4,0,0



### MULTIVARIATE CURVEFIT

VARIABLE	REGR COEFF	MEAN VALUE	STD DEV
1 [CONSTANT	.936715 ]	•543333	6.63995 E-2
2 3	-1.42542 E-3 -4.03510 E-3	65.6667 8.24333	9.91072 1.35663
4	193222	1.37933	.241536

STANDARD DEVIATION OF RESIDUALS = 3.43456 E-2 INDEX OF DETERMINATION (R-SQ) = .732445 ZERO-CHECK ON MEAN RESIDUAL = -1.24176 E-8

### ACTUAL VS CALCULATED

ACTUAL	CALCULATED	DIFFERENCE	PCT DIFFER
.43	.397707	-3.22929 E-2	-8.1
.55	.548383	-1.61731 E-3	2
.55	.545747	-4.25326 E-3	-,7
.55	.540663	-9.33653 E-3	-1.7
.54	.548005	8.00545 E-3	1.4
.52	.549001	2.90011 E-2	5.2
•62	.542922	-7.70778 E-2	-14.1
.6	•549027	-5.09726 E-2	<b>-9.</b> 2
•5	.494608	-5.39153 E-3	-1
.55	•500929	-4.90715 E-2	-9.7
•52	·489929	-3.00713 E-2	-6.1
•53	.493157	-3.68432 E-2	-7.4
. 4	.471776	7.17755 E-2	15.2
. 46	.487481	2.74814 E-2	5.6
.57	.555386	-1.46145 E-2	-2.6
•59	<b>.573</b> 512	-1.64875 E-2	<b>-</b> 2.8
• 49	.494179	4.17869 E-3	.8
. 45	.495415	4.54155 E-2	9.1
• 48	• 50 49 9	2.49899 E-2	4.9
.47	.501924	3.19242 E-2	6.3
.46	.498078	3.80777 E-2	7.6
.61	.622468	1.24682 E-2	2.
•59	.62653	<b>3.65296 E-</b> 2	5.8
•6	.631828	3.18277 E-2	5.
•57	.608933	.038933	6.3
.64	.630859	-9.14134 E-3	-1.4
.62	.611784	-8.21613 E-3	-1.3
.54	.567746	2.77464 E-2	4.8
.66	.609929	-5.00713 E-2	<b>-8.</b> 2
.64	.607104	-3.28959 E-2	-5.4



### **PURPOSE**

To test a network of activities and events, prior to performing a critical path analysis. Checks are made for (1) too many activities, (2) multiple starts, (3) multiple ends, (4) duplicate activities, and (5) illogical loops.

### INSTRUCTIONS

Input data is entered by activities in the following format:

1 DATA  $I_1$ ,  $J_1$ ,  $D_1$ ,  $A_1$ ,  $I_2$ ,  $J_2$ ,  $D_2$ ,  $A_2$ , ...  $I_k$ ,  $J_k$ ,  $D_k$ ,  $A_k$ 

(Continue on lines 2-99 as needed)

#### where:

- I is the starting event for the activity
- J is the ending event for the activity
- D is the duration of the activity
- A is the cost of the activity
- K is the number of activities in the network

If no errors are detected, the program will print

If a paper tape (for input to CPMTWO) is desired, the tape punch should be turned on immediately following the response to this question. The format of the tape is controlled by a data line at 130:

130 DATA W, N, L, P



CPMONE \* \* \* M015
Page 2

where:

W is the width of the cost field (char.)

N is the width of the event field (char.)

L is the number of activities per output line

P is a flag:  $P \neq 0$  requests a trace P = 0 requests no trace

As the program exists in the library, this line reads:

so that the maximum cost for any one activity is \$9999, the maximum activity number is 999, and each output line contains 3 activities. This may be altered by the user to suit his particular application.

Messages indicating errors in the network are as follows:

### 1. DUPLICATE ACTIVITIES

$$X I_x J_x D_x A_x$$

where:

X is the activity number

 $I_x$  is the beginning event

 $J_x$  is the ending event

 $D_x$  is the duration of the event

 $A_{x}$  is the cost plus 1.

### 2. MULTIPLE STARTS

 $X I_x J_x$ 

(symbols as above)

### 3. MULTIPLE ENDS

 $X I_x J_x$ 

(symbols as above)



#### 4. LOGIC LOOP

 $X_1 \quad I_{x1} \quad J_{x2}$ 

 $X_{2}$   $I_{x2}$   $J_{x3}$ 

 $X_1 - I_{x1} - J_{xa}$ 

(symbols as above)

### 5. TOO MANY ACTIVITIES

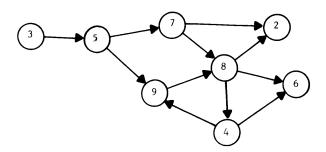
### RESTRICTIONS

The starting event for the network must have only one exit, sometimes necessitating introduction of an extra (dummy) event.

The program may not find all errors on a single run. Therefore, corrections should be made after each run, and the process continued until the NO ERRORS...message appears.

### SAMPLE PROBLEM

Test the following network for errors:



where denotes an event and denotes an activity (Ignore cost and duration).

## SAMPLE SOLUTION

The first run detects that the network has two end events, namely 2 and 6. Assuming that a path from 2 to 6 has been inadvertently omitted, that path is then defined in line 12.

The second run finds an illogical loop involving events 4, 8, and 9. Assuming that the direction of the activity connecting events 4 and 9 is in error, the appropriate change is made to line 10.



```
CPMONE * * *
M015
Page 4
```

The third run indicates that the network is now error free.

Following is a copy of the printout that will appear at your teletypewriter.

### NOTE:

All user supplied information is underlined.

#### READY.

```
1 DATA 3,5,0,0

2 DATA 5,7,0,0

3 DATA 7,2,0,0

4 DATA 7,8,0,0

5 DATA 8,2,0,0

6 DATA 8,6,0,0

7 DATA 5,9,0,0

8 DATA 9,8,0,0

9 DATA 8,4,0,0

10 DATA 4,9,0,0

11 DATA 4,6,0,0

RUN

WAIT.
```

#### CPMONE

MULTIPLE ENDS: 3 7 2 6 8 6

12 DATA 2,6,0,0 RUN

### CPMONE

LØGIC LØØP:

9 8 4

10 4 9

8 9 8

10 DATA 9,4,0,0 RUN

### CPMONE

NØ ERRØRS. TYPE 'S' TØ STØP, ØR '1' FØR ØUTPUT LEACH CHARACTER IS ØUTPUT INDIVIDUALLY). WHICH? S



# S



STATISTICAL

Name MANDSD \* \* \*
Gode S001

### PROGRAM ABSTRACT

### **PURPOSE**

To calculate the mean, variance, and standard deviation for each of several sets of individual values or frequency distributions.

#### INSTRUCTIONS

To use this program enter data for each set of 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 O, 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:

Or eqivalently:



```
MANDSD * * + 
S001
Page 2
```

### NOTE:

Statement numbers 1 thru 299 are available for continuation of the data field.

Additional instructions may be found in the listing

### SAMPLE PROBLEM

Determine the statistical characteristics of the following data points:

261.4	252.1	255.5	258.3	253.2
270.8	268.3	249.6	256.3	266.4
265.4	250.3	280.9	259.3	
261.4	272.3	270.3	270.1	
258.1	262.8	263.2	259.3	

To use this program to obtain the data's statistical characteristics, prepare the following data tape:

```
1 DATA 22, 261.4, 270.8, 265.4, 261.4, 258.1, 252.1, 268.3, 250.3 2 DATA 272.3, 262.8, 255.5, 249.6, 280.9, 270.3, 263.2, 258.3, 256.3 DATA 259.3, 270.1, 259.3, 253.2, 266.4
```

### NOTE:

The first data value (22) represents the total number of values.



### SAMPLE SOLUTION

These sample solutions are copies of the printout that will appear at your teletypewriter.

### NOTE:

All user supplied information is underlined.

### READY.

```
1 DATA 22, 261.4, 270.8, 265.4, 261.4, 258.1, 252.1, 268.3, 250.3

2 DATA 272.3, 262.8 ←, 255.5, 249.6, 280.9, 270.3, 263.2, 258.5, 256.3

3 DATA 259.3, 270.1, 259.3, 253.2, 266.4

RUN

WAIT.
```

MANDSD

ARITHMETIC MEAN, VARIANCE, AND STANDARD DEVIATION

### INDIVIDUAL SET NUMBER 1

```
270.8
262.8
                                   265.4 26
255.5
               261.4
272.3
INPUT VALUES:
                                                      258.i
                                                                252.1
                                                         280.9
                                                                   270.3
268.3
          250.3
                                               249.6
          258.3
                   256.3
                             259.3
                                      270.1
                                                259.3
                                                         253.2
                                                                   266.4
263.2
```

NUMBER OF VALUES = 22
ARITHMETIC MEAN = 262.059
STANDARD DEVIATION = 7.96691
SAMPLE VARIANCE = 60.5866
EST TRUE VARIANCE = 63.4716
ST ERROR MEAN = 1.69855



```
MANDSD * * *
S001
Page 4
```

### SAMPLE PROBLEM

Assume that each data point has a frequency associated with it. See the following printout for the frequencies used.

To use this program prepare the following data tape:

```
1 DATA 0, 22, 261.4, 3, 270.8, 4, 265.4, 2, 261.4, 7, 258.1, 3 252.1, 5, 268.3, 7, 250.3, 1, 272.3, 9, 262.8, 2, 255.5, 8 3 DATA 249.6, 5, 280.9, 9, 270.3, 3, 263.2, 8, 258.3, 2, 256.3, 3 259.3, 5, 270.1, 3, 259.3, 2, 253.2, 5, 266.4, 6
```

### NOTE:

The first data value (0) indicates grouped data. The second data value (22) indicates the number of groups. The frequency associated with each data value is punched directly after that data value.



### SAMPLE SOLUTION

I DATA 0, 22, 261.4, 3, 270.8, 4, 265.4, 2, 261.4, 7, 258.1, 3

2 DATA 252.1, 5, 268.3, 7, 250.3, 1, 272.3, 9, 262.8, 2, 255.5, 8

2 DATA 249.6, 5, 280.9, 9, 270.3, 3, 263.2, 8, 258.3, 2, 256.3, 3

4 DATA 259.3, 5, 270.1, 3, 259.3, 2, 253.2, 5, 266.4, 6

RUN WAIT.

MA NDSD

ARITHMETIC MEAN, VARIANCE, AND STANDARD DEVIATION

### FØR GRØUPED DATA SET 1

X-VALUE	FREQUENCY
261.4	3
270.8	4
265.4	2
261.4	7 3
258.1	3
252.1	5
268.3	7
250.3	1
272.3	9
262.8	2
255.5	8
249.6	5
280.9	9
270.3	3
263.2	8
258.3	2
256.3	3
259.3	5
270.1	3
259.3	2
253.2	5
266.4	6

NUMBER OF VALUES = 102
ARITHMETIC MEAN = 263.524
STANDARD DEVIATION = 8.57248
SAMPLE VARIANCE = 72.767
EST TRUE VARIANCE = 73.4875
ST ERROR MEAN = .848802



### **PURPOSE**

To provide a description of univariate data with up to 300 observations on one variable.

### INSTRUCTIONS

Enter data on lines numbered 0-699.

Additional instructions may be obtained by listing the program STADES \* \* \*.

### SAMPLE PROBLEM

Determine statistical characteristics for the following data points:

261.4	252.1	255.5	258.3	253.2
270.8	268.3	249.6	256.3	266.4
265.4	250.3	280.9	259.3	
261.4	272.3	270.3	270.1	
258.1	262.8	263.2	259.3	



```
UNISTA * * *
S002
Page 2
```

#### SAMPLE SOLUTION

This sample solution is a copy the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

#### READY.

```
100 DATA 261.4,270.8,265.4,261.4,258.1,252.1,268.3,250.3,272.3
101 DATA 262.8,255.5,249.6,280.9,270.3,263.2,258.3,256.3,259.3
102 DATA 270.1,259.3,253.2,266.4
RUN
```

UNISTA

PLEASE SPECIFY A TYPICAL CLASS INTERVAL FOR FREQUENCY DISTRIBUTIONS: L,U =7260,280

### SUMMARY STATISTICS

NUMBER ØF VARIATES = 22
ARITHMETIC MEAN = 262.059
STANDARD DEVIATIØN = 7.78374
VARIANCE = 60.5865
CØEFF ØF VAR (PCT) = 2.97
STANDARD SKEWNESS = .385
STANDARD EXCESS = -.306

#### ØRDER STATISTICS

SMALLEST VARIATE = 249.6 LØWER DECILE = 250.84 FIRST QUARTILE = 256.1 MEDIAN = 261.4 THIRD QUARTILE = 268.75 UPPER DECILE = 271.85 LARGEST VARIATE = 280.9

TØTAL RANGE = 31.3
DECILE RANGE = 21.01
SEMI-QUARTILE RANGE = 6.325
BØWLEY'S SKEWNESS = .162
PEARSØN SKEWNESS = .254



## FREQUENCY DISTRIBUTION

	UP TØ BUT		PERCENT
FRØM	NØT INCLUDING	FREQUENCY	FREQUENCY
220	240	0	0
240	260	10	45.455
260	280	11	50.
280	300	1	4.545
300	320	0	0

## CUMULATIVE DISTRIBUTIØN

VALUE	NUMBER LESS	PERCENT LESS	VARIATE SUM - PCT
	Than value	Than value	LESS THAN VALUE
240	0	0	0
260	10	45.455	44.265
280	21	95.455	95.128
300	22	100.	100.
ØRDER	ED ARRAY		
249.6 250.3 252.1 253.2 255.5 256.3	258.1 258.3 259.3 259.3 261.4 261.4	262.8 263.2 265.4 266.4 268.3	270.1 270.3 270.8 272.3 280.9



Name STATAN \* \* \*
Code S003

## PROGRAM ABSTRACT

### **PURPOSE**

To perform a statistical analysis on Data for one variable. It computes 34 different measures for an array of weighted (as with frequencies) or unweighted values of the variable. It also gives a 10-class frequency distribution summary, and a recapitulation of the input data in terms of deviations from the mean and as an ordered array.

### **INSTRUCTIONS**

To use this program supply data in either of these 2 formats as determined by the problem:

2) FOR DATA WITH WEIGHTS OR FREQUENCIES:
10 DATA 1, X(1), F(1), X(2), F(2), X(3), F(3),.....

Where the initial 0 or 1 signals the presence or the absence of weights. Lines 11 through 99 are available for additional input data.

### NOTES:

This program produces output corresponding to the listing in the National Bureau of Standards Handbook No. 101.

There can be no more than 99 values entered. If the values are weighted the maximum amount of data cannot exceed 99 values and 99 weights.

Additional instructions may be obtained by listing the program STATEX \* \* \*.



```
STATAN * * *
S003
Page 2
```

### SAMPLE PROBLEM

Suppose you had obtained the following data points as the result of an experiment:

261 /	252.1	255.5	258.3	253.2
261.4	232.1	200.0		
270.8	268.3	249.6	256.3	266.4
265.4	250.3	280.9	259.3	
261.4	272.3	270.3	270.1	
258.1	262.8	263.2	259.3	

To use this program to get the data's statistical characteristics you would prepare the following data tape:

```
10 DATA 0, 261.4, 270.8, 265.4, 261.4, 258.1, 252.1, 268.3, 250.3
11 DATA 272.3, 262.8, 255.5, 249.6, 280.9, 270.3, 263.2, 258.3, 256.3
12 DATA 259.3, 270.1, 259.3, 253.2, 266.4
```

Where the first data value (0) indicates unweighted data.

### SAMPLE SOLUTION

These sample solutions are copies of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

```
10 DATA 1,261.4,3,270.8,4,265.4,2,261.4,7,258.1,3
11 DATA 252.1,5,268.3,7,250.3,1,272.3,9,262.8,2,255.5,8
12 DATA 249.6,5,280.9,9,270.3,3,263,2,8,258.3,2,256.3,3
13 DATA 259.3,5,270.1,3,259.3,2,253.2,5,266.4,6
```

RUN WAIT.

#### STATAN

COMPUTATIONS ON THE DATA ARRAY:

```
NUMBER OF VALUES = 22
NUMBER OF NONZERO WEIGHTS = 22
SUM OF WEIGHTED VALUES = 5765.3
WEIGHTED MEAN = 263.524
UNWEIGHTED MEAN = 262.059
SMALLEST VALUE = 249.6
LARGEST VALUE = 280.9
RANGE = 31.3
WEIGHTED SUM OF SQUARES = 4.23187 E 7
VARIANCE = 353.436
STANDARD DEVIATION = 18.7999
STANDARD ERROR OF MEAN = 1.86147
COEFFICIENT OF VARIATION = 7.13405 E-2
```



STUDENT'S T = 141.568
MEAN SQUARE SUCCESSIVE DIFFERENCES = 145.4
[MEAN SQ SUCC DIFF]/(VARIANCE) = .411389
MEDIAN = 261.4
NUMBER ØF RUNS UP AND DØWN = 11
EXPECTED NUMBER ØF RUNS = 14.3333
STD ERRØR ØF NUMBER ØF RUNS = 1.89444
[ACTUAL RUNS - EXP RUNS]/(STD ERR) = 1.75954

FREQUENCY DISTRIBUTION (TEN EQUAL CLASSES): 3 2 3 4 2 3 3 1 0

#### COMPUTATIONS ON DEVIATIONS FROM MEAN:

NUMBER ØF + SIGNS IN DEVIATIONS = 8
NUMBER ØF - SIGNS IN DEVIATIONS = 14
NUMBER ØF RUNS [SIGN CHANGES + 1] = 12
EXPECTED NUMBER ØF RUNS = 11.1818
SID ERRØR ØF NUMBER ØF RUNS = 2.10993
[ACTUAL RUNS - EXP RUNS]/[SID ERR] = .387777
TREND VALUE =-.476061
SID ERRØR ØF TREND = 5.77038 E-2
[TREND]/[SID ERRØR] =-8.25009
BETA ØNE = 1.99451 E-4
BETA TWØ = 8.39401 E-2
MEAN DEVIATION = 6.58369

#### RECAPITULATION OF INPUT:

VALUE	DEVIATIONS	WEIGHTS	ORDERED ARRAY
261.4	-2.12353	3	249.6
270.8	7.27647	4	250.3
265.4	1.87647	2	252.1
261.4	-2.12353	2 7	253.2
258.1	-5.42353	3 5 7	255.5
252.1	-11.4235	5	256.3
268.3	4.77647	7	258.1
250.3	-13.2235	1	258.3
272.3	8.77647	9 2 8 5 9 3 8 2 3 5 3	259.3
262.8	723527	2	259.3
255.5	-8.02353	8	261.4
249.6	-13.9235	5	261.4
280.9	17.3765	•	262.8
270.3	6.77647	3	263.2
263.2	323527	8	265.4
258.3	-5.22353	2	266.4
256.3	-7.22353	3	268.3
259.3	-4.22353	5	270.1
270.1	6.57647	3	270.3
259.3	-4.22353	2 5	270.8
253.2	-10.3235		272.3
266.4	2.87647	6	280.9



```
STATAN * * *
S003
Page 4
```

### SAMPLE PROBLEM

Suppose that each data point has a weight associated with it. See the printout for the weights used.

To use this program prepare the following data tape:

```
10 DATA 1, 261.4, 3, 270.8, 4, 265.4, 2, 261.4, 7, 258.1, 3
11 DATA 252.1, 5, 268.3, 7, 250.3, 1, 272.3, 9, 262.8, 2, 255.5, 8
12 DATA 249.6, 5, 280.9, 9, 270.3, 3, 263.2, 8, 258.3, 2, 256.3. 3
13 DATA 259.3, 5, 270.1, 3, 259.3, 2, 253.2, 5, 266.4, 6
```

#### NOTE:

The first data value (1) indicates weighted values; the weight associated with each data point is punched directly after that data point.

### SAMPLE SOLUTION

```
10 DATA 0, 261.4, 270.8, 265.4, 261.4, 258.1, 252.1, 268.3, 250.3

11 DATA 272.3, 262.8, 255.5, 249.6, 280.9, 270.3, 263.2, 258.3, 256.3

12 DATA 259.3, 270.1, 259.3, 253.2, 266.4

RUN

WAIT.
```

#### STATAN

COMPUTATIONS ON THE DATA ARRAY:

```
NUMBER OF VALUES = 22
NUMBER OF NONZERO WEIGHTS = 22
SUM OF WEIGHTS = 22
SUM OF UNWEIGHTED VALUES = 5765.3
WEIGHTED MEAN = 262.059
UNWEIGHTED MEAN = 262.059
SMALLEST VALUE = 249.6
LARGEST VALUE = 280.9
RANGE = 31.3
WEIGHTED SUM OF SQUARES = 1.51218 E 6
VARIANCE = 63.4711
STANDARD DEVIATION = 7.96688
STANDARD ERROR OF MEAN = 1.69854
CØEFFICIENT ØF VARIATIØN = 3.04011 E-2
STUDENT'S T = 154.285
MEAN SQUARE SUCCESSIVE DIFFERENCES = 145.4
[MEAN SQ SUCC DIFF]/[VARIANCE] = 2.29081
MEDIAN = 261.4
NUMBER OF RUNS UP AND DOWN = 11
EXPECTED NUMBER OF RUNS = 14.3333
STD ERROR OF NUMBER OF RUNS = 1.89444
[ACTUAL RUNS - EXP RUNS]/[STD ERR] = 1.75954
```



FREQUENCY DISTRIBUTION (TEN EQUAL CLASSES): 3 2 3 4 2 3 3 1 0 1

### COMPUTATIONS ON DEVIATIONS FROM MEAN:

NUMBER ØF + SIGNS IN DEVIATIØNS = 10

NUMBER ØF - SIGNS IN DEVIATIØNS = 12

NUMBER ØF RUNS (SIGN CHANGES + 1) = 12

EXPECTED NUMBER ØF RUNS = 11.9091

SID ERRØR ØF NUMBER ØF RUNS = 2.26883

[ACTUAL RUNS - EXP RUNS]/(SID ERR) = 4.00687 E-2

IREND VALUE =-5.76505 E-2

SID ERRØR ØF TREND = 6.12764 E-2

(ITREND)/(SID ERRØR) =-.940827

BETA ØNE = .148617

BETA IWØ = 2.67928

MEAN DEVIATIØN = 6.35537

### RECAPITULATION OF INPUT:

VALUE	DEVIATIONS	WEIGHTS	ORDERED ARRAY
261.4	659089	i	249.6
270.8	8.74091	1	250.3
265.4	3.34091	1	252.1
261.4	659089	1	253.2
258.1	-3.95909	1	255.5
252.1	-9.95909	1	256.3
268.3	6.24091	1	258.1
250.3	-11.7591	1	258.3
272.3	10.2409	1	259.3
262.8	.740911	1	259.3
255.5	-6.55909	1	261.4
249.6	-12.4591	1	261.4
280.9	18.8409	1	262.8
270.3	8.24091	1	263.2
263.2	1.14091	1	265.4
258.3	-3.75909	1	266.4
256.3	-5.75909	Ī	268.3
259.3	-2.75909	1	270.1
270.0	8.04091	1	270.3
259.3	-2.75909	i	270.8
253.2	-8.85909	1	272.3
266.4	4.34091	1	280.9



### **PURPOSE**

To perform several types of calculations for normal and student's-T distributions. Given one- or two-tailed probabilities, it will produce the corresponding limits; given a variate or a set of limits, it will produce the corresponding probabilities.

### INSTRUCTIONS

To use this program enter data as follows:

```
100 DATA DF, MEAN, SIGMA, (BLOCK1), (BLOCK2),....
```

Where df is degrees of freedon (setting df=zero signals normal distribution), mean and sigma are the mean and standard deviation of the distribution, and the data blocks may be any mixture of the 4 types shown below:

BLOCK(INPUT)	OUTPUT PRODUCED
1,V 2,L,U	PROB OF X EXCEEDING THE VALUE V
3, P	VALUE WHICH IS EXCEEDED WITH PROB P
4,P	LIMITS CONTAINING X WITH PROB P

For example, the line of data shown below would produce as output the probability of a normally distributed variable with mean 100 and standard deviation 10 being in the range 95-105, and also the value of the variable that will be exceeded only 2.5 percent of the time:

```
100 DATA 0,100,10,2,95,105,3,0.025
```

Data for additional cases may be continued on lines 101-199 as needed.

Additional instructions may be obtained by listing the program PROVEX \* \* \*.



PROVAR \* \* \*
S004
Page 2

#### SAMPLE PROBLEM

Given: Monthly sales (in pounds) will be distributed normally with a mean of 155,000. 99 percent of the time actual sales will be within 18,000 pounds of the mean. The standard deviation can be approximated by 6,000 pounds. Based on the above information the following problems can be solved:

- 1. What is the probability that sales volume will exceed 165,000 pounds? 170,000 pounds?
- 2. What is the probability that sales volume will be at least 145,000 pounds?
- 3. What is the probability that sales volume will be between 150,000 and 160,000 pounds?
- 4. What sales volume level will fall below 25 percent of the time?
- 5. What sales volume range can be expected 50 percent of the time?

To use this program prepare the following data lines:

```
100 DATA 0, 155000, 6000, 1, 165000, 1, 170000, 1, 145000, 2, 150000 101 DATA 160000, 3, .75, 4, .5
```

Question 2 is really the same as Question 1 and, therefore, uses type 1 input.

In order to answer Question 4 above, the value which is exceeded  $75\,\mathrm{percent}$  of the time was requested.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

```
100 DATA 0, 155000, 6000, 1, 165000, 1, 170000, 1, 145000, 2, 150000
101 DATA 160000, 3, .75, 4, .5
RUN
```

PRØVAR

CALCULATIONS FOR A NORMAL DISTRIBUTION HAVING A MEAN OF 155000 AND A SIGMA OF 6000

#### SAMPLE PROBLEM

To illustrate the use of the Student-t portion of this program, calculate several values of t which could be used for testing the significance between 2 sample means. Consider the following conditions (all of which are based on single-tail area):

- 1. 20 degrees of freedom, alpha of .05
- 2. 17 degrees of freedom, alpha of .025
- 3. 32 degrees of freedom, alpha of .03

To use this program type the following data lines:

```
100 DATA 20, 0, 1, 3, .05
100 DATA 17, 0, 1, 3, .025
100 DATA 32, 0, 1, 3, .03
```

Standard Student-t curves are based on a mean of 0 and a sigma of 1.

Since the degrees of freedom were different for each case the program was run 3 times.

To get the two-tail areas, simply multiply by 2 the answers given by the program.

This program will provide a critical value for 3 percent, something most tables do not provide.

### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.



PROVAR \* \* \* S004 Page 4

> 100 DATA 20, 0, 1, 3, .05 101 RUN WAIT.

PRØVAR

CALCULATIONS FOR A STUDENT'S T-DISTRIBUTION HAVING A MEAN OF O AND A SIGMA OF I AND HAVING 20 DEGREES OF FREEDOM.

CASE THE PROBABILITY OF A VARIATE:

1 EXCEEDING 1.72459 IS .05

100 DATA 17, 0, 1, 3, .025 RUN WAIT.

PR ØVAR

CALCULATIONS FOR A STUDENT'S T-DISTRIBUTION HAVING A MEAN OF O AND A SIGMA OF I AND HAVING 17 DEGREES OF FREEDOM.

CASE THE PROBABILITY OF A VARIATE:

I EXCEEDING 2.10928 IS .025

100 DATA 32, 0, 1, 3, .03 RUN WAIT.

PRØVAR

CALCULATIONS FOR A STUDENT'S T-DISTRIBUTION HAVING A MEAN OF O AND A SIGMA OF 1 AND HAVING 32 DEGREES OF FREEDOM.

CASE THE PROBABILITY OF A VARIATE:

EXCEEDING 1.94981 IS .03



### **PURPOSE**

To produce an equation that best fits input points described by X and Y coordinates. This fit is made in the least-squares sense.

### INSTRUCTIONS

To use this linear regression program enter data using the following format:

O DATA K

Where K represents the following functions:

DATA 
$$X[1], Y[1], X[2], Y[2], \ldots, X[N], Y[N]$$
 [Where  $X[1], Y[1]$  is the first point,  $X[2], Y[2]$  is the second, and so on until all points have been entered. Additional data statements 2-199 may be used as needed.]

Then type RUN.

Additional instructions may be found in the listing.

### SAMPLE PROBLEM

Determine what curve best fits the following bivariate data:

X	<u>Y</u>	X	<u>Y</u>	X	Y
1.0	38.10	3.0	11.78	5.0	5.30
1.5	14.67	3.5	1.67	5.5	1.67
2.0	12.76	4.0	5.35	6.0	8.92
2.5	13.15	4.5	14.60	6.5	15.67



```
LINREG * * *
S005
Page 2
```

Insert the following data. This may be done by either preparing a data tape or via the teletypewriter.

```
O DATA 1
1 DATA 1, 38.1, 1.5, 14.67, 2, 12.76, 2.5, 13.15, 3, 11.78
2 DATA 3.5, 1.67, 4, 5.35, 4.5, 14.6, 5, 5.3, 5.5, 1.67, 6
3 DATA 8.92, 6.5, 15.67
```

### NOTE:

The data given at line 0 indicates to fit a linear curve first.

The exponential and power fit may be accomplished simply by entering a new line 0.

This same data is used in the POLFIT \* \* \* and SIXCUR \* \* \* examples.

### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

### NOTE:

All user supplied information is underlined.



SAVE WAIT. READY.

OLD
OLD PROBLEM NAME--LINREG
WAIT.
READY.

O DATA I I DATA I,38.1,1.5,14.67,2,12.76,2.5,13.15,3,11.78 2 DATA 3.5,1.67,4,5.35,4.5,14.6,5,5.3,5.5,1.67,6 3 DATA 8.92,6.5,15.67 RUN WAIT.

LINREG 16:38

LINEAR: Y=A+B+X WITH A= 22.544 AND B=-2.81972

CØEFFICIENTS: CØRREL = -.527239 DETERM = .277981

CØMPARISØN ØF ACTUAL Y'S WITH Y'S ESTIMATED FRØM EQUATION:

X-ACTUAL	Y-ACTUAL	Y-ESTIM	DIFFER	PCT-DIFF
1	38.1	19.7242	-18.3758	-48.2304
1.5	14.67	18.3144	3.64437	24.8423
2	12.76	16.9045	4.14451	32.4805
2.5	13.15	15.4947	2.34465	17.83
3	11.78	14.0848	2.30479	19.5653
3.5	1.67	12.6749	11.0049	658.978
4	5.35	11.2651	5.91507	110.562
4.5	14.6	9.85521	-4.74479	-32.4986
5	5.3	8.44535	3.14535	59.3462
5.5	1.67	7.03549	5.36549	321.287
6	8.92	5.62563	-3.29437	-36.9324
6.5	15.67	4.21577	-11.4542	-73.0966

TIME: 3 SECS.



LINREG \* \* \* S005 Page 4

O DATA 2 RUN WAIT.

LINREG 15:31

EXPONENTIAL: Y=A\*EXP[B\*X] WITH A: 19.6408 AND B:-.218326
INDEXES: CORREL: -.425584 DETERM: .181122

COMPARISON OF ACTUAL Y'S WITH Y'S ESTIMATED FROM EQUATION:

X-ACTUAL	Y-ACTUAL	Y- ESTIM	DIFFER	PCT-DIFF
1	38.1	15.7886	-22.3114	-58.5602
1.5	14.67	14.1558	514224	-3.50528
2	12.76	12.6918	-6.81533 E-2	534117
2.5	13.15	11.3793	-1.77069	-13.4653
3	11.78	10.2025	-1.57749	-13.3912
3.5	1.67	9.14741	7.47741	447.749
4	5.35	8.20143	2.85143	53.2977
4.5	14.6	7.35327	-7.24673	-49.6351
5	5.3	6.59283	1.29283	24.393
5.5	1.67	5.91103	4.24103	253.954
6	8.92	5.29973	-3.62027	-40.586
6.5	15.67	4.75166	-10.9183	-69.6767

TIME: 3 SECS.

O DATA 3 RUN WAIT.

LINREG 15:34

PØWER: Y=A\*[X+B] WITH A= 23.5273 AND B=-.842416

INDEXES: CORREL = -.533299 DETERM = .284408

COMPARISON OF ACTUAL Y'S WITH Y'S ESTIMATED FROM EQUATION:

X-ACTUAL	Y-ACTUAL	Y- ESI I M	DIFFER	PCT-DIFF
1	38.1	23.5273	-14.5727	-38.3
1.5	14.67	16.7198	2.04979	14
2	12.76	13.1214	.361408	2.5
2.5	13.15	10.8728	-2.27719	-17.4
3.	11.78	9.32477	-2.45523	-20.9
3.5	1.67	8.1892	6.5192	390.4
4	5.35	7.31792	1.96792	36.8
4.5	14.6	6.62668	-7.97332	-54.7
5.	5.3	6.06386	.763862	14.4
5.5	1.67	5.59602	3.92602	235.1
6.	8.92	5.20051	-3.71949	-41.8
6.5	15.67	4.8614	-10.8086	-69.1

TIME: 3 SECS.



### **PURPOSE**

To define confidence limits on simple linear regressions.

### INSTRUCTIONS

Enter input data using the following format:

100 DATA 116, 132, 104, 139 200 DATA 105, 120, 85, 121

Then type: RUN

NOTE:

Line numbers 0-699 are free for use as data statements, as required. All values for one variable are given in data statements, followed by all data for a second variable, and so on. One convenient way to arrange input is to put all values of variable 1 at lines 100-199, all for variable 2 at lines 200-299, etc. If separate tapes are made for each variable, the full use of input flexibility can be obtained.

Additional instructions may be obtained by listing the program STADES \* \* \*

### SAMPLE PROBLEM

Determine the confidence limits using the following observed data

Y = 116, 132, 104, 139X = 105, 120, 85, 121



COLINR \* \* \*
S006
Page 2

### SAMPLE SOLUTION

The following sample solutions are copies of the printout that will appear at your teletype-writer.

NOTE:

All user supplied information is underlined.

100 DATA 116, 132, 104, 139 200 DATA 105, 120, 85, 121 RUN WAIT.

CØLINR

SIMPLE LINEAR REGRESSIØN

EQUATION: Y = A + B\*X

HOW MANY OBSERVATIONS ON EACH VARIABLE? 4

VARIABLE	MEA N	VARIANCE	STD DEVIATION
X Y	107.75 122.75	212.688 186.688	14.5838 13.6634
INDEX [R+2]	EXPL VAR	UNEXPL VAR	STD ERRØR
.884752	165.172	21.5154	4.63847
PARAMETER	VALUE	95 PCT CØNFII	DENCE LIMITS
A B	24.7523 .909492	15.8192 .296961	33.6853 1.52202

ESTIMATED VALUES OF Y (FROM THE REGRESSION) AND CONFIDENCE LIMITS FOR INDIVIDUAL VALUES OF Y, FOR EACH VALUE OF X:

X-ACTUAL	Y-ACTUAL	Y- CALC	95 PCT CØNFI	DENCE LIMITS
105	116	120.249	100.203	140.295
120	132	133.891	112.554	155.229
85	104	102.059	77.7037	126.414
121	139	134.801	113.24	156.362

TIME: 3 SECS.



### SAMPLE PROBLEM

Determine the confidence limits using the following observed data:

$$Y = -3, -2, -1, -0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10$$
  
 $X = 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, -1, -2, -3$ 

### SAMPLE SOLUTION

100 DATA -3, -2, -1, -0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
200 DATA 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, -1, -2, -3
RUN
WAIT.

CØLINR

SIMPLE LINEAR REGRESSION

EQUATION: Y = A + B \* X

HOW MANY OBSERVATIONS ON EACH VARIABLE? 14

VARIABLE	MEAN	VARIANCE	STD DEVIATION
X Y	3.5 3.5	16.25 16.25	4.03113 4.03113
INDEX (R12)	EXPL VAR	UNEXPL VAR	SID ERRØR
1	16.25	0	0
PARAMET ER	VALUE	95 PCT CONFIG	DENCE LIMITS
A B	7 -1	7 -1	7 -1

ESTIMATED VALUES OF Y (FROM THE REGRESSION) AND CONFIDENCE LIMITS FOR INDIVIDUAL VALUES OF Y, FOR EACH VALUE OF  $\chi_{\epsilon}$ 

X-ACTUAL	Y-ACTUAL	Y- CALC	95 PCT	CONFIDENCE LIMITS
10	-3	-3	-3	-3
9	<b>-</b> 2	-2	<b>-</b> 2	<del>-</del> 2
8	-1	-1	-1	-1
7	0	0	0	0
6	I	1	1	1
5	2	2	2	2
4	3	3	3	3
3	4	4	4	4
2	5	5	5	5
1	6	6	6	6
0	7	7	7	7
-1	8	8	8	8
•2	9	9	9	9
-3	10	10	10	10

TIME: 4 SECS.



#### **PURPOSE**

To determine confidence limits for a population proportion based on the  $norma_{\iota}$  curve approximation.

#### NOTE:

For small sample sizes use the program BICONF \* \* \*.

#### INSTRUCTIONS

To use this program enter values for X and N when requested by the program.

#### NOTE:

X = number of successes in sample
N = sample size

Additional instructions may be found in the listing.

#### 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. Suppose the agency is willing to settle for accuracy of only 50 percent (or 75, or 90, or 95, etc.) in their prediction, what limits should they choose?

Suppose that they decide to make a larger survey for greater accuracy. This time they poll 2000 people and find that 1150 people (or 57.5 percent) are planning to vote for Candidate A. What limits should they then pick for a 50 percent (or 75, or 90, or 95, etc.) chance of accuracy?



CONBIN \* \* \*
S007
Page 2

### SAMPLE SOLUTION

These sample solutions are copies of the printout that will appear at your teletypewriter.

### NOTE:

All user supplied information is underlined.

RUN WAIT.

CONBIN

CONFIDENCE LIMITS FOR A POPULATION PROPORTION BASED ON THE NORMAL CURVE APPROXIMATION. (FOR SMALL SAMPLE SIZES USE THE PROGRAM BICONF\*\*\*). WHAT ARE X (NUMBER OF SUCCESSES IN SAMPLE), N (SAMPLE SIZE)? 110, 200

BEST ESTIMATE OF POPULATION PROPORTION (PCT) = 55.

### CONFIDENCE LIMITS ON POPULATION PROPORTION:

CONF LEVEL	LOWER LIM	UPPER LIM
50	52.377	57.623
75	50.703	59.297
90.	48.964	61.036
95.	47.855	62.145
99.	45.689	64.311
99.9	43.174	66.826
99.99	41.063	68.937

RUN WAIT.

CONBIN

CONFIDENCE LIMITS FOR A POPULATION PROPORTION BASED ON THE NORMAL CURVE APPROXIMATION. (FOR SMALL SAMPLE SIZES USE THE PROGRAM BICONF\*\*\*). WHAT ARE X (NUMBER OF SUCCESSES IN SAMPLE), N (SAMPLE SIZE)? 1150, 2000

BEST ESTIMATE OF POPULATION PROPORTION (PCT) = 57.5

#### CONFIDENCE LIMITS ON POPULATION PROPORTION:

CONF LEVEL	LOWER LIM	UPPER LIM
50	56.729	58.271
75	56.203	58.797
90.	55.657	59.343
95.	55.308	59.692
99.	54.628	60.372
99.9	53.838	61.162
99.99	53.174	61.826



### **PURPOSE**

To compute confidence limits for the difference between 2 population means, wased on data supplied for 2 samples, 1 from each population.

#### INSTRUCTIONS

To use this program type the data in the following format:

100 DATA  $\rm H1,N1,M1,S1,\ H2,N2,M2,S2$  THEN RUN

NOTE:

H1 = SIZE OF POPULATION 1 [LET H1 EQUAL ZERO IF POPULATION IS INFINITE]

N1 = SIZE OF SAMPLE 1

M1 = ARITHMETIC MEAN OF SAMPLE 1

S1 = STANDARD DEVIATION OF SAMPLE 1 [BASED ON DIVISOR OF N1]

H2, N2, M2, S2 ARE THE SAME FOR SAMPLE 2.

Additional instructions may be found in the listing.

## SAMPLE PROBLEM

Determine the confidence limits for these 2 samples

- (1) 0, 21, 30.9048, 29.2752
- (2) 0, 21, 44, 26.8239



CONDIF \* \* \*
S008
Page 2

### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

### NOTE:

All user supplied information is underlined.

### 100 DATA 0.21.30.9048.29.2752.0.21.44.26.8239 RUN WAIT.

### CONDIF

STATISTIC	SAMPLE I	SAMPLE 2
SAMPLE MEAN SAMPLE VARIANCE SAMPLE SID DEVIATION	30.9048 857.037 29.2752	44 719.522 26.8239
SAMPLE SIZE PØPULATIØN SIE ESTIM PØPN STD DEV STD ERRØR ØF MEAN	21 INFINITE 29.9982 6.54613	21 INFINITE 27.4863 5.99801
DIFF BETWEEN MEANS STD ERRØR ØF DIFF DEGR ØF FREEDØM [DIFF]	8.	3.0952 .87851 9.7

### CONFIDENCE LIMITS ON DIFFERENCE BETWEEN MEANS:

CONF LEVEL	LØWER LIM	UPPER LIM
50	-19.1389	-7.05145
75	-23.4602	-2.73022
90.	-28.0478	1.85743
95.	-31.0433	4.85287
99.	-37.1143	10.9239
99.9	-44.6336	18.4432
99.99	-51.4662	25.2758
99.999	-57.9524	31.762



### **PURPOSE**

To compute confidence limits for an unknown population mean based on random sample data.

### **INSTRUCTIONS**

To use this program enter the input data using this format:

Additional instructions may be found in the listing.

### SAMPLE PROBLEM

Analyze the data which is entered in the following sample solution.



CONLIM \* \* \*
S009
Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

## NOTE:

All user supplied information is underlined.

# 100 DATA 2.3.6.9.8.11,13,16,23,45,67,89,35,67,13,43,21,67,98,7,6 RUN

## CONLIM

## VALUES OF SAMPLE STATISTICS:

SIZE OF SAMPLE	21
SAMPLE MEAN VALUE	30.9048
VARIANCE OF SAMPLE	857.039
SAMPLE STD DEVIATION	29.2752
ESTIMATED POPN STD DEV	29.9982
STANDARD FRROR OF MEAN	6.54614

# CONFIDENCE LIMITS ON POPULATION MEAN:

CONF LEVEL	LOWER LIM	UPPER LIM
50	26.4895	35.32
75	23.3745	38.4351
90.	20.1373	41.6722
95.	18.0745	43.735
99.	14.0428	47.7667
99.9	9.36435	52.4452
99.99	5.43601	56.3735
99.999	1.99002	59.8195



## **PURPOSE**

To determine the confidence limits for a population proportion based on the e. et binomial distribution.

## INSTRUCTIONS

Enter values for X, N, and C when requested by the program.

#### NOTE:

- X Successes.
- N Sample size.
- C Confidence Coefficient in percent.

Additional instructions may be found in the listing.

## 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?



BICONF \* \* \*
S010
Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

RUN WAIT.

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 COEFFICIENT IN PERCENT)? 110,200,95

BEST ESTIMATE OF POPULATION PROPORTION [PCT] = 55.

THE 95 PERCENT CONFIDENCE LIMITS ON THE POPULATION PROPORTION (PCT) ARE 47.8249 AND 62.0247



Name BITEST \* \* \*
Code S011

# PROGRAM ABSTRACT

## **PURPOSE**

To perform a statistical test of a binomial proportion.

#### INSTRUCTIONS

Enter values for X, N, and P when requested by the program.

#### NOTE:

- X Successes in sample
- N Sample size
- P Population proportions

Additional instructions may be found in the listing.

## SAMPLE PROBLEM

Consider a city in which 75 percent 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 percent 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(The true proportion of the 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 solutions.



BITEST \* \* \*
S011
Page 2

## SAMPLE SOLUTION

These sample solutions are copies of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined.

READY.

RUN WAIT.

BITEST

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

IN SAMPLES OF SIE 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

RUN WAIT.

BITEST

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

IN SAMPLES OF SIE 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



Name BINDIS \* \* \*
Code S012

## PROGRAM ABSTRACT

## **PURPOSE**

To compute the binomial distribution function for problems of this type: In a series of N independent trials, each with probability of success P, what is the probability that there will be exactly X successess?

## **INSTRUCTIONS**

Enter values for P, N, and M, when requested by the program.

#### NOTE:

This program will determine all the values of X for which the probability is significantly large [up to 7 standard deviations away from P\*N]

The number M is a multiplier of the Binomial function useful in scaling the function to a conveniently graphable range. [M does not affect the values of the binomial function, but is multiplied and printed out in a separate column. Each value of B\*M is rounded off to the nearest integer.]

Additional instructions may be found in the listing.

## SAMPLE PROBLEM

Determine the probability that in 30 rolls of a die it will come up 3 exactly 6 times (or 7, or 8, or 9, etc).

To use this program enter the following data: P = 1/6 = .166667

N = 30

 $\mathbf{M} = \mathbf{100}$ 



```
BINDIS * * *
S012
Page 2
```

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

## NOTE:

All user supplied information is underlined.

RUN WAIT.

BINDIS

DØ YØU WANT INSTRUCTIONS (1=YES, 0=NØ)? 0
WHAT ARE P,N,M? .166667, 30, 100

BINOMIAL DISTRIBUTION: N = 30 P = .166667

X	X/N	B(X,P,N)	B * 100
0	0	4.21267 E-3	0
1	3.33333 E-2	2.52761 E-2	3
2 3	6.66667 E-2	7.33008 E-2	7
	. 1	.136828	14
<b>4</b> 5	.133333	.184719	18
5	.166667	.192108	19
6	.2	.16009	i 6
7	.233333	.109777	11
8	.266667	6.31217 E-2	6
9	.3	3.08596 E-2	3
10	.333333	1.29611 E-2	1
11	.366667	4.71312 E-3	0
12	. 4	1.49249 E-3	0
13	.433333	4.03306 E-4	0
14	.466667	1.00375 E-4	0
15	.5	2.14133 E-5	Ō
16	•533333	4.01501 E-6	Ō
17	.566667	6.61297 E-7	Ō



SEVPRO \* \* \*
S013
Page 2

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.

#### SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

READY.

100 DATA 1217, 45, 948, 49, 1165, 33, 1121, 44 RUN WAIT.

SEVPRØ 11:14

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 = 7.81993 CORRESPONDING NORMAL DEVIATE = 1.71866

THE PROBABILITY OF THIS VALUE OF CHI-SQUARE BEING EXCEEDED BY CHANCE ALONE IS .043

TIME: 2 SECS.

#### 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 proportions 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.



#### **PURPOSE**

To apply a CHI-SQUARE test to several sample proportions.

## **INSTRUCTIONS**

To use this program simply supply values for N and S in the following format:

```
100 DATA N1,S1, N2,S2, N3,S3, ..... RUN
```

#### where:

```
N1 = size of sample
S1 = the number of successes in sample 1.
```

Repeat for the total number of samples.

Additional instructions may be found in the listing.

## 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. This data appears on the following page.



## **PURPOSE**

To perform a one way analysis of variance with equal sample sizes.

## INSTRUCTIONS

To use this program enter data using the following format:

```
100 DATA M,N
200 DATA X11,X12,X13,...,X1N
201 DATA X21,X22,X23,...,X2N
ETC UNTIL
2XX DATA XM1,XM2,XM3,...,XMN
```

## where:

```
M = number of samples
N = common sample size
XIJ = observations
```

Additional instructions maybe found in the listing.

# SAMPLE PROBLEM

Determine what the probability is that the variability in the observed data is due to pure chance.

As Manager of the Materials Laboratory, you have been following with interest the preparation of tensile test specimens on three rather exotic alloys being developed for high-temperature use. The materials are difficult to fabricate, but the men have finally succeeded in getting four test bars ready for stretching in the tensile test machines. Since these alloys differ only in the relative amounts of a single ingredient, the main purpose for the test is to discover the effect of the ingredient on the tensile strength, if indeed it has any at all. Results of the twelve tests are on the following page.



ONEWAY \* \* \*
S014
Page 2

(Tensile	Values in	1000	lbs./sq.	inch)
Alloy A	Alloy	В	A110	эу С
181.4	166.3		<b>1</b> 76	. 4
168.6	172.1		183	. 2
174.0	179.2		189	. 4
183.2	159.7		177	. 5

What's the probability that the observed variability is due to pure chance rather than the amount of the added ingredient?

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

#### NOTE:

All user supplied information is underlined.

	DATA				
200	DATA	181.4.	168.6.	174, 18	33.2
201	DATA	166.3,	172.1,	179.2.	159.7
202	DATA	176.4.	183.2.	189.4.	177.5
RUN					
WAT	Γ.				

ØNEWAY 11:30

A N A L Y S I S Ø F V A R I A N C E 3 SAMPLES ØF SIZE 4

SAMPLE TØTAL	SAMPLE MEAN
707.2	176.8
677.3	169.325
726.5	181.625
	707.2 677.3

MEAN SQUARE [BETWEEN SAMPLES] = 153.631
MEAN SQUARE [WITHIN SAMPLES] = 50.1616
CALCULATED VALUE OF F-RATIO = 3.06273
CORRESPONDING NORMAL DEVIATE = 1.30578

THE PROBABILITY OF AN F-RATIO THIS LARGE OCCURRING BY CHANCE ALONE IS .096

TIME: 2 SECS.

### ANALYSIS OF RESULT

The evidence as to the effect of varying amounts of the alloying ingredient is not too clear. If the ingredient had no effect at all, and we ran ten experiments like this, we'd expect one of the ten to show as much diversity of sample means as we actually found. Maybe the test method should be looked at for improvement; there's quite a bit of variability among specimens of the same alloy.



## **PURPOSE**

To test 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

Additional instructions may be found in the listing.

## 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 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.?



TESTUD \* \* \*
S015
Page 2

## SAMPLE SOLUTION

This sample solution is a copy of the printout that will appear at your teletypewriter.

NOTE:

All user supplied information is underlined

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 POPULATION MEAN IS .0006

TIME: 2 SECS.

## 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.



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