Natural Science Report, Ochanomizu University, Vol. 22, No. 1, 1971
お茶の水女子大学 自然科学報告 第22巻 第1号

Fortran Subroutine Programs for Curve-plotting by Means of the Line-printer

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(Received January 14, 1971)

§1. Introduction

The graph printing of computed results is very often needed, especially when the electronic computer is used for computation. In this case it is natural to make the computor itself plot curves. The FORTRAN subroutine programs given in this article have been developed for this purpose, and are hoped to be useful for the computor system without the XY-plotter. The first program OU68Y1, the subroutine CRVPLA, aims at plotting the ordinate in the usual linear scale, while the second program OU6941, the subroutine LOGPLA, at plotting the ordinate in the logarithmic scale. These two subroutine may be used to plot several curves simultaneously.

§2. The Subroutine CRVPLA (OU68Y1)

The purpose of this subroutine is to print the graph of a single-valued real function $Y=f(X)$ of a real varisble X by means of the line-printer. The variable X is usually assumed to start from a given initial value, to change its value by a given constant amount, and to stop after a given number of steps. This change of X should be controlled by the main program, in which the subroutine is called. The evaluation of the function f(X) corresponding to each value of X should also be done either in the main program or in a suitable subroutine. The graph is printed on the line-printer paper with the X-axis in the running-direction of the paper and the Y-axis perpendicular to that

direction. The graph-point corresponding to an evaluated value Y is plotted with an arbitrary chosen symbol, provided that the value Y falls within a given interval (YMIN, YMAX). The point is plotted with the letter O either at the lower or the upper end of the interval in accordance with the cases $Y<YMIN$ or $Y>YMAX$. The value of abscissa X is printed to the left of the interval, and that of Y to the right.

2.1. The Use

The subroutine CRVPLA has three entries CRVPLB, CRVPLC, and CRVPLD other than CRVPLA. CRVPLA (YMIN, YMAX, *) should be called first to specify the values YMIN and YMAX. In the place of the asterisk the statement number, say 1, to be returned to if $YMIN \geqq YMAX$ should be written preceded by the symbol $ as $1. When CRVPLA is called, the scale indices 0, 10, 20, ⋯, 100 and the comment that 0 and 100 correspond respectively to the given values YMIN and YMAX are printed.

Next, CRVPLB (X, LP) should be called to print the value of X and the scale marks. The pattern of scale marks is controlled by a non-negative integer LP. If LP=1, the symbol + and the space printed alternately, namely, +'s at the positions with the scale indices 0, 2, 4, ⋯, 100. If LP=2, 3, ⋯, then only two +'s are printed at 0 and 100 to enclose the graph area combined with the +'s when LP=1. The special value LP=0 is reserved for automatic printing of the section-paper's pattern; on the every fifth line the + symbols are printed at 0, 2, 4, ⋯, 100 and on the other lines only at 0, 10, 20, ⋯, 100.

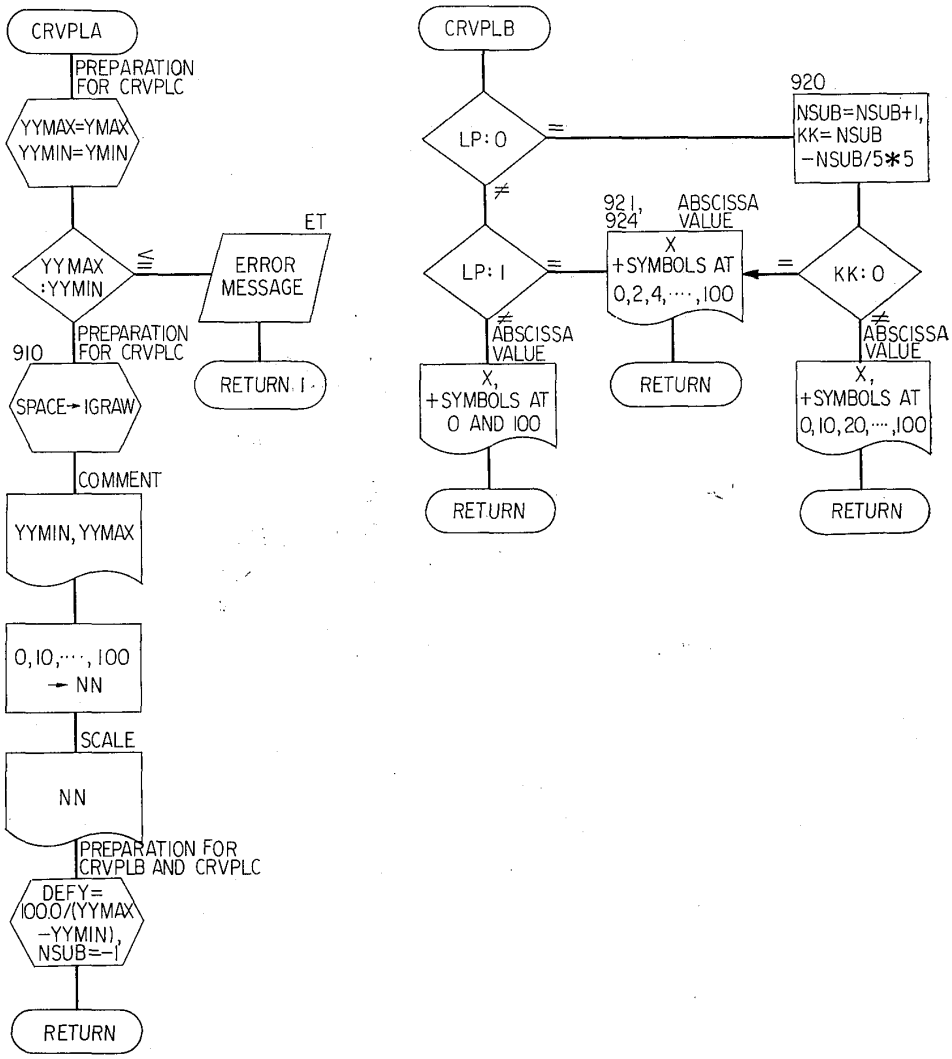
Then CRVPLC (Y, *, *, IP) should be called. The graph-point is printed at a position corresponding to the evaluated value of Y among the positions with scale indices 0, 1, 2, ⋯, 100 by making use of a symbol specified by IP. If the symbol @, say, is to be used, 1H @ should be written for IP. In the place of the first asterisk the statement number to be returned to when $Y<YMIN$ should be written, while in the place of the second asterisk the statement number to be returned to when $Y>YMAX$ should be written, for instance, as $100 if the statement number is 100. CRVPLC may be called any number of times with different arguments Y and IP in order to print many curves.

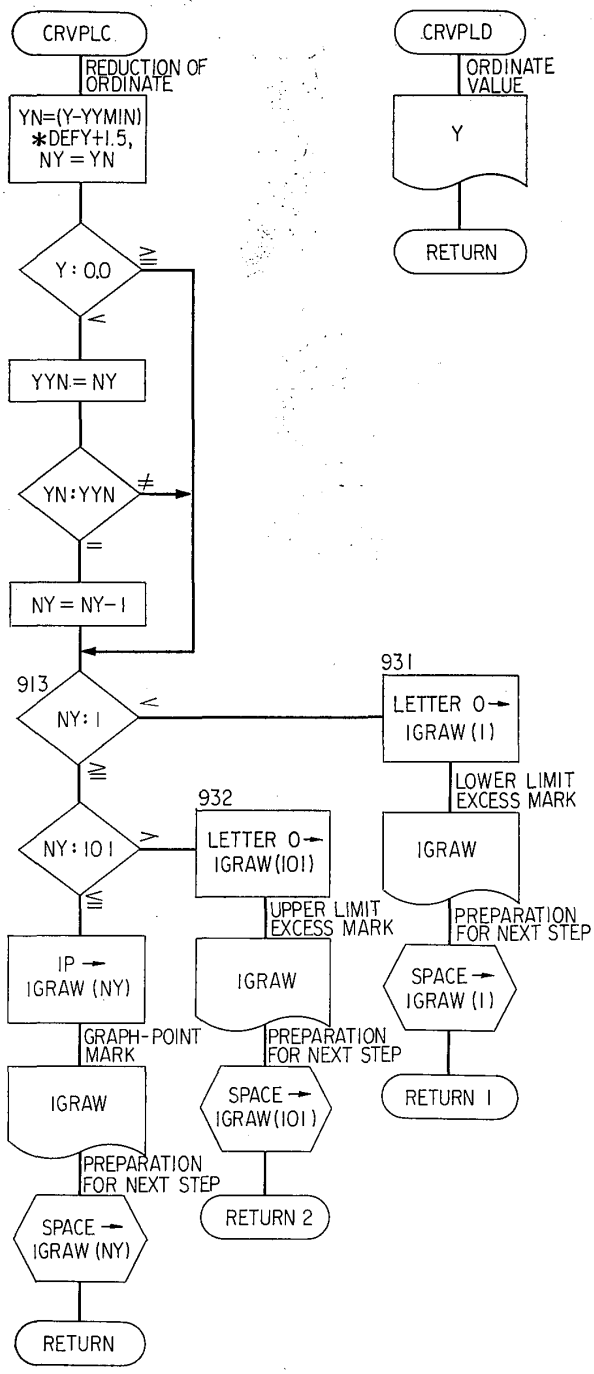
Finally, if the explicit value of Y is wanted, CRVPLD (Y) should be called. The value of Y is printed on the left-side of the graph-area, and of course only one value of Y corresponding to one graph-curve can be printed for each value of X.

In this way, CRVPLB, CRVPLC, and CRVPLD if necessary, should be called repeatedly for every new value of the variable X. CRVPLA,

however, should be called only in two cases: first, when the values of YMIN and YMAX are specified for the first time; and second, when the values of YMIN and YMAX are changed, and only if the comment for this change is necessary.

2.2. *Flowchart*




CRVPLC
REDUCTION OF ORDINATE
YN=(Y-YYMIN) *DEFY+1.5, NY = YN
Y : 0.0
≧
<
YYN = NY
YN : YYN
≠
=
NY = NY-1
913
NY : 1
<
≧
NY : 101
>
≦
IP → IGRAW (NY)
GRAPH-POINT MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW (NY)
RETURN
932
LETTER 0 → IGRAW(101)
UPPER LIMIT EXCESS MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW(101)
RETURN 2
931
LETTER 0 → IGRAW (1)
LOWER LIMIT EXCESS MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW (1)
RETURN 1
CRVPLD
ORDINATE VALUE
Y
RETURN

2.3. *Program List*[1)]

```
      SUBROUTINE CRVPLA(YMIN,YMAX,*)
C
C THE CURVE OF A REAL SINGLE-VALUE FUNCTION Y(X) OF A REAL VARIABLE X IS
C  PLOTTED BETWEEN YMIN AND YMAX.
C FOR *,A STATEMENT-NO. TO BE RETURNED TO WHEN YMIN IS NOT LESS THAN
C  YMAX SHOULD BE WRITTEN PRECEDED BY $.
C
      DIMENSION NN(11),IGRAW(101)
      YYMAX=YMAX
      YYMIN=YMIN
      IF(YYMAX.GT.YYMIN) GO TO 910
      WRITE(6,9901)
 9901 FORMAT(1H ,10X,38H***ERROR***YMIN IS NOT LESS THAN YMAX.)
      RETURN 1
  910 DO 911 ISUB=1,101
  911 IGRAW(ISUB)=8454144
      WRITE(30,9911) YYMIN,YYMAX
 9911 FORMAT(1HO,15X,16HO CORRESPONDS TO,E18.10,24H  AND 100 CORRESPONDS
     1 TO,E18.10/16X,42HO MEANS THE CURVE OUTSIDE OF THESE LIMITS.)
      NN(1)=0
      DO 912 JSUB=1,10
  912 NN(JSUB+1)=NN(JSUB)+10
      WRITE(30,9912) (NN(JSUB),JSUB=1,11)
 9912 FORMAT(1HO,6X,10I10,I11)
      DEFY=100.0/(YYMAX-YYMIN)
      NSUB=-1
      RETURN
C
      ENTRY CRVPLB(X,LP)
C
C THE VALUE OF X IS PRINTED ON THE LEFT OF THE GRAPH.
C IF LP=0,EVERY 5TH LINE IS + + + + + + + ....,
C          AND OTHER LINES ARE +          +   ....
C IF LP=1,THE LINE PRINTED IS + + + + + + + ....
C IF LP=2,3,....,THE + SYMBOL IS PRINTED ONLY AT THE LEFT AND RIGHT ENDS.
C
      IF(LP.EQ.0) GO TO 920
      IF(LP.EQ.1) GO TO 921
      WRITE(30,9925) X
 9925 FORMAT(1H ,E15.8,1H+,99X,1H+)
      RETURN
  921 WRITE(30,9924) X
 9924 FORMAT(1H ,E15.8,10(10H+ + + + + ),1H+)
      RETURN
  920 NSUB=NSUB+1
      KK=NSUB-NSUB/5*5
      IF(KK.EQ.0) GO TO 924
      WRITE(30,9923) X
 9923 FORMAT(1H ,E15.8,10(10H+          ),1H+)
      RETURN
  924 WRITE(30,9924) X
      RETURN
C
      ENTRY CRVPLC(Y,*,*,IP)
C
C A GRAPH POINT IS PRINTED WITH A SYMBOL SPECIFIED BY IP.
C FOR IP,A SYMBOL TO BE USED SHOULD BE WRITTEN PRECEDED BY 1H.
C FOR THE FIRST *,A ST.-NO. TO BE RETURNED TO WHEN Y IS LESS THAN YMIN
C  SHOULD BE WRITTEN PRECEDED BY $.
C FOR THE SECOND *,A ST.-NO. TO BE RETURNED TO WHEN Y IS GREATER THAN
C  YMAX SHOULD BE WRITTEN PRECEDED BY $.
C
      YN=(Y-YYMIN)*DEFY+1.5
      NY=YN
      IF(Y.GE.0.0) GO TO 913
      YYN=NY
      IF(YN.EQ.YYN) NY=NY-1
  913 IF(NY.LT.1) GO TO 931
      IF(NY.GT.101) GO TO 932
      IGRAW(NY)=IP
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
 9922 FORMAT(1H+,15X,101A1)
      IGRAW(NY)=8454144
      RETURN
  931 IGRAW(1)=11468800
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
      IGRAW(1)=8454144
      RETURN 1
  932 IGRAW(101)=11468800
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
      IGRAW(101)=8454144
      RETURN 2
C
      ENTRY CRVPLD(Y)
C
C THE VALUE OF Y IS PRINTED ON THE RIGHT OF THE GRAPH.
C
      WRITE(30,9926) Y
 9926 FORMAT(1H+,116X,E15.8)
      RETURN
      END
```

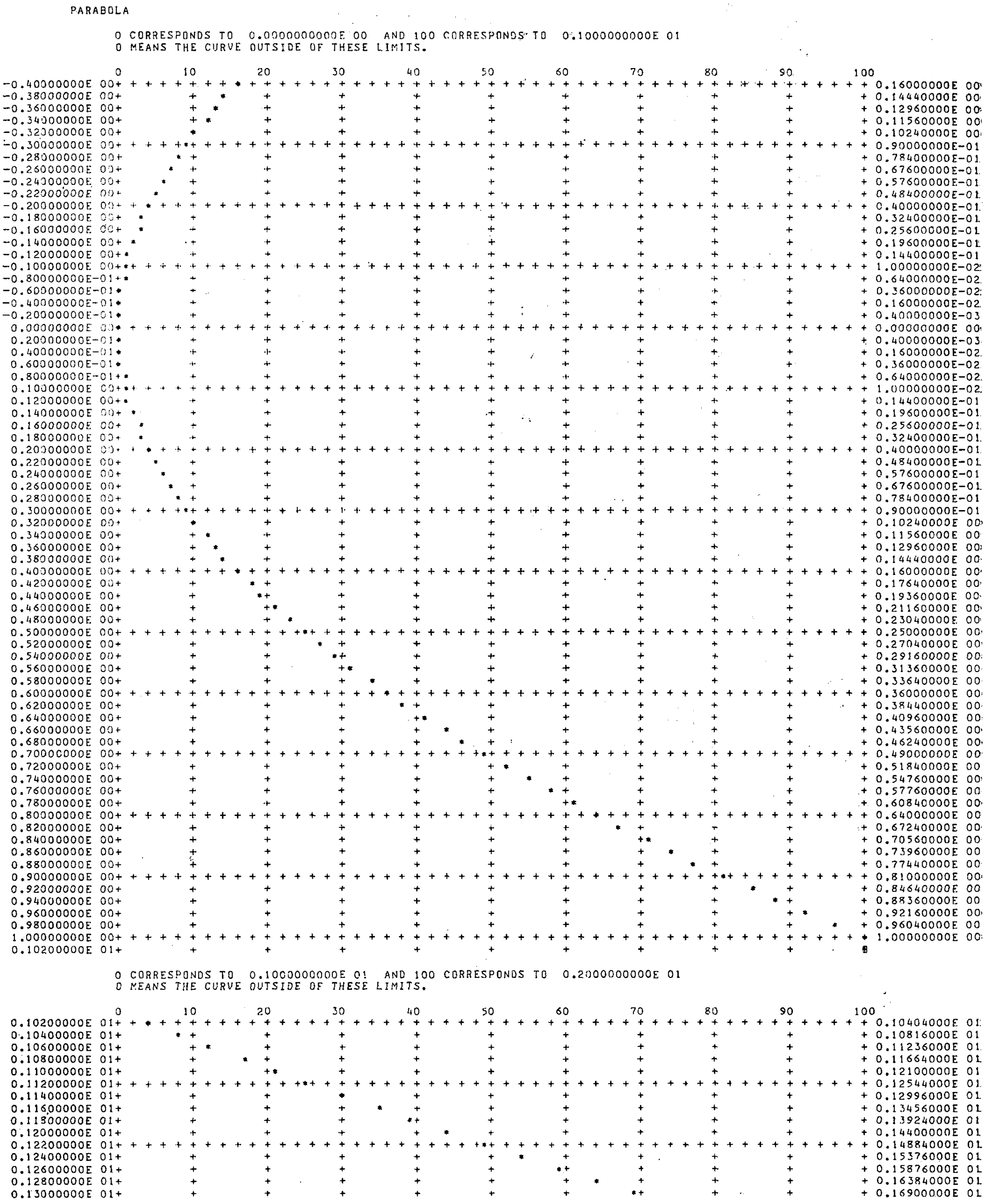
1) The computor used is OKIMINITAC-7000. The numbers 8454144 and 11468800 are its numerical codes corresponding to the space and the letter O respectively.

2.4. Examples

Two examples are given for illustration. In the first, the parameter LP of zero value is used, and the alteration of YMIN and YMAX when the graph curve reaches either the upper or the lower end of Y axis is made. In the second, three curves are plotted simultaneously, and the parameter LP is controlled so as to print the scale marks only at the boundary of the graph area.

The main program of the first example and the printed graph are shown below.

```
      WRITE(30,100)
  100 FORMAT(1H0/10X,8HPARABOLA)
      YMIN=0.0
      YMAX=1.0
      CALL CRVPLA(YMIN,YMAX,$21)
      X=-0.4
      DO 10 J=1,86
      Y=X*X
   40 CALL CRVPLB(X,0)
      CALL CRVPLC(Y,$20,$30,1H*)
      CALL CRVPLD(Y)
   10 X=X+0.02
      GO TO 21
   20 YMIN=YMIN-1.0
      YMAX=YMAX-1.0
      CALL CRVPLA(YMIN,YMAX,$21)
      GO TO 40
   30 YMIN=YMIN+1.0
      YMAX=YMAX+1.0
      CALL CRVPLA(YMIN,YMAX,$21)
      GO TO 40
   21 STOP
      END
```



```
PARABOLA

        0 CORRESPONDS TO  0.0000000000E 00  AND 100 CORRESPONDS TO  0.1000000000E 01
        0 MEANS THE CURVE OUTSIDE OF THESE LIMITS.

                  0    10    20    30    40    50    60    70    80    90    100
-0.40000000E 00+   0.16000000E 00
-0.38000000E 00+   0.14440000E 00
-0.36000000E 00+   0.12960000E 00
-0.34000000E 00+   0.11560000E 00
-0.32000000E 00+   0.10240000E 00
-0.30000000E 00+   0.90000000E-01
-0.28000000E 00+   0.78400000E-01
-0.26000000E 00+   0.67600000E-01
-0.24000000E 00+   0.57600000E-01
-0.22000000E 00+   0.48400000E-01
-0.20000000E 00+   0.40000000E-01
-0.18000000E 00+   0.32400000E-01
-0.16000000E 00+   0.25600000E-01
-0.14000000E 00+   0.19600000E-01
-0.12000000E 00+   0.14400000E-01
-0.10000000E 00+   1.00000000E-02
-0.80000000E-01+   0.64000000E-02
-0.60000000E-01+   0.36000000E-02
-0.40000000E-01+   0.16000000E-02
-0.20000000E-01+   0.40000000E-03
 0.00000000E 00+   0.00000000E 00
 0.20000000E-01+   0.40000000E-03
 0.40000000E-01+   0.16000000E-02
 0.60000000E-01+   0.36000000E-02
 0.80000000E-01+   0.64000000E-02
 0.10000000E 00+   1.00000000E-02
 0.12000000E 00+   0.14400000E-01
 0.14000000E 00+   0.19600000E-01
 0.16000000E 00+   0.25600000E-01
 0.18000000E 00+   0.32400000E-01
 0.20000000E 00+   0.40000000E-01
 0.22000000E 00+   0.48400000E-01
 0.24000000E 00+   0.57600000E-01
 0.26000000E 00+   0.67600000E-01
 0.28000000E 00+   0.78400000E-01
 0.30000000E 00+   0.90000000E-01
 0.32000000E 00+   0.10240000E 00
 0.34000000E 00+   0.11560000E 00
 0.36000000E 00+   0.12960000E 00
 0.38000000E 00+   0.14440000E 00
 0.40000000E 00+   0.16000000E 00
 0.42000000E 00+   0.17640000E 00
 0.44000000E 00+   0.19360000E 00
 0.46000000E 00+   0.21160000E 00
 0.48000000E 00+   0.23040000E 00
 0.50000000E 00+   0.25000000E 00
 0.52000000E 00+   0.27040000E 00
 0.54000000E 00+   0.29160000E 00
 0.56000000E 00+   0.31360000E 00
 0.58000000E 00+   0.33640000E 00
 0.60000000E 00+   0.36000000E 00
 0.62000000E 00+   0.38440000E 00
 0.64000000E 00+   0.40960000E 00
 0.66000000E 00+   0.43560000E 00
 0.68000000E 00+   0.46240000E 00
 0.70000000E 00+   0.49000000E 00
 0.72000000E 00+   0.51840000E 00
 0.74000000E 00+   0.54760000E 00
 0.76000000E 00+   0.57760000E 00
 0.78000000E 00+   0.60840000E 00
 0.80000000E 00+   0.64000000E 00
 0.82000000E 00+   0.67240000E 00
 0.84000000E 00+   0.70560000E 00
 0.86000000E 00+   0.73960000E 00
 0.88000000E 00+   0.77440000E 00
 0.90000000E 00+   0.81000000E 00
 0.92000000E 00+   0.84640000E 00
 0.94000000E 00+   0.88360000E 00
 0.96000000E 00+   0.92160000E 00
 0.98000000E 00+   0.96040000E 00
 1.00000000E 00+   1.00000000E 00
 0.10200000E 01+

        0 CORRESPONDS TO  0.1000000000E 01  AND 100 CORRESPONDS TO  0.2000000000E 01
        0 MEANS THE CURVE OUTSIDE OF THESE LIMITS.

                  0    10    20    30    40    50    60    70    80    90    100
 0.10200000E 01+   0.10404000E 01
 0.10400000E 01+   0.10816000E 01
 0.10600000E 01+   0.11236000E 01
 0.10800000E 01+   0.11664000E 01
 0.11000000E 01+   0.12100000E 01
 0.11200000E 01+   0.12544000E 01
 0.11400000E 01+   0.12996000E 01
 0.11600000E 01+   0.13456000E 01
 0.11800000E 01+   0.13924000E 01
 0.12000000E 01+   0.14400000E 01
 0.12200000E 01+   0.14884000E 01
 0.12400000E 01+   0.15376000E 01
 0.12600000E 01+   0.15876000E 01
 0.12800000E 01+   0.16384000E 01
 0.13000000E 01+   0.16900000E 01
```

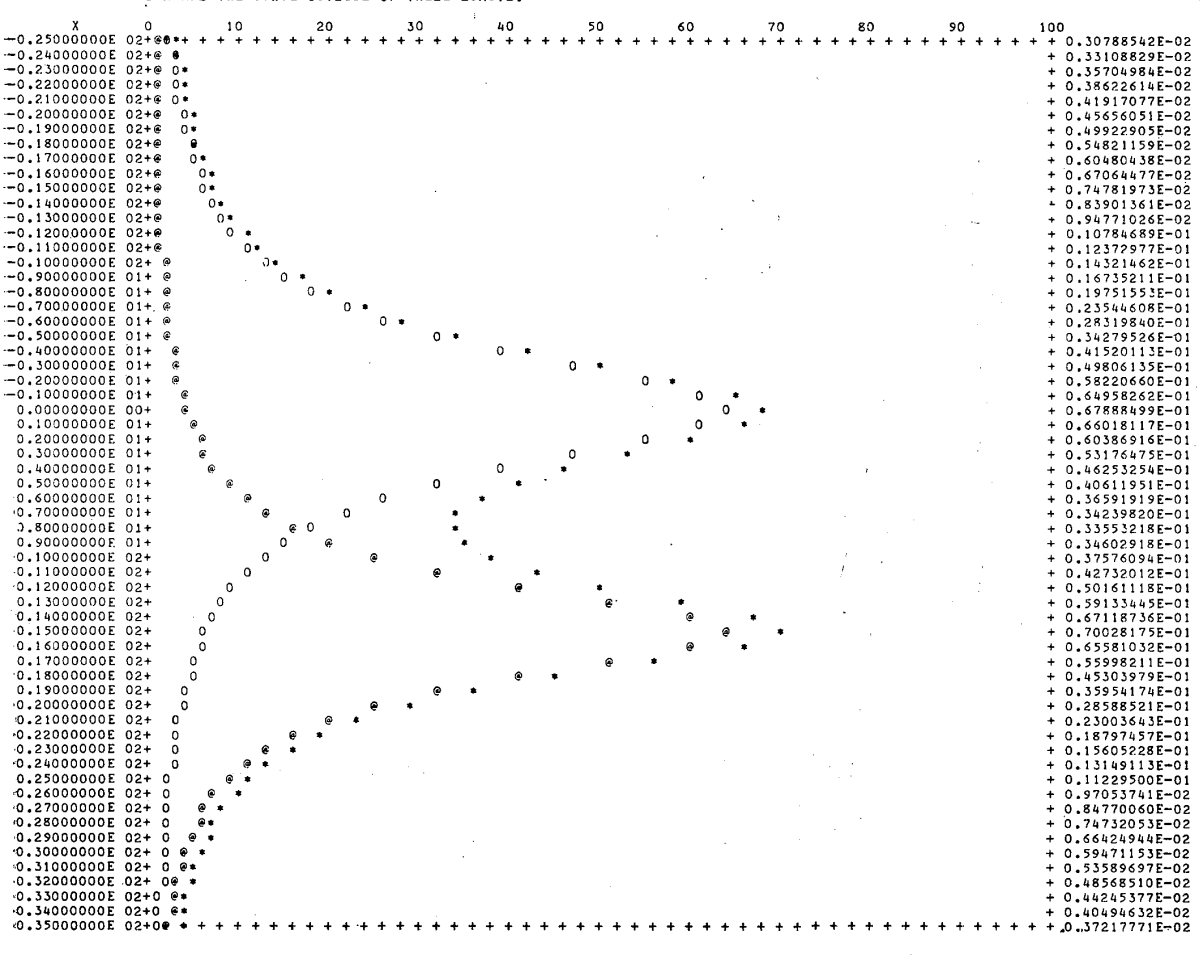
The main program of the second example and the printed graphs are as follows.

```
    1 WRITE(6,100)
  100 FORMAT(/10X,27HKEY INPUT***Z1,Z2,C,D,CR/LF)
      READ(5,200) Z1,Z2,C,D
  200 FORMAT(4E20.12)
      GO TO 3
    2 WRITE(6,110)
  110 FORMAT(/10X,41HKEY INPUT***XINI,DX,YMIN,YMAX,NSTEP,CR/LF)
      READ(5,111) XINI,DX,YMIN,YMAX,NSTEP
  111 FORMAT(4E20.12,I5)
    3 WRITE(6,120)
  120 FORMAT(/10X,19HKEY INPUT***M CR/LF)
      READ(5,122) M
  122 FORMAT(I1)
      IF(M.EQ.1) GO TO 1
      IF(M.EQ.2) GO TO 2
      IF(M.EQ.9) GO TO 21
CCCCCCCCCC
C     M=1 READ Z1,Z2,C,AND D
C     M=2 READ XINI,DX,YMIN,YMAX,AND NSTEP
C     M=9 STOP
C     OTHER M  CURVE-PLOTTING
CCCCCCCCCC
      WRITE(30,300) Z1,Z2,C,D
  300 FORMAT(1H1/10X,23HDOUBLE LORENTZIAN LINES//15X,73HY=Y1+Y2, Y1=Z1/(
     1(X*X+Z1*Z1)*3.1416), Y2=C*Z2/(((X-D)*(X-D)+Z2*Z2)*3.1416)/16X,3HZ1
     2=,E15.8,5X,3HZ2=,E15.8,5X,2HC=,E15.8,5X,2HD=,E15.8)
      CALL CRVPLA(YMIN,YMAX,$1)
      WRITE(30,400)
  400 FORMAT(1H+,7X,1HX,130X,1HY)
      LP=1
      X=XINI
      DO 10 J=1,NSTEP
      Y1=Z1/((X*X+Z1*Z1)*3.1415926536)
      Y2=C*Z2/(((X-D)*(X-D)+Z2*Z2)*3.1415926536)
      Y=Y1+Y2
      IF(LP.EQ.NSTEP) LP=1
      CALL CRVPLB(X,LP)
      CALL CRVPLC(Y1,$20,$20,1HO)
   20 CALL CRVPLC(Y2,$30,$30,1H@)
   30 CALL CRVPLC(Y,$40,$40,1H*)
   40 CALL CRVPLD(Y)
      LP=LP+1
   10 X=X+DX
      GO TO 3
   21 STOP 104
      END
```

```
DOUBLE LORENTZIAN LINES

    Y=Y1+Y2, Y1=Z1/((X*X+Z1*Z1)*3.1416), Y2=C*Z2/(((X-D)*(X-D)+Z2*Z2)*3.1416)
     Z1= 0.50000000E 01     Z2= 0.40000000E 01     C= 0.80000000E 00     D= 0.15000000E 02

     O CORRESPONDS TO  0.0000000000E 00  AND 100 CORRESPONDS TO  0.1000000000E 00
     O MEANS THE CURVE OUTSIDE OF THESE LIMITS.
```



§ 3. The Subroutine LOGPLA (OU6941)

The purpose of this subroutine is in the semi-logarithmic plotting of a single-valued real positive function Y=f(X) of a real variable X, and this subroutine is a slight modification of the preceding subroutine CRVPLA.

3.1. The Use

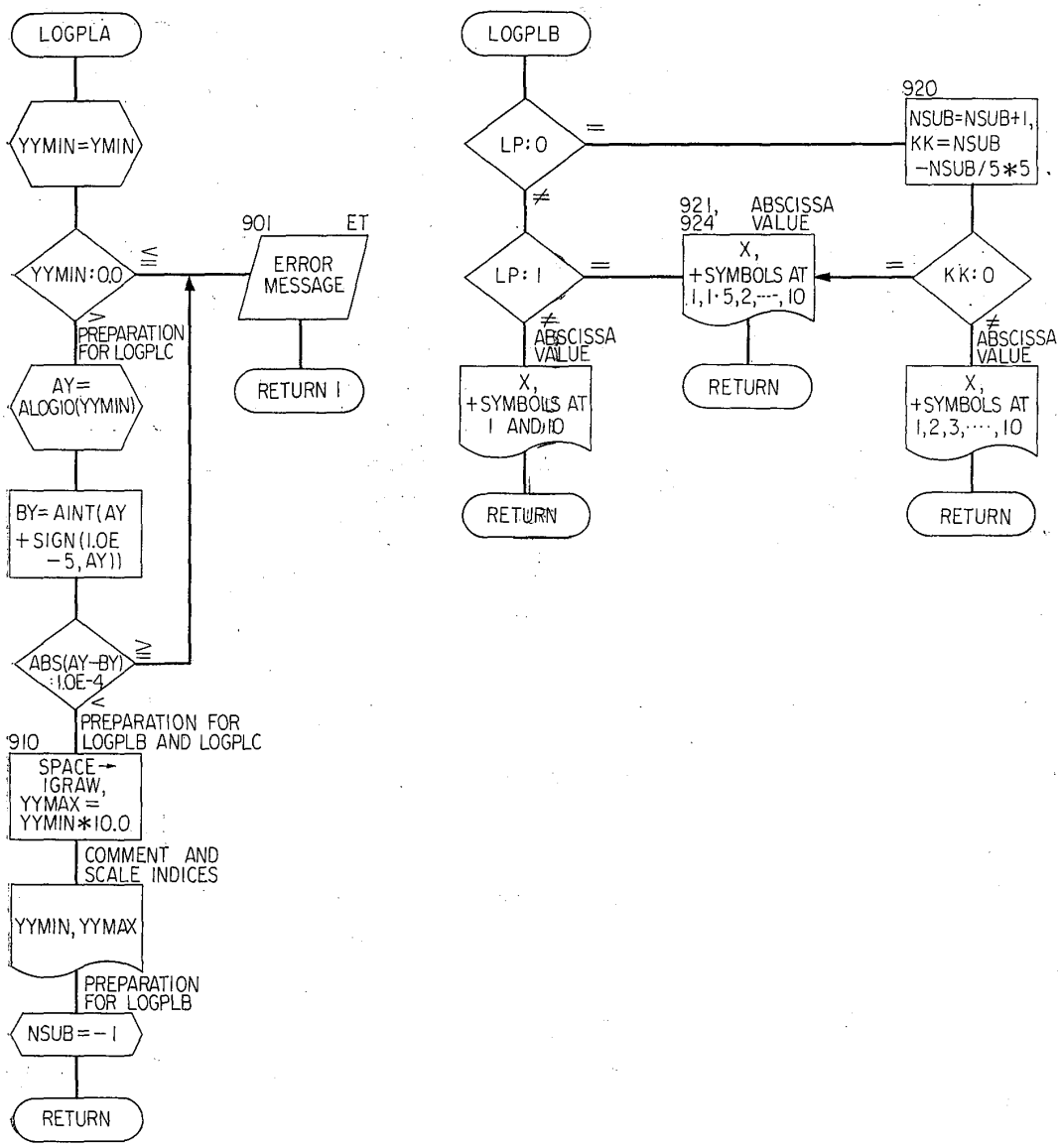
The subroutine LOGPLA has three entries LOGPLB, LOGPLC and LOGPLD other than LOGPLA. LOGPLA (YMIN, *) should be called first to specify the value of YMIN. The value of YMAX is taken as ten times that of YMIN by the subroutine. In the place of the asterisk the statement number to be returned to when the given value of YMIN is not a power of ten should be written. When LOGPLA is called, the scale indices 1, 2, 3, ⋯, 10 and the comment that the indices 1 and 10 correspond to the specified values of YMIN and YMAX are printed.

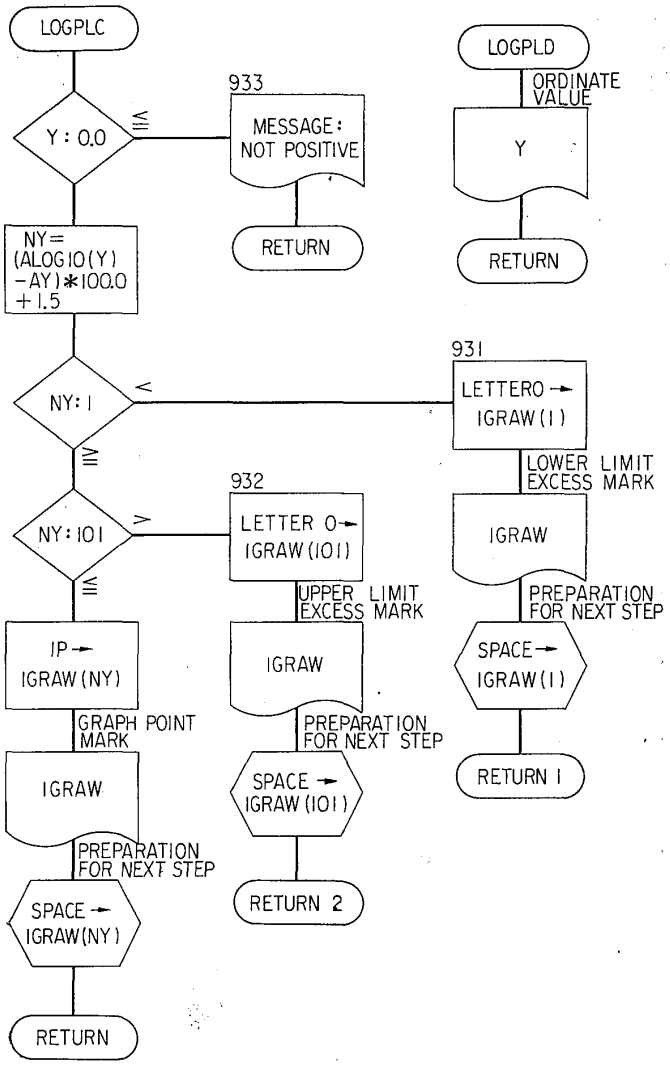
Next, LOGPLB (X, LP) should be called to print the value of abscissa X and the scale marks. The scale marks, i.e. the + symbols are printed at the positions corresponding to the scale indices 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, and 10 when LP=1, and only at the positions 1 and 10 when LP=2, 3, ⋯. If LP=0, the + symbols are printed on every fifth line at the positions for LP=1 and on the other lines at the positions corresponding to the scale indices 1, 2, 3, ⋯, 10.

Then, LOGPLC (Y, *, *, IP) should be called in order to print the graph-point with a symbol specified by IP. The use of LOGPLC is almost the same as that of CRVPLC. The only difference is that, if the value of Y is not positive, the message NOT POSITIVE is printed in place of the graph-point.

Finally, LOGPLD (Y) should be called when the value of Y is to be printed.

3.2. *Flowchart*




LOGPLC
Y : 0.0
≦
933
MESSAGE : NOT POSITIVE
RETURN
NY= (ALOG10(Y) -AY)*100.0 +1.5
NY : 1
<
931
LETTER0 → IGRAW(1)
LOWER LIMIT EXCESS MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW(1)
RETURN 1
≧
NY : 101
>
932
LETTER 0 → IGRAW(101)
UPPER LIMIT EXCESS MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW(101)
RETURN 2
≦
IP → IGRAW(NY)
GRAPH POINT MARK
IGRAW
PREPARATION FOR NEXT STEP
SPACE → IGRAW(NY)
RETURN
LOGPLD
ORDINATE VALUE
Y
RETURN

3.3. Program List

```
      SUBROUTINE LOGPLA(YMIN,*)
C
C SUBROUTINE FOR THE SEMI-LOG PLOTTING OF A GIVEN SINGLE-VALUE REAL
C   POSITIVE FUNCTION Y=Y(X).
C YMIN SHOULD BE A POWER OF 10, THEN YMAX BECOMES 10 TIMES YMIN.
C FOR *,A STATEMENT-NO. TO BE RETURNED TO WHEN YMIN IS NOT A POWER OF
C  10SHOULD BE WRITTEN PRECEDED BY $.
C
      DIMENSION IGRAW(101)
      YYMIN=YMIN
      IF(YYMIN.LE.0.0) GO TO 901
      AY=ALOG10(YYMIN)
      BY=AINT(AY+SIGN(1.0E-5,AY))
      IF(ABS(AY-BY).LT.1.0E-4) GO TO 910
  901 WRITE(6,9901)
 9901 FORMAT(1H ,10X,38H***ERROR***YMIN IS NOT A POWER OF TEN.)
      RETURN 1
  910 DO 911 ISUB=1,101
  911 IGRAW(ISUB)=8454144
      YYMAX=YYMIN*10.0
      WRITE(30,9911) YYMIN,YYMAX
 9911 FORMAT(1H0,15X,16H1 CORRESPONDS TO,E18.10,23H  AND 10 CORRESPONDS
     1TO,E18.10/16X,42H0 MEANS THE CURVE OUTSIDE OF THESE LIMITS.)
      WRITE(30,9912)
 9912 FORMAT(1H0,15X,1H1,29X,1H2,17X,1H3,11X,1H4,9X,1H5,7X,1H6,6X,1H7,
     14X,1H8,4X,1H9,3X,2H10)
      NSUB=-1
      RETURN
C
      ENTRY LOGPLB(X,LP)
C
C THE VALUE OF X IS PRINTED ON THE LEFT OF THE GRAPH.
C IF LP=0,EVERY 5TH LINE IS +     +   +  ...,
C         AND OTHER LINES ARE +         +   ....
C IF LP=1,THE LINE PRINTED IS +     +   +  ....
C IF LP=2,3,...,THE + SYMBOL IS PRINTED ONLY AT THE LEFT AND RIGHT ENDS.
      IF(LP.EQ.0) GO TO 920
      IF(LP.EQ.1) GO TO 921
      WRITE(30,9925) X
 9925 FORMAT(1H ,E15.8,1H+,99X,1H+)
      RETURN
  921 WRITE(30,9924) X
 9924 FORMAT(1H ,E15.8,1H+,17X,1H+,11X,1H+,9X,1H+,7X,1H+,2(6H     +),2(5
     1H    +),7X,1H+,6X,1H+,3(5H    +))
      RETURN
  920 NSUB=NSUB+1
      KK=NSUB-NSUB/5*5
      IF(KK.EQ.0) GO TO 924
      WRITE(30,9923) X
 9923 FORMAT(1H ,E15.8,1H+,29X,1H+,17X,1H+,11X,1H+,9X,1H+,7X,1H+,6X,1H+,
     13(5H    +))
      RETURN
  924 WRITE(30,9924) X
      RETURN
C
      ENTRY LOGPLC(Y,*,*,IP)
C
C A GRAPH POINT IS PRINTED WITH A SYMBOL SPECIFIED BY IP.
C FOR IP,A SYMBOL TO BE USED SHOULD BE WRITTEN PRECEDED BY 1H.
C FOR THE FIRST *,A ST.-NO. TO BE RETURNED TO WHEN Y IS LESS THAN YMIN
C  SHOULD BE WRITTEN PRECEDED BY $.
C FOR THE SECOND *,A ST.-NO. TO BE RETURNED TO WHEN Y IS GREATER THAN
C  YMAX SHOULD BE WRITTEN PRECEDED BY $.
C
      IF(Y.LE.0.0) GO TO 933
      NY=(ALOG10(Y)-AY)*100.0+1.5
      IF(NY.LT.1) GO TO 931
      IF(NY.GT.101) GO TO 932
      IGRAW(NY)=IP
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
 9922 FORMAT(1H+,15X,101A1)
      IGRAW(NY)=8454144
      RETURN
  931 IGRAW(1)=11468800
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
      IGRAW(1)=8454144
      RETURN 1
  932 IGRAW(101)=11468800
      WRITE(30,9922) (IGRAW(KSUB),KSUB=1,101)
      IGRAW(101)=8454144
      RETURN 2
  933 WRITE(30,9933)
 9933 FORMAT(1H+,17X,12HNOT POSITIVE)
      RETURN
C
      ENTRY LOGPLD(Y)
C
C THE VALUE OF Y IS PRINTED ON THE RIGHT OF THE GRAPH.
C
      WRITE(30,9926) Y
 9926 FORMAT(1H+,116X,E15.8)
      RETURN
      END
```

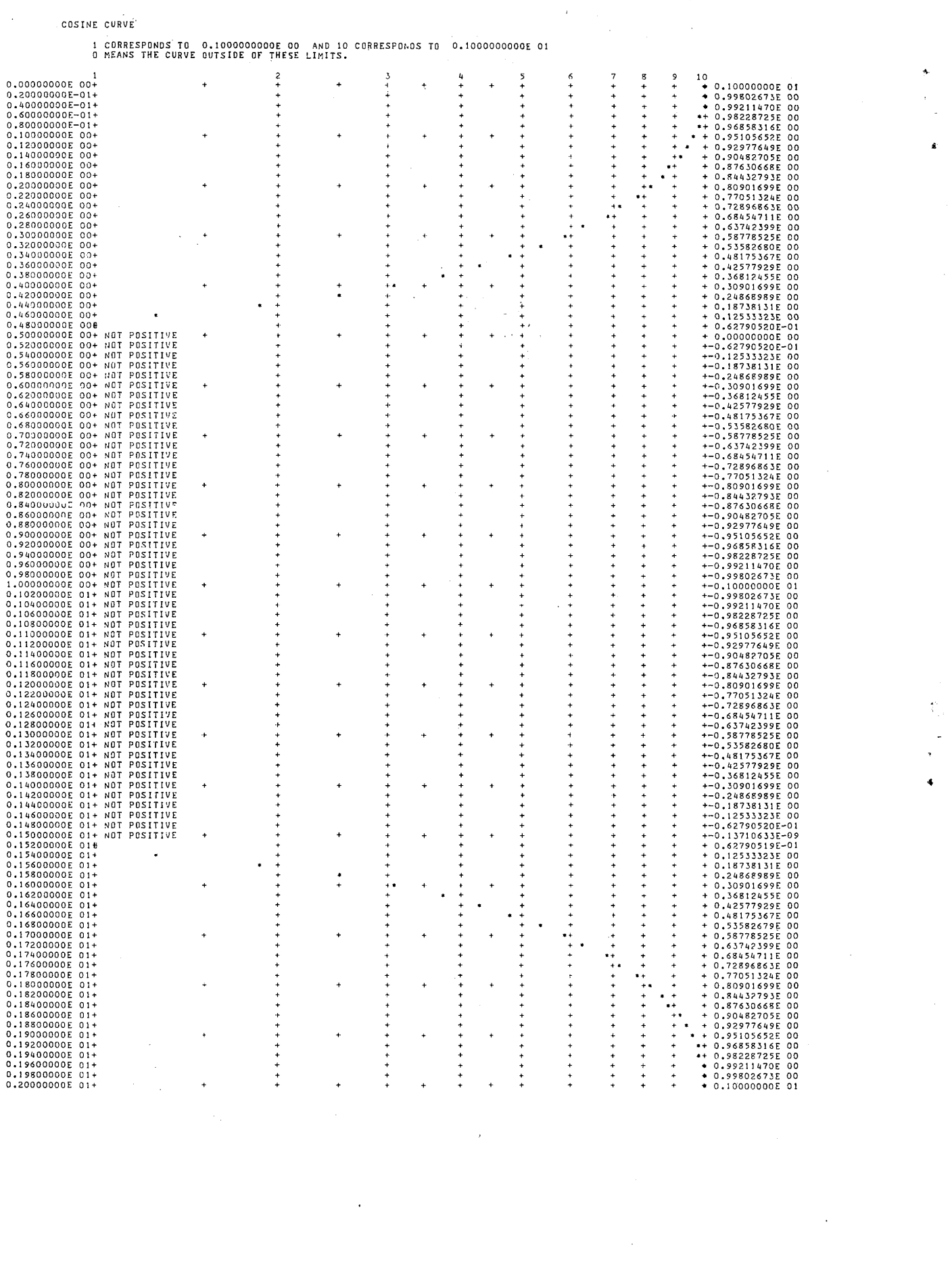
3.4. Example

An example is given to show how the subroutine LOGPLA works, especially when the ordinate Y becomes negative. The main program and the graph printed (with LP=0) are given below.

```
  1 WRITE(6,66)
 66 FORMAT(1H0,25HKEY INPUT***YMIN,LP,CR/LF)
    READ(5,55) YMIN,LP
 55 FORMAT(E20.12,I5)
    IF(LP.EQ.999) GO TO 21
    WRITE(30,100)
100 FORMAT(1H0/11X,12HCOSINE CURVE)
    CALL LOGPLA(YMIN,$1)
    X=0.0
    DO 10 J=1,101
    Y=COS(X*3.1415926536)
    CALL LOGPLB(X,LP)
    CALL LOGPLC(Y,$20,$20,1H*)
 20 CALL LOGPLD(Y)
 10 X=X+0.02
    GO TO 1
 21 STOP
    END
```

COSINE CURVE

1 CORRESPONDS TO 0.10000000000E 00 AND 10 CORRESPONDS TO 0.10000000000E 01
0 MEANS THE CURVE OUTSIDE OF THESE LIMITS.



§ 4. Histogram Printing

Subroutines for the histogram printing are easily obtained by making slight modifications from the subroutines given above. Two arithmetic statements appearing under the entries CRVPLC, namely,

```
      IGRAW (NY)=IP
```

and

```
      IGRAW (NY)=8454144
```

should be changed into

```
      DO 914 I=1, NY
      IGRAW (I)=IP
  914 CONTINUE
```

and

```
      DO 915 J=1, NY
      IGRAW (J)=8454144
  915 CONTINUE
```

respectively. When these modified subroutine are used, it will be preferable to control the parameter LP of CRVPLB (X, LP) or LOGPLB (X, LP) in such a way as was done in the second example of § 2.

Shown below is a histogram obtained by using the main program of the second example of § 2 and the subroutine CRVPLA corrected as above.

DOUBLE LORENTZIAN LINES

Y=Y1+Y2, Y1=Z1/((X*X+Z1*Z1)*3.1416), Y2=C*Z2/(((X-D)*(X-D)+Z2*Z2)*3.1416)
Z1= 0.50000000E 01 Z2= 0.40000000E 01 C= 0.90000000E 00 D= 0.20000000E 02

0 CORRESPONDS TO 0.0000000000E 00 AND 100 CORRESPONDS TO 0.1000000000E 00
0 MEANS THE CURVE OUTSIDE OF THESE LIMITS.