Tektronix
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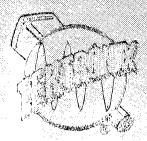

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Phone: (503) 644-0161
TWX: 910-467-8708

Welcome:

Your membership in the 4050 Series Applications Library and subscription to our monthly newsletter are services to the users of 4050 Series Desktop Computers.

As a member, you are encouraged to submit any programs you feel are of value to others. In exchange for having a program included in the library, you will receive your choice of 3 free programs, on a new tape, in return for the tape submitted.

Your active participation not only will help to ensure the success of this service, but will enhance the broad scope of programs we are offering.

On the following pages are documentation instructions plus submittal and order forms. Additional forms can be obtained from your local Tektronix Sales Engineer or the Applications Librarian.

If you have suggestions or questions about our 4050 Series Applications Library or its contents, please let us know.

4050 Series Applications Library Staff
Group 451
Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Attachments

DESKTOP COMPUTER
APPLICATIONS LIBRARY ORDER FORM

DO NOT SEND payment with your order. You will be billed when your order is shipped.

SHIPPING ADDRESS

NAME: _____
(Individual name required for shipping)

COMPANY: _____

ADDRESS: _____

_____

_____

BILLING ADDRESS

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

PURCHASE ORDER NUMBER: _____
(Write "None" if not required)

ABSTRACT NUMBERS	TITLE	DOCUMENTATION COST
__/__-____/_		
__/__-____/_		
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Charge for Documentation and Program Listing are as published in TEKniques.

☐ Deliver the above programs on a tape cartridge in the order listed. I understand there is an additional handling charge per program and a charge for the tape cartridge at the current Tektronix list price. Tek reserves the right to charge for additional tapes, if required, to deliver the above ordered programs. (Programs will be reproduced on Tektronix tapes only.)

☐ Deliver the above programs on a flexible disk in the order listed. I understand there is an additional handling charge per program and a charge for the flexible disk at the current Tektronix list price. Tek reserves the right to charge for additional disks, if required, to deliver the above ordered programs. (Programs will be reproduced on Tektronix disks only).

The program material ordered herein is supplied without warranty or representation of any kind. Tektronix, Inc. assumes no responsibility and shall have no liability, consequential or otherwise, of any kind arising from the use of this program or any part thereof.

Mail to:

United States
Applications Library
Group 451
Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Outside United States
Send to the Applications Library serving your area. (Addresses are listed on the back of TEKniques.)

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000-6396-00

7/80

DOCUMENTATION GUIDELINES

December 1976

The following information is a guideline for documenting your programs for submittal to the library. Please use the specially designed forms.

The documentation should be done in two main parts:

Part 1, first page, is a brief description of what the program does and what is required to run the program.

Part 2, page two and the remainder will contain a more detailed description of the program function, if needed, and information on program operation with examples.

A detailed outline on the actual forms is attached. All of the information will be supplied by the author of the program except the abstract number which is assigned by Tektronix, Inc.

When your program is included in the library, you will receive 3 free programs of your choice.

Your free programs will be sent on tape in exchange for allowing us to keep your master tape.

If you wish your master tape returned, your free programs will be sent in the form of documentation and listings.

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APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
Name of the program	*To be supplied by Tektronix, Inc. Leave blank.*
ORIGINAL DATE / REVISION DATE	MEMORY REQUIREMENT
	1 See Below
AUTHOR	PERIPHERALS
Name of programmer. Address & Phone	*2 See Below*

ABSTRACT

Describe in the space provided here what the program does. Limit the length of your description so that it will fit in this square.

---

1 8K (Standard 4051)
16K (Option 20)
24K (Option 21)
32K (Option 22)

2 List peripherals required. Show optional peripherals as well but label them as such. (i.e. 4662, 4641, 4924)

TITLE	ABSTRACT NO:
Name of Program	*Leave blank*

1. *DESCRIPTION*

   A more detailed description of what the program does, if the first page did not leave enough room for a complete detailed description. If the description on the first page is complete skip this part.

2. *DATA TAPE STRUCTURE*

   If the program provides for storing data on tape or loading data from tape, the following information should be given here:

   a. *Type of tape data files (binary or ASCII)*
   b. *Files used e.g. files 10 through 15*
   c. *Format used to store the data in each file*
   d. *An index of all data files showing their contents*
   e. *An indication of whether the same tape or a separate data tape is required. An indication of whether the data tape or data files on the program tape must be pre-MARKed.*

3. *INTERNAL DATA STORAGE*

   a. *List in a table format all variables used by the program. For example:*

Variable	*Used to Store . . .*	*Type*
N	*Number of observations*	*Simple*
X$	*Keyboard input*	*String*
A	*Data from first N observations*	*Array (3,4)*

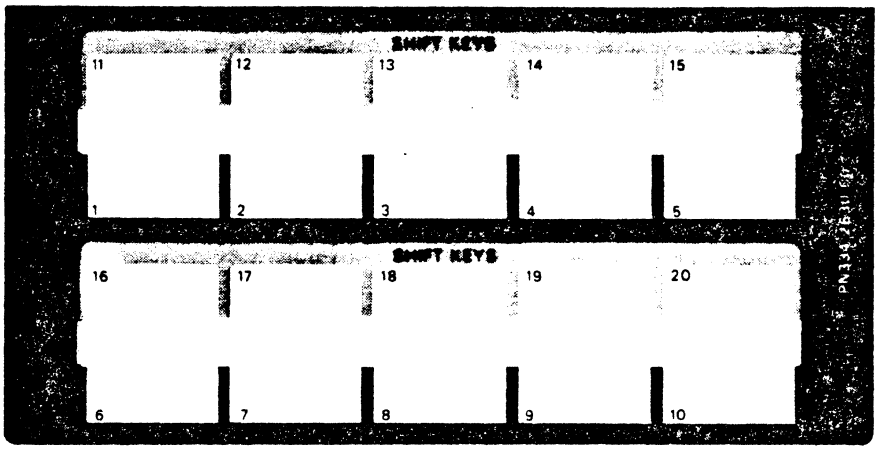
   b. *Format used to store data internally, if not obvious from part a.*

4. *METHODS*

   Describe method used. Use flow chart to show logic if necessary.

TITLE	ABSTRACT NUMBER
Name of Program	*Leave blank*

TITLE TAPE # FILE #



5. *OPERATING INSTRUCTIONS*

   a. *Overlay*

      Describe in a table format what each user definable key does, if an overlay is used.

   b. *Program Loading*

      Program Loading Instructions

   c. *Program Execution*

      1. *A brief description of how the program is run*
      2. *Examples*

TITLE	ABSTRACT NO:
Name of Program	*Leave Blank*

6. *REFERENCES*

List all references that you have used or those that might help the user to better understand what the program does and how it does it.

7. *LISTING*

Program listings with plenty of REMARK statements identifying the various modules.

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DESKTOP COMPUTER APPLICATIONS LIBRARY PROGRAM

TITLE		ABSTRACT NUMBER
ORIGINAL DATE	REVISION DATE	EQUIPMENT AND OPTIONS REQUIRED
AUTHOR		PERIPHERALS

ABSTRACT

TAPE 1

READ DOCUMENTATION THOROUGHLY BEFORE USING THE PROGRAM ON TAPE

The program(s) you requested on tape are as follows:

	FILE #1	51/00-0601/0	CHECK BOOK BALANCING
	FILE #2	51/00-1402/0	SCHEMATIC DRAWING PROGRAM II (16K)
	FILE #3	51/00-1403/0	LOGIC CIRCUIT BEHAVIOUR ANALYSIS
(1)	FILE #4	51/00-3301/0	LIGHTING INTENSITY DISTRIBUTION
(2)	FILES #5-53	51/00-5201/0	CHEMISTRY AND PHYSICS TEXTBOOK PROBLEMS ADAPTED TO 4051 BASIC
	FILE #54	51/00-8005/1	FLOWCHART (REVISION)
(3)	FILES #55-56	51/00-8012/0	LEROY CHARACTER GENERATOR
(4)	FILES #57-61	51/00-8015/0	FLOW DIAGRAMMER
	FILE #62	51/00-9507/0	3-D WITH PERSPECTIVE
	FILES #63-65	51/00-9515/0	FORMS DESIGN

(1) Table files must follow program file

(2) Must be first 49 files on tape or recode

(3) Is a subroutine; needs a program to initiate it

(4) Requires 62 dedicated files

TAPE 2

READ DOCUMENTATION THOROUGHLY BEFORE USING THE PROGRAM ON TAPE

The program(s) you requested on tape are as follows:

	FILE #1	51/00-9516/0	ADVANCED MEDIA GRAPHING
(1)	FILES #2-3	51/00-9520/0	DIGITIZE & DRAW
(2)	FILES #4-15	51/00-5401/1	GRAPHICS DEMO FOR ASTRONOMY & PHYSICS
	FILE #16	51/00-9506/0	THREE DIMENSIONAL DATA PLOT PROGRAM
	FILE #17	51/00-6001/0	HAND CALCULATOR
	FILE #18	51/00-5501/0	PLANE TRIANGLE SOLUTIONS
	FILE #19	51/00-5502/0	CIRCLE SOLUTIONS

(1) Requires a data tape

(2) Updated version. Must be first 12 files on tape or recode.

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APPLICATION LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0
	MEMORY REQUIREMENT
	8K
AUTHOR	PERIPHERALS
Kathy Thurman, G.S. Software Engineering	

ABSTRACT

This routine is designed to help the user balance his personal checkbook.

The user is asked to input

1. Ending statement balance
2. Ending checkbook balance
3. All outstanding checks
4. All outstanding deposits
5. Check charges or handling costs

The output is the adjusted check book balance. If this does not agree with the bank statement after adjustments, the difference is printed and the user is guided to check the entries he has made regarding his statement and check register.

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

HARDWARE REQUIREMENTS

4051 - Minimum configuration

OPERATING HINTS

Outstanding checks and deposits are entered in two matrices, each dimensioned for up to 100 entries. After the user has made all entries, the adjusted check book balance is printed on the screen. If this amount agrees with the statement balance after adjustments, the message:

CHECK BOOK AND BANK STATEMENT AGREE

is printed on the screen. The user should then enter the adjusted check book balance in his check register.

If the adjusted check book balance and the adjusted statement balance do not agree, the user is asked to check the handling cost he has entered. Note: Do not enter the handling cost in the program if it has already been entered and subtracted in the check register.

The user is next guided to check outstanding checks and deposits and to check the math in the check register. After completion of any of these steps the program will check to see if the check book and statement balances now agree.

If, after trying all these steps, a balance is not achieved, the user should check the dollar amounts on all returned checks against the check register and statement for errors or transpositions.

OPERATING INSTRUCTIONS

After keying in the program code or entering it from a tape file, type RUN to begin program execution. Answer questions and follow instructions that appear on the screen.

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

VARIABLE MAP

VARIABLE	TAPE FILE	USAGE
A$		Program loop
A		Matrix storing values of outstanding checks
B		Matrix storing values of outstanding deposits
I		Loop index
J		Loop index
K		Loop index
X1		Ending statement balance
X2		Ending check book balance
X3		Handling cost
X4		Total - outstanding checks
X5		Total - outstanding deposits
X6		Check for balance
X7		Intermediate total
Y1		Input - Error detection loop
Z		Program loop counter

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

USER PROGRAMMABLE KEYS

KEY	LABEL	TAPE FILE	FUNCTION
1			Signal end of entry of outstanding checks
2			Signal end of entry of outstanding deposits
3			Review outstanding checks
4			Review outstanding deposits
5			Review check register
6			Signal end of review of check register
7-20			Unused

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

```
1 FUZZ 10,1.0E-10
2 SET KEY
3 GO TO 1000
4 GO TO 1190
8 GO TO 1270
12 GO TO 1610
16 GO TO 1850
20 GO TO 2080
24 GO TO 2130
1000 PRINT "L                ** ROUTINE TO BALANCE CHECK BOOK **"

1010 REM Kathy Thurman, G S Software Engineering, October, 1975
1020 REM

1040 DELETE A,B
1050 DIM A(100),B(100)
1060 A=0
1070 B=0
1080 X4=0
1090 X5=0
1100 X6=0
1110 Z=1
1120 PRINT "JJEnter the ending bank balance from your statement  $";
1130 INPUT X1
1140 PRINT "JEnter ending checkbook balance  $";
1150 INPUT X2
1160 PRINT "JEnter all outstanding checks.  Press user definable "
1170 PRINT "key 1 after last entry."
1180 INPUT A
1190 FOR I=1 TO 100
1200    IF A(I)=0 THEN 1230
1210    X4=X4+A(I)
1220 NEXT I
1230 I=I-1
1240 PRINT "JEnter any deposits made after the statement date.  Press"
1250 PRINT "User Definable Key 2 after the last entry."
1260 INPUT B
1270 FOR J=1 TO 100
1280    IF B(J)=0 THEN 1310
1290    X5=X5+B(J)
1300 NEXT J
1310 J=J-1
1320 PRINT "JEnter any check charge or handling cost shown on your"
1330 PRINT "statement that has not been deducted in your check book $";
1340 INPUT X3
```

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

```
1350 PRINT "JAdjusted check book balance should be $";X1-X4+X5
1360 X6=X1-X4+X5-(X2-X3)
1370 IF X6<>0 THEN 1400
1380 PRINT "CHECK BOOK AND BANK STATEMENT AGREE GGGG"
1390 END
1400 PRINT "JJAccording to the data entered, your adjusted check book"
1410 PRINT "balance is $";X2-X3
1420 PRINT "There is a $";X6;" difference between your check book and"
1430 PRINT "bank statement."
1440 GO TO Z OF 1450,1540
1450 PRINT "JThe handling cost you entered is $";X3
1460 PRINT "Is it correct (Y/N)  ";
1470 Z=2
1480 INPUT A$
1490 IF A$="Y" THEN 1530
1500 PRINT "LEnter correct handling cost  $";
1510 INPUT X3
1520 GO TO 1350
1530 PAGE
1540 PRINT "JTo review outstanding checks entered, press User Definable"
1550 PRINT "Key 3."
1560 PRINT "JTo review outstanding deposits entered, press User"
1570 PRINT "Definable Key 4."
1580 PRINT "JTo check math in your check register, press User"
1590 PRINT "Definable Key 5."
1600 INPUT Y1
1610 PRINT "LOutstanding checks will be printed in the order they"
1620 PRINT "were entered.  If there are corrections, enter the item"
1630 PRINT "number, carriage return and the correct amount.J"
1640 PRINT "ITEM NO.IAMOUNT"
1650 X7=0
1660 FOR K=1 TO I
1670    PRINT K,A(K)
1680    X7=X7+A(K)
1690 NEXT K
1700 PRINT "JAre there corrections or additions to the list (Y/N) ";
1710 INPUT A$
1720 IF A$="N" THEN 1820
1730 PRINT "JEnter item number, carriage return, correct amount"
1740 INPUT K
1750 INPUT A(K)
1760 IF K<=I THEN 1780
1770 I=K
1780 PRINT "JDo you have other corrections (Y/N)  ";
1790 INPUT A$
```

TITLE	ABSTRACT NUMBER
CHECK BOOK BALANCING	51/00-0601/0

```
1800 IF A$="Y" THEN 1730
1810 GO TO 1640
1820 X4=X7
1830 PAGE
1840 GO TO 1350
1850 PRINT "LOutstanding deposits will be printed in the order they"
1860 PRINT "were entered.  If there are corrections or additions, enter"
1870 PRINT "the item number, carriage return and the correct amount.J"
1880 PRINT "ITEM NO.IAMOUNT"
1890 X7=0
1900 FOR K=1 TO J
1910    PRINT K,B(K)
1920    X7=X7+B(K)
1930 NEXT K
1940 PRINT "JAre there corrections or additions to the list (Y/N) ";
1950 INPUT A$
1960 IF A$="N" THEN 2060
1970 PRINT "JEnter item number, carriage return, correct amount"
1980 INPUT K
1990 INPUT B(K)
2000 IF K<=J THEN 2020
2010 J=K
2020 PRINT "JDo you have other corrections (Y/N)  ";
2030 INPUT A$
2040 IF A$="Y" THEN 1970
2050 GO TO 1880
2060 X5=X7
2070 GO TO 1350
2080 PRINT "LFind the point in your check register where the last"
2090 PRINT "statement was balanced.  Using the calculator pad, check"
2100 PRINT "all addition and subtraction in the check register.  When"
2110 PRINT "all items have been checked, press User Definable Key 6."
2120 END
2130 PRINT "Enter the corrected check register balance  $";
2140 INPUT X2
2150 GO TO 1350
```

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4051

APPLICATIONS LIBRARY PROGRAM

TITLE		ABSTRACT NUMBER
SCHEMATIC DRAWING PROGRAM II		51/00-1402/0
ORIGINAL DATE	REVISION DATE	MEMORY REQUIREMENT
		16K Bytes
AUTHOR		PERIPHERALS
		Hard Copy Unit (Optional)

ABSTRACT

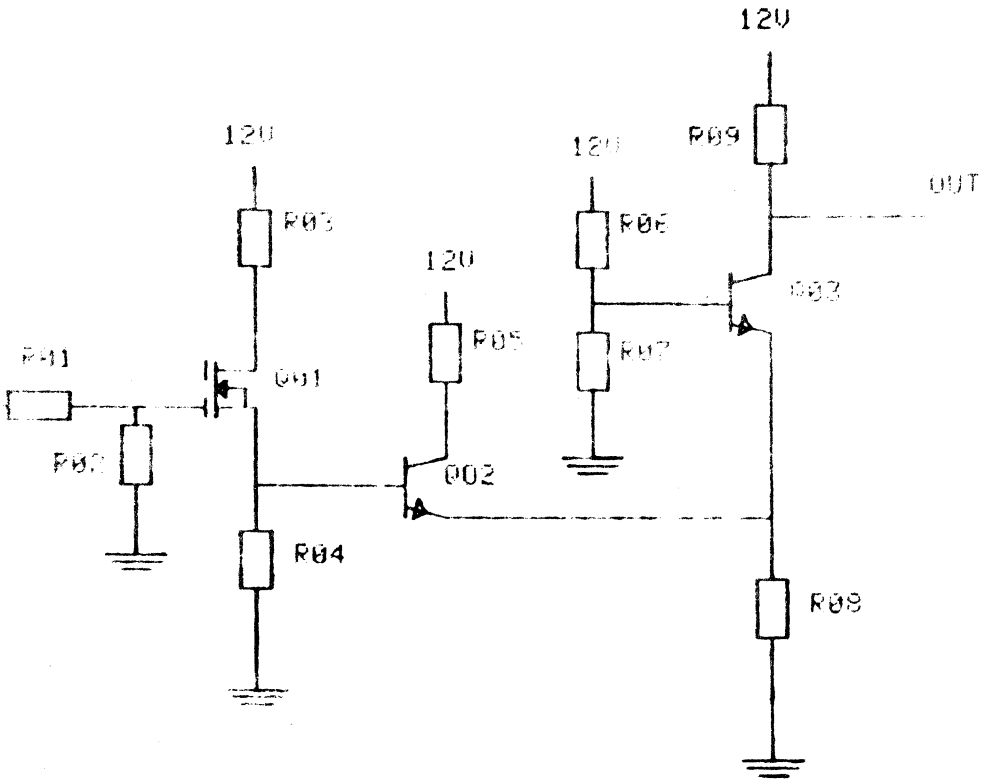
This program allows you to interactively draw schematics on the 4051 screen. The User Definable Keys are used to select the position of component symbols and connecting lines. A choice of eight standard electronic symbols plus a line segment are available:

Resistor
Capacitor
Coil
Diode
Transistor
MOSFET
Variable Capacitor
Earth (ground)

Up to 50 symbols or line segments can be drawn in one schematic using this program.

With this program, you use the pointer (graphic cursor) to select starting and ending points where a symbol is to be located. Then you select the symbol itself. You use specified User Definable Keys to move the pointer. This program also includes the facility to delete symbols or line segments, and to redraw the schematic after editing.

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0



TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

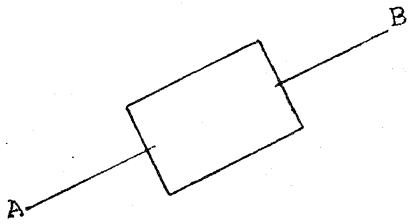
The following symbols can be drawn:

D = diode
C = capacitor
R = resistor
L = Coil
N = npn transistor
V = variable capacitor
E = earth
M = mosfet
SPACE BAR = line

The program allows you to draw on one page, 50 symbols and 45 labels. To draw a new schematic press User Definable Key 11. The cursor will appear in the middle of the screen. For drawing a symbol you have to determine 3 parameters:

1 - STARTING POINT
2 - ENDING POINT
3 - SYMBOL

EXAMPLE



When you want to draw a resistor, first move the cursor to the starting point A. Press U.D.K. 3 to determine this point, reset move to point B. Press U.D.K. to determine this point. Having pressed U.D.K. 8 the cursor will appear in the middle of the screen. Now you are supposed to select a symbol. For a resistor press R the resistor will now be drawn between A and B. For putting a label with the symbol, move the cursor to the point where the first character should be.

Press U.D.K. 9. The graphic cursor will disappear and a blinking question mark will take it's place.

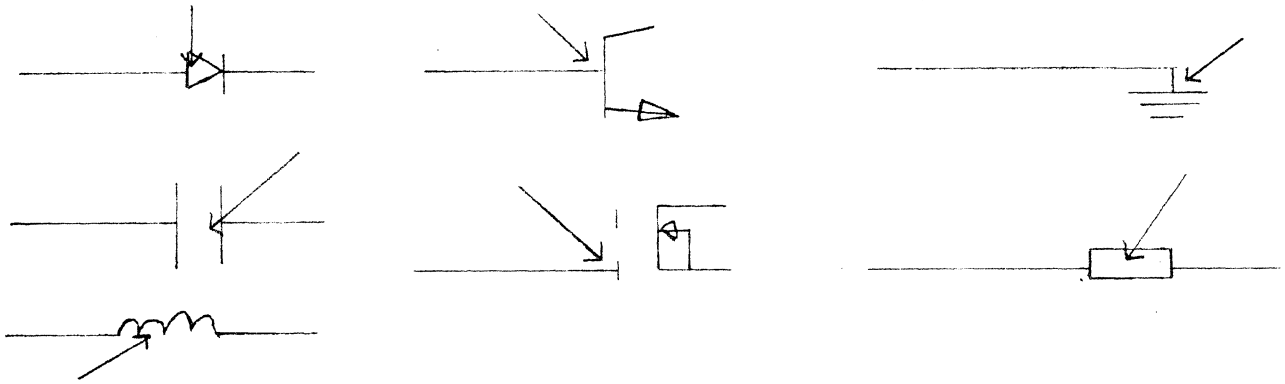
Now type in the label (N.B: MAX LENGTH 3 CHARACTERS).

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

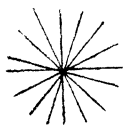
Having finished your schematic you probably want to save it on tape. Press U.D.K. 20. A question is posed which asks you to type in the name of the schematic. Type in a name (N.B: MAX LENGTH 16 CHARACTERS). The schematic will be stored and your program is finished.

DELETING SYMBOLS AND LABELS

For deleting a symbol move the cursor to point indicated by arrow.



For deleting a label put the cursor on the first character. Press U.D.K. 14. Symbol shown below (will be drawn over the symbol or label which indicates that the symbol or label is deleted.



Redrawing PRESS U.D.K. 4 and the schematic will be redrawn without the deleted symbols and labels.

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

REDRAWING AND UPDATING

If you want to change or recall an existing schematic PRESS U.D.K. 15. A list of available schematics will appear on the screen. PRESS the number of the schematic you want to see. The schematic will be drawn.

Now you can follow the same procedure when making a new schematic (adding new symbols, adding labels and deleting).

To save the changed schematic PRESS U.D.K. 20 and give it THE SAME name as the original on tape. The old schematic will be replaced by the new one.

If you want to save both the old and the new schematic the new one must be given a different name.

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
                    *** PROGRAM TO DRAW SCHEMATICS ***

U,D,K,1,3,6 AND 7 TO MOVE THE CURSER

[illegible]   TO DETERMINE THE BEGINNING OF A SYMBOL

[illegible]   TO REDRAW ALL SYMBOLS AND VALUES

[illegible]   TO DETERMINE THE ENDING OF A SYMBOL

[illegible]   AND [illegible] TO START AND END THE PROGRAM

[illegible]   TO DRAW VALUES WITH THE SYMBOLS (MAX. [illegible] CHARACTERS)

[illegible] 11 TO CREATE NEW SCHEMATICS

[illegible] 15 TO REDRAW AND TO 'UPDATE' EXISTING SCHEMATICS

[illegible] 20 TO SAVE A NEW OR AN UPDATED SCHEMATIC ON TAPE

[illegible] 14 TO REMOVE THE SYMBOL ON WHICH THE CURSER STANDS.
               TO REMOVE THE VALUE PLACE THE CURSER ON THE
               FIRST CHARACTER OF THE VALUE

[illegible]
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

AFTER PRESSING U.D.K.8,USE THE KEYBOARD TO SELECT SYMBOLS

D=DIODE ;C=CAPACITOR ;R=RESISTOR ;L=COIL ;N=NPN TRANSISTOR
V=VARIABEL CAPACITOR ;E=EARTH ;M=MOSFET ;SPACEBAR=LINE

FOR DRAWING A NEW SCHEMATIC PRESS U.D.K. 11,
FOR REDRAWING AN EXISTING SCHEMATIC PRESS U.D.K. 15:

[illegible] U.D.K. 11 OR 15?

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
1 INIT
2 SET KEY
3 GO TO 100
4 X=X-1
5 RETURN
8 X=X+1
9 RETURN
12 A=X
13 B=Y
14 RETURN
16 GO TO 2450
20 GO TO 1
24 Y=Y-1
25 RETURN
28 Y=Y+1
29 RETURN
32 GOSUB 530
34 RETURN
36 GOSUB 2930
37 GOSUB 4240
38 RETURN
40 END
44 GO TO 360
56 GOSUB 2570
57 RETURN
60 GO TO 3790
80 GO TO 3450
100 PRINT @32,18:5
110 SET DEGREES
120 DIM A$(4),B$(4),Y$(4),Z$(4),D$(650),Q$(405),C$(20),S$(1057),L$(17)
130 DIM O$(1),F$(1),N$(3),E$(1),H$(13),I$(17),J$(4)
140 PRINT "LI*** PROGRAM TO DRAW SCHEMATICS  51/00-1402/0 ***"
150 PRINT "JJU.D.K.1,2,6 AND 7 TO MOVE THE CURSER"
160 PRINT "JU.D.K.3 TO DETERMINE THE BEGINNING OF A SYMBOL"
170 PRINT "JU.D.K.4 TO REDRAW ALL SYMBOLS AND VALUES"
180 PRINT "JU.D.K.8 TO DETERMINE THE ENDING OF A SYMBOL"
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
190 PRINT "JU.D.K.5 AND 10 TO START AND END THE PROGRAM"
200 PRINT "JU.D.K.9 TO DRAW VALUES WITH THE SYMBOLS (MAX.3 CHARACTERS)"
210 PRINT "JU.D.K.11 TO CREATE NEW SCHEMATICS"
220 PRINT "JU.D.K.15 TO REDRAW AND TO 'UPDATE' EXISTING SCHEMATICS"
230 PRINT "JU.D.K. 20 TO SAVE A NEW OR AN UPDATED SCHEMATIC ON TAPE"
240 PRINT "JU.D.K.14 TO REMOVE THE SYMBOL ON WHICH THE CURSER STANDS."
250 PRINT "         TO REMOVE THE VALUE PLACE THE CURSER ON THE"
260 PRINT "         FIRST CHARACTER OF THE VALUE"
270 PRINT "JJPRESS RETURNGG: ";
280 INPUT O$
290 PRINT "LJJAFTER PRESSING U.D.K.8,USE THE KEYBOARD TO SELECT SYMBOLS"
300 PRINT "JJD=DIODE ;C=CAPACITOR ;R=RESISTOR ;L=COIL ;N=NPN TRANSISTOR"
310 PRINT "V=VARIABEL CAPACITOR ;E=EARTH ;M=MOSFET ;SPACEBAR=LINE"
320 PRINT "JJJFOR DRAWING A NEW SCHEMATIC PRESS U.D.K. 11,"
330 PRINT "FOR REDRAWING AN EXISTING SCHEMATIC PRESS U.D.K. 15:GG"
340 PRINT "JJPRESS U.D.K. 11 OR 15:?"
350 WAIT
360 PAGE
370 D$=""
380 Q$=""
390 N=1
400 V=1
410 G=0
420 S$=""
430 A=65
440 B=50
450 X=65
460 Y=50
470 F$=""
480 MOVE X,Y
490 PRINT @32,24:"¦"
500 FOR I=1 TO 15
510 NEXT I
520 GO TO 480
530 IF X<=A OR X>A AND Y<>B THEN 580
540 IF X<>A AND Y<=B OR Y>B THEN 580
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
550 PRINT "↑YOUR STARTING AND ENDING POSITION ARE THE SAME"
560 PRINT "PRESS U.D.K.4 AND TRY AGAIN","GG"
570 GO TO 40
580 C=ASN((Y-B)/SQR((X-A)↑2+(Y-B)↑2))
590 IF X=>A THEN 650
600 C=ACS((X-A)/SQR((X-A)↑2+(Y-B)↑2))
610 IF X<=A AND Y=>B THEN 650
620 C=ACS((Y-B)/SQR((X-A)↑2+(Y-B)↑2))
630 ROTATE C+90
640 GO TO 660
650 ROTATE C
660 IF F$="R" THEN 680
670 POINTER K,L,E$
680 MOVE A,B
690 G=POS(" RCLNEVMD",E$,1)
700 IF E$="" THEN 670
710 GOSUB G OF 850,730,920,1050,1170,1390,1520,1680,1970
720 RETURN
730 D=(SQR((X-A)↑2+(Y-B)↑2)-6)/2
740 RDRAW D,0
750 RDRAW 0,-1.5
760 RDRAW 6,0
770 RDRAW 0,3
780 RDRAW -6,0
790 RDRAW 0,-1.5
800 RMOVE 6,0
810 RDRAW D,0
820 IF F$="R" THEN 840
830 GOSUB 2100
840 RETURN
850 ROTATE 0
860 E$="J"
870 MOVE A,B
880 RDRAW X-A,Y-B
890 IF F$="R" THEN 910
900 GOSUB 2100
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
910 RETURN
920 D=(SQR((X-A)↑2+(Y-B)↑2)-1.5)/2
930 RDRAW D,0
940 RDRAW 0,-3
950 RDRAW 0,6
960 RMOVE 1.5,0
970 RDRAW 0,-6
980 RDRAW 0,3
990 RDRAW D,0
1000 ROTATE 0
1010 IF F$="R" THEN 1040
1020 IF S$="V" THEN 1040
1030 GOSUB 2100
1040 RETURN
1050 D=(SQR((X-A)↑2+(Y-B)↑2)-9.5428)/2
1060 RDRAW D,0
1070 FOR H=0 TO 1440 STEP 30
1080     E=-0.2*(COS(H)-1)
1090     F=0.55*SIN(H)
1100     RDRAW E,F
1110 NEXT H
1120 RDRAW D,0
1130 ROTATE 0
1140 IF F$="R" THEN 1160
1150 GOSUB 2100
1160 RETURN
1170 ROTATE 0
1180 RDRAW X-A,Y-B
1190 IF X<A AND Y<B THEN 1220
1200 ROTATE C
1210 GO TO 1230
1220 ROTATE C+90
1230 RDRAW 0,-3
1240 RDRAW 0,6
1250 RDRAW 0,-1
1260 RDRAW 4,1
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
1270 RMOVE 0,-6
1280 RDRAW -4,1
1290 RDRAW 0,-1
1300 RMOVE 1,0.75
1310 RDRAW 0.25,SQR(0.9375)
1320 RDRAW -0.5,-2*SQR(0.9375)
1330 RDRAW 1.25,0.75
1340 RDRAW -0.75,1.25
1350 ROTATE 0
1360 IF F$="R" THEN 1380
1370 GOSUB 2100
1380 RETURN
1390 ROTATE 0
1400 MOVE A,B
1410 RDRAW X-A,Y-B
1420 RDRAW 0,-2
1430 RDRAW -3,0
1440 RDRAW 6,0
1450 RMOVE -0.5,-0.75
1460 RDRAW -5,0
1470 RMOVE 1,-0.75
1480 RDRAW 3,0
1490 IF F$="R" THEN 1510
1500 GOSUB 2100
1510 RETURN
1520 S$="V"
1530 GOSUB 920
1540 IF X<A AND Y<B THEN 1570
1550 ROTATE C
1560 GO TO 1580
1570 ROTATE C+90
1580 RMOVE -D-1.5,0
1590 RDRAW -3,-3
1600 RDRAW 6,6
1610 RDRAW 1,-1
1620 RDRAW -2,2
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
1630 ROTATE 0
1640 IF F$="R" THEN 1660
1650 GOSUB 2100
1660 S$=""
1670 RETURN
1680 ROTATE 0
1690 RDRAW X-A,Y-B
1700 IF X<A AND Y<B THEN 1730
1710 ROTATE C
1720 GO TO 1740
1730 ROTATE C+90
1740 RMOVE 0,-1
1750 RDRAW 0,2
1760 RMOVE 0,2
1770 RDRAW 0,2
1780 RMOVE 1,0
1790 RDRAW 0,-6
1800 RDRAW 0,1
1810 RDRAW 4,0
1820 RDRAW -4,0
1830 RDRAW 0,5
1840 RDRAW 0,-1
1850 RDRAW 4,0
1860 RMOVE 0,-4
1870 RDRAW -1,0
1880 RDRAW 0,2
1890 RDRAW -3,0
1900 RDRAW 1,1
1910 RDRAW 0,-2
1920 RDRAW -1,1
1930 ROTATE 0
1940 IF F$="R" THEN 1960
1950 GOSUB 2100
1960 RETURN
1970 D=(SQR((X-A)↑2+(Y-B)↑2)-2)/2
1980 RDRAW D,0
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
1990 RDRAW 0,2
2000 RDRAW 0,-4
2010 RDRAW 2,2
2020 RDRAW -2,2
2030 RMOVE 2,0
2040 RDRAW 0,-4
2050 RDRAW 0,2
2060 RDRAW D,0
2070 IF F$="R" THEN 2090
2080 GOSUB 2100
2090 RETURN
2100 N$="+++"
2110 A$=STR(A)
2120 A$=REP("",1,1)
2130 B$=STR(B)
2140 B$=REP("",1,1)
2150 Y$=STR(X)
2160 Y$=REP("",1,1)
2170 Z$=STR(Y)
2180 Z$=REP("",1,1)
2190 D$=D$&A$
2200 IF LEN(A$)=3 THEN 2250
2210 DIM N$(3-LEN(A$))
2220 D$=D$&N$
2230 DIM N$(3)
2240 N$="+++"
2250 D$=D$&B$
2260 IF LEN(B$)=3 THEN 2310
2270 DIM N$(3-LEN(B$))
2280 D$=D$&N$
2290 DIM N$(3)
2300 N$="+++"
2310 D$=D$&Y$
2320 IF LEN(Y$)=3 THEN 2370
2330 DIM N$(3-LEN(Y$))
2340 D$=D$&N$
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
2350 DIM N$(3)
2360 N$="+++"
2370 D$=D$&Z$
2380 IF LEN(Z$)=3 THEN 2430
2390 DIM N$(3-LEN(Z$))
2400 D$=D$&N$
2410 DIM N$(3)
2420 N$="+++"
2430 D$=D$&E$
2440 RETURN
2450 PAGE
2460 F$="R"
2470 IF D$="" THEN 3150
2480 FOR I=1 TO LEN(D$) STEP 13
2490     GOSUB 4140
2500     A=VAL(A$)
2510     B=VAL(B$)
2520     X=VAL(Y$)
2530     Y=VAL(Z$)
2540     GOSUB 530
2550 NEXT I
2560 GO TO 3150
2570 IF D$="" THEN 3150
2580 FOR I=1 TO LEN(D$)-12 STEP 13
2590     GOSUB 4140
2600     IF A$="" THEN 3150
2610     A=VAL(A$)
2620     B=VAL(B$)
2630     S=VAL(Y$)
2640     D=VAL(Z$)
2650     IF E$="N" OR E$="M" THEN 2710
2660     IF E$="E" THEN 2730
2670     P=ABS(A+0.5*(S-A))
2680     Q=ABS(B+0.5*(D-B))
2690     IF ABS(P-X)<2 AND ABS(Q-Y)<2 THEN 2760
2700     GO TO 2740
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
2710      IF ABS(S-X)<2 AND ABS(D-Y)<2 THEN 2760
2720      GO TO 2740
2730      IF ABS(S-X)<2 AND ABS(D-Y-2)<2 THEN 2760
2740 NEXT I
2750 GO TO 3150
2760 D$=REP("",I,13)
2770 IF E$="N" OR E$="M" THEN 2810
2780 IF E$="E" THEN 2830
2790 MOVE P,Q
2800 GO TO 2840
2810 MOVE S,D
2820 GO TO 2840
2830 MOVE S,D-2
2840 FOR I=0 TO 330 STEP 30
2850      O=SIN(I)
2860      P=COS(I)
2870      RDRAW 3*O,3*P
2880      RDRAW -3*O,-3*P
2890 NEXT I
2900 X=X-2
2910 Y=Y+2
2920 GO TO 470
2930 MOVE X,Y
2940 INPUT P$
2950 IF LEN(P$)<>3 THEN 2930
2960 I$=STR(X)
2970 I$=REP("",1,1)
2980 J$=STR(Y)
2990 J$=REP("",1,1)
3000 Q$=Q$&P$
3010 Q$=Q$&I$
3020 IF LEN(I$)=3 THEN 3070
3030 N$="+++"
3040 DIM N$(3-LEN(I$))
3050 Q$=Q$&N$
3060 DIM N$(3)
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
3070 N$="+++"
3080 Q$=Q$&J$
3090 IF LEN(J$)=3 THEN 3140
3100 DIM N$(3-LEN(J$))
3110 Q$=Q$&N$
3120 DIM N$(3)
3130 N$="+++"
3140 RETURN
3150 IF Q$="" THEN 3170
3160 GO TO 3190
3170 F$=""
3180 GO TO 480
3190 FOR M=1 TO LEN(Q$)-8 STEP 9
3200     H$=SEG(Q$,M,9)
3210     I$=SEG(H$,4,3)
3220     J$=SEG(H$,7,3)
3230     P$=SEG(H$,1,3)
3240     I=VAL(I$)
3250     J=VAL(J$)
3260     IF F$="R" THEN 3400
3270     IF ABS(I-X)>2 OR ABS(J-Y)>2 THEN 3420
3280     Q$=REP("",M,9)
3290     ROTATE 0
3300     RMOVE 2,1
3310     FOR I=0 TO 330 STEP 30
3320         O=SIN(I)
3330         P=COS(I)
3340         RDRAW 1.5*O,1.5*P
3350         RDRAW -1.5*O,-1.5*P
3360     NEXT I
3370     X=X-1
3380     Y=Y+1
3390     GO TO 470
3400     MOVE I,J
3410     PRINT P$
3420 NEXT M
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
3430 F$=""
3440 GO TO 480
3450 PAGE
3460 X$=CHR(13)
3470 W$=CHR(19)
3480 K$="                    "
3490 PRINT "JTYPE IN THE NAME OF THIS SCHEMATIC (MAX. 16 CHARACTERS)"
3500 PRINT "JINPUT NAME:GG ";
3510 INPUT C$
3520 IF LEN(C$)>16 THEN 3490
3530 PRINT @33,0:0,0,1
3540 FOR U=2 TO 100
3550     FIND U
3560     INPUT @33:T$
3570     G$=SEG(T$,9,1)
3580     L$=SEG(T$,11,LEN(C$))
3590     IF L$=C$ THEN 3650
3600     IF G$="L" THEN 3620
3610 NEXT U
3620 PRINT @33,0:0,0,0
3630 FIND U
3640 MARK 1,1500
3650 PRINT @33,0:0,0,0
3660 FIND U
3670 PRINT @33:D$;" ";Q$
3680 PRINT @33,0:0,0,1
3690 FIND U
3700 K$=REP(C$,2,LEN(C$))
3710 IF G$="N" OR G$="L" THEN 3730
3720 GO TO 3740
3730 T$=REP("A",9,1)
3740 T$=REP(K$,10,17)
3750 FIND U
3760 PRINT @33:T$;X$;W$
3770 PRINT @33,0:0,0,0
3780 END
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
3790 PRINT "LJJSELECT OUT OF THE FOLLOWING SCHEMATICS:J"
3800 PRINT @33,0:0,0,1
3810 FOR I=2 TO 100
3820     FIND I
3830     INPUT @33:G$
3840     J$=SEG(G$,9,1)
3850     IF J$="L" THEN 3930
3860     H$=SEG(G$,2,3)
3870     H=VAL(H$)
3880     H=H-1
3890     H$=STR(H)
3900     I$=SEG(G$,10,17)
3910     PRINT H$;" ";I$
3920 NEXT I
3930 PRINT @33,0:0,0,0
3940 PRINT "JJTYPE IN THE NUMBER OF THE SCHEMATIC,"
3950 PRINT "THAT HAS TO BE DRAWN"
3960 PRINT "TYPE IN ZERO IF NONE:G ";
3970 INPUT O
3980 IF O<=H THEN 4010
3990 PRINT "JJNOT EXISTING NUMBER TRY AGAINGG: ";
4000 GO TO 3970
4010 IF O=0 THEN 4110
4020 FIND O+1
4030 INPUT @33:S$
4040 FOR I=1 TO LEN(S$)
4050     G$=SEG(S$,I,1)
4060     IF G$=" " THEN 4080
4070 NEXT I
4080 D$=SEG(S$,1,I-1)
4090 Q$=SEG(S$,I+1,LEN(S$)-I)
4100 GO TO 2450
4110 FIND 0
4120 PRINT "JJJI*** PROGRAM FINISHED ***GGGGG"
4130 END
4140 H$=SEG(D$,I,13)
```

TITLE	ABSTRACT NO:
SCHEMATIC DRAWING PROGRAM II	51/00-1402/0

```
4150 A$=SEG(H$,1,3)
4160 B$=SEG(H$,4,3)
4170 Y$=SEG(H$,7,3)
4180 Z$=SEG(H$,10,3)
4190 E$=SEG(H$,13,1)
4200 IF E$<>"J" THEN 4230
4220 E$=" "
4230 RETURN
4240 X=X-1
4250 Y=Y+1
4260 F$=""
4270 RETURN
```

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APPLICATIONS LIBRARY PROGRAM

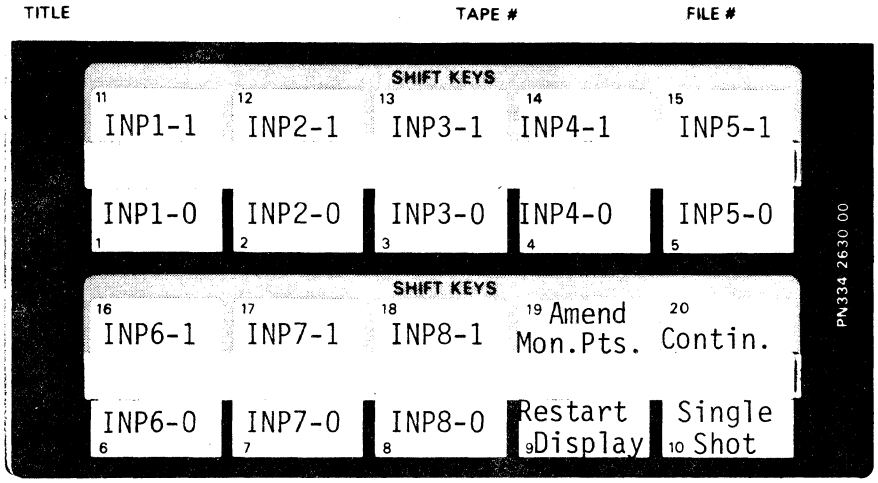
TITLE		ABSTRACT NUMBER
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR		51/00-1403/0
ORIGINAL DATE 8 August 1977	REVISION DATE	MEMORY REQUIREMENT 16K
AUTHOR K. J. Orford	Physics Department Durham University South Road, Durham	PERIPHERALS None

ABSTRACT

The program stores the interrelationships of logic elements (gates, latches, etc.) in a complex circuit and predicts the state of all the elements at a short time later. Optionally, it then stops and prints out, or continues and predicts the next state and prints until stopped, or continually predicts subsequent states and shows a selected number (up to 12) as waveforms on the display. The three modes may be selected by User Definable Keys. Up to eight input lines may be used and changed at will during execution using the User Definable Keys.

325 Statements.

TITLE	PART NUMBER
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0



TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

1. Description

The program starts with a short description of its facilities. It then requests the user to input details of the logic circuit. A logic circuit should be drawn as a block diagram, and its blocks numbered 1, 2, 3, etc. Each block may have more than one input, but each has only one output, other outputs must be simulated with other blocks. An array B(I) stores the logical values (0 or 1) of the output of the Ith block. The blocks must be numbered in a certain order:

(1) Gates first: mixed in any order and may have up to 8 inputs. Types allowed:

AND, NAND, OR, NOR, NOT (Inverter), EOR (Exclusive OR--only 2 inputs allowed)

then

(2) Monostables

(3) Delays

(4) D-type latches (used to simulate other types, and to construct shift registers)

(5) Astables

(6) External levels used as inputs, controlled by the User Definable Keys

The format for these inputs is given in the invitation to enter the logic block details.

The program stores the block numbers whose outputs form the inputs of other blocks, e.g., Gate 1 may have 2 inputs, one from Gate 4 output and one from Gate 7 output. The input for this gate would then be:

1: AND, 4, 7 if it were an AND gate.

All the interrelationships are input and stored.

The current values of the outputs of all the blocks are then used, together with the relationships, to predict the future outputs at one increment of time later. The time increment is taken to be the transit time delay of a simple gate. Logical devices which respond to charging levels to trigger them (monostable, delays and latches) only respond when the relevant input charges state in the correct way. To accomplish this, the previous state of the logic block outputs are stored in array A(I). When a device is "triggered," the current time is noted and the appropriate action is taken at the correct delay.

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

In summary, the present and immediately previous states of all the logic blocks are stored, together with the input/output corrections and the immediately following state is predicted.

The defacet form of output is to display as developing waveforms up to 12 nominated logic block output states. This continuous process may be modified by changing the state of one of the external levels using a User Definable Key, or the process may be slowed down by pressing the "single shot" key which will advance the waveforms by one delay unit at a time. If no such outputs are nominated, the state of all the blocks is indicated by a string of 0/1 for each delay unit.

2. Data Tape Structure

No data tape.

3. Internal Data Storage

Variable	Used to Store	Type
A$	Keyboard input	String
A	Previous state of logic outputs	Array (N)
B	Current state of logic outputs	Array (N)
C	Future state of logic outputs	Array (N)
D	Positions of commas in A$	Array (N)
J4	Dummy to shorten statement (=K(I,1))	Simple
K	Logic blocks which provide inputs to other blocks	Array (N,N1)
K1	Dummy to shorten statement (=K(I,1))	Simple
K2	Dummy to shorten statement (=K(I,2))	Simple
L	Subscript variable	Simple
L$	Segment of A$	String
M	Logic blocks to be monitored	Array (M1)
M1	Number of blocks to be monitored	Simple
N	Total number of blocks used	Simple
N1	(a) Maximum number of inputs to any block	Simple
	Then after arrays are dimensioned	
	(b) Number of gates	
N2	Number of gates + monostables	Simple
N3	Number of gates, monostables + delays	Simple
N4	N3 + number of latches	Simple
N5	N4 + number of astables	Simple
N9	Number of external lines	Simple
N8	User Definable Key number	Simple
P	Branching address	Array (M)
P1	Position in A$ of comma	Simple
P2	Position of T$ in Z$	Simple

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ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

P3	Dummy to shorten list of addresses	Simple
P4	Position of comma in A$	Simple
Q$	Segment of A$	String
Q9	Flag for single shot/continuous advance	Simple
R	Number of inputs to logic blocks	Array (N)
R$	Segment of A$	String
T	Current time in delay units	Simple
TØ	Time at which block was triggered	Array (N)
T$	First segment of A$	String
Z1	Branching address for each type of logic block	Array (18)
Z$	List of permitted gate types	String

4. Operation

(a) An overlay is used to

(1) Set the states of the 8 possible inputs

(2) To set single shot/continuous mode

(3) To restart the "timebase" of the display

(4) To change the points which are monitored and/or to change from waveform output to tabular

Key Number	Function
1	Sets input No. 1 to logic 0 without interrupting program
2	Sets input No. 2 to logic 0 without interrupting program
3	Sets input No. 3 to logic 0 without interrupting program
4	Sets input No. 4 to logic 0 without interrupting program
5	Sets input No. 5 to logic 0 without interrupting program
6	Sets input No. 6 to logic 0 without interrupting program
7	Sets input No. 7 to logic 0 without interrupting program
8	Sets input No. 8 to logic 0 without interrupting program
9	Restarts display from T=0 and all inputs=0
10	Advances the display by one delay unit then stops
11	Sets input No. 1 to logic 1 without interrupting program
12	Sets input No. 2 to logic 1 without interrupting program
13	Sets input No. 3 to logic 1 without interrupting program
14	Sets input No. 4 to logic 1 without interrupting program
15	Sets input No. 5 to logic 1 without interrupting program
16	Sets input No. 6 to logic 1 without interrupting program
17	Sets input No. 7 to logic 1 without interrupting program
18	Sets input No. 8 to logic 1 without interrupting program
19	Interrupts program to allow monitored parts to be re-chosen
20	Returns display to continuous advance from current value of T

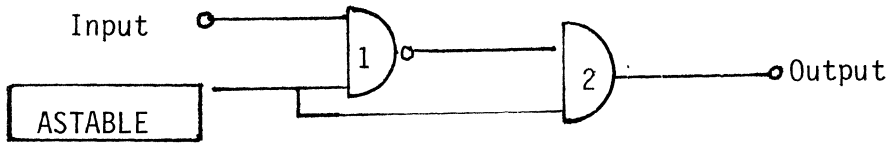
TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

(b) Program is loaded and commenced by RUN

(c) Program should be self-explanatory while running. All necessary instructions are given and should be followed. Most of the required responses are checked for validity and queried if not recognised, and the question re-asked.

(d) an example of how a circuit's behaviour is analysed is for the following circuit:

Example circuit



If input 1 is HI, then the output of Gate 1 is always the inverse of the other input, the astable in this example. The inputs of Gate 2 have therefore always opposite values, and the output will remain LO, except for a period one gate delay long when the astable changes from LO to HI. At this instant the inputs of Gate 2 are HI (just) and also HI from Gate 1 output. This lasts for 1 gate delay time until Gate 1 responds to its changed input.

Realisation:

Number units: Gate No. 1 = 1
Gate No. 2 = 2
Astable = 3
External Input = 4

5. Sample Program

```
PREDICTED BEHAVIOUR OF A LOGIC CIRCUIT

 This program stores the relationships between the inputs
and outputs of up to about 150 (depending on the memory
available) logic elements and calculates the relationships
which they will have a short time later (about one gate
delay). The results are shown on the display as 0/1 levels
as a function of time, i.e. as if on a CRO screen.
This process may be continuous from the time origin (key 9),
repetative from the current screen position (key 20), or
single shot from the current position (key 10).
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

The system may have any number of each of the 9 types of basic element (from which more complex elements may be constructed) and up to 8 inputs controlled by the User Definable Keys.

Press RETURN key to continue

Logical "blocks" permitted are:
1 GATE- AND,OR,NAND,NOR(<=8 inputs)+NOT,EOR(exclusive)
2 O/S (monostable),+trigger, Q output only
3 DELAY from + edge, prompt from - edge of input
4 LATCH- D type (use to make shift registers)
5 ASTABLE.
6 EXTERNAL input level
ALL TIMES ARE IN TERMS OF A GATE DELAY
Number all logical blocks and inputs from #1, using the order given above.

1. Total number of "blocks" (max. 50) 4
2. Maximum number of inputs to any block ? 2
3. How many points to be monitored on display ? 4
4. Enter 4 points : 1, 2, 3, 4 (i.e., all of them)

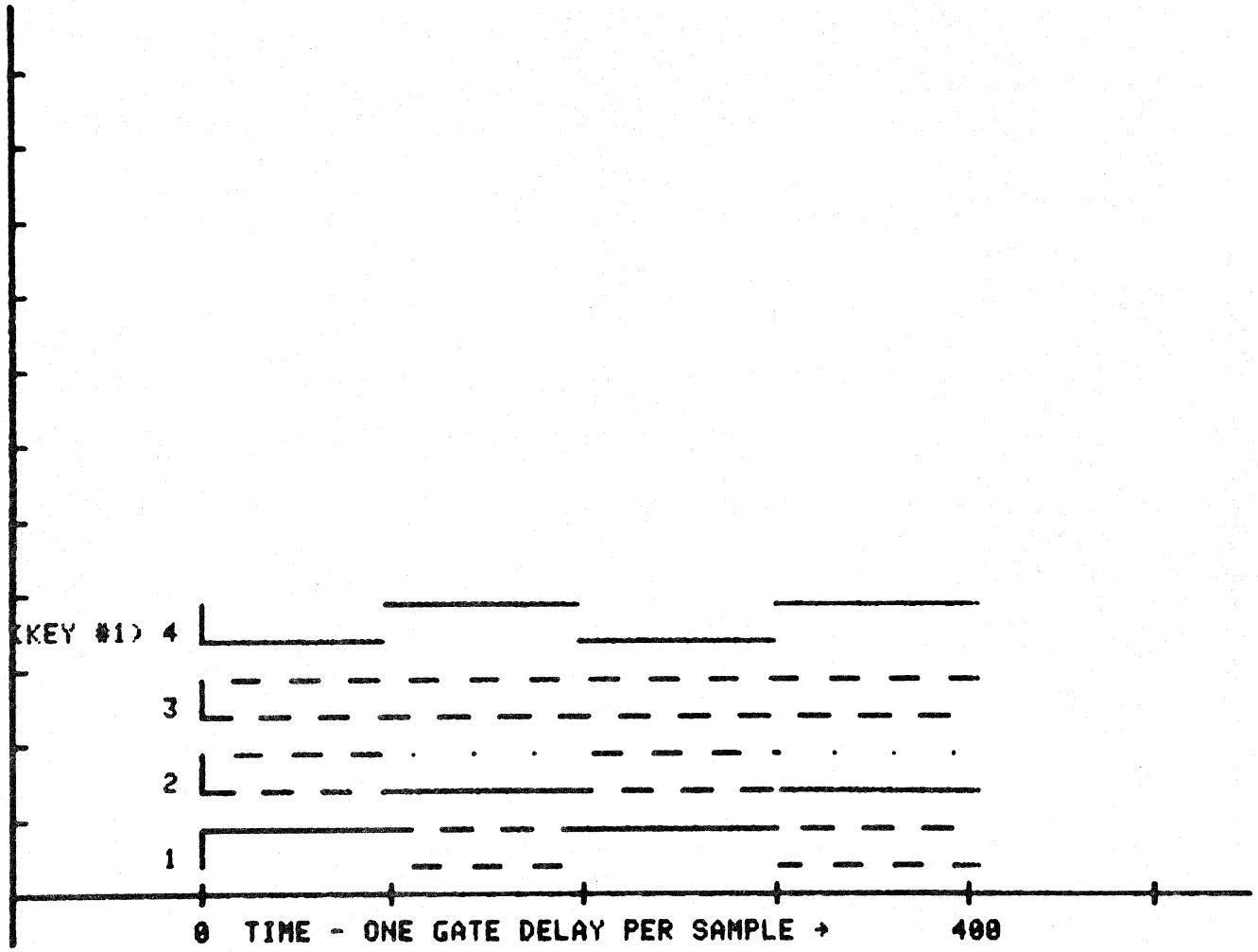
TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/QO-1403/0

```
   Enter LAST at end of each list, or NONE if no items in list

5. Enter details of gate: (TYPE,INPUT1,INPUT2 etc)
   Types : AND,NAND,OR,NOR,NOT,EOR. - LAST to end list
    1:NAND,3,4
6. Enter details of gate: (TYPE,INPUT1,INPUT2 etc)
   Types : AND,NAND,OR,NOR,NOT,EOR. - LAST to end list
    2:AND,1,3
7. Enter details of gate: (TYPE,INPUT1,INPUT2 etc)
   Types : AND,NAND,OR,NOR,NOT,EOR. - LAST to end list
    3:LAST
8. Enter details of O/S: (INPUT,LENGTH) - LAST to end list
    3:NONE
9. Enter details of delay:(INPUT,LENGTH) - LAST to end list
    3:NONE
10. Enter details of latch: (DATA,CLOCK) - LAST to end list
    3:NONE
11. Enter details of astables : (PERIOD) LAST to end list
    3:8
12. Enter details of astables : (PERIOD) LAST to end list
    4:LAST
13. How many external lines/inputs ? 1
```

Program now blanks screen and draws:

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0



TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
  1 GO TO 100
  4 C(N5+1)=0
  5 RETURN
  8 C(N5+2)=0
  9 RETURN
 12 C(N5+3)=0
 13 RETURN
 16 C(N5+4)=0
 17 RETURN
 20 C(N5+5)=0
 21 RETURN
 24 C(N5+6)=0
 25 RETURN
 28 C(N5+7)=0
 29 RETURN
 32 C(N5+8)=0
 33 RETURN
 36 Q9=0
 37 T=0
 38 GO TO 1550
 40 Q9=1
 41 GO TO 2380
 44 C(N5+1)=1
 45 RETURN
 48 C(N5+2)=1
 49 RETURN
 52 C(N5+3)=1
 53 RETURN
 56 C(N5+4)=1
 57 RETURN
 60 C(N5+5)=1
 61 RETURN
 64 C(N5+6)=1
 65 RETURN
 68 C(N5+7)=1
 69 RETURN
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
 72 C(N5+8)=1
 73 RETURN
 76 PAGE
 77 GOSUB 2600
 78 GO TO 36
 80 Q9=0
 81 GO TO 2380
 90 REM 51/00-1403/0 *** LOGIC CIRCUIT BEHAVIOR ANALYSIS ***
 95 REM AUTHOR:  K. J. ORFORD, DURHAM UNIVERSITY
100 INIT
110 PRINT @32,26:0
120 PAGE
130 SET KEY
140 PRINT "   PREDICTED BEHAVIOUR OF A LOGIC CIRCUIT"
150 PRINT "_  This program stores the relationships between the inputs"
160 PRINT "and outputs of up to about 150 (depending on the memory"
170 PRINT "available) logic elements and calculates the relationships"
180 PRINT "which they will have a short time later (about one gate"
190 PRINT "delay). The results are shown on the display as 0/1 levels"
200 PRINT "as a function of time, i.e. as if on a CRO screen."
210 PRINT "This process may be continuous from the time origin (key 9),"
220 PRINT "repetative from the current screen position (key 20), or"
230 PRINT "single shot from the current position (key 10)."
240 PRINT "_   The system may have any number of each of the 9 types"
250 PRINT "of basic element (from which more complex elements may be"
260 PRINT "constructed) and up to 8 inputs controlled by the User"
270 PRINT "Definable Keys."
280 PRINT "_  Press RETURN key to continue"
290 INPUT A$
300 PAGE
310 REMARK **** READ IN PROGRAM CONSTANTS ****
320 PRINT "_Logical ""blocks"" permitted are:"
330 PRINT "   1 GATE- AND,OR,NAND,NOR(<=8 inputs)+NOT,EOR(exclusive)"
340 PRINT "   2 O/S (monostable),+trigger, Q output only"
350 PRINT "   3 DELAY  from + edge, prompt from - edge of input"
360 PRINT "   4 LATCH- D type  (use to make shift registers)"
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
370 PRINT "   5 ASTABLE."
380 PRINT "   6 EXTERNAL  input level"
390 PRINT "ALL TIMES ARE IN TERMS OF A GATE DELAY"
400 PRINT @32,18:0
410 PRINT "Number all logical blocks and inputs from #1, using the"
420 PRINT @32,18:5
430 PRINT "order given above."
440 PRINT "Total number of ""blocks"" (max. 50)  ";
450 INPUT N
451 IF N<=50 THEN 460
452 PRINT "MAXIMUM NO OF BLOCKS IS 50!"
453 GO TO 440
460 PRINT "Maximum number of inputs to any block ? ";
470 INPUT N1
480 IF N1<=8 THEN 510
490 PRINT "MAXIMUM OF 8"
500 GO TO 460
510 IF N1=>2 THEN 530
520 N1=2
530 GOSUB 2600
540 PRINT " Enter LAST at end of each list, or NONE if no items in list"
550 PRINT
560 REMARK *** DIMENSION ARRAYS AND SET STARTING VALUES ***
570 DATA 6,6,1,1,1,2,2,2,3,3,3,4,4,4,5,5,5,5
580 DIM A(N),B(N),C(N),T0(N),R(N),P(N),D(N),Z1(18),K(N,N1),C9(N)
590 READ Z1
600 A=0
610 Q9=0
620 B=0
630 C=0
640 N9=0
650 R=1
660 D=0
670 P=11
680 K=0
690 T0=1
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
700 I=1
710 Z$="ORNOTNORANDEORNAND"
720 REMARK ********** START OF READ IN STAGE *****************
730 REMARK *** READ IN GATE DETAILS ***
740 PRINT "Enter details of gate: (TYPE,INPUT1,INPUT2 etc)"
750 PRINT "Types : AND,NAND,OR,NOR,NOT,EOR. - LAST to end list"
760 PRINT I;":";
770 INPUT A$
780 IF A$="LAST" OR A$="NONE" THEN 1010
781 E=POS(A$,", ",1)
782 E$=SEG(A$,LEN(A$),1)
783 F$=","
784 IF E=0 AND E$>F$ THEN 790
785 PRINT "NO SPACES ALLOWED BETWEEN ENTRIES ";
786 PRINT "AND NO COMMA AFTER LAST ENTRY."
787 PRINT "PLEASE RE-ENTER ",I
788 GO TO 740
790 J=1
800 D(J)=POS(A$,",",1)
801 IF D(J)>0 THEN 810
802 PRINT "COMMAS REQUIRED AFTER TYPE AND INPUTS; ";
803 PRINT "TRY AGAIN."
804 GO TO 740
810 T$=SEG(A$,1,D(1)-1)
820 R(I)=1
830 IF T$="NOT" THEN 890
840 J=J+1
850 D(J)=POS(A$,",",D(J-1)+1)
860 IF D(J)=0 THEN 880
870 GO TO 840
880 R(I)=J-1
890 P2=POS(Z$,T$,1)
900 P(I)=Z1(P2)
910 IF P2>0 THEN 940
920 PRINT "WHAT ???"
930 GO TO 740
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
940 D(R(I)+1)=LEN(A$)
950 FOR L=1 TO R(I)
960     L$=SEG(A$,D(L)+1,D(L+1)-D(L))
970     K(I,L)=VAL(L$)
980 NEXT L
990 I=I+1
1000 GO TO 740
1010 REMARK *** READ IN O/S INFO.**
1020 N1=I-1
1030 PRINT "Enter details of O/S: (INPUT,LENGTH) - LAST to end list"
1040 GOSUB 2400
1050 IF P2=0 THEN 1090
1060 P(I)=7
1070 I=I+1
1080 GO TO 1030
1090 REMARK *** READ IN DELAY INFO. ***
1100 N2=I-1
1110 PRINT "Enter details of delay:(INPUT,LENGTH) - LAST to end list"
1120 GOSUB 2400
1130 IF P2=0 THEN 1170
1140 P(I)=8
1150 I=I+1
1160 GO TO 1110
1170 REMARK *** READ IN LATCH INFO. ***
1180 N3=I-1
1190 PRINT "Enter details of latch: (DATA,CLOCK) - LAST to end list"
1200 PRINT I;":";
1210 INPUT A$
1220 IF A$="LAST" OR A$="NONE" THEN 1310
1230 P(I)=9
1240 P4=POS(A$,",",1)
1250 Q$=SEG(A$,1,P4-1)
1260 R$=SEG(A$,P4+1,LEN(A$)-P4)
1270 K(I,1)=VAL(Q$)
1280 K(I,2)=VAL(R$)
1290 I=I+1
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
1300 GO TO 1190
1310 REMARK ** READ IN ASTABLES **
1320 N4=I-1
1330 PRINT "Enter details of astables : (PERIOD) LAST to end list"
1340 PRINT I;":";
1350 INPUT A$
1360 IF A$="LAST" OR A$="NONE" THEN 1410
1370 P(I)=10
1380 R(I)=VAL(A$)
1390 I=I+1
1400 GO TO 1330
1410 REMARK ** READ IN EXTERNAL LINES **
1420 N5=I-1
1430 PRINT "How many external lines/inputs ? ";
1440 INPUT N$
1450 IF N$="LAST" OR N$="NONE" THEN 1380
1460 N9=VAL(N$)
1470 GO TO 1500
1480 N9=0
1490 N5=N4+N9
1500 IF N=N5+N9 THEN 1550
1510 PAGE
1520 PRINT "GGGGYOU CAN'T ADD UP!!   TRY AGAIN"
1530 RESTORE
1540 GO TO 440
1550 REMARK ********** END OF READ IN STAGE **********************
1560 T=0
1570 PAGE
1580 PRINT @32,26:2
1590 IF M1=0 THEN 1790
1600 N8=0
1610 FOR I=1 TO M1
1620     MOVE 0,8*I
1630     PRINT @32,18:0
1640     IF M(I)<=N5 THEN 1680
1650     N8=N8+1
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
1660      PRINT "(KEY #";N8;") ";M(I);
1670      GO TO 1700
1680      PRINT @32,18:5
1690      PRINT "          ";M(I);
1700      MOVE 20,8*I
1710      DRAW 20,4+8*I
1720 NEXT I
1730 WINDOW 0,130,-5,95
1740 AXIS 20,8
1750 WINDOW 0,130,0,100
1760 MOVE 19.5,0
1770 PRINT @32,18:5
1780 PRINT "0  TIME - ONE GATE DELAY PER SAMPLE }        400";
1790 A=B
1800 B=C
1810 REMARK ******** START OF LOOP TO CALCULATE CURRENT STATE *******
1820 FOR I=1 TO N
1830      IF P(I)>6 THEN 1850
1840      GO TO P(I) OF 1870,1890,1940,1990,1940,1890
1850      P3=P(I)-6
1860      GO TO P3 OF 2040,2080,2150,2210,2230
1870      C(I)=NOT(B(K(I,1)))
1880      GO TO 2230
1890      C(I)=B(K(I,1))
1900      FOR J=2 TO R(I)
1910          C(I)=C(I) OR B(K(I,J))
1920      NEXT J
1930      GO TO 2010
1940      C(I)=B(K(I,1))
1950      FOR J=2 TO R(I)
1960          C(I)=C(I) AND B(K(I,J))
1970      NEXT J
1980      GO TO 2010
1990      C(I)=B(K(I,1)) OR B(K(I,2)) AND NOT(B(K(I,1)) AND B(K(I,2)))
2000      GO TO 2230
2010      GO TO P(I) OF 2230,2020,2230,2230,2020,2230
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
2020      C(I)=NOT(C(I))
2030      GO TO 2230
2040      REMARK ** O/S **
2050      GOSUB 2550
2060      C(I)=C(I) OR A(J4)<B(J4) AND T<=T0(I)+R(I)
2070      GO TO 2230
2080      REMARK ** DELAY **
2090      GOSUB 2550
2100      D(I)=D(I) OR A(J4)<B(J4)
2110      IF D(I)=1 AND B(J4)=1 THEN 2130
2120      D(I)=0
2130      C(I)=D(I) AND T=>T0(I)+R(I)
2140      GO TO 2230
2150      REMARK ** LATCHES **
2160      K1=K(I,1)
2170      K2=K(I,2)
2180      IF B(K2)<=A(K2) THEN 2230
2190      C(I)=B(K1)
2200      GO TO 2230
2210      REMARK ** ASTABLES **
2220      C(I)=INT(T/R(I)+0.5-INT(T/R(I)))
2230 NEXT I
2240 REMARK ****** END OF CALCULATION OF C(I) ******
2250 IF M1=0 THEN 2300
2260 FOR I=1 TO M1
2270      MOVE T/4+20,8*I+4*C(M(I))
2280      DRAW T/4+20,8*I+4*C(M(I))
2290 NEXT I
2300 IF M1>0 THEN 2360
2310 FOR I=1 TO N
2320      PRINT USING 2330:C(I)
2330      IMAGE 1D,S
2340 NEXT I
2350 PRINT
2360 IF Q9=0 THEN 2380
2370 WAIT
```

TITLE	ABSTRACT NO:
ANALYSIS OF LOGIC CIRCUIT BEHAVIOUR	51/00-1403/0

```
2380 T=T+1
2390 GO TO 1790
2400 REMARK *** READ O/S AND DELAY DETAILS SUBROUTINE ***
2410 PRINT I;":";
2420 INPUT A$
2430 P2=0
2440 IF A$="LAST" OR A$="NONE" THEN 2540
2450 P2=1
2460 P1=POS(A$,",",1)
2470 IF P1>0 THEN 2500
2480 PRINT "WHAT ??   REPEAT"
2490 GO TO 2410
2500 T$=SEG(A$,P1+1,LEN(A$)-P1)
2510 U$=SEG(A$,1,P1-1)
2520 K(I,1)=VAL(U$)
2530 R(I)=VAL(T$)
2540 RETURN
2550 REMARK *** SUBROUTINE FOR O/S+DELAY ***
2560 J4=K(I,1)
2570 IF B(J4)<=A(J4) THEN 2590
2580 TO(I)=T
2590 RETURN
2600 REM ** ROUTINE FOR READING/AMENDING DISPLAY INFO. **
2610 PRINT "How many points to be monitored on display ? ";
2620 INPUT M1
2630 IF M1=0 THEN 2730
2640 IF M1<=N THEN 2670
2650 PRINT "GGGTHAT IS MORE THAN THE TOTAL NUMBER !!"
2660 GO TO 2610
2670 IF M1<=12 THEN 2700
2680 PRINT "GGMAXIMUM OF 12 TO FIT IN SCREEN"
2690 GO TO 2610
2700 PRINT "Enter ";M1;" points :"
2710 DIM M(M1)
2720 INPUT M
2730 RETURN
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0
ORIGINAL DATE / REVISION DATE	MEMORY REQUIREMENT: 16K (Option 20)
AUTHOR: Florent van Vlasselaer (TEK Belgium) for Europe Lighting Intl.	PERIPHERALS: Optional: 4631, 4662

ABSTRACT

The program calculates the lighting intensity distribution over a user-specified area. The output is in the form of a grid showing the intensity in the individual squares. Total intensity and average intensity per square are also given.

The user gives the dimensions of the area, position and height of the lamp, its type and strength and the point in the area at which the lamp is directed.

Using a table for that type of lamp, the program calculates the distribution and outputs it in the form of a grid. The grid is labeled and the total intensity and average intensity per square is given. Output on the plotter is optional.

The program was conceived specifically for football fields but can be used for any rectangular area.

Only the table of values for projector type 'D' are given here; the values for projector type 'C' have to be implemented by the user. This type uses a much larger matrix and would need a 32K (Option 22) 4051.

231 Statements plus a 30 x 10 table of values.

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

DESCRIPTION

In order to determine the distribution of the intensity the program requires two kinds of data: parameters input by the operator in response to questions and values read from a table stored on magnetic tape.

The information supplied by the operator gives the dimensions of the area in question, the position and height of the lamp, its type and strength and the point in the area at which the lamp is directed.

The type of lamp determines which table of candlepower values will be loaded from tape.

The program then calculates the distribution (approx. run time 3 minutes) and outputs it in the form of a grid. The lower left hand corner of the grid is the point (10, 10) and each division represents 10 metres.

The picture is labeled and the total intensity and average intensity per square is given. There also exist options to produce output on the plotter and to make additional runs using a different type of projector and different values for strength of lamp and the point the projector is directed at.

TAPE STRUCTURE

Candle power tables must be on the two subsequent files following the program file. The tables are INPUT into a matrix in one operation; the data for file two is shown in Figure 1. The extreme left hand column (70 to -70) and the top row (0 to 80) represent angles. The value of 10,000 is a dummy one and is there to fill up the matrix in order to make the index addressing simple.

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

OPERATING INSTRUCTIONS

1. Load the program and run.

2. A message will appear saying what the program is - operator responds by pressing RETURN key.

3. A list of requests will appear to which the operator responds by entering the values and pressing RETURN key. These requests are as follows:

Enter the length	(L 1 - in metres)
Enter the width	(L 2 - in metres)
Enter position, height of post	(X1,Y1,HO
Type of projector	(C or D)*
Strength of lamp	(P)
Aiming point	(T1,T2)

4. A message appears saying that the program is running (Run time is approx. 3 minutes).

5. When the calculations are complete the operator is asked if output is to be on the screen or the plotter - after the operator's response the grid is drawn.

6. A question appears asking if a copy should be made on the plotter.

7. The last question asks if any supplementary runs are to be made.

* Unless the table of values for "C" type has been input by the user, this must be answered with "D".

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

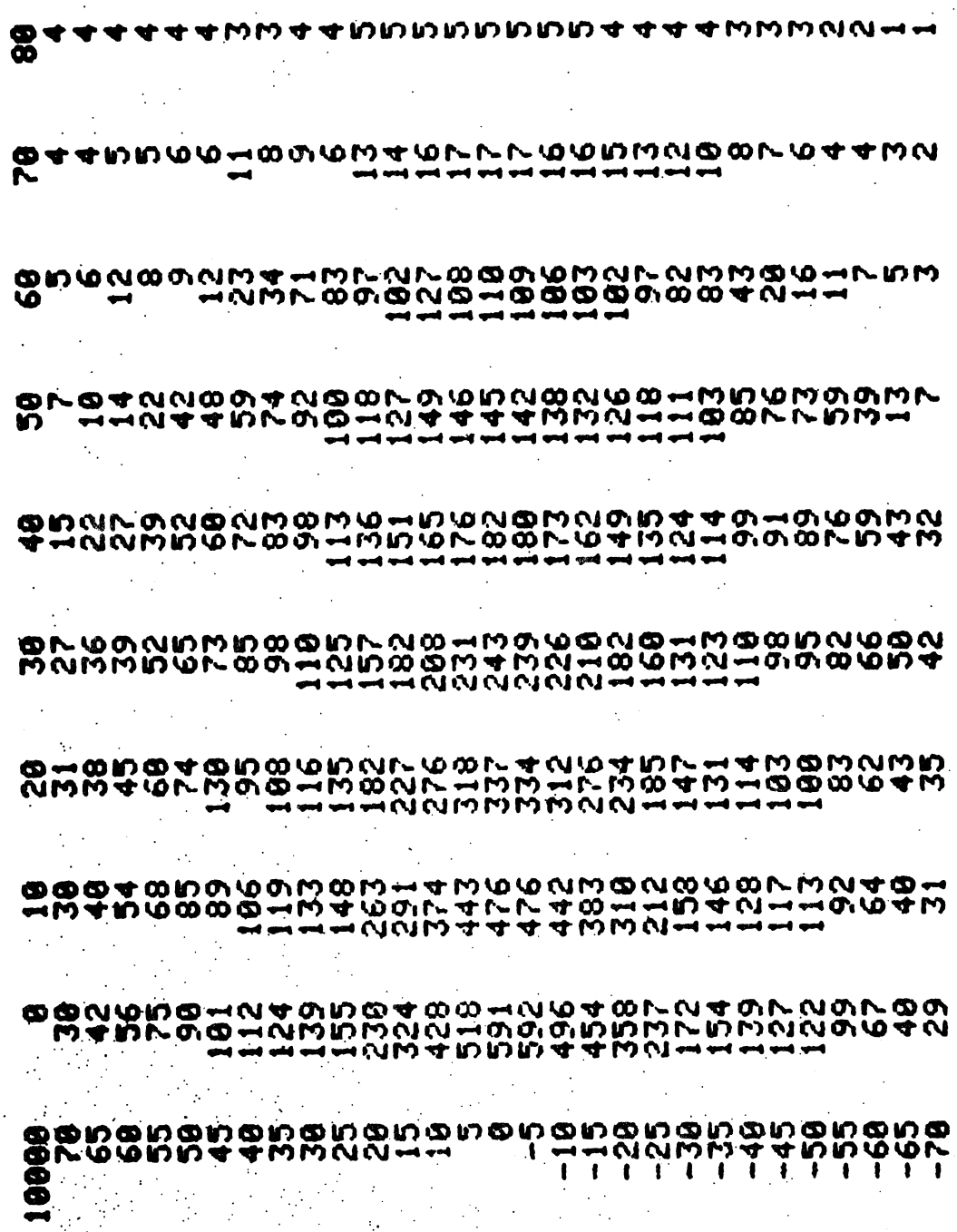


FIGURE 1

TITLE

LIGHTING INTENSITY DISTRIBUTION

ABSTRACT NO:

51/00-3301/0

APPLICATION PROGRAM

Calculation of lighting distribution

```
ENTER LENGTH (L1- in metres )..................= 100
ENTER WIDTH (L2- in metres ) ..................= 60
ENTER POSITION, HEIGHT OF POST (X1,Y1,H) .....= 45*5*20
TYPE OF PROJECTOR..............................= d
STRENGTH OF LAMP (P) ..........................= 190
AIMING POINT (T1,T2)...........................= 30*30

THE PROGRAM IS RUNNING !

DO YOU WANT THE OUTPUT ON THE SCREEN OR THE PLOTTER ?
ENTER S FOR THE SCREEN OR P FOR THE PLOTTER s
```

EUROPE LIGHTING
Brussels.

FOOTBALL GROUND 60 M X 100 M.

Total intensity ....= 762.4
Arithmetic mean ....= 9.9

2.2	2.7	2.6	2.4	2.1	1.8	1.5	1.1	0.6	0.3	0.1
3.4	4.3	4.7	4.2	3.6	2.8	2.1	1.4	0.6	0.1	0.1
5.2	8.1	9.4	8.5	6.5	4.6	2.9	1.5	0.4	0.1	0.0
7.9	15.1	20.8	18.5	12.7	7.4	4.1	1.6	0.2	0.1	0.0
10.2	24.0	50.8	45.2	23.4	11.3	5.0	0.5	0.1	0.0	0.0
11.1	26.4	67.8	80.4	33.6	13.8	2.4	0.1	0.0	0.0	0.0
9.6	20.2	40.1	57.1	38.9	10.3	0.0	0.0	0.0	0.0	0.0

aim

lamp

copy on the plotter ?
#yes# or #no# = NO

TITLE
LIGHTING INTENSITY DISTRIBUTION

ABSTRACT NO:
51/00-3301/0

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000-6405-02

TEKTRONIX 4051 PROGRAM

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

DO YOU WANT TO MAKE A FURTHER CALCULATION ?

REPLY BY #yes# or #no# = YES

```
TYPE OF PROJECTOR.............................= D

STRENGTH OF LAMP (P) .........................= 200

AIMING POINT (T1,T2)..........................= 50*80

THE PROGRAM IS RUNNING !

DO YOU WANT THE OUTPUT ON THE SCREEN OR THE PLOTTER ?
ENTER S FOR THE SCREEN OR P FOR THE PLOTTER S
```

000-6405-02

EUROPE LIGHTING
Brussels.

FOOTBALL GROUND 60 M X 100 M.

Total intensity ....= 1380.0
Arithmetic mean ....= 17.9

aim

4.3	5.9	7.2	8.7	9.4	7.5	5.5	3.8	2.4	1.5	0.9
6.1	8.4	11.3	14.1	15.0	11.2	7.3	4.7	2.7	1.5	1.0
8.4	13.4	18.6	23.5	23.1	16.6	9.9	5.5	2.9	1.7	1.1
11.7	21.9	33.0	41.3	38.1	23.3	12.6	6.2	2.9	1.8	1.1
14.5	31.9	65.8	71.6	54.5	29.1	14.4	5.5	2.9	1.7	1.0
13.3	34.3	85.0	110.8	66.5	33.0	12.4	5.2	2.5	1.1	0.5
9.9	21.5	51.8	79.9	65.5	27.0	6.2	1.2	0.3	0.1	0.1

lamp

copy on the plotter ?
#yes# or #no# = NO

TITLE
LIGHTING INTENSITY DISTRIBUTION

ABSTRACT NO: 51/00-3301/0

PAGE NO: 8

TEKTRONIX 4051 PROGRAM

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

DO YOU WANT TO MAKE A FURTHER CALCULATION ?

REPLY BY #yes# or #no# = NO

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
100 INIT
105 PRINT "WHAT IS THE FILE NUMBER OF THIS PROGRAM? ";
106 INPUT N1
110 PAGE
120 PRINT @32,26:1
140 O=32
150 SET DEGREES
155 REM  51/00-3301/0 *** LIGHTING INTENSITY DISTRIBUTION ***
156 REM  Author: Florent van Vlasselaer, Belgium
160 PRINT "          A P P L I C A T I O N  P R O G R A M           "
170 PRINT "          ------------------------------------          "
180 PRINT USING "/10X42AS":"Calculation of lighting distribution    "
190 INPUT P$
200 PRINT USING "5/":
210 PRINT "ENTER LENGTH (L1- in metres )..................= G";
220 INPUT L1
230 PRINT
240 PRINT "ENTER WIDTH (L2- in metres ) ..................= G";
250 INPUT L2
260 WINDOW 0,L1+20,0,(L2+20)*130/100
270 DIM R(L2/10+1,L1/10+1),R1(L2/10+1,L1/10+1)
280 R1=0
290 PRINT "JENTER POSITION, HEIGHT OF POST (X1,Y1,H) .....= G";
300 INPUT X1,Y1,H
310 REM ** RE-ENTRY **
320 PRINT "JTYPE OF PROJECTOR.............................= G";
330 INPUT P$
340 IF P$="D" THEN 370
350 IF P$="C" THEN 420
360 GO TO 320
370 DELETE D
380 DIM D(30,10)
390 FIND N1+1
400 INPUT @33:D
410 GO TO 460
420 DELETE C
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
430 DIM C(500,2)
440 FIND N1+2
450 INPUT @33:C
460 PRINT "JSTRENGTH OF LAMP (P) .....................= G";
470 INPUT P
480 PRINT "JAIMING POINT (T1,T2).....................= G";
490 INPUT T1,T2
500 PRINT "JJTHE PROGRAM IS RUNNING !GGG"
510 A9=ATN(SQR((T1-X1)↑2+(T2-Y1)↑2)/H)
520 X5=1
530 Y5=1
540 R=0
550 FOR Y2=L2+10 TO 10 STEP -10
560     FOR X2=10 TO L1+10 STEP 10
570         GOSUB 1140
580         X5=X5+1
590     NEXT X2
600     Y5=Y5+1
610     X5=1
620 NEXT Y2
630 R1=R1+R
640 PRINT "GGJJDO YOU WANT THE OUTPUT ON THE SCREEN OR THE PLOTTER ?"
650 PRINT "ENTER S FOR THE SCREEN OR P FOR THE PLOTTER ";
660 INPUT P$
670 IF P$="P" THEN 730
680 IF P$="S" THEN 710
690 PAGE
700 GO TO 640
710 O=32
720 GO TO 750
730 WINDOW 0,130,0,100
735 PRINT @1,17:2,2
740 O=1
750 GOSUB 1750
760 HOME @O:
770 MOVE @O:70,90
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
780 PRINT @0: USING "22A4D.1D":"Total intensity ....= ";SUM(R1)
790 MOVE @0:70,86
800 PRINT @0: USING "22A3D.1D":"Arithmetic mean ....= ";SUM(R1)/77
810 MOVE @0:0,96
820 PRINT @0,17:3,3
830 PRINT @0:" EUROPE LIGHTING"
840 PRINT @0:" Brussels."
850 PRINT @0,17:2,2
860 MOVE @0:0,100
870 RDRAW @0:50,0
880 RDRAW @0:0,-10
890 RDRAW @0:-50,0
900 RDRAW @0:0,10
910 MOVE @0:0,10
920 O=32
930 WINDOW 0,L1+20,0,(L2+20)*130/100
940 MOVE 0,6
950 PRINT "copy on the plotter ?"
960 PRINT "#yes# or #no# = GGGG";
970 INPUT P$
980 IF P$="yes" THEN 730
990 IF P$="NO" THEN 1020
1000 MOVE 0,0
1010 GO TO 950
1020 PRINT @32,26:0
1030 PAGE
1040 PRINT "DO YOU WANT TO MAKE A FURTHER CALCULATION ?G"
1050 PRINT "JREPLY BY #yes# or #no# = GGGG";
1060 INPUT P$
1070 IF P$="yes" THEN 1100
1080 IF P$="NO" THEN 1120
1090 GO TO 1020
1100 PAGE
1110 GO TO 320
1120 PAGE
1130 END
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
1140 REM ** calculate the luminosity **
1150 A1=(T1-X1)↑2+(T2-Y1)↑2+(X2-X1)↑2+(Y2-Y1)↑2-(X2-T1)↑2-(Y2-T2)↑2
1160 A1=A1/(2*SQR((T1-X1)↑2+(T2-Y1)↑2)*SQR((X2-X1)↑2+(Y2-Y1)↑2)) MIN 1
1165 A1=ACS(A1)
1170 A2=ATN(SQR((X2-X1)↑2+(Y2-Y1)↑2)/H)
1180 A3=ABS(ASN(SIN(A2)*SIN(A1)))
1190 A3=INT(A3+0.5)
1200 IF A3<=80 THEN 1220
1210 RETURN
1220 A4=ATN(COS(A1)*TAN(A2))-A9
1230 A4=INT(A4+0.5)
1240 IF A4<=70 AND A4=>-70 THEN 1260
1250 RETURN
1260 FOR I=2 TO 10
1270     IF D(1,I)=A3 THEN 1540
1280 NEXT I
1290 FOR I=2 TO 30
1300     IF D(I,1)=A4 THEN 1670
1310 NEXT I
1320 REM ** INTERPOLATION  **
1330 FOR I=2 TO 10
1340     IF D(1,I)>A3 THEN 1360
1350 NEXT I
1360 Z2=I
1370 Z3=I-1
1380 FOR I=2 TO 30
1390     IF D(I,1)<A4 THEN 1410
1400 NEXT I
1410 Z4=I-1
1420 Z5=I
1430 K=D(Z4,Z3)
1440 L=D(Z4,Z2)
1450 M=D(Z5,Z3)
1460 N=D(Z5,Z2)
1470 G1=K-(K-L)/10*(A3-D(1,Z3))
1480 G2=M-(M-N)/10*(A3-D(1,Z3))
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
1490 G3=G1-(G2-G1)/5*(A4-D(Z4,1))
1500 F=G3
1510 E=F*P*COS(A2)↑3/H↑2
1520 R(Y5,X5)=E
1530 RETURN
1540 Z6=I
1550 FOR I=2 TO 30
1560     IF D(I,1)=A4 THEN 1650
1570 NEXT I
1580 FOR I=2 TO 30
1590     IF D(I,1)<A4 THEN 1610
1600 NEXT I
1610 K=D(I-1,Z6)
1620 M=D(I,Z6)
1630 G3=K-(M-K)/5*(A4-D(I-1,1))
1640 GO TO 1500
1650 G3=D(I,Z6)
1660 GO TO 1500
1670 Z7=I
1680 FOR I=2 TO 10
1690     IF D(1,I)>A3 THEN 1710
1700 NEXT I
1710 K=D(Z7,I-1)
1720 L=D(Z7,I)
1730 G3=K-(K-L)/10*(A3-D(1,I-1))
1740 GO TO 1500
1750 PAGE
1760 MOVE @0:60,96
1770 PRINT @0,17:1.7,2
1780 PRINT @0:"FOOTBALL GROUND";
1790 MOVE @0:60,94
1800 PRINT @0:"---------------";
1810 MOVE @0:95,96
1820 PRINT @0: USING "3D5A3D3A":L2;" M X ";L1;" M."
1830 MOVE @0:10,10
1840 RDRAW @0:0,L2
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-3301/0

```
1850 RDRAW @0:L1,0
1860 RDRAW @0:0,-L2
1870 RDRAW @0:-L1,0
1880 FOR I=20 TO L2 STEP 10
1890      MOVE @0:10,I
1900      GOSUB 1970
1910 NEXT I
1920 FOR I=20 TO L1 STEP 10
1930      MOVE @0:I,10
1940      GOSUB 2040
1950 NEXT I
1960 GO TO 2110
1970 REM **  EXIT GRID **
1980 FOR I1=10 TO L1 STEP 10
1990      RMOVE @0:3/2,0
2000      RDRAW @0:7,0
2010      RMOVE @0:3/2,0
2020 NEXT I1
2030 RETURN
2040 REM ** EXIT GRID **
2050 FOR I1=10 TO L2 STEP 10
2060      RMOVE @0:0,3/2
2070      RDRAW @0:0,7
2080      RMOVE @0:0,3/2
2090 NEXT I1
2100 RETURN
2110 MOVE @0:X1,Y1
2120 PRINT @0,18:5
2130 PRINT @0:"¦"
2140 MOVE @0:T1,T2
2150 PRINT @0:"¦"
2160 PRINT @0,18:0
2170 MOVE @0:X1,Y1
2180 DRAW @0:T1,T2
2190 PRINT @0:"J aim"
2200 MOVE @0:X1,Y1
```

TITLE	ABSTRACT NO:
LIGHTING INTENSITY DISTRIBUTION	51/00-330170

```
2210 PRINT @0:" lamp"
2220 X=1
2230 Y=1
2240 PRINT @0,17:1.5,2
2250 FOR I=L2+10 TO 10 STEP -10
2260     FOR I1=10 TO L1+10 STEP 10
2270         MOVE @0:I1+0.5,I+0.5
2280         PRINT @0: USING "3D.1D":R1(X,Y)
2290         Y=Y+1
2300     NEXT I1
2310     Y=1
2320     X=X+1
2330 NEXT I
2340 PRINT @0,17:1.5,2
2350 RETURN
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0
ORIGINAL DATE: 10/77 / REVISION DATE:	MEMORY REQUIREMENT: 8K
AUTHOR: Adapted by: Dr. P. C. Holman	PERIPHERALS: 4631 Hard Copy Unit Optional

ABSTRACT

Problem Solving in Physical Chemistry by Roland R. Roskos
Publisher: West Publishing Company
Computers, BASIC, and Physics by Herbert D. Peckham
Publisher: Addison-Wesley Publishing Company

Two textbooks emphasize the use of computers for problem solving in the sciences of chemistry and physics. Both employ BASIC as the language. Dr. Holman and students have modified programs from the books to run on the 4051. Programs can be used to solve common types of problems in these branches of the science. It saves student time normally used keying in programs for use in studies.

12 programs from chemistry; 34 programs from physics. Only listings are available (written and/or tape). Documentation is available in the source textbooks. Both books are summarized in TEKniques Vol. 2 No. 1.

Permission to include materials from these texts was graciously granted by the publisher of each.

Statements: 1135 and 2141 respectively.

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

FILE STRUCTURE

49 files encompass these two textbooks. The first 13 files are from Problem Solving in Physical Chemistry; files 14 through 49 are from Computers, BASIC, and Physics.

File 1 of the first 13 contains the menu for problems from the Chemistry textbook. Recode line 300 to reflect correct file numbers on the tape.

File 14 is the introduction to the Physics textbook and appends file 15 for the menu. Recode line 101 in file 14 and line 4740 in file 15 to reflect correct file numbers on the tape. Also, the following line numbers in the sequential files in the second program return to file 15 and will have to be recoded if they (and file 15) occupy different files on the tape:

File #	Line #	File #	Line #	File #	Line #	File #	Line #
16	480	24	510	32	490	41	600
17	560	25	370	33	570	42	630
18	590	26	560	34	460	43	630
19	730	27	450	35	400	44	360
20	580	28	510	36	620	45	460
21	450	29	470	37	330	46	450
22	660	30	410	38	420	47	350
23	520	31	440	39	380	48	510
				40	460	49	600

OPERATING INSTRUCTIONS

FINd file 1 for the Chemistry textbook and OLD. The program is tutorial. However, once the problem is finished, you will have to FINd file 1 again for the menu and OLD.

FINd file 14 for the Physics textbook and OLD. The program is tutorial and upon completion of the problem chosen will return you to the menu in file 15.

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
1 REM *** 51/00-5201/0 ***
2 REM ROSKOS TEXTBOOK
3 REM EDITOR: DR. P.C. HOLMAN

100 INIT
200 PAGE
250 W=250
256 V=150
300 DATA 2,3,4,5,6,7,8,9,10,11,12,13
400 DIM N(12)
500 READ N
550 GOSUB 5000
555 PRINT "GGGGGGGGGGGGGGGGGG"
560 PRINT
600 PRINT "                 ****   ** *** ***  ******  ******  *****  "
700 PRINT "                ****** **** *** **  ******  ******  ******  "
800 PRINT "                **  **  *** *** **    **      **    **  **  "
900 PRINT "                **  **  **  **  **    **      **    **  **  "
1000 PRI "                ** **  **  **  **    **      **    ** **   "
1100 PRI "                ******  **  **  **  ******  ******  ** **   "
1200 PRI "                 ****  ***  **  **  ******  ****** ***  **  "
1300 PRINT
1400 PRINT "                        S O F T W A R E   S Y S T E M  "
1500 PRINT
1550 FOR I=1 TO W
1560 NEXT I
1570 PRINT USING 1575:
1575 IMAGE 19X,"*** ",S
1580 LET A$="ROSKOS'"
1590 GOSUB 8000
1595 PRINT "-- ";
1597 LET A$="PHYSICAL "
1598 GOSUB 8000
1600 LET A$="CHEMISTRY"
1610 GOSUB 8000
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
1620 PRINT " ***"
1700 PRINT
1750 FOR I=1 TO W
1760 NEXT I
1800 PRINT "                          PROGRAM   PAGE   TITLE "
1900 PRINT "                          =======   ====   ===== "
2000 PRINT "                             1       25    CHM VANDWALL "
2100 PRINT "                             2       34    CHM PLOT"
2200 PRINT "                             3       39    CHM COMNT"
2300 PRINT "                             4       44    CHM AREA"
2400 PRINT "                             5       54    CHM ARRAY"
2500 PRINT "                             6       56    CHM SLINT"
2600 PRINT "                             7       58    CHM LINEQ"
2700 PRINT "                             8       67    CHM POLEQ"
2800 PRINT "                             9       77    CHM ROOTS"
2900 PRINT "                            10       99    CHM ELEVL"
3000 PRINT "                            11      122    CHM GFORRX"
3100 PRINT "                            12      155    CHM RATES"
3200 PRINT
3300 PRINT "                  ENTER THE PROGRAM YOU WANT: ";
3400 INPUT IO
3500 IF IO<0.5 OR IO=>12.5 THEN 3300
3600 FIND N(IO)
3700 OLD
5000 MOVE 59,99
5010 DRAW 61,99
5020 MOVE 60,99
5030 DRAW 60,97
5050 MOVE 64,99
5060 DRAW 64,97
5070 MOVE 66,99
5080 DRAW 66,97
5090 MOVE 64,98
5100 DRAW 66,98
5110 MOVE 71,99
5120 DRAW 69,99
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
5130 DRAW 69,97
5140 DRAW 71,97
5150 MOVE 69,98
5160 DRAW 71,98
5170 FOR I=1 TO V
5180 NEXT I
5190 MOVE 0,95
5200 DRAW 0,92
5210 DRAW 2,92
5220 DRAW 2,95
5230 MOVE 4,92
5240 DRAW 4,95
5250 DRAW 6,92
5260 DRAW 6,95
5270 MOVE 8,92
5280 DRAW 8,95
5290 MOVE 10,95
5300 DRAW 11,92
5310 DRAW 12,95
5320 MOVE 16,95
5330 DRAW 14,95
5340 DRAW 14,92
5350 DRAW 16,92
5360 MOVE 14,93
5370 DRAW 15,93
5380 MOVE 18,92
5390 DRAW 18,95
5400 DRAW 20,95
5410 DRAW 20,94
5420 DRAW 18,94
5430 DRAW 20,92
5440 MOVE 24,94
5450 DRAW 24,95
5460 DRAW 22,95
5470 DRAW 22,94
5480 DRAW 24,93
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
5490 DRAW 24,92
5500 DRAW 22,92
5510 DRAW 22,93
5520 MOVE 26,95
5530 DRAW 26,92
5540 MOVE 28,95
5550 DRAW 29,95
5560 DRAW 29,92
5570 DRAW 29,95
5580 DRAW 30,95
5590 MOVE 32,95
5600 DRAW 33,93
5610 DRAW 33,92
5620 DRAW 33,93
5630 DRAW 34,95
5640 MOVE 38,95
5650 DRAW 38,92
5660 DRAW 40,92
5670 DRAW 40,95
5680 DRAW 38,95
5690 MOVE 44,95
5700 DRAW 42,95
5710 DRAW 42,94
5720 DRAW 43,94
5730 DRAW 42,94
5740 DRAW 42,92
5750 MOVE 48,95
5760 DRAW 48,92
5770 DRAW 50,92
5780 DRAW 50,95
5790 MOVE 49,92
5800 DRAW 49,94
5810 MOVE 52,95
5820 DRAW 52,92
5830 MOVE 56,94
5840 DRAW 56,95
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
5850 DRAW 54,95
5860 DRAW 54,94
5870 DRAW 56,93
5880 DRAW 56,92
5890 DRAW 54,92
5900 DRAW 54,93
5910 MOVE 60,95
5920 DRAW 58,95
5930 DRAW 58,92
5940 DRAW 60,92
5950 MOVE 64,95
5960 DRAW 62,95
5970 DRAW 62,92
5980 DRAW 64,92
5990 DRAW 64,95
6000 MOVE 66,92
6010 DRAW 66,95
6020 DRAW 68,92
6030 DRAW 68,95
6040 MOVE 72,94
6050 DRAW 72,95
6060 DRAW 70,95
6070 DRAW 70,94
6080 DRAW 72,93
6090 DRAW 72,92
6100 DRAW 70,92
6110 DRAW 70,93
6120 MOVE 74,95
6130 DRAW 74,92
6140 MOVE 76,92
6150 DRAW 76,95
6160 DRAW 78,92
6170 DRAW 78,95
6180 MOVE 80,93
6190 DRAW 82,93
6200 MOVE 86,94
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
6210 DRAW 86,95
6220 DRAW 84,95
6230 DRAW 84,94
6240 DRAW 86,93
6250 DRAW 86,92
6260 DRAW 84,92
6270 DRAW 84,93
6280 MOVE 88,95
6290 DRAW 90,95
6300 MOVE 89,95
6310 DRAW 89,92
6320 MOVE 94,95
6330 DRAW 92,95
6340 DRAW 92,92
6350 DRAW 94,92
6360 MOVE 92,93
6370 DRAW 93,93
6380 MOVE 96,95
6390 DRAW 97,92
6400 DRAW 98,95
6410 MOVE 102,95
6420 DRAW 100,95
6430 DRAW 100,92
6440 DRAW 102,92
6450 MOVE 100,93
6460 DRAW 101,93
6470 MOVE 104,92
6480 DRAW 104,95
6490 DRAW 106,92
6500 DRAW 106,95
6510 MOVE 110,94
6520 DRAW 110,95
6530 DRAW 108,95
6540 DRAW 108,94
6550 DRAW 110,93
6560 DRAW 110,92
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
6570 DRAW 108,92
6580 DRAW 108,93
6590 MOVE 114,92
6600 DRAW 114,95
6610 DRAW 116,95
6620 DRAW 116,94
6630 DRAW 114,94
6640 MOVE 120,95
6650 DRAW 118,95
6660 DRAW 118,92
6670 DRAW 120,92
6680 DRAW 120,95
6690 MOVE 122,95
6700 DRAW 122,92
6710 MOVE 124,92
6720 DRAW 124,95
6730 DRAW 126,92
6740 DRAW 126,95
6750 MOVE 128,95
6760 DRAW 130,95
6770 MOVE 129,95
6780 DRAW 129,92
6790 FOR I=1 TO V
6800 NEXT I
6810 MOVE 53,87
6820 DRAW 53,90
6830 DRAW 55,90
6840 DRAW 55,89
6850 DRAW 53,89
6860 MOVE 57,87
6870 DRAW 57,90
6880 DRAW 59,90
6890 DRAW 59,89
6900 DRAW 57,89
6910 DRAW 59,87
6920 MOVE 63,90
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
6930 DRAW 61,90
6940 DRAW 61,87
6950 DRAW 63,87
6960 MOVE 61,88
6970 DRAW 62,88
6980 MOVE 67,89
6990 DRAW 67,90
7000 DRAW 65,90
7010 DRAW 65,89
7020 DRAW 67,88
7030 DRAW 67,87
7040 DRAW 65,87
7050 DRAW 65,88
7060 MOVE 71,90
7070 DRAW 69,90
7080 DRAW 69,87
7090 DRAW 71,87
7100 MOVE 69,88
7110 DRAW 70,88
7120 MOVE 73,87
7130 DRAW 73,90
7140 DRAW 75,87
7150 DRAW 75,90
7160 MOVE 77,90
7170 DRAW 79,90
7180 MOVE 78,90
7190 DRAW 78,87
7200 MOVE 83,89
7210 DRAW 83,90
7220 DRAW 81,90
7230 DRAW 81,89
7240 DRAW 83,88
7250 DRAW 83,87
7260 DRAW 81,87
7270 DRAW 81,88
7280 FOR I=1 TO W
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
7290 NEXT I
7300 RETURN
8000 FOR I=1 TO 5
8010     PRINT A$;
8020     FOR J=1 TO LEN(A$)
8030         PRINT USING 8040:
8040         IMAGE "H",S
8050     NEXT J
8060 NEXT I
8070 FOR K=1 TO LEN(A$)
8080     PRINT " ";
8090 NEXT K
8100 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM (CHMVANDWALL #191) * JANET GROSSKOPF

120 PAGE
130 PRINT "VAN DER WAALS EQUATION"
140 PRINT "SOLVES FOR PRESSURE OF NITROGEN"
150 PRINT
160 PRINT "V1,P1, AND T1 ARE CRITICAL CONSTANTS"
170 LET V1=0.09
180 LET P1=33.5
190 LET T1=126.1
200 LET N=0.5
205 PRINT
210 PRINT "WHAT IS THE TEMPERATURE? ";
220 INPUT T
230 PRINT
240 LET B=1/3*V1
250 LET A=3*P1*V1↑2
260 LET R=8*P1*V1/(3*T1)
280 FOR V=0.2 TO 2 STEP 0.2
290     LET P=N*R*T/(V-N*B)-A*N↑2/V↑2
300     PRINT V,P
310 NEXT V
320 END
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM (CHMPLOT #192) * JANET GROSSKOPF

120 PAGE
130 LET A=-0.00723
140 LET B=1.5E-5
150 LET C=4.02E-9
160 DEF FNF(X)=1+A*X+B*X↑2+C*X↑3
170 DIM Z(1000),P(4)
180 PRINT "WHERE DO YOU WISH TO BEGIN THE"
190 PRINT "EVALUATION OF THE CONTINUOUS FUNCTION? ";
200 INPUT X1
210 PRINT
220 PRINT "AT WHICH POINT DO YOU WISH TO STOP THE EVALUATION? ";
230 INPUT X2
240 PRINT
250 PRINT "HOW MANY SEGMENTS IN THE X-INTERVAL? ";
260 INPUT N9
270 PRINT
280 PRINT "DO YOU WANT A LISTING OF THE VALUES? (1=YES,0=NO) ";
290 INPUT G1
300 PAGE
310 PRINT "X-VALUES                                  *** Y - AXIS ***"
320 PRINT " BELOW"
330 LET M1=-1.0E+37
340 LET M2=1.0E+37
350 LET D1=(X2-X1)/N9
360 FOR I9=1 TO N9+1
370     LET X3=X1+(I9-1)*D1
380     LET Z(I9)=FNF(X3)
390     IF Z(I9)=>M2 THEN 410
400     LET M2=Z(I9)
410     IF Z(I9)<=M1 THEN 430
420     LET M1=Z(I9)
430 NEXT I9
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 LET P(1)=M2
450 LET P(2)=M2+18*(M1-M2)/56
460 LET P(3)=M2+36*(M1-M2)/56
470 LET P(4)=M2+54*(M1-M2)/56
480 PRINT USING 490:P(1),P(2),P(3),P(4)
490 IMAGE 10T,-3D.6D,27T,-3D.6D,43T,-3D.6D,60T,-3D.6D
500 FOR I9=1 TO 72
510     IF I9=16 THEN 570
520     IF I9=34 THEN 570
530     IF I9=52 THEN 570
540     IF I9=68 THEN 570
550     PRINT "-";
560     GO TO 580
570     PRINT "Y";
580 NEXT I9
590 LET Z1=INT(-M2*56/(M1-M2)+1.5)+15
600 FOR I9=1 TO N9+1
610     LET S2=X1+(I9-1)*D1
620     PRINT USING 630:S2
630     IMAGE 3D,16T,S
640     LET Y1=INT(56*(Z(I9)-M2)/(M1-M2)+1.5)+15
650     LET T1=ABS(S2)-D1*0.5
660     FOR J9=16 TO 72
670         IF Y1=J9 THEN 750
680         IF Z1=J9 THEN 770
690         IF T1<0 THEN 790
700         IF J9<=Y1 THEN 730
710         IF J9<=Z1 THEN 730
720         GO TO 820
730         PRINT " ";
740         GO TO 800
750         PRINT "+";
760         GO TO 800
770         PRINT "0";
780         GO TO 800
790         PRINT "Y";
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
800     NEXT J9
810     GO TO 830
820     PRINT
830 NEXT I9
840 IF G1=0 THEN 960
850 FOR I9=1 TO 5
860     PRINT
870 NEXT I9
880 PRINT "TO CONTINUE PRESS`RETURN'"
890 INPUT Z$
900 PAGE
910 PRINT "X-VALUE","Y-VALUE"
920 FOR I9=1 TO N9+1
930     LET X3=X1+(I9-1)*D1
940     PRINT X3,Z(I9)
950 NEXT I9
960 END
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1 INIT

2 REM (CHMCOMNT #190) * JANET GROSSKOPF

3 PAGE

10 REM THIS PROGRAM USES THE IDEAL GAS EQUATION
30 REM R*V=N*R*T
50 REM TO CALCULATE THE VOLUME OF A GAS AT VARIOUS
60 REM PRESSURES AND AT A SPECIFIED TEMPERATURE

90 LET R=0.08206
100 PRINT "WHAT IS THE TEMPERATURE IN DEGREES CENTIGRADE ";
110 INPUT T
120 PRINT "WHAT IS THE NUMBER OF MOLES ";
130 INPUT N
140 PRINT "THE ABSOLUTE TEMPERATURE IS ";
150 LET T=T+273.15
160 PRINT T
170 PRINT "THE GAS CONSTANT IS ";R
180 PRINT
190 PRINT
200 PRINT "PRESSURE","VOLUME"
210 FOR P=1 TO 10
220     LET V=N*R*T/P
230     PRINT P,V
240 NEXT P
250 END
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
470 LET A=6.214
480 LET B=0.010396
490 LET C=-3.545E-6
500 DEF FNF(X)=A+B*X+C*X↑2
510 PRINT "WHAT IS THE LOWER LIMIT OF INTEGRATION ";
520 INPUT S1
530 PRINT
540 PRINT "WHAT IS THE UPPER LIMIT OF INTEGRATION ";
550 INPUT S2
560 PRINT
570 PRINT "HOW MANY SEGMENTS IN THE INTERVAL ";
580 INPUT N9
590 PRINT
600 IF N9<=2 THEN 630
610 IF INT(N9/2)*2<>N9 THEN 640
620 GO TO 660
630 PRINT
640 PRINT "THIS MUST BE A NUMBER GREATER THAN 2 AND EVEN."
650 GO TO 560
660 PRINT "THE VALUE OF THE INTERGRAL IS ";
670 H8=(S2-S1)/N9
680 S3=0
690 S4=0
700 FOR I9=2 TO N9-2 STEP 2
710     S3=S3+FNF(S1+(I9-1)*H8)
720     S4=S4+FNF(S1+I9*H8)
730 NEXT I9
740 H9=H8/3*(4*(S3+FNF(S1+(N9-1)*H8))+2*S4+FNF(S1)+FNF(S2))
750 PRINT H9
760 FOR I9=1 TO 4
770     PRINT
780 NEXT I9
790 PRINT "DO YOU WISH TO USE MORE SEGMENTS, (1=YES, 0=NO) ";
800 INPUT D9
810 IF D9=1 THEN 560
820 END
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM (CHMARRAYS #194) * JANET GROSSKOPF

120 PAGE
130 PRINT "THE PROGRAM WILL READ 6 X-Y DATA POINTS; IT WILL CALCULATE"
140 PRINT "THE PRODUCT OF EACH OF THE X-Y DATA POINTS AND STORE EACH"
150 PRINT "PRODUCT TERM IN AN ARRAY Z; AND IT WILL ALSO SUM THE POINTS"
160 PRINT "IN EACH ARRAY."
170 DIM X(20),Y(20),Z(20)
180 LET X1=0
190 LET Y1=0
200 LET Z1=0
210 READ N
220 FOR I=1 TO N
230     READ X(I),Y(I)
240 NEXT I
250 FOR J=1 TO N
260     LET Z(J)=X(J)*Y(J)
270 NEXT J
280 FOR K=1 TO N
290     LET X1=X1+X(K)
300     LET Y1=Y1+Y(K)
310     LET Z1=Z1+Z(K)
320 NEXT K
330 PRINT
340 PRINT X1,Y1,Z1
350 DATA 6
360 DATA 0,1.1
370 DATA 1,1.9
380 DATA 2,3
390 DATA 3,4.1
400 DATA 4,4.9
410 DATA 5,6
420 END
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM(CHMSLINT #195) * JANET GROSSKOPF

120 PAGE
130 PRINT "THIS PROGRAM CALCULATES THE BEST SLOPE AND INTERCEPT FOR"
140 PRINT "A LEAST SQUARES LINE FIT ON A SET OF DATA POINTS"
145 PRINT
160 DATA 7
170 DATA 0.5,4
180 DATA 0.333333,5
190 DATA 0.25,6
200 DATA 0.2,7
210 DATA 0.166667,8
220 DATA 0.14285,9
230 DATA 0.125,10
240 DIM X(20),Y(20)
250 LET A=0
260 LET C=0
270 LET D=0
280 LET E=0
290 READ N
300 FOR I=1 TO N
310     READ X(I),Y(I)
320     GOSUB 460
330     LET A=A+X(I)
340     LET C=C+Y(I)
350     LET D=D+X(I)↑2
360     LET E=E+Y(I)*X(I)
370 NEXT I
380 LET F=A*C
390 LET G=A↑2
400 LET H=C*D
410 LET M=(N*E-F)/(N*D-G)
420 LET B=(D*C-A*E)/(N*D-G)
430 PRINT "THE SLOPE IS ";M
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
435 PRINT
440 PRINT "THE INTERCEPT IS ";B
450 GO TO 470
460 LET X(I)=1/X(I)
470 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM (CHEM-LINEQ) # 196) * JANET GROSSKOPF

120 PAGE
130 PRINT "THE PROGRAM CHEM-LINEQ BEST FITS EXPERIMENTAL DATA WITH A"
140 PRINT "STRAIGHT LINE BY THE LEAST SQUARES METHOD. EXPERIMENTAL"
150 PRINT "X-Y DATA POINTS ARE FED INTO THE COMPUTER PROGRAM AND THE"
160 PRINT "COMPUTER OUTPUTS THE SLOPE AND INTERCEPT OF THE BEST-FIT"
170 PRINT "LINE. THE COMPUTER ALSO DETERMINES THE STANDARD DEVIATIONS"
180 PRINT "FOR THE SLOPE AND INTERCEPT. IT CALCULATES A CORRELATION"
190 PRINT "COEFFICIENT AND PRINTS OUT A DIFFERENCE TABLE."
200 PRINT
210 DATA 7
220 DATA 0.5,4
230 DATA 0.333,5
240 DATA 0.25,6
250 DATA 0.2,7
260 DATA 0.1667,8
270 DATA 0.1428,9
280 DATA 0.125,10

500 REM FIRST DATA STATEMENT IS NUMBER OF POINTS
510 REM THEN THE POINTS ARE TYPED IN WITH THE
520 REM X-VALUES AND Y-VALUE SEPARATED BY COMMAS
530 REM

540 DIM R(100),H(100),K(100),Y(100),Z(100),Q(100),X(100)
550 READ N
560 PRINT
570 PRINT "TYPE EQUATION NUMBER OR ZERO (0.) FOR HELP ";
580 INPUT H9
590 IF H9=0 THEN 650
600 IF H9<1 THEN 630
610 IF H9>7 THEN 630
620 GO TO 890
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
630 PRINT "NUMBER MUST BE BETWEEN 1 AND 5"
640 GO TO 560
650 PRINT
660 PRINT "THESE ARE THE LINEAR TRANSFORMABLE EQUATIONS THAT"
670 PRINT "YOU HAVE TO CHOOSE FROM. PLEASE USE THE NUMBER"
680 PRINT "THAT PRECEEDS THE EQUATION."
690 PRINT
700 FOR I=1 TO 7
710     PRINT I;
720     GOSUB I OF 750,770,790,810,830,850,870
730 NEXT I
740 GO TO 560
750 PRINT " Y=M*X+B"
760 RETURN
770 PRINT " Y=M(1/X)+B"
780 RETURN
790 PRINT " LOG(Y)=M*X+B"
800 RETURN
810 PRINT " LOG(Y)=M*(1/X)+B"
820 RETURN
830 PRINT " (1/Y)=M*X+B"
840 RETURN
850 PRINT " LOG(Y)=M*LOG(X)+B"
860 RETURN
870 PRINT " Y=M*LOG(X)+B"
880 RETURN
890 PRINT
900 PRINT " ","STANDARD DEVIATION FOR ";
910 GOSUB H9 OF 750,770,790,810,830,850,870
920 PRINT
930 PRINT "OF Y VALUES";
940 LET S=0
941 LET S1=0
942 LET S2=0
943 LET S3=0
944 LET S4=0
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
945 LET S5=0
946 LET S6=0
947 LET S7=0
948 LET S8=0
950 FOR I=1 TO N
960     READ H(I),K(I)
970     GO TO H9 OF 980,1010,1040,1070,1100,1130,1160
980     LET X(I)=H(I)
990     Y(I)=K(I)
1000     GO TO 1180
1010     X(I)=1/H(I)
1020     Y(I)=K(I)
1030     GO TO 1180
1040     X(I)=H(I)
1050     Y(I)=LOG(ABS(K(I)))
1060     GO TO 1180
1070     X(I)=1/H(I)
1080     Y(I)=LOG(ABS(K(I)))
1090     GO TO 1180
1100     X(I)=H(I)
1110     Y(I)=1/K(I)
1120     GO TO 1180
1130     X(I)=LOG(ABS(H(I)))
1140     Y(I)=LOG(ABS(K(I)))
1150     GO TO 1180
1160     X(I)=LOG(ABS(H(I)))
1170     Y(I)=K(I)
1180     S1=S1+X(I)
1190     S2=S2+Y(I)
1200     S3=S3+X(I)↑2
1210     S4=S4+Y(I)↑2
1220     S5=S5+X(I)*Y(I)
1230 NEXT I
1240 S6=S1↑2
1250 S7=S2↑2
1261 D1=N*S3-S6
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1270 M=(N*S5-S1*S2)/D1
1280 B=(S2-M*S1)/N
1290 FOR I=1 TO N
1300     GO TO H9 OF 1310,1330,1350,1370,1430,1390,1410
1310     R(I)=M*H(I)+B
1320     GO TO 1440
1330     R(I)=M*(1/H(I))+B
1340     GO TO 1440
1350     R(I)=EXP(M*H(I)+B)
1360     GO TO 1440
1370     R(I)=EXP(M*(1/H(I))+B)
1380     GO TO 1440
1390     R(I)=EXP(B)*ABS(H(I))↑M
1400     GO TO 1440
1410     R(I)=M*LOG(ABS(H(I)))+B
1420     GO TO 1440
1430     R(I)=1/(M*H(I)+B)
1440     S=S+(K(I)-R(I))↑2
1450 NEXT I
1460 PRINT "         ";SQR(S/(N-1))
1470 LET T1=0
1471 LET T2=0
1472 LET T3=0
1473 LET T4=0
1474 LET T5=0
1480 FOR I=1 TO N
1490     Q(I)=M*X(I)+B
1500     S8=S8+(Y(I)-Q(I))↑2
1510     T1=T1+X(I)
1520     LET T2=T2+Y(I)
1530 NEXT I
1540 LET T1=T1/N
1550 LET T2=T2/N
1560 LET D2=(N-2)*D1
1570 LET M1=SQR(ABS(N*S8/D2))
1580 LET B1=SQR(ABS(S8*S3/D2))
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
1590 PRINT "OF SLOPE",M1
1600 PRINT "OF INTERCEPT",B1
1610 PRINT
1620 PRINT "VALUE OF M=",M
1630 PRINT "VALUE OF B=",B
1640 PRINT
1650 FOR I=1 TO N
1660     LET T3=T3+(X(I)-T1)*(Y(I)-T2)
1670     T4=T4+(X(I)-T1)↑2
1680     LET T5=T5+(Y(I)-T2)↑2
1690 NEXT I
1700 LET R1=SGN(M)*T3/SQR(T4*T5)
1710 PRINT "CORRELEATION COEFFICIENT=",R1
1720 PRINT
1730 PRINT "DO YOU WANT A TABLE OF DEVIATIONS, (1=YES, 0=NO) ";
1731 INPUT H6
1740 IF H6<>1 THEN 2090
1741 PRINT
1742 PRINT "PRESS `RETURN' TO CONTINUE ";
1743 INPUT R$
1744 PAGE
1760 PRINT
1770 PRINT " ","TABLE SORTED ACCORDING TO X VALUES"
1780 PRINT
1790 PRINT "X VALUE";"   ";"Y VALUE";"   ";"Y PREDICTED";"   ";
1791 PRINT "         PERCENT DIFFERENCE"
1800 PRINT
1810 FOR I=1 TO N-1
1820     LET S=0
1830     FOR J=1 TO N-I
1840         IF H(J)<=H(J+1) THEN 1950
1850         LET S=1
1860         LET D=H(J+1)
1870         LET H(J+1)=H(J)
1880         LET H(J)=D
1890         LET D=K(J+1)
```

TITLE

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Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

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```
1900          LET K(J+1)=K(J)
1910          LET K(J)=D
1920          LET D=R(J+1)
1930          LET R(J+1)=R(J)
1940          LET R(J)=D
1950      NEXT J
1960      IF S=0 THEN 1980
1970 NEXT I
1980 FOR I=1 TO N
1990      PRINT USING 1995:H(I),K(I),R(I)
1995      IMAGE 2T,1D.3D,14T,2D,23T,1D.5DS
2000      IF K(I)=0 THEN 2070
2010      LET P=100*(K(I)-R(I))/K(I)
2020      IF P<0 THEN 2050
2030      PRINT "                              ";P
2040      GO TO 2080
2050      PRINT "         ";P
2060      GO TO 2080
2070      PRINT
2080 NEXT I
2090 END
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM CHEM-POLEQ #197 * JANET GROSSKOPF

120 PAGE
130 PRINT "THE PROGRAM CHEM-POLEQ FITS A SET OF PLOTTED X AND Y DATA"
140 PRINT "POINTS WITH A POLYNOMIAL BY LEAST SQUARES METHOD."
150 PRINT
160 DATA 10
170 DATA 0,1
180 DATA 50,0.90817
190 DATA 100,0.835226
200 DATA 150,0.782257
210 DATA 200,0.750816
220 DATA 250 0.743141
230 DATA 300,0.762106
240 DATA 350,0.811227
250 DATA 400,0.894656
260 DATA 450,1.01719
500 DIM X(100),Y(100),A(625),B(25),E(100),Z(100)
510 READ N
520 LET S1=0
530 FOR I=1 TO N
540     READ X(I),Y(I)
550     LET S1=S1+Y(I)
560 NEXT I
570 PRINT
580 PRINT "TYPE HIGHEST POWER OF X IN POLYNOMIAL"
590 PRINT "THAT YOU WANT FIT THROUGH THESE POINTS ";
600 INPUT M
610 IF M=>N THEN 650
620 IF M<=0 THEN 650
630 IF M<>INT(M) THEN 650
640 GO TO 670
650 PRINT "THIS MUST BE AN INTEGER > ZERO AND LESS THAN ";N
660 GO TO 570
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

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```
670 PRINT
680 PRINT "STANDARD DEVIATION OF ACTUAL AND PREDICTED POINTS=";
690 FOR I=1 TO M+1
700     FOR J=1 TO M+1
710         IF J=1 AND I=1 THEN 770
720         LET S=0
730         FOR L=1 TO N
740             LET S=S+X(L)↑(I+J-2)
750         NEXT L
760         LET A(I+(M+1)*(J-1))=S
770     NEXT J
780 NEXT I
790 LET A(1)=N
800 FOR I=2 TO M+1
810     LET S=0
820     FOR J=1 TO N
830         LET S=S+Y(J)*X(J)↑(I-1)
840     NEXT J
850     LET B(I)=S
860 NEXT I
870 LET B(1)=S1

880 REM ROUTINE TO LINEAR EQUATIONS
890 REM

900 LET M1=M+1
910 LET NO=M1

920 REM FORWARD SOLUTION

930 LET T1=0
940 LET K1=0
950 LET J1=-M1
960 FOR JO=1 TO M1
970     LET J2=JO+1
980     LET J1=J1+M1+1
```

TITLE

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ABSTRACT NO:

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```
990     LET B1=0
1000     LET I1=J1-J0
1010     FOR I0=J0 TO M1

1020         REM SEARCH FOR MAX COEFF

1030         LET I2=I1+I0
1040         IF ABS(B1)=>ABS(A(I2)) THEN 1070
1050         LET B1=A(I2)
1060         LET I3=I0
1070     NEXT I0

1080     REM TEST FOR SINGULAR MATRIX

1090     IF ^BS(B1)>T1 THEN 1130
1100     LET K1=1
1110     PRINT " SINGULAR MATRIX / CHECK DATA"
1120     STOP
1130     LET L1=J0+M1*(J0-2)
1140     LET I1=I3-J0
1150     FOR K0=J0 TO M1
1160         LET L1=L1+M1
1170         LET L2=L1+I1
1180         LET S1=A(L1)
1190         LET A(L1)=A(L2)
1200         LET A(L2)=S1
1210         LET A(L1)=A(L1)/B1
1220     NEXT K0
1230     LET S1=B(I3)
1240     LET B(I3)=B(J0)
1250     LET B(J0)=S1/B1

1260     REM

1270     IF J0=N0 THEN 1410
1280     LET I4=N0*(J0-1)
```

TITLE

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ABSTRACT NO:

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```
1290     FOR I6=J2 TO N0
1300         LET I5=I4+I6
1310         LET I1=J0-I6
1320         FOR J4=J2 TO M1
1330             LET I7=M1*(J4-1)+I6
1340             LET J3=I7+I1
1350             LET A(I7)=A(I7)-A(I5)*A(J3)
1360         NEXT J4
1370         LET B(I6)=B(I6)-B(J0)*A(I5)
1380     NEXT I6
1390 NEXT J0

1400 REM BACK SOLUTION

1410 LET N1=M1-1
1420 LET I1=M1*M1
1430 FOR J0=1 TO N1
1440     LET Z1=I1-J0
1450     LET Z2=N0-J0
1460     LET Z3=N0
1470     FOR K0=1 TO J0
1480         LET B(Z2)=B(Z2)-A(Z1)*B(Z3)
1490         LET Z1=Z1-M1
1500         LET Z3=Z3-1
1510     NEXT K0
1520 NEXT J0

1530 REM ****** END OF LINEAR SOLVER ROUTINE

1540 LET S2=0
1550 FOR I=1 TO N
1560     LET S=B(1)
1570     FOR J=1 TO M
1580         LET S=S+B(J+1)*X(I)↑J
1590     NEXT J
1600     LET E(I)=S
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1610     LET S2=S2+(Y(I)-S)↑2
1620 NEXT I
1630 LET S2=SQR(S2/(N-1))
1640 PRINT S2
1650 PRINT
1660 PRINT
1670 PRINT "COEFFICIENTS OF POLYNOMIAL"
1680 FOR I=1 TO M
1690     PRINT
1700     PRINT B(M-I+2);" * X↑ ";M-I+1
1710 NEXT I
1720 PRINT
1730 PRINT "PLUS CONSTANT ";B(1)
1740 PRINT
1750 PRINT
1760 PRINT "DO YOU WANT A TABLE OF DEVIATIONS (0=NO,1=YES) ";
1770 INPUT T
1780 IF T=0 THEN 2120
1785 PRINT "PRESS `RETURN' TO CONTINUE";
1786 INPUT R$
1790 PAGE
1800 PRINT " ","TABLE SORTED ACCORDING TO X VALUES"
1810 PRINT
1820 PRINT "X-VALUE";"    ";"Y-VALUE";"     ";"Y FIT";"                ";
1821 PRINT " PERCENT DIFFERENCE"
1830 PRINT
1840 FOR I=1 TO N-1
1850     LET S=0
1860     FOR J=1 TO N-1
1870         IF X(J)<X(J+1) THEN 1980
1880         LET S=1
1890         LET D=X(J+1)
1900         LET X(J+1)=X(J)
1910         LET X(J)=D
1920         LET D=Y(J+1)
1930         LET Y(J+1)=Y(J)
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1940          LET Y(J)=D
1950          LET D=E(J+1)
1960          LET E(J+1)=E(J)
1970          LET E(J)=D
1980      NEXT J
1990      IF S=0 THEN 2010
2000 NEXT I
2010 FOR I=1 TO N
2020      PRINT USING 2021:X(I),Y(I),E(I)
2021      IMAGE 2T,3D,11T,1D.6D,23T,1D.6D,36TS
2030      IF Y(I)=0 THEN 2100
2040      LET P=100*(Y(I)-E(I))/Y(I)
2050      IF P>0 THEN 2080
2060      PRINT P
2070      GO TO 2110
2080      PRINT " ",P
2090      GO TO 2110
2100      PRINT
2110 NEXT I
2120 END
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * (CHEM-ROOTS #198) * JANET GROSSKOPF

120 PAGE
130 PRINT "WHAT IS THE HIGHEST DEGREE OF X IN THE POLYNOMIAL ";
140 INPUT M
150 DIM X(31),C(31),R(31),Z(30),F(31),G(3)
160 IF INT(M)<>M THEN 200
170 IF M<1 THEN 200
180 IF M>31 THEN 200
190 GO TO 220
200 PRINT "THIS MUST BE AN INTEGER > THAN 0 AND < 31"
210 GO TO 130
220 PRINT "WHAT IS THE CONSTANT TERM ";
230 INPUT X(1)
240 LET F(1)=X(1)
250 PRINT
260 PRINT "COEFFICIENTS"
270 FOR I=2 TO M+1
280     PRINT
290     PRINT "X ↑ ";I-1;"   ";
300     INPUT X(I)
310     LET F(I)=X(I)
320 NEXT I
330 FOR I=1 TO M
340     LET R(I)=0
350     LET Z(I)=0
360 NEXT I
370 PRINT
380 FOR I=1 TO 72
390     PRINT "-";
400 NEXT I
410 I1=0
420 N1=M
430 IF X(N1+1)=0 THEN 450
```

TITLE

Chemistry and Physics
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ABSTRACT NO:

51/00-5201/0

```
440 GO TO 470
450 PRINT "THE COEFFICIENT ON THE HIGHEST DEGREE WAS ZERO."
460 GO TO 1960
470 LET N2=N1
480 LET N3=N1+1
490 LET N4=1
500 LET K1=N1+1
510 FOR L=1 TO K1
520     LET M1=K1-L+1
530     LET C(M1)=X(L)
540 NEXT L
550 LET X0=0.00500101
560 Y0=0.010001
570 LET I2=0
580 LET X1=X0
590 LET X0=-10*Y0
600 LET Y0=-10*X1
610 LET X1=X0
620 LET Y1=Y0
630 LET I2=I2+1
640 GO TO 680
650 LET I1=1
660 LET X2=X1
670 LET Y2=Y1
680 LET I3=0
690 LET U1=0
700 LET U2=0
710 LET V=0
720 LET Y3=0
730 LET X3=1
740 LET U=C(N1+1)
750 IF U=0 THEN 1260
760 FOR I=1 TO N1
770     LET L=N1-I+1
780     LET X4=X1*X3-Y1*Y3
790     LET Y4=X1*Y3+Y1*X3
```

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```
800     LET U=U+C(L)*X4
810     LET V=V+C(L)*Y4
820     LET U1=U1+I*X3*C(L)
830     LET U2=U2-I*Y3*C(L)
840     LET X3=X4
850     LET Y3=Y4
860 NEXT I
870 LET S=U1*U1+U2*U2
880 IF S=0 THEN 1170
890 LET D1=(V*U2-U*U1)/S
900 LET X1=X1+D1
910 LET D2=-(U*U2+V*U1)/S
920 LET Y1=Y1+D2
930 IF ABS(X1)<ABS(Y1) THEN 960
940 LET Q9=ABS(X1)
950 GO TO 970
960 LET Q9=ABS(Y1)
970 IF Q9>0.1 THEN 990
980 LET Q9=0.1
990 IF ABS(D1)+ABS(D2)<Q9*1.0E-5 THEN 1060
1000 LET I3=I3+1
1010 IF I3<500 THEN 690
1020 IF I1<>0 THEN 1060
1030 IF I2<500 THEN 580
1040 PRINT "NO ROOTS FOUND AFTER 500 TRIES ON 5 STARTING VALUES."
1050 GO TO 1960
1060 FOR L=1 TO N3
1070     LET M1=K1-L+1
1080     LET T=X(M1)
1090     LET X(M1)=C(L)
1100     LET C(L)=T
1110 NEXT L
1120 LET I4=N1
1130 LET N1=N2
1140 LET N2=I4
1150 IF I1=0 THEN 650
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
1160 GO TO 1200
1170 IF I1=0 THEN 580
1180 LET X1=X2
1190 LET Y1=Y2
1200 LET I1=0
1210 IF ABS(Y1/X1)<1.0E-4 THEN 1290
1220 LET A=X1+X1
1230 LET S=X1*X1+Y1*Y1
1240 LET N1=N1-2
1250 GO TO 1330
1260 LET X1=0
1270 LET N2=N2-1
1280 LET N3=N3-1
1290 LET Y1=0
1300 LET S=0
1310 LET A=X1
1320 LET N1=N1-1
1330 LET C(2)=C(2)+A*C(1)
1340 FOR L=2 TO N1
1350     LET C(L+1)=C(L+1)+A*C(L)-S*C(L-1)
1360 NEXT L
1370 LET Z(N4)=Y1
1380 LET R(N4)=X1
1390 LET N4=N4+1
1400 IF S=0 THEN 1440
1410 LET Y1=-Y1
1420 LET S=0
1430 GO TO 1370
1440 IF N1>0 THEN 550
1450 FOR I=1 TO M
1460     IF Z(I)<>0 THEN 1650
1470     IF M<I+1 THEN 1660
1480     IF Z(I+1)<>0 THEN 1650
1490     IF ABS(R(I)-R(I+1))>ABS(R(I)+R(I+1))*0.01 THEN 1650
1500     LET G(3)=(R(I)+R(I+1))*0.5
1510     FOR J=0 TO 2
```

TITLE

Chemistry and Physics
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ABSTRACT NO:

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```
1520          LET C(M+1)=F(M+1)
1530          IF J=2 THEN 1550
1540          LET G(J+1)=R(I+J)
1550          FOR L=1 TO M
1560              LET J5=M-L+1
1570              LET C(J5)=F(J5)+G(J+1)*C(J5+1)
1580          NEXT L
1590          LET X(J+1)=C(1)
1600      NEXT J
1610      IF ABS(X(1))<=ABS(X(3)) THEN 1650
1620      IF ABS(X(2))<=ABS(X(3)) THEN 1650
1630      LET R(I)=(R(I)+R(I+1))*0.5
1640      LET R(I+1)=R(I)
1650 NEXT I
1660 PRINT
1670 PRINT
1680 LET S=0
1690 FOR I=1 TO M
1700      IF Z(I)<>0 THEN 1720
1710      LET S=S+1
1720 NEXT I
1730 IF S>0 THEN 1770
1740 PRINT "THERE ARE NO REAL ROOTS OF THIS POLYNOMIAL"
1750 PRINT
1760 GO TO 1850
1770 PRINT "THESE ARE THE REAL ROOTS OF THE POLYNOMIAL"
1780 PRINT
1790 FOR I=1 TO M
1800      IF Z(I)<>0 THEN 1830
1810      PRINT
1820      PRINT R(I)
1830 NEXT I
1840 PRINT
1850 IF S<M THEN 1890
1860 PRINT "THERE ARE NO COMPLEX ROOTS OF THE POLYNOMIAL"
1870 PRINT
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1880 GO TO 1960
1890 PRINT "THESE ARE THE COMPLEX ROOTS OF THE POLYNOMIAL"
1900 PRINT
1910 FOR I=1 TO M
1920     IF Z(I)=0 THEN 1950
1930     PRINT
1940     PRINT R(I),"PLUS",Z(I),"TIMES SQR(-1)"
1950 NEXT I
1960 END
```

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ABSTRACT NO:

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```
1 INIT

2 REM( CHMELEVL #199) * JANET GROSSKOPF

3 PAGE
10 PRINT "************ ENERGY LEVEL PROGRAM ************"
20 PRINT
30 PRINT "1 = SIMPLE VIBRATIONAL  - E=U*(V+0.5)"
40 PRINT "2 = STRETCH VIBRATIONAL - E=U*(V+0.5)-X*U*(V+0.5)↑2"
50 PRINT "3 = SIMPLE ROTATIONAL   - E=H*(J)*(J+1)/(8*P↑2*I*C)"
60 PRINT "4 = COMPLEX ROTATIONAL  - E=B*J*(J+1)-D*J↑2*(J+1)↑2"
70 PRINT "5 = EXIT FROM PROGRAM"
80 PRINT
90 PRINT "PLEASE CHOOSE, 1,2,3,4, OR 5"
100 INPUT K
110 PRINT
120 GO TO K OF 140,180,220,270,660
130 GO TO 90
140 PRINT "PLEASE TYPE IN THE WAVE NUMBER ";
150 INPUT U
160 PRINT
170 GO TO 340
180 PRINT "INPUT ANHARMONICITY CONSTANT ";
190 INPUT X
200 PRINT
210 GO TO 140
220 PRINT "THE MOMENT OF INERTIA YOU TYPE"
230 PRINT "WILL BE MULTIPLIED BY 10↑(-40) ";
240 INPUT I
250 PRINT
260 GO TO 340
270 PRINT "WHAT IS THE VALUE OF `B' ";
280 INPUT B
290 PRINT
300 PRINT "PLEASE TYPE IN THE `D' VALUE ";
310 INPUT D
```

TITLE	ABSTRACT NO:
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```
320 PRINT
330 GO TO 340
340 PRINT "START EVALUATION AT QUANTUM LEVEL ";
350 INPUT M
360 PRINT
370 PRINT "STOP EVALUATION AT QUANTUM LEVEL ";
380 INPUT L
390 PAGE
391 PRINT
400 PRINT "..... ENERGIES WILL BE IN WAVENUMBERS OR CM↑(-1)....."
410 PRINT
420 PRINT "************************************************************"
430 PRINT
440 PRINT "LEVEL #","E VALUE ","CHANGE IN E"
450 PRINT "--------","-------","-----------"
460 PRINT
470 LET V=M
480 GO TO K OF 490,510,530,550
490 LET E=U*(V+0.5)
500 GO TO 560
510 LET E=U*(V+0.5)-X*U*(V+0.5)↑2
520 GO TO 560
530 LET E=6.6256E+13*V*(V+1)/(3.14159↑2*8*I*2.9979E+10)
540 GO TO 560
550 LET E=B*V*(V+1)-D*V↑2*(V+1)↑2
560 IF V>M THEN 590
570 LET D5=0
580 GO TO 600
590 D5=E-E1
600 PRINT V,E,D5
610 LET E1=E
620 PRINT
630 LET V=V+1
640 IF V-1<L THEN 480
650 GO TO 80
660 END
```

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```
1 INIT

2 REM (CHMGFORRX #200) * JANET GROSSKOPF

3 PAGE
5 DEF FNF(T1)=-A1*T1*LOG(T1)-B1/2*T1↑2-C1/6*T1↑3+D1+D2*T1
6 ON SIZE THEN 140
10 LET A1=-0.783
15 LET B1=0.0242
20 LET C1=-1.2473E-5
25 LET D1=-41891
30 LET D2=43.816
35 DEF FNG(T1)=FNF(T1)+8.314*T1*LOG((P3+X1)*(P4+X1)/((P1-X1)*(P2-X1)))
40 PRINT "YOU ARE RUNNING THE REACTION: CO + H2O =CO2 + H2"
45 PRINT
50 PRINT "AT WHAT TEMPERATURE IS IT TAKING PLACE ";
55 INPUT T1
60 PRINT
65 PRINT "STANDARD FREE ENERGY FOR THIS REACTION IS ";FNF(T1)
70 PRINT
75 PRINT "WHAT ARE THE INITIAL PARTIAL PRESSURES FOR THE FOLLOWING:"
80 PRINT
85 PRINT "CO ";
90 INPUT P1
95 PRINT "H2O ";
100 INPUT P2
105 PRINT "CO2 ";
110 INPUT P3
115 PRINT "H2 ";
120 INPUT P4
125 PRINT
130 X1=0
135 PRINT "FREE ENERGY FOR THE REACTION IS NOW ",FNG(T1)
140 PRINT
145 PRINT "INPUT CHANGE IN PRESSURE(DELTA P) OR ZERO (0.) TO STOP"
150 PRINT
```

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```
155 PRINT
160 PRINT "DELTA P ";
165 INPUT X1
170 PRINT
175 IF X1>0 THEN 210
180 IF X1<0 THEN 190
185 GO TO 265
190 IF ABS(X1)>P3 MIN P4 THEN 200
195 GO TO 225
200 PRINT "THIS REVERSAL WOULD LEAD TO NEGATIVE PRODUCT PRESSURES"
205 GO TO 150
210 IF X1<P1 MIN P2 THEN 225
215 PRINT "THIS CHANGE WOULD USE UP MORE THAN THE INITIAL PRODUCTS"
220 GO TO 160
225 PRINT
230 PRINT "NEW FREE ENERGY FOR REACTION = ",FNG(T1)
235 PRINT
240 PRINT "P OF CO",P1-X1
245 PRINT "P OF H2O",P2-X1
250 PRINT "P OF CO2",P3+X1
255 PRINT "P OF H2",P4+X1
260 GO TO 150
265 END
```

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```
100 INIT

110 REM (CHM-RATES) * JANET GROSSKOPF

120 PAGE
130 PRINT "INSTRUCTIONS(1=YES,0=NO)"
140 INPUT N
150 IF N=0 THEN 830
160 PRINT
170 PRINT "DICTIONARY OF VARIABLES (1=YES,0=NO)"
180 INPUT N
190 IF N=0 THEN 310
200 PRINT
210 PRINT "T=TIME"
220 PRINT "C=CONC."
230 PRINT "K=RATE CONSTANT FOR REACTION"
240 PRINT "CO=INITIAL CONC. FOR SINGLE SPECIES REACTION."
250 PRINT "K=RATE CONSTANT FOR REACTION"
260 PRINT "AO=INITIAL CONC OF REACTION A"
270 PRINT "BO=INITIAL CONC. OF REACTION B"
280 PRINT "X =CONCENTRATION OF AO AND BO REACTED."
290 PRINT "A = AO - X"
300 PRINT "B=BO-X"
310 FOR I=0 TO 8 STEP 4
320     PRINT
330     GOSUB INT(I/4)+1 OF 920,940,960
340     GOSUB INT(I/4)+1 OF 390,390,460
350     PRINT
360 NEXT I
370 PRINT "TYPE -1 FOR OPTION TO STOP PROGRAM ENTIRELY"
380 GO TO 830
390 PRINT "OPTION #","INPUT","OUTPUT","STOP LOOP"
400 PRINT
410 PRINT I,"CO,K,T","C","TYPE T=0"
420 PRINT I+1,"CO,T,C","K","TYPE T=0"
430 PRINT I+2,"CO,K,C","T","TYPE C=0"
```

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```
440 PRINT I+3,"K,T,C","CO","AUTOMATIC"
450 RETURN
460 PRINT "OPTION #","INPUT","OUTPUT","STOP LOOP"
470 PRINT
480 PRINT 8,"AO,BO,T,X","X,A,B","TYPE T=0"
490 PRINT 9,"AO,BO,T,X","A,B,K","TYPE B=0"
500 PRINT 10,"AO,BO,K,X","A,B,T","TYPE X=0"
510 RETURN
520 GO TO 830
530 PRINT "INITIAL CONC. OF A ";
540 INPUT AO
550 PRINT "INITIAL CONC. OF B ";
560 INPUT BO
570 IF ABS(AO-BO)>1.0E-6 THEN 610
580 PRINT
590 PRINT "AO=BO : IT IS ADVISABLE TO USE ";
600 GOSUB 940
610 RETURN
620 PRINT "CONC. USED",X
630 LET A=AO-X
640 LET B=BO-X
650 PRINT "CONC. OF A",A
660 PRINT "CONC. OF B",B
670 RETURN
680 PRINT "CONC. USED ";
690 INPUT X
700 RETURN
710 PRINT "INITIAL CONC. ";
720 INPUT CO
730 RETURN
740 PRINT "PRESENT TIME ";
750 INPUT T
760 RETURN
770 PRINT "PRESENT CONC. ";
780 INPUT C
790 RETURN
```

TITLE	ABSTRACT NO:
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```
800 PRINT "RATE CONSTANT ";
810 INPUT K
820 RETURN
830 PRINT
840 PRINT "---------------"
850 PRINT
860 PRINT "OPTION ";
870 INPUT L
880 PRINT
890 GOSUB L+1 OF 1000,1080,1180,1270,1330,1410,1500,1590,1650,1740,1840
900 IF L<>-1 THEN 830
910 GO TO 1950
920 PRINT "1st ORDER : LOG(C) = K*T+LOG(C0)"
930 GO TO 980
940 PRINT "2nd ORDER : 1/C = K*T+1/C0"
950 GO TO 980
960 PRINT "1st ORDER IN 2 REACTANTS:LOG((A0-X)/(B0-X))/(A0-B0) ="
970 PRINT " = K*T+LOG(A0/B0)/(A0/B0)"
980 PRINT
990 RETURN
1000 GOSUB 920
1010 GOSUB 710
1020 GOSUB 800
1030 PRINT
1040 GOSUB 740
1050 PRINT "PRESENT CONC. ",C0*EXP(-K*T)
1060 IF T<>0 THEN 1030
1070 RETURN
1080 GOSUB 920
1090 GOSUB 710
1100 PRINT
1110 GOSUB 740
1120 IF T=0 THEN 1160
1130 GOSUB 770
1140 PRINT "RATE CONSTANT",(LOG(C0)-LOG(C))/T
1150 GO TO 1100
```

TITLE	ABSTRACT NO:
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```
1160 PRINT "PRESENT CONC. ",C0
1170 RETURN
1180 GOSUB 920
1190 GOSUB 710
1200 GOSUB 800
1210 PRINT
1220 GOSUB 770
1230 IF C=0 THEN 1260
1240 PRINT "PRESENT TIME",(LOG(C0)-LOG(C))/K
1250 GO TO 1210
1260 RETURN
1270 GOSUB 920
1280 GOSUB 800
1290 GOSUB 740
1300 GOSUB 770
1310 PRINT "INITIAL CONC.",EXP(K*T)*C
1320 RETURN
1330 GOSUB 940
1340 GOSUB 710
1350 GOSUB 800
1360 PRINT
1370 GOSUB 740
1380 PRINT "PRESENT CONC.",1/(K*T+1/C0)
1390 IF T<>0 THEN 1360
1400 RETURN
1410 GOSUB 940
1420 GOSUB 710
1430 PRINT
1440 GOSUB 740
1450 IF T=0 THEN 1490
1460 GOSUB 770
1470 PRINT "RATE CONCENTRATION",(1/C-1/C0)/T
1480 GO TO 1430
1490 RETURN
1500 GOSUB 940
1510 GOSUB 710
```

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```
1 REM *** 51/00-5201/0 ***
2 REM PECKHAM TEXTBOOK
3 REM AUTHOR:  DR. P.C. HOLMAN

100 INIT
101 FIND 15
102 APPEND 350
110 LET P1=0
120 PAGE
130 W=750
140 V=150
180 PRINT "JJ                THE UNIVERSITY OF WISCONSIN-STEVENS POINT"
190 PRINT "GGGGGGGGGGGGGGGGGG"
220 PRINT "JJJJJ"
230 PRINT "                 ****   ** *** ***  ******  ******  *****  "
240 PRINT "                ****** **** *** **  ******  ******  ******  "
250 PRINT "                **  **  *** *** **    **      **    **  **  "
260 PRINT "                **  **  **  **  **    **      **    **  **  "
270 PRINT "                **  **  **  **  **    **      **    ** **   "
280 PRINT "                ******  **  **  **  ******  ******  ** **   "
290 PRINT "                 ****  ***  **  *** ******  ****** ***  **  "
310 FOR I=1 TO W
320 NEXT I
330 PRINT "JJJJ"
331 PRINT "                              HERBERT D. PECKHAMJ"
332 PRINT "                          'COMPUTERS, BASICS, AND PHYSICS'J"
333 PRINT "                         ADDISON AND WESLEY PUBLISHING CO."
340 FOR I=1 TO 1000
341 NEXT I

350 REM* SECOND FILE STARTS HERE
```

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```
1520 GOSUB 800
1530 PRINT
1540 GOSUB 770
1550 IF C=0 THEN 1580
1560 PRINT "PRESENT TIME",(1/C-1/C0)/K
1570 GO TO 1530
1580 RETURN
1590 GOSUB 940
1600 GOSUB 800
1610 GOSUB 740
1620 GOSUB 770
1630 PRINT "INITIAL CONC. ",1/C-K*T
1640 RETURN
1650 GOSUB 960
1660 GOSUB 530
1670 GOSUB 800
1680 PRINT
1690 GOSUB 740
1700 LET X=A0*(1-EXP(K*T*(A0-B0)))/(1-A0/B0*EXP(K*T*(A0+B0)))
1710 GOSUB 620
1720 IF T<>0 THEN 1680
1730 RETURN
1740 GOSUB 960
1750 GOSUB 530
1760 PRINT
1770 GOSUB 680
1780 IF X=0 THEN 1830
1790 GOSUB 740
1800 GOSUB 630
1810 PRINT "RATE CONSTANT",LOG(B0*(A0-X)/A0/(B0-X))/(T*(A0-B0))
1820 GO TO 1760
1830 RETURN
1840 GOSUB 960
1850 GOSUB 530
1860 GOSUB 800
1870 PRINT
```

TITLE	ABSTRACT NO:
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```
1880 GOSUB 680
1890 GOSUB 630
1900 PRINT "PRSENT TIME",LOG(B0*(A0-X)/A0/(B0-X))/(K*(A0-B0))
1910 IF X<>0 THEN 1870
1920 RETURN

1930 REM
1940 REM

1950 END
```

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```
350 REM* SECOND FILE STARTS HERE

351 LET P1=0
355 GOSUB 4550
360 PRINT
370 PRINT "    1       65-67    BESSEL       BESSEL FUNCTION"
380 PRINT
390 PRINT "    2      117-120   CIR.AY       CIRCUIT ANALYSIS"
400 PRINT
410 PRINT "    3      108-116   D.H.O.       DAMP. HARMONIC OSCILLATOR"
420 PRINT
430 PRINT "    4      181-187   EIGEN        EIGENVALUES & VECTORS"
440 PRINT
450 PRINT "    5      139-144   E.P.D.       ELL. PARTICLE DIFFER."
460 PRINT
470 PRINT "    6       49- 60   F.D.         FINITE DIFF."
480 PRINT
490 PRINT "    7       16- 18   G.C.D.       GREATEST COMMON DIVISOR"
500 PRINT
510 PRINT "    8       73- 80   IATI         INTEGRATING A TABBED FUN."
520 PRINT
530 PRINT "    9       63- 65   INTPTN       INTERPOLATION"
540 PRINT
550 PRINT "   10       19- 20   L.NO.        LARGEST NUMBER"
560 PRINT
570 PRINT "   11       43- 44   L.SQRS       LEAST SQUARES"
580 PRINT
590 GOSUB 4650
600 GOSUB 4550
605 PRINT
610 PRINT "   12      172-173   LORENZ       LORENZ CONTRACTIONS"
620 PRINT
630 PRINT "   13      158-161   MATFUN       MATRIX FUNCTIONS"
640 PRINT
650 PRINT "   14      156-158   MATMAT       MATRIX MATHEMATICS"
```

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```
660 PRINT
670 PRINT "    15       214-215    MEANSD       CAL. MEAN & STD. DEV."
680 PRINT
690 PRINT "    16       206-207    M.C.IN.      MONTE CARLO INTEGRATION"
700 PRINT
710 PRINT "    17       208-210    M.C.SN.      LAPLACE'S EQUATION"
720 PRINT
730 PRINT "    18       112-116    OSCI         OSCILLATOR"
740 PRINT
750 PRINT "    19       141,306    PAR.DF       PARTICLE DIFFUSION"
760 PRINT
770 PRINT "    20       122,278    PENDLM       PENDULUM"
780 PRINT
790 PRINT "    21        47- 48    POTMAP       POTENTIAL MAP"
800 PRINT
810 PRINT "    22        73- 75    PRBINT       PROBABILITY INTREGRAL"
820 PRINT
830 PRINT "    23        40- 41    PROMOT       PROJECTILE MOTION"
840 PRINT
850 GOSUB 4650
860 GOSUB 4550
865 PRINT
870 PRINT "    24        75- 78    RADINT       RADIANCY INTEGRAL"
880 PRINT
890 PRINT "    25       200,211    RNWK I       ONE DIM. RANDOM WALK"
900 PRINT
910 PRINT "    26       199-203    RNWKII       TWO DIM. RANDOM WALK"
920 PRINT
930 PRINT "    27       220-222    REGANY       REGRESSION ANALYSIS"
940 PRINT
950 PRINT "    28       126,286    ROCKET       LAUNCHES A ROCKET"
960 PRINT
970 PRINT "    29        18, 30    SIM.EQ       SIMULTANEOUS EQUATIONS"
980 PRINT
990 PRINT "    30        93-101    SLIBOD       SLIDING BODY SIMULATION"
1000 PRINT
```

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```
1010 PRINT "   31      203-205   STASIM       STATISTICAL SIMULATION"
1020 PRINT
1030 PRINT "   32       21,256   SQRSQ.       SQUARE ROOTS & SQUARES"
1040 PRINT
1050 PRINT "   33      191-192   TRACER       TRACES AN OPTICAL RAY"
1060 PRINT
1070 PRINT "   34      151,291   VIBSTG       VIBRATING STRING"
1080 PRINT

1090 REM
1100 REM

1110 GOSUB 4650

2140 REM

2150 PRINT "YOU HAVE NOT SELECTED A PROGRAM TO RUN. IF YOU WANT TO "
2160 PRINT "GO THRU THE DIRECTORY AGAIN TYPE IN 1. IF NOT"
2170 PRINT "TYPE IN 0."
2180 PRINT "YOUR RESPONSE ? ";
2190 INPUT P4
2200 IF P4=0 THEN 2230
2210 GO TO 350
2220 LET P1=0
2230 PAGE
2240 END
4520 FOR I=1 TO W
4530 NEXT I
4540 RETURN

4550 REM * HEADING ROUTINE

4560 PAGE
4570 LET P1=P1+1
4580 PRINT " ","S O F T W A R E   S Y S T E M";
4590 PRINT "         PAGE ";P1;" OF 3"
```

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```
4600 PRINT
4610 PRINT " "," D I R E C T O R Y "
4620 PRINT
4630 PRINT "   FILE    PAGE(S)    NAME       ";
4631 PRINT " DESCRIPTION"
4632 FOR T=1 TO 10
4633     PRINT "K                                    DESCRIPTION"
4635 NEXT T
4640 RETURN

4650 REM * PAGE QUESTIONS

4660 PRINT
4670 PRINT "DO YOU WANT TO RUN A PROGRAM FROM THIS PAGE?(1-YES,0-";
4680 PRINT "NO) ";
4690 INPUT P2
4700 IF P2=1 THEN 4720
4710 RETURN
4720 PRINT " WHAT NUMBER DO YOU WANT? ";
4730 INPUT P3
4740 LET F3=P3+15
4750 FIND F3
4760 OLD
4770 RUN
4780 LIST
```

TITLE

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```
100 INIT

110 REM * BESSEL ** MICHAEL VOICA

120 PAGE
130 PRINT "BESSEL FN DERIVATIVE"
140 GOSUB 500
150 PRINT
160 PRINT "HOW MANY POINTS ARE YOU GOING TO INPUT"
170 INPUT T9
180 IF T9<=3 THEN 640
190 PRINT "ENTER YOUR ";T9;" J VALUES"
200 PRINT
210 PRINT
220 DIM J(T9),K(T9),L(T9)
230 INPUT J
240 PAGE
250 PRINT
260 PRINT "YOUR BESSEL'S TABLE IS AS FOLLOWS:"
270 PRINT
280 PRINT
290 PRINT "  X","  J(X)","  J1(X)","  J2(X)"
300 PRINT
310 PRINT
320 LET K(1)=(-3*J(1)+4*J(2)-J(3))/0.2
330 LET L(1)=(2*J(1)-5*J(2)+4*J(3)-J(4))/0.01
340 FOR I=2 TO T9-1
350     LET K(I)=(J(I+1)-J(I-1))/0.2
360     LET L(I)=(J(I-1)-2*J(I)+J(I+1))/0.01
370 NEXT I
380 LET K(T9)=(3*J(T9)-4*J(T9-1)+J(T9-2))/0.2
390 LET L(T9)=(2*J(T9)-5*J(T9-1)+4*J(T9-2)-J(T9-3))/0.01
400 FOR I=1 TO T9
410     PRINT I/10,J(I),K(I),L(I)
420 NEXT I
430 PRINT
```

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```
440 PRINT "DO YOU WISH TO TRY AGAIN.(1=YES,0=NO)"
450 INPUT T5
460 IF T5=1 THEN 120
470 IF T5<>0 THEN 440
480 FIND 15
490 OLD
500 PRINT
510 PRINT "A BESSEL FUNCTION IS USED IN PHYSICS TO COMPUTE DERIVATIVES"
520 PRINT " OF A WELL BEHAVED FUNCTION THAT IS DIFFICULT TO COMPUTE."
530 PRINT
540 PRINT "YOU WILL ONLY BE ASKED TO INPUT:"
550 PRINT "     1-THE NO. OF POINTS YOU WISH TO INPUT"
560 PRINT "     2-YOUR POINTS"
570 PRINT
580 PRINT
590 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
600 INPUT O$
610 PAGE
620 PRINT
630 RETURN
640 PRINT "YOU NUMBER MUST BE AT LEAST 4"
650 GO TO 160
```

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```
100 INIT

110 REM

120 PAGE
130 GOSUB 580
140 PRINT
150 PAGE
160 PRINT "INPUT THE VALUE FOR THE BREAKER(E,IN VOLTS)"
170 INPUT E
180 PRINT
190 PRINT "INPUT THE VALUE FOR THE FIRST RESISITOR(L, IN HENRYS)"
200 INPUT L
210 PRINT
220 PRINT "INPUT YOUR AMOUNT OF OHMS(a)"
230 INPUT A
240 PRINT
250 PRINT "INPUT YOUR OHMS/AMP↑2(b)"
260 INPUT B
270 PRINT
280 PRINT "INPUT HOW YOU WANT TIME PRINTED(eg: .1 OF A SECOND WOULD"
290 PRINT "PRINT YOUR TABLE IN TENTHS OF A SEC.)"
300 INPUT D
310 PRINT
320 PRINT "INPUT THE AMOUNT OF SECONDS YOU WISH THE CIRCUIT TO RUN"
330 INPUT T2
340 LET I1=0
350 PAGE
360 PRINT "TIME","CURRENT"
370 PRINT "(SEC)","(AMPERES)"
380 PRINT
390 PRINT
400 FOR T=0 TO T2 STEP D
410     PRINT T,I1
420     LET K1=E/L-B*I1↑3/L-A*I1/L
430     LET K2=E/L-B*(I1+0.5*K1*D)↑3/L-A*(I1+0.5*K1*D)/L
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440     LET K3=E/L-B*(I1+0.5*K2*D)↑3/L-A*(I1+0.5*D)/L
450     LET K4=E/L-B*(I1+K3*D)↑3/L-A*(I1+K3*D)/L
460     LET I2=I1+D*(K1+2*K2+2*K3+K4)/6
470     LET I1=I2
480 NEXT T
490 PRINT
500 PRINT " DO YOU WANT TO DO ANOTHER? YES OR NO ";
510 INPUT E$
520 IF E$="YES" OR E$="Y" THEN 150
530 IF E$="NO" OR E$="N" THEN 560
540 PRINT "ANSWER YES OR NO!"
550 GO TO 510
560 FIND 15
570 OLD
580 PRINT "THIS PROGRAM IS A CIRCUIT ANALYSIS, USING THE RUNGE KUTTA"
590 PRINT "METHOD. THE PROGRAM WILL PRINT OUT THE TIME(SEC.) AS"
600 PRINT "WELL AS THE CURRENT(AMPS.)AT THAT GIVEN TIME."
610 PRINT "THE CIRCUIT USED IN THE PROGRAM IS A SIMPLE BOX CIRCUIT"
620 PRINT "WITH TWO RESISTORS, ONE BREAKER, AND A SWITCH."
630 PRINT
640 PRINT "KUTTA'S EQUATIONS ARE AS FOLLOWS"
650 PRINT "     1)R=a+bi2"
660 PRINT "     2)E=L(di/dt)-(a+bi2)i=0"
670 PRINT "     3)di/dt=(E/L)-((b/L)i3)-((a/L)i)"
680 PRINT
690 PRINT "NOTE:"
700 PRINT "     1)a IS A CONSTANT(VOLTAGE IN OHMS)"
710 PRINT "     2)b IS A CONSTANT(OHMS/AMP↑2)"
720 PRINT "     3)L IS THE FIRST RESISTOR(PARAMETER IN HENRYS)"
730 PRINT "     4)R IS THE SECOND RESISTOR"
740 PRINT "     5)E IS THE BREAKER(PARAMETER IN VOLTS)"
750 PRINT "     6)i IS A CONSTANT"
760 PRINT
770 PRINT "WHEN YOU ARE READY, HIT RETURN"
780 INPUT Y$
790 PAGE
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

800 RETURN

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM*DAMPED HARMONIC OSCILLATOR ** MICHAEL VOICA

120 PAGE
130 GOSUB 1250
140 PAGE
150 PRINT "WHICH APPROACH DO YOU DESIRE:"
160 PRINT "      1-EULER'S METHOD"
170 PRINT "      2-ADVANCED EULER'S METHOD"
180 PRINT "      3-RUNGE KUTTA METHOD"
190 PRINT
200 PRINT " PLEASE ENTER 1,2, OR 3"
210 INPUT R
220 IF R>3 OR R<1 THEN 200
230 GO TO R OF 240,610,880
240 PAGE
250 PRINT
260 PRINT
270 PRINT "ENTER THE MASS OF THE OBJECT(IN GRAMS)"
280 INPUT M
290 PRINT "ENTER THE FORCE IMPOSED ON THE OBJECT(DYNES SEC./CM)"
300 INPUT K
310 PRINT "ENTER THE LENGTH OF THE RUN(IN SEC.)"
320 INPUT C
330 PRINT "ENTER THE DAMPING FORCE (DYNES SEC./CM)"
340 INPUT XO
350 PRINT "ENTER THE INITIAL POSITION"
360 INPUT VO
370 PRINT "ENTER HOW YOU WISH TABLE PRINTED(0.1 SEC., 1 SEC.,ETC)"
380 INPUT D
390 LET X1=XO
400 LET V1=VO
410 FOR T=0 TO 2 STEP D
420     LET Z1=X1+V1*D
430     LET Z2=V1+(-C*V1/M-K*X1/M)*D
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440     LET X2=X1+0.5*(V1+Z2)*D
450     LET V2=V1+0.5*(-C*V1/M-K*X1/M+(-C*Z2/M-K*Z1/M))*D
460     LET X1=X2
470     LET V1=V2
480 NEXT T
490 PRINT
500 PRINT
510 PRINT "AT T=2 SEC. THE DISPLACEMENT =";X1;" CM"
520 PRINT
530 PRINT " DO YOU WISH TO DO ANOTHER ? YES OR NO ";
540 INPUT E$
550 IF E$="YES" OR E$="Y" THEN 140
560 IF E$="NO" OR E$="N" THEN 590
570 PRINT "ANSWER YES OR NO!"
580 GO TO 540
590 FIND 15
600 OLD
610 PAGE
620 PRINT "ENTER THE MASS OF THE OBJECT(IN GRAMS)"
630 PRINT
640 INPUT M
650 PRINT "ENTER THE FORCE IMPOSED ON THE OBJECT(DYNES SEC./CM)"
660 INPUT K
670 PRINT "ENTER THE LENGTH OF THE RUN(IN SEC.)"
680 INPUT C
690 PRINT "ENTER THE DAMPING FORCE (DYNES SEC./CM)"
700 INPUT XO
710 PRINT "ENTER THE INITIAL POSITION"
720 INPUT VO
730 PRINT "ENTER HOW YOU WISH TABLE PRINTED(.1 SEC., 1 SEC.,ETC)"
740 INPUT D
750 LET X1=XO
760 LET V1=VO
770 PAGE
780 PRINT "TIME","VELOCITY","POSITION"
790 PRINT
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
800 FOR T=0 TO 2 STEP D
810     PRINT T,V1,X1
820     LET X2=X1+V1*D
830     LET V2=V1+(-C*V1/M-K*X1/M)*D
840     LET X1=X2
850     LET V1=V2
860 NEXT T
870 GO TO 520
880 PAGE
890 PRINT
900 PRINT "ENTER THE MASS OF THE OBJECT(IN GRAMS)"
910 INPUT M
920 PRINT "ENTER THE FORCE IMPOSED ON THE OBJECT(DYNES SEC./CM)"
930 INPUT K
940 PRINT "ENTER THE LENGTH OF THE RUN(IN SEC.)"
950 INPUT C
960 PRINT "ENTER THE DAMPING FORCE (DYNES SEC./CM)"
970 INPUT XO
980 PRINT "ENTER THE INITIAL POSITION"
990 INPUT VO
1000 PRINT "ENTER HOW YOU WISH TABLE PRINTED(0.1 SEC., 1 SEC.,ECT)"
1010 INPUT D
1020 LET X1=XO
1030 LET V1=VO
1040 PRINT
1050 PAGE
1060 PRINT "TIME","POSITION","ERROR"
1070 FOR T=0 TO 2 STEP D
1080     LET W=SQR(99)/10
1090     LET X=EXP(-T/10)*(10*COS(W*T)+1/W*SIN(W*T))
1100     PRINT T,X1,-X
1110     LET K1=V1
1120     LET L1=-C*V1/M-K*X1/M
1130     LET K2=V1+D*L1/2
1140     LET L2=-C*(V1+D*L1/2)/M-K*(X1+D*K1/2)/M
1150     LET K3=V1+D*L2/2
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
1160     LET L3=-C*(V1+D*L2/2)/M-K*(X1+D*K2/2)/M
1170     LET K4=V1+D*L3
1180     LET L4=-C*(V1+D*L3)/M-K*(X1+D*K3)/M
1190     LET X2=X1+D*(K1+2*K2+2*K3+K4)/6
1200     LET V2=V1+D*(L1+2*L2+2*L3+L4)/6
1210     LET X1=X2
1220     LET V1=V2
1230 NEXT T
1240 GO TO 520
1250 PRINT "THIS PROGRAM SOLVES SECOND ORDER EQUATIONS, USING EITHER"
1260 PRINT "EULERS METHOD, WHICH IS LEAST ACCURATE, THE IMPROVED EULER"
1270 PRINT "METHOD,WHICH IS BETTER, OR THE KUTTA METHOD, WHICH IS THE "
1280 PRINT "BEST."
1290 PRI "    THIS PROGRAM DETRMINES HOW FAST AND AT WHAT LOCATION AN "
1300 PRINT "OBJECT WILL BE FROM ITS ORIGIN AT A GIVEN TIME(T)."
1310 PRINT
1320 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
1330 INPUT Z$
1340 PAGE
1350 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * EIGENVALUES AND EIGENVECTORS ** MICHAEL VOICA

120 PAGE
130 GOSUB 750
140 PAGE
150 INIT
160 PRI "INPUT THE SIZE OF YOUR SQUARE MATRIX(ONLY ONE ENTRY REQUIRED)"
170 INPUT N
180 DIM A(N,N),B(N,N),X(N,1),Y(N,1)
190 PRINT "JJ"
200 PRINT "INPUT MATRIX A"
210 INPUT A
220 LET S=0
230 LET K1=0
240 LET K2=K1
250 LET K3=K2
260 LET K=1
270 LET X=1
280 LET Y=0
290 LET B=0
300 LET Y=A MPY X
310 IF Y(N,1)=0 THEN 330
320 GO TO 340
330 LET Y(N,1)=1.0E-3
340 FOR I=1 TO N-1
350     LET Y(I,1)=Y(I,1)/Y(N,1)
360 NEXT I
370 LET K3=K2
380 LET K2=K1
390 LET K1=K
400 LET K=Y(N,1)
410 LET Y(N,1)=1
420 IF ABS(K-K3)=0 THEN 450
430 LET X=Y
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 GO TO 300
450 IF S=1 THEN 580
460 PAGE
470 PRINT
480 PRINT "ESTIMATE OF LARGEST EIGENVALUE IS ";K
490 PRINT
500 PRINT "CORRESPONDING EIGENVECTOR IS "
510 FOR I=1 TO N
520     PRINT Y(I,1)
530 NEXT I
540 LET B=INV(A)
550 LET A=B
560 LET S=1
570 GO TO 270
580 PRINT
590 PRINT
600 PRINT "ESTIMATE OF SMALLEST EIGENVALUE IS ";1/K
610 PRINT
620 PRINT "CORRESPONDING EIGENVECTOR IS "
630 FOR I=1 TO N
640     PRINT Y(I,1)
650 NEXT I
660 PRINT "JJ"
670 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
680 INPUT S$
690 IF S$="YES" OR S$="Y" THEN 140
700 IF S$="NO" OR S$="N" THEN 730
710 PRINT "ANSWER YES OR NO!!!"
720 GO TO 680
730 FIND 15
740 OLD
750 PRINT "EIGENVALUES & EIGENVECTORS"
760 PRINT "-------------------------"
770 PRINT "JJ"
780 PRINT " THIS PROGRAM TAKES A GIVEN MATRIX(A, WHICH YOU WILL INPUT)"
790 PRINT "AND FINDS THE LARGEST AND SMALLEST EIGENVALUES AS WELL AS"
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
800 PRINT "THE CORRESPONDING EIGENVECTORS. THE PROGRAM USES THE"
810 PRINT "ITERATIVE METHODS DEFINED IN EQUATIONS 8-31(Pg. 175)"
820 PRINT "AND 8-32(Pg.177). AS CRITERIA FOR CONVERGENCE, THE PROGRAM"
830 PRINT "WILL SAY THAT IF THERE IS NO CHANGE IN FOUR SUCCESSIVE"
840 PRINT "k AND g VALUES (SEE EQUATIONS 8-31, AND 8-32), THE PROCESS"
850 PRINT "IS SAID TO CONVERGE."
860 PRINT
870 PRINT "     BESIDES INPUTTING MATRIX A, YOU WILL ALSO BE ASKED TO"
880 PRINT "INPUT THE SIZE OF MATRIX A. SINCE THIS MATRIX MUST BE A"
890 PRINT "PERFECT SQUARE (eq:3x3,4x4,etc.), THE COMPUTER WILL ASK FOR"
900 PRINT "ONLY ONE NUMBER (eq:FOR 3X3 INPUT 3). IF MORE THAN ONE"
910 PRINT "NUMBER IS LOADED IN, EVERY NUMBER AFTER THE FIRST WILL BE"
920 PRINT "LOADED IN MATRIX A."
930 PRINT "JJ"
940 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
950 INPUT G$
960 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM

120 PAGE
130 GOSUB 600
140 PAGE
150 INIT
160 PRINT "ENTER THE SIZE OF THE 2 DIMENSIONAL GRID(eq:8,8)"
170 INPUT A7,A8
180 DIM V(A7,A8)
190 PRINT
200 LET A6=A7*A8
210 PRINT "INPUT YOUR ";A6;" VALUES FOR YOUR GRID."
220 PRINT
230 INPUT V
240 LET K=0
250 LET S=0
260 FOR I=2 TO A7-1
270     FOR J=2 TO A8-1
280         LET D=(V(I+1,J)+V(I,J+1)+V(I-1,J)+V(I,J-1)-4*V(I,J))/4
290         LET S=S+ABS(D)
300         LET V(I,J)=V(I,J)+D
310     NEXT J
320 NEXT I
330 LET K=K+1
340 IF S>2 THEN 250
350 PAGE
360 PRINT
370 PRINT "TABLE OF VALUES OF THE ELECTROSTATIC POTENTIAL"
380 PRINT "-----------------------------------------"
390 PRINT
400 FOR I=1 TO A7
410     FOR J=1 TO A8
420         PRINT USING 430:INT(V(I,J))
430         IMAGE 3D,5X,S
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440     NEXT J
450     PRINT
460     PRINT
470 NEXT I
480 PRINT
490 PRINT
500 PRINT
510 PRINT "NUMBER OF PASSES FOR CONVERGENCE = ";K
520 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
530 INPUT A$
540 IF A$="YES" OR A$="Y" THEN 140
550 IF A$="NO" OR A$="N" THEN 580
560 PRINT "PLEASE ANSWER YES OR NO"
570 GO TO 530
580 FIND 15
590 OLD
600 PRINT
610 PRINT "ELECTROSTATIC POTENTIAL GRID"
620 PRINT "---------------------------"
630 PRINT
640 PRINT "THIS IS A PROGRAM THAT WORKS OUT AN ELECTROSTATIC POTENTIAL"
650 PRINT "GRID, AS WELL AS STATING THE NUMBER OF PASSES THAT WERE "
660 PRINT "REQUIRED IN THE CONVERGENCE.  YOU WILL BE ASKED TO DIMENSION"
670 PRINT "THE GRID TO THE SIZE YOU WANT, AND WILL THEN BE ASKED TO "
680 PRINT "INPUT THE GRID VALUES."
690 PRINT "THE MACHINE WILL ASK FOR INFORMATION AS IT IS REQUIRED."
700 PRINT
710 PRINT "NOTE:"
720 PRINT "     THIS PROGRAM CAN TAKE 90 SECONDS TO RUN AFTER INPUTTING"
730 PRINT "THE GRID VALUES."
740 PRINT
750 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
760 INPUT Y$
770 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM* FINITE DIFFERENCES ** MICHAEL VOICA

120 PAGE
130 GOSUB 470
140 PAGE
150 INIT
160 PRINT "INPUT THE NO. OF RUNS YOU WANT "
170 INPUT N
180 LET N=N+3
190 DIM X(N)
200 IF N>1 THEN 230
210 PRINT "YOU MUST HAVE AT LEAST 1 RUN. "
220 GO TO 170
230 PAGE
240 PRINT "FOR X=1 TO ";N-3
250 PRINT
260 PRINT
270 PRINT
280 PRINT "    SIN(X)","    1st DIFF.","    2nd DIFF.","    3rd DIFF."
290 PRINT
300 FOR I=1 TO N
310     LET X(I)=SIN(I/10)
320 NEXT I
330 FOR I=1 TO N-3
340     LET D1=X(I)-X(I+1)
350     LET D2=X(I)-2*X(I+1)+X(I+2)
360     LET D3=-X(I)+3*X(I+1)-3*X(I+2)+X(I+3)
370     PRINT X(I),D1,D2,D3
380 NEXT I
390 PRINT
400 PRINT " DO YOU WANT TO TRY ANOTHER ? YES OR NO ";
410 INPUT E$
420 IF E$="YES" OR E$="Y" THEN 140
430 IF E$="NO" OR E$="N" THEN 450
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 PRINT " ANSWER YES OR NO !"
450 FIND 15
460 OLD
470 PRINT
480 PRINT "THIS PROGRAM FINDS THE SIN(X) AND THE 1st, 2nd AND 3rd"
490 PRINT "FORWARD DIFFERENCES. YOU WILL BE ALLOWED TO INPUT"
500 PRINT "THE NUMBER OF LOOPS, WITH EACH LOOP INCREASING X BY 0.1."
510 PRINT
520 PRINT
530 PRINT "WHEN YOU ARE READY, HIT RETURN."
540 INPUT W$
550 PAGE
560 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
 100 INIT

110 REM* GREATEST COMMON DIVISOR ** MICHAEL VOICA

120 PAGE
130 PRINT "GREATEST COMMON DIVISOR  "
140 GOSUB 680
150 LET N3=0
160 PAGE
170 PRINT "INPUT THE AMOUNT OF NUMBERS THAT ARE GOING TO BE TESTED."
180 INPUT N4
190 DIM A(N4)
200 PRINT
210 PRINT
220 PRINT "INPUT YOUR ";N4;" VALUES"
230 PRINT "ENTER FIRST VALUE, THEN HIT RETURN"
240 LET N3=N3+1
250 INPUT A(N3)
260 IF N3>N4 THEN 320
270 IF N3+1=N4 THEN 300
280 PRINT "ENTER YOUR NEXT VALUE, AND HIT RETURN."
290 GO TO 240
300 PRINT "ENTER THE LAST VALUE, HIT RETURN AND WAIT."
310 INPUT A(N4)
320 PRINT
330 FOR I4=1 TO 160000
340     FOR I=2 TO N4
350         IF A(I-1)<=A(I) THEN 370
360         GO TO 390
370         IF A(I-1)>0 THEN 430
380         GO TO 470
390         LET C=A(I)
400         LET A(I)=A(I-1)
410         LET A(I-1)=C
420         GO TO 370
430         LET A(I)=A(I)-A(I-1)
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440     NEXT I
450 NEXT I4
460 IF N4=2 AND A(1)>0 THEN 520
470 IF A(2)>0 THEN 520
480 LET A(2)=A(2)+1
490 IF N4>2 THEN 510
500 GO TO 520
510 LET I=A(1)-A(2)
520 IF N4>2 THEN 550
530 PRINT A(2);
540 GO TO 560
550 PRINT A(1);

560 REM

570 PRINT " IS THE GREATEST COMMON DIVISOR    "
580 PRINT
590 PRINT
600 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
610 INPUT G$
620 IF G$="YES" OR G$="Y" THEN 150
630 IF G$="NO" OR G$="N" THEN 660
640 PRINT "PLEASE ANSWER YES OR NO!"
650 GO TO 610
660 FIND 15
670 OLD
680 PRINT
690 PRINT "THIS PROGRAM DETERMINES THE GREATEST COMMON DIVISOR FOR"
700 PRINT "A SERIES OF NUMBERS. YOU WILL BE ASKED TO FIRST INPUT"
710 PRINT "THE AMOUNT OF NUMBERS YOU WISH TO TEST, THEN THE NUMBERS"
720 PRINT "THEMSELVES. THE MACHINE WILL THEN RETURN THE GREATEST"
730 PRINT "COMMON DIVISOR."
740 PRINT
750 PRINT
760 PRINT "HIT RETURN WHEN YOU ARE READY TO CONTINUE."
770 INPUT E$
```

TITLE	ABSTRACT NO:
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```
780 PAGE
790 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM ** INTEGRATING A TABULATED FUNCTION ** MICHAEL VOICA

120 PAGE
130 GOSUB 540
140 PRINT
150 PRINT "ENTER THE NUMBER OF FIGURES WHICH YOU ARE GOING TO INPUT."
160 INPUT H1
170 PRINT
180 PRINT
190 DIM Y(H1)
200 LET A=0
210 LET B=0
220 PRINT
230 PRINT "INPUT YOUR NUMBERS."
240 FOR I=1 TO H1
250     INPUT Y(I)
260 NEXT I
270 LET A=A+Y(1)+Y(2)
280 LET B=B+Y(1)+4*Y(2)+Y(H1)
290 FOR I=3 TO H1-1 STEP 2
300     LET A=A+Y(I)+Y(I+1)
310     LET B=B+2*Y(I)+4*Y(I+1)
320 NEXT I
330 LET A1=0.2*A
340 LET B1=0.2*B/3
350 PRINT
360 PRINT
370 PRINT "APPROXIMATIONS TO INTEGRAL "
380 PRINT
390 PRINT "RECTANGULAR: ";A1
400 PRINT "PARABOLIC ";B1
410 PRINT
420 PRINT
430 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
```

TITLE	ABSTRACT NO:
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```
440 INPUT R$
450 IF R$="YES" OR R$="Y" THEN 480
460 IF R$="NO" OR R$="N" THEN 520
470 GO TO 500
480 PAGE
490 GO TO 140
500 PRINT "PLEASE ANSWER YES OR NO!"
510 GO TO 440
520 FIND 15
530 OLD
540 PRINT
550 PRINT " THIS PROGRAM USES THE RECTANGULAR RULE(SEE PAGE 70) AND"
560 PRINT "THE PARABOLIC RULE(SEE PAGE 73) IN ORDER TO EVALUATE THE"
570 PRINT "INTEGRAL OF THE EQUATION ON PAGE 79. YOU WANT TO COMPARE"
580 PRINT "TWO APPROXIMATIONS. YOU WILL BE ASKED TO INPUT YOUR "
590 PRINT "NUMBERS FOR THE EQUATIONS AS GIVEN."
600 PRINT
610 PRINT
620 PRINT "NOTE:"
630 PRINT "     YOU MUST HAVE AT LEAST 9 NUMBERS."
640 PRINT
650 PRINT
660 PRINT "WHEN YOU ARE READY, HIT RETURN."
670 PRINT
680 PRINT
690 INPUT J$
700 PAGE
710 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * INTERPOLATION  ** MICHAEL VOICA

120 PAGE
130 GOSUB 530
140 PRINT
150 PRINT "INPUT THE NO. OF LOOPS YOU DESIRE"
160 INPUT D5
170 IF D5>6 THEN 200
180 PRINT "YOU MUST HAVE AT LEAST 7 LOOPS!"
190 GO TO 160
200 DIM V(D5)
210 PAGE
220 PRINT
230 PRINT "THE INTERPOLATION TABLE IS:"
240 PRINT "--------------------------"
250 PRINT
260 PRINT
270 PRINT "TIME","EXACT","LINEAR","QUADRATIC"
280 PRINT "(SEC.)","SOLN.","APPROX","APPROX"
290 PRINT
300 FOR T=1 TO D5-1
310     LET V(T)=10*EXP(-T/20)
320 NEXT T
330 FOR T=3 TO D5-4 STEP 2
340     LET U=(V(T+1)-V(T-1))/2+V(T-1)
350     LET A=(V(T+3)-2*V(T+1)+V(T-1))/4
360     LET B=(V(T+3)-V(T-1))/4
370     LET C=V(T+1)
380     LET W=A-B+C
390     PRINT T,V(T),U,W
400 NEXT T
410 PRINT
420 PRINT
430 PRINT "DO YOU WISH TO TRY AGAIN.(YES OR NO)"
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 INPUT F$
450 IF F$="YES" OR F$="Y" THEN 490
460 IF F$="NO" OR F$="N" THEN 510
470 PRINT "PLEASE ANSWER YES OR NO!"
480 GO TO 440
490 PAGE
500 GO TO 140
510 FIND 15
520 OLD
530 PRINT
540 PRINT "THIS PROGRAM INTERPOLATES THE EQUATIONS ON PAGE 64."
550 PRINT " YOU WILL NOT BE REQUIRED TO FURNISH ANY DATA EXCEPT"
560 PRINT "FOR THE NUMBER OF NUMBERS YOU ARE GOING TO OUTPUT. THE"
570 PRINT "COMPUTER WILL DO THE REST."
580 PRINT
590 PRINT "NOTE:"
600 PRINT "  YOU MUST HAVE AT LEAST SEVEN(7) LOOPS."
610 PRINT
620 PRINT
630 PRINT "WHEN YOU ARE READY, HIT RETURN."
640 INPUT J$
650 PAGE
660 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * LARGEST NUMBER ** MICHAEL VOICA

120 PAGE
130 GOSUB 390
140 PRINT
150 PAGE
160 PRINT "INPUT HOW MANY NUMBERS YOU INTEND TO INPUT"
170 INPUT N
180 DIM X(N)
190 PRINT "INPUT YOUR ";N;" NUMBERS"
200 FOR I=1 TO N
210     INPUT X(I)
220 NEXT I
230 LET L=X(1)
240 FOR I=2 TO N
250     IF L>X(I) THEN 270
260     LET L=X(I)
270 NEXT I
280 PRINT
290 PRINT
300 PRINT "GREATEST VALUE IS ";L
310 PRINT "JJDO YOU WANT TO DO ANOTHER ? YES OR NO ";
320 INPUT E$
330 IF E$="YES" OR E$="Y" THEN 150
340 IF E$="NO" OR E$="N" THEN 370
350 PRINT "ANSWER YES OR NO!"
360 GO TO 320
370 FIND 15
380 OLD
390 PRINT
400 PRINT
410 PRINT "THIS PROGRAM FINDS THE LARGEST OF A SERIES OF NUMBERS."
420 PRINT "YOU WILL BE ALLOWED TO INPUT BOTH HOW MANY NUMBERS YOU WILL"
430 PRINT "USE, AND WHAT THOSE NUMBERS ARE."
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PRINT
450 PRINT
460 PRINT "WHEN YOU ARE READY,HIT RETURN."
470 INPUT F$
480 PAGE
490 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM* LEAST SQUARES PROBLEM ** MICHAEL VOICA

120 PAGE
130 PRINT "LEAST SQUARES PROBLEM"
140 PRINT "--------------------"
150 GOSUB 580
160 PAGE
170 PRINT
180 PRINT
190 LET S1=0
200 LET S2=0
210 LET S3=0
220 LET S4=0
230 PRINT "INPUT THE NO. OF SETS OF DATA"
240 PRINT
250 INPUT N
260 PRINT
270 PRINT
280 PRINT "INPUT YOUR ";N;" SETS OF DATA, IN ";N;" PAIRS"
290 PRINT "FIRST YOUR 'M' FACTOR, THEN YOUR 'B' FACTOR FOR THE EQUATION"
300 PRINT "Y=MX+B"
310 FOR I=1 TO N
320     INPUT X,Y
330     LET S1=S1+X
340     LET S2=S2+Y
350     LET S3=S3+X*Y
360     LET S4=S4+X↑2
370 NEXT I
380 LET S5=S1↑2
390 LET S6=N*S4
400 LET A=(S2*S4-S3*S1)/(S6-S5)
410 LET B=(N*S3-S1*S2)/(S6-S5)
420 PAGE
430 PRINT "FOR ";N;" SETS OF DATA "
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PRINT "THE LEAST SQUARES LINEAR"
450 PRINT "EQUATION IS"
460 PRINT
470 PRINT "Y=";B;"X";"+";A
480 PRINT
490 PRINT
500 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
510 INPUT B$
520 IF B$="YES" OR B$="Y" THEN 160
530 IF B$="NO" OR B$="N" THEN 560
540 PRINT "PLEASE ANSWER YES OR NO"
550 GO TO 510
560 FIND 15
570 OLD
580 PRINT
590 PRINT
600 PRINT "THIS PROGRAM SOLVES A SERIES OF LEAST SQUARES EQUATIONS"
610 PRINT "YOU WILL FIRST BE ASKED TO INPUT THE NO. OF EQUATIONS"
620 PRINT "TO BE USED(IN THE FORM OF Y=MX+B, YOU INPUT X AND B)"
630 PRINT "AND THEN INPUT THE POINTS."
640 PRINT
650 PRINT
660 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
670 INPUT H$
680 PAGE
690 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM* LORENZ CONTRACTION ** MICHAEL VOICA

120 PAGE
130 GOSUB 470
140 PRINT
150 PRINT
160 PRINT
170 PRINT "INPUT YOUR TIME(T=0 IS STARTING,NO. MUST BE SMALLER THAN 1)"
180 INPUT B
190 IF B=>1 THEN 170
200 PRINT "INPUT YOUR FINISHED TIME(MUST BE SMALLER THAN 1)"
210 INPUT S
220 IF S=>1 THEN 200
230 PRINT "INPUT INTERVAL FOR TABLE(MUST BE SMALLER THAN 1)"
240 INPUT L1
250 IF L1=>1 THEN 230
260 LET L=L1
270 GOSUB 690
280 PRINT " V/C","     L/LO"
290 FOR I=B TO L STEP S
300     LET X=SQR(1-I*I)
310     PRINT I,X
320 NEXT I
330 IF L=0.99 THEN 390
340 PRINT L
350 LET B=L+S/10
360 LET S=S/10
370 LET L=L+L/10
380 GO TO 290
390 PRINT "DO YOU WISH TO TRY AGAIN.";
400 PRINT "PLEASE ANSWER YES OR NO"
410 INPUT S$
420 IF S$="YES" OR S$="Y" THEN 170
430 IF S$="NO" OR S$="N" THEN 450
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 GO TO 400
450 FIND 15
460 OLD
470 PRINT
480 PRINT
490 PRINT "LORENZ CONTRACTION"
500 PRINT "-------------------"
510 PRINT
520 PRINT
530 PRINT "THE LORENZ CONTRACTION INDICATES THAT A BODY OF LENGTH Lo"
540 PRINT "MEASURED IN A REFERENCE FRAME AT REST WILL HAVE LENGTH L"
550 PRINT "WHEN MOVING WITH A CONSTANT VELOCITY V IN A DIRECTION"
560 PRINT "ALONG ITS OWN LENGTH, AS MEASURED BY AN OBSERVER AT REST."
570 PRINT "THE VALUE L IS GIVEN IS:"
580 PRINT "     L=Lo*SQR(1-(V↑2/C↑2))"
590 PRINT
600 PRINT "YOU WILL BE ASKED TO INPUT VALUES FOR STARTING TIME,"
610 PRINT "ENDING TIME, AND INTERVAL BETWEEN PRINTOUTS(IN SEC.)"
620 PRINT "THESE VALUES WILL BE USED TO DETERMINE Lo,V,AND C"
630 PRINT
640 PRINT
650 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
660 INPUT U$
670 PAGE
680 RETURN
690 PAGE
700 PRINT
710 PRINT " YOUR TABLE IS AS FOLLOWS,WITH:"
720 PRINT "     1-V=VELOCITY"
730 PRINT "     2-L=LENGTH"
740 PRINT "     3-C=YOUR OBSERVATION POINT"
750 PRINT "     4-Lo=LENGTH AT REST"
760 PRINT
770 PRINT
780 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * INVERSE, TRANSPOSE OF A MATRIX (Pg. 163) ** MICHAEL VOICA

120 PAGE
130 GOSUB 530
140 PAGE
150 PRINT
160 PRINT "INPUT YOUR MATRIX SIZE(eq:3,3 = 3X3)"
170 INPUT H
180 INPUT S
190 DIM A(H,S),B(H,S),C(H,S),I(H,S)
200 PRINT "J"," INPUT YOUR MATRIX, NO LARGER THAN 15 X 15"
210 PRINT "INPUTTING EACH NO. BY ROWS., ONE AT A TIME"
220 PRINT "JJ"
230 FOR T=1 TO H
240     FOR Y=1 TO S
250         INPUT A(T,Y)
260     NEXT Y
270 NEXT T
280 LET B=INV(A)
290 PAGE
300 PRINT "INVERSE OF A IS:"
310 PRINT
320 PRINT B;
330 LET C=TRN(A)
340 PRINT
350 PRINT
360 PRINT "THE TRANSPOSE IS"
370 PRINT
380 PRINT C
390 PRINT
400 PRINT
410 LET I=A MPY B
420 PRINT "A*TRANSPOSE(A) IS :"
430 PRINT I
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PRINT
450 PRINT "DO YOU WISH TO TRY ANOTHER(YES OR NO)"
460 INPUT A$
470 IF A$="YES" OR A$="Y" THEN 140
480 IF A$="NO" OR A$="N" THEN 510
490 PRINT "PLEASE ANSWER YES OR NO."
500 GO TO 460
510 FIND 15
520 OLD
530 PRINT
540 PRINT "THIS PROGRAM CALCULATES THE FOLLOWING:"
550 PRINT "     1-INVERSE OF A GIVEN MATRIX"
560 PRINT "     2-TRANSPOSE OF THAT MATRIX"
570 PRINT "     3-MATRIX MULTIPLIED BY ITS INVERSE"
580 PRINT
590 PRINT "YOU WILL BE REQUIRED TO INPUT THE MATRIX SIZE(eq:3,3=3X3)"
600 PRINT "AS WELL AS THE MEMBERS OF THE MATRIX(BY ROWS)"
610 PRINT
620 PRINT
630 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
640 INPUT J$
650 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * MATRIX MATH (Pg.162) ** MICHAEL VOICA

120 PAGE
130 GOSUB 490
140 PAGE
150 PRINT
160 PRINT "INPUT THE DIMENSIONS OF YOUR MATRIX(eq:3,3=3X3)"
170 INPUT V,F
180 DIM A(V,F),B(V,F),C(V,F)
190 PRI "INPUT YOUR FIRST MATRIX,BY ROWS(YOU MUST INPUT ";V*F;" NUMBERS"
200 PRINT
210 INPUT A
220 PRINT
230 PRI "INPUT THE SECOND MATRIX,BY ROWS(YOU MUST INPUT ";V*F;" NUMBERS"
240 PRINT
250 INPUT B
260 PAGE
270 PRINT
280 LET C=A+B
290 PRINT "MATRIX A + MATRIX B="
300 PRINT C
310 PRINT
320 PRINT
330 PRINT "MATRIX A - MATRIX B="
340 LET C=A-B
350 PRINT C
360 PRINT
370 PRINT
380 PRINT "MATRIX A * MATRIX B="
390 LET C=A MPY B
400 PRINT C
410 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
420 INPUT Q$
430 IF Q$="YES" OR Q$="Y" THEN 140
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 IF Q$="NO" OR Q$="N" THEN 470
450 PRINT "PLEASE ANSWER YES OR NO."
460 GO TO 420
470 FIND 15
480 OLD
490 PRINT
500 PRINT
510 PRINT "THIS PROGRAM CALCULATES THE FOLLOWING:"
520 PRINT "     1-ADDS 2 MATRICES"
530 PRINT "     2-SUBTRACTS TWO MATRICES"
540 PRINT "     3-MULTIPLIES TWO MATRICES"
550 PRINT
560 PRINT "YOU WILL BE REQUIRED TO SPECIFY THE MATRIX SIZE(eq:3,3=3x3)"
570 PRINT "AND THE MATRICES THEMSELVES, INPUTTING BY ROWS"
580 PRINT
590 PRINT "NOTE:"
600 PRINT "     YOU MUST INPUT THE ENTIRE ARRAY. IF YOU DIMENSION THE "
610 PRINT "ARRAY 3X3, YOU MUST INPUT 9 NUMBERS"
620 PRINT
630 PRINT
640 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
650 INPUT B$
660 PAGE
670 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * MEAN AND STAND. DEVIATION(Pg. 219) ** MICHAEL VOICA

120 PAGE
130 GOSUB 430
140 PAGE
150 LET N=0
160 LET S1=0
170 LET S2=0
180 PRINT "INPUT YOUR VALUES."
190 PRINT "REMEMBER, FOR NUMBERS OVER 1000 USE FLOATING POINT"
200 PRINT "WHEN YOU ARE THROUGH ENTER 9999"
210 INPUT X
220 IF X=9999 THEN 270
230 LET N=N+1
240 LET S1=S1+X
250 LET S2=S2+X*X
260 GO TO 210
270 LET M=S1/N
280 LET S=SQR((N*S2-S1*S1)/(N*(N-1)))
290 LET P=0.6745*S
300 PAGE
310 PRINT "JJJJJJJJJJJJJ"
320 PRINT "                    MEAN= ";M;"J"
330 PRINT "                    STANDARD DEVIATION=";S;"J"
340 PRINT "                    POSSIBLE ERROR=";P;"JJJJJ"
350 PRINT "DO YOU WANT TO DO ANOTHER ? YES OR NO ";
360 INPUT E$
370 IF E$="YES" OR E$="Y" THEN 140
380 IF E$="NO" OR E$="N" THEN 410
390 PRINT " ANSWER YES OR NO "
400 GO TO 360
410 FIND 15
420 OLD
430 PRINT
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 PRINT
450 PRINT " THIS PROGRAM DETERMINES THE MEAN AND STANDARD DEVIATION"
460 PRINT "FOR A SERIES OF NUMBERS,WHICH YOU INPUT"
470 PRINT "YOU ARE ALLOWED TO INPUT AN UNLIMITED AMOUNT OF NUMBERS"
480 PRINT "UP TO 1000. IF YOUR NUMBER IS LARGER, USE FLOATING POINT"
490 PRINT "(eg:1.23E05=123000)"
500 PRINT "WHEN YOU HAVE INPUT ALL YOUR NUMBERS, INPUT            "
510 PRINT "THE VALUE 9999."
520 PRINT
530 PRINT
540 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
550 INPUT B$
560 PAGE
570 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM* MONTE CARLO INTEGRATION ** MICHAEL VOICA

120 PAGE
130 GOSUB 460
140 PAGE
150 PRINT
160 PRINT
170 PRINT "PLEASE STAND BY."
180 PRINT
190 PRINT
200 LET C=0
210 FOR N=1 TO 10000
220     IF N<>2500 OR N<>7500 THEN 260
230     PRINT "PLEASE WAIT.";N/10000;"% DONE."
240     PRINT
250     PRINT
260     LET R=RND(-1)
270     LET S=RND(-1)
280     IF S<=SQR(1-R↑2) THEN 300
290     GO TO 310
300     LET C=C+1
310 NEXT N
320 PRINT "ACTUAL VALUE IS 0.785821"
330 PRINT
340 PRINT
350 PRINT "MONTE CARLO ESTIMATE"
360 PRINT "OF INTREGRAL=";C/N
370 PRINT
380 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
390 INPUT N$
400 IF N$="YES" OR N$="Y" THEN 140
410 IF N$="NO" OR N$="N" THEN 440
420 PRINT "PLEASE ANSWER YES OR NO!!!"
430 GO TO 390
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 FIND 15
450 OLD
460 PRINT
470 PRINT "MONTE CARLO INTEGRATION"
480 PRINT "-----------------------"
490 PRINT
500 PRINT
510 PRINT "THIS PROGRAM INTEGRATES A SIMPLE FUNCTION WHICH HAS A KNOWN"
520 PRINT "VALUE TO PERMIT US TO COMPARE THE NUMERICAL ESTIMATE WITH"
530 PRINT "THE EXACT VALUE. IN THIS CASE THE EXACT VALUE IS ";
540 GOSUB 620
550 PRINT "/4"
560 PRINT "OR 0.785398. THE EQUATION IS ON PAGE 92."
570 PRINT
580 PRINT
590 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
600 INPUT Z$
610 RETURN
620 MOVE 87.04,80
630 RMOVE 0,1
640 RDRAW 3,0
650 RMOVE -2,0
660 RDRAW 0,-2
670 RMOVE 1,2
680 RDRAW 0,-2
690 RMOVE 1,0
700 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * LAPLACE'S EQUATION ** MICHAEL VOICA

120 PAGE
130 GOSUB 510
140 LET U=0
150 FOR N=1 TO 100
160     LET X=3
170     LET Y=3
180     LET R=RND(-1)
190     LET S=RND(-1)
200     IF R<=0.5 THEN 230
210     IF S<=0.5 THEN 280
220     GO TO 300
230     IF S<=0.5 THEN 260
240     LET X=X-1
250     GO TO 310
260     LET X=X+1
270     GO TO 310
280     LET Y=Y+1
290     GO TO 310
300     LET Y=Y-1
310     IF X=1 THEN 360
320     IF Y=6 THEN 360
330     IF Y=1 THEN 370
340     IF X=6 THEN 370
350     GO TO 180
360     LET U=U+100
370 NEXT N
380 PRINT
390 PRINT "ESTIMATE OF SOLUTION "
400 PRINT "AT POINT 3,3 IS ";U/100
410 PRINT
420 PRINT
430 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 INPUT L$
450 IF L$="YES" OR L$="Y" THEN 140
460 IF L$="NO" OR L$="N" THEN 490
470 PRINT "PLEASE ANSWER YES OR NO"
480 GO TO 440
490 FIND 15
500 OLD
510 PRINT
520 PRINT "LAPLACE'S EQUATION"
530 PRINT "------------------"
540 PRINT
550 PRINT
560 PRINT "THIS PROGRAM DETERMINES THE POTENTIAL FUNCTION AT A POINT"
570 PRINT "GIVEN AT 3,3. SINCE THE BOUNDRIES ARE FOUR STEPS AWAY, ABOUT"
580 PRINT "EIGHT STEPS WILL BE REQUIRED TO TERMINATE EACH WALK."
590 PRINT "NO INPUT ON YOUR PART IS REQUIRED."
600 PRINT
610 PRINT
620 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
630 INPUT G$
640 PAGE
650 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT
110 PAGE

120 REM

130 GOSUB 590
140 PAGE
150 PRINT
160 PRINT "ENTER THE MASS OF THE OBJECT(IN GRAMS)"
170 INPUT M
180 PRINT "ENTER THE FORCE IMPOSED ON THE OBJECT(DYNES SEC./CM)"
190 INPUT K
200 PRINT "ENTER THE LENGTH OF THE RUN(IN SEC.)"
210 INPUT C
220 PRINT "ENTER THE DAMPING FORCE (DYNES SEC./CM)"
230 INPUT XO
240 PRINT "ENTER THE INITIAL POSITION"
250 INPUT VO
260 PRINT "ENTER HOW YOU WISH TABLE PRINTED(0.1 SEC., 1 SEC.,ETC)"
270 INPUT D
280 LET X1=XO
290 LET V1=VO
300 PRINT
310 PAGE
320 PRINT "TIME","POSITION","ERROR"
330 FOR T=0 TO 2 STEP D
340     LET W=SQR(99)/10
350     LET X=EXP(-T/10)*(10*COS(W*T)+1/W*SIN(W*T))
360     PRINT T,X1,X1-X
370     LET K1=V1
380     LET L1=-C*V1/M-K*X1/M
390     LET K2=V1+D*L1/2
400     LET L2=-C*(V1+D*L1/2)/M-K*(X1+D*K1/2)/M
410     LET K3=V1+D*L2/2
420     LET L3=-C*(V1+D*L2/2)/M-K*(X1+D*K2/2)/M
430     LET K4=V1+D*L3
```

TITLE	ABSTRACT NO:
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```
440     LET L4=-C*(V1+D*L3)/M-K*(X1+D*K3)/M
450     LET X2=X1+D*(K1+2*K2+2*K3+K4)/6
460     LET V2=V1+D*(L1+2*L2+2*L3+L4)/6
470     LET X1=X2
480     LET V1=V2
490 NEXT T
500 PRINT "JJ"
510 PRINT "DO YOU WISH TO TRY AGAIN."
520 INPUT Q$
530 IF Q$="YES" OR Q$="Y" THEN 130
540 IF Q$="NO" OR Q$="N" THEN 570
550 PRINT "PLEASE ANSWER YES OR NO."
560 GO TO 520
570 FIND 15
580 OLD
590 PRINT
600 PRINT "     THIS PROGRAM USES THE EULER'S METHOD TO SIMULATE A"
610 PRINT "DAMPED HARMONIC OSCILLATOR(SEE PAGES 108-110)."
620 PRINT
630 PRINT "YOU WILL BE ASKED TO INPUT THE FOLLOWING:"
640 PRINT
650 PRINT "     1-MASS OF THE OBJECT(GRAMS)"
660 PRINT "     2-DAMPING FORCE (DYNES SEC/CM)"
670 PRINT "     3-FORCE IMPOSED ON THE OBJECT(DYNES SEC./CM.)"
680 PRINT "     4-LENGTH OF THE RUN(SEC.)"
690 PRINT "     5-INITIAL POSITION"
700 PRINT "     6-INTERVAL FOR PRINTOUT(SEC.)"
710 PRINT "JJ"
720 PRINT "WHEN YOU ARE READY TO CONTINUE , HIT RETURN"
730 INPUT H$
740 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * PARTICLE DIFFUSION ** MICHAEL VOICA

120 PAGE
130 GOSUB 480
140 PAGE
150 PRINT
160 PRINT "                    PARTICLE DIFFUSION"
170 PRINT
180 PRINT
190 LET C=0
200 PRINT
210 PRINT "INPUT THE NUMBER OF TRIALS YOU DESIRE."
220 INPUT N
230 PRINT
240 PRINT
250 FOR I=1 TO N
260     LET X=0
270     LET R=RND(-1)
280     IF R>0.5 THEN 310
290     LET X=X-1
300     GO TO 320
310     LET X=X+1
320     IF X>10 THEN 340
330     IF X<0 THEN 350
340     LET C=C+1
350 NEXT I
360 PRINT "BASED ON ";N;" TRIALS"
370 PRINT "PROBABILITY OF A PENETRATION =";C/N
380 PRINT
390 PRINT
400 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
410 INPUT X$
420 IF X$="YES" OR X$="Y" THEN 140
430 IF X$="NO" OR X$="N" THEN 460
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PRINT "PLEASE ANSWER YES OR NO."
450 GO TO 410
460 FIND 15
470 OLD
480 PRINT
490 PRINT
500 PRINT "THIS PROGRAM WILL GIVE YOU THE PROBABILITY OF A      "
510 PRINT "NEUTRON DIFFUSION TAKING PLACE. THE PROGRAM PRINTS OUT"
520 PRINT "WHAT PORTION OF THE NEUTRONS PENETRATED, WHILE YOU INPUT"
530 PRINT "THE AMOUNT OF TRIALS YOU DESIRE."
540 PRINT
550 PRINT
560 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
570 INPUT U$
580 PAGE
590 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * PENDULUM(Pg.278) ** MICHAEL VOICA

120 PAGE
130 GOSUB 420
140 PAGE
150 GOSUB 620
160 PRINT "TIME","  ANGLE"," ANGULAR VELOCITY"
170 PRINT
180 LET Y=980/L
190 LET A1=A0
200 LET W1=W0
210 LET C=50
220 FOR T=0 TO 2 STEP D
230     IF C=>50 THEN 260
240     LET C=C+1
250     GO TO 280
260     PRINT T,A1,W1
270     LET C=1
280     LET A2=A1+W1*D
290     LET W2=W1-Y*SIN(A1)*D
300     LET A1=A2
310     LET W1=W2
320 NEXT T
330 PRINT
340 PRINT
350 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
360 INPUT M$
370 IF M$="YES" OR M$="Y" THEN 140
380 IF M$="NO" OR M$="N" THEN 400
390 GO TO 350
400 FIND 15
410 OLD
420 PRINT
430 PRINT
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PRINT "THIS PROGRAM TAKES AN UNDAMPED SIMPLE PENDULUM, AND USING"
450 PRINT "THE EQUATION OF MOTION(Pg. 122) WE WILL BE ABLE TO DESCRIBE"
460 PRINT "THE MOTION."
470 PRINT "YOU WILL INPUT THE FOLLOWING:"
480 PRINT "     1-PENDULUM LENGTH(L)"
490 PRINT "     2-PENDULUM MASS(M)"
500 PRINT "     3-ACCELERATION OF GRAVITY(G)"
510 PRINT "     4-ANGLE OF DISPLACEMENT(THETA)"
520 PRINT
530 PRINT
540 PRINT "YOU WILL ALSO BE ASKED TO INPUT A TIME INCREMENT(eq:EVERY"
550 PRINT "0.1 OF A SECOND)"
560 PRINT
570 PRINT
580 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
590 INPUT H$
600 PAGE
610 RETURN
620 PRINT
630 PRINT
640 PRINT "INPUT THE ANGLE OF DISPLACEMENT(THETA)"
650 INPUT AO
660 PRINT
670 PRINT "INPUT THE TIME(T)"
680 INPUT WO
690 PRINT
700 PRINT "INPUT THE LENGTH(L)"
710 INPUT L
720 PRINT
730 PRINT "INPUT THE ACCELERATION OF GRAVITY(G)"
740 INPUT D
750 PAGE
760 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM* POTENTIAL MAP ** MICHAEL VOICA

120 PAGE
130 GOSUB 640
140 PAGE
141 INIT
150 PRINT "THIS IS A POTENTIAL MAP"
160 PRINT
170 PRINT
180 PRINT "INPUT THE NUMBER OF LOOPS(T)"
190 INPUT N
200 DIM X(N),Y(N),Q(N)
210 GOSUB 780
220 FOR I=1 TO N
230     INPUT X(I),Y(I),Q(I)
240 NEXT I
250 PAGE
260 PRINT " ","         POTENTIAL MAP"
270 PRINT
280 PRINT
290 FOR V=4 TO -4 STEP -1
300     FOR U=-4 TO 4
310         LET A=0
320         FOR I=1 TO N
330             IF X(I)=U THEN 350
340             GO TO 430
350             IF Y(I)=V THEN 370
360             GO TO 430
370             LET A=1
380             IF Q(I)=>0 THEN 400
390             GO TO 420
400             PRINT "+     ";
410             GO TO 430
420             PRINT "-     ";
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
430          NEXT I
440          IF A=1 THEN 510
450          LET P=0
460          FOR I=1 TO N
470              LET P=P+Q(I)/SQR((U-X(I))↑2+(V-Y(I))↑2)
480          NEXT I
490          PRINT USING 500:INT(P)
500          IMAGE 4D.1D,1X,S
510      NEXT U
520      PRINT
530      PRINT
540 NEXT V
550 PRINT "JJ"
560 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
570 INPUT E$
580 IF E$="YES" OR E$="Y" THEN 140
590 IF E$="NO" OR E$="E" THEN 620
600 PRINT "PLEASE ANSWER YES OR NO."
610 GO TO 570
620 FIND 15
630 OLD
640 PRINT
650 PRINT
660 PRINT "THIS PROGRAM PRINTS A POTENTIAL MAP FROM A CHARGE "
670 PRINT "DISTRIBUTION. IT SHOWS THE POTENTIAL OF ALL UNOCCUPIED"
680 PRINT "SQUARES AS HAVING A CHARGE."
690 PRINT "YOU WILL BE ASKED TO INPUT THE FOLLOWING:"
700 PRINT "      1-THE NUMBER OF TRIALS(T)"
710 PRINT "      2-THE X,Y,AND Z COORDINATES FROM A SYSTEM(X,Y,Z)"
720 PRINT
730 PRINT
740 PRINT "WHEN YOU ARE READY TO CONTINUE,HIT RETURN"
750 INPUT V$
760 PAGE
770 RETURN
780 PRINT
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 Basic	51/00-5201/0

```
790 PRINT "INPUT YOUR VALUES FOR EACH RUN,FIRST YOUR X COORDINATE,"
800 PRINT "THEN YOUR Y COORDINATE, AND FINALLY YOUR Z COORDINATE."
810 PRINT "eq:3,5.2,0"
820 PRINT
830 PRINT "THESE ARE YOUR X,Y,Z VALUES"
840 PRINT "YOU MUST INPUT ONE SET OF 3 FOR EACH TRIAL."
850 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * PROBABILTY INTEGRAL ** MICHAEL VOICA

120 PAGE
130 GOSUB 350
140 PAGE
150 PRINT
160 PRINT "ENTER YOUR ERROR FUNCTION"
170 INPUT D
180 LET A=0
190 DEF FNA(X)=EXP(-X↑2)/2
200 LET A=A+FNA(0)+FNA(1)
210 FOR X=D TO 1-D STEP D
220     LET A=A+2*FNA(0.732658)
230 NEXT X
240 PRINT "THE VALUE OF THE INTEGRAL=";0.398942*A*D/2
250 PRINT
260 PRINT
270 PRINT "DO YOU WISH TO TRY ANOTHER RUN(YES OR NO)"
280 INPUT S$
290 IF S$="YES" OR S$="Y" THEN 140
300 IF S$="NO" OR S$="N" THEN 330
310 PRINT "PLEASE ANSWER YES OR NO"
320 GO TO 280
330 FIND 15
340 OLD
350 PRINT
360 PRINT
370 PRINT "THIS PROGRAM EXAMINES THE NORMAL PROBABLITY INTEGRAL"
380 PRINT "FOR THE EQUATION ON PAGE 73.YOU WILL BE ASKED TO INPUT ONLY"
390 PRINT "THE CHANGE IN X, WHICH IS THE ERROR FUNCTION."
400 PRINT
410 PRINT
420 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
430 INPUT V$
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440 PAGE
450 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM* PROJECTILE MOTION ** MICHAEL VOICA

120 PAGE
130 GOSUB 440
140 PRINT "PROJECTILE MOTION."
150 PRINT
160 PRINT
170 PRINT "INPUT YOUR INITIAL SPEED(V0)"
180 INPUT V0
190 PRINT
200 PRINT "INPUT YOUR ANGLE AT TIME OF FIRING(THETA)"
210 INPUT A
220 PAGE
230 GOSUB 580
240 PRINT "TABLE"
250 PRINT
260 PRINT
270 PRINT " T","   VX","    VY","    V"
280 PRINT
290 FOR T=0 TO 10
300     LET V1=V0*COS(A)
310     LET V2=V0*SIN(A)-32.2*T
320     LET V=SQR(V1↑2+V2↑2)
330     PRINT T,V1,V2,V
340 NEXT T
350 PRINT "JJ"
360 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
370 INPUT A$
380 IF A$="YES" OR A$="Y" THEN 140
390 IF A$="NO" OR A$="N" THEN 420
400 PRINT "PLEASE ANSWER YES OR NO!"
410 GO TO 370
420 FIND 15
430 OLD
```

TITLE

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ABSTRACT NO:

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```
440 PRINT
450 PRINT "PROJECTILE MOTION"
460 PRINT "-----------------JJ"
470 PRINT "THIS PROGRAM SIMULATES THE FIRING OF A PROJECTILE INTO THE"
480 PRI "AIR AT AN INITIAL SPEED OF VO AT AN ANGLE THETA WITH RESPECT "
490 PRINT "TO THE HORIZONTAL, AND DETERMINES ITS SUBSEQUENT MOTION."
500 PRINT "YOU WILL BE ASKED TO INPUT BOTH THE INITIAL SPEED(VO) AND"
510 PRINT "THE ANGLE(THETA), AND THE COMPUTER WILL CALCULATE THE REST"
520 PRINT "AND PRINT A TABLE RUNNING TO 10 SECONDS."
530 PRINT "JJ"
540 PRINT "WHEN YOU ARE READY TO CONTINUE HIT RETURN"
550 INPUT K$
560 PAGE
570 RETURN
580 PRINT
590 PRINT "VX=VO*COS(THETA)"
600 PRINT "VY=VO*SIN(THETA)-GRAVITATIONAL PULL"
610 PRINT "V=((VX↑2)+(VY↑2))↑0.5JJ"
620 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * RADIANCY INTEGRAL ** MICHAEL VOICA

120 PAGE
130 GOSUB 400
140 PAGE
150 PRINT "ENTER THE WIDTH OF EACH WAVELENGTH(TWO INPUTS(A & B))"
160 INPUT L1,L2
170 PRINT "INPUT THE NUMBER OF STRIPS((C),CAN NOT EQUAL 0)"
180 INPUT N
190 PRINT "INPUT THE BLACK BODY RADIATOR TEMPERATURE(IN DEGREES K)(T)"
200 INPUT T
210 LET D=(L2-L1)/N
220 PRINT "JJJJJJJJJJ"
230 DEF FNR(L)=3.75E-12/(L↑5*(EXP(1.44/(L*T))-1))
240 LET A=0
250 LET A=A+FNR(L1)+4*FNR(L1+D)+FNR(L2)
260 FOR L=L1+2*D TO L2-2*D STEP 2*D
270     LET A=A+2*FNR(L)+4*FNR(L+D)
280 NEXT L
290 PRINT "RADIANCY = ";D*A/3;" WATTS/SQUARE CM."
300 DATA 4.0E-5,7.0E-5,20,1000
310 PRINT "JJ"
320 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
330 INPUT F$
340 IF F$="YES" OR F$="Y" THEN 140
350 IF F$="NO" OR F$="N" THEN 380
360 PRINT "PLEASE ANSWER YES OR NO!"
370 GO TO 330
380 FIND 15
390 OLD
400 PRINT "JJ"
410 PRINT "RADIANCY INTEGRAL USES THE BLACK BODY LAW(SEE Pg.75-76)"
420 PRINT "TO CALCULATE THE RADIANCY IN THE VISIBLE WAVELENGTHS."
430 PRI "WE WILL USE THE PARABOLIC APPROXIMATION(Pg. 73, EQUATION 5-8)"
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

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```
440 PRINT "J"
450 PRINT "YOU WILL BE ASKED TO INPUT:"
460 PRINT "     1-NUMBER OF STRIPS(C)"
470 PRINT "     2-TEMPERATURE(IN DEGREES K)(T)"
480 PRINT "     3-SYSTEM OF UNITS BEING EMPLOYED(A & B)"
490 PRINT "JJ"
500 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
510 INPUT Z$
520 PAGE
530 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM* RANDOM WALK ** MICHAEL VOICA

120 PAGE
130 GOSUB 480
140 PAGE
150 PRINT "JJ"
160 PRINT "RANDOM WALK"
170 PRINT
180 PRINT
190 DIM A(41)
200 PRINT "INPUT THE NUMBER OF STEPS IN EACH WALK(0,1,3,ECT.)"
210 INPUT N
220 FOR J=1 TO 41
230     LET A(J)=0
240 NEXT J
250 PRINT "INPUT THE DESIRED NUMBER OF WALKS(INDIVIDUAL MOVEMENTS)"
260 INPUT N1
270 FOR M=1 TO N1
280     LET X=0
290     FOR J=1 TO N
300         LET R=RND(-1)
310         IF R=>0.5 THEN 340
320         LET X=X-1
330         GO TO 350
340         LET X=X+1
350     NEXT J
360     LET I=X+21
370     LET A(I)=A(I)+1
380 NEXT M
390 PRINT A
400 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
410 INPUT V$
420 IF V$="YES" OR V$="Y" THEN 140
430 IF V$="NO" OR V$="N" THEN 460
```

TITLE

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ABSTRACT NO:

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```
440 PRINT "PLEASE ANSWER YES OR NO!!!"
450 GO TO 410
460 FIND 15
470 OLD
480 PRINT
490 PRINT "RANDOM WALK"
500 PRINT "-----------"
510 PRINT "JJ"
520 PRINT "THIS PROGRAM IS USED TO INVESTIGATE DIFFUSION PROBLEMS."
530 PRINT "THE PROGRAM STARTS YOU FROM POINT M,N(PAGE 199,FIGURE 9-1)"
540 PRINT "ASSIGNS THAT POINT AS THE ORIGIN,AND THEN RANDOMLY SELECTS"
550 PRINT "TWO VALUES BETWEEN ZERO AND ONE. IF THE FIRST VALUE IS >0.5"
560 PRINT "THEN YOU TAKE ONE(1) STEP IN THE Y DIRECTION. IF THE"
570 PRINT "FIRST NUMBER IS <=0.5 THEN YOU TAKE ONE STEP IN THE X"
580 PRINT "DIRECTION."
590 PRINT
600 PRINT "     IF THE SECOND NUMBER IS <=0.5 THEN YOU TAKE ONE STEP"
610 PRINT "IN THE POSITIVE(+) DIRECTION, AND IF THE SECOND NUMBER IS"
620 PRINT ">0.5 , YOU TAKE ONE STEP IN THE NEGATIVE(-) DIRECTION."
630 PRINT
640 PRINT "     THE PROGRAM TAKES THE NUMBER OF WALKS(MOVEMENTS)"
650 PRINT "AND PRINTS ALL NON-ZERO TERMINATION FREQUENCIES FOR EACH"
660 PRINT "APPROPRIATE VALUE OF X."
670 PRINT
680 PRINT "   YOU WILL BE ALLOWED TO INPUT THE NUMBER OF WALKS, AND THE"
690 PRINT "NUMBER OF STEPS IN EACH WALK."
700 PRINT "JJ"
710 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
720 INPUT T$
730 PAGE
740 RETURN
```

TITLE	ABSTRACT NO:
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```
100 INIT

110 REM * 2 DIMENSIONAL RANDOM WALK ** MICHAEL VOICA

120 PAGE
130 GOSUB 620
140 PAGE
150 PRINT "JJ"
160 PRINT "INPUT THE NUMBER OF WALKS(MOVEMENTS) (A MUTIPLE OF 10) ";
170 INPUT N1
171 LET N2=N1/10
172 IF N2<>INT(N2) THEN 160
180 PAGE
190 PRINT
200 PRINT "SAMPLE","MAXIMUM EXTENSION"
210 PRINT "SIZE","FROM ORIGIN"
220 PRINT
230 LET E=0
240 LET X=0
250 LET Y=0
260 LET C=0
270 FOR N=1 TO N1
280     LET R=RND(-1)
290     LET S=RND(-1)
300     IF R<=0.5 THEN 320
310     GO TO 380
320     IF S<=0.5 THEN 340
330     GO TO 360
340     LET X=X+1
350     GO TO 420
360     LET X=X-1
370     GO TO 420
380     IF S<=0.5 THEN 410
390     LET Y=Y-1
400     GO TO 420
410     LET Y=Y+1
```

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```
420     LET L=SQR(X↑2+Y↑2)
430     IF L>E THEN 460
440     LET C=C+1
450     GO TO 480
460     LET E=L
470     GO TO 440
480     IF C=10 THEN 500
490     GO TO 520
500     PRINT N,E
510     LET C=0
520 NEXT N
530 PRINT "JJ"
540 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
550 INPUT R$
560 IF R$="YES" OR R$="Y" THEN 140
570 IF R$="NO" OR R$="N" THEN 600
580 PRINT "PLEASE ANSWER YES OR NO."
590 GO TO 550
600 FIND 15
610 OLD
620 PRINT
630 PRINT "2 DIMENSIONAL RANDOM WALK"
640 PRINT "-------------------------"
650 PRINT "JJ"
660 PRINT "     THIS PROGRAM IS USED TO INVESTIGATE THE MAXIMUM "
670 PRINT "EXCURSION FROM THE ORIGIN AS A FUNCTION OF A NUMBER OF"
680 PRINT "STEPS."
690 PRINT
700 PRINT "     THE COMPUTER SELECTS TWO NUMBERS BETWEEN 0 AND 1 AT"
710 PRINT "RANDOM. IF THE FIRST NUMBER IS BETWEEN 0 AND 0.5,THEN"
720 PRINT "YOU TAKE A STEP IN THE X DIRECTION. IF THE NUMBER IS"
730 PRINT "LARGER THAN 0.5, THEN YOU TAKE A STEP IN THE Y DIRECTION"
740 PRINT "(SEE PAGE 199,FIGURE 9-1)"
750 PRINT
760 PRINT "     IF THE SECOND NUMBER IS BETWEEN 0 AND 0.5, YOU THEN"
770 PRINT "TAKE ONE STEP IN THE POSITIVE(+) DIRECTION, AND IF THE "
```

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```
780 PRINT "SECOND NUMBER IS GREATER THAN 0.5, YOU TAKE A STEP IN THE "
790 PRINT "NEGATIVE(-) DIRECTION."
800 PRINT
810 PRINT "     THE PROGRAM TAKES THE NUMBER OF WALKS(MOVEMENT)"
820 PRINT "AND PRINTS ALL NON-ZERO TERMINATION FREQUENCIES FOR EACH"
830 PRINT "APPROXIMATE VALUE OF X"
840 PRINT
850 PRINT "YOU WILL INPUT ONLY THE NUMBER OF WALKS YOU WANT."
860 PRINT "JJ"
870 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
880 INPUT B$
890 RETURN
```

TITLE

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ABSTRACT NO:

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```
100 INIT

110 REM * REGRESSION ANALYSIS ** MICHAEL VOICA

120 PAGE
130 GOSUB 650
140 DIM A(3,3),B(3,1),C(3,1),D(3,3)
150 PAGE
160 PRINT "INPUT THE NUMBER OF SETS OF DATA YOU WILL BE USING"
170 PRINT
180 INPUT N
190 LET S1=0
200 LET S2=0
210 LET S3=0
220 LET S4=0
230 LET S5=0
240 LET S6=0
250 LET S7=0
260 PRINT "INPUT YOUR DATA, FIRST INPUTTING THE NUMERIC VALUES FOR"
270 PRINT "MATRIX A, THEN THE NUMERIC VALUES FOR MATRIX CJ"
280 FOR I=1 TO N
290     INPUT X,Y
300     LET S1=S1+X
310     LET S2=S2+X↑2
320     LET S3=S3+X↑3
330     LET S4=S4+X↑4
340     LET S5=S5+Y
350     LET S6=S6+X*Y
360     LET S7=S7+X*X*Y
370 NEXT I
380 LET A(1,1)=N
390 LET A(2,1)=S1
400 LET A(1,2)=A(2,1)
410 LET A(3,1)=S2
420 LET A(2,2)=S2
430 LET A(1,3)=S2
```

TITLE

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```
440 LET A(3,2)=S3
450 LET A(2,3)=S3
460 LET A(3,3)=S4
470 LET C(1,1)=S5
480 LET C(2,1)=S6
490 LET C(3,1)=S7
500 LET D=INV(A)
510 LET B=D MPY C
520 PAGE
530 PRINT "JJ"
540 PRINT "THE QUADRATIC REGRESSION LINE IS:JJ"
550 PRINT "Y=";B(1,1);"+";B(2,1);"X+";B(3,1);"X↑2"
560 PRINT "JJ"
570 PRINT "DO YOU WISH TO TRY ANOTHER(YES OR NO)"
580 INPUT D$
590 IF D$="YES" OR D$="Y" THEN 150
600 IF D$="NO" OR D$="N" THEN 630
610 PRINT "PLEASE ANSWER YES OR NO"
620 GO TO 580
630 FIND 15
640 OLD
650 PRINT "JJ"
660 PRINT "REGRESSION ANALYSIS"
670 PRINT "-------------------"
680 PRINT "JJ"
690 PRINT "     THIS PROGRAM FITS A QUADRATIC POLYNOMIAL TO A SET"
700 PRINT "OF DATA USING THE LEAST SQUARES APPROACH."
710 PRINT "     THE MATRIX SIZE HAS ALREADY BEEN SET AT TWO"
720 PRINT "MATRICES AT 3X3, AND 2 MATRICES 3X1. YOU WILL BE ASKED"
730 PRINT "TO LOAD IN THE MATRIX VALUES(N)."
740 PRINT
750 PRINT "NOTE:"
760 PRINT "     1-MATRIX A=3X3 MATRIX,AND FIRST ONE LOADED INTO "
770 PRINT "       COMPUTER."
780 PRINT "     2-MATRIX B=3X1 MATRIX, STORES THE ANSWER FOR THE"
790 PRINT "       EQUATION: MATRIX D * MATRIX C"
```

TITLE

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ABSTRACT NO:

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```
800 PRINT "     3-MATRIX C=3X1 MATRIX:SECOND MATRIX LOADED"
810 PRINT "     4-MATRIX D=3X3 MATRIX:STORES INVERSE OF MATRIX A"
820 PRINT
830 PRINT
840 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
850 INPUT H$
860 PAGE
870 RETURN
```

TITLE	ABSTRACT NO:
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```
100 INIT

110 REM * ROCKET(PAGE 286) ** MICHAEL VOICA

120 PAGE
130 GOSUB 650
140 INIT
150 PAGE
160 PRINT
170 PRINT "INPUT YOUR INITIAL THRUST(T1)J"
180 INPUT F
190 PRINT "INPUT THE RATE THE ROCKET WILL TRAVEL AT AFTER TAKEOFF(R)J"
200 INPUT R0
210 PRINT "INPUT INITIAL TIME(T)(eq:TIME 0=0)"
220 INPUT V0
230 PRINT "INPUT THE INITIAL MASS(M)."
240 INPUT M0
250 PRINT "INPUT THE RATE OF MASS LOSS TO THE ROCKET(E)J"
260 INPUT E
270 READ D
280 LET K=980*6.37E+8*6.37E+8
290 LET R1=R0
300 LET V1=V0
310 LET M=M0
320 LET T=0
330 IF F/M-K/R1↑2<0 THEN 520
340 LET Z1=R1+V1*D
350 LET Z2=V1+(F/M-K/R1↑2)*D
360 LET R2=R1+0.5*(V1+Z2)*D
370 LET V2=V1+0.5*(F/M-K/R1↑2+(F/M-K/Z1↑2))*D
380 LET M=M-E*D
390 LET T=T+D
400 IF M<=M0/2 THEN 440
410 LET R1=R2
420 LET V1=V2
430 GO TO 340
```

TITLE

Chemistry and Physics
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ABSTRACT NO:

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```
440 PRINT "INITIAL MASS =";M0;" GRAMS"
450 PRINT "THRUST=";F;" DYNES"
460 PRINT "RATE OF MASS LOSS=";E;" GRAMS/SEC."
470 PRINT "WHEN HALF THE MASS HAS BEEN EXHAUSTED"
480 PRINT "POSITION=";R2/6.37E+8;" EARTH RADII FROM THE EARTH'S CEN."
490 PRINT "VELOCITY=";V2/1.13E+7;" ESCAPE VELOCITY"
500 PRINT "TIME=";T;" SECONDS"
510 GO TO 570
520 PRINT "THRUST TOO SMALL FOR TAKEOFF."
530 DATA 5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
540 DATA 5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
550 DATA 5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
560 DATA 5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5
570 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
580 INPUT S$
590 IF S$="YES" OR S$="Y" THEN 140
600 IF S$="NO" OR S$="N" THEN 630
610 PRINT "PLEASE ANSWER YES OR NO."
620 GO TO 421
630 FIND 15
640 OLD
650 PRINT
660 PRINT "ROCKET"
670 PRINT "------"
680 PRINT "JJ"
690 PRINT "     THIS PROGRAM DESCRIBES THE RADIAL MOTION OF A ROCKET"
700 PRINT "WITH AN INITIAL MASS OF M, LOSING MASS AT THE RATE OF E,"
710 PRINT "THROUGH THE ENGINE PRODUCING A THRUST (T) DIRECTED TOWARDS"
720 PRINT "THE CENTER OF THE EARTH."
730 PRINT
740 PRINT "     YOU WILL BE ASKED TO INPUT:"
750 PRINT "          1-ROCKET'S INITIAL MASS(M)"
760 PRINT "          2-ROCKET'S LOSS OF MASS(E)"
770 PRINT "          3-INITIAL TIME OF TAKEOFF(T)"
780 PRINT "          4-THRUST(T1)"
790 PRINT "          5-RATE OF ROCKET AFTER TAKEOFF(R)"
```

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```
800 PRINT
810 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
820 INPUT S$
830 PAGE
840 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM* SIMULTANEOUS EQUATIONS ** MICHAEL VOICA

120 PAGE
130 GOSUB 380
140 PAGE
150 PRINT "SIMULTANEOUS EQUATIONS"
160 PRINT
170 PRINT
180 PRINT "INPUT A, B, C VARIABLES"
190 INPUT A,B,C
200 PRINT
210 PRINT "INPUT E, F, G VARIABLES"
220 INPUT D,E,F
230 LET Z=B*D-A*E
240 IF Z=0 THEN 290
250 LET X=(B*F-C*E)/Z
260 LET Y=(C*D-A*F)/Z
270 PRINT "ROOTS ARE ";X;" AND ";Y
280 GO TO 300
290 PRINT "NO SOLUTION"
300 PRINT "JJ"
310 PRINT "DO YOU WISH TO TRY AGAIN(YES OR NO)"
320 INPUT Q$
330 IF Q$="YES" OR Q$="Y" THEN 140
340 IF Q$="NO" OR Q$="N" THEN 360
350 PRINT "PLEASE ANSWER YES OR NO!"
360 FIND 15
370 OLD
380 PRINT "J"
390 PRINT "SIMULTANEOUS EQUATIONS"
400 PRINT "----------------------"
410 PRINT "JJ"
420 PRI "   THIS PROGRAM SOLVES FOR A PAIR OF SIMULTANEOUS EQUATIONS"
430 PRINT "THE TWO EQUATIONS ARE:"
```

TITLE	ABSTRACT NO:
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```
440 PRINT "     1-AX+BY=C, WHERE YOU INPUT A,B, AND C"
450 PRINT "     2-EX+FY=G, WHERE YOU INPUT E,F, AND G"
460 PRINT
470 PRINT "PLEASE NOTE THAT IF (B*E-A*F)=0, THERE WILL BE NO SOLUTION."
480 PRINT "JJ"
490 PRINT "WHEN YOU ARE READY TO CONTINUE HIT RETURN."
500 INPUT W$
510 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * SLIDING BODY ** MICHAEL VOICA

120 PAGE
130 GOSUB 480
140 PAGE
150 PRINT
160 PRINT "JINPUT THE INITIAL VELOCITY(K)"
170 INPUT K
180 PRINT "JINPUT THE RETARDING FORCE(M)"
190 INPUT M
200 PRINT "JRATE OF NORMAL ACCELERATION(A)."
210 INPUT V0
220 PRINT "JINPUT THE INTERVALS OF TIME TO BE PRINTED ON THE GRAPH(TI)"
230 INPUT D
240 PAGE
250 PRINT "JJ"
260 PRINT "TIME","VELOCITY","ERROR"
270 LET V1=V0
280 FOR T=0 TO 1 STEP D
290     LET V=V0*EXP(-K*T/M)
300     PRINT T,V1,V1-V
310     LET K1=-K*V/M
320     LET K2=-K*(V1+0.5*K1*D)/M
330     LET K3=-K*(V1+0.5*K2*D)/M
340     LET K4=-K*(V1+K3*D)/M
350     LET V2=V1+D*(K1+2*K2+2*K3+K4)/6
360     LET V1=V2
370 NEXT T
380 DATA 2,1,10,0.05
390 PRINT "JJ"
400 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
410 INPUT L$
420 IF L$="YES" OR L$="Y" THEN 140
430 IF L$="NO" OR L$="N" THEN 460
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 PRINT "PLEASE ANSWER YES OR NO!!"
450 GO TO 410
460 FIND 15
470 OLD
480 PRINT "J"
490 PRINT "SLIDING BODY"
500 PRINT "------------"
510 PRINT "JJ"
520 PRI "     THIS PROGRAM USES THE RUNGE KUTTA METHOD FOR FIRST ORDER"
530 PRI "EQUATIONS TO ILLUSTRATE WHAT WOULD HAPPEN TO AN OBJECT SLIDING"
540 PRINT "ON A SURFACE WHICH UNDERGOES A RETARDING FORCE PROPORTIONAL"
550 PRINT "TO ITS VELOCITY. EQUATIONS FOR THIS PROBLEM ARE ON PAGE"
560 PRINT "99."
570 PRINT
580 PRINT "     YOU WILL INPUT THE FOLLOWING:"
590 PRINT "          1-RATE OF NORMAL ACCELERATION(A)."
600 PRINT "          2-INTERVALS OF TIME TO BE PRINTED ON GRAPH(TI)."
610 PRINT "          3-VALUE FOR INITIAL VELOCITY(K)."
620 PRINT "          4-VALUE FOR RETARDING FORCE(M)."
630 PRINT "JJ"
640 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
650 INPUT H$
660 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * STATS SIMULATION(PAGE-205) ** MICHAEL VOICA

120 PAGE
130 GOSUB 470
140 PAGE
150 PRINT "JINPUT THE TOTAL NUMBER OF SAMPLES TO BE USED(Y)"
160 INPUT Y
170 PRINT "JINPUT THE INTERVAL FOR THE PRINTOUT(N)"
180 INPUT N1
190 PRINT "JJ"
200 PAGE
210 PRINT "POPULATION MEAN =0"
220 PRINT
230 PRINT "SAMPLE","SAMPLE"
240 PRINT "SIZE","MEAN"
250 PRINT
260 FOR N=10 TO Y STEP N1
270     LET S=0
280     FOR I=1 TO N
290         LET Y=0
300         FOR J=1 TO 12
310             LET Y=Y+RND(-1)
320         NEXT J
330         LET Y=Y-6
340         LET S=S+Y
350     NEXT I
360     PRINT N,S/N
370 NEXT N
380 PRINT
390 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
400 INPUT B$
410 IF B$="YES" OR B$="Y" THEN 140
420 IF B$="NO" OR B$="N" THEN 450
430 PRINT "PLEASE ENTER YES OR NO!!!"
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 GO TO 400
450 FIND 15
460 END
470 PRINT "J"
480 PRINT "STATISTICAL SIMULATION"
490 PRINT "----------------------"
500 PRINT "JJ"
510 PRINT "     THIS PROGRAM USES A NORMALLY DISTRIBUTED SEQUENCE TO"
520 PRINT "ILLUSTRATE THE EFFECT OF SAMPLING ERROR. THE EQUATIONS"
530 PRINT "ARE GIVEN ON PAGE 197, AND WE USE THEM TO GENERATE A "
540 PRINT "SEQUENCE OF RANDOM NUMBERS WHICH ARE DRAWN FROM A NORMAL"
550 PRINT "DISTRIBUTION WITH A MEAN OF 0, AND A VARIANCE OF 1."
560 PRINT "THE PROGRAM WILL THEN COMPUTE THE MEAN AFTER `N' SAMPLES,"
570 PRINT "UP TO `Y' SAMPLES, TO SHOW THAT AS THE SAMPLING POPULATION"
580 PRINT "APPROACHES A TRUE POPULATION, THE SAMPLING ERROR DECREASES."
590 PRINT
600 PRINT "      YOU WILL BE ASKED TO INPUT BOTH THE INTERVAL FOR THE"
610 PRINT "PRINTOUT(N), AND THE TOTAL AMOUNT OF SAMPLES TO BE USED(Y)"
620 PRINT "JJ"
630 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN."
640 INPUT G$
650 RETURN
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
100 INIT

110 REM * SQUARE ROOTS,SQUARED ** MICHAEL VOICA

120 PAGE
130 GOSUB 360
140 PAGE
150 PRINT "INPUT THE SMALLEST NO. OF THE TABLE(BEGINNING OF TABLE)"
160 INPUT T
170 PRINT "JINPUT THE LARGEST NO. OF THE TABLE(END OF TABLE)"
180 INPUT R
190 PRINT "JINPUT THE TABLE INTERVAL"
200 INPUT W
210 PAGE
220 PRINT
230 PRINT "X","X SQUARED","SQUARE ROOT OF X"
240 PRINT
250 FOR X=T TO R STEP W
260     PRINT X,X↑2,SQR(X)
270 NEXT X
280 PRINT "JJ"
290 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
300 INPUT E$
310 IF E$="YES" OR E$="Y" THEN 140
320 IF E$="NO" OR E$="N" THEN 350
330 PRINT "PLEASE ANSWER YES OR NO."
340 GO TO 300
350 FIND 15
351 OLD
352 END
360 PRINT
370 PRINT "     THIS PROGRAM GIVES YOU BOTH THE SQUARE ROOT, AND"
380 PRINT "THE SQUARE OF A NUMBER OR SERIES OF NUMBERS."
390 PRINT "YOU WILL BE ASKED TO INPUT:"
400 PRINT "     1-THE SMALLEST NUMBER(BEGINNING OF THE TABLE)"
410 PRINT "     2-THE LARGEST NUMBER(END OF THE TABLE)"
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
420 PRINT "     3-INTERVAL FOR PRINTOUT"
430 PRINT "JJ"
440 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
450 INPUT Y$
460 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM* RAY TRACING(PAGE 298) ** MICHAEL VOICA

120 PAGE
130 GOSUB 530
140 PAGE
150 INIT
160 LET I1=0
170 PRINT "INPUT THE SIZE OF YOUR MATRICES."
180 PRINT "REMEMBER, SINCE EACH MATRIX IS A PERFECT SQUARE, INPUT ONLY"
190 PRINT "ONE NUMBER."
200 INPUT S
210 DIM A(S,S),Y(S,S),Z(S,S)
220 LET N=4
230 LET Y=0
240 FOR I=1 TO S
250     LET Y(I,I)=1
260 NEXT I
270 GO TO 380
280 LET I1=I1+1
290 GO TO I1 OF 300,320,360,340
300 PRINT "INPUT MATRIX A(FIRST MATRIX)."
310 GO TO 370
320 PRINT "INPUT MATRIX B(SECOND MATRIX)."
330 GO TO 370
340 PRINT "INPUT MATRIX D(FINAL MATRIX)."
350 GO TO 370
360 PRINT "INPUT MATIX C(THIRD MATRIX)."
370 RETURN
380 FOR I=1 TO N
390     GOSUB 280
400     INPUT A
410     LET Z=Y MPY A
420     LET Y=Z
430 NEXT I
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
440 PRINT Y
450 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
460 INPUT O$
470 IF O$="YES" OR O$="Y" THEN 140
480 IF O$="N" OR O$="NO" THEN 510
490 PRINT "PLEASE ANSWER YES OR NO."
500 GO TO 460
510 FIND 15
520 OLD
530 PRINT
540 PRINT "RAY TRACING"
550 PRINT "-----------"
560 PRINT "JJ"
570 PRINT "     THIS PROGRAM USES MATRIX METHODS TO APPROXIMATE "
580 PRINT "FUNCTIONS IN THE GEOMETRIC OPTIONS. THIS APPLICATION USES"
590 PRINT "MATRICES TO TRACE A PARAXIAL RAY THROUGH A SYSTEM OF LENSES"
600 PRINT "AND SPACES. THE EQUATIONS FOR THIS PROBLEM ARE GIVEN ON"
610 PRINT "PAGE 191."
620 PRINT "     YOU WILL DIMENSION A SQUARE MATRIX(INPUT ONLY ONE(1)"
630 PRINT "NUMBER, SINCE THAT IS ALL THAT IS REQUIRED TO SQUARE THE"
640 PRINT "MATRICES (eg:FOR A 2X2 MATRIX, INPUT ONLY 2)."
650 PRINT
660 PRINT "     YOU ALSO MUST INPUT THE MATRIX VALUES INTO MATRIX A,"
670 PRINT "MATRIX B, MATRIX C,AND MATRIX D."
680 PRINT "J    THE COMPUTER WILL THEN PRINT OUT THE SYSTEM MATRIX."
690 PRINT
700 PRINT "NOTE:"
710 PRINT "    MATRICES A,B,C, AND D ALL REPRESENT EITHER A LENS, OR A"
720 PRINT "SPACE OF THE OPTICAL SYSTEM."
730 PRINT "JJ"
740 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
750 INPUT C$
760 RETURN
```

TITLE

Chemistry and Physics
Textbook Problems Adapted to 4051 BASIC

ABSTRACT NO:

51/00-5201/0

```
100 INIT

110 REM * VIBRATING STRING ** MICHAEL VOICA

120 PAGE
130 GOSUB 620
140 INIT
150 PAGE
160 DIM Y(10,5)
170 PRINT "JINPUT THE CHANGE IN X(X)"
180 INPUT X1
190 PRINT "JINPUT THE CHANGE IN T(T)"
200 INPUT K
210 READ D
220 FOR I=1 TO 10
230     LET Y(I,1)=0.01*SIN((I-1)*X1)
240 NEXT I
250 LET A=D↑2/(K*X1↑2)
260 FOR J=2 TO 5
270     LET Y(1,J)=0
280     LET Y(10,J)=0
290 NEXT J
300 FOR I=2 TO 9
310     LET Y(I,2)=0.5*(A*(Y(I-1,1)+Y(I+1,1))+2*(1-A)*Y(I,1))
320 NEXT I
330 FOR J=2 TO 4
340     FOR I=2 TO 9
350         LET Y(I,J+1)=A*(Y(I-1,J)+Y(I+1,J))+2*(1-A)*Y(I,J)-Y(I,J-1)
360     NEXT I
370 NEXT J
380 PAGE
390 FOR J=1 TO 5
400     PRINT
410     PRINT
420     PRINT "AT ";(J-1)*D;" SEC., THE DISPLACEMENTS ARE:"
430     PRINT
```

TITLE	ABSTRACT NO:
Chemistry and Physics Textbook Problems Adapted to 4051 BASIC	51/00-5201/0

```
440     FOR I=1 TO 10
450         PRINT USING 460:Y(I,J)
460         IMAGE-1D.7D,2X,S
470         IF I<>5 THEN 490
480         PRINT " "
490     NEXT I
500     PRINT
510     PRI "------------------------------------------------------------"
520 NEXT J
530 DATA 0.316228
540 PRINT "DO YOU WANT TO TRY AGAIN(YES OR NO)"
550 INPUT I$
560 IF I$="YES" OR I$="Y" THEN 140
570 IF I$="NO" OR I$="N" THEN 600
580 PRINT "PLEASE ANSWER YES OR NO."
590 GO TO 550
600 FIND 15
610 OLD
620 PRINT
630 PRINT "THIS PROGRAM SIMULATES A VIBRATING STRING. THE EQUATION FOR"
640 PRINT "THE STRING VIBRATIONS IS GIVEN ON PAGE 151. "
650 PRINT "YOU WILL BE ASKED TO INPUT THE FOLLOWING:"
660 PRINT "   (FROM EQUATION ON PAGE 151)"
670 PRINT
680 PRINT "     1- THE CHANGE IN X(X)"
690 PRINT "     2- THE CHANGE IN T(T)"
700 PRINT "JJ"
710 PRINT "WHEN YOU ARE READY TO CONTINUE, HIT RETURN"
720 INPUT S$
730 RETURN
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE		ABSTRACT NUMBER
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS		51/00-8005/1
ORIGINAL DATE	REVISION DATE 9/77	MEMORY REQUIREMENT 16K - See note below
AUTHOR Han Klinkspoor, Datatek Revised by Leland C. Sheppard, Sunnyvale, CA		PERIPHERALS 4631 Hard Copy Unit optional

ABSTRACT

Memory Requirement: 9K for the program; will run on 16K machine and chart programs with up to 170 branches. On 24K or 32K machines, it will chart programs with 700 or more branches.

This is a revised version of 51/00-8005/0; the purpose of the revision was to increase the speed of the program while reducing its appetite for memory. Some compromises were made to allow the program to be run on a 16K machine; these are described in the section on restrictions. The overall flow of the program was not modified from the original.

This program will flow chart any 4051 BASIC program from a tape file. It does the job in the following way:

In the first pass, a map of the branches is made to enable "look ahead" in the second pass. In the second pass, program lines are processed one at a time. The line number is stripped off and the branch table is examined to draw incoming or outgoing branches, if any. As each entry in the branch table is processed, the page number on which that reference occurred is plugged back into the branch table for subsequent printing. As the program is charted, the current page number and the starting and ending statement numbers shown on that page are printed on the bottom of the page.

Advantages: Runs about 3 times as fast in pass 2 as the old and requires about ½ the memory. It includes page number references in the branch table and the range of statement numbers shown on a page are printed with the page number at the bottom.

Restrictions: Limit of 4 character statement numbers to allow the program to run on a 16K machine. This may be modified to 5. Maximum of 20 FOR/NEXT loops unless modified to increase the limit. Page limit is 99 but may be modified.

TITLE	ABSTRACT NO:
FLOWCHART FOR 4051 BASIC PROGRAMS	51/00-8005/1

ABSTRACT for 4051 FLOWCHARTER. File 4/042

This is a rewrite of 51/00-8005/0; the purpose of the rewrite was to increase the speed of the program while reducing its appetite for memory. Some compromises were made to allow the program to be run on a 16K machine; please see the section on restrictions. The overall flow of the program was not modified from the original.

This program will flowchart any 4051 BASIC program from a tape file. It does the job in the following way:

In the first pass, a map of the branches is made to enable "look ahead" in the second pass.

In the second pass, program lines are processed one at a time. The line number is stripped off and the branch table is examined to draw incoming or outgoing branches, if any.

As each entry in the branch table is processed in pass 2 the page # on which that reference occurred is plugged back into the branch table for subsequent printing. As the program is charted the current page # and the starting and ending statement numbers that are shown on that page are printed at the bottom of the page.

The output from the printing of the branch table will look as follows:

BR#	FROM	PAGE	TO	PAGE		BR#	FROM	PAGE	TO	PAGE	
1	1	1	100	2		34	1700	12	4000	22	SUBR.CALL
2	8	1	7000	28	SUBR.CALL	35	1720	12	1910	14	
3	17	1	17	1		36	1750	12	1790	13	
4	32	1	8000	31		37	1760	13	1780	13	
5	40	2	1000	7		38	1770	13	1790	13	
6	280	3	8000	31	SUBR.CALL	39	1780	13	5000	25	SUBR.CALL
7	300	3	1000	7	INTERRUPT	40	1810	13	1860	14	

The detailed description of the FLOWCHARTERs function is as follows:

In the first pass all branches ("from" and "to" statement numbers) are stored in strings D$ ("from") and E$ ("to"). Strings J$ and K$ are used to store flags indicating sub-routine calls or interrupt service requests (to differentiate

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FLOWCHART FOR 4051 BASIC PROGRAMS	51/00-8005/1

them from normal branches).

Each element in D$ and E$ is 4 bytes; each in J$ and K$ is 2 bytes. The flags are contained in one of the 2; the 2nd will be used for page numbers during pass 2.

An example: (assume the first statement encountered in the program to be charted is "1 GO TO 100")

D$ positions 1-4: " 1" ("from" or origin)
E$ positions 1-4: " 100" ("to" or destination)
J$ positions 1-2: " " (no flags, not GOSUB)
K$ positions 1-2: " " (no flags, not ON)

No page numbers have been placed in J$ or K$ since we are still in pass 1 (they may not be printable anyway since they are stored in binary. More about that later).

Another example: assume the following:

D$ positions 41-44: " 510"
E$ positions 41-44: "3000"
J$ positions 21-22: "- "
K$ positions 21-22: " "

This would mean that branch #11 was a GOSUB in statement 510 to statement 3000 ("510 GOSUB 3000").

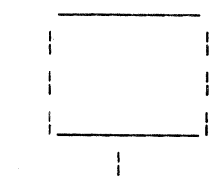
In the second pass program lines are processed one at a time. The statement number is stripped off and saved (if first or perhaps last on a page). The branch table is examined for incoming branches. The Basic Verb is checked and if it is different from the previous one a box is drawn around command(s) on the screen (this can result in several statements of a similar type in one box). The statement is then checked for outgoing branches, FOR/NEXT connections to be drawn, etc. At the point where the incoming and outgoing branch checks are made the current page number is stored in J$ (for incoming) or K$ (for outgoing) as a 1 byte binary counter. This technique was used as a memory saving device so that the FLOWCHARTER could be run on a 16K 4051. The functions used to convert to and from binary are ASC and

TITLE	ABSTRACT NO:
FLOWCHART FOR 4051 BASIC PROGRAMS	51/00-8005/1

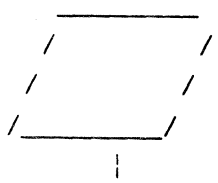
CHR. Paging is done by the program after drawing unsatisfied loops to continue over the page boundary. The page number is printed in the lower left corner along with the first and last statement numbers which appeared on that page.

Operation of the program is as follows: Load the program and type RUN. After a short delay during initialization the program will display the flowchart symbols used (the program does it graphically; it is reproduced here using print characters for illustration only).

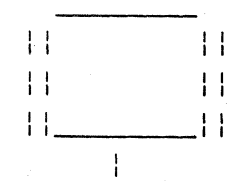
F L O W C H A R T S Y M B O L S



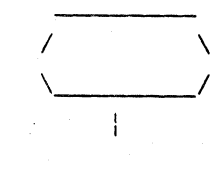
CALCULATION



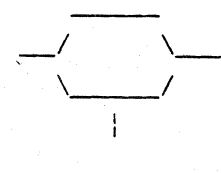
INPUT/OUTPUT OPERATION.



GRAPHICS.

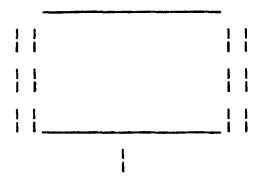


MISC.



CONDITIONAL BRANCH

TITLE	ABSTRACT NO:
FLOWCHART FOR 4051 BASIC PROGRAMS	51/00-8005/1



SUBROUTINE CALL.

(The graphics and subroutine call boxes are actually double boxes which could not readily be reproduced here.)

After a short pause the screen will page and a request for the file number of the program to be charted will appear:

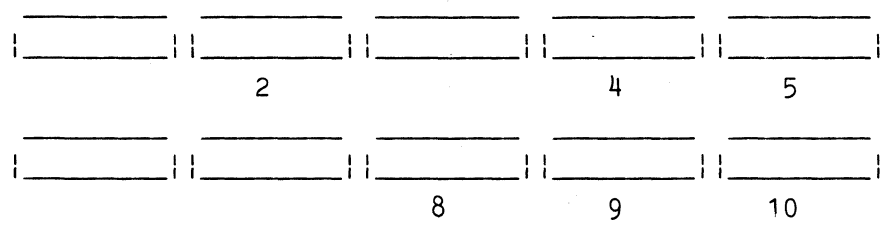
Specify File # to be flowcharted:

Respond with your program file #. The screen will clear.
At the end of pass 1 the following message will appear:

Flowchart between line numbers:

Respond with "1,9999" for the entire file or a range (less than that) of statement numbers of your choice.

The function keys available are as follows:



Key 2: Print the branch table (automatic on range 1-9999; use key when flowcharting part of program)

Key 4: Suspend execution (1 instruction loop where screen is left as is; useful for studying a page)

TITLE	ABSTRACT NO:
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Key 5: Run (Resume execution after Suspend; picks up where it left off)

Key 8: Display Symbols (same as starting display)

Key 9: End (terminate the run immediately)

Key 10: Restart Pass 2 (line number request is reissued so a new range can be specified if desired)

Memory Requirements: 9K for program; will run on a 16K machine and chart programs with up to 170 branches; on 24K or 32K machines it will chart programs with 700 or more branches.

Peripherals Required: None. 4631 Hardcopy optional.

Restrictions:

1. statement numbers 1-9999 allowed; modify N and alter the statements which initialize G$ and H$ to allow 5 character statement numbers (the limit of 4 was used to allow the program to run on a 16K machine).
2. Maximum of 20 FOR/NEXT loops can be handled in one program without modification; increase F and F$ and the respective initialization and search loops to increase this limit.
3. the page limit is 99 without modification to the image used to print the branch table; the page limit is 127 for the one byte binary counters.
4. when a partial range is specified for the 2nd pass the page number references in the branch table will be incomplete and will print (during branch table print) as page # 32; the flowcharter cannot distinguish between a blank (decimal 32) and a real page number (since J$ and K$ were initialized to blanks and never changed).
5. for those of you who may also have the original flowcharter the reason for changing variable names in this version was to save memory; using all single character variable

TITLE	ABSTRACT NO:
FLOWCHART FOR 4051 BASIC PROGRAMS	51/00-8005/1

names before using any 2 character names removed several hundred bytes from the size of the original program.

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
1 GO TO 100
8 GOSUB 7000
9 END
16 Z9=1
17 IF Z9=1 THEN 17
18 RETURN
20 Z9=0
21 RETURN
32 GO TO 8000
36 END
40 GO TO 1000

100 REM 4051 FLOWCHARTER. (C:03/042 A:04/042) File 2/042
110 REM Author: Han Klinkspoor, SA, Datatek, April 1976
120 REM  Rewrite: Leland C. (Chuck) Sheppard, July 1977

130 INIT

140 REM S=# of Branch References

150 S=400

160 REM N=length of max stmt #

170 N=4
180 DIM A$(171+1),C$(100+1),D$(S*N+1),E$(S*N+1),F$(40+1),Z$(52+1)
190 DIM F(20),I$(2+1),M$(2+1),L$(72+1),B$(3+1)
200 DIM H$(N+2),G$(N+2),J$(S*2+1),K$(S*2+1),N$(N+2),Y$(2+1),V$(2+1)
210 D$=""
220 E$=""
230 J$=""
240 FOR I=1 TO S*2/10
250     J$=J$&"          "
260 NEXT I
270 K$=J$
280 GOSUB 8000
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
290 PRINT USING "20(100(""""))ps":
300 ON EOF (0) THEN 1000

310 REM A$=Basic Command Names

320 G=0
330 A$="PRIINPWRIREAWBYRBYFINAPPSAVOLDSECTLIMARKILPAGHOMMOVDRARMORDR"
340 A$=A$&"AXIGINVIEWINSCAROTPOIINISETDIMFUZDEFON POLOFFDATRESRUNENDRET"
350 A$=A$&"STOWAICLOCOPFORNEXIF GO GOSCALLISDELRENREMIMALETMAT"
360 PRINT "Specify File # to be flowcharted:"
370 INPUT F3
380 PAGE

390 REM [Pass 1: build branch table]

400 FIND F3
410 INPUT @33:L$
420 IF LEN(L$)=0 THEN 410
430 A=POS(L$," ",1)+1
440 H$="    "
450 G$=SEG(L$,1,A-2)
460 H$=REP(G$,1+N-LEN(G$),LEN(G$))
470 C$=SEG(L$,A,3)
480 V=1
490 C=POS(A$,C$,V)
500 IF C=0 THEN 550
510 IF (C+2)/3=INT((C+2)/3) THEN 540
520 V=C+1
530 GO TO 490
540 C=(C+2)/3
550 IF C<47 OR C>49 AND C<>33 THEN 410
560 P=POS(L$," OF",A)+POS(L$,"TH",A)
570 P=(A+5)*(P=0)+(P+4)*(P<>0)
580 C$=SEG(L$,P,70)
590 G=G+1
600 IF G<=S THEN 640
```

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FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
610 PRINT "GGG# of branches >";S;", Program Mod Needed (Lines Below).J"
620 LIST 140,200
630 END
640 IF C<>49 THEN 660
650 J$=REP("-",G*2-1,1)
660 D$=D$&H$
670 PO=VAL(C$)
680 G$="    "
690 N$=STR(PO)
700 N$=SEG(N$,2,LEN(N$)-1)
710 G$=REP(N$,1+N-LEN(N$),LEN(N$))
720 E$=E$&G$
730 IF C<>33 THEN 750
740 K$=REP("-",G*2-1,1)
750 A=POS(C$,",",1)
760 IF A=0 THEN 410
770 C$=REP("",1,A)
780 GO TO 590

1000 REM [EOF reached]

1010 SET KEY
1020 F=-1
1030 F$=""
1040 FOR I=1 TO 4
1050     F$=F$&"          "
1060 NEXT I
1070 T=1
1080 PRINT "Flowchart between Line Numbers: "
1090 INPUT L1,L2

1100 REM [Pass 2: Chart]

1110 ON EOF (0) THEN 9000
1120 C$="B E G I N"
1130 O2=0
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
1140 H=53
1150 C=H
1160 X=65
1170 Y=100
1180 W=X
1190 M=0
1200 L=0
1210 FIND F3
1220 PAGE
1230 MOVE X,Y
1240 GO TO 1580
1250 INPUT @33:L$
1260 IF LEN(L$)=0 THEN 1250
1270 GOSUB 6000
1280 L=VAL(L$)
1290 IF L<L1 THEN 1250
1300 IF L>L2 THEN 9000
1310 H$="    "
1320 G$=STR(L)
1330 G$=SEG(G$,2,LEN(G$)-1)
1340 H$=REP(G$,1+N-LEN(G$),LEN(G$))

1350 REM Stmt # right aligned

1360 IF O2<>0 THEN 1380
1370 O2=L
1380 IF L>80 OR L/4<>INT(L/4) THEN 1440
1390 GOSUB 3000
1400 RMOVE 0,-2
1410 PRINT "HHHHHHHH**** Key #";L/4;" ****";
1420 MOVE X,U-4-4*(C<>48)
1430 GIN X,Y
1440 GOSUB 2000
1450 P=POS(L$," ",1)+1
1460 C$=SEG(L$,P,3)
1470 C=(POS(A$,C$,1)+2)/3
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
1480 IF C<>1 OR POS(L$,"@",P)=0 THEN 1510
1490 C$=SEG(L$,POS(L$,"@",P)+1,3)
1495 C$=REP("0",1,0)
1500 C=1+(VAL(C$)=32)*20.5
1505 C$=REP("",1,1)
1510 IF C=H AND (H<45 OR H>50) AND H<>39 AND H<>40 THEN 1530
1520 GOSUB 3000
1530 C$=SEG(L$,P,LEN(L$)-P+1)
1540 C$=REP("",1,ASC(C$)=32)
1550 I$=SEG(C$,LEN(C$),1)
1560 C$=REP("",LEN(C$),I$=" ")
1570 H=C
1580 IF C<>47 THEN 1620
1590 P=POS(C$,"TH",3)
1600 C$=SEG(C$,4,P-5)
1610 GOSUB 6000
1620 RMOVE 0,-2.8-2.5*(C=47)
1630 GIN X,U
1640 M=0
1650 IF C<>48 OR POS(C$,"OF",1)<>0 THEN 1730
1660 MOVE X,U+6.2
1670 W=64
1680 U=U+1.3
1690 M=1
1700 GOSUB 4000
1710 GIN A,Y
1720 GO TO 1910
1730 L0=LEN(C$)*0.896

1740 REM Look for Ctrl Characters if Print or $tring

1750 IF C=54 THEN 1790
1760 IF C=1 OR POS(C$,"$=",1)<>0 OR POS(C$,"POS(",1)<>0 THEN 1780
1770 IF C<>55 THEN 1790
1780 GOSUB 5000
1790 MOVE X-L0,U
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
1800 PRINT C$;
1810 IF C=46 THEN 1860
1820 IF C<>45 THEN 1870
1830 P=POS(C$,"=",5)
1840 V$=SEG(C$,P-2,2)
1850 GO TO 1870
1860 V$=SEG(C$,LEN(C$)-1,2)
1870 W=W MAX 70 MAX L0+65.6
1880 IF C<47 OR C>49 AND C<>33 THEN 1920
1890 GOSUB 4000
1900 IF U=>98 THEN 1920
1910 U=U-3*(C=47 OR C=48)
1920 MOVE X,U
1930 P2=L
1940 GO TO 1250

2000 REM [Incoming Branch Check]

2010 IF G=0 THEN 2300
2020 O=1
2030 I=POS(E$,H$,O)
2040 IF I=0 THEN 2290
2050 IF (I+N-1)/N=INT((I+N-1)/N) THEN 2080
2060 O=I+1
2070 GO TO 2030
2080 I=(I+N-1)/N
2090 Y$=CHR(T)
2100 K$=REP(Y$,I*2,1)
2110 GOSUB 3000
2120 GOSUB 6000
2130 MOVE X-60,Y
2140 PRINT USING "6d,""">"",s":I
2150 I$=SEG(J$,I*2-1,1)
2155 M$=SEG(K$,I*2-1,1)
2160 IF I$<>"-" THEN 2200
2170 PRINT "SUBR CALL";
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
2180 GO TO 2220
2200 IF M$<>"-" THEN 2220
2210 PRINT "INTERRUPT";
2220 RMOVE 12+16*(I$="-" OR M$="-"),1.3
2230 DRAW X,Y+1.3
2240 RDRAW 0,-4
2250 GIN X,Y
2260 U=Y
2270 I=I*N
2280 GO TO 2060
2290 GOSUB 6000
2300 RETURN

3000 REM [Draw Boxes]

3010 IF M THEN 3530
3020 U=U-0.5
3030 MOVE X,U
3040 A=(Y-U)/2+U
3050 B=2*X-W
3060 IF H<27 OR H=47 OR H=49 OR H=50 OR H>54 THEN 3250

3070 REM Misc Box

3080 PRINT @32,20:W,U,W+1,A,W,Y,B,Y,B-1,A,B,U,X,U
3090 IF H<>45 AND H<>46 THEN 3480
3100 MOVE W+1,A
3110 IF H=46 THEN 3190

3120 REM "For" Statement

3130 J=POS(F$,"  ",1)
3140 IF J=0 THEN 3470
3150 F$=REP(V$,J,2)
3160 PRINT @32,20:130-J,A
3170 F((J+1)/2)=A
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
3180 GO TO 3470

3190 REM "Next" Statement

3200 B=POS(F$,V$,1)
3210 PRINT @32,20:130-B,A,130-B,F(B/2)
3220 F$=REP("  ",B,2)
3230 F((B+1)/2)=-1
3240 GO TO 3470
3250 IF H>6 OR H<1 THEN 3290

3260 REM Box for I/O Operations

3270 PRINT @32,20:W,U,W+2,Y,B,Y,B-2,U,X,U
3280 GO TO 3480
3290 IF H=>1 AND H<15 OR (H>27 AND H<49) OR H>50 THEN 3390

3300 REM Calculation Box

3310 PRINT @32,20:W+1,U,W+1,Y,B-1,Y,B-1,U,X,U
3320 IF H<15 OR H>28 AND H<>49 AND H<>50 THEN 3480

3330 REM Graphic/Subroutine Call Box

3340 W=W+(H=49 OR H=50)
3350 B=B-(H=49 OR H=50)
3360 PRINT @32,20:X,U-0.5,W+0.5,U-0.5,W+0.5,Y+0.5,B-0.5,Y+0.5
3370 PRINT @32,20:B-0.5,U-0.5,X,U-0.5,X,U
3380 GO TO 3480
3390 IF H<>47 THEN 3470

3400 REM Decision Box Drawing

3410 IF U>15 OR Y-U>8.5 THEN 3440
3420 U=U-3
3430 MOVE X,U
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
3440 PRINT @32,20:W-4,U,W+4,Z,W-4,Y,X,Y,B+4,Y,B-4,Z,B+4,U,X,U
3450 MOVE W+4,Z+2
3460 PRINT "YES";
3470 MOVE X,U

3480 REM Box Done

3490 GIN X,Y
3500 Y=Y-4
3510 DRAW @32,20+(H>37 AND H<43):X,Y
3520 W=65
3530 M=1
3540 RETURN

4000 REM [Outgoing Branch Check]

4010 IF G=0 THEN 4300
4020 IF H=33 THEN 4100
4030 Z=U+1.5
4040 MOVE W+(H<>48 AND H<>49)*3+1,Z
4050 IF W<100 THEN 4080
4060 RDRAW 1,0
4070 GO TO 4090
4080 DRAW 110,Z
4090 RMOVE -0.8,-1.28
4100 O=1
4110 I=POS(D$,H$,O)
4120 IF I=0 THEN 4300
4130 IF (I+N-1)/N=INT((I+N-1)/N) THEN 4160
4140 O=I+1
4150 GO TO 4110
4160 I=(I+N-1)/N
4170 Y$=CHR(T)
4180 J$=REP(Y$,I*2,1)
4190 IF H<>33 THEN 4210
4200 PRINT "      INT SERVICE--";
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
4210 GIN P,U
4220 PRINT ">";I;
4230 IF U>10+5*(H=47) THEN 4270
4240 P2=L
4250 GOSUB 6000
4260 MOVE P,100
4270 RMOVE 0,-2.6
4280 I=I*N
4290 GO TO 4140
4300 RETURN

5000 REM [Convert Control Characters]

5010 FOR I=1 TO 8
5020     Q=1
5030     B$=SEG("HGIJKL↑ ",I,1)
5040     D=POS(C$,B$,Q)
5050     IF D=0 THEN 5120
5060     A=ASC(B$)
5070     B$=CHR(A+64)
5080     B$=B$&"H "
5090     C$=REP(B$,D,1)
5100     Q=D+3
5110     GO TO 5030
5120 NEXT I
5210 RETURN

6000 REM [Page Full]

6010 IF U>10+5*(H=47) THEN 6200
6020 GOSUB 3000
6030 FOR J=1 TO 20
6040     IF F(J)<0 THEN 6080
6050     PRINT @32,21:131-2*J,F(J)
6060     PRINT @32,20:131-2*J,0
6070     F(J)=100
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
6080 NEXT J
6090 MOVE 0,0
6100 PRINT T;" (";O2;"-";P2;")";
6110 T=T+1
6120 COPY
6130 PRINT USING "20(100("""""))ps":
6140 O2=L*(P2<>L)
6150 U=98
6160 W=X
6170 MOVE X,U+2
6180 DRAW X,U+0.5
6190 GIN X,Y
6200 RETURN

7000 REM [Print Branch Table]

7010 C$="3d,x,4a,2x,2d,x,4a,2x,2d,2x,9a,4x,s"
7020 PAGE
7030 IF G=0 THEN 7320
7040 FOR I=1 TO G/66+1
7050     A=(I-1)*66
7060     PAGE
7070     PRINT USING "2(""BR# FROM PAGE  TO PAGE"",14x),72(""="")":
7080     FOR K=A+1 TO A+33 MIN A+(G-A+1)/2
7090         B=33 MIN INT(0.5*(G-A))+(INT(G/2)<>G/2)
7100         FOR J=K TO K+B STEP B
7110             IF J>G THEN 7270
7120             L$=""
7130             I$=SEG(J$,J*2-1,1)
7140             IF I$<>"-" THEN 7170
7150             L$="SUBR.CALL"
7160             GO TO 7200
7170             M$=SEG(K$,J*2-1,1)
7180             IF M$<>"-" THEN 7200
7190             L$="INTERRUPT"
7200             G$=SEG(D$,J*N-N+1,N)
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
7210              H$=SEG(E$,J*N-N+1,N)
7220              I$=SEG(J$,J*2,1)
7230              P1=ASC(I$)
7240              M$=SEG(K$,J*2,1)
7250              P3=ASC(M$)
7260              PRINT USING C$:J,G$,P1,H$,P3,L$
7270          NEXT J
7280      NEXT K
7290      IF I+1>G/66+1 AND G-A<66 THEN 7310
7300      COPY
7310 NEXT I
7320 PRINT
7330 PRINT USING "20(100(""""))s":
7340 PRINT "# Branches: ";G
7350 COPY
7360 RETURN

8000 REM [Display Symbols]

8010 DATA 0,"CALCULATION.",3,"INPUT/OUTPUT OPERATION.",20,"GRAPHICS."
8020 DATA 30,"MISC.",47,"CONDITIONAL BRANCH.",49,"SUBROUTINE CALL.",-1
8030 RESTORE 8010
8040 PRINT USING """LJIF L O W C H A R T   S Y M B O L S""":
8050 Y=85
8060 X=25
8070 W=35
8080 M=0
8090 READ H
8100 U=Y-8
8110 Z=U+4*(H=47)
8120 IF H=-1 THEN 8210
8130 READ L$
8140 GOSUB 3000
8150 IF H<>47 THEN 8180
8160 MOVE 39,Z
8170 RDRAW 6,0
```

TITLE	ABSTRACT NO:
FLOWCHART PROGRAM FOR 4051 BASIC PROGRAMS	51/00-8005/1

```
8180 MOVE 60,Y+8
8190 PRINT L$;
8200 GO TO 8060
8210 HOME
8220 RETURN

9000 REM [End of Program]

9010 GOSUB 3000
9020 MOVE 0,0
9030 PRINT T;" (";O2;"-";P2;")";
9040 PRINT USING "20(100(""""))s":
9050 COPY
9060 PRINT USING "10(100(""""))s":
9070 IF L2<9999 THEN 9090
9080 GOSUB 7000
9090 END
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE		ABSTRACT NUMBER
Leroy Character Generator		51/00-8012/0
ORIGINAL DATE: 6/77	REVISION DATE:	MEMORY REQUIREMENT: 9705 bytes (full version)
AUTHOR: Mark Mehall		PERIPHERALS: 4662 (Optional)

ABSTRACT

This set of routines draws alphanumeric characters and special symbols on a 4051 or 4662. The characters and symbols can be any size, at any angle and may be positioned at any location on the screen or plotter surface. Since the routines do not interfere with the user's window and viewport, they can be used with existing programs for annotation. Labels can be placed on axes, points can be indicated, and legends can be added to graphs. There are 128 possible symbols, including upper and lower-case letters, numbers, sixteen centered symbols, and special characters. The routines also offer subscripts and superscripts, underlining, *italics*, tab settings, backspace and carriage return functions. The characters are similar to the Leroy style.

TITLE

Leroy Character Generator

ABSTRACT NO:

51/00-8012/0

DESCRIPTION

There are three routines in this package and one data file. The first routine (GOSUB 9000) initializes the tables used by the program from the data file. This routine should be used only once during each program. The second routine (GOSUB 9100) does the actual character generation. The routine requires three variables: C$ – the string of ASCII characters to be drawn, S – the size of the characters in Graphic Display Units (GDUs), and A – the angle (in degrees) of counterclockwise rotation. The third routine (GOSUB 9200) is an entry point to allow some special features to be used. It will be discussed later.

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

OPERATING INSTRUCTIONS

Insert the tape into the 4051 and load the program into memory. The user then must enter the parameter program to initialize the tables, set the angle, size the characters, define the character string, determine the X, Y point to begin the draw, followed with a GOSUB 9100 and END (see the 3 examples attached).

SAVING PARAMETER PROGRAMS

Parameter programs saved on a separate file must include a dummy 9000 REM statement. To run these with the Leroy Character Generator, load the parameter program FIND the # of the Leroy program and APPEND 9000.

LIMITATIONS

The Leroy program is coded to run on the 4051 Graphic Display Screen. If you are writing to the plotter, change line 9010 to read 9010 U9=1.

The explicit instructions for using the many features of this program follow the page of characters available (page 9).

TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

EXAMPLE #1 PROGRAM

```
100 REM INITIALIZE THE CHARACTER GENERATOR
110 GOSUB 9000
120 REM SET ANGLE TO 0
130 A=0
140 REM SET CHARACTER STRING
150 C$="A Character String"
160 REM SET THE SCALE TO 4 (GDUs)
170 S=4
180 REM MOVE TO THE BEGINNING LOCATION
190 MOVE 65,50
200 REM EXECUTE THE ROUTINE
210 GOSUB 9100
220 END
```

EXAMPLE #1 RESULT

A Character String

TITLE

Leroy Character Generator

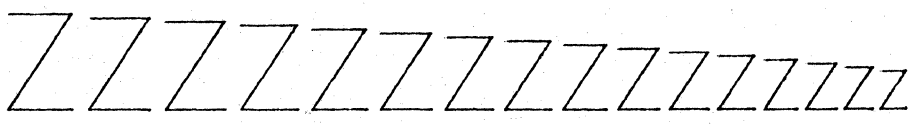
ABSTRACT NO:

51/00-8012/0

EXAMPLE #2 PROGRAM

```
100 REM SET ANGLE TO 0
110 A=0
120 REM SET CHARACTER STRING TO BE "Z"
130 C$="Z"
140 REM MOVE TO THE BEGINNING LOCATION
150 MOVE 65,50
160 REM SET THE SIZE OF THE STRING
170 FOR S=5 TO 2 STEP -0.2
180 REM EXECUTE THE ROUTINE
190 GOSUB 9100
200 NEXT S
210 END
```

EXAMPLE #2 RESULT



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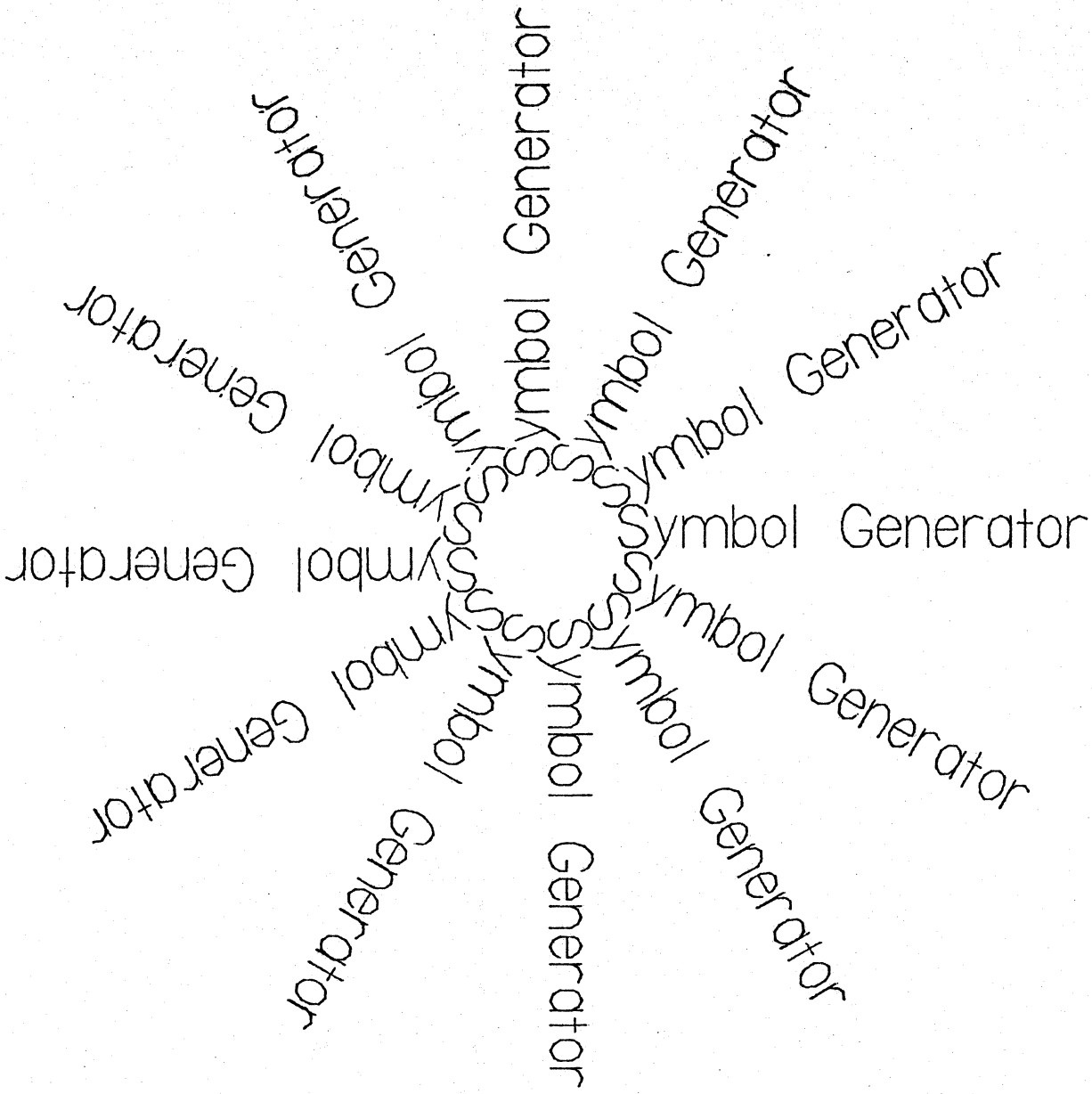
EXAMPLE #3 PROGRAM

```
100 REM SET CHARACTER STRING
110 C$="  Symbol Generator"
120 REM SET THE SCALE TO 2.5 (GDUs)
130 S=2.5
140 REM SET THE ANGLE
150 FOR A=0 TO 330 STEP 30
160 REM MOVE TO THE BEGINNING LOCATION
170 MOVE 65,50
180 REM EXECUTE THE ROUTINE
190 GOSUB 9100
200 NEXT A
210 END
```

TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

EXAMPLE #3 RESULT



TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

CHARACTERS AVAILABLE

There are 128 characters in this set of routines. The printable ASCII characters (decimal 32 through 126) may be obtained directly from the 4051 keyboard. The ASCII control codes (decimal 0 through 31) have been defined to produce special characters (see table). Decimal 0 through 15 are centered symbols and decimal 16 through 31 are mathematical characters. The control code characters can be obtained by using the CTRL key on the 4051. For example C$="A" (CTRL A) produces ⊙

There are two characters which cannot be obtained directly from the keyboard. Both decimal 13 and 127 must be defined using the CHR function (e.g. C$=CHR(127)).

TITLE

LEROY CHARACTER GENERATOR

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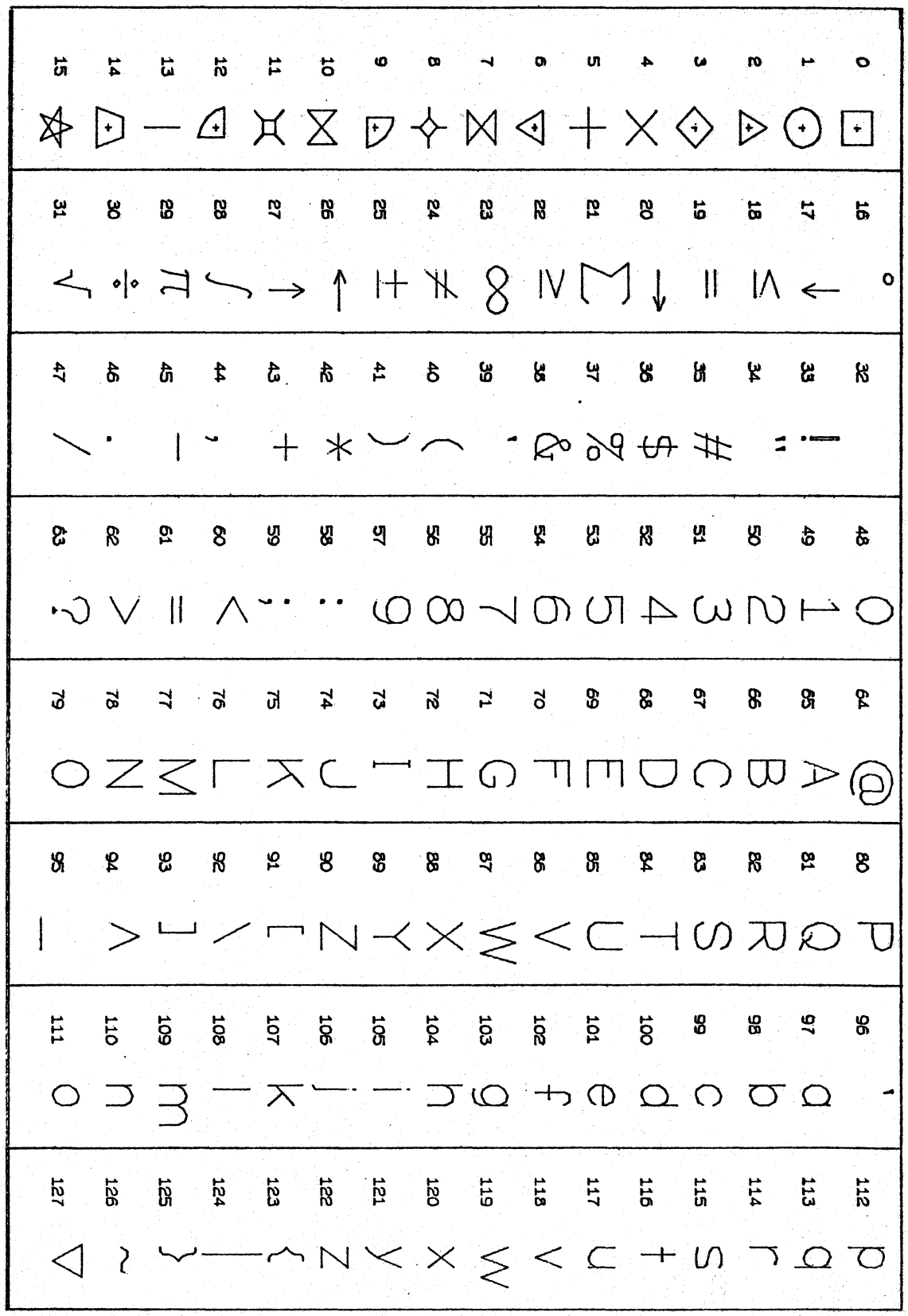

Characters Available

TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

FEATURES

The control character | is used to convey special instructions according to the character which follows the |. For example, |7 means to enter the subscript mode. If a | is followed by a character which is not defined as a code, it will be ignored. A single | is drawn if two of them appear successively. Control characters may appear anywhere in C$.

Superscripts and subscripts

If the characters |5, |6, |7, or |8, are encountered, an instruction regarding superscripts and subscripts is executed:

|5 means to enter the superscript mode;
|6 means to leave the superscript mode;
|7 means to enter the subscript mode;
|8 means to leave the subscript mode.

Superscripts may have subscripts or superscripts, etc. For example the string C$="P|52|6Q" produces the result:

$$P^{2}Q$$

and the string C$="e|5x|7k|8|52(n-1)|6|6dx|7k|8" produces the result:

$$e^{x_k^{2(n-1)}dx_k}$$

TITLE

Leroy Character Generator

ABSTRACT NO:

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Establishing a reference point and returning to it

If the characters |9 are encountered, the coordinates of the next available position are stored for future reference. If the characters |A are encountered, the drawing will continue at the position stored in the last reference to |9. If |9 has not used, the reference point is assumed to be the starting location used when GOSUB 9100 was invoked. Since GOSUB 9100 resets the reference point, GOSUB 9200 should be used with |9.

Tab

A single "tab setting" is provided. The position of the tab setting is established (or revised) by using the control characters |B in C$ when at the desired location. Any subsequent use of the control characters |C will cause the following characters to be drawn at a point directly below the point at which |B was invoked. If |B has not been used, it is assumed that the tab was set at the starting location when GOSUB 9100 was invoked. The tab (|C) is usually used with multiple calls to carriage return (see below). The "tab set" position is preserved from one call to GOSUB 9100 or GOSUB 9200 to another.

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Underlining

The underscoring of a word or a series of words is accomplished by the use of the code |9 to establish the beginning of the underscored material and the code |D to establish the end of the underscored material. For example the string C$="The |9title|D" produces the result:

The title

If |D is invoked without |9 ever having been used, underlining will start from the starting location when GOSUB 9100 was executed.

Backspace

If the characters |E are encountered, drawing will continue *starting at the beginning of the last drawn character.* Backspace may not be called meaningfully more than once in succession, since the only pertinent information stored is the beginning location of the last plotted character.

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Leroy Character Generator	51/00-8012/0

Carriage return

The control characters |F are used when drawing is to be resumed at a point located at 1.5*S below the beginning point of the previous execution of GOSUB 9100. Carriage returns may be used successively.

Italics

When a group of letters is to be *italicized*, the control characters |G are placed before the group and the control characters |H after the group, in C$. For example, the string C$="|Gtime|H, T" produces the result:

time, T

Italics are "carried over" from one call to GOSUB 9100 (or GOSUB 9200) to the next.

For example, the series of statements:

```
C$="|G"
GOSUB 9100
C$=STR(PI)
GOSUB 9200
C$="|H r|52"
GOSUB 9200
```

produces the result:

3.14159265359 r^2

TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

MEMORY REQUIREMENTS

The full version takes 9705 bytes of storage. The following can be used to decrease the amount of memory required:

1. Delete all REM statements (except 9000, 9100 and 9200). This version requires 6683 bytes.

2. Remove the special functions by deleting lines 9226 through 9364. This version uses 5334 bytes.

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9000 REM THIS ROUTINE INITIALIZES THE TABLES USE BY THE
9002 REM CHARACTER GENERATOR. IT SHOULD BE EXECUTED (ONCE) BEFORE
9004 REM THE CHARACTER GENERATOR IS USED. (i.e. GOSUB 9000)

9006 DIM N$(257),D$(513),M$(2279),E$(1),F$(1),G$(1)

9008 REM SET GRAPHIC DEVICE (DEFAULT IS SCREEN)

9010 U9=32
9011 PRINT "FILE # OF DATA? ";
9012 INPUT Z
9013 PAGE
9014 FIND Z
9016 READ @33:N$,D$,M$

9018 REM SET CODE FOR NO ITALICS

9020 I9=0
9022 RETURN

9100 REM ***CHARACTER GENERATOR ROUTINE*** 51/00-8012/0
9102 REM VARIABLES USED -
9104 REM   S - SCALE OF THE CHARACTERS IN GRAPHIC DISPLAY UNITS (GDUs)
9106 REM   C$ - ASCII CHARACTER STRING TO BE PLOTTED
9108 REM   A     - ANGLE (IN DEGREES) OF COUNTERCLOCKWISE ROTATION
9109 REM Z - DATA FILE #
9110 REM LOCAL VARIABLES USED -
9112 REM   X4,Y4    - TAB REFERENCE
9114 REM   X5,Y5    - GENERAL REFERENCE POINT ALSO UNDERLINE REFERENCE
9116 REM   X6,Y6    - CURRENT LOCATION
9118 REM   X7,Y7    - CHARACTER MOVES
9120 REM   X8,Y8    - STARTING CHARACTER STRING LOCATION USED FOR CR
9122 REM   X9,Y9    - WORK VARIABLES
9124 REM   S9,C9  - SIN(A) AND COS(A)
9126 REM   E$,F$,G$ - WORK STRINGS
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9128 REM   N$   - TABLE OF MOVES PER CHARACTER
9130 REM   D$   - TABLE OF INDEX INTO M$ AND WIDTH
9132 REM   M$   - CHARACTER MOVES
9134 REM   I9   - ITALICS CODE (1=ON  0=OFF)
9136 REM   L9,M9 - INDEX VARIABLES
9138 REM   P9   - DRAW CODE (1=MOVE 2=DRAW)
9140 REM   S8   - CORRECTED SCALE FACTOR
9142 REM   U9   - UNIT NUMBER OF GRAPHIC DEVICE (DEFAULT IS 32)
9144 REM   C8   - ASCII DECIMAL EQUIVALENT OF LETTER OF C$
9146 REM   W8   - CHARACTER WIDTH (IN GDUs) USED FOR BACKSPACE
9148 REM   N9,D9 - MISC. VARIABLES
9150 REM GET BEGINNING LOCATION

9152 INPUT @U9,_4:X6,Y6

9154 REM SAVE STARTING LOCATION

9156 X8=X6
9158 Y8=Y6

9160 REM SET REFERENCE POINT

9162 X5=X6
9164 Y5=Y6

9200 REM ENTRY POINT FOR BYPASSING THE GIN COMMAND
9202 REM THE CHARACTERS WILL BE DRAWN AT THE END OF THE LAST STRING
9204 REM CORRECT SCALE FACTOR FOR GDUs

9206 S8=S*1.25
9208 SET DEGREES

9210 REM ALL ANGLES IN DEGREES

9212 S9=SIN(A)
9214 C9=COS(A)
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9216 FOR L9=1 TO LEN(C$)

9218      REM GET A CHARACTER

9220      E$=SEG(C$,L9,1)
9222      C8=ASC(E$)

9224      REM CHECK FOR CONTROL CHARACTER

9226      IF C8<>124 THEN 9366
9228      L9=L9+1
9230      E$=SEG(C$,L9,1)
9232      C8=ASC(E$)

9234      REM CHECK FOR ANOTHER CONTROL CHARACTER, IF YES DRAW ONE

9236      IF C8=124 THEN 9366

9238      REM CHECK FOR 5 THROUGH 9

9240      IF C8<53 OR C8>57 THEN 9246
9242      GO TO C8-52 OF 9252,9262,9272,9282,9292

9244      REM CHECK FOR A THROUGH G

9246      IF C8<65 OR C8>72 THEN 9520
9248      GO TO C8-64 OF 9300,9308,9316,9324,9332,9340,9356,9362

9250      REM ENTER SUPERSCRIPT MODE (CODE 5)

9252      Y6=Y6+S8*0.3333*C9
9254      X6=X6-S8*0.3333*S9
9256      S8=S8*0.6
9258      GO TO 9518

9260      REM LEAVE SUPERSCRIPT MODE (CODE 6)
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9262      S8=S8*1.6667
9264      Y6=Y6-S8*0.3333*C9
9266      X6=X6+S8*0.3333*S9
9268      GO TO 9518

9270      REM ENTER SUBSCRIPT MODE (CODE 7)

9272      Y6=Y6-S8*0.2667*C9
9274      X6=X6+S8*0.2667*S9
9276      S8=S8*0.6
9278      GO TO 9518

9280      REM LEAVE SUBSCRIPT MODE (CODE 8)

9282      S8=S8*1.6667
9284      Y6=Y6+S8*0.2667*C9
9286      X6=X6-S8*0.2667*S9
9288      GO TO 9518

9290      REM ESTABLISH REFERENCE POINT (CODE 9)

9292      X5=X6
9294      Y5=Y6
9296      GO TO 9520

9298      REM RETURN TO REFERENCE POINT (CODE A)

9300      X6=X5
9302      Y6=Y5
9304      GO TO 9518

9306      REM ESTABLISH TAB REFERENCE (CODE B)

9308      X4=X6-X8
9310      Y4=Y6-Y8
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9312      GO TO 9520

9314      REM TAB OPERATOR (CODE C)

9316      X6=X4+X8
9318      Y6=Y4+Y8
9320      GO TO 9518

9322      REM UNDERLINE (CODE D)

9324      PRINT @U9,21:X6+0.2667*S8*S9,Y6-0.2667*S8*C9
9326      PRINT @U9,20:X5+0.2667*S8*S9,Y5-0.2667*S8*C9
9328      GO TO 9518

9330      REM BACKSPACE (CODE E)

9332      X6=X6-X9*C9
9334      Y6=Y6-X9*S9
9336      GO TO 9518

9338      REM CARRIAGE RETURN (CODE F)

9340      X9=X8+1.5*S8*S9
9342      Y9=Y8-1.5*S8*C9
9344      X6=X9
9346      Y6=Y9
9348      X8=X9
9350      Y8=Y9
9352      GO TO 9518

9354      REM ITALICS MODE (CODE G)

9356      I9=1
9358      GO TO 9520

9360      REM NO ITALICS (CODE H)
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9362     I9=0
9364     GO TO 9520
9366     P9=2
9368     N9=C8*2+1
9370     E$=SEG(N$,N9,1)
9372     F$=SEG(N$,N9+1,1)
9374     N9=ASC(E$)*16+ASC(F$)
9376     D9=C8*4+1
9378     E$=SEG(D$,D9,1)
9380     F$=SEG(D$,D9+1,1)
9382     G$=SEG(D$,D9+2,1)
9384     W8=D9
9386     D9=ASC(E$)*256+ASC(F$)*16+ASC(G$)
9388     D9=D9*2+1
9390     E$=SEG(D$,W8+3,1)
9392     W8=ASC(E$)
9394     FOR M9=D9 TO D9+2*N9-1 STEP 2
9396         X$=SEG(M$,M9,1)
9398         X7=ASC(X$)
9400         Y$=SEG(M$,M9+1,1)
9402         Y7=ASC(Y$)

9404         REM CHECK FOR SPECIAL CODE

9406         IF X7=15 THEN 9474

9408         REM OFFSET FOR NONCENTERED SYMBOLS

9410         X7=X7-1
9412         Y7=Y7-3

9414         REM CHECK FOR CENTERED SYMBOLS

9416         IF C8>16 THEN 9426
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9418          REM OFFSET FOR CENTERED SYMBOLS

9420          Y7=Y7-6
9422          X7=X7-6

9424          REM ITALICIZE IT

9426          IF I9=0 THEN 9432
9428          X7=X7+0.3*Y7

9430          REM ROTATE IT

9432          IF A=0 THEN 9444
9434          X9=-Y7*S9+X7*C9
9436          Y9=Y7*C9+X7*S9
9438          X7=X9
9440          Y7=Y9

9442          REM SCALE IT

9444          X9=X7*0.06667*S8+X6
9446          Y9=Y7*0.06667*S8+Y6
9448          X7=X9
9450          Y7=Y9

9452          REM CHECK FOR A MOVE

9454          IF P9=2 THEN 9464

9456          REM DRAW IT

9458          PRINT @U9,20:X7,Y7
9460          GO TO 9468

9462          REM MOVE TO IT
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9464          PRINT @U9,21:X7,Y7

9466          REM RESET DRAW CODE

9468          P9=1
9470          GO TO 9500

9472          REM SPEC CODE X7=15

9474          GO TO Y7+1 OF 9482,9498,9490
9476          GO TO 9500

9478          REM MOVE CODE
9480          REM Y7=0

9482          P9=2
9484          GO TO 9500

9486          REM Y7=2
9488          REM INCREASE SCALE FACTOR

9490          S8=S8*2
9492          GO TO 9500

9494          REM Y7=1
9496          REM DECREASE SCALE FACTOR

9498          S8=S8*0.5
9500      NEXT M9

9502      REM CHECK FOR CENTERED SYMBOL (RETURN TO CENTER OF SYMBOL)

9504      IF C8<17 THEN 9518

9506      REM CALCULATE WIDTH OF CHARACTER
```

TITLE	ABSTRACT NO:
LEROY CHARACTER GENERATOR	51/00-8012/0

```
9508      X9=W8*0.06667*S8

9510      REM CALCULATE NEXT LOCATION

9512      Y6=Y6+X9*S9
9514      X6=X6+X9*C9

9516      REM MOVE TO IT

9518      PRINT @U9,21:X6,Y6
9520 NEXT L9
9522 RETURN
```

TITLE	ABSTRACT NO:
Leroy Character Generator	51/00-8012/0

REMARKS

This set of routines is based on a program developed at the University of Illinois by J. W. Phillips. Please send any comments or suggestions to:

Mark Mehall
Tektronix, Inc.
5350 Keystone Court
Rolling Meadows, Ill. 60008

TEKTRONIX®

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APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
FLOW DIAGRAMMER	51/00-8015/0
ORIGINAL DATE: 12/77 / REVISION DATE:	MEMORY REQUIREMENT: 16K (Option 20)
AUTHOR: Keith S. Reid-Green, Educational Testing Service	PERIPHERALS: 4662 Plotter

ABSTRACT

This program is used to design, store, recall and modify flow diagrams for use in program and system documentation.

A diagram consists of a heading, ten different box types, their connecting lines and labeling. Boxes and lines may be solid or dotted and may be arranged up to four across and nine deep on a page.

The first 62 files of a tape must be dedicated to this program.

Statements: 915

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

TABLE OF CONTENTS

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Description: The program consists of five phases:

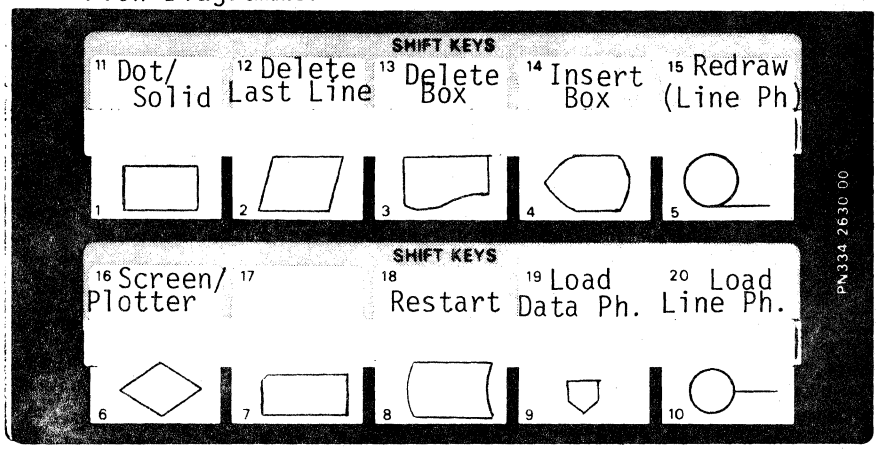
PHASE	FUNCTION
1.	Main menu and function keys
2.	Enter boxes
3.	Connect, insert, delete boxes
4.	Enter box data and heading
5.	Store or retrieve diagrams

These phases are stored on files 1 - 5 of the magnetic tape. Files 6 through 42 contain information about the current diagram; file 6 contains the diagram heading, or title, the box definition array Z and the number of connectors Z1. Files 43 through 62 are used to store diagrams.

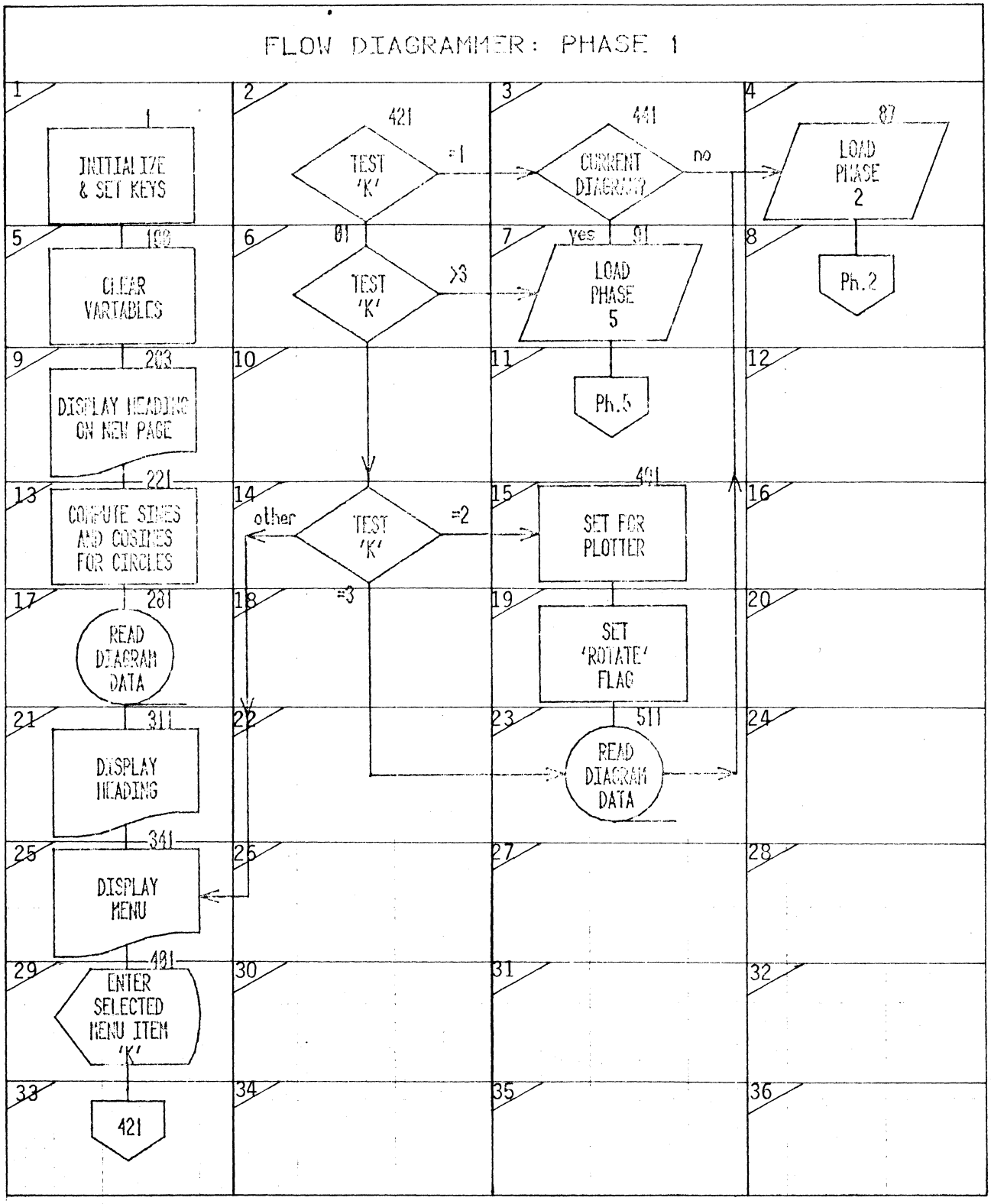
The user should arrive at the terminal with a rough-flow diagram drawn on the diagramming matrix form. (Page 3)

TITLE	PART NUMBER
FLOW DIAGRAMMER	51/00-8015/0

TITLE Flow Diagrammer TAPE # FILE #



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

To begin the program, press 'AUTO LOAD'. If the magnetic tape does not move immediately, press 'BREAK' twice, then press 'AUTO LOAD'. After a few seconds, the words 'FLOW DIAGRAMMER' will appear near the top of the screen and the tape will move. Then either the message 'There is no current diagram' or 'Current diagram is (title)' will appear, followed by the menu:-

F L O W D I A G R A M M E R

There is no current diagram

Enter:

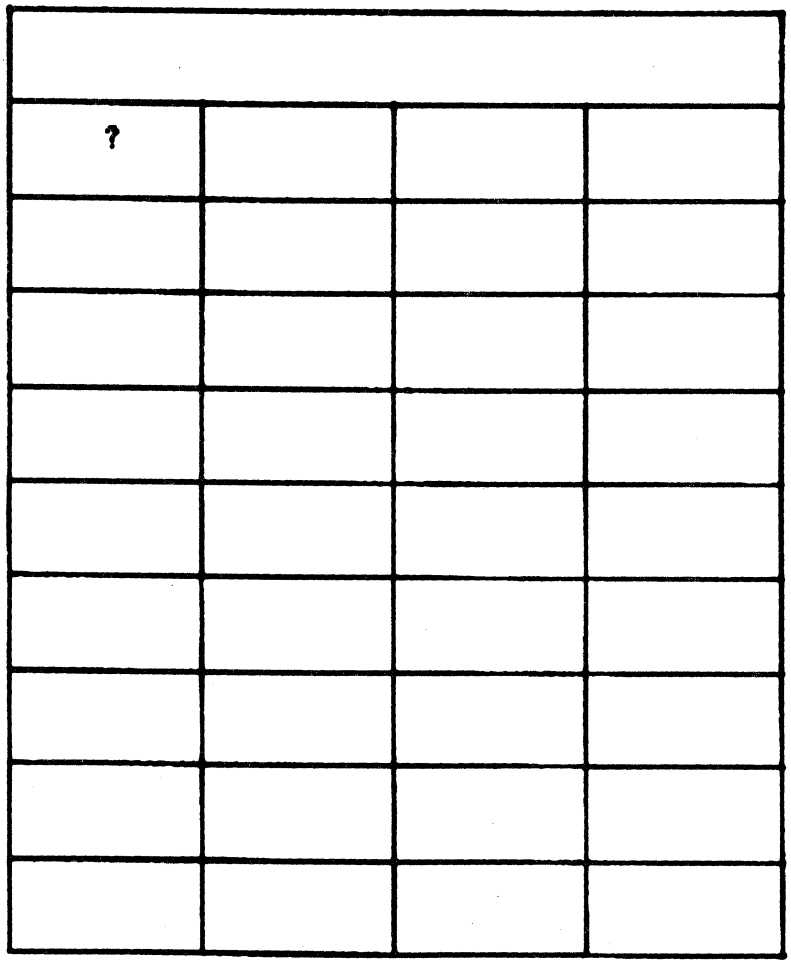
1 to start a new diagram
2 to redraw current diagram
3 to change current diagram
4 to retrieve a stored diagram
5 to destroy part or all of stored data:

If there is no current diagram, selecting menu items 2 or 3 makes no sense. Selecting item 1 will ititiate phase 2, selecting 4 or 5 will initiate phase 5.

If a current diagram exists, selecting 1, 4 or 5 will initiate phase 5, selecting 2 will cause the current diagram to be plotted, and selecting 3 will initiate phase 3. If 2 is selected, a piece of 11 x 16 inch paper must be in place on the plotter and the plotter otherwise prepared for action.

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

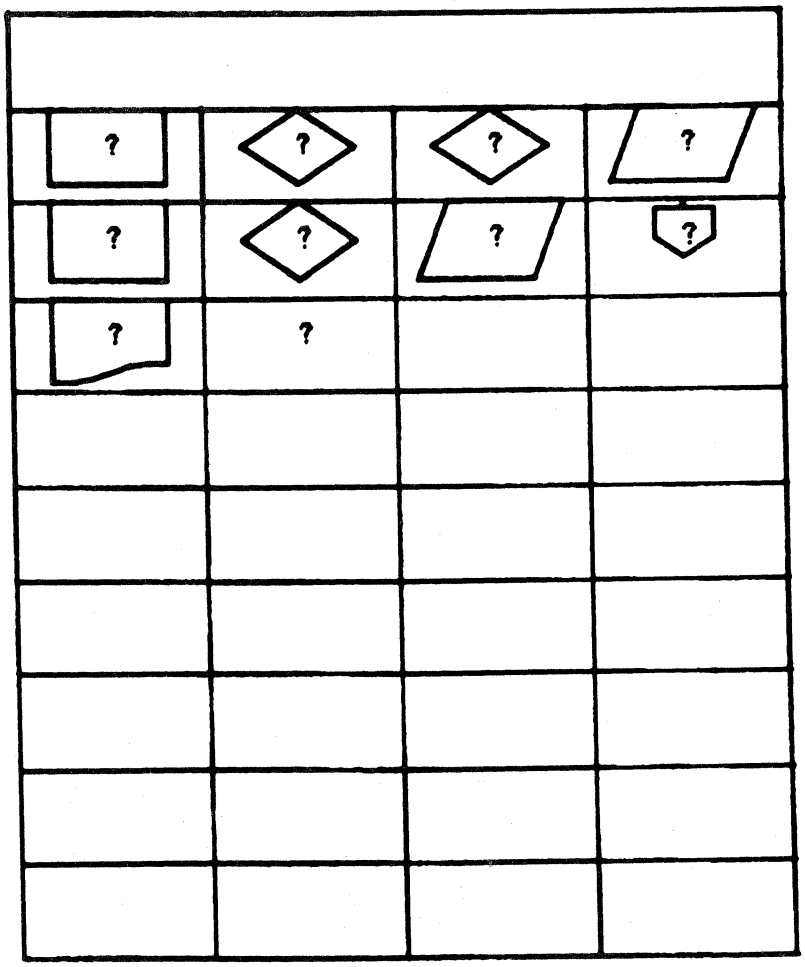
Starting a new diagram: Selecting item 1 from the main menu causes either phase 5 or phase 2 to be loaded from tape. Phase 5 will be loaded if there is a diagram, so that it may be saved or deleted. Otherwise, phase 2 is loaded and the diagram matrix is drawn on the screen.



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

The question mark moves from section to section as box types are selected by User Definable Keys. The question mark may be moved without selecting a box type by pressing 'return'. When a UDK is pressed, it is necessary to wait for the box to appear on the screen before pressing another UDK.

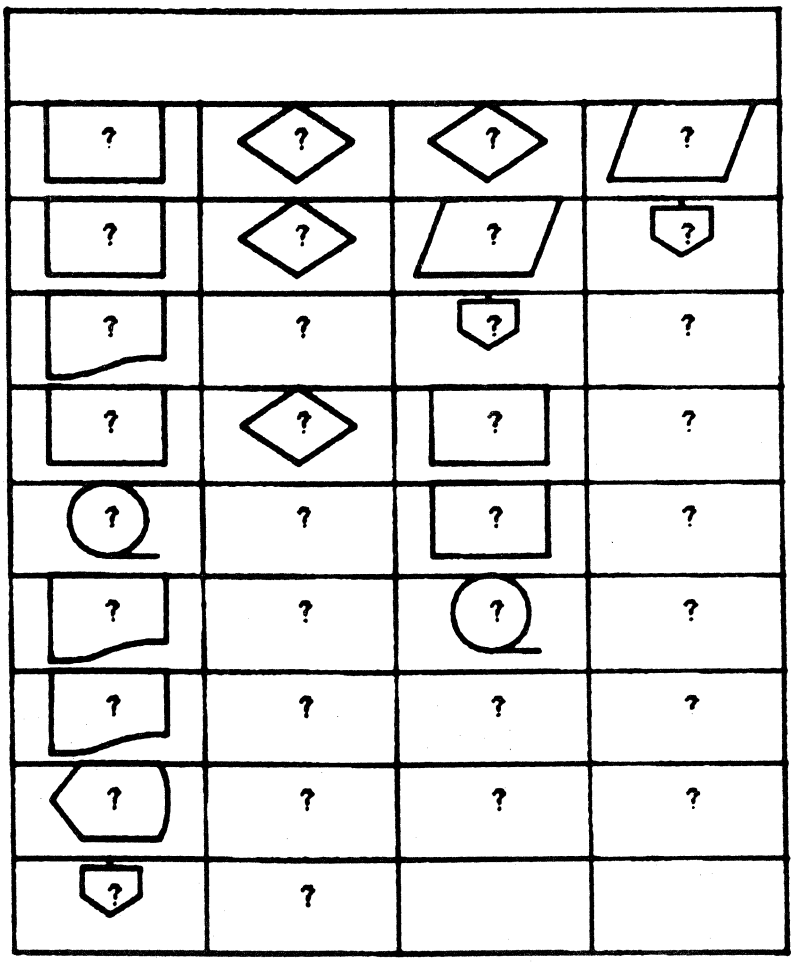
Shown below is the result of pressing UDKs 1, 6, 6, 2, 1, 6, 2, 9 and 3. The next section is to be left blank, so 'return' will be pressed and the question mark will appear in the following section.



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

In phase 2, User Definable Keys 1-10, 11, 16, 18 and 20 are meaningful. Key 11 is used to change the line drawing mode from solid to dotted lines or vice versa. Key 16 will allow the screen output to appear on the plotter, but should not be used in phase 2. Key 18 allows return to phase 1 in order to restart. Key 20 will be pressed to enter phase 3 after completing the assignment of boxes to sections. If a box is assigned to the last section or if 'return' is pressed when the question mark reaches the last section, phase 3 is loaded.

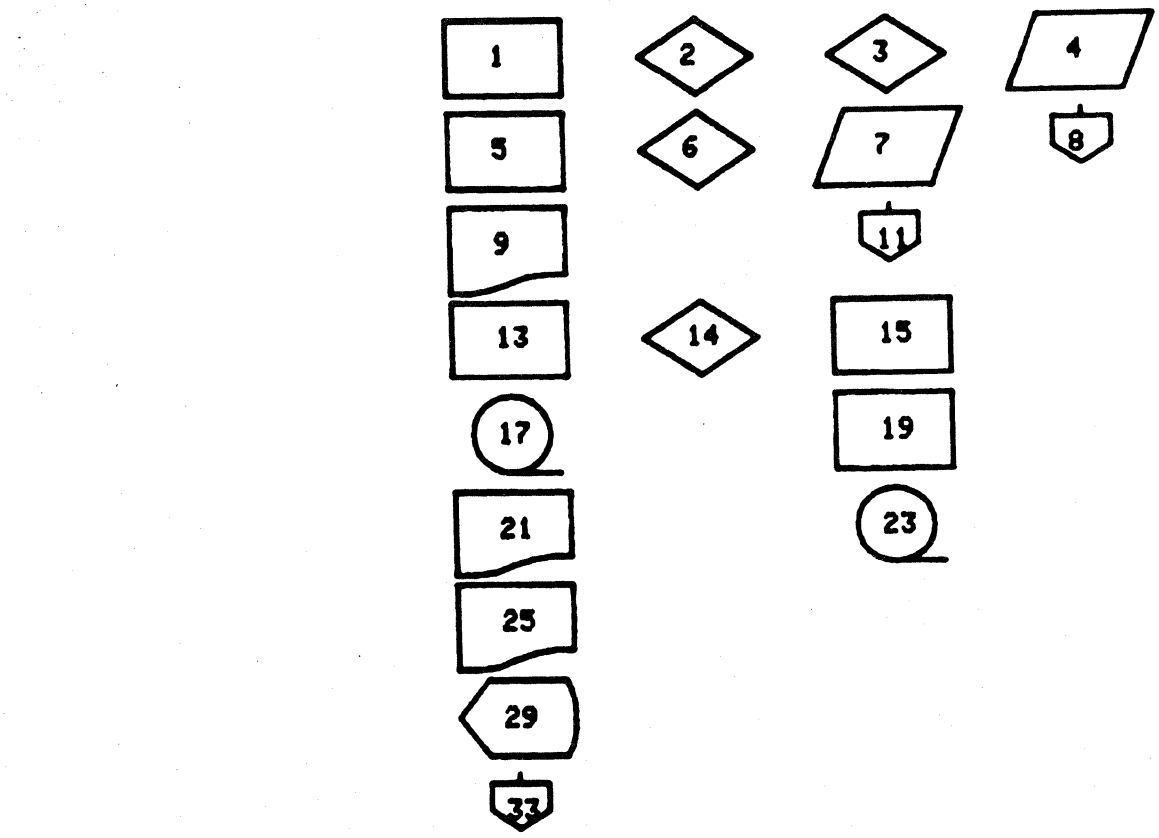
Note that keys 12-15 are <u>not</u> active during phase 2. Errors in the assignment of boxes must be corrected in phase 3. Shown below is the final assignment of boxes for the sample diagram. Key 20 should now be pressed.



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Connecting boxes and correcting errors: When phase 3 is loaded, the screen is cleared and the defined boxes are displayed, showing the assigned box numbers. All User Definable Keys are currently meaningful except 17, (not used) and 20. Consequently, boxes may be added or removed at any time during this phase. If a box has been connected to other boxes and is then removed, all connections to and from the box are also removed.

Shown below is the initial phase 3 display.



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

The terminal is now awaiting input. For each pair of boxes to be connected, the user enters the 'from' box number and presses 'return'. The word 'side' is displayed, and the user enters 'r' for right-hand side, 'b' for bottom, or 'l' for left-hand side, and presses 'return'. The same procedure is repeated for the 'to' box, except that 'r', 'l' or 't' for top are the permissible sides. Then the type of line is input when the word 'type' is displayed.

There are three line types; 1, 2 or 3. Type 1 connects boxes by drawing in the up or down direction from box to box, then in the 'across' direction to complete the connection. Type 2 draws half way across, then up or down, (with an arrow in the middle of this line) then the other half way across. Type 3 draws across then up/down. Types 4, 5 and 6 are dotted line equivalents of types 1, 2 and 3, respectively. Examples are shown on page 10; note particularly the connections from boxes 6 to 11 and 17 to 15.

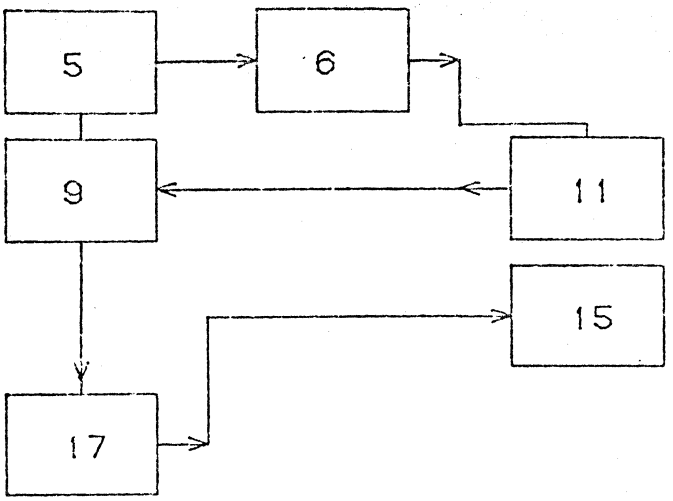
TITLE

FLOW DIAGRAMMER

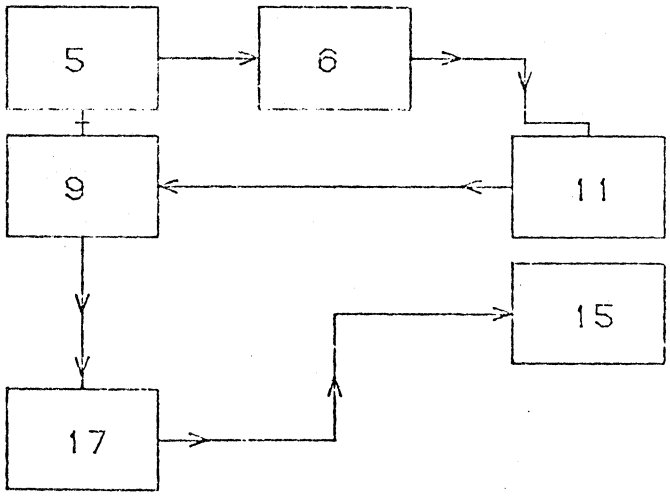
ABSTRACT NO:

51/00-8015/0

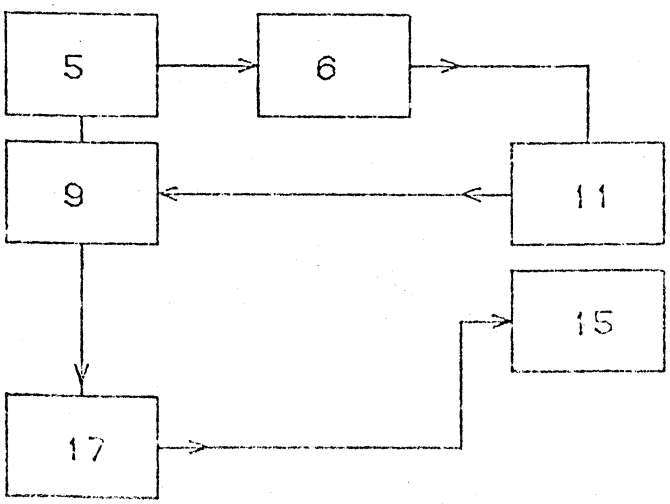
TYPE 1



TYPE 2



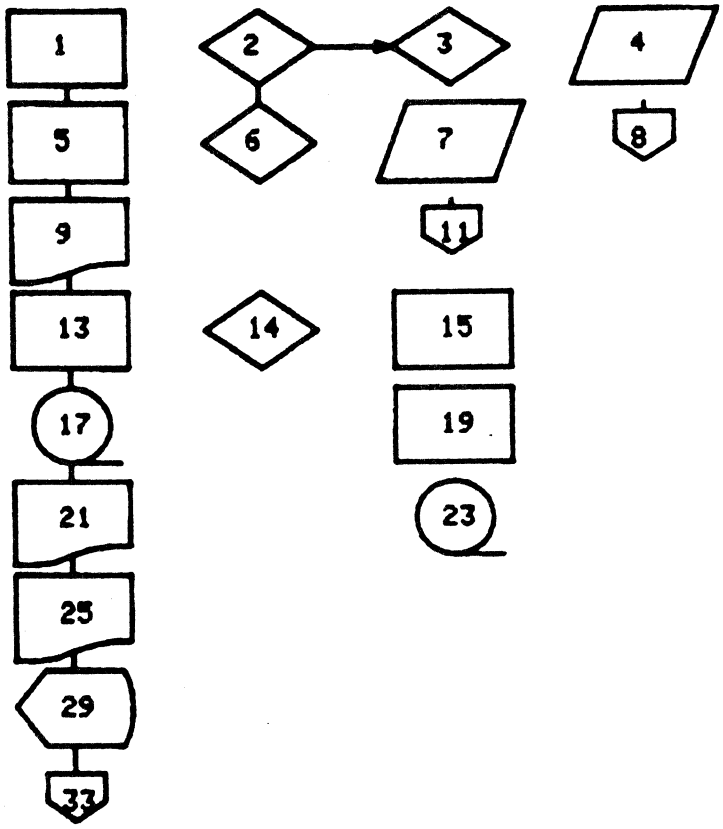
TYPE 3



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

In the following illustration, the user has entered eleven commands to connect boxes and is approaching the end of a 'page' on the screen. Pressing the 'redraw' key, (UDK 15) will cause the screen to be erased, the diagram redrawn and 'from' to appear at the top of the screen. Connecting may continue.

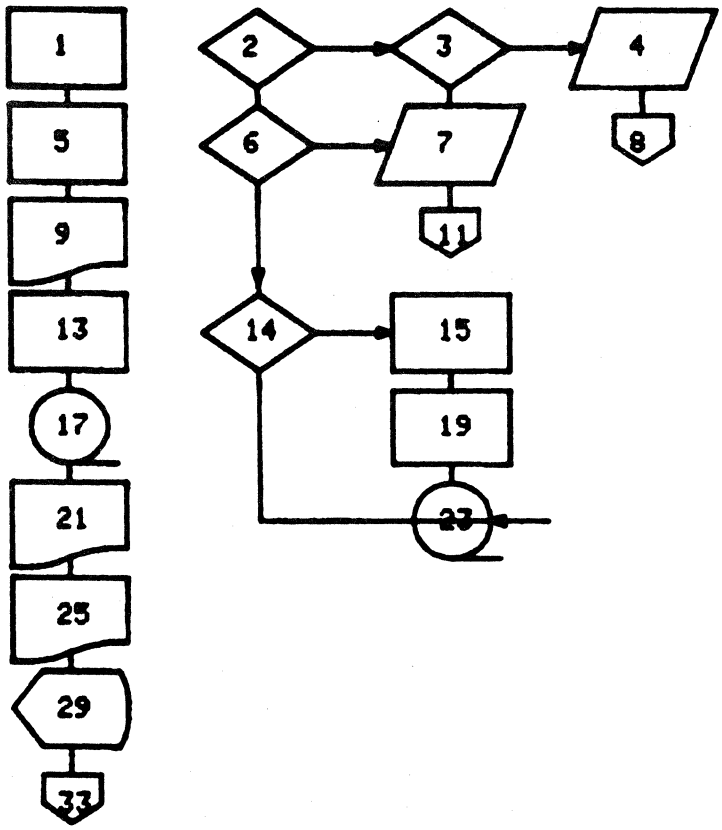
```
from 1     side B
to   5     side T
type 1
from 5     side B
to   9     side T
type 1
from 9     side B
to   13    side T
type 1
from 13    side B
to   17    side T
type 1
from 17    side B
to   21    side T
type 1
from 21    side B
to   25    side T
type 1
from 25    side B
to   29    side T
type 1
from 29    side B
to   33    side T
type 1
from 2     side B
to   6     side T
type 1
from 2     side R
to   3     side L
type 1
from
```



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

After having entered several additional commands, the user has made a mistake, (shown below) by requesting that the bottom of box 14 be connected to the right-hand side of box 23. To correct such mistakes, UDK 12, 'delete last line', is pressed.

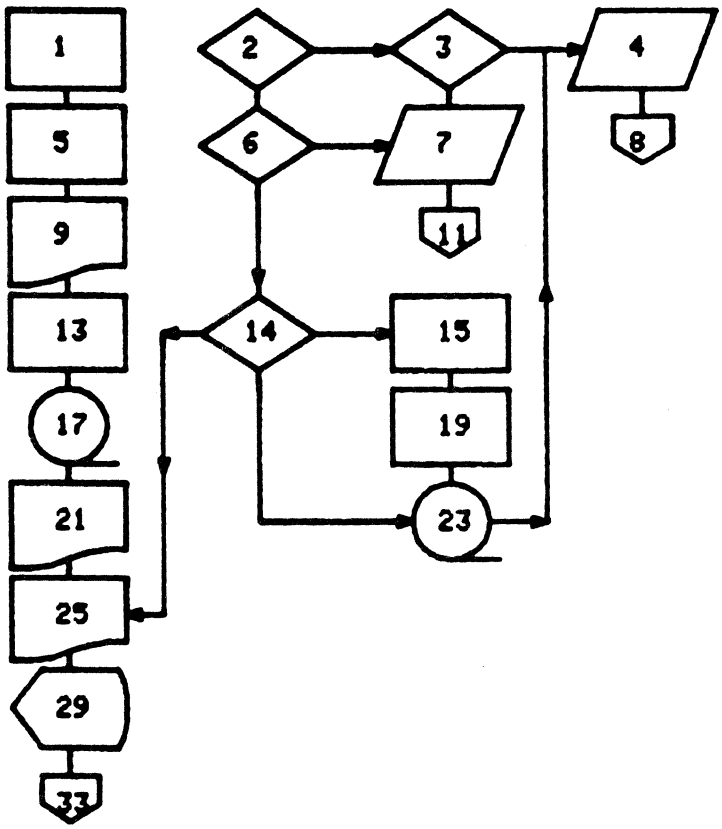
```
from 6    side R
to   7    side L
type 1
from 6    side B
to   14   side T
type 1
from 7    side B
to   11   side T
type 1
from 3    side R
to   4    side L
type 1
from 3    side B
to   7    side T
type 1
from 4    side B
to   8    side T
type 1
from 14   side R
to   15   side L
type 1
from 15   side B
to   19   side T
type 1
from 19   side B
to   23   side T
type 1
from 14   side B
to   23   side R
type 1
from
```



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Shown below is the completely connected diagram.

```
from 14   side B
to   23   side L
type 1
from 23   side R
to   4    side L
type 2
from 14   side L
to   25   side R
type 2
from
```



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

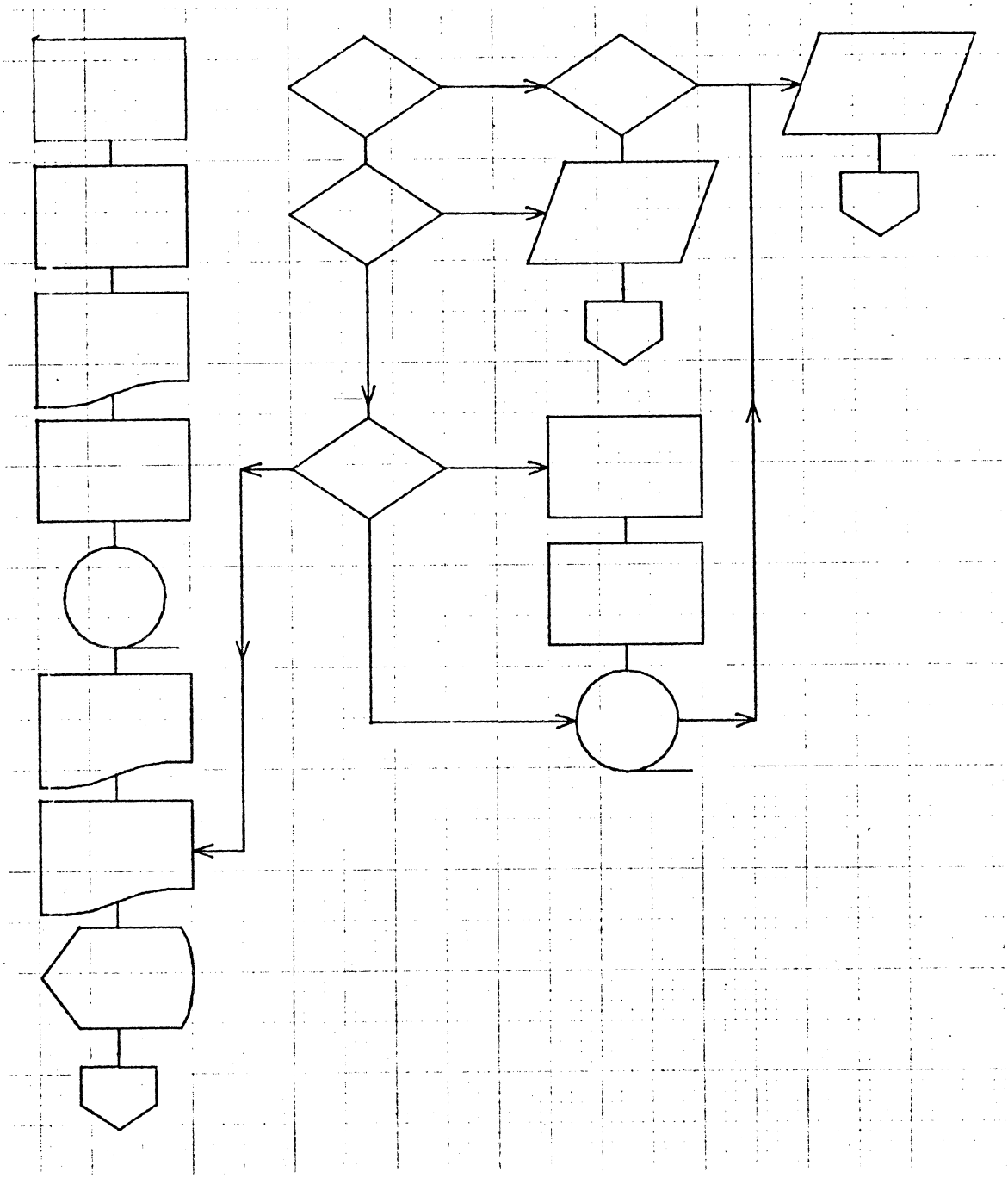
The user now has two choices; to plot the diagram or to load phase 4, the data entry phase. It is preferable at this point to press UDK 16, then UDK 15. This will cause the diagram to be output to the 4662 Plotter as shown on page 15. After plotting and before continuing, ready the plotter with new paper.

TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

51/00-8015/0



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Now load phase 4 by pressing UDK 19. When phase 4 is loaded, the following menu appears:

```
Enter:
 1) to enter heading
 2) to enter box data
 3) to plot box data
```

First, enter '1' and press 'return'. The message 'Enter heading' appears. Enter a heading of 50 or fewer characters and press 'return'.

```
Enter:
 1) to enter heading
 2) to enter box data
 3) to plot box data
1

Enter heading: FLOW DIAGRAMMER: PHASE 1
```

The menu will return to the screen, now enter '2' and press 'return'.

```
Enter:
 1) to enter heading
 2) to enter box data
 3) to plot box data
2
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Then enter a box number, up to four lines of information to be entered into the box (up to 20 characters per line) and information, if any, to appear outside the box (up to 8 characters per line.) Press 'return' to omit a line. Automatic centering of in-box data will take place. Do not add extraneous spaces after a line since they will be counted as characters in the centering algorithm. If it necessary to enter data on, say, lines 1, 3 and 4, enter a space in line 2 before pressing 'return'.

Examples of data entry for boxes 1 and 14 are shown below:

```
box number: 1

Enter line 1: INITIALIZE
      line 2: & SET KEYS
      line 3:
      line 4:

      above box: 1
      on right connector:
      on bottom connector:
      on left connector:


box number: 14

Enter line 1: TEST
      line 2: 'K'
      line 3:
      line 4:

      above box:
      on right connector: =2
      on bottom connector: =3
      on left connector: other
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

After entering all box data, select menu item 3 of phase 4, 'plot box data', and the heading and annotations will be output to the plotter. (See page 19)

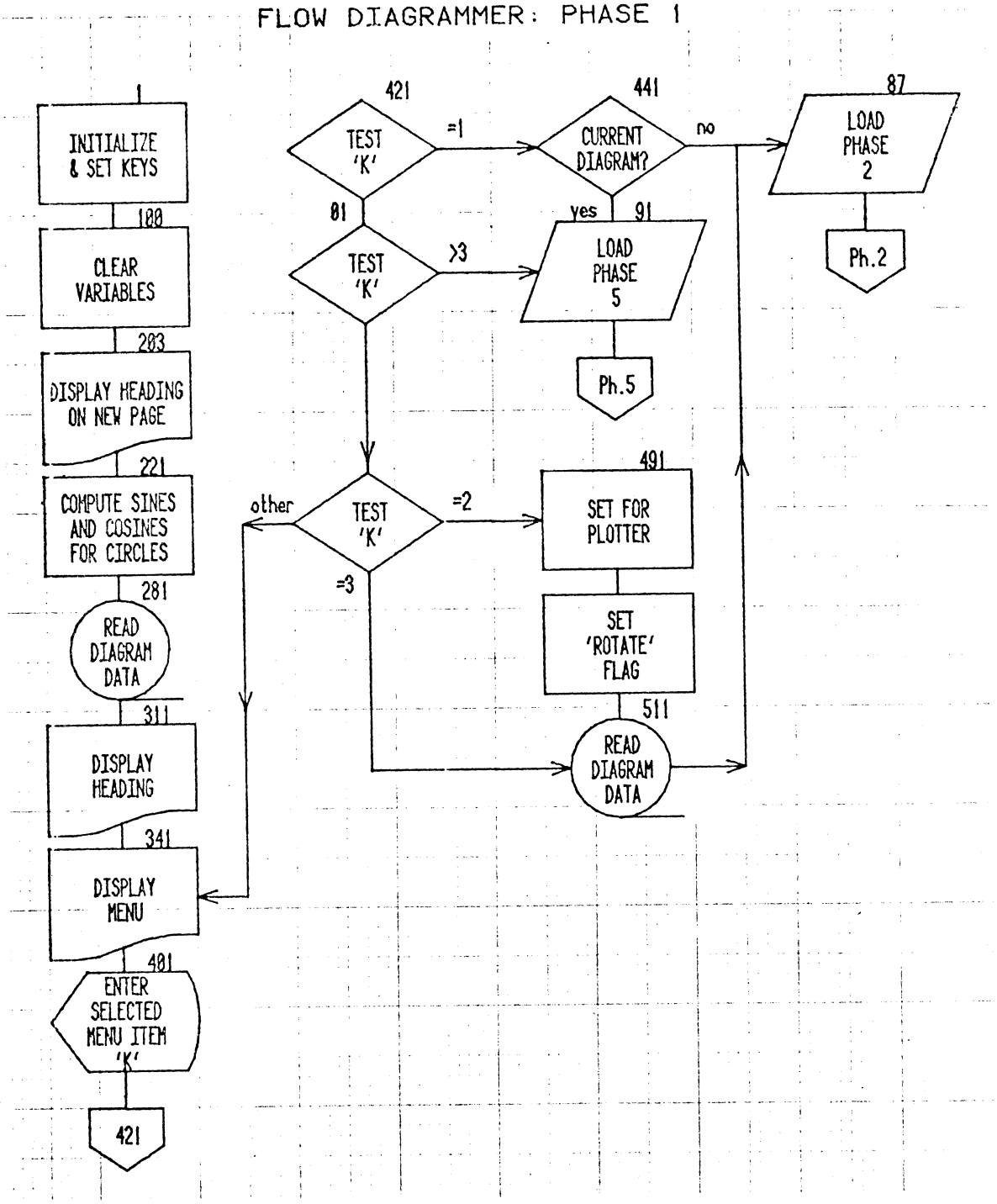
Phase 1 will then be reloaded and the main menu will be displayed. Corrections may be made at this point.

Note: Be sure the plotter has paper.

```
FLOW DIAGRAMMER: PHASE 1


Enter:
 1) to enter heading
 2) to enter box data
 3) to plot box data
3
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

After the diagram is finished, phase 1 is reloaded and the main menu reappears:-

```
                    F L O W   D I A G R A M M E R


Current diagram is FLOW DIAGRAMMER: PHASE 1


Enter:

  1 to start a new diagram
  2 to redraw current diagram
  3 to change current diagram
  4 to retrieve a stored diagram
  5 to destroy part or all of stored data:
```

The user may select any item; item 2 will cause another copy of the current diagram to be drawn, item 3 will permit correction of any errors, (the current diagram will reappear on the screen and phase 3 will be active,) or item 1 will be selected if a new diagram is to be drawn.

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Selecting item 4 will generate the following:-

```
Current diagram: FLOW DIAGRAMMER: PHASE 1

Stored diagrams:
 1 FLOW DIAGRAMMER: PHASE 1
 2 ROTATED LINE ROUTINE
 3 DRAW BOXES FROM FUNCTION KEYS

WARNING--The current diagram will be destroyed.
Press 'return' to proceed or key 18 to save current diagram.
```

and after the user presses 'return' or UDK 18 the main menu will be redisplayed. If item 4 is selected when no current diagram exists, the message is:-

```
No current diagram

Stored diagrams:
 1 FLOW DIAGRAMMER: PHASE 1
 2 ROTATED LINE ROUTINE
 3 DRAW BOXES FROM FUNCTION KEYS

Enter number of diagram to retrieve:
```

Item 5 is an acceptable choice at this time, since its selection has no effect on the current program.

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

If item 1 is selected while a current diagram is active, phase 5 is loaded and the following message appears:-

```
Current diagram: FLOW DIAGRAMMER: PHASE 1
Stored diagrams:
...none
Enter 1 to store current diagram,0 to destroy:
```

The user enters '1' and presses 'return' to store the current diagram. The 37 files used to store the heading, lines and box data for the current diagram are read and consolidated into a single long file. If the box data, including separators, (\ and ~, which must not be used in diagrams,) exceeds 1000 characters, the message

```
Diagram too big to store
STOP IN LINE 641 PRIOR TO LINE 651
```

is displayed. To destroy the diagram and return to the main menu, enter 'RUN 651' and press 'return'.

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

If the diagram is not too big, the message

```
Enter 0 to save on available space,
Enter number to replace stored diagram:
```

is displayed. Normally, the user will enter '0' and press 'return'. However, if the current diagram was previously retrieved for modification, it is preferable to return it to the file from which it was retrieved, in order to destroy the previous version of the diagram.

If item 5 is selected, the user intends to destroy one or more stored diagrams. This need only be done when twenty diagrams (the maximum) are stored and a current diagram must be saved. The message

```
No current diagram

Stored diagrams:
 1 FLOW DIAGRAMMER: PHASE 1
 2 ROTATED LINE ROUTINE
 3 DRAW BOXES FROM FUNCTION KEYS

Enter 0 to retain all stored diagrams,
      diagram number to delete a specific diagram,
      or 99 to destroy all stored diagrams:
```

appears. After the user selects the appropriate action, the main menu will be redisplayed.

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Data Tape Structure:

File 1	ASCII Program	3000
Files 2-5	ASCII Program	4800 each
File 6	Binary Data	1024
Files 7-42	Binary Data	768 each
Files 43-62	Binary Data	3072 ea

Internal Data Storage:

Variable	Used to Store...	Type
A,B,C,D	Endpoints of lines	Simple
C5	Cosines	Array (25)
H$	Headings	String (50)
K	Last function key	Simple
L$	Diagram	Array (1000)
M	Device address	Simple
R	Rotate flag	Simple
S	Dotted line flag	Simple
S5	Sines	Array (25)
T	Box types	Array (4,10)
Z	Connectors	Array (50)
Z1	Number of connectors	Simple

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Appendix A

Flow Diagramming Matrix Form

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

FLOW DIAGRAMMING MATRIX

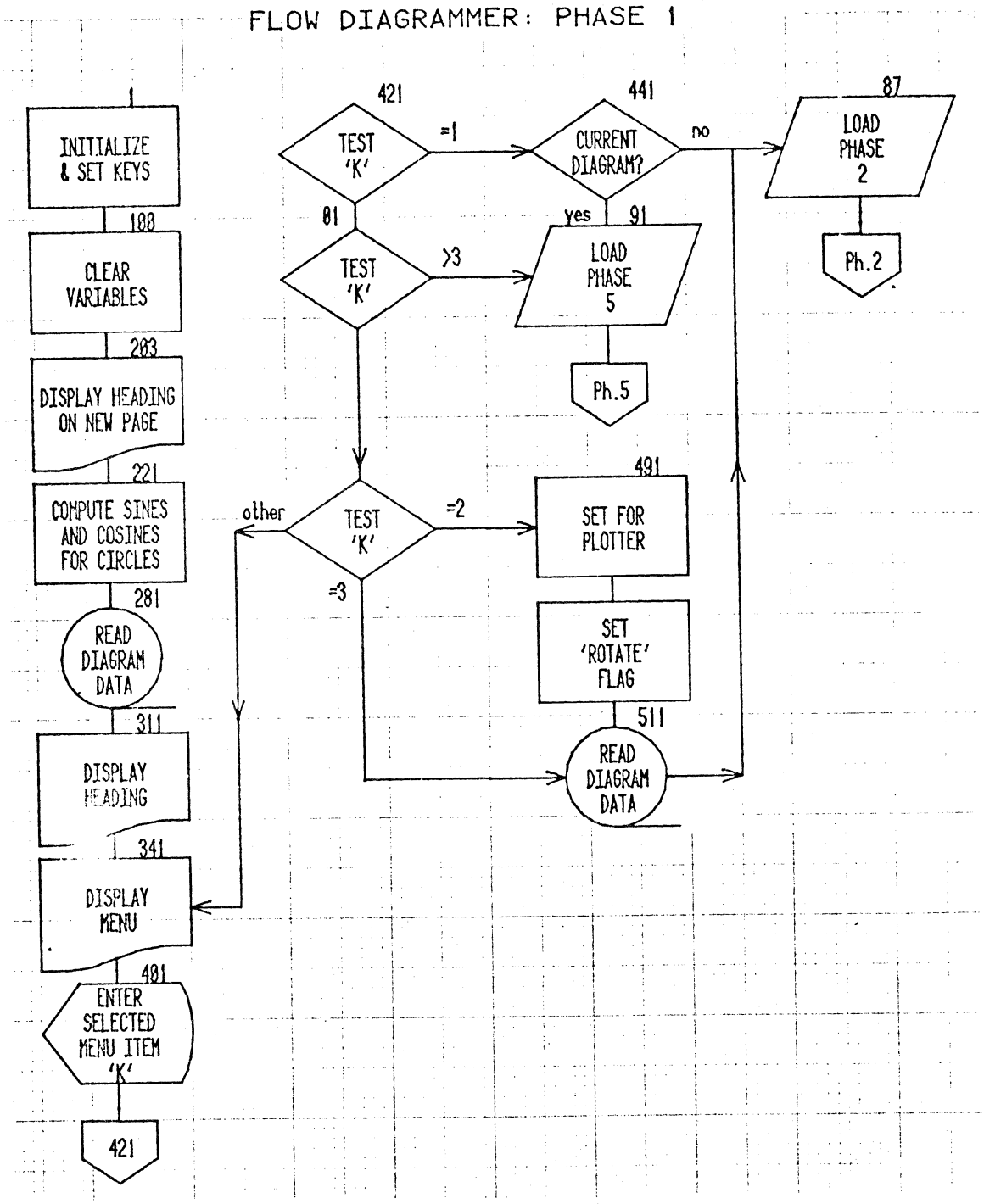
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Appendix B

Flow Diagrams

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

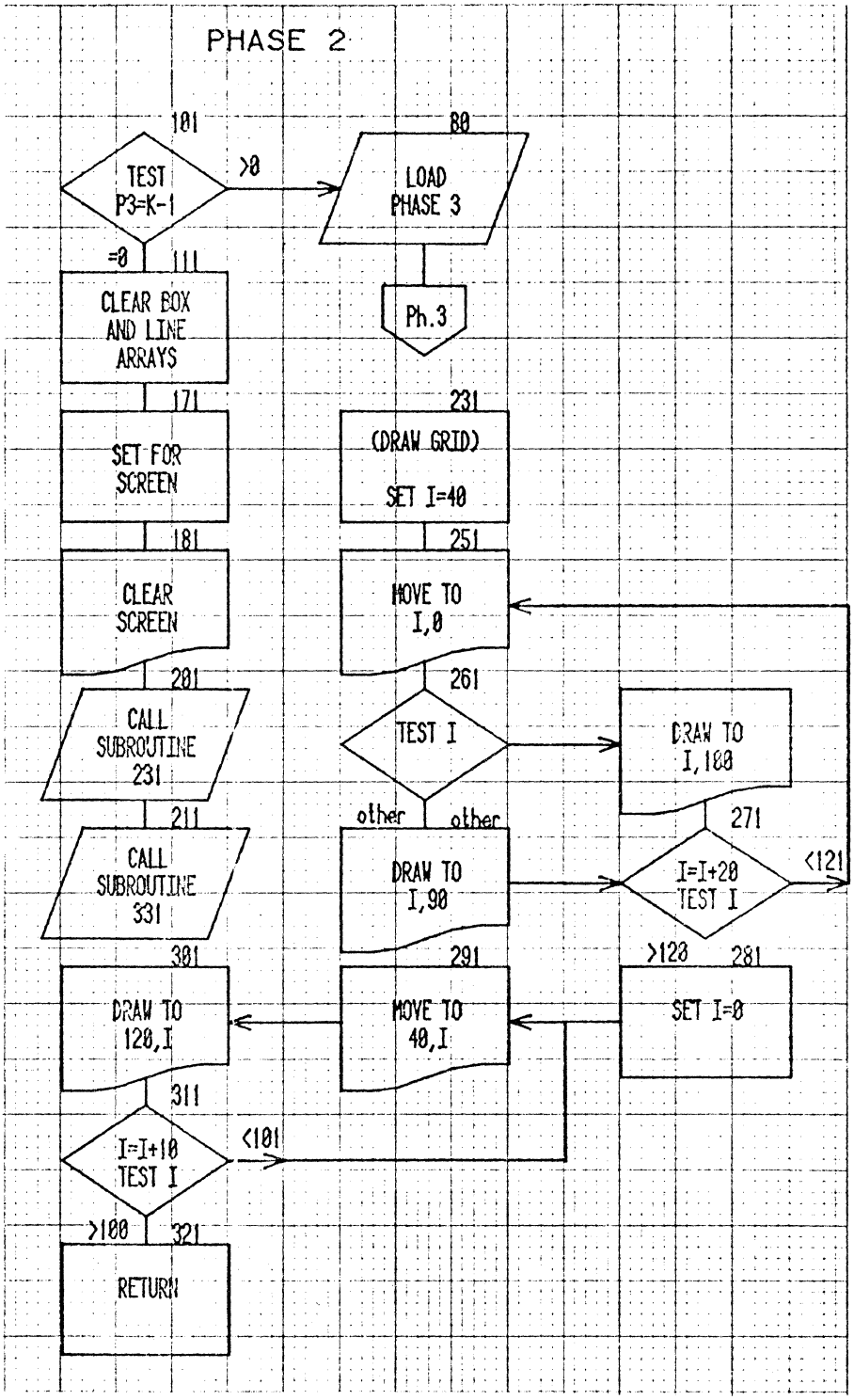


TITLE

FLOW DIAGRAMMER

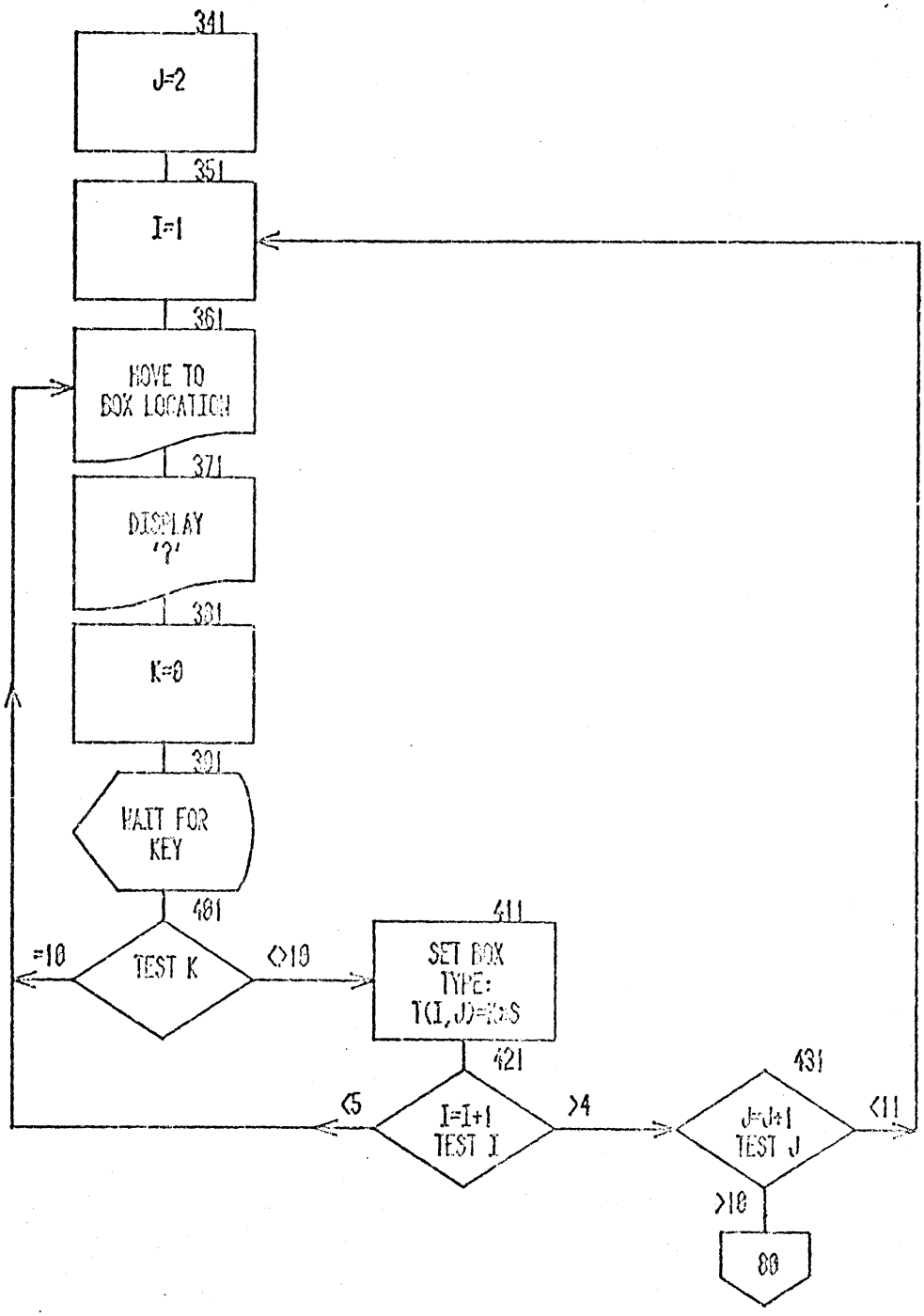
ABSTRACT NO:

51/00-8015/0



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

SELECT BOXES FROM FUNCTION KEYS



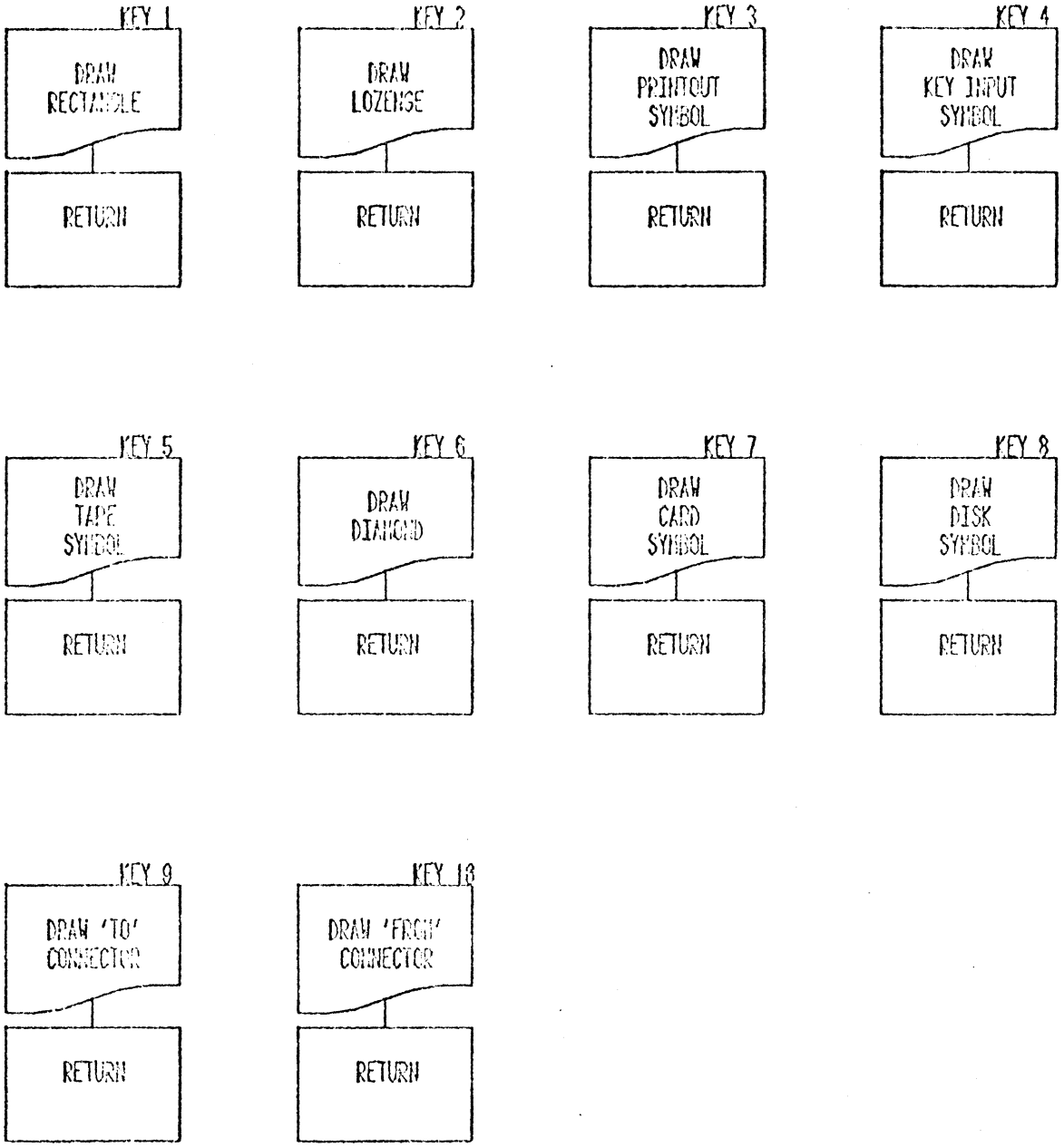
TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

51/00-8015/0

DRAW BOXES FROM FUNCTION KEYS 1-10



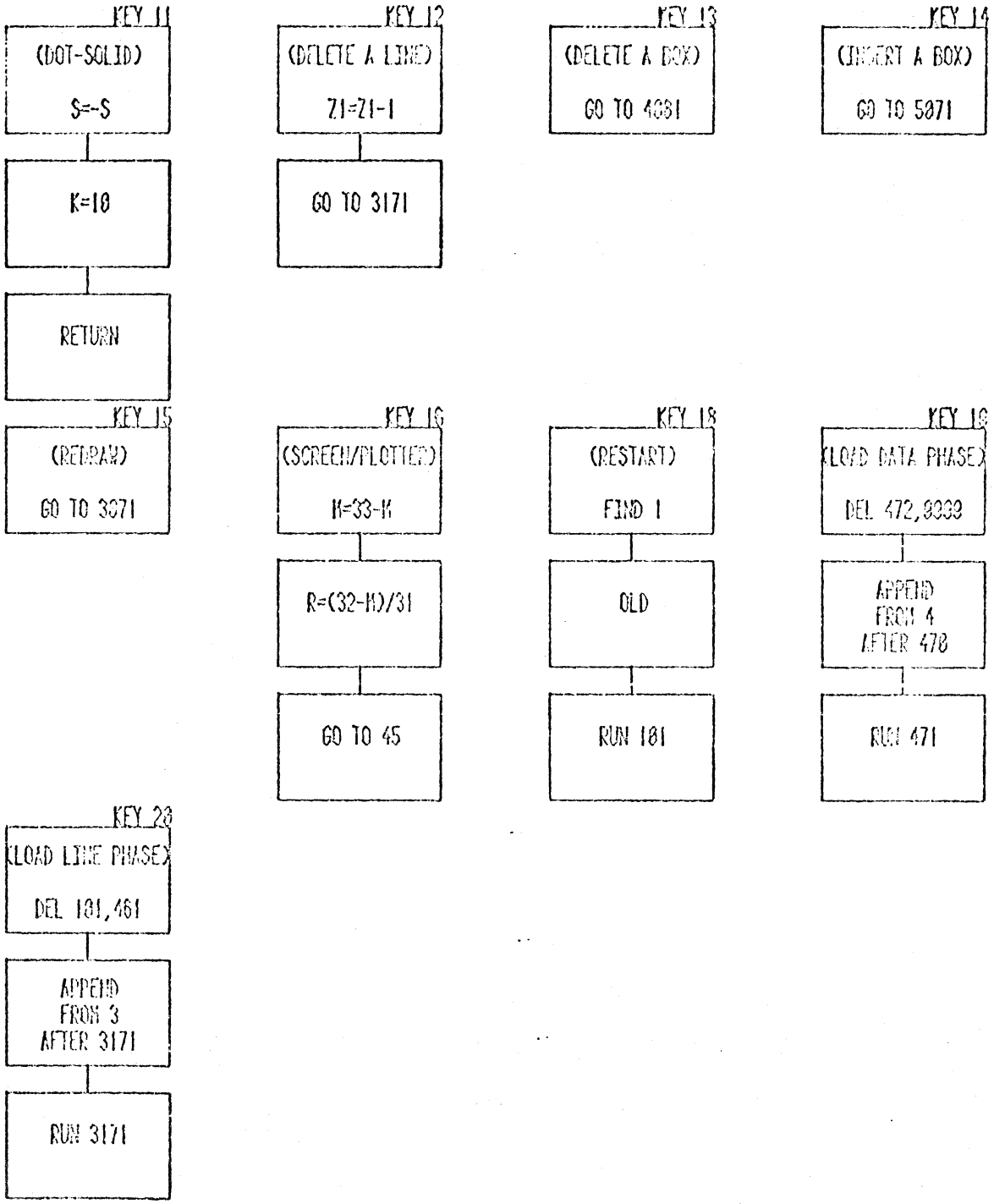
TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

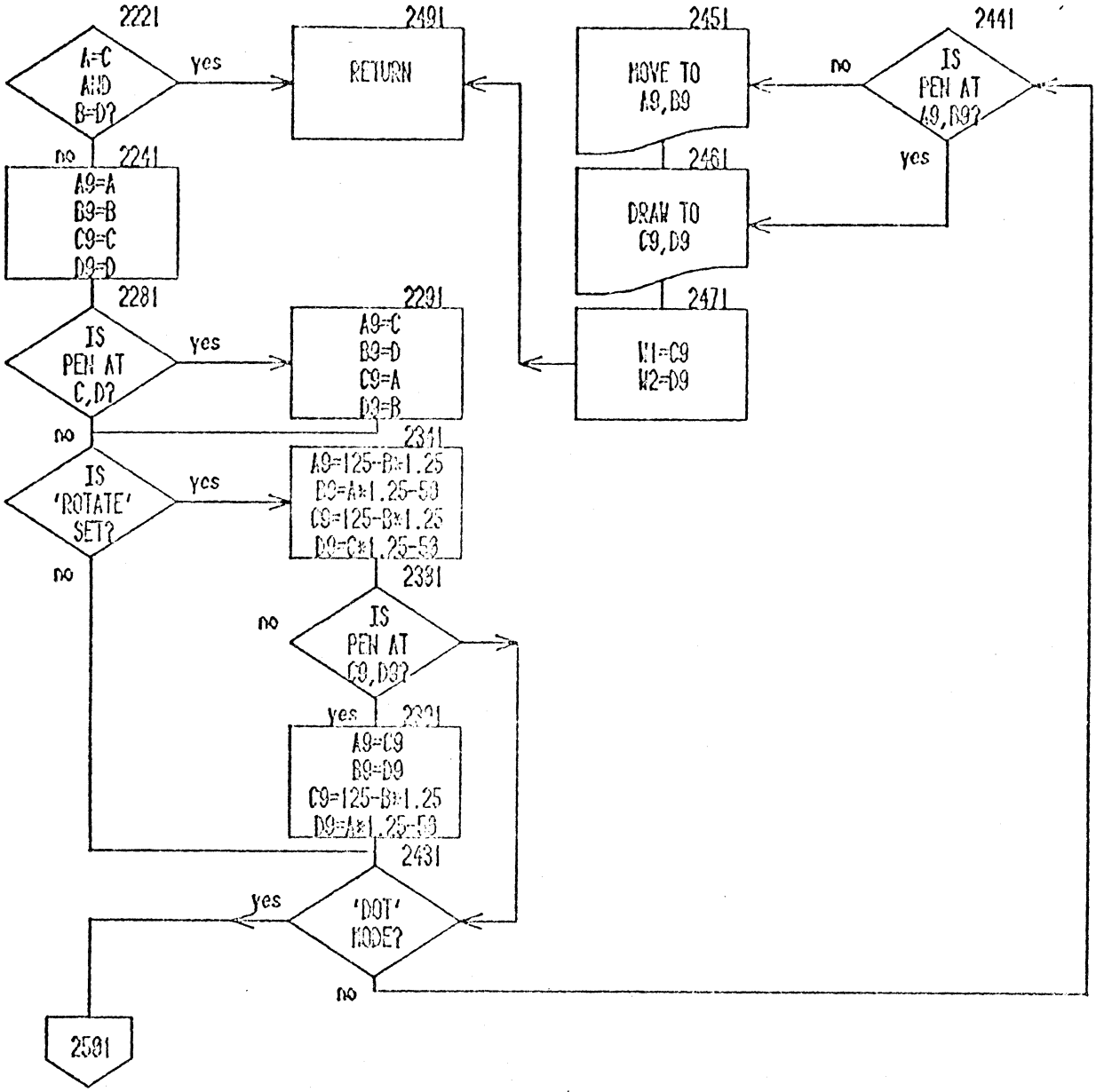
51/00-8015/0

FUNCTION KEYS 11-20



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

ROTATED LINE ROUTINE



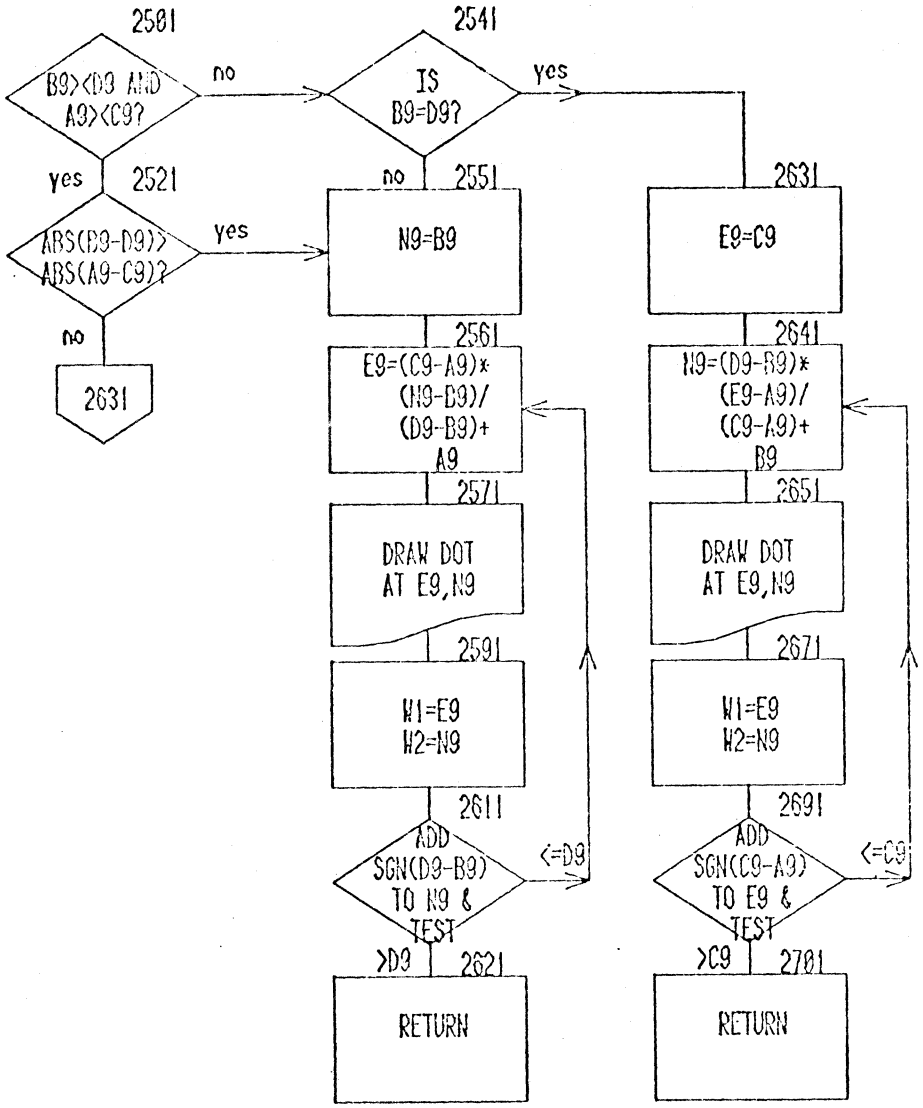
TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

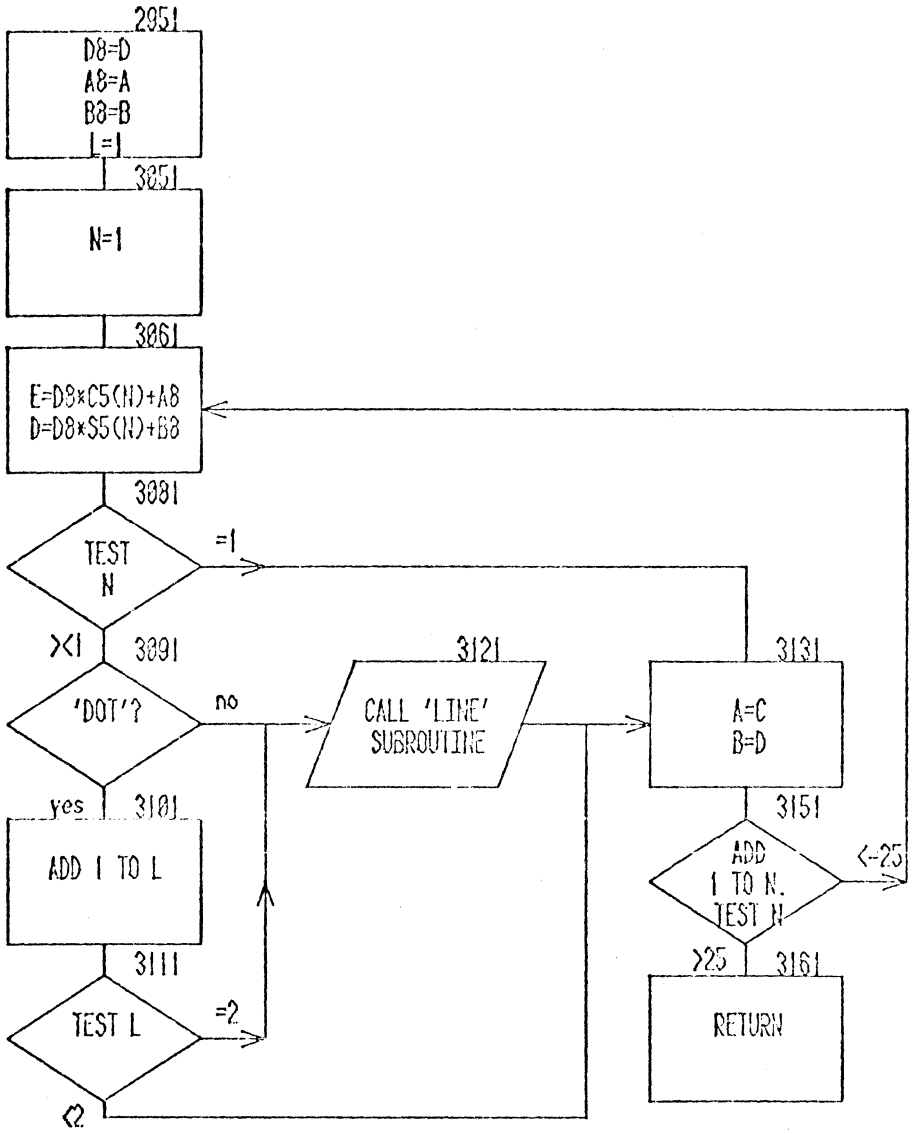
51/00-8015/0

Rotated Line Routine (Continued)



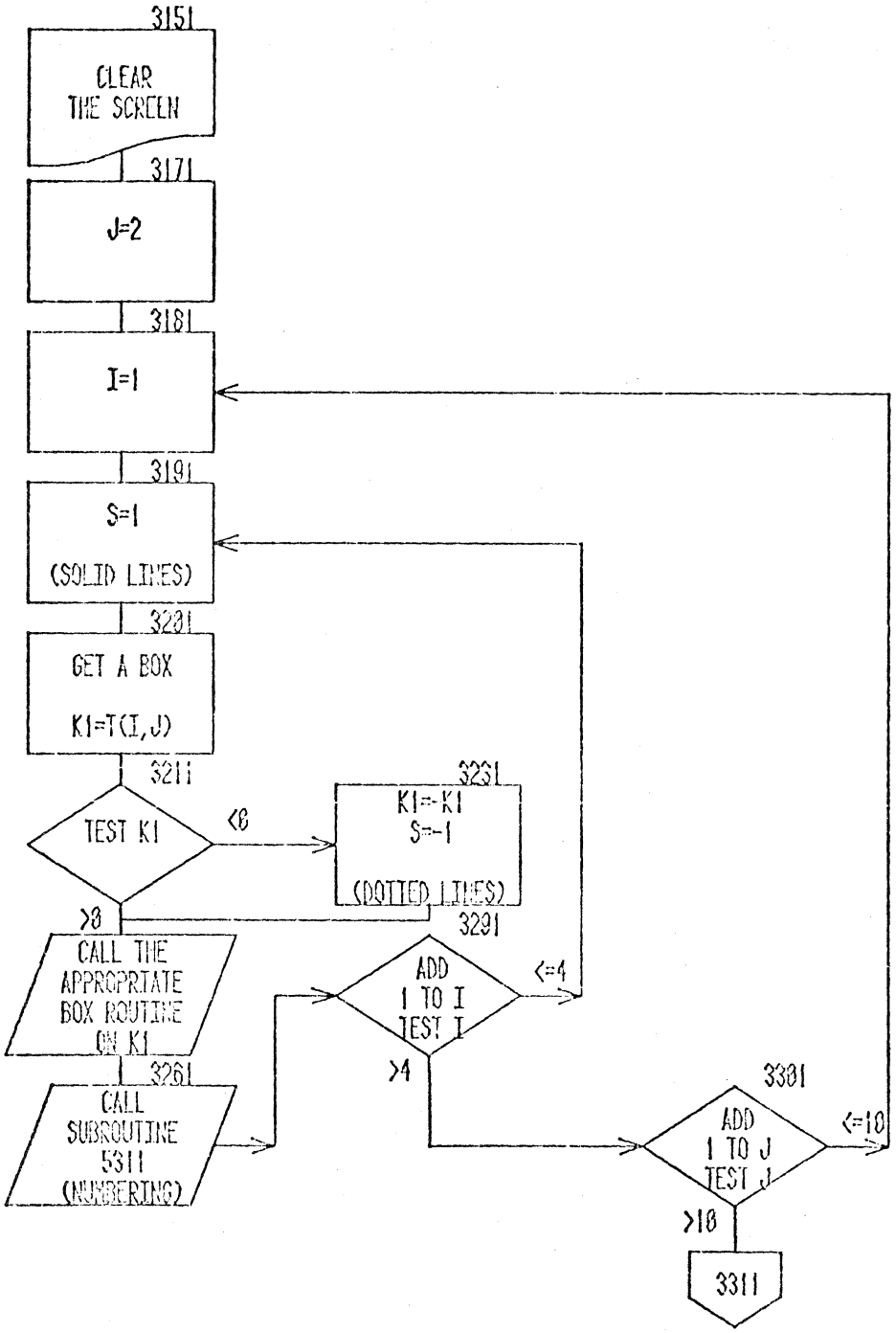
TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

CIRCLE ROUTINE



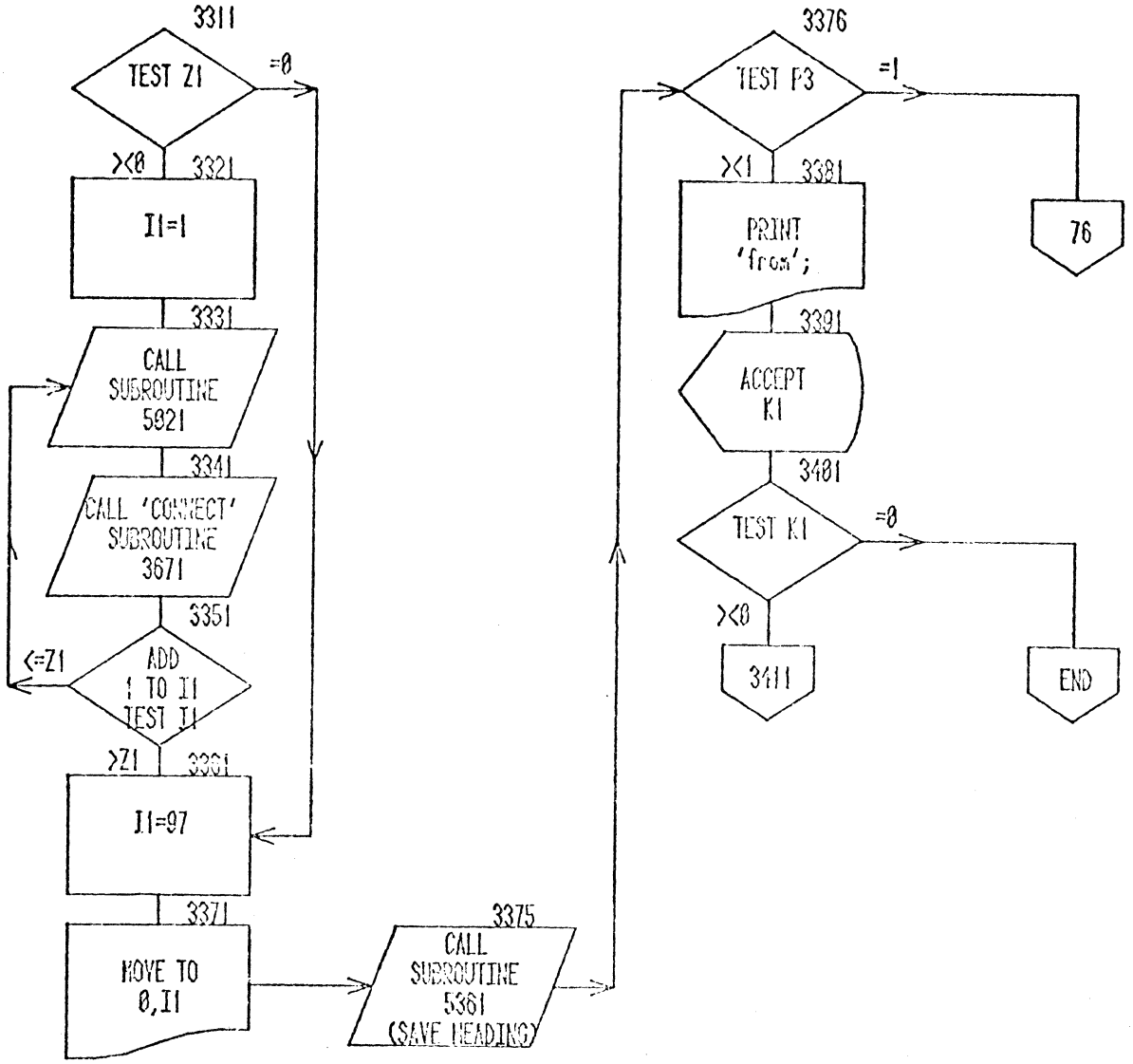
TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

PHASE 3: DISPLAY BOXES



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

CONNECT BOXES



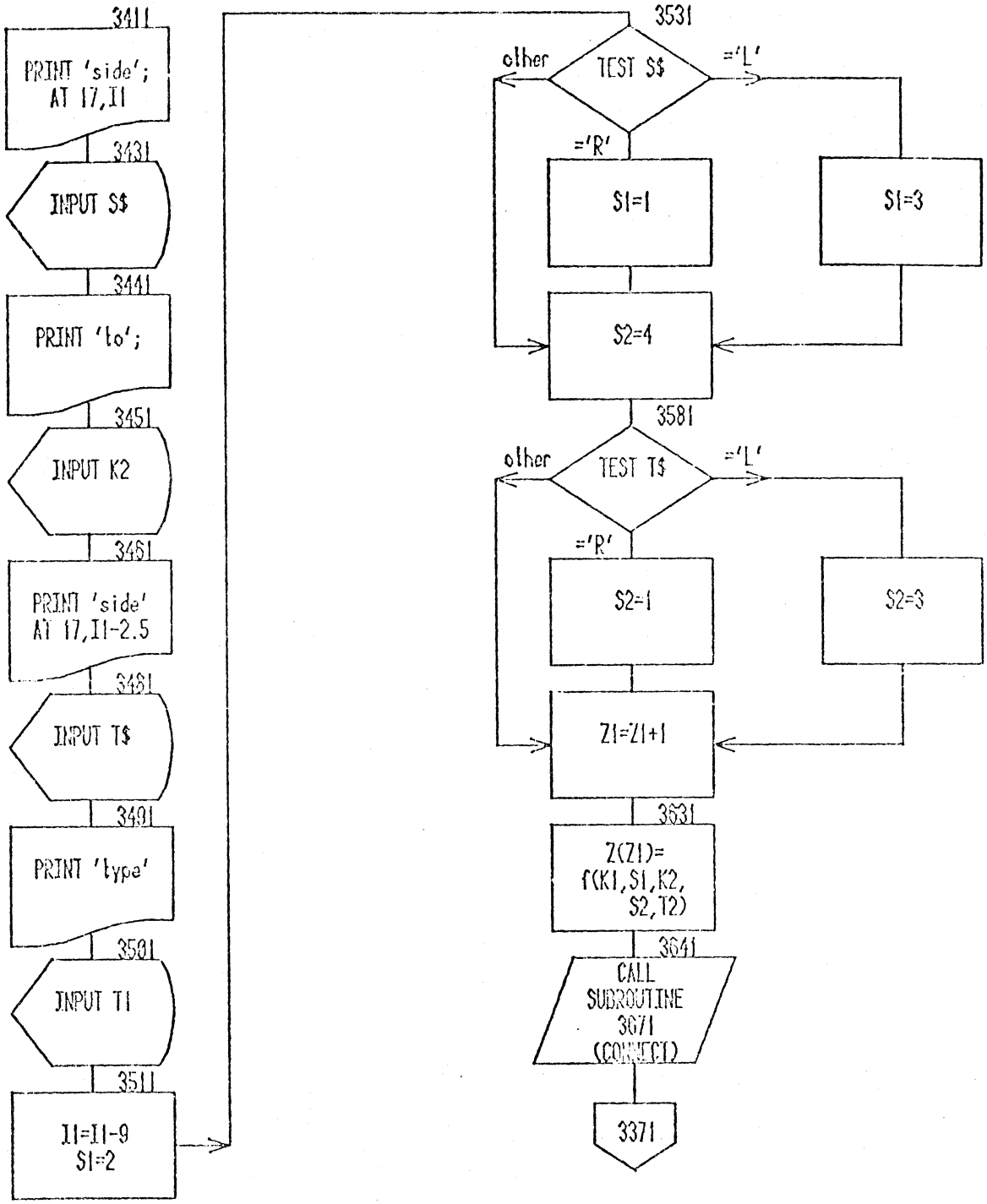
TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

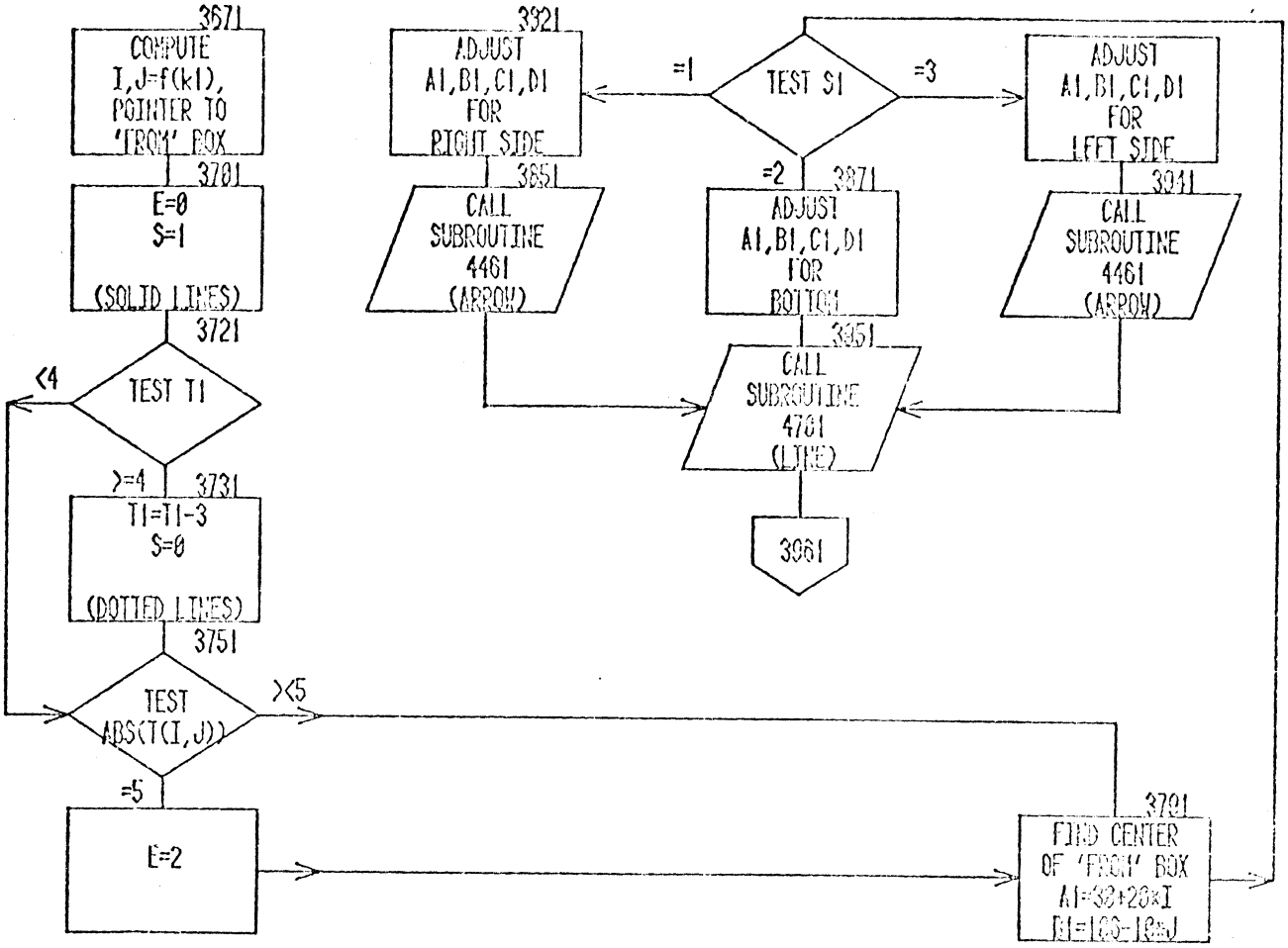
51/00-8015/0

Connect Boxes (Continued)



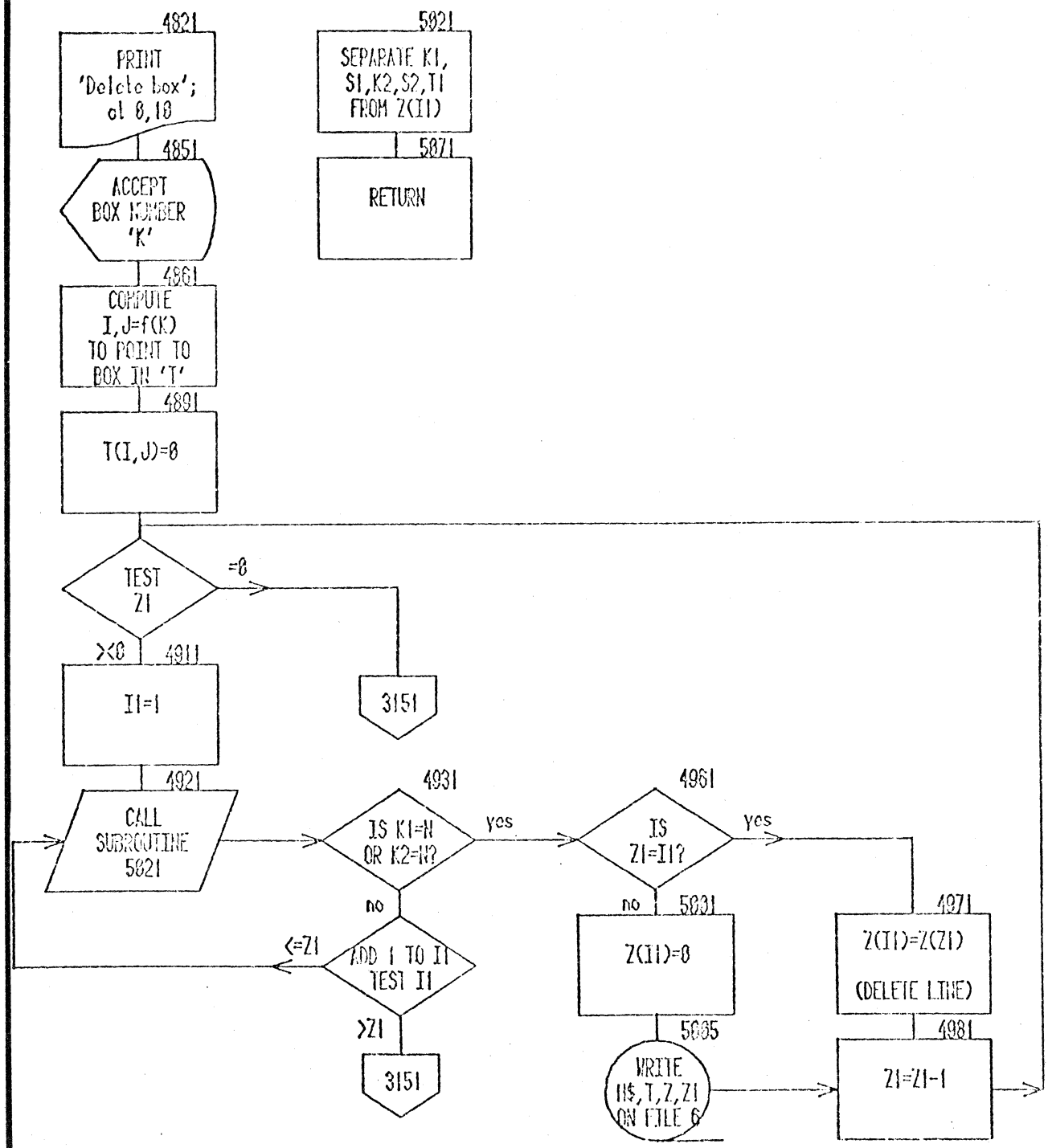
TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

DRAW CONNECTING LINES



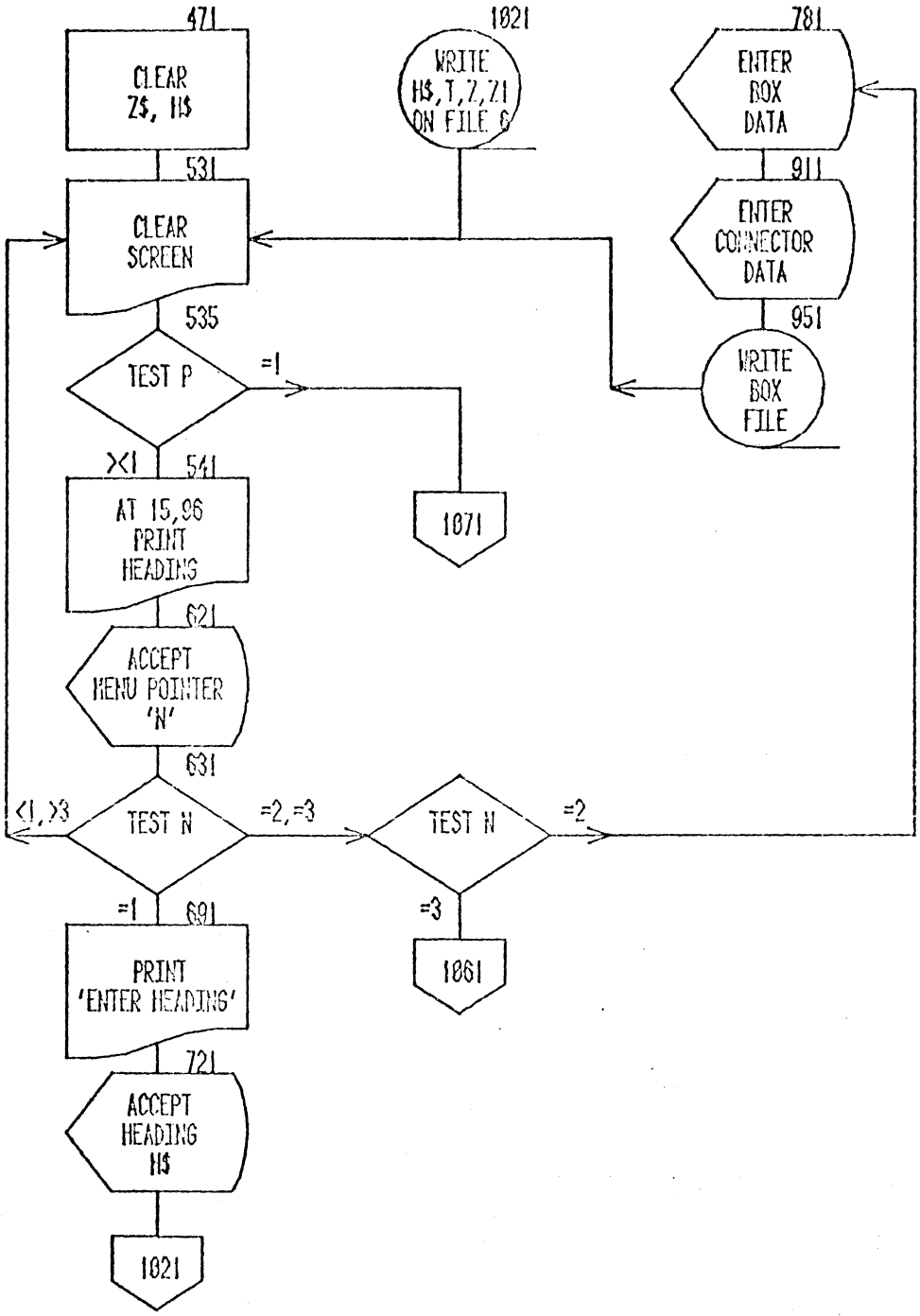
TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

DELETE A BOX



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

PHASE 4



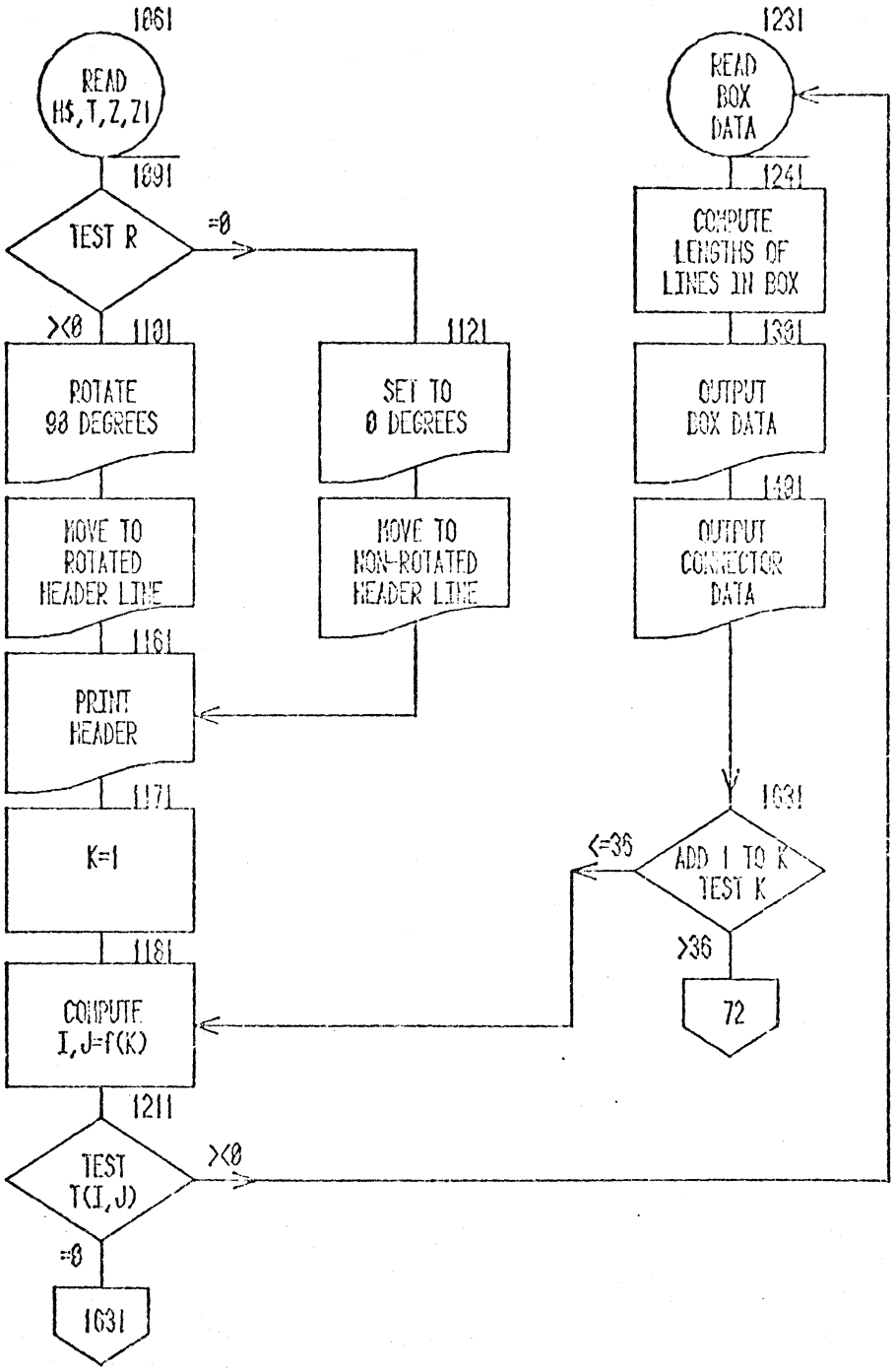
TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

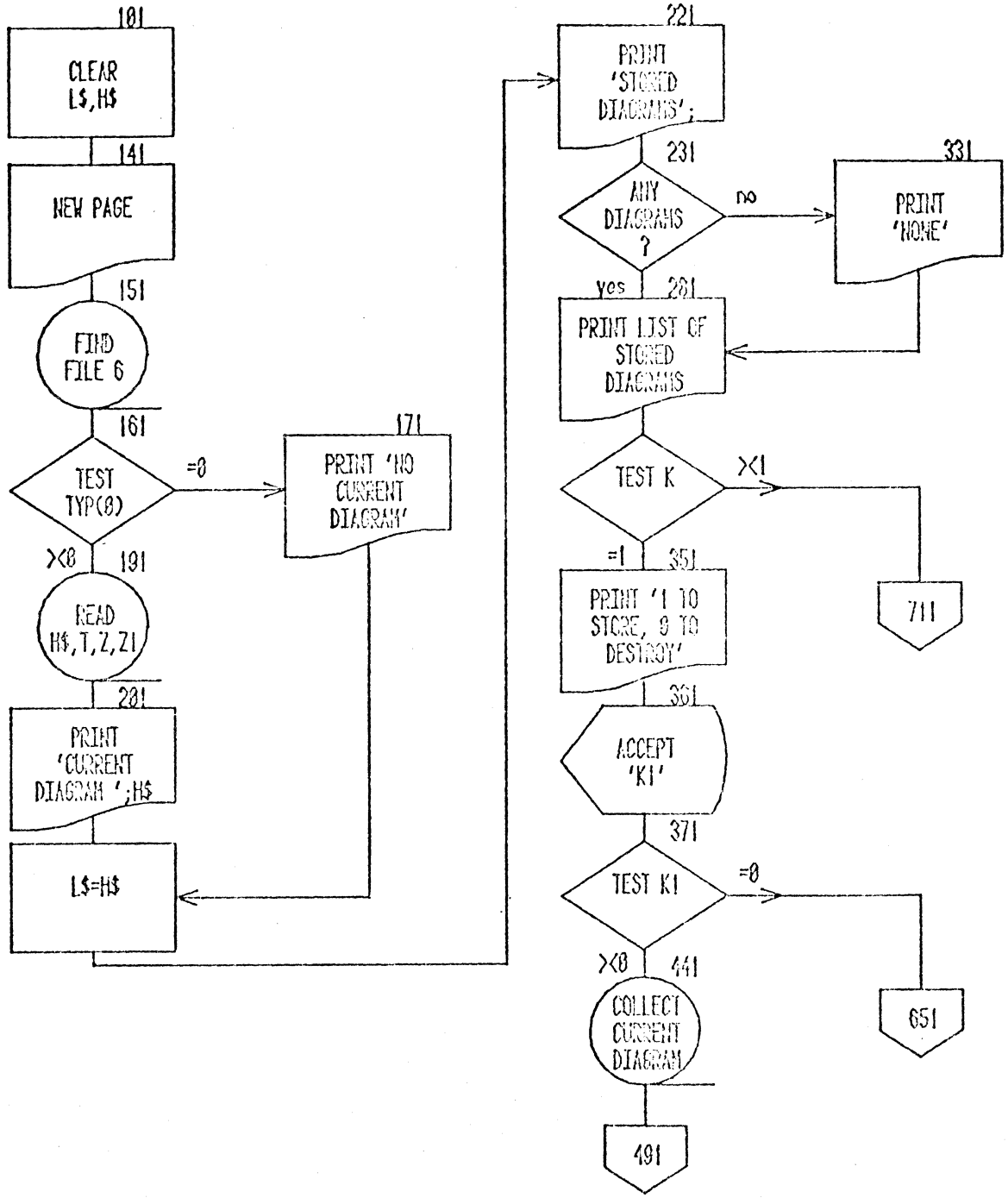
51/00-8015/0

PLOT BOX DATA



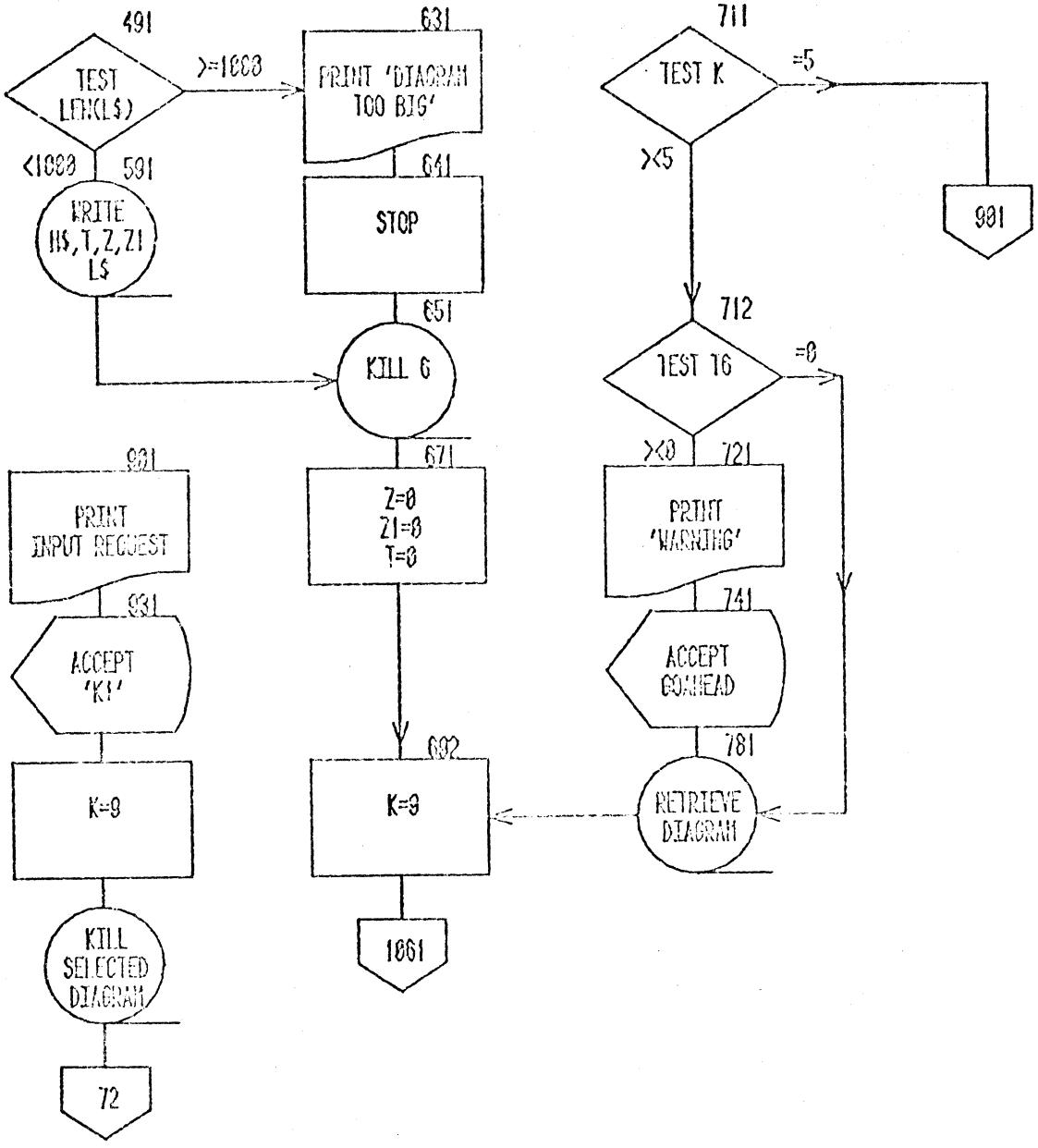
TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

PHASE 5



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Phase 5 (Continued)



TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

Appendix C

Program Listings

TITLE

FLOW DIAGRAMMER

ABSTRACT NO:

51/00-8015/0

```
1 INIT
2 SET KEY
3 GO TO 100
4 K=1
5 GOSUB 471
6 RETURN
8 K=2
9 GOSUB 651
10 RETURN
12 K=3
13 GOSUB 691
14 RETURN
16 K=4
17 GOSUB 991
18 RETURN
20 K=5
21 GOSUB 1361
22 RETURN
24 K=6
25 GOSUB 1441
26 RETURN
28 K=7
29 GOSUB 1561
30 RETURN
32 K=8
33 GOSUB 1741
34 RETURN
36 K=9
37 GOSUB 1871
38 RETURN
40 K=11
41 GOSUB 2101
42 RETURN
44 S=-S
45 K=10
46 RETURN
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
48 Z1=Z1-1
49 GO TO 3171
52 GO TO 4941
56 GO TO 5251
60 GO TO 3171
64 M=33-M
65 R=(32-M)/31
66 GO TO 45
72 FIND 1
73 OLD
74 RUN 101
76 DELETE 472,9999
77 FIND 4
78 APPEND 471
79 RUN 471
80 DELETE 101,461
82 FIND 3
83 APPEND 3171
84 RUN 3171
87 DELETE 111,9999
88 FIND 2
89 GO TO 92
90 P3=0
91 FIND 5
92 APPEND 101
93 GO TO 101
94 DELETE L$
95 DELETE 111,9999
96 IF K=9 THEN 72
97 IF K=4 OR K=5 THEN 90
98 GO TO 88
99 GO TO 101
100 DIM T(4,10),Z(50),S$(1),T$(1),K$(10),H$(50),Z$(120),S5(25),C5(25)
101 P3=0
111 PAGE
121 PRINT "                F ";
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
122 REM *** FLOW DIAGRAMMER ***
123 REM ** AUTHOR: KEITH S. REID-GREEN **
124 REM ** EDUCATIONAL TESTING SERVICE **

131 W1=0
141 W2=0
151 M=32
161 R=0
171 T=0
172 PRINT "L ";
181 Z=0
191 Z1=0
201 SET DEGREES
202 PRINT "O ";
203 H$="W DIAGRAMMER"
211 FOR I=0 TO 360 STEP 15
221     C5(INT(I/15)+1)=COS(I)
231     S5(INT(I/15)+1)=SIN(I)
232     IF I-INT(I/10)*10<>0 THEN 241
233     K$=SEG(H$,1,1)
234     K$=K$&" "
235     PRINT K$;
236     H$=SEG(H$,2,LEN(H$)-1)
241 NEXT I
242 PRINT
261 H$="                                                    "
281 FIND 6
291 IF TYP(0)=0 THEN 331
301 READ @33:H$,T,Z,Z1
311 PRINT "JJJJCurrent diagram is ";H$
321 GO TO 341
331 PRINT "JJJJThere is no current diagram"
341 PRINT "JJJJEnter:"
351 PRINT "J  1 to start a new diagram"
361 PRINT "  2 to redraw current diagram"
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
371 PRINT "  3 to change current diagram"
381 PRINT "  4 to retrieve a stored diagram"
391 PRINT "  5 to destroy part or all of stored data: GGG";
401 INPUT K
411 P3=K-1
421 GO TO K OF 441,491,511,95,95
431 GO TO 200
441 FIND 6
451 IF TYP(0)=0 THEN 87
461 READ @33:H$,T,Z,Z1
471 IF H$="                                                    " THEN 87
481 GO TO 91
491 M=1
501 R=1
511 FIND 6
521 READ @33:H$,T,Z,Z1
531 GO TO 87
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
101 IF P3>0 THEN 80
111 T=0
121 Z=0
131 Z1=0
141 R=0
151 W1=0
161 W2=0
171 M=32
181 PAGE
191 S=1
201 GOSUB 231
211 GOSUB 331
221 END

231 REM .....draw grid.....

241 FOR I=40 TO 120 STEP 20
251     MOVE @M:I,0
261     DRAW @M:I,100-10*SGN((I+40)/80-INT((I+40)/80))
271 NEXT I
281 FOR I=0 TO 100 STEP 10
291     MOVE @M:40,I
301     DRAW @M:120,I
311 NEXT I
321 RETURN

331 REM .....select boxes.....

341 FOR J=2 TO 10
351     FOR I=1 TO 4
361         MOVE 30+20*I,105-10*J
371         PRINT "?";
381         K=0
391         INPUT K$
401         IF K=10 THEN 361
411         T(I,J)=K*S
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
421     NEXT I
431 NEXT J
441 GO TO 80

451 REM
461 REM .....box routines.....

471 A=24+20*I
481 F=0
491 GOSUB 511
501 RETURN
511 B=110-10*J
521 C=A-F
531 D=B-8
541 GOSUB 2221
551 A=C+12
561 B=D
571 GOSUB 2221
581 C=A+F
591 D=B+8
601 GOSUB 2221
611 A=C-12
621 B=D
631 GOSUB 2221
641 RETURN
651 A=25.5+20*I
661 F=3
671 GOSUB 511
681 RETURN
691 A=24+20*I
701 B=110-10*J
711 C=A
721 D=B-9
731 GOSUB 2221
741 B=D
751 A=C+2
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
761 GOSUB 2221
771 C=A+2
781 D=B+0.3
791 GOSUB 2221
801 A=C+2
811 B=D+0.7
821 GOSUB 2221
831 C=A+2
841 D=B+0.7
851 GOSUB 2221
861 A=C+2
871 B=D+0.3
881 GOSUB 2221
891 C=A+2
901 D=B
911 GOSUB 2221
921 A=C
931 B=D+7
941 GOSUB 2221
951 C=A-12
961 D=B
971 GOSUB 2221
981 RETURN
991 A=27+20*I
1001 B=110-10*J
1011 C=A-3
1021 D=B-4
1031 GOSUB 2221
1041 B=B-8
1051 GOSUB 2221
1061 D=B
1071 C=A+8
1081 GOSUB 2221
1091 B=B+1
1101 A=C+0.5
1111 GOSUB 2221
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1121 C=C+0.75
1131 D=D+2
1141 GOSUB 2221
1151 B=B+2
1161 A=A+0.4
1171 GOSUB 2221
1181 C=C+0.25
1191 D=D+2
1201 GOSUB 2221
1211 B=B+2
1221 GOSUB 2221
1231 C=C-0.25
1241 D=D+2
1251 GOSUB 2221
1261 A=A-0.4
1271 B=B+2
1281 GOSUB 2221
1291 C=C-0.75
1301 D=D+2
1311 GOSUB 2221
1321 A=C-8
1331 B=B+1
1341 GOSUB 2221
1351 RETURN
1361 D=4
1371 GOSUB 2181
1381 A=30+20*I
1391 B=102-10*J
1401 C=A+5
1411 D=B
1421 GOSUB 2221
1431 RETURN
1441 A=30+20*I
1451 B=110-10*J
1461 C=A-6
1471 D=B-4
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1481 GOSUB 2221
1491 B=B-8
1501 GOSUB 2221
1511 C=C+12
1521 GOSUB 2221
1531 B=B+8
1541 GOSUB 2221
1551 RETURN
1561 A=26+20*I
1571 B=110-10*J
1581 C=A-2
1591 D=B-2
1601 GOSUB 2221
1611 A=C
1621 B=D-6
1631 GOSUB 2221
1641 C=A+12
1651 D=B
1661 GOSUB 2221
1671 A=C
1681 B=D+8
1691 GOSUB 2221
1701 C=A-10
1711 D=B
1721 GOSUB 2221
1731 RETURN
1741 A=25+20*I
1751 B=110-10*J
1761 GOSUB 2711
1771 D=B
1781 C=A+12
1791 GOSUB 2221
1801 A=C
1811 B=D+8
1821 C=C-12
1831 D=B
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1841 GOSUB 2221
1851 GOSUB 2711
1861 RETURN
1871 A=30+20*I
1881 B=110-10*J
1891 C=A
1901 D=B-1
1911 GOSUB 2221
1921 A=C-3
1931 B=D
1941 GOSUB 2221
1951 C=A
1961 D=B-3
1971 GOSUB 2221
1981 A=C+3
1991 B=D-2
2001 GOSUB 2221
2011 C=C+6
2021 GOSUB 2221
2031 A=C
2041 B=D+3
2051 GOSUB 2221
2061 C=A-3
2071 D=B
2081 GOSUB 2221
2091 RETURN
2101 D=2.5
2111 GOSUB 2181
2121 A=32.5+20*I
2131 C=A+3.5
2141 B=106-10*J
2151 D=B
2161 GOSUB 2221
2171 RETURN
2181 A=30+20*I
2191 B=106-10*J
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
2201 GOSUB 2951
2211 RETURN

2221 REM .....draw from a,b to c,d.....

2231 IF A=C AND B=D THEN 2491
2241 A9=A
2251 B9=B
2261 C9=C
2271 D9=D
2281 IF C<>W1 OR D<>W2 THEN 2331
2291 A9=C
2301 B9=D
2311 C9=A
2321 D9=B
2331 IF R=0 THEN 2431
2341 A9=125-B*1.25
2351 B9=A*1.25-50
2361 C9=125-D*1.25
2371 D9=C*1.25-50
2381 IF C9<>W1 OR D9<>W2 THEN 2431
2391 A9=C9
2401 B9=D9
2411 C9=125-B*1.25
2421 D9=A*1.25-50
2431 IF S<>1 THEN 2501
2441 IF A9=W1 AND B9=W2 THEN 2461
2451 MOVE @M:A9,B9
2461 DRAW @M:C9,D9
2471 W1=C9
2481 W2=D9
2491 RETURN
2501 IF B9<>D9 AND A9<>C9 THEN 2521
2511 GO TO 2541
2521 IF ABS(B9-D9)>ABS(A9-C9) THEN 2551
2531 GO TO 2631
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
2541 IF B9=D9 THEN 2631
2551 FOR N9=B9 TO D9 STEP SGN(D9-B9)
2561     E9=(C9-A9)*(N9-B9)/(D9-B9)+A9
2571     MOVE @M:E9,N9
2581     DRAW @M:E9,N9
2591     W1=E9
2601     W2=N9
2611 NEXT N9
2621 RETURN
2631 FOR E9=A9 TO C9 STEP SGN(C9-A9)
2641     N9=(D9-B9)*(E9-A9)/(C9-A9)+B9
2651     MOVE @M:E9,N9
2661     DRAW @M:E9,N9
2671     W1=E9
2681     W2=N9
2691 NEXT E9
2701 RETURN
2711 C=A-0.5
2721 D=B-1
2731 GOSUB 2221
2741 A=A-0.75
2751 B=B-2
2761 GOSUB 2221
2771 C=C-0.4
2781 D=D-2
2791 GOSUB 2221
2801 A=A-0.25
2811 B=B-2
2821 GOSUB 2221
2831 D=D-2
2841 GOSUB 2221
2851 A=A+0.25
2861 B=B-2
2871 GOSUB 2221
2881 C=C+0.5
2891 D=D-2
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
2901 GOSUB 2221
2911 A=A+0.75
2921 B=B-2
2931 GOSUB 2221
2941 RETURN

2951 REM .....circle.....

2961 D8=D
2971 A8=A
2981 B8=B
2991 L=1
3051 FOR N=1 TO 25
3061     C=D8*C5(N)+A8
3071     D=D8*S5(N)+B8
3081     IF N=1 THEN 3131
3091     IF S=1 THEN 3121
3101     L=L+1
3111     IF L<2 THEN 3131
3121     GOSUB 2221
3131     A=C
3141     B=D
3151 NEXT N
3161 RETURN

3171 REM
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
3151 REM ...........redraw boxes.............

3161 PAGE
3171 FOR J=2 TO 10
3181     FOR I=1 TO 4
3191         S=1
3201         K1=T(I,J)
3211         IF K1=0 THEN 3291
3221         IF K1>0 THEN 3251
3231         S=-1
3241         K1=-K1
3251         GOSUB K1 OF 471,651,691,991,1361,1441,1561,1741,1871,1871,2101
3261         GOSUB 5311
3291     NEXT I
3301 NEXT J
3311 IF Z1=0 THEN 3361
3321 FOR I1=1 TO Z1
3331     GOSUB 5021
3341     GOSUB 3671
3351 NEXT I1
3361 I1=97
3371 MOVE 0,I1
3375 GOSUB 5361
3376 IF P3=1 THEN 76
3381 PRINT "from ";
3391 INPUT K1
3401 IF K1=0 THEN 3661
3411 MOVE 17,I1
3421 PRINT "side ";
3431 INPUT S$
3441 PRINT "to   ";
3451 INPUT K2
3461 MOVE 17,I1-2.5
3471 PRINT "side ";
3481 INPUT T$
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
3491 PRINT "type ";
3501 INPUT T1
3511 I1=I1-9
3521 S1=2
3531 IF S$<>"r" THEN 3551
3541 S1=1
3551 IF S$<>"l" THEN 3571
3561 S1=3
3571 S2=4
3581 IF T$<>"r" THEN 3601
3591 S2=1
3601 IF T$<>"l" THEN 3621
3611 S2=3
3621 Z1=Z1+1
3631 Z(Z1)=(((K1*10+S1)*100+K2)*10+S2)*10+T1
3641 GOSUB 3671
3651 GO TO 3371
3661 END

3671 REM .....connect.....

3681 J=INT((K1-1)/4)+2
3691 I=K1-4*(J-2)
3701 E=0
3711 S=1
3721 IF T1<4 THEN 3751
3731 S=0
3741 T1=T1-3
3751 IF ABS(T(I,J))<>5 THEN 3791
3761 E=2
3791 A1=30+20*I
3801 B1=106-10*J
3811 GO TO S1 OF 3821,3871,3911
3821 C1=A1+10
3831 A1=A1+6-E
3841 D1=B1
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
3851 GOSUB 4461
3861 GO TO 3951
3871 B1=B1-4
3881 C1=A1
3891 D1=B1-1
3901 GO TO 3951
3911 C1=A1-10
3921 A1=A1-6+E
3931 D1=B1
3941 GOSUB 4461
3951 GOSUB 4701
3961 J=INT((K2-1)/4)+2
3971 I=K2-4*(J-2)
3981 E=0
3991 IF ABS(T(I,J))<>5 THEN 4031
4001 E=2
4031 A2=30+20*I
4041 B2=106-10*J
4051 GO TO S2 OF 4061,4111,4151,4111
4061 C2=A2+10
4071 D2=B2
4081 A2=A2+6-E
4091 GOSUB 4541
4101 GO TO 4191
4111 B2=B2+4
4121 D2=B2+1
4131 C2=A2
4132 GOSUB 4761
4133 L=INT((K1-1)/4)+2
4134 IF I-(K1-4*(L-2))<>0 OR ABS(J-L)=1 THEN 4201
4135 A=C2-0.5
4136 B=D2+1.5
4137 C=C2
4138 D=D2
4139 GOSUB 2221
4140 A=A+1
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
4141 GOSUB 2221
4145 GO TO 4191
4151 C2=A2-10
4161 D2=B2
4171 A2=A2-6+E
4181 GOSUB 4541
4191 GOSUB 4761
4201 GO TO T1 OF 4211,4281,4391
4211 A1=C1
4221 B1=D2
4231 GOSUB 4701
4241 A2=A1
4251 B2=B1
4261 GOSUB 4761
4271 RETURN
4281 A1=(C1+C2)/2
4291 B1=D1
4301 GOSUB 4701
4311 C1=A1
4321 D1=D2
4331 GOSUB 4701
4341 GOSUB 4621
4351 A2=A1
4361 B2=D2
4371 GOSUB 4761
4381 RETURN
4391 A1=C2
4401 B1=D1
4411 GOSUB 4701
4421 A2=C2
4431 B2=D1
4441 GOSUB 4761
4451 RETURN
4461 L=INT((K2-1)/4)+2
4462 IF ABS(I-(K2-4*(L-2)))=1 AND J=L THEN 4531
4469 A=C1-1.5*SGN(C1-A1)
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
4471 B=D1+0.5
4481 C=C1
4491 D=D1
4501 GOSUB 2221
4511 B=B-1
4521 GOSUB 2221
4531 RETURN
4541 A=A2-1.5*SGN(A2-C2)
4551 B=B2+0.5
4561 C=A2
4571 D=B2
4581 GOSUB 2221
4591 B=B-1
4601 GOSUB 2221
4611 RETURN
4621 B=(D1+B1)/2
4631 A=A1
4641 C=A1-0.5
4651 D=B-1.5*SGN(D1-B1)
4661 GOSUB 2221
4671 C=C+1
4681 GOSUB 2221
4691 RETURN
4701 A=A1
4711 B=B1
4721 C=C1
4731 D=D1
4741 GOSUB 2221
4751 RETURN
4761 A=A2
4771 B=B2
4781 C=C2
4791 D=D2
4801 GOSUB 2221
4811 RETURN
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
4815 REM
4817 REM
4821 REM .....delete box.....
4823 REM
4825 REM

4831 MOVE 0,10
4841 PRINT "Delete boxGGG ";
4851 INPUT N
4861 J=INT((N-1)/4)
4871 I=N-J*4
4881 J=J+2
4891 T(I,J)=0
4901 IF Z1=0 THEN 3151
4911 FOR I1=1 TO Z1
4921     GOSUB 5021
4931     IF K1=N OR K2=N THEN 4961
4941 NEXT I1
4951 GO TO 3151
4961 IF I1=Z1 THEN 5001
4971 Z(I1)=Z(Z1)
4981 Z1=Z1-1
4991 GO TO 4901
5001 Z(I1)=0
5005 GOSUB 5361
5011 GO TO 4981
5021 K1=INT(Z(I1)/100000)
5031 S1=INT(Z(I1)/10000)-K1*10
5041 K2=INT(Z(I1)/100)-(K1*10+S1)*100
5051 S2=INT(Z(I1)/10)-((K1*10+S1)*100+K2)*10
5061 T1=Z(I1)-INT(Z(I1)/10)*10
5071 RETURN

5075 REM
5077 REM
5081 REM .....insert box.....
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
5083 REM
5085 REM

5101 FOR J=2 TO 10
5111     FOR I=1 TO 4
5131         GOSUB 5311
5151     NEXT I
5161 NEXT J
5171 MOVE 0,15
5181 PRINT "insert box at GGG";
5191 INPUT K
5200 PRINT "select a box"
5201 J=INT((K-1)/4)+2
5211 I=K-(J-2)*4
5221 MOVE 30+20*I,105-10*J
5231 K=0
5241 INPUT K$
5261 IF K=10 OR K=0 THEN 5241
5271 T(I,J)=K*S
5275 GOSUB 5361
5281 GO TO 3151

5301 REM

5311 MOVE 27+20*I,105-10*J
5321 K$=STR(J*4-8+I)
5331 PRINT K$
5341 RETURN
5361 IF P3=0 THEN 5381
5365 FIND 6
5371 WRITE H$,T,Z,Z1
5381 RETURN
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
471 REM .....enter data in boxes.....

481 DIM R$(8),X$(20)
491 Z$="                                    "
501 Z$=Z$&Z$
511 Z$=Z$&Z$
521 H$=SEG(Z$,1,50)
531 PAGE
535 IF P3=1 THEN 1071
541 MOVE 15,96
551 PRINT H$
561 PRINT
571 PRINT "JJJJEnter:"
591 PRINT " 1) to enter heading"
601 PRINT " 2) to enter box data"
611 PRINT " 3) to plot box dataGGG"
621 INPUT N
631 GO TO N OF 691,781,1061
641 GO TO 531

651 REM .....get data from tape.....

661 FIND 6
662 IF TYP(0)<>0 THEN 671
663 PAGE
664 PRINT "JJJJJ     No current diagram"
665 GO TO 87
671 READ @33:H$,T,Z,Z1
681 GO TO 531

691 REM .....enter heading.....

701 PRINT
711 PRINT "JJEnter heading: GGG";
721 INPUT H$
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
731 GO TO 1021
741 INPUT X$
751 Z$=Z$&X$
761 Z$=Z$&"\"
771 RETURN

781 REM .....enter box data.....

791 PAGE
801 PRINT "JJJJbox number: GGG";
811 INPUT N
821 PRINT "JEnter line 1:GGG ";
831 INPUT Z$
841 Z$=Z$&"\"
851 PRINT "      line 2:GGG ";
861 GOSUB 741
871 PRINT "      line 3:GGG ";
881 GOSUB 741
891 PRINT "      line 4:GGG ";
901 GOSUB 741
911 PRINT "J      above box:GGG ";
921 GOSUB 741
931 PRINT "      on right connector:GGG ";
941 GOSUB 741
951 PRINT "      on bottom connector:GGG ";
961 GOSUB 741
971 PRINT "      on left connector:GGG ";
981 GOSUB 741
991 FIND N+6
1001 WRITE Z$
1011 GO TO 531

1021 REM .....save data on tape.....

1031 FIND 6
1041 WRITE H$,T,Z,Z1
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1051 GO TO 531

1061 REM .....plot box data.....

1071 FIND 6
1081 READ @33:H$,T,Z,Z1
1091 IF R=0 THEN 1121
1101 PRINT @M,25:90
1111 GO TO 1151
1121 PRINT @M,7:
1131 MOVE @M:80-0.75*LEN(H$),96
1141 GO TO 1161
1151 MOVE @M:5,(80-0.75*LEN(H$))*1.25-50
1161 PRINT @M:H$
1171 FOR K=1 TO 36
1181     J=INT((K-1)/4)
1191     I=K-J*4
1201     J=J+2
1211     IF T(I,J)=0 THEN 1631
1221     FIND K+6
1231     READ @33:Z$
1241     L1=POS(Z$,"\",1)-1
1251     L2=POS(Z$,"\",L1+2)-2-L1
1261     L3=POS(Z$,"\",L1+L2+3)-3-L1-L2
1271     L4=POS(Z$,"\",L1+L2+L3+4)-4-L1-L2-L3
1281     A=30+20*I
1291     B=106.2-10*J
1301     IF L1=0 THEN 1491
1311     IF L2=0 THEN 1361
1321     IF L3=0 THEN 1361
1331     B=B+1
1341     IF L4=0 THEN 1361
1351     B=B+1
1361     E=L1
1371     GOSUB 1661
1381     B=B-2
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1391      E=L2
1401      GOSUB 1661
1421      B=B-2
1431      E=L3
1441      GOSUB 1661
1461      B=B-2
1471      E=L4
1481      GOSUB 1661
1491      A=30+20*I
1501      B=106-10*J
1511      C=A+2
1521      D=B+4.1
1531      GOSUB 1781
1541      C=A+7
1551      D=B+1
1561      GOSUB 1781
1571      C=0
1581      D=B-5.6
1591      GOSUB 1781
1601      C=A-7-0.375*LEN(Z$)
1611      D=B+1
1621      GOSUB 1781
1631 NEXT K
1641 GO TO 72
1661 IF E>0 THEN 1691
1671 Z$=SEG(Z$,2,LEN(Z$)-1)
1681 RETURN
1691 X$=SEG(Z$,1,E)
1701 Z$=SEG(Z$,E+2,LEN(Z$)-E-1)
1711 PRINT @M,17:0.896,2.816
1721 IF R=1 THEN 1751
1731 MOVE @M:A-0.375*(E-1),B
1741 GO TO 1761
1751 MOVE @M:125-B*1.25,(A-0.375*(E-1))*1.25-50
1761 PRINT @M:X$
1771 RETURN
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1781 E=POS(Z$,"\",1)-1
1791 R$=SEG(Z$,1,E)
1801 Z$=SEG(Z$,E+2,LEN(Z$)-E-1)
1802 IF LEN(R$)=0 THEN 1861
1803 IF C<>0 THEN 1811
1804 C=A-LEN(R$)*0.75-1
1811 IF R=1 THEN 1841
1821 MOVE @M:C,D
1831 GO TO 1851
1841 MOVE @M:125-D*1.25,C*1.25-50
1851 PRINT @M:R$
1861 RETURN
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
101 REM .....phase 5.....

111 DIM L$(1000)
121 L$=""
131 H$="                                                    "
141 PAGE
151 FIND 6
160 T6=TYP(0)
161 IF T6<>0 THEN 191
171 PRINT "JJNo current diagram"
181 GO TO 211
191 READ @33:H$,T,Z,Z1
201 PRINT "JJCurrent diagram: ";H$
211 L$=H$
221 PRINT "JStored diagrams:"
231 FOR I=43 TO 62
241     FIND I
251     IF TYP(0)=0 THEN 301
261     READ @33:H$
271     K$=STR(I-42)
281     PRINT K$;" ";H$
291 NEXT I
301 H$=L$
311 L$=""
321 IF I<>43 THEN 341
331 PRINT "...none"
341 IF K<>1 THEN 711
351 PRINT "JEnter 1 to store current diagram,0 to destroy: GGG";
361 INPUT K1
371 IF K1=0 THEN 651
381 IF I=>62 THEN 401
391 PRINT "JEnter 0 to save on available space,"
401 PRINT "Enter number to replace stored diagram: GGG";
411 INPUT K1
421 L$=""
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
431 FIND 6
441 READ @33:H$,T,Z,Z1
451 FOR I=7 TO 42
461     FIND I
462     IF TYP(0)<>0 THEN 471
463     Z$="\\\\\\\\"
464     GO TO 481
471     READ @33:Z$
481     Z$=Z$&"~"
491     IF LEN(Z$)+LEN(L$)=>1000 THEN 631
501     L$=L$&Z$
511 NEXT I
521 IF K1=0 THEN 551
531 FIND K1+42
541 GO TO 591
551 FOR I=43 TO 62
561     FIND I
571     J=TYP(0)
581     IF J>0 THEN 611
591     WRITE H$,T,Z,Z1,L$
601     GO TO 651
611 NEXT I
621 GO TO 141
631 PRINT "JDiagram too big to store"
641 STOP
651 FIND 6
661 KILL 6
671 Z=0
681 Z1=0
691 T=0
692 K=9
701 GO TO 94
711 IF K=5 THEN 901
712 IF T6=0 THEN 751
721 PRINT "JWARNING--The current diagram will be destroyed."
731 PRI "Press 'return' to proceed or key 18 to save current diagram.GG"
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
741 INPUT Z$
751 PRINT "JEnter number of diagram to retrieve: GGG";
761 INPUT K1
771 FIND K1+42
781 READ @33:H$,T,Z,Z1,L$
791 FIND 6
801 WRITE H$,T,Z,Z1
811 FOR I=7 TO 42
821     J=POS(L$,"~",1)
831     Z$=SEG(L$,1,J-1)
841     L$=SEG(L$,J+1,LEN(L$)-J+1)
851     FIND I
861     WRITE Z$
871 NEXT I
881 GO TO 692
901 PRINT "JEnter 0 to retain all stored diagrams,"
911 PRINT "      diagram number to delete a specific diagram,"
921 PRINT "      or 99 to destroy all stored diagrams: GGG";
931 INPUT K1
932 K=9
941 IF K1=0 THEN 72
951 FOR I=43 TO 62
961     IF K1<>99 THEN 991
971     KILL I
981     GO TO 1071
991     IF K1=>I-42 THEN 1071
1001     FIND I
1002     IF TYP(0)=0 AND I=43 THEN 72
1011     IF TYP(0)=0 THEN 1061
1021     READ @33:H$,T,Z,Z1,L$
1031     IF I=43 THEN 1071
1032     FIND I-1
1041     WRITE H$,T,Z,Z1,L$
1051     GO TO 1071
1061     FIND I-1
1062     IF TYP(0)=0 THEN 72
```

TITLE	ABSTRACT NO:
FLOW DIAGRAMMER	51/00-8015/0

```
1063     KILL I-1
1071 NEXT I
1081 GO TO 72
```

TEKTRONIX®

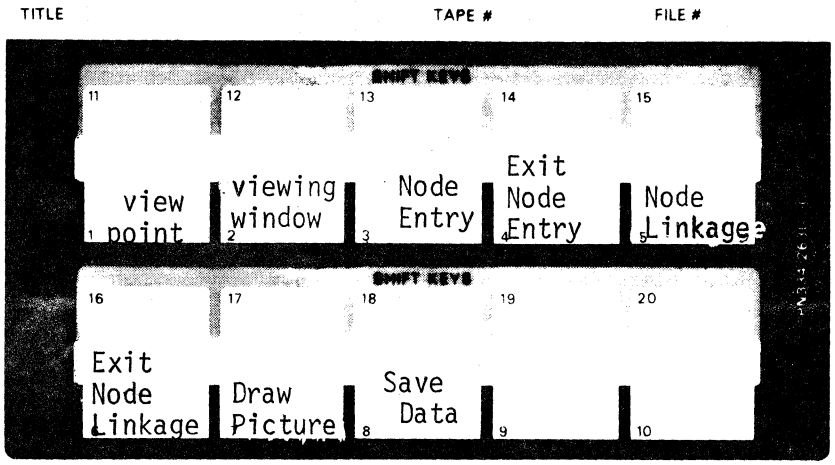
APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
3-D with Perspective	51/00-9507/0
ORIGINAL DATE: October 28, 1976 / REVISION DATE:	MEMORY REQUIREMENT: 10000 + bytes
AUTHOR: Will Gallant	PERIPHERALS: 4662 Optional

ABSTRACT

This program accepts points in space defined by X, Y, Z coordinates and a table defining their interconnection. A viewpoint (position of your eye) in space and a nose to screen distance (code of vision) is also requested. Data may be input from tape files or the keyboard. A training example is built in. The 3-D algorithm was suggested in Principles of Interactive Computer Graphics by Newman and Sproull; McGraw Hill publishers.

TITLE	ABSTRACT NUMBER
3-D with Perspective	51/00 - 950770



1. Selection of eye position in space.
2. Viewing window or cone of vision. Also considered nose to screen distance.
3. Enter X, Y, Z coordinates of each line end point (node).
4. Exit from node entry.
5. Establish node to node linkage, i.e. define lines.
6. Exit from linkage definition.
7. Erase the screen and draw the object.
8. Save the node and linkage data in a tape file.

TITLE	ABSTRACT NO:
3-D with Perspective	51/00 - 9507/0

This BASIC code uses some of the unique features of the Tektronix 4051 Graphic Computing System. I will endeavor to explain the overall scheme of preparing (digitizing) a figure in 3-D and the routines which subsequently display the figure. Since each step in the process is controlled by a "user definable" key on the 4051, perhaps a step through the code via these keys would be useful.

Statement #1 arms the keys. When a key is pressed, control is transferred to a statement number assigned to the key. i.e.:

Key #1 = statement #4
Key #2 = statement #8
Key #3 = statement #12

.....

Key #20 = statement #80

Key #1 transfers control to the subroutine at statements #100 thru #130. The X, Y, Z viewpoint in space is requested. +Z is heigth above the 0, 0, 0 point of the object to be viewed.

If you are looking at a cube 1 unit on a side placed on the ground 10 units in front of you then; +Z will be about 5.5 units to your eyes, your toes will be about -10 Y units from the center of the object, and X will probably be 0. -X will be off to your left and +X will be off to your right.

After an object is defined and entered you may pick arbitrary viewpoints thru key #1 without re entering your data.

This program is set up to look at the 0, 0, 0 point in an object. By adding a bias (offset) to your data values you could "look at" other points in your object from a constant point in space. Matrix T (500, 3) allows for 500 X, Y, Z values. You need only add the bias to one or more vectors of this matrix to shift the objects 0, 0, 0 point.

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3-D with Perspective	51/00 - 9507/0

Key #2 transfers control to the subroutine at Statements #200 thru 240. A request is made for the eye to screen distance. This figure has the effect of a wide-angle or telephoto lens. The request is for inches, however enter the number in the same units as the figure. Experimentation is the best teacher here, try 12 for approximately a 45^{0} cone of vision. Too wide an angle (eg. 3) exaggerates perspective. Too narrow a cone and you may be looking right through your object.

Key #3 transfers control to the subroutine starting at Statement #300. I have built into the code a figure of the Washington Monument and Reflecting Pool. Typing "M" will cause the Monument to be transformed to reflect the viewpoint in space selected earlier. After you become accustomed to working with 3-D objects this excess code may be removed. Try -5000, -200, 50 as a vantage point to view the tower and pool. Then move above the tower with 100, 100, 1000. The elevator door is on the side of the tower opposite the pool. The pool surface is a few feet below the base of the tower.

Should you wish to enter your own data, just respond to the questioning with an X, Y, Z value for each point or node in the figure. The 4051 is capable of dynamically allocating and freeing dimensioned variables. Therefore, you may wish to fix the bounds of your data arrays to the actual number of nodes in your 3-D figure.

If you have some data prepared (in node and linkage format) it may be read from a file in this step. Variables F and G are number of nodes and number of line segments respectively. These two values are read from the file first to set the upper bounds for the arrays O and W which will hold the picture data.

TITLE	ABSTRACT NO:
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Pressing Key #4 transfers control out of the node entry loop.

Key #5 initiates node linkage requests or line segment definition in the subroutine starting at Line 2000. Again, you may wish to set upper limits or dimensioned variables to accommodate your machine.

Key #6 transfers control out of node linkage definition.

Key #7 starts the 3-D to 2-D transformation at Line 4000. WINDOW defines the position on the screen in which the picture is to be drawn. VIEWPORT defines the limits of the line segments that will be drawn in the WINDOW. Any lines drawn through the edges of the VIEWPORT will be clipped. Since the transformation matrix includes the bounds of the WINDOW, I have made VIEWPORT and WINDOW the same while drawing titles.

Subroutine 4430 is called once. The result is a 4 X 4 transformation matrix C. Every point in the figure will be multiplied by C to convert the X, Y, Z point to a point on the screen. Since the matrix multiplication in this code is software (rather the matrix ROM Pack) it takes about 3/4 of a second to effect transformation of each node in an object.

Examination of the code may reveal some shortcuts and more optimal ways to do repetitive computation. Straight forward coding and liberal use of remarks was the objective more than a fast package.

Subroutine 5290 takes the object in "O", an F by 3 matrix, multiplies by C and draws each line segment scaled to fit in the window.

No hidden line elimination is attempted in this exercise. See Newman & Sproull for a treatment of hidden line, hidden surface, and grey scale shading algorithms. This is an excellent book on both theory and "how to" on computer graphics. Several other practical references are given in the bibliography.

TITLE	ABSTRACT NO:
3-D with Perspective	51/00 - 9507/0

Figure: A cube with X, Y, and Z written on adjacent sides.

Node #	X	Y	Z
1	-1	-1	1
2	1	-1	1
3	1	1	1
4	-1	1	1
5	-1	-1	-1
6	1	-1	-1
7	1	1	-1
8	-1	1	-1
9	-.5	-.5	1
10	.5	.5	1
11	.5	-.5	1
12	-.5	.5	1
13	-.5	-1	-.5
14	0	-1	0
15	.5	-1	.5
16	-.5	-1	.5
17	1	-.5	.5
18	1	.5	.5
19	1	-.5	-.5
20	1	.5	-.5

Line #	Linkage
1	1 2
2	2 3
3	3 4
4	4 1
5	5 6
6	6 7
7	7 8
8	8 5
9	1 5
10	2 6
11	3 7
12	4 8
13	9 10
14	11 12
15	13 15
16	14 16
17	17 18
18	18 19
19	19 20

TITLE	ABSTRACT NO:
3-D with Perspective	51/00 - 9507/0

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Applied Research Lab
University of Texas at Austin
(ACM, 1133 Avenue of the Americas, NY, NY, 10036)

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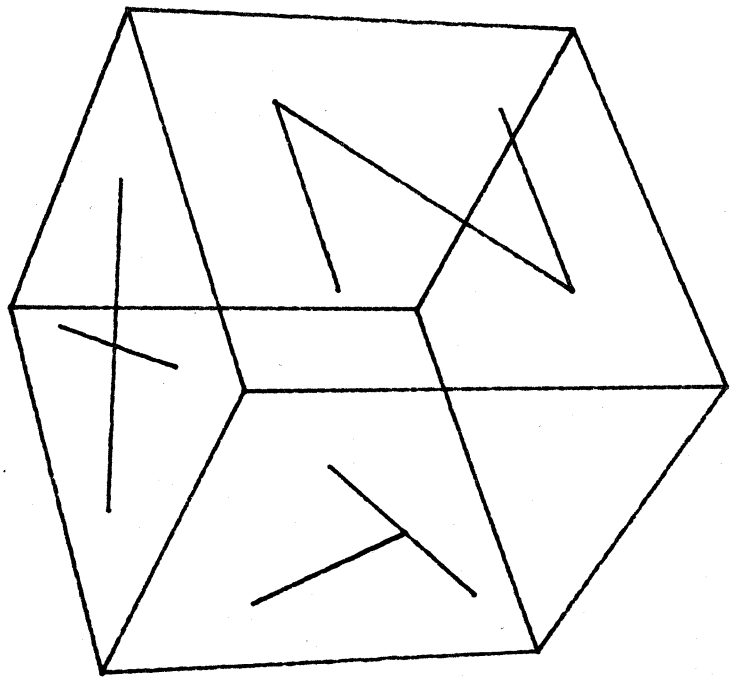
TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

VIEWPOINT
X= 9
Y= -7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



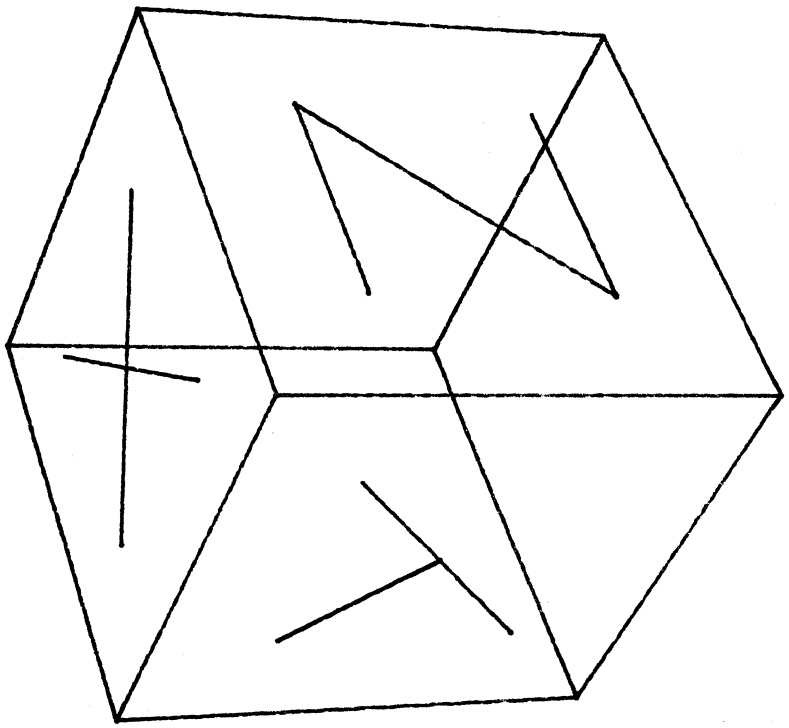
TITLE

3-D with Perspective

ABSTRACT NO:

51/00-9507/0

VIEWPOINT
X= 8
Y= -7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



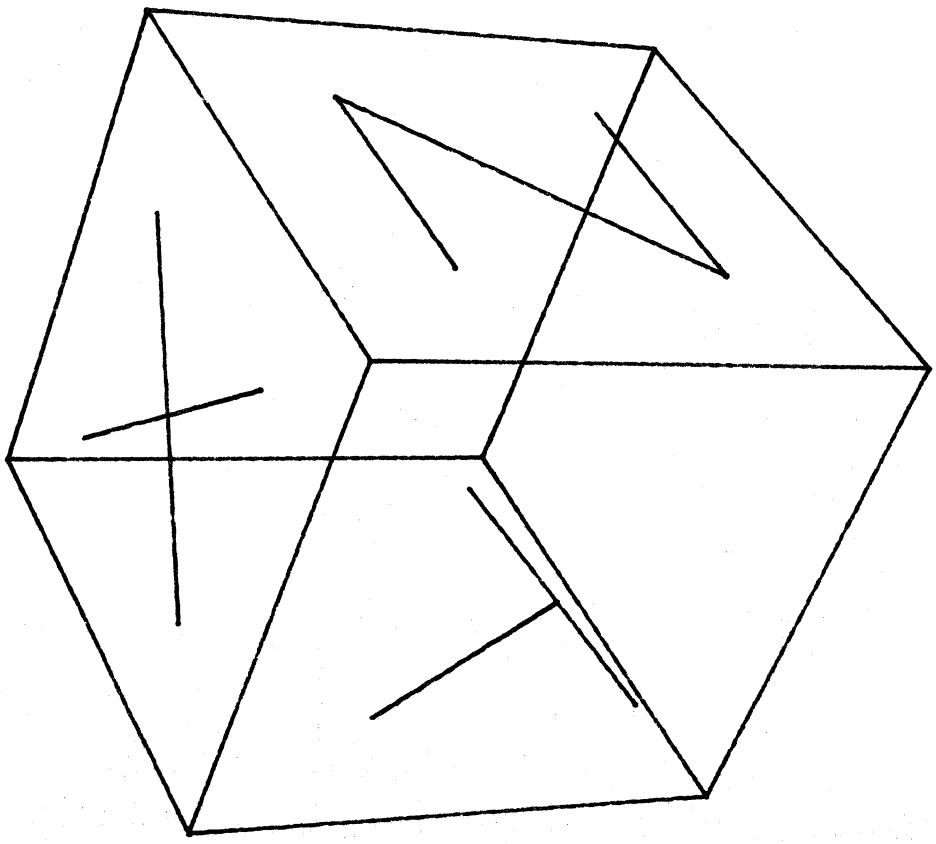
TITLE

3-D with Perspective

ABSTRACT NO:

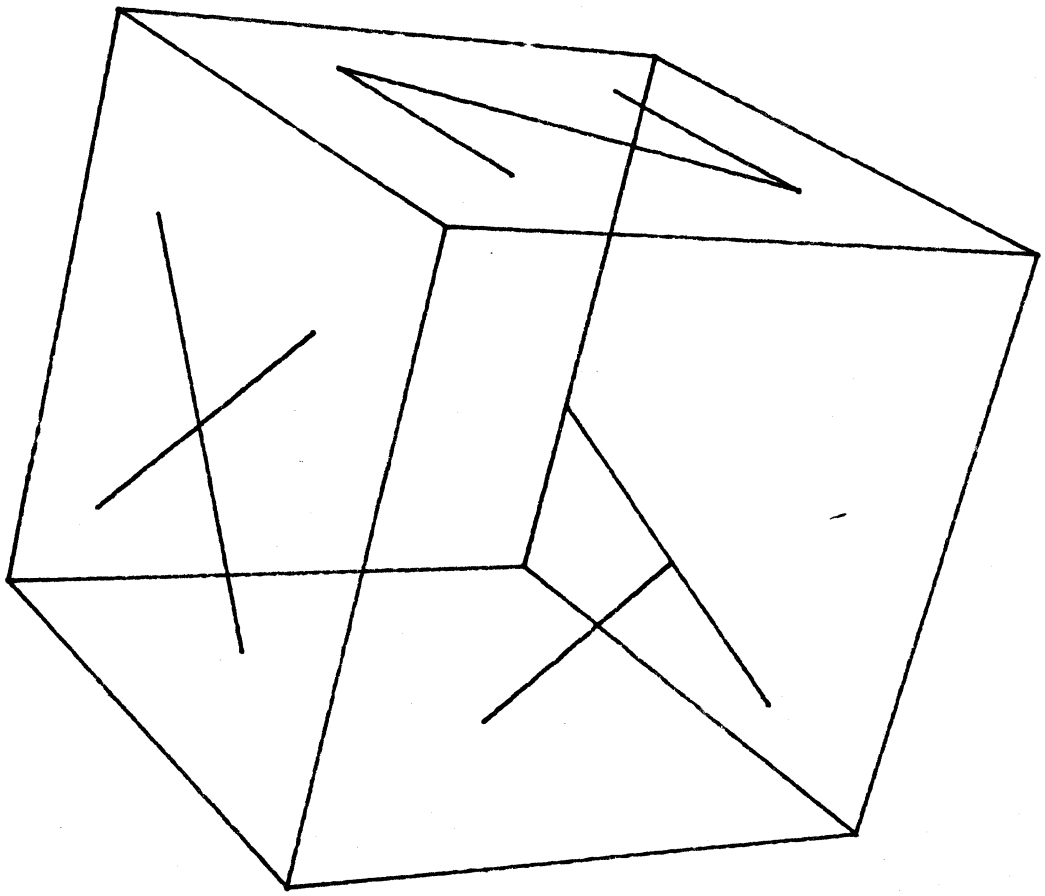
51/00-9507/0

VIEWPOINT
X= 5.5
Y= -7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



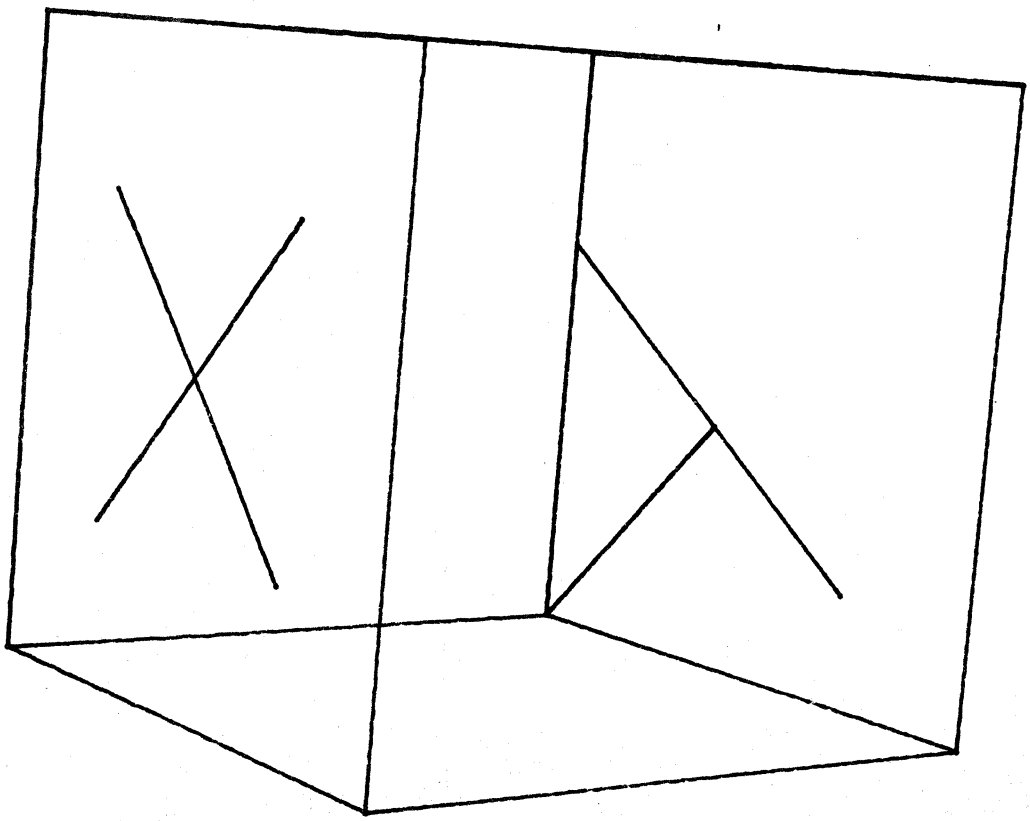
TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

VIEWPOINT
X= 3
Y= -7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

VIEWPOINT
X= 1
Y= -7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



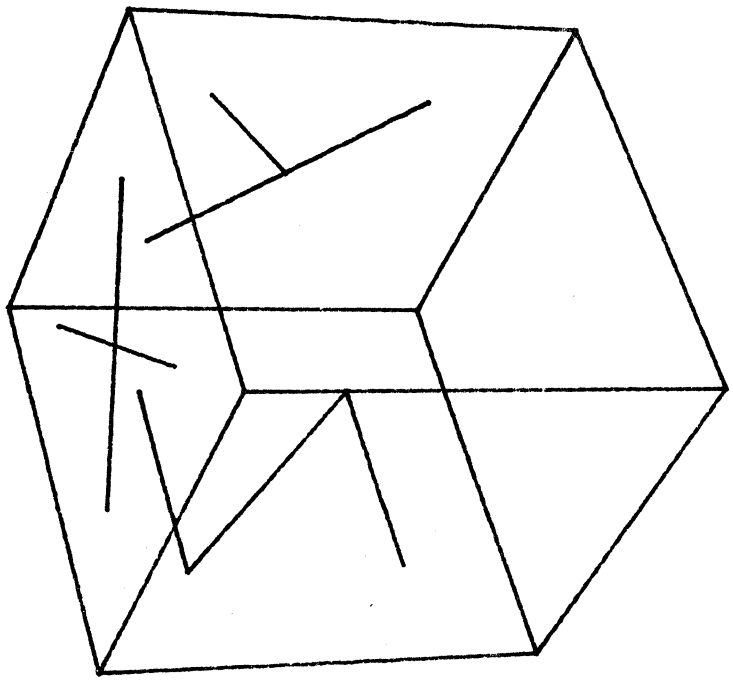
TITLE

3-D with Perspective

ABSTRACT NO:

51/00-9507/0

VIEWPOINT
X= -9
Y= 7
Z= 5
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



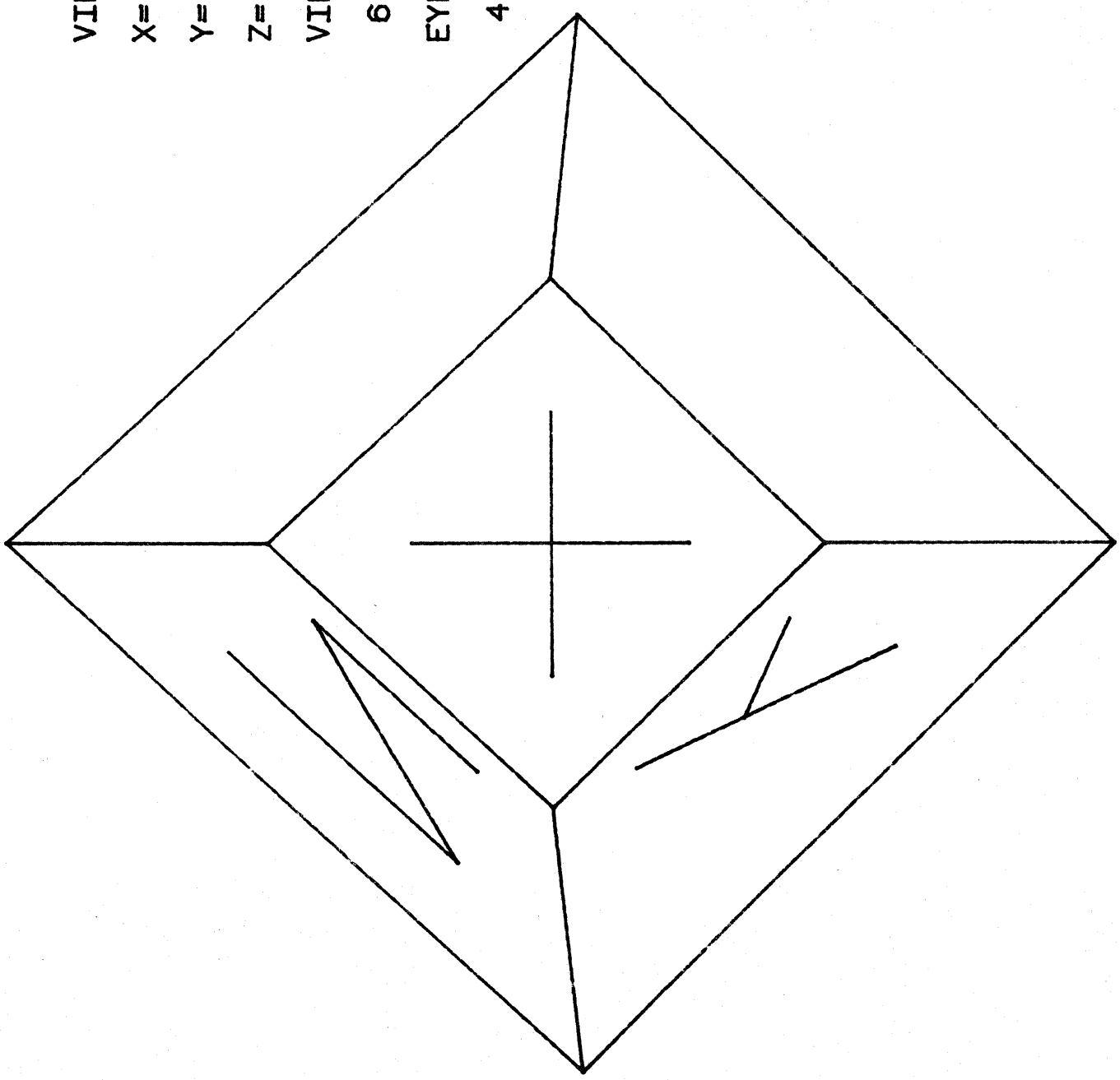
TITLE

3-D with Perspective

ABSTRACT NO:

51/00-9507/0

VIEWPOINT
X= 0.1
Y= 0.1
Z= -3
VIEWPORT
6" X 6"
EYE TO SCREEN
4"



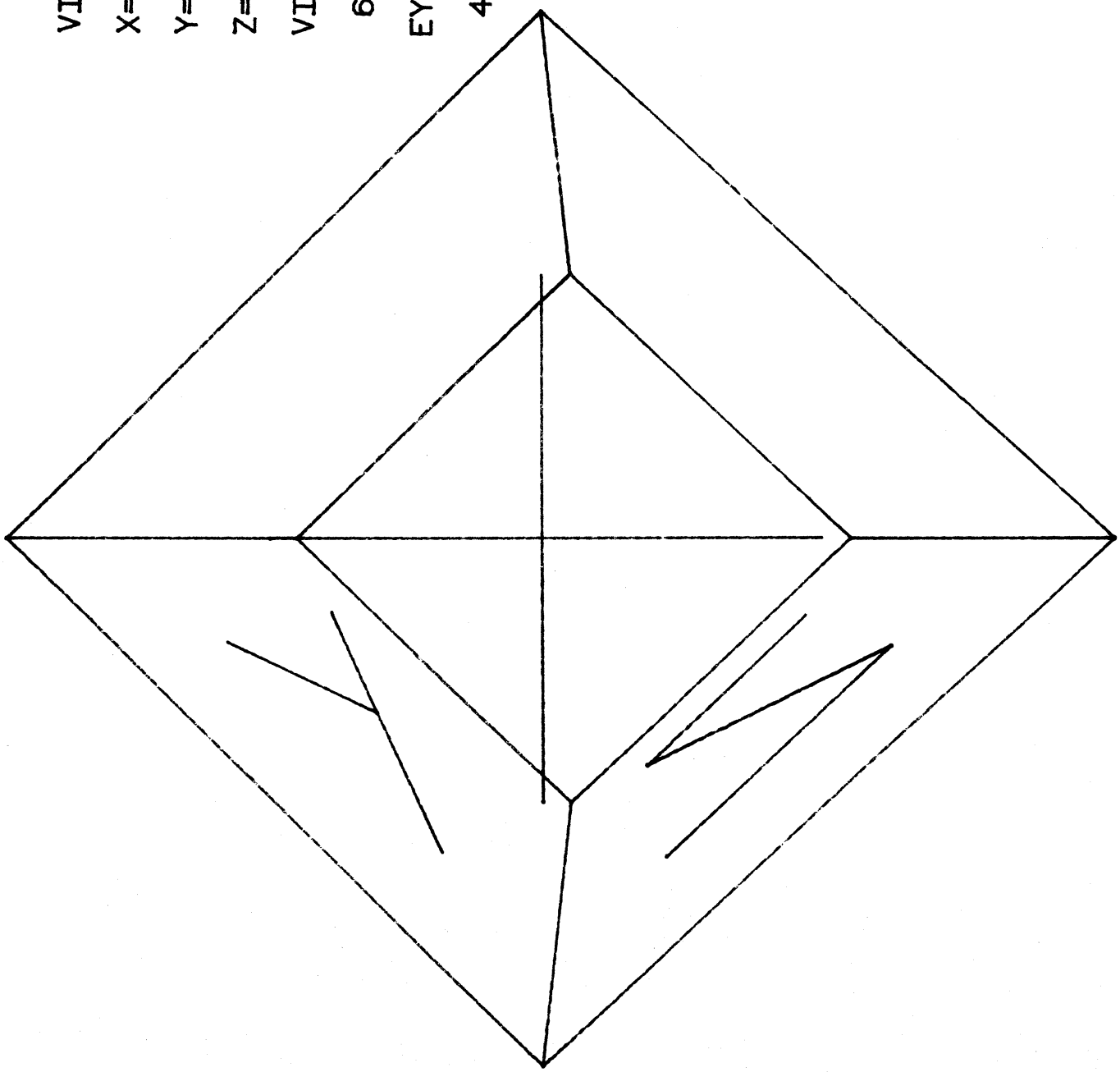
TITLE

3-D with Perspective

ABSTRACT NO:

51/00-9507/0

VIEWPOINT
X= 0.1
Y= 0.1
Z= 3
VIEWPORT
6" X 6"
EYE TO SCREEN
4"

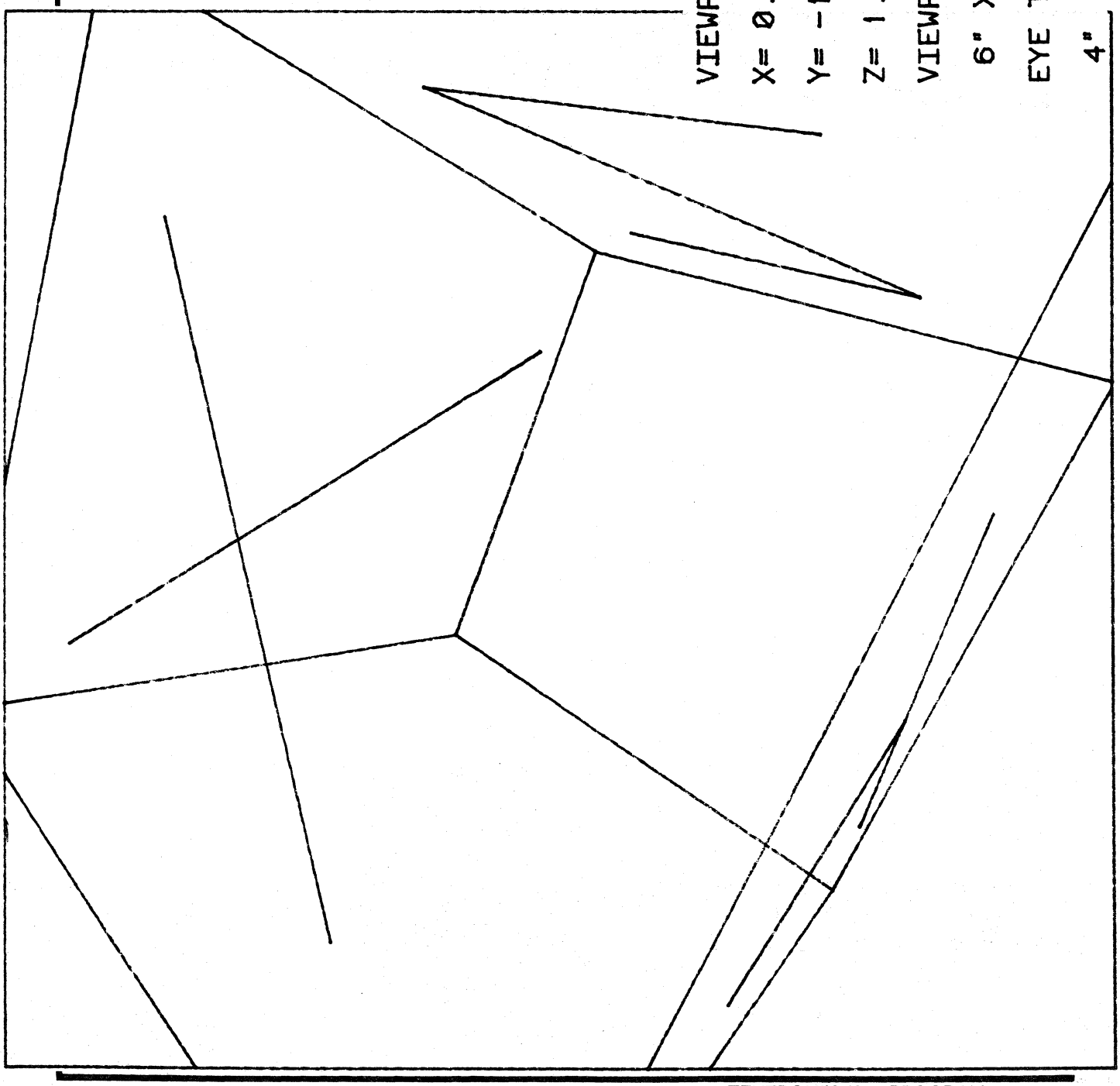


TITLE

3-D with Perspective

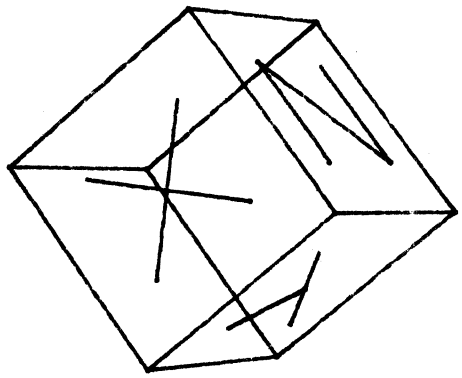
ABSTRACT NO:

51/00-9507/0



TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

VIEWPOINT
X= 9
Y= -7
Z= 20
VIEWPORT
6" X 6"
EYE TO SCREEN
12"



TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
1 SET KEY
2 WAIT
4 GOSUB 100
5 END
8 GOSUB 200
9 END
12 GOSUB 300
13 END
16 GOSUB 1000
17 END
20 GOSUB 2000
21 END
24 GOSUB 3000
25 END
28 GOSUB 4000
29 END
32 GOSUB 3100
33 END

90 REM 51/00-9507/0  3-D WITH PERSPECTIVE
100 REM SELECT EYE POINT RELATIVE TO 0,0,0 IN FIGURE

110 PRINT "JJJ   ENTER X,Y,Z VIEWPOINT IN SPACE G: ";
120 INPUT X,Y,Z
130 RETURN
200 PRINT "JJJ   ENTER DISTANCE FROM EYE TO SCREEN (IN INCHES) G: ";
210 INPUT N

220 REM FIX SCREEN WINDOW TO 6" SQUARE.

230 S=6
240 RETURN
300 PAGE
310 DIM M$(1)
320 PRINT "J DO YOU HAVE SOME DATA READY? G";
330 INPUT M$
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
340 IF M$="Y" THEN 580

350 REM F IS NUMBER OF POINTS TO BE TRANSFORMED.....

360 F=17
370 I=F+1
380 DIM O(F,3),XO(F),YO(F)

390 REM THE WASHINGTON MONUMENT.....

400 RESTORE
410 DATA -100,-100,0,100,-100,0,100,100,0,-100,100,0,-50,-50,900
420 DATA 50,-50,900,50,50,900,-50,50,900,0,0,1000

430 REM THE DOORWAY.....

440 DATA -4,-100,0,-4,-100,8,4,-100,8,4,-100,0

450 REM THE REFLECTING POOL.....

460 DATA -200,1500,-10,200,1500,-10,200,2500,-10,-200,2500,-10
470 READ O
480 DELETE T
490 DIM T(23,2)
500 DATA 1,2,2,3,3,4,4,1,1,5,2,6,3,7,4,8,8,5,5,6,6,7,7,8,8,9,5,9,6,9,7,9
510 DATA 10,11,11,12,12,13,14,15,15,16,16,17,17,14
520 READ T

530 REM G IS NUMBER OF LINE SEGMENTS TO BE DRAWN.....

540 G=23
550 PRINT "JJ  I HAVE THE WASHINGTON MONUMENT ON FILE."
560 GO TO 3010
580 PRINT "J IS IT ON TAPE? G";
590 INPUT M$
600 IF M$="Y" THEN 5470
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
610 PRINT "JJJ   ENTER X,Y,Z VALUE  FOR EACH POINT IN SPACE :"
620 DELETE T
630 DIM T(500,3)
640 FOR I=1 TO 500
650     PRINT "   POINT #";I;"  ";
660     INPUT T(I,1),T(I,2),T(I,3)
670 NEXT I
680 PRINT "GGGG UPPER BOUND OF 500 POINTS REACHED, PROGRAM MOD NEEDED"
690 RETURN
1000 F=I-1
1010 DIM O(F,3),XO(F),YO(F)
1020 FOR I=1 TO F
1030     O(I,1)=T(I,1)
1040     O(I,2)=T(I,2)
1050     O(I,3)=T(I,3)
1060 NEXT I
1070 DELETE T
1080 PRINT " I HAVE ";F;" POINTS."
1090 PRINT " PRESS FUNCTION KEY 5 TO ENTER NODE LINKAGES."
1100 RETURN
2000 PAGE
2010 PRINT "JJJENTER START NODE,END NODE FOR EACH LINE SEGMENT."
2020 DELETE T
2030 DIM T(500,2)
2040 FOR I=1 TO 500
2050     PRINT "LINE #";I;" ";
2060     INPUT T(I,1),T(I,2)
2070 NEXT I
2080 PRINT " UPPER LIMIT OF 500 LINES REACHED, PROGRAM MOD NEEDED."
2090 RETURN
3000 G=I-1
3010 DIM W(G,2)
3020 FOR I=1 TO G
3030     W(I,1)=T(I,1)
3040     W(I,2)=T(I,2)
3050 NEXT I
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
3060 DELETE T
3070 PRINT "JJJ  I HAVE ";G;" LINE SEGMENTS READY TO DRAW IN 3D."
3080 PRINT "  PRESS FUNCTION KEY 7 TO COMMENCE 3D TRANSFORMATIONG"
3090 RETURN
3100 PAGE
3110 PRINT "J  DO YOU HAVE A FILE MARKED FOR THE FIGURE ? ";
3120 INPUT A$
3130 IF A$<>"Y" THEN 3200
3140 PRINT "J WHICH FILE NUMBER ? ";
3150 INPUT F2
3160 FIND F2
3170 WRITE F,G,O,W
3180 FIND F2
3190 PRINT "GJ SAVED IN FILE ";F2
3200 PRINT "  PRESS FUNCTION KEY 7 TO COMMENCE 3D TRANSFORMATIONG"
3210 RETURN

4000 REM INITIALIZE 3D ROUTINE

4010 PAGE
4020 PRINT "TYPE 1 FOR SCREEN, 2 FOR PLOTTER, 3 FOR 4923 TAPE :";
4030 INPUT E
4040 E=32*(E=1)+(E=2)+33*(E=3)
4050 IF E=0 THEN 4020
4060 PAGE
4070 WINDOW 0,130,0,100
4080 VIEWPORT 0,130,0,100
4081 IF E<>33 THEN 4099     4260
4082 DIM G$(1),U$(1),D$(1)
4083 U$=CHR(31)
4084 G$=CHR(29)
4085 D$=CHR(20)
4086 PRINT @33,0:1,1,1
4087 H1=1023/130
4088 V1=780/100
4089 PRINT " WHICH FILE NUMBER ? ";
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
4090 INPUT F2
4091 PRINT @33,0:1,1,1
4092 FIND F2
4094 GOSUB 9000
4095 GO TO 4340
4099 MOVE @E:105,80
4100 PRINT @E:"VIEWPOINT"
4110 MOVE @E:105,75
4120 PRINT @E:"X= ";X
4130 MOVE @E:105,70
4140 PRINT @E:"Y= ";Y
4150 MOVE @E:105,65
4155 PRINT @E:"Z= ";Z
4160 MOVE @E:105,60
4170 PRINT @E:"VIEWPORT"
4180 MOVE @E:105,55
4190 PRINT @E:S;""" X ";S;""""
4200 MOVE @E:105,50
4210 PRINT @E:"EYE TO SCREEN"
4220 MOVE @E:105,45
4230 PRINT @E:N;""""
4260 VIEWPORT 0,100,0,100
4270 WINDOW 0,100,0,100
4280 MOVE @E:0,0
4290 DRAW @E:0,100
4300 DRAW @E:100,100
4310 DRAW @E:100,0
4320 DRAW @E:0,0
4330 HOME
4340 WINDOW 0,1023,0,1023

4342 REM SET SCALE FOR 4923 TAPE OUTPUT

4344 H1=0.7692307
4346 V1=0.7692307
4350 S1=1023/2
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
4360 REM COMPUTE THE 3D TRANSFORMATION MATRIX FOR THIS EYE POINT

4370 GOSUB 4430

4380 REM DRAW THE FIGURE IN "O"

4390 GOSUB 5290
4400 HOME
4410 PRINT @E:"GGG"
4411 IF E<>33 THEN 4420
4412 PRINT @33,0:0,0,0
4420 RETURN

4430 REM INITIALIZE PLATFORM (EYEPOINT) IN SPACE TO LOOK
4440 REM DIRECTLY AT 0,0,0. (T1*T2 IN NEWMAN & SPROULL).
4450 REM INPUT :  3 SPACE VIEWPOINT X,Y,Z
4460 REM          DISTANCE FROM EYE TO SCREEN
4470 REM          SCREEN WIDTH ASSUMED TO BE 8 INCHES
4480 REM OUTPUT:  4X4 TRANSFORMATION MATRIX C

4490 DIM A(4,4),B(4,4),C(4,4),T(4),D(4)
4500 T=0
4510 A=0
4520 B=0

4530 REM C IS INITIALIZED BY MATRIX MULTIPLICATION ROUTINE

4540 A(1,1)=-1
4550 A(2,3)=-1
4560 A(3,2)=1
4570 A(4,1)=X
4580 A(4,2)=-Z
4590 A(4,3)=Y
4600 A(4,4)=1
```

TITLE	ABSTRACT NO:
3-D with Perspetive	51/00-9507/0

```
4610 REM ROTATE ABOUT Y AXIS OF VIEWPOINT

4620 A1=SQR(Y↑2+X↑2)
4630 T1=Y/A1
4640 T2=X/A1
4650 B(1,1)=T1
4660 B(1,3)=T2
4670 B(2,2)=1
4680 B(3,1)=-T2
4690 B(3,3)=T1
4700 B(4,4)=1

4710 REM MULTIPLY MATRICES A & B, PLACE RESULT IN C

4720 GOSUB 5010

4730 REM ROTATE ABOUT X AXIS OF VIEWPOINT

4740 B1=SQR(Z↑2+A1↑2)
4750 P1=A1/B1
4760 P2=Z/B1
4770 B=0
4780 A=C
4790 B(1,1)=1
4800 B(2,2)=P1
4810 B(2,3)=-P2
4820 B(3,2)=P2
4830 B(3,3)=P1
4840 B(4,4)=1

4850 REM MULTIPLY MATRICES A & B, PLACE RESULT IN C

4860 GOSUB 5010

4870 REM APPLY PERSPECTIVE RELATIVE TO EYE & SCREEN SIZE
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
4880 A=C
4890 B=0

4900 REM PERSP = (EYE TO SCREEN DIST)/(SCREEN SIZE /2)

4910 P=N/(S/2)
4920 B(1,1)=P
4930 B(2,2)=P
4940 B(3,3)=1
4950 B(4,4)=1

4960 REM MULTIPLY MATRICES A & B, PLACE RESULT IN C

4970 GOSUB 5010

4980 REM C NOW CONTAINS A TRANSFORMATION MATRIX TO HANDLE
4990 REM CONVERSION FROM 3D DATA SPACE TO 2D DATA SPACE.

5000 RETURN

5010 REM THIS ROUTINE MULTIPLIES TWO 4X4 MATRICES
5020 REM INPUT :  A(4,4) & B(4,4)
5030 REM OUTPUT:  C(4,4)

5040 C=0
5050 FOR I=1 TO 4
5060     FOR J=1 TO 4
5070         FOR K=1 TO 4
5080             C(I,J)=C(I,J)+A(I,K)*B(K,J)
5090         NEXT K
5100     NEXT J
5110 NEXT I
5120 RETURN

5130 REM THIS ROUTINE WILL TRANSFORM A 3D POINT TO 2D
5140 REM RELATIVE TO THE VIEWPOINT IN SPACE.
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
5150 REM INPUT :  3D COORDINATES IN T(1),T(2),T(3)
5160 REM OUTPUT:  2D COORDINATES IN X & Y
5170 REM D IS A SCRATCH MATRIX

5180 D=0
5190 T(4)=1
5200 FOR I=1 TO 4
5210     FOR J=1 TO 4
5220         D(I)=D(I)+T(J)*C(J,I)
5230     NEXT J
5240 NEXT I
5250 X2=D(1)
5260 Y2=D(2)
5270 Z2=D(3)
5280 RETURN

5290 REM TRANSFORM AND DRAW OBJECT IN "O".............
5300 REM F IS NUMBER OF POINTS IN OBJECT
5310 REM G IS NUMBER OF LINE SEGMENTS IN OBJECT

5320 FOR Q=1 TO F
5330     T(1)=O(Q,1)
5340     T(2)=O(Q,2)
5350     T(3)=O(Q,3)

5360     REM CALL 3D TO 2D TRANSFORMATION

5370     GOSUB 5130
5380     XO(Q)=S1*(X2/Z2)+S1
5390     YO(Q)=S1*(Y2/Z2)+S1
5400 NEXT Q

5401 REM IS THIS FOR 4923 TAPE ?

5402 IF E<>33 THEN 5410
5403 X4=1.0E+8
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
5404 Y4=1.0E+8
5405 FOR I=1 TO G
5406      GOSUB 9500
5407 NEXT I
5408 PRINT @E:U$;D$
5409 GO TO 5460
5410 FOR I=1 TO G

5420      REM PRINT XO(W(I,1));YO(W(I,1));" TO ";XO(W(I,2));YO(W(I,2))

5430      MOVE @E:XO(W(I,1)),YO(W(I,1))
5440      DRAW @E:XO(W(I,2)),YO(W(I,2))
5450 NEXT I
5460 RETURN

5470 REM FETCH THE DATA FROM TAPE.........

5480 PRINT "JWHICH FILE NUMBER? G";
5490 INPUT F2
5500 FIND F2
5510 READ @33:F
5520 READ @33:G
5530 DELETE O,XO,YO,W
5540 DIM W(G,2),O(F,3),XO(F),YO(F)
5550 READ @33:O,W
5560 PRINT "JI HAVE ";F;" POINTS, AND ";G;" LINE SEGMENTS."
5570 PRINT " PRESS FUNCTION KEY 7 TO DRAW FIGURE.G "
5580 RETURN

6000 REM 4923 GRAPHICS SUPPORT (MOVE ENTRY)

6010 PRINT @E:G$;

6020 REM 4923 GRAPHICS SUPPORT (DRAW ENTRY)

6030 Y$=CHR(INT(X3*H1/32)+32)
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
6040 Z$=CHR(INT(X3*H1-32*INT(X3*H1/32))+64)
6050 W$=CHR(INT(Y3*V1/32)+32)
6060 X$=CHR(INT(Y3*V1-32*INT(Y3*V1/32))+96)
6070 PRINT @E:W$;X$;Y$;Z$;
6080 RETURN

9000 REM SPECIAL HANDLING FOR 4923 TAPE
9010 REM X3,Y3 = COORDS TO BE CONVERTED TO ASCII STRINGS

9020 X3=105
9030 Y3=80
9040 GOSUB 6000
9050 PRINT @E:U$;"VIEWPOINT";
9060 Y3=75
9070 GOSUB 6000
9080 PRINT @E:U$;"X= ";X;
9090 Y3=70
9100 GOSUB 6000
9110 PRINT @E:U$;"Y= ";Y;
9120 Y3=65
9130 GOSUB 6000
9140 PRINT @E:U$;"Z= ";Z;
9150 Y3=60
9160 GOSUB 6000
9170 PRINT @E:U$;"VIEWPORT";
9180 Y3=55
9190 GOSUB 6000
9200 PRINT @E:U$;S;""" X ";S;""""";
9210 Y3=50
9220 GOSUB 6000
9230 PRINT @E:U$;"EYE TO SCREEN";
9240 Y3=45
9250 GOSUB 6000
9260 PRINT @E:U$;N;""""";
9270 VIEWPORT 0,100,0,100
9280 WINDOW 0,100,0,100
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
9281 S2=10
9290 X3=0
9300 Y3=0
9310 GOSUB 6000
9320 Y3=100
9330 GOSUB 6020
9340 X3=100
9350 GOSUB 6020
9360 Y3=0
9370 GOSUB 6020
9380 X3=0
9390 GOSUB 6020
9400 PRINT @E:U$;
9410 RETURN

9500 REM DUMP TO 4923 TAPE

9530 X3=XO(W(I,1))
9540 Y3=YO(W(I,1))
9550 IF X3=X4 AND Y3=Y4 THEN 9590
9560 GOSUB 6000
9570 GO TO 9590

9580 REM CONCATENATE DRAWS WHEN POSSIBLE

9590 X3=XO(W(I,2))
9600 Y3=YO(W(I,2))
9610 X4=X3
9620 Y4=Y3
9630 GOSUB 6020
9640 RETURN

10000 REM ATTEMPT AT GENERATING ROTATING OBJECT FOR 4014

10010 E$=CHR(27)
10020 P$=CHR(112)
```

TITLE	ABSTRACT NO:
3-D with Perspective	51/00-9507/0

```
10030 SET DEGREES
10031 X5=X
10032 Y5=Y
10040 FOR I3=0 TO 360 STEP 10
10050     X=X5+X*SIN(I3)
10060     Y=Y5+Y*COS(I3)
10070     PRINT @E:E$;P$;
10080     GOSUB 4430
10090     GOSUB 5290
10100     FOR I=1 TO G
10110         X4=1.0E+8
10120         Y4=1.0E+8
10130         GOSUB 9500
10140     NEXT I
10150 NEXT I3
10160 PRINT "GGG  FINISHED"
10170 END
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
FORMS DESIGN	51/00-9515/0
ORIGINAL DATE: May, 1977 / REVISION DATE:	MEMORY REQUIREMENT: 24K
AUTHOR: Dr. P. C. Holman-University of Wisconsin	PERIPHERALS: 4631 Hard Copy

ABSTRACT

A program for designing any form or straight line geometric pattern. The screen is treated as a graph and the user is prompted for horizontal and vertical coordinates. The pattern may be drawn after any sequence of coordinate points input and the user may review his coordinate points after each draw. Changes are allowed throughout design construction.

Two methods are employed, one being faster but not as extensive as the other. Both are tutorial.

488 Statements.

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

OPERATING INSTRUCTIONS

Insert the tape cartridge into the 4051 and press the AUTOLOAD key.

The first file instructs in using the screen as a grid (piece of graph paper), using 130 vertical lines and 100 horizontal lines.

The second file contains the design program.

The third file contains the faster, briefer program.

The program is tutorial.

FILE STRUCTURE

The first file calls the second during the program so they must be in sequence on the tape.

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
100 PAGE
110 PRINT "YOU ARE NOW GOING TO RECEIVE INFORMATION AND INSTRUCTIONS"
120 PRINT "THAT WILL PERMIT YOU TO CONSTRUCT OR DESIGN A FORM."
130 PRINT
140 PRINT "    YOU MAY ALSO WANT TO NOTE THAT WITH THIS PROGRAM YOU CAN"
150 PRINT "    CONSTRUCT ANY GEOMETRIC DESIGN COMPOSED OF STRAIGHT "
160 PRINT "    LINES."
170 PRINT
180 PRINT "    AS YOU GAIN EXPERIENCE USING COORDINATES YOU WILL BEGIN"
190 PRINT "    TO UNDERSTAND THE VERSATILITY OF THIS PROGRAM."
200 PRINT
210 PRINT "YOU MUST VISUALIZE THE SCREEN AS A GRID (OR AS A PIECE OF"
220 PRINT "GRAPH PAPER) THAT HAS 130 VERTICAL LINES AND 100 HORIZONTAL"
230 PRINT "LINES. THE LOWER LEFT CORNER OF THE GRID IS THE ""0"" POINT"
240 PRINT "OR THE ORIGIN FOR BOTH THE VERTICAL AND HORIZONTAL. THE"
250 PRINT "FOLLOWING PICTURE SHOWS WHAT WE MEAN."
260 FOR I=1 TO 5000
270 NEXT I
280 PAGE
290 VIEWPORT 20,115,15,90
300 WINDOW 0,130,0,100
310 FOR I=0 TO 130
320     AXIS 0,0,I,I
330 NEXT I
340 HOME
350 VIEWPORT 15,115,10,90
360 WINDOW -4,131,-5,100
370 AXIS 5,10,2,1
380 FOR A=0 TO 100 STEP 10
390     MOVE 0,A
400     IF A=0 THEN 430
410     PRINT "HHH";A;
420     GO TO 440
430     PRINT "HH";A;
440 NEXT A
450 GO TO 460
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
460 FOR B=0 TO 130 STEP 10
470     MOVE B,0
480     IF B>9 THEN 510
490     PRINT "HJ";B;
500     GO TO 560
510     LET B$=STR(B)
520     FOR K=1 TO LEN(B$)
530         LET X$=SEG(B$,K,1)
540         PRINT X$;"J";"H";
550     NEXT K
560 NEXT B
570 VIEWPORT 0,130,0,100
580 H$="HORIZONTAL LINE NUMBER"
590 MOVE 0,LEN(H$)+56
600 PRINT "HH";
610 FOR I=1 TO LEN(H$)
620     X$=SEG(H$,I,1)
630     PRINT X$;"HJ";
640 NEXT I
650 V$="VERTICAL LINE NUMBER"
660 MOVE 65,0
670 FOR I=1 TO LEN(V$)/2
680     PRINT "H";
690 NEXT I
700 PRINT V$;
710 HOME
720 A$="HORIZONTAL AND VERTICAL COORDINATES"
730 MOVE 45-LEN(A$)/2,94
740 PRINT A$;
750 HOME
760 FOR I=1 TO 2000
770 NEXT I
780 PAGE
790 PRINT "YOU MAY WANT TO RULE A PIECE OF GRAPH PAPER WITH 130"
800 PRINT "VERTICAL AND 100 HORIZONTAL LINES TO USE AS A ""ROUGHOUT"" "
810 PRINT "WORKSHEET FOR YOUR FORMS DESIGN."
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
820 PRINT "JJJJJJJJJ";
830 PRINT "DO YOU WANT TO READ THE INSTRUCTIONS AGAIN? (Y=YES,N=NO) ";
840 INPUT A$
850 IF A$="Y" THEN 880
860 IF A$="N" THEN 890
870 GO TO 830
880 GO TO 100
890 PRINT
900 PRINT "ARE YOU READY TO RUN THE FORMS DESIGN PROGRAM? (Y=YES,N=NO)";
910 PRINT "  ";
920 INPUT A$
930 IF A$="Y" THEN 960
940 IF A$="N" THEN 830
950 GO TO 890
960 FIND 4
970 OLD
980 RUN
```

TITLE	ABSTRACT NO.
FORMS DESIGN	51/00-9515/0

```
100 INIT
110 LET U$="COORDINATES"
120 PAGE
130 LET N1=1
140 DELETE X,Y,M,X1,Y1,M1,C4
150 DIM X(50,4),Y(50,4),M(50,2),X1(50,2),Y1(50,2),M1(50,2),C4(50)
160 LET J1=0
170 LET I9=0
180 LET A1=0
190 LET B$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
200 LET C$=" "
210 LET Z1=1
220 LET Z$="CORNERPOINT "
230 PRINT "DO YOU WANT TO DRAW ONE LINE FROM POINT ""A"" TO ""B""";
240 PRINT "? (Y=YES,N=NO) : ";
250 INPUT A$
260 IF A$="Y" THEN 320
270 IF A$="N" THEN 290
280 GO TO 230
290 LET A1=A1+1
300 GO TO Z1 OF 490,580
310 LET Z1=1
320 LET I9=I9+1
330 LET A1=0
340 IF I9>50 THEN 2130
350 FOR I=1 TO 2
360     LET D$=SEG(B$,I,1)
370     LET G$=SEG(Z$,7,6)
380     IF I9>26 THEN 400
390     GO TO 410
400     LET C$=STR(I9)
410     GOSUB 2100
420     INPUT X1(I9,I),Y1(I9,I)
430     IF I=1 THEN 450
440     GO TO 470
450     LET M1(I9,1)=X1(I9,I)
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
460     LET M1(I9,2)=Y1(I9,I)
470 NEXT I
480 GO TO 300
490 PRINT
500 PRINT "ARE YOU READY TO HAVE YOUR FORM DRAWN? (Y=YES,N=NO) ";
510 INPUT A$
520 IF A$="Y" THEN 860
530 IF A$="N" THEN 550
540 GO TO 490
550 LET Z1=2
560 LET A1=A1+1
570 GO TO 230
580 PRINT "HOW MANY CORNERS DO YOU WANT TO DRAW LINES TO: ";
590 IF J1>50 THEN 2130
600 J1=J1+1
610 INPUT C4(J1)
620 IF C4(J1)=0 THEN 650
630 LET A1=0
640 GO TO 720
650 LET J1=J1-1
660 LET A1=A1+1
670 IF A1=>4 THEN 2010
680 IF J1=0 THEN 700
690 GO TO 490
700 Z1=1
710 GO TO 690
720 IF J1>26 THEN 740
730 GO TO 750
740 LET C$=STR(J1-26)
750 FOR J=1 TO C4(J1)
760     LET D$=SEG(B$,J,1)
770     LET G$=SEG(Z$,1,6)
780     GOSUB 2100
790     INPUT X(J1,J),Y(J1,J)
800     IF J=C4(J1) THEN 820
810     GO TO 840
```

TITLE	ABSTRACT NO.
FORMS DESIGN	51/00-9515/0

```
820     LET M(J1,1)=X(J1,J)
830     LET M(J1,2)=Y(J1,J)
840 NEXT J
850 GO TO 490
860 PAGE
870 LET A1=0
880 IF Z1=1 THEN 900
890 GO TO 910
900 IF J1=0 THEN 980
910 MOVE 0,0
920 FOR K=1 TO J1
930     MOVE M(K,1),M(K,2)
940     FOR L=1 TO C4(K)
950         DRAW X(K,L),Y(K,L)
960     NEXT L
970 NEXT K
980 HOME
990 IF I9=0 THEN 1040
1000 FOR Q=1 TO I9
1010     MOVE M1(Q,1),M1(Q,2)
1020     DRAW X1(Q,2),Y1(Q,2)
1030 NEXT Q
1040 INPUT Y$
1050 PAGE
1060 PRINT "DO YOU WANT A LIST OF 1) CORNER COORDINATES,"
1070 PRINT "                      2) LINE SEGMENT COORDINATES, OR"
1080 PRINT "                      3) NEITHER ? ";
1090 INPUT B1
1100 GO TO B1 OF 1120,1140,1820
1110 GO TO 1050
1120 LET X8=1
1130 GO TO 1150
1140 LET X8=7
1150 LET G$=SEG(Z$,X8,6)
1160 GO TO B1 OF 1170,1190
1170 IF J1=0 THEN 1210
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
1180 GO TO 1230
1190 IF I9=0 THEN 1210
1200 GO TO 1230
1210 PRINT "NO ";G$;" ";U$;" -- TRY ANOTHER LIST ITEM!"
1220 GO TO 1060
1230 LET U$="COORDINATES"
1240 PRINT USING 1250:G$,U$,U$,U$,U$
1250 IMAGE 6A,4(3X,11A)
1260 LET H$="HORZ"
1270 LET V$="VERT"
1280 PRINT USING 1290:" NO.  ",H$,"1",V$,H$,"2",V$,H$,"3",V$,H$,"4",V$
1290 IMAGE 6A,4(3X,4A,1X,1A,1X,4A)
1300 PRINT USING 1310:
1310 IMAGE 6("="),3X,4(11("="),3X)
1320 IF B1=2 THEN 1350
1330 LET P=J1
1340 GO TO 1360
1350 LET P=I9
1360 FOR N=1 TO P
1370     IF B1=2 THEN 1430
1380     PRINT USING 1390:N,X(N,1),Y(N,1),X(N,2),Y(N,2),X(N,3),Y(N,3)
1390     IMAGE 3D,3X,3(3X,4D,3X,4D),S
1400     PRINT USING 1410:X(N,4),Y(N,4)
1410     IMAGE 3X,4D,3X,4D
1420     GO TO 1460
1430     PRINT USING 1440:N,X1(N,1),Y1(N,1),X1(N,2),Y1(N,2)
1440     IMAGE 3D,3X,2(3X,4D,3X,4D),2(3X,"NOT IN USE*")
1450     LET N1=2
1460 NEXT N
1470 LET N1=1
1480 PRINT "DO YOU WANT TO CHANGE ANY ";G$;" ";U$;"? (Y=YES,N=NO) ";
1490 INPUT A$
1500 IF A$="Y" THEN 1530
1510 IF A$="N" THEN 1060
1520 GO TO 1480
1530 PRINT "ENTER ";G$;"#, THEN ";U$;" COLUMN #:"
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
1540 PRINT "(I.E. ""2,3"" MEANS ";G$;" ROW #2, COLUMN #3): ";
1550 INPUT G1,G2
1560 PRINT
1570 PRINT "VERT,HORZ(";G1;",";G2;")= ";
1580 IF B1=2 THEN 1670
1590 IF G1<1 THEN 1770
1600 IF G2>4 THEN 1750
1610 INPUT X(G1,G2),Y(G1,G2)
1620 IF G2=C4(G1) THEN 1640
1630 GO TO 1790
1640 LET M(G1,1)=X(G1,G2)
1650 LET M(G1,2)=Y(G1,G2)
1660 GO TO 1790
1670 IF G2>2 THEN 1750
1680 IF G1<1 THEN 1770
1690 INPUT X1(G1,G2),Y1(G1,G2)
1700 IF G2=1 THEN 1720
1710 GO TO 1790
1720 LET M1(G1,1)=X1(G1,G2)
1730 LET M1(G1,2)=Y1(G1,G2)
1740 GO TO 1790
1750 PRINT G2;" IS AN ILLEGAL COLUMN # -- TRY AGAIN!"
1760 GO TO 1530
1770 PRINT G1;" IS AN ILLEGAL ROW # -- TRY AGAIN!"
1780 GO TO 1530
1790 PRINT "ANY MORE CHANGES? (Y=YES,N=NO) ";
1800 INPUT A$
1810 GO TO 1500
1820 PRINT "DO YOU WANT TO ADD MORE ";U$;"? (Y=YES,N=NO) ";
1830 INPUT A$
1840 IF A$="Y" THEN 1870
1850 IF A$="N" THEN 1910
1860 GO TO 1820
1870 PRINT "WHICH ";U$;", 1) CORNER, OR 2) LINE SEGMENTS? ";
1880 INPUT B1
1890 GO TO B1 OF 580,310
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
1900 GO TO 1870
1910 PRINT "DO YOU WANT TO DRAW A NEW FORM DESIGN? (Y=YES,N=NO) ";
1920 INPUT A$
1930 IF A$="Y" THEN 100
1940 IF A$="N" THEN 1960
1950 GO TO 1910
1960 PRINT "DO YOU WANT THE FORM DRAWN? (Y=YES,N=NO) ";
1970 INPUT A$
1980 IF A$="Y" THEN 860
1990 IF A$="N" THEN 2010
2000 GO TO 1960
2010 PRINT USING 2020:
2020 IMAGE 20("*"),S
2030 PRINT USING 2040:"END OF PROGRAM*****FORMS DESIGN*"
2040 IMAGE 32A,S
2050 PRINT USING 2020:
2060 PRINT
2070 FIND 3
2080 OLD
2090 END
2100 PRINT D$;C$;". ENTER ";G$;" """;D$;C$;""" VERTICAL AND HORIZONTAL";
2110 PRINT " ";U$;": ";
2120 RETURN
2130 PRINT "MAXIMUM LIMIT FOR ";G$;U$;" ""50"" HAS BEEN EXCEEDED ";
2140 PRINT I7;"."
2150 GO TO 490
```

TITLE	ABSTRACT NO
FORMS DESIGN	51/00-9515/0

```
100 PAGE
110 PRINT "IN A MOMENT YOU ARE GOING TO ENTER YOUR LINE SEGMENT DATA."
120 PRINT
130 PRINT "EACH LINE SEGMENT HAS TWO ENDS.  EACH END HAS A VERTICAL AND"
140 PRINT "HORIZONTAL COORDINATE, AND YOU MUST SPECIFY EACH OF THEM."
150 PRINT
160 PRINT "FOR EXAMPLE, YOU WANT TO DRAW A SQUARE AROUND THE OUTSIDE OF"
170 PRINT "SCREEN.  THE VERTICAL COORDINATE OF THE LOWER LEFT CORNER OF"
180 PRINT "THE SCREEN IS 0, AND THE HORIZONTAL COORDINATE IS ALSO 0."
190 PRINT "YOU WOULD ENTER"
200 PRINT "1V=0"
210 PRINT "1H=0"
220 PRINT "YOU WOULD THEN GO TO THE LOWER RIGHT CORNER OF THE SCREEN"
230 PRINT "AND SPECIFY THE VERTICAL AND HORIZONTAL COORDINATE PAIR."
240 PRINT "2V=130"
250 PRINT "2H=0"
260 PRINT "YOU WOULD THEN WANT TO SPECIFY THE COORDINATE PAIR FOR THE "
270 PRINT "VERTICAL LINE ON THE RIGHT SIDE OF THE SCREEN."
280 PRINT "3V=130"
290 PRINT "3H=0"
300 PRINT
310 PRINT "4V=130"
320 PRINT "4H=100"
330 PRINT
340 PRINT "JUST CONTINUE ENTERING LINE SEGMENT COORDINATE PAIRS FOR"
350 PRINT "ALL OF YOUR LINE SEGMENTS."
360 PRINT
370 PRINT "WHEN YOU HAVE ENTERED ALL LINE SEGMENTS TYPE ""DONE"""
380 PRINT
390 PRINT "REMEMBER THAT THE SCREEN HAS 130 VERTICAL UNITS AND 100"
400 PRINT "HORIZONTAL UNITS, AND THAT THE LOWER LEFT CORNER OF THE"
410 PRINT "SCREEN IS THE ORIGIN OR ZERO-ZERO POINT."
420 PRINT
430 PRINT "YOU MAY FIND IT IS BEST TO USE A PIECE OF GRAPH PAPER THAT"
440 PRINT "HAS 130 VERTICAL AND 100 HORIZONTAL LINES FOR A WORKSHEET."
450 LET I1=0
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

```
460 REM

470 DELETE X1,Y1,M1
480 A1=170
490 DIM X1(A1,2),Y1(A1,2),M1(A1,2)
500 LET I9=0
510 LET Z$="POINT"
520 LET I9=I9+1
530 IF I9>A1 THEN 1570
540 FOR I=1 TO 2
550     PRINT
560     PRINT I9;" V=";
570     INPUT E$
580     IF E$="END" THEN 710
590     IF ASC(E$)<48 THEN 700
600     IF ASC(E$)>58 THEN 700
610     LET X1(I9,I)=VAL(E$)
620     PRINT I9;" H=";
630     INPUT Y1(I9,I)
640     IF I=1 THEN 660
650     GO TO 680
660     LET M1(I9,1)=X1(I9,I)
670     LET M1(I9,2)=Y1(I9,I)
680 NEXT I
690 GO TO 520
700 I9=I9-1
710 PAGE
720 IF I9=0 THEN 1570
730 LET T9=I9
740 FOR Q=1 TO T9
750     MOVE M1(Q,1),M1(Q,2)
760     DRAW X1(Q,2),Y1(Q,2)
770 NEXT Q
780 HOME
790 INPUT A$
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

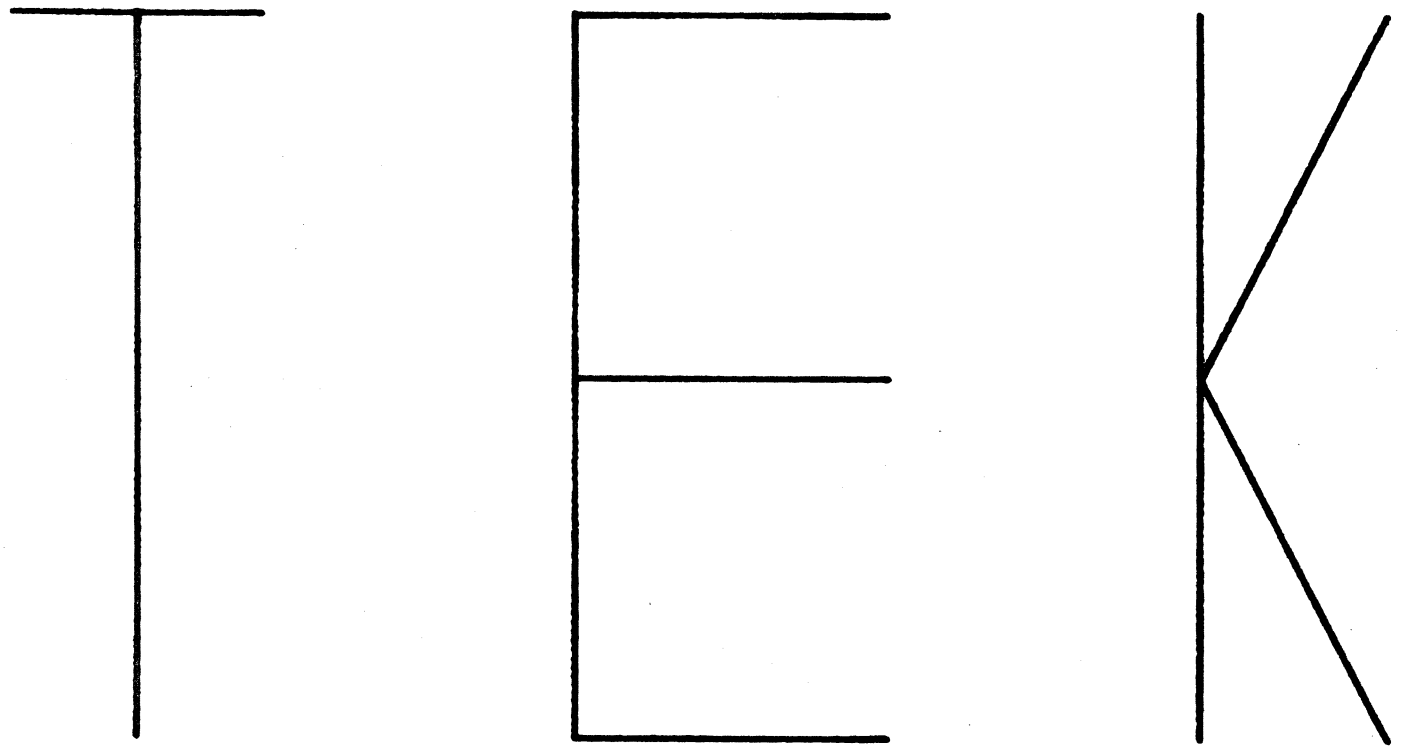
```
800 PAGE
810 I1=0
820 PRINT "LIST? (1=YES, 2=NO) ";
830 INPUT A$
840 IF ASC(A$)>50 THEN 820
850 IF ASC(A$)<49 THEN 820
860 GO TO VAL(A$) OF 880,1080
870 GO TO 820
880 PAGE
890 GOSUB 1760
900 FOR I5=1 TO T9
910     LET I1=I1+1
920     IF I1=26 THEN 960
930     IF I1=51 THEN 1020
940     GOSUB 1810
950     GO TO 1070
960     HOME
970     PRINT USING 980:
980     IMAGE 37T,S
990     GOSUB 1760
1000     GOSUB 1810
1010     GO TO 1070
1020     INPUT A$
1030     PAGE
1040     LET I1=0
1050     GOSUB 1760
1060     GOSUB 1810
1070 NEXT I5
1080 PRINT "CHANGES? (1=YES, 2=NO) ";
1090 INPUT A$
1100 IF ASC(A$)>50 THEN 1080
1110 IF ASC(A$)<49 THEN 1080
1120 GO TO VAL(A$) OF 1140,1510
1130 GO TO 1080
1140 PRINT "ENTER LINE SEGMENT NO. (""LS NO."""): ";
1150 INPUT G1
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

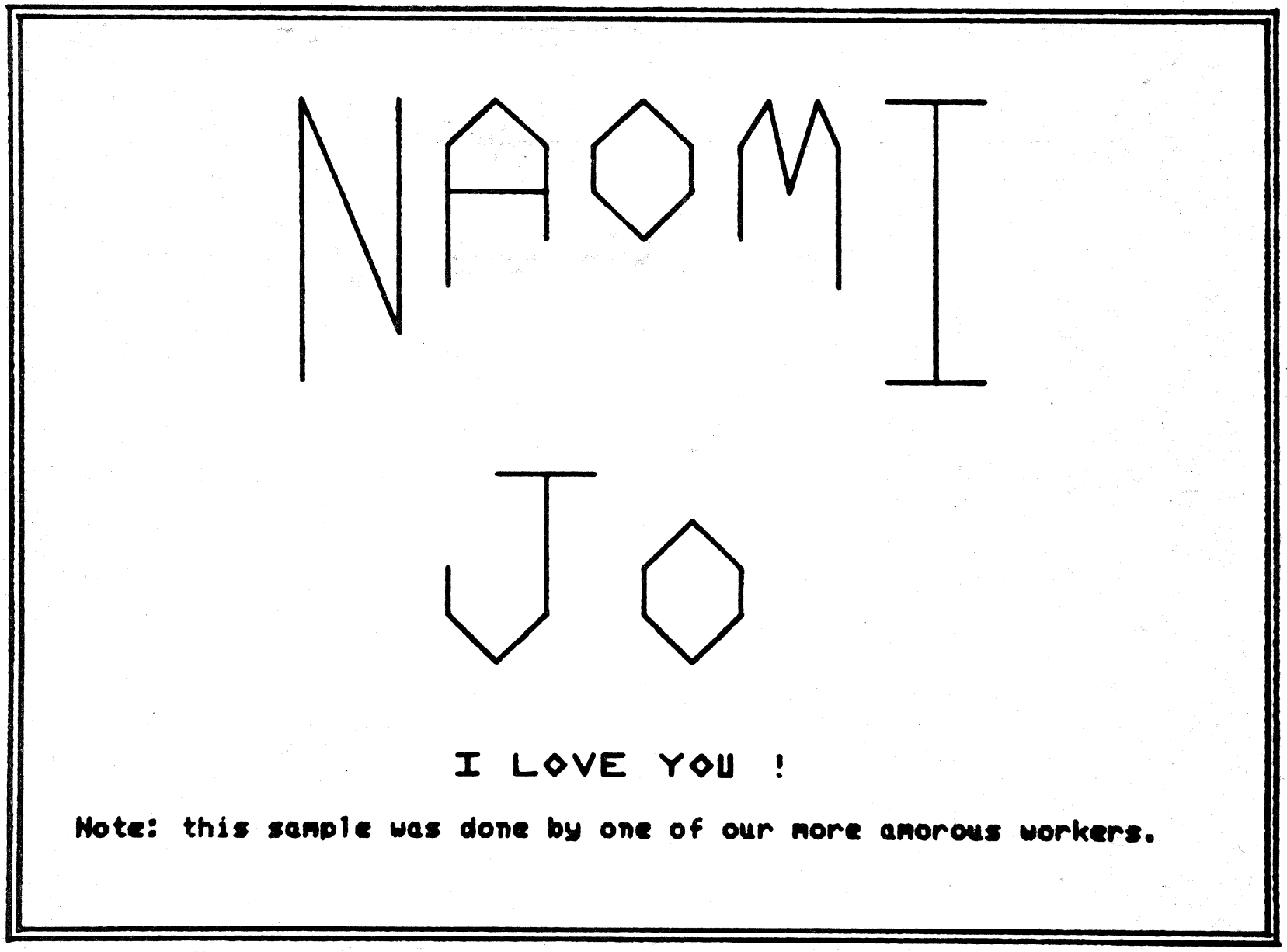
```
1160 PRINT "ENTER COLUMN NO.: ";
1170 INPUT G2
1180 IF G1>A1 THEN 1210
1190 IF G2>2 THEN 1240
1200 GO TO 1270
1210 PRI "SORRY--";G1;" EXCEEDS ";A1;"(MAXIMUM LIMIT FOR LINE SEGMENT";
1220 PRINT "S)--TRY AGAIN!"
1230 GO TO 1140
1240 PRI "SORRY--";G2;" EXCEEDS 2 (MAXIMUM LIMIT FOR LINE SEGMENT POI;"
1250 PRINT "NTS)--TRY AGAIN!"
1260 GO TO 1160
1270 IF G1<1 THEN 1300
1280 IF G2<1 THEN 1330
1290 GO TO 1370
1300 PRI "SORRY--";G1;" IS LESS THAN 1 (MINIMUM LIMIT FOR LINE SEGMEN";
1310 PRINT "TS)--TRY AGAIN!"
1320 GO TO 1140
1330 PRI "SORRY--";G2;" IS LESS THAN 1 (MINIMUM LIMIT FOR LINE SEGMEN";
1340 PRINT "T POINTS)"
1350 PRINT "--TRY AGAIN!--"
1360 GO TO 1160
1370 PRINT G1;" V=";
1380 INPUT X1(G1,G2)
1390 IF G2=1 THEN 1430
1400 INPUT Y1(G1,G2)
1410 IF G2=1 THEN 1430
1420 GO TO 1450
1430 LET M1(G1,1)=X1(G1,G2)
1440 LET M1(G1,2)=Y1(G1,G2)
1450 PRINT "ANY MORE CHANGES? (1=YES,2=NO) ";
1460 INPUT A$
1470 IF ASC(A$)>50 THEN 1450
1480 IF ASC(A$)<49 THEN 1450
1490 GO TO VAL(A$) OF 1140,1510
1500 GO TO 1450
1510 PRINT "DO YOU WANT TO ADD MORE DATA? (1=YES, 2=NO) ";
```

TITLE	ABSTRACT NO:
FORMS DESIGN	51/00-9515/0

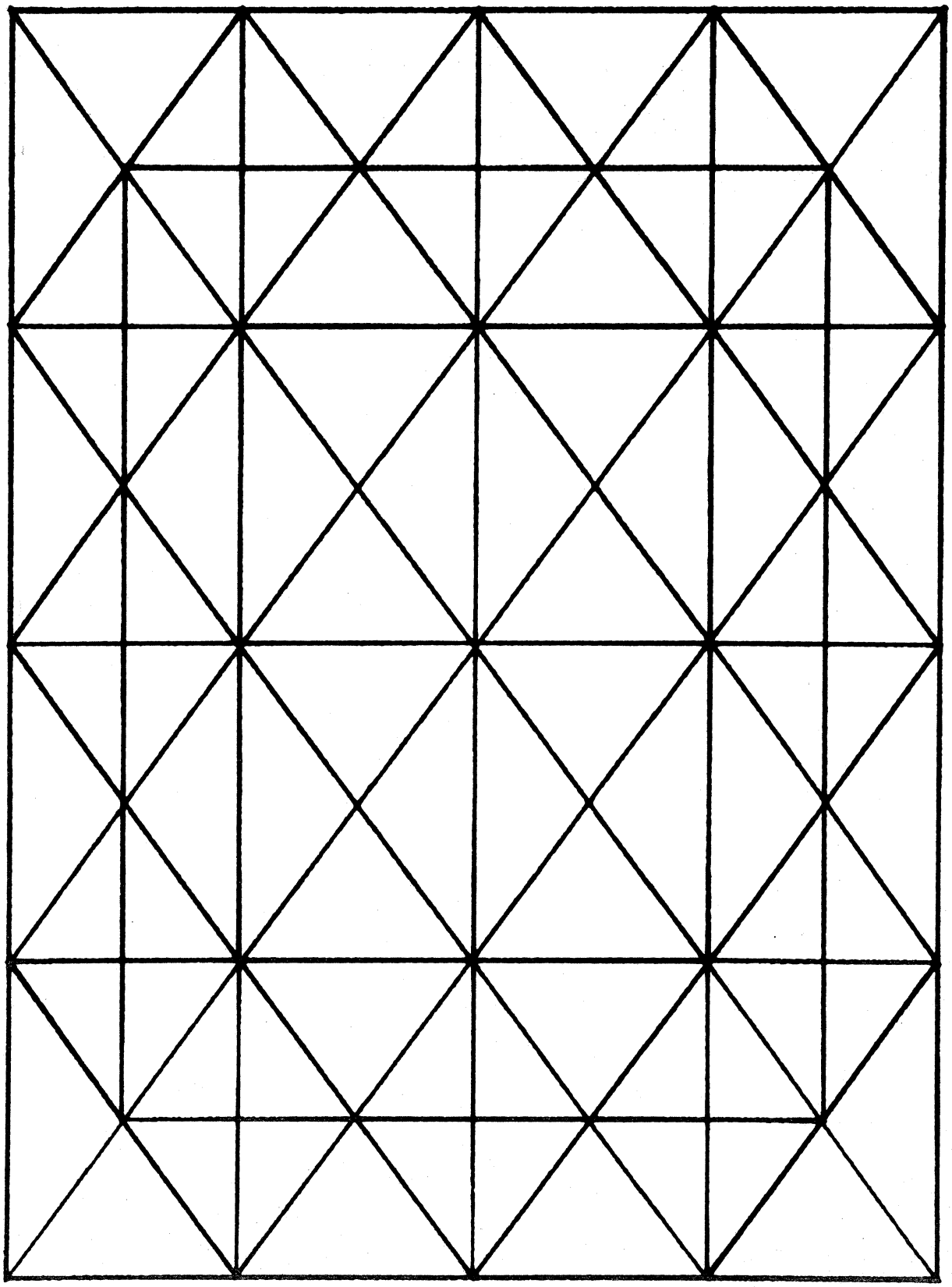
```
1520 INPUT A$
1530 IF ASC(A$)>50 THEN 1510
1540 IF ASC(A$)<49 THEN 1510
1550 GO TO VAL(A$) OF 520,1570
1560 GO TO 1510
1570 PRINT "DO YOU WANT YOUR FORM DRAWN NOW? (1=YES, 2=NO) ";
1580 INPUT A$
1590 IF ASC(A$)>50 THEN 1570
1600 IF ASC(A$)<49 THEN 1570
1610 GO TO VAL(A$) OF 710,1630
1620 GO TO 1680
1630 PRINT "DO YOU WANT TO START A NEW FORM? (1=YES, 2=NO) ";
1640 INPUT A$
1650 IF ASC(A$)>50 THEN 1630
1660 IF ASC(A$)<49 THEN 1630
1670 GO TO VAL(A$) OF 110,1690
1680 GO TO 1630
1690 PRINT USING 1700:
1700 IMAGE 17("*"),S
1710 PRINT USING 1720:"END OF PROGRAM*****FORMS DESIGN EXPRESS"
1720 IMAGE 39A,S
1730 PRINT USING 1740:
1740 IMAGE 16("*2)
1750 END
1760 PRINT USING 1770:" LS ","LINE SEGMENT*","LINE SEGMENT*"
1770 IMAGE 4A,2X,13A,1X,13A,33("H"),"J",S
1780 PRINT USING 1770:" NO."," VERT 1 HORZ "," VERT 2 HORZ "
1790 PRINT USING 1770:"====","====== ======","====== ======"
1800 RETURN
1810 PRINT USING 1820:I5,X1(I5,1),Y1(I5,1),X1(I5,2),Y1(I5,2)
1820 IMAGE 4D,2X,3(3D.2D,1X),3D.2D,33("H"),"J",S
1830 RETURN
```

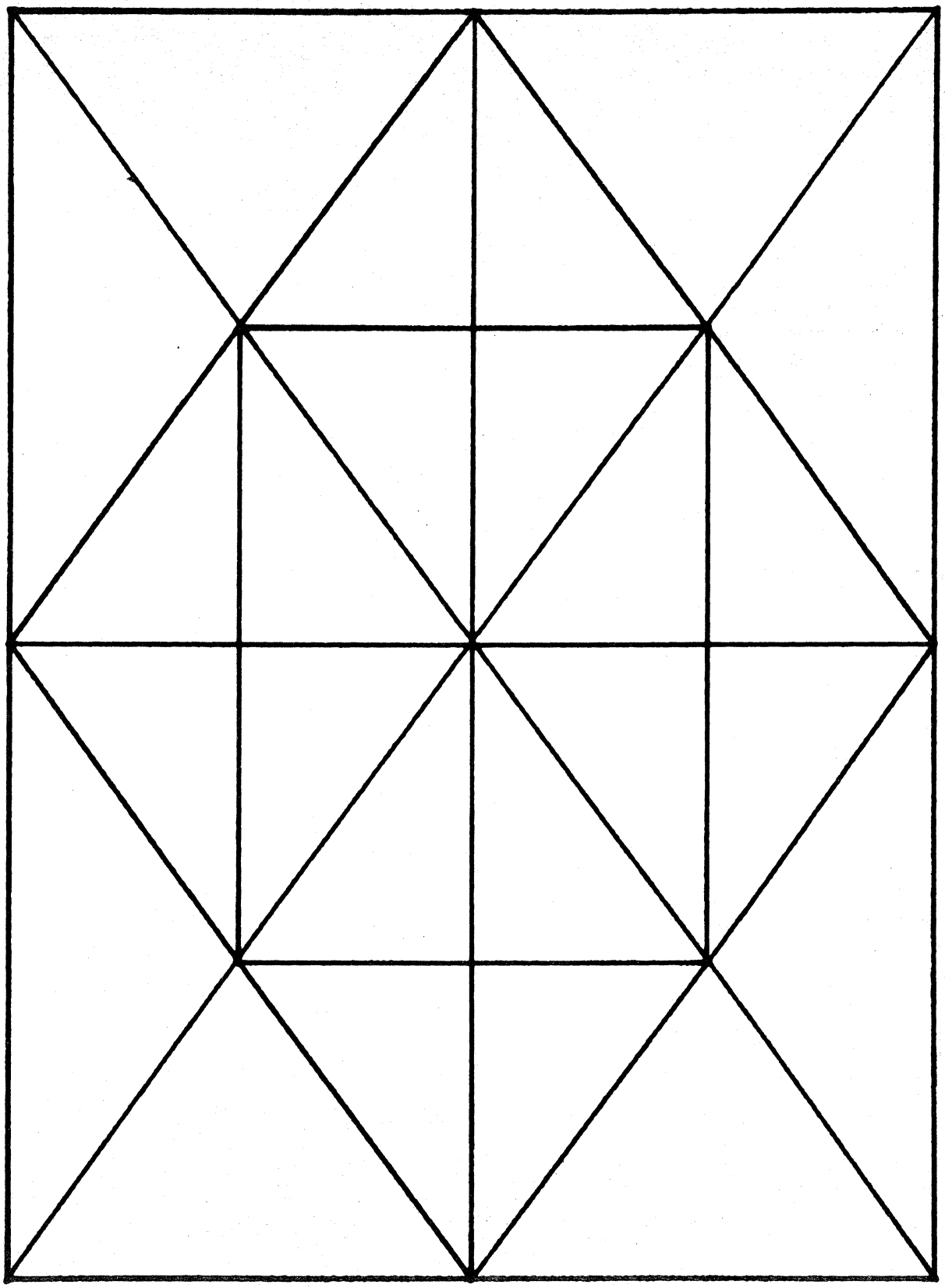


TEK YOU OLD HOUND DOGS -- THE OFFICES OF MANAGEMENT INFORMATION AND INSTITUTIONAL RESEARCH AT THE UNIVERSITY OF WISCONSIN - STEVENS POINT HAVE DONE IT AGAIN

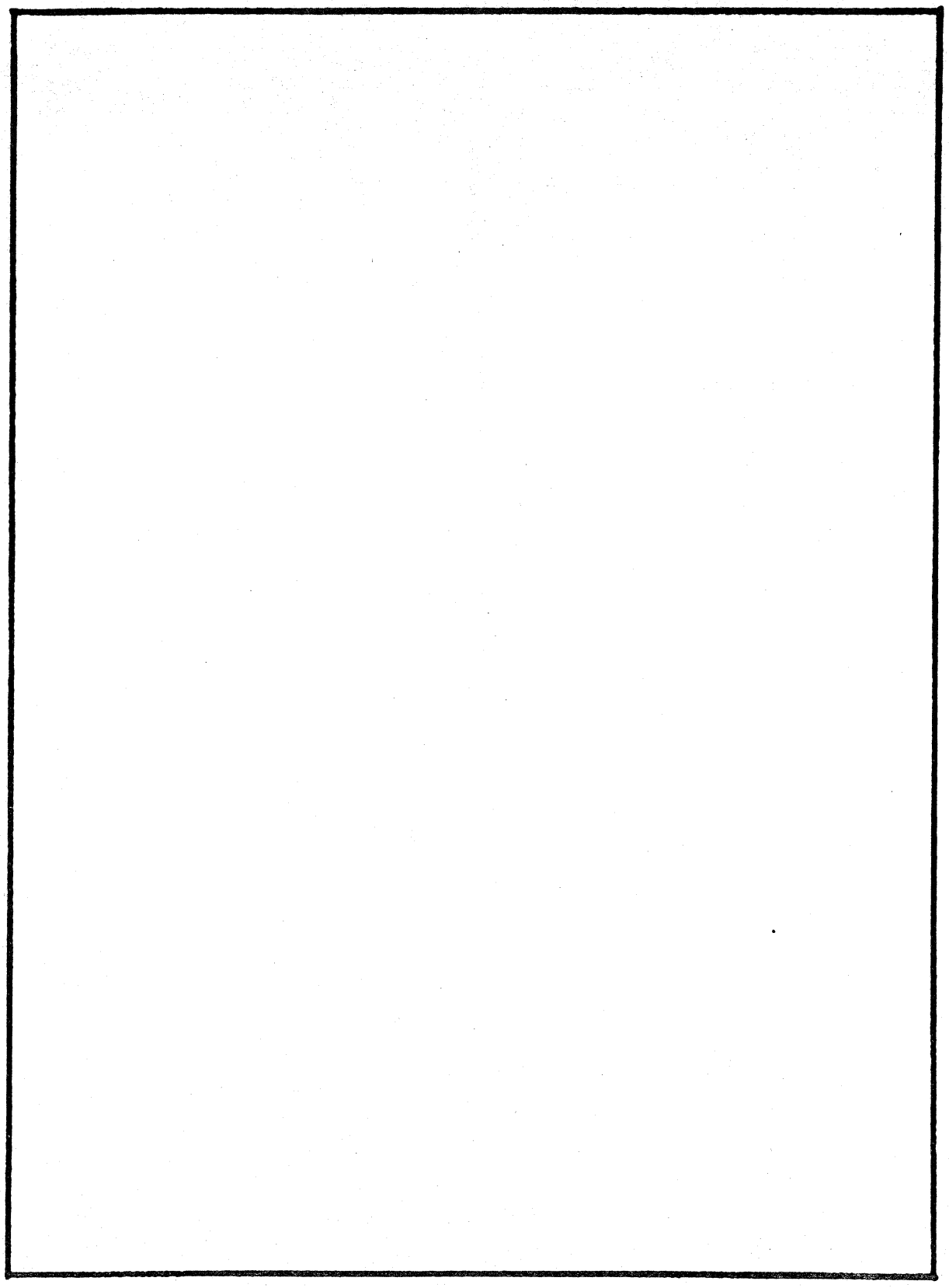


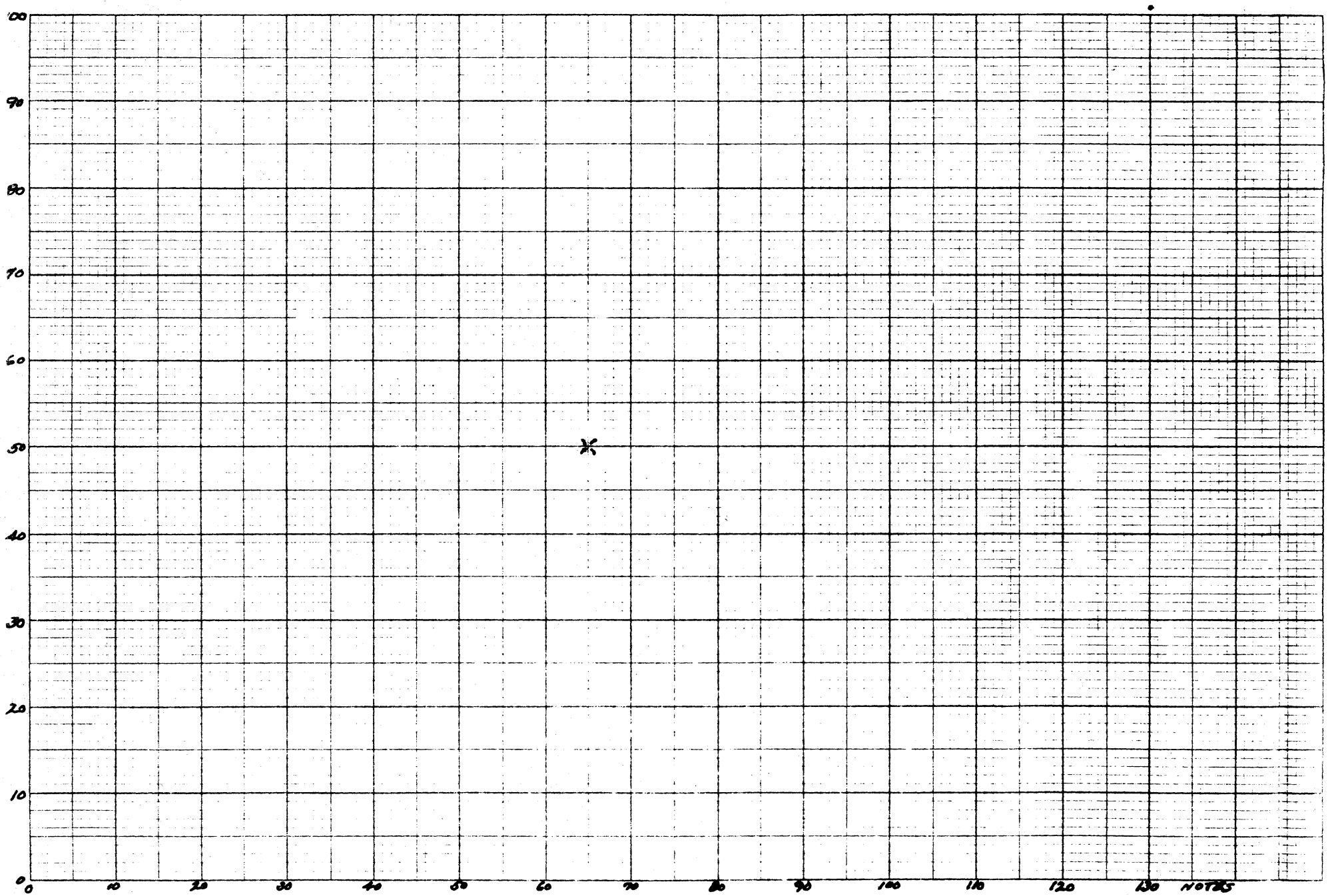
Note: this sample was done by one of our more amorous workers.





```
1 V=0
1 H=0

1 V=130
1 H=0

2 V=130
2 H=0

2 V=130
2 H=100

3 V=130
3 H=100

3 V=0
3 H=100

4 V=0
4 H=100

4 V=0
4 H=0

5 V=DONE
```





FORMS DESIGN WORKSHEET -- UWSP-OMSIR ©4/25/77

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4051

APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
ADVANCED MEDIA GRAPHICS	51/00-9516/0
ORIGINAL DATE / REVISION DATE	MEMORY REQUIREMENT
	24K
AUTHOR	PERIPHERALS
Patrick Rafferty, Lyle Wallis, University of Missouri-Columbia	4662, 4952

ABSTRACT

Advanced Media Graphics (AMG) speeds preparation of classroom aids and program documentation. AMG draws diamonds, boxes, lines and circles; rotates text, draws titles, simplifies outlining, rotates arrow heads, and flowcharts with complete preview and delete capabilities using the 4952 Joystick.

AMG enables the user to create high quality graphics on paper, overhead projector transparencies and slides. An interactive approach has been taken to make it as easy as possible to use the full capabilities.

AMG can be broken down as follows:

1. Title and Text section.
2. Arc-Character section.
3. Box.
4. Circle.
5. Diamond.
6. Line.
7. Outline section allowing user to set tab and character scale variables to speed outlines; includes text input.
8. Flowchart - an independent code section that uses the command processor concept and the pointer command to allow the user to choose both the position and the type of figure with only one keystroke.
9. Arrowhead section.

744 Statements

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

ADVANCED MEDIA GRAPHICS

VERSION 1.0

TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0

CAPABILITIES

The Advanced Media Graphics (AMG) software enables the user to create high quality graphics on paper, overhead projector transparencies and slides. AMG is capable of producing Titles and Text, Circles, Arc-Characters, Flowcharts and Outlines as well as Lines, Boxes, Diamonds, and Arrowheads.

An interactive approach has been taken to make it as easy as possible to use the full capabilities of AMG

SOFTWARE DESCRIPTION

AMG can be broken down as follows:

1. Title and Text section-A freestanding module that handles character output.
2. Arc-Character section-A freestanding module to rotate characters around a circle.
3. Box-A freestanding module that draws boxes.
4. Circle-A freestanding module that plots circles.
5. Diamond-A freestanding module that plots diamonds.
6. Line-A freestanding module that draws lines.
7. Outline-A freestanding module to speed outlining.
8. Flowchart-A freestanding module made up of 16 sub-modules. Each submodule performs one task such as setting up a display file or deleting an entry from a file.

9. Arrowhead-An interdependent module that accesses the Flowchart Arrowhead submodule.

HARDWARE

Hardware requirements consist of a 4051 Graphics System with 32K bytes of memory. A 4662 Digital Plotter and a 4952 Joystick control are the neccessary peripherals.

OPERATING INSTRUCTIONS

Turn on the 4051 Processor and the 4662 Plotter. Insert the tape and execute a FIN command. When curser reappears execute an OLD command and then a RUN command. At this point instructions should appear on the screen. Use of each module is described in the following examles.

All machine responses are in UPPER CASE

EXAMPLE #1-TITLES

Key T and then Return

INPUT X AND Y CHARACTER SCALE

4,4 (These could be anything from 1-9 and x need not equal y)

INPUT TEXT OR TITLE

Example #1
Return

POSITION PLOTTER PEN AND DEPRESS CALL

Position pen to starting point of title and push the call button on the front panel of the 4662 Plotter.

The output would look like this:

Example #1

EXAMPLE #2-TEXT

Key I and then Return

INPUT X AND Y CHARACTER SCALE

4,4 (These could be anything from 1-9 and x need not equal y)
Return

INPUT TEXT OR TITLE

Example #2
Return

POSITION PLOTTER PEN AND DEPRESS CALL

Position pen to desired position and push call.

The output looks like this:

Example #2

TITLE

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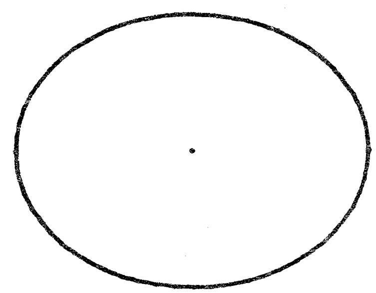
EXAMPLE #3-CIRCLES

Key C and then Return

PLACE PEN AT THE CENTER OF CIRCLE AND INPUT RADIUS

.2 (Radius can vary from 0 <R<1)
Return

The results look like this:



Notice that the circle is actually an ellipse.
All circles and Arc-Character translate into ellipses

EXAMPLE #4-ARC-CHARACTERS

Key A and then Return

INPUT ROTATED CHARACTER SCALE

5.5
Return

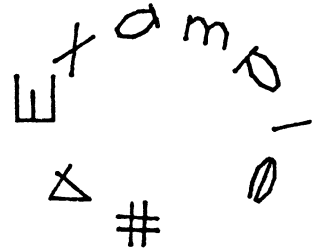
INPUT LINE OF TEXT

Example #4
Return

POSITION PEN AT CENTER OF ARC AND PUSH CALL

POSITION PEN AT BEGINNING OF CHARACTERS AND PUSH CALL

Output



EXAMPLE #5-OUTLINES

Key 0 and then return

POSITION PEN TO LOWER LEFT AND UPPER RIGHT OF PAPER AND DEPRESS CALL BUTTON

(Usually it is easiest to use the LOCATE controls on the front panel of the 4662 Plotter to find the corners of your paper.)

ENTER NUMBER OF OUTLINE LEVELS

3 (You can use as many levels in your outline as you wish. For this example I have chosen 3)

ENTER TAB FROM LEFT MARGIN IN INCHES FOR LEVEL 1
AND SCALE FOR CHARACTERS AT THIS LEVEL
2,3,3 (CNC

ENTER TAB FROM LEFT MARGIN IN INCHES FOR LEVEL 2
AND SCALE FOR CHARACTERS AT THIS LEVEL

2.5,2,2

ENTER TAB FROM LEFT MARGIN IN INCHES FOR LEVEL 3
AND SCALE FOR CHARACTERS AT THIS LEVEL

3,2,2

EXAMPLE #5(Cont.)

POSITION PLOTTER PEN TO DESIRED VERTICAL
POSITION AND ENTER OULTLINE LEVEL NUMBER

1 (In general it is best to place the pen in the upper left corner of the page and for vertical spacing use the LF (Line Feed) key on the keyboard. An accurate spacing is then easy to obtain.

In the following keyboard entry J represents the linefeed key.)

ENTER TEXT FOR LEVEL 2 ITEM NUMBER
1
CARRAGE RETURN FOR NEW LEVEL OF E TO QUIT

JJ Notice the double-spacing

Output:

Notice the double-spacing

(By useing the carrige return you can move to any level of the outline that you wish. Be carefull not to forget the LF for vertical spacing)

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EXAMPLE #6-FLOWCHARTING

(The flowchart module is somewhat different than the rest of the AMG software. When using the flowchart module there will be nothing on the screen except a flashing pointer. This pointer is controled by the 4952 Joystick control. To create, say a I/O figure, merely position the pointer to the correct spot on the screen and press the proper key on the keyboard (In this case I) The screen represents the page on which you are drawing. Due to aspect ratio differences that can occur the left one or two inches of the paper(or transparency) will not be used. You should remember this when centering the flowchart on the screen.

Incorporated into the flowchart software are provisions for deleting any mistakes and allowing for change.

All commands are instituted by pressing one key on the keyboard. A list of commands and further instructions may be obtained at any time by pressing "?". Also you will asked if you want to see these instructions when you begin the flowchart program. A scale factor allows you to make the figures any size that you wish.

It would be difficult to show an example such as example #1-5. The menu has been illustrated and the command key for each figure is in parenthesis beside it. Remember that at any time you can get help without loseing the work you have already done by pushing "?".

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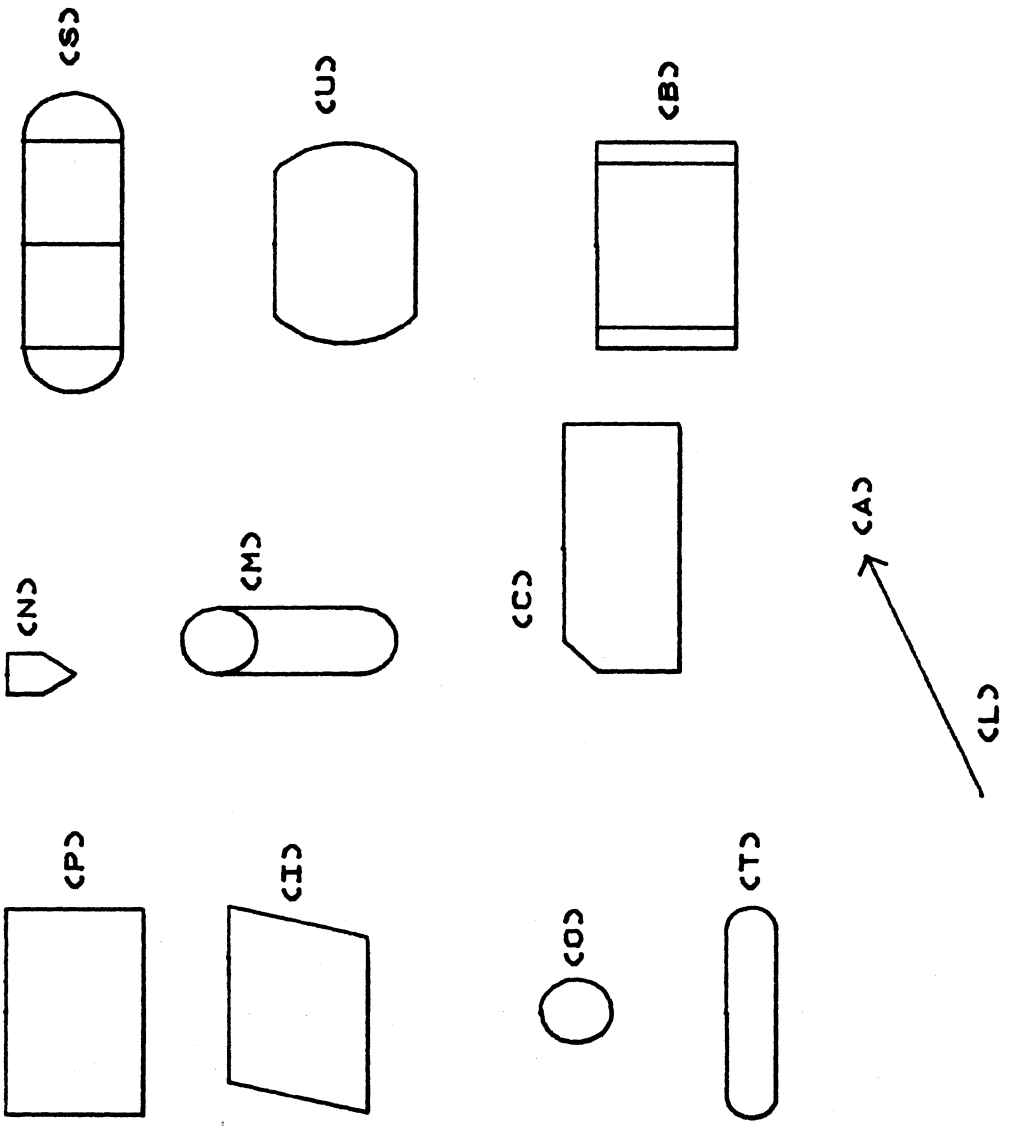
EXAMPLE #6(CONT.)



EXAMPLE #6(Cont.)

Some notes on flowcharting:

Not shown on the menu but also available are:

1. DELETE (E)
   To use delete key E. Then press identifying letter. Press Return and then the identifying numbers and then press Return once again.

2. REDRAW (R)
   To use REDRAW just push R.

3. PLOT (H)
   To use PLOT just push H.

4. QUIT (Q)
   This returns you to the rest of AMG.

5. INSTRUCTIONS (?)
   This command prints the instructions on the screen. To see the flowchart that you have already written use REDRAW.

To use the LINE command move pointer to the beginning of the line, press L then move pointer to the end of the line and press L again. The line will be drawn between these two points.

The ARROWHEAD command is related to the LINE command. An arrowhead may be drawn only on the last line drawn. To use ARROWHEAD place pointer

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EXAMPLE #6(Cont.)

near the end of the line on which you want the arrowhead. The arrowhead will be rotated in order to align itself with this line. The ARROWHEAD module will place the arrowhead on the end of the line CLOSEST to the pointer.

The COMMAND PROCESSOR figure is of variable length. When you push S a message will appear on the screen asking how many segments you wish. The segments are a standard size (determined by the scale factor) and the more the segments the longer the entire figure.

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EXAMPLE #7-BOXES

Key B and then Return

MOVE PLOTTER PEN TO LOWER LEFT AND
UPPER RIGHT OF BOX DEPRESSING CALL BUTTON

(The box will be drawn between these two points)

Output:

TITLE

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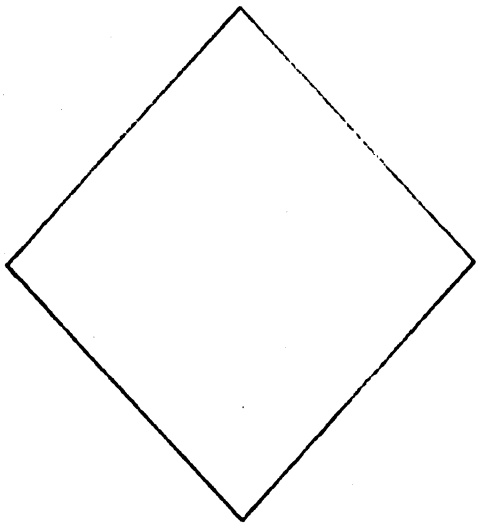
EXAMPLE #8-DIAMONDS

Key D and then Return

POSITION PLOTTER PEN AT TOP AND LEFT CORNERS
OF DIAMOND AND DEPRESS CALL

Output:



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EXAMPLE #9-ARROWHEADS

Key R and then Return

POSITION PEN NEAR PROPER END OF LAST LINE MADE
AND DEPRESS CALL

(The arrowheads here follow the same guidlines
as the ARROWHEADS of the FLOWCHART module.)

Output:

TITLE

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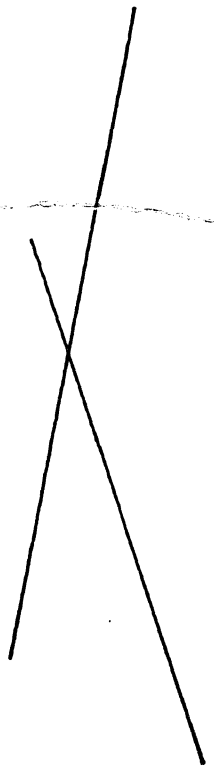
EXAMPLE #10-LINES

Key L and then Return

MOVE PEN TO START AND END POINTS OF LINE
DEPRESSING CALL BUTTON

(The line will be drawn between these two points)

Output:



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SOME GENERAL NOTES:

If at any time the system gives you an error type RUN and start over.

If you do not plan to use the plotter for some length of time be sure to cap the pen to keep it from drying out.

Program execution can be halted at any time by keying E.

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SYSTEM DOCUMENTATION

Advanced Media Graphics uses the command processor concept to transfer control to the different code sections. The user chooses one of the following eleven commands when the program executes.

1. Title - an independent module that draws titles. The darkness of the title is chosen as follows:

$$\text{darkness} = \begin{cases} y \text{ char scale}, & y \leq 5 \\ 5, & y \text{ char scale} > 5 \end{cases}$$

2. Text - text section uses the same code as the title section except that the darkness scale is preset to one.

3. arc-character - uses the alpha-Rotate command to rotate text.

4. Box - Inputs corners of box using GIN commands and draws box between these points

5. Circle - uses sin & cos functions to draw a specified circle.

6. Diamond - Inputs corners of diamond using GIN commands and draws between these points.

7. Line - Inputs endpoints using GIN commands and draws between these points.

8. outline - This section allows the user to set tab and character scale variables to speed the outlines.

9. flow chart - an independent code section that uses the command processor concept and the pointer command to allow the user to choose both the position and the type of figure with only one keystroke.

   The user can initiate the following commands:

Draw	Terminal
"	Process
"	off-page-connector
"	Decision
"	Line

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" I/O

" Disk

" on-page-connector

" card

" Arrow

" command processor

" Misc.

" Pre-defined Processor

Menu

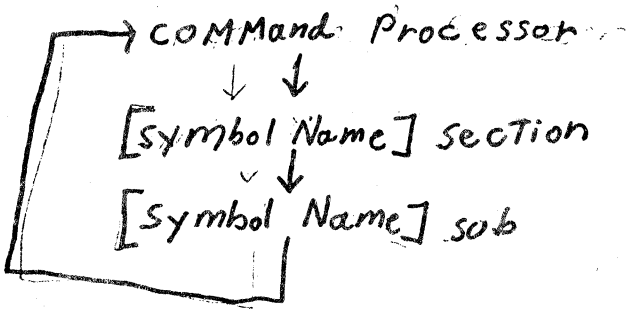
Plot

redraw

Quit

delete

Program Flow following a Draw [Figure Name] command is similar for all symbols.



All modules labeled [figure name] sec enter the (x,y) coordinates of the figure into the display file. All modules labeled [Figure Name] sub draw the symbol at the current output device. The display file consists of 13 vector arrays, one vector per figure. (x,y) coordinates

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of the figure and any special info such as rotation Angle, etc., are placed in the vector.

Delete sets the x coordinate of the specified symbol to zero

The Plot command reads each vector and calls [Figure Name] sub to output the symbol at the plotter if x=0 then the symbol will not be output. Redraw shares the same code except it outputs at the GS display.

The Menu command displays the name on the GS Screen. The QUIT command transfers control to the beginning of AMG.

10. Arrowhead - transfers control to the draw arrowhead module of the Flow chart section.

11. End - stops program execution.

TITLE

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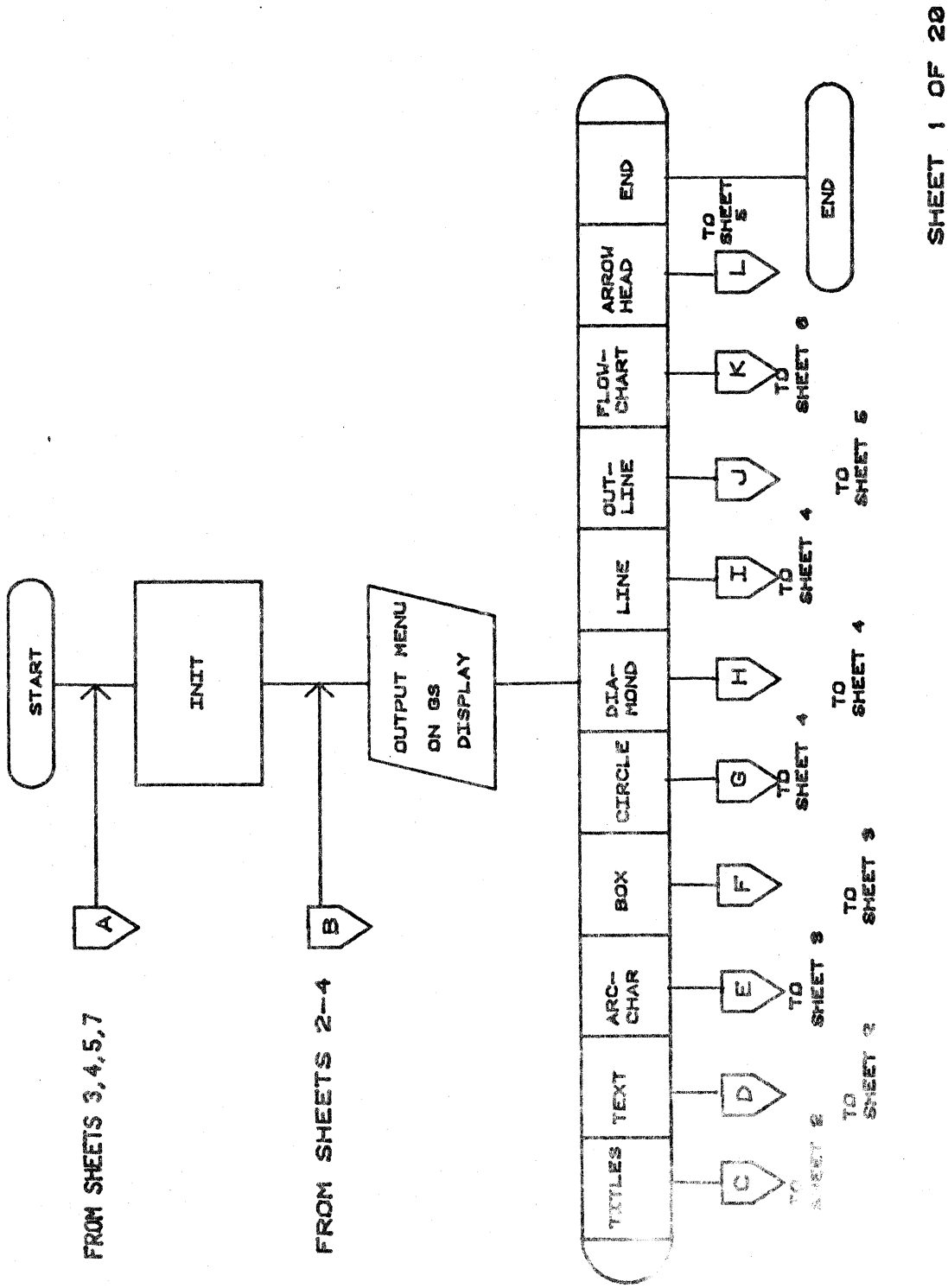

TITLE

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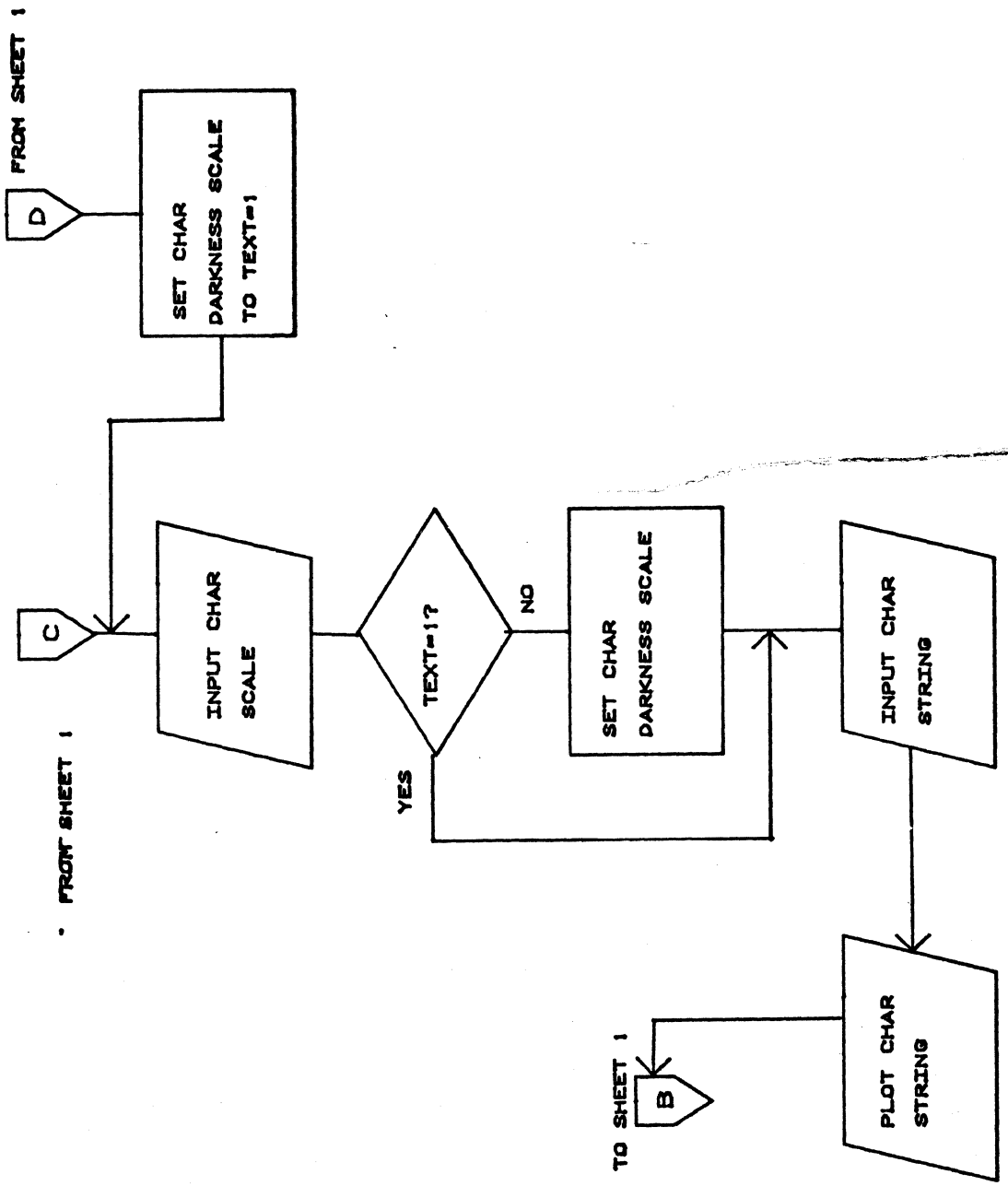

TITLE

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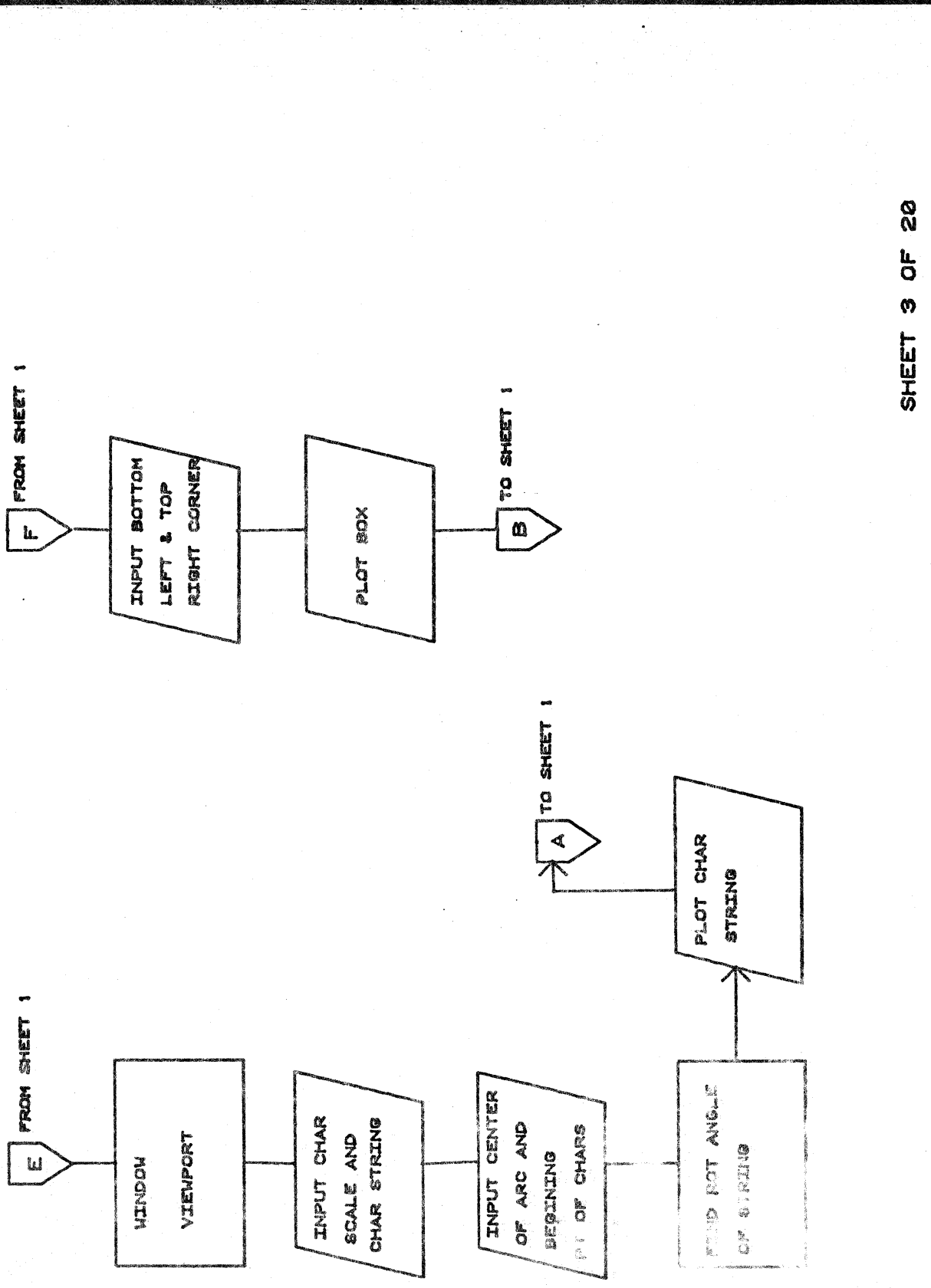

TITLE

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ABSTRACT NO:

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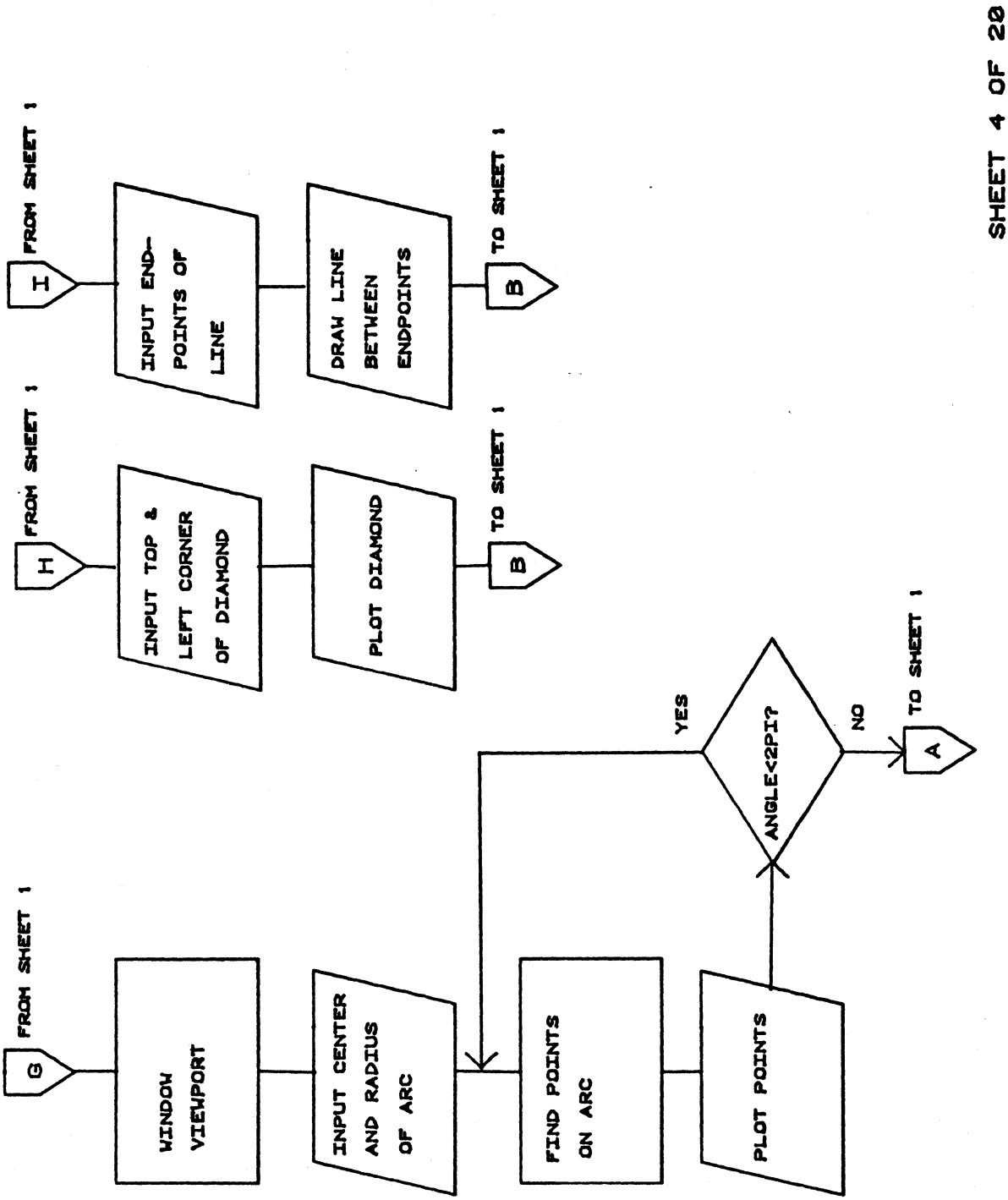

TITLE

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ABSTRACT NO:

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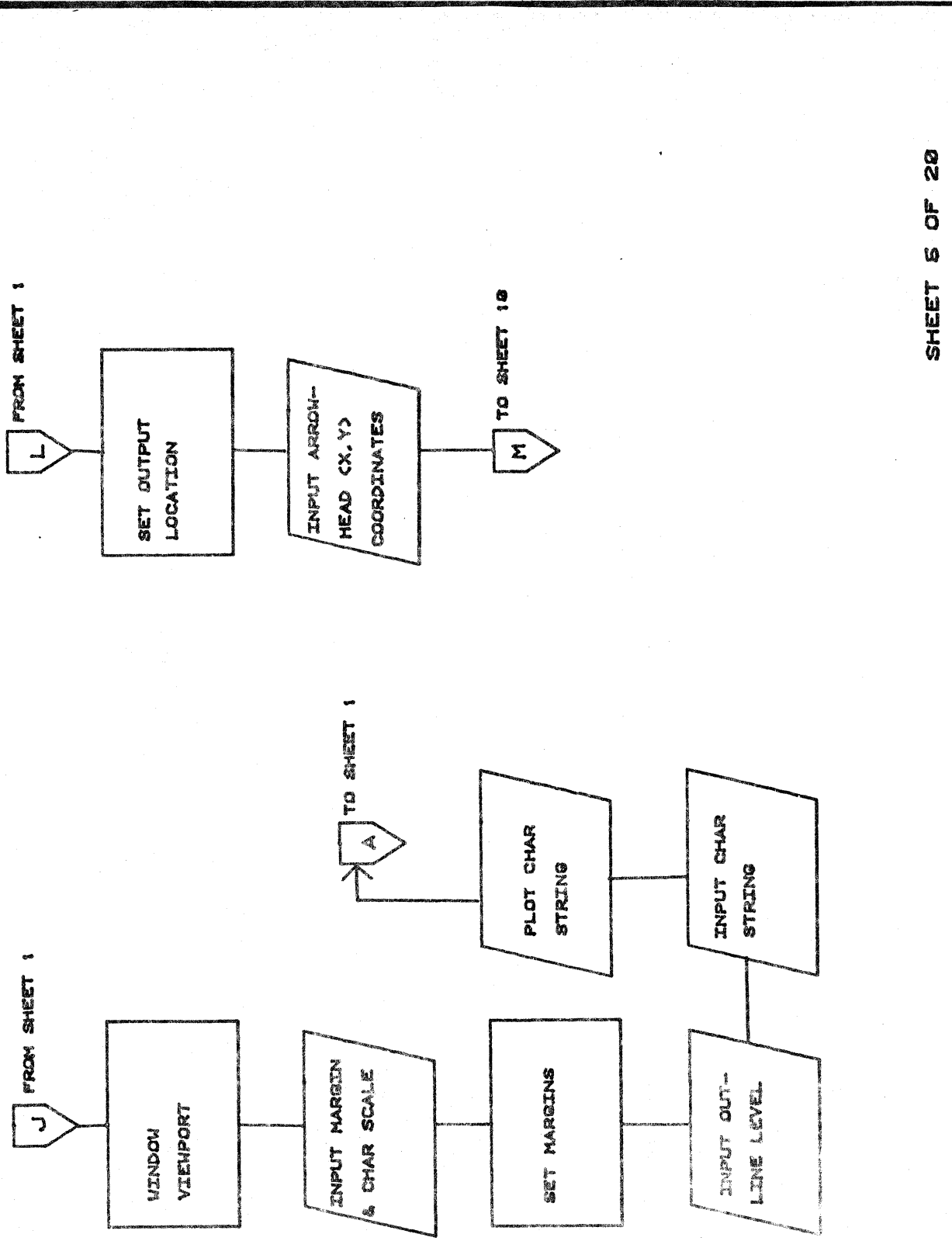

TITLE	ABSTRACT NO:
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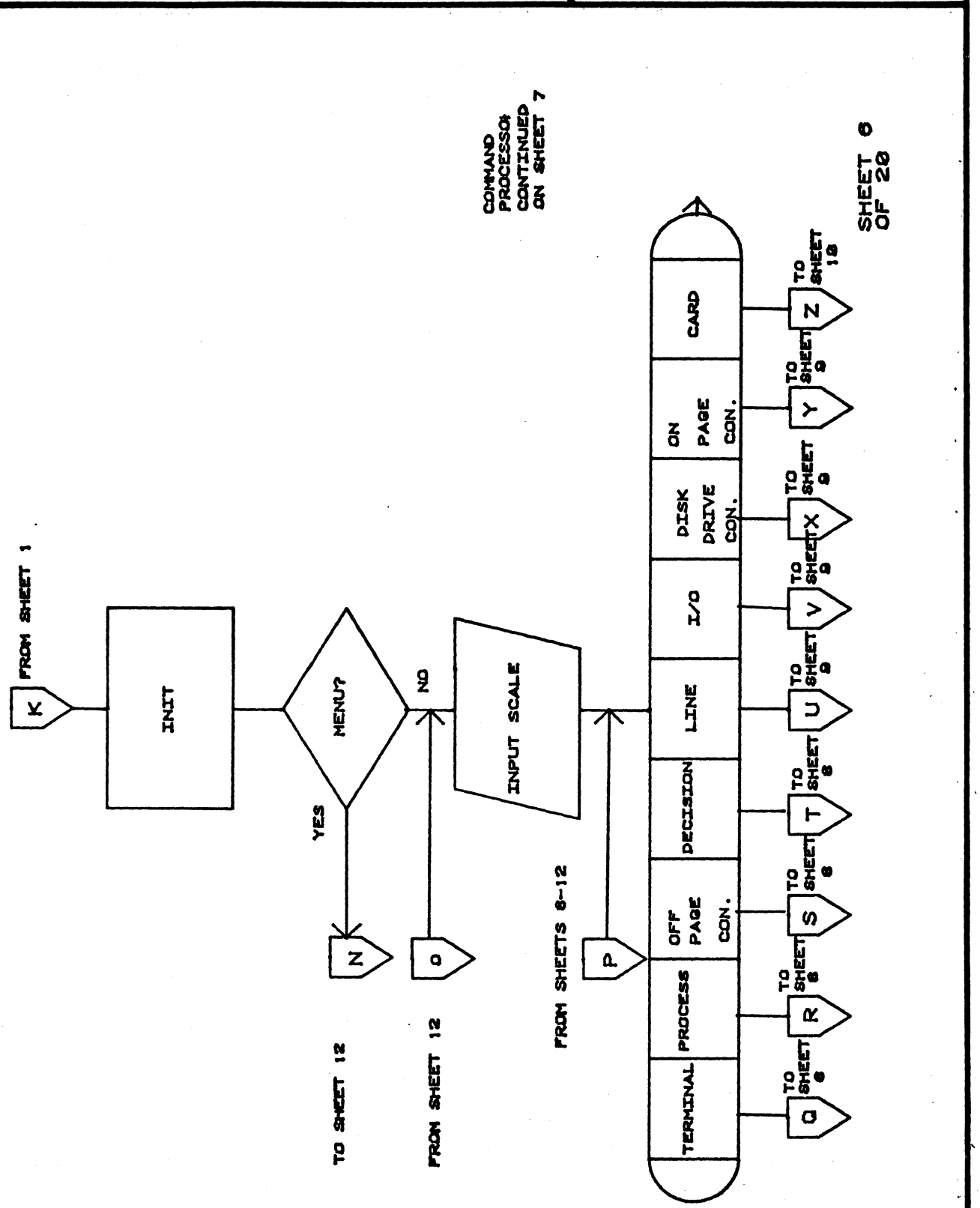

TITLE

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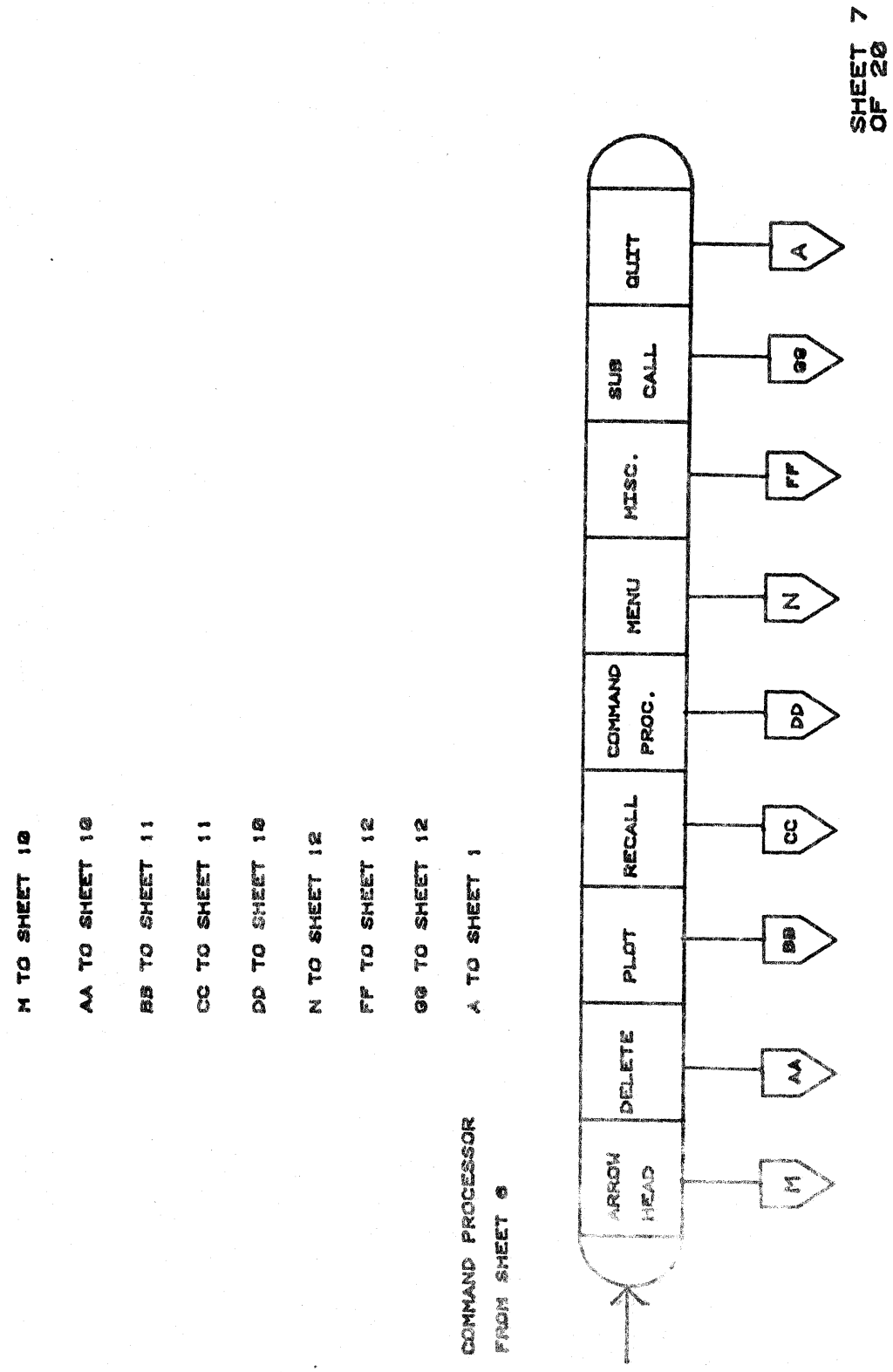
ABSTRACT NO:

51/00-9516/0

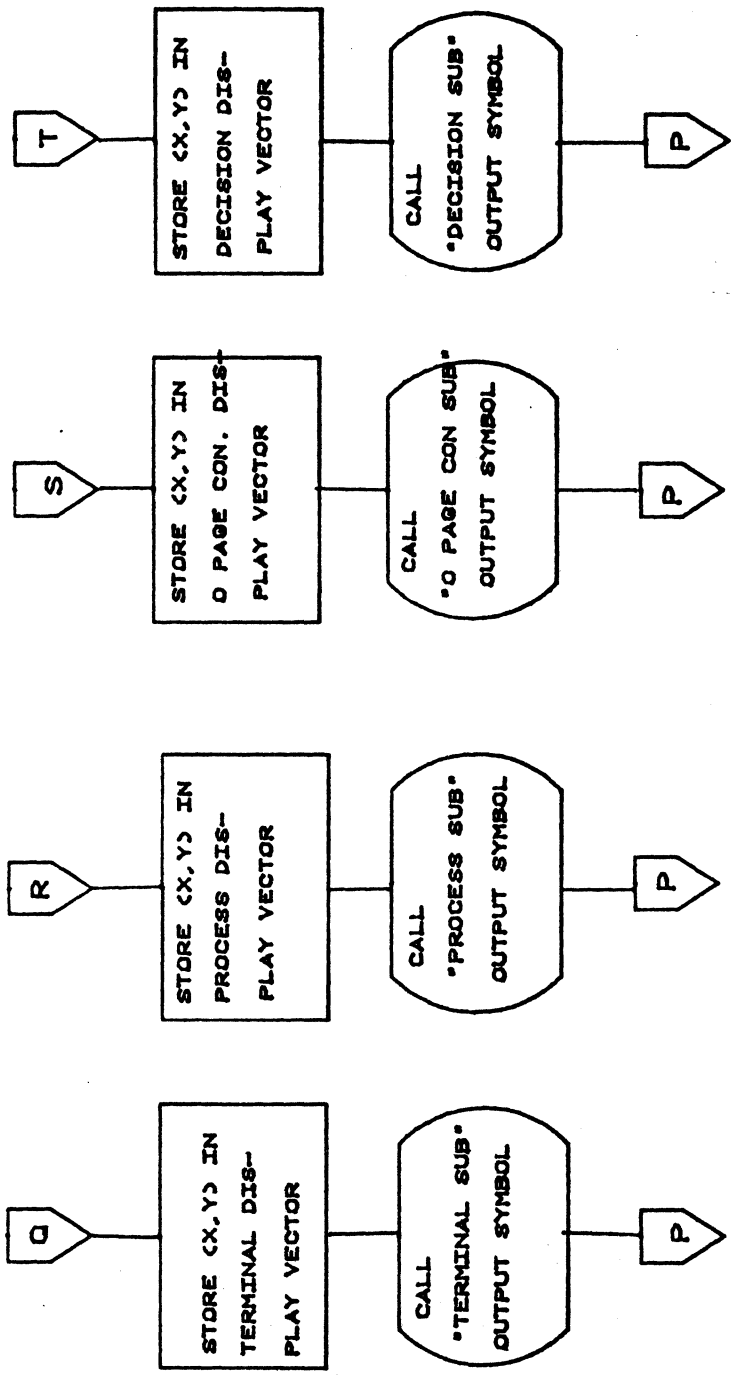


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0



Q,R,S,T FROM SHEET 6

P TO SHEET 6

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TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

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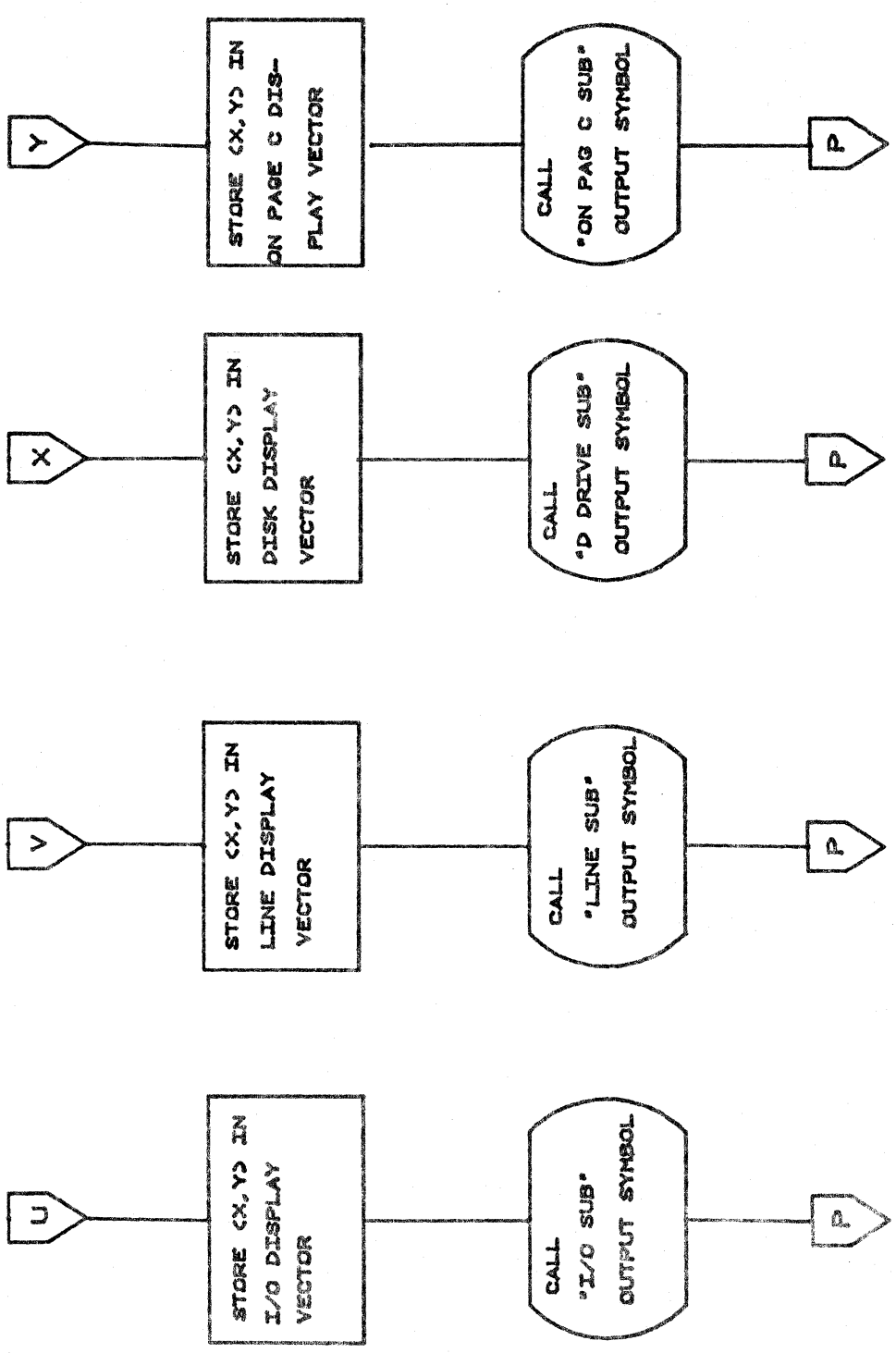

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TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

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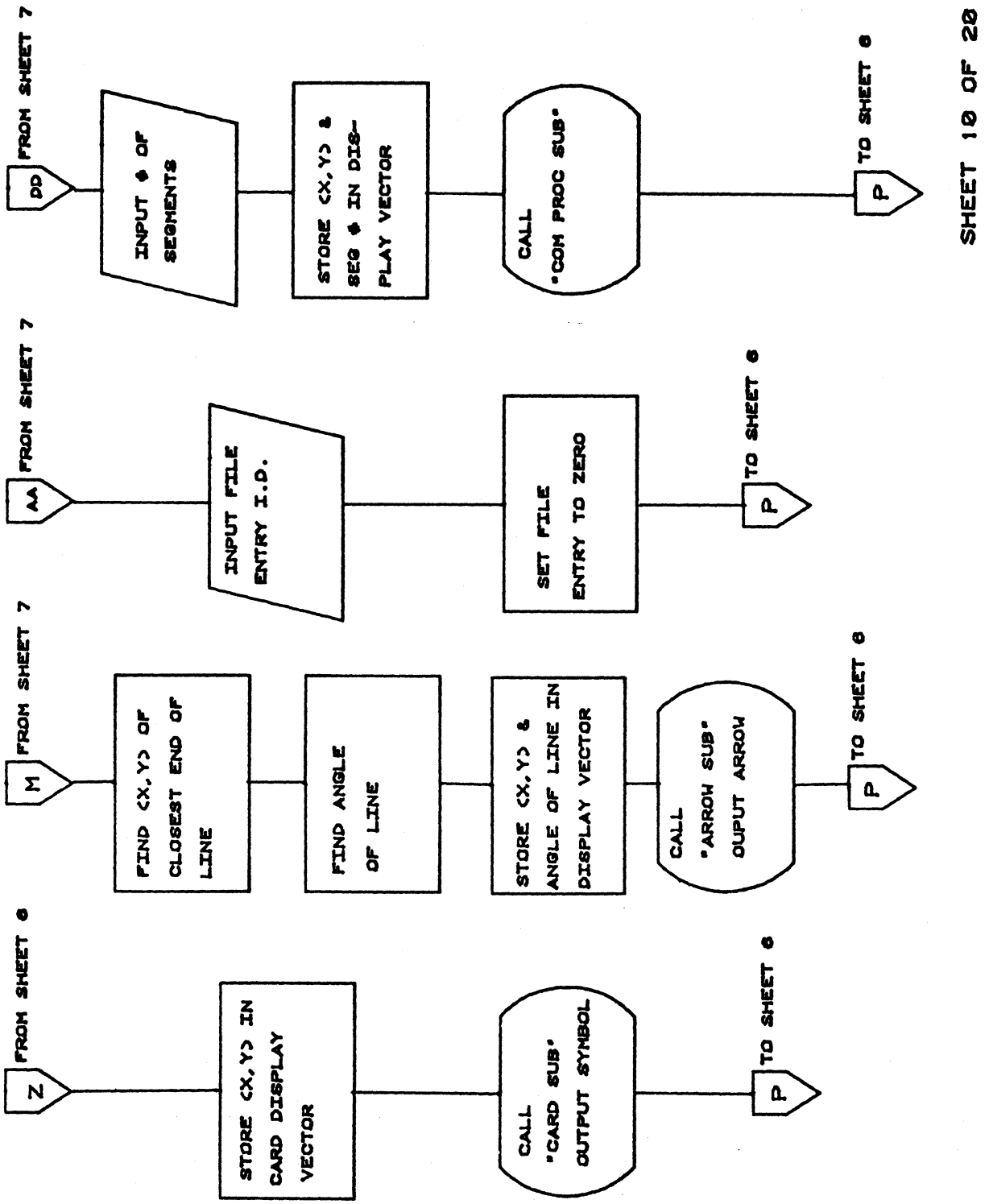

TITLE

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ABSTRACT NO:

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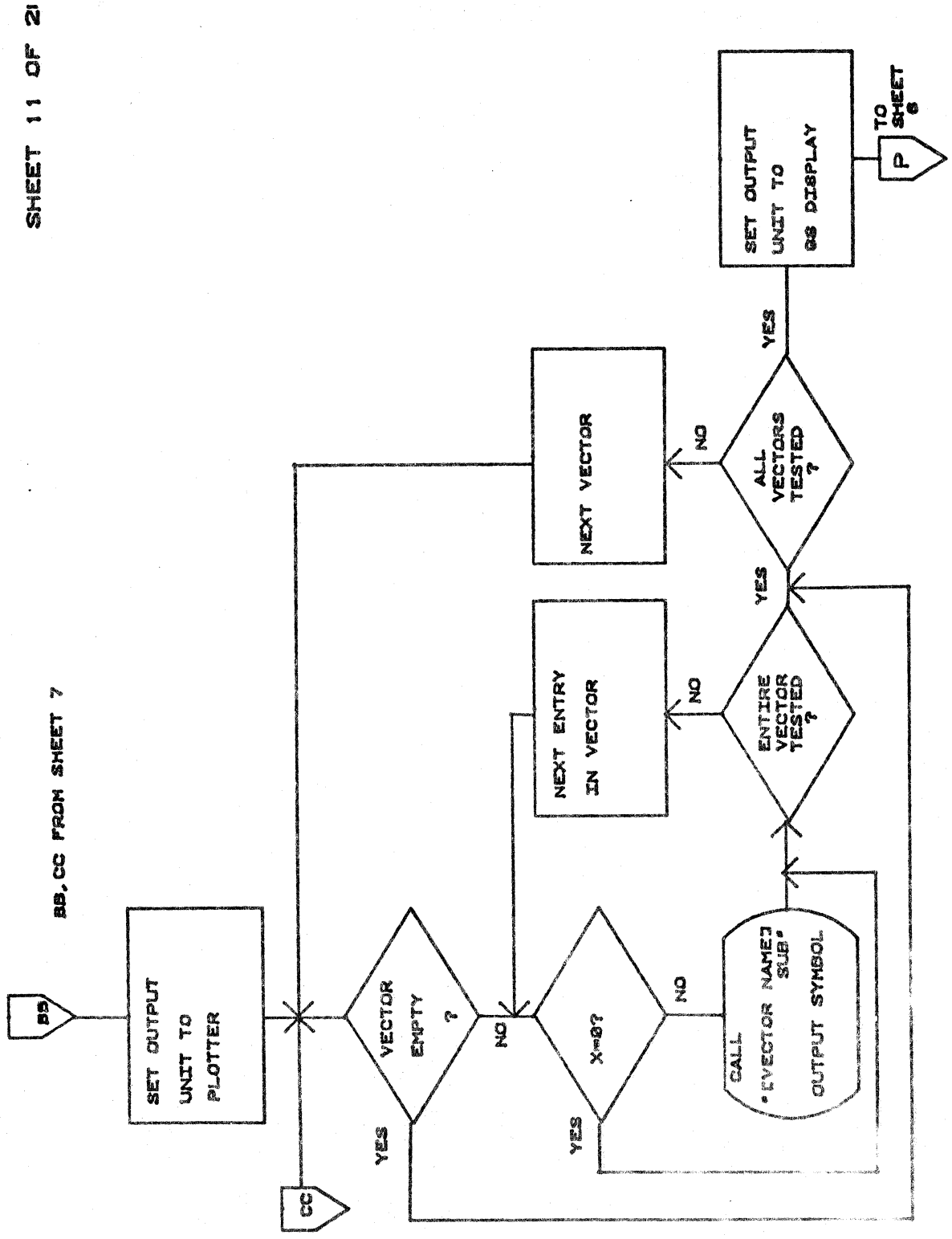
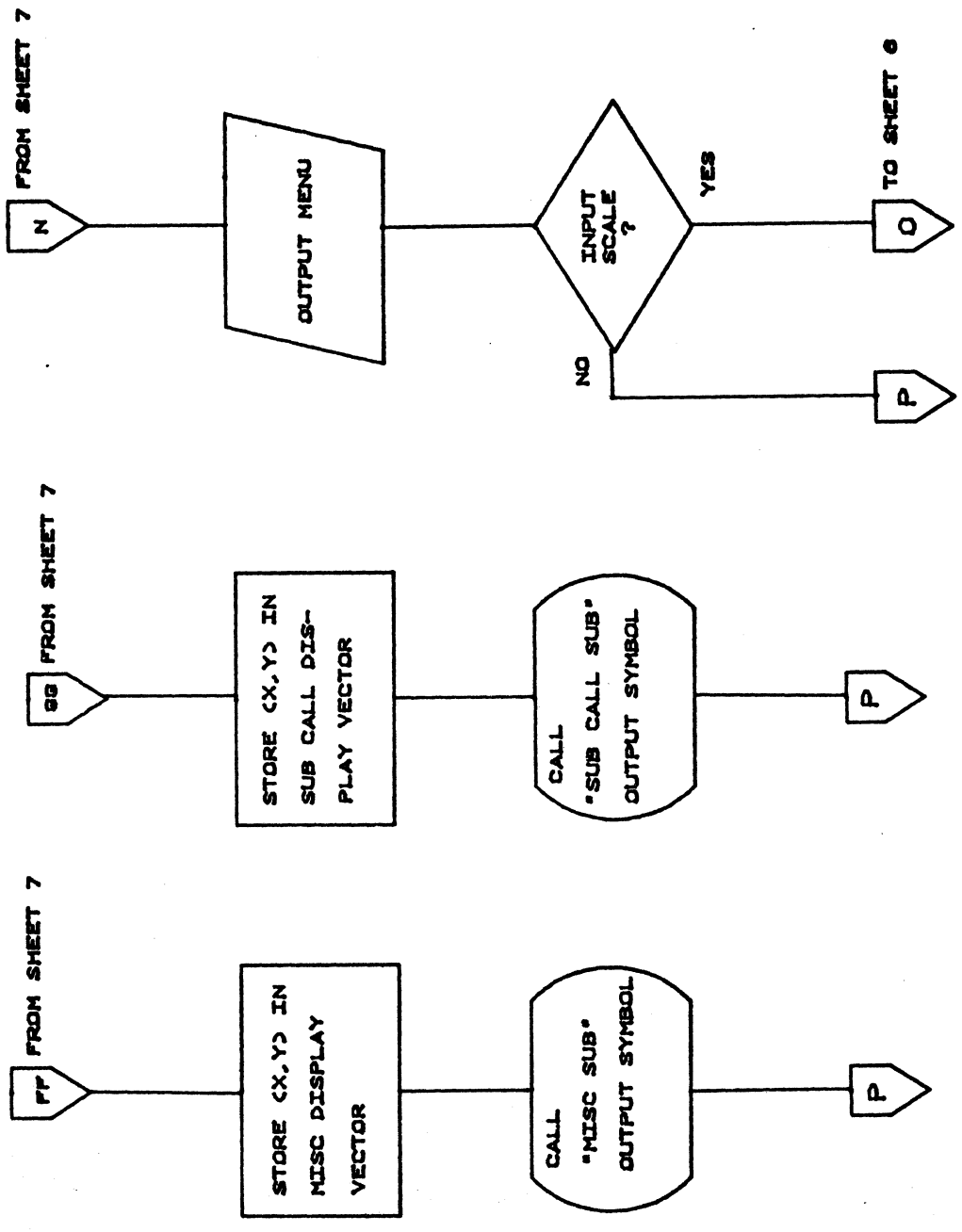


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0

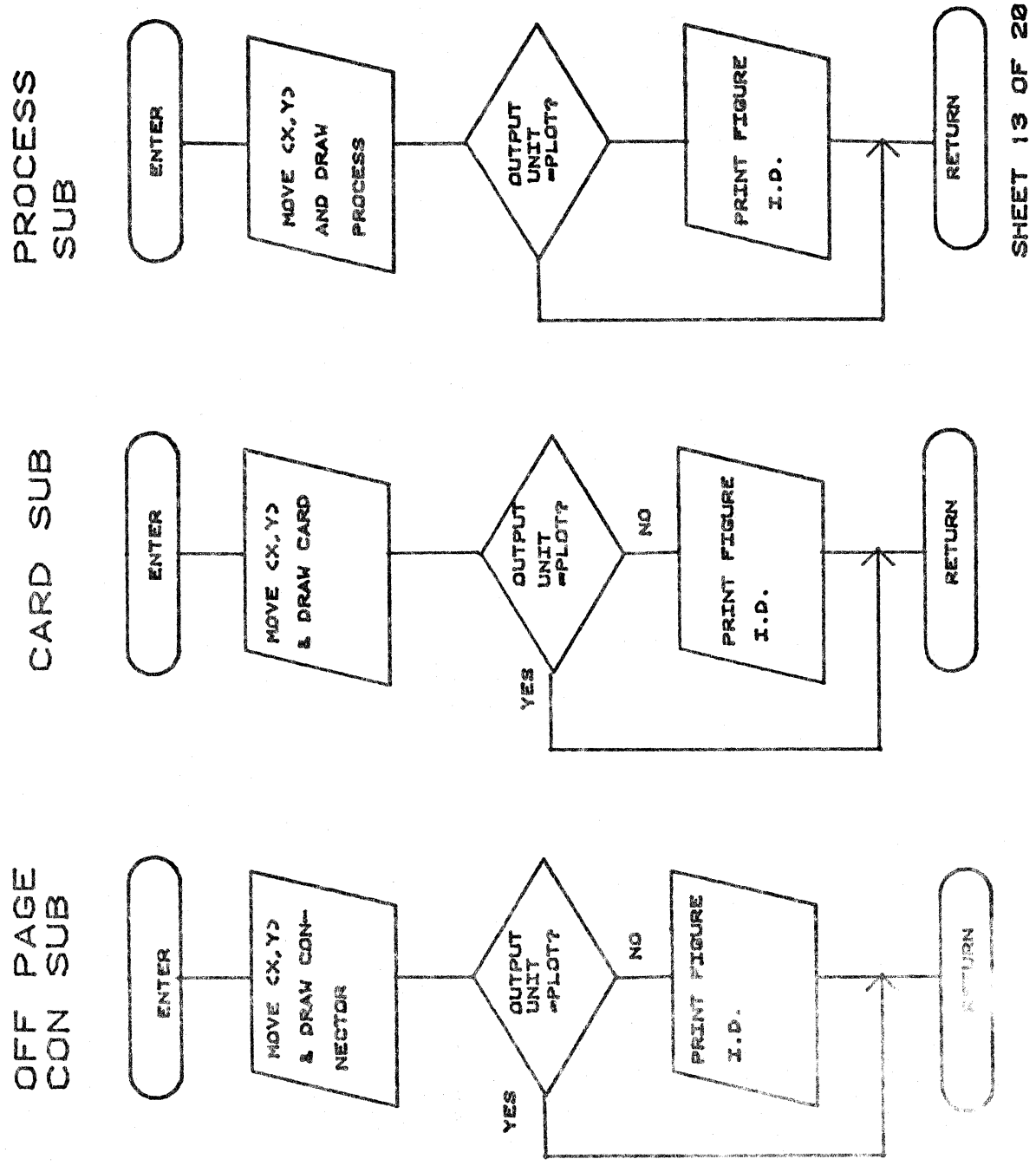


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0



TITLE	ABSTRACT NO:
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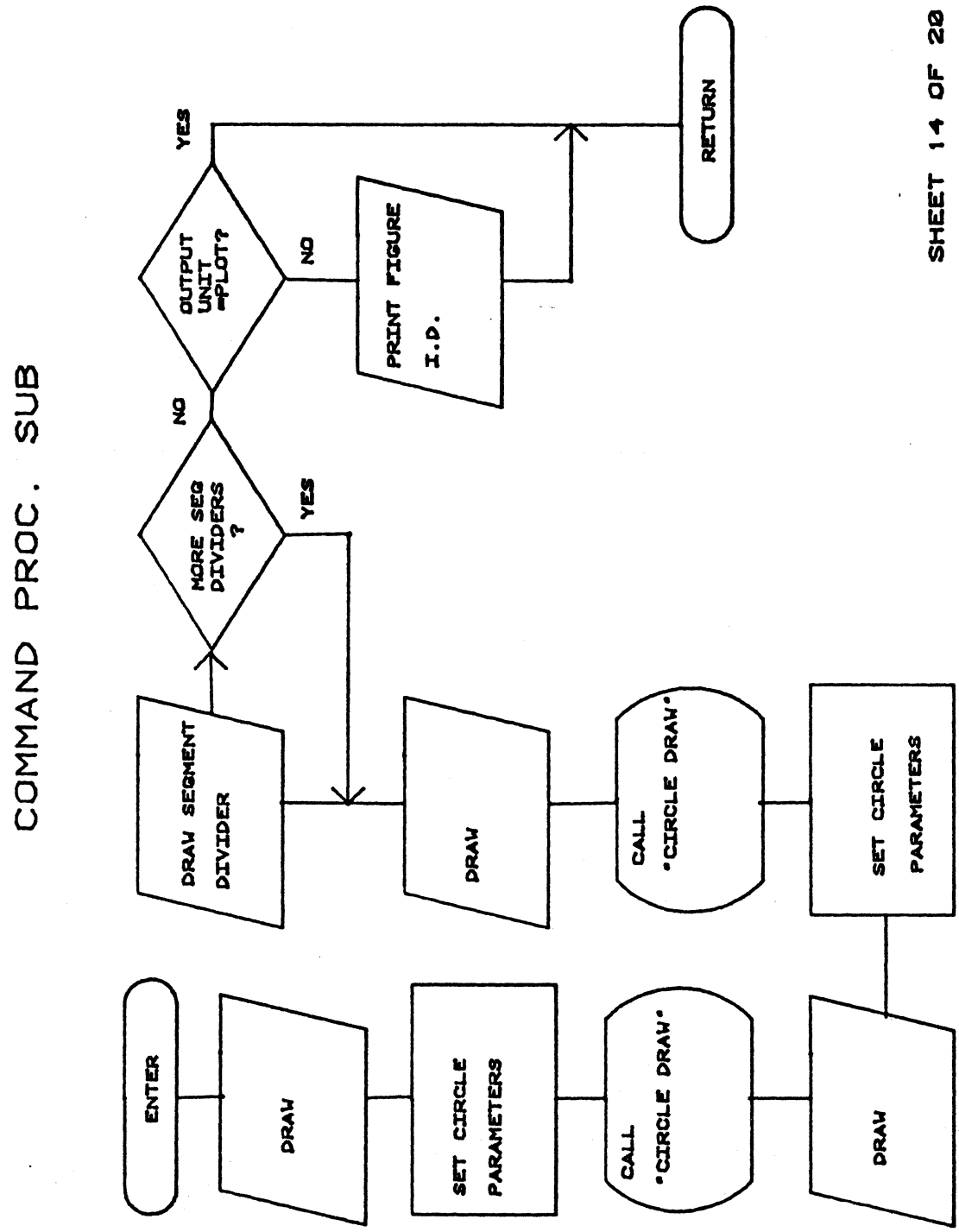
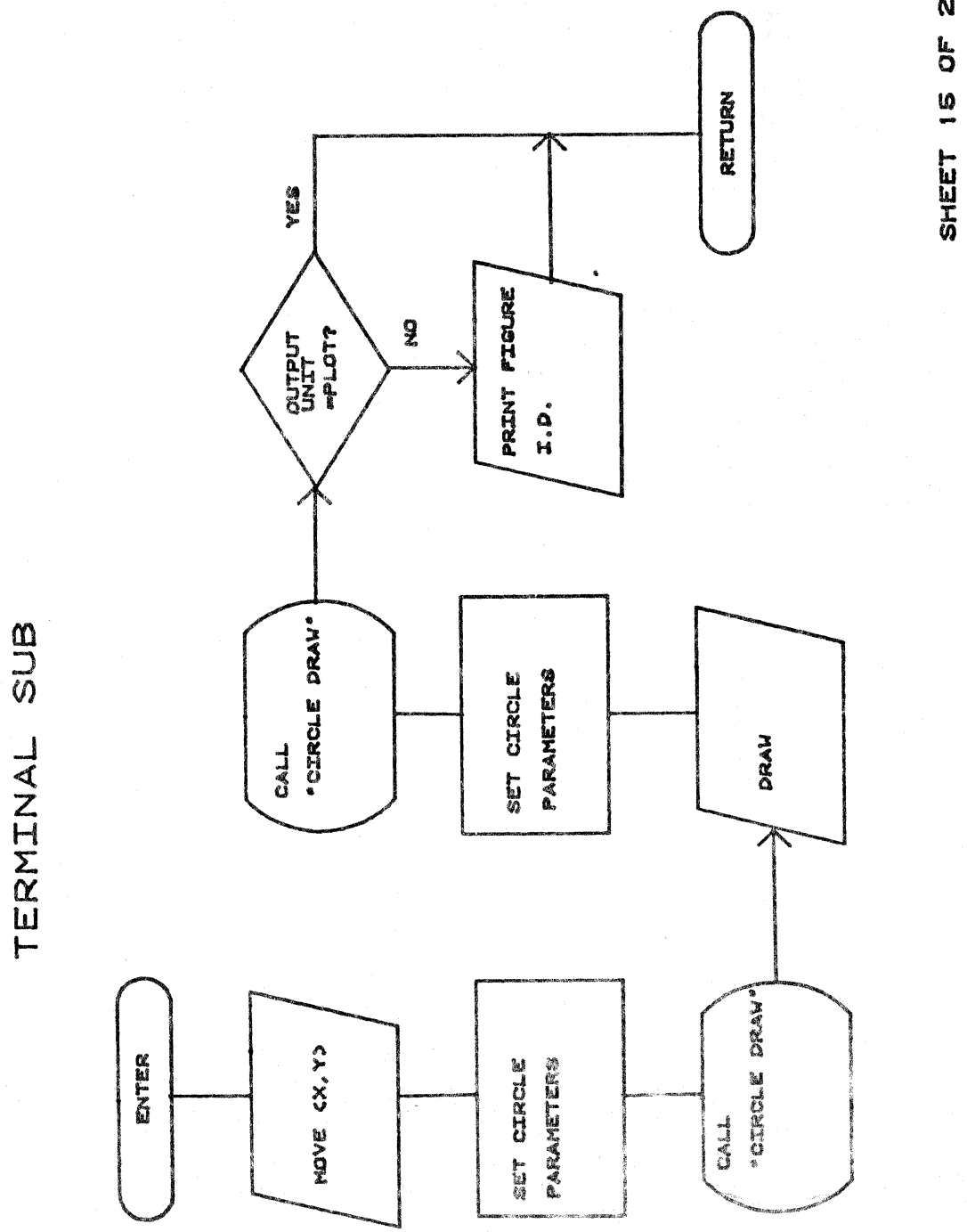


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0



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TITLE

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ABSTRACT NO:

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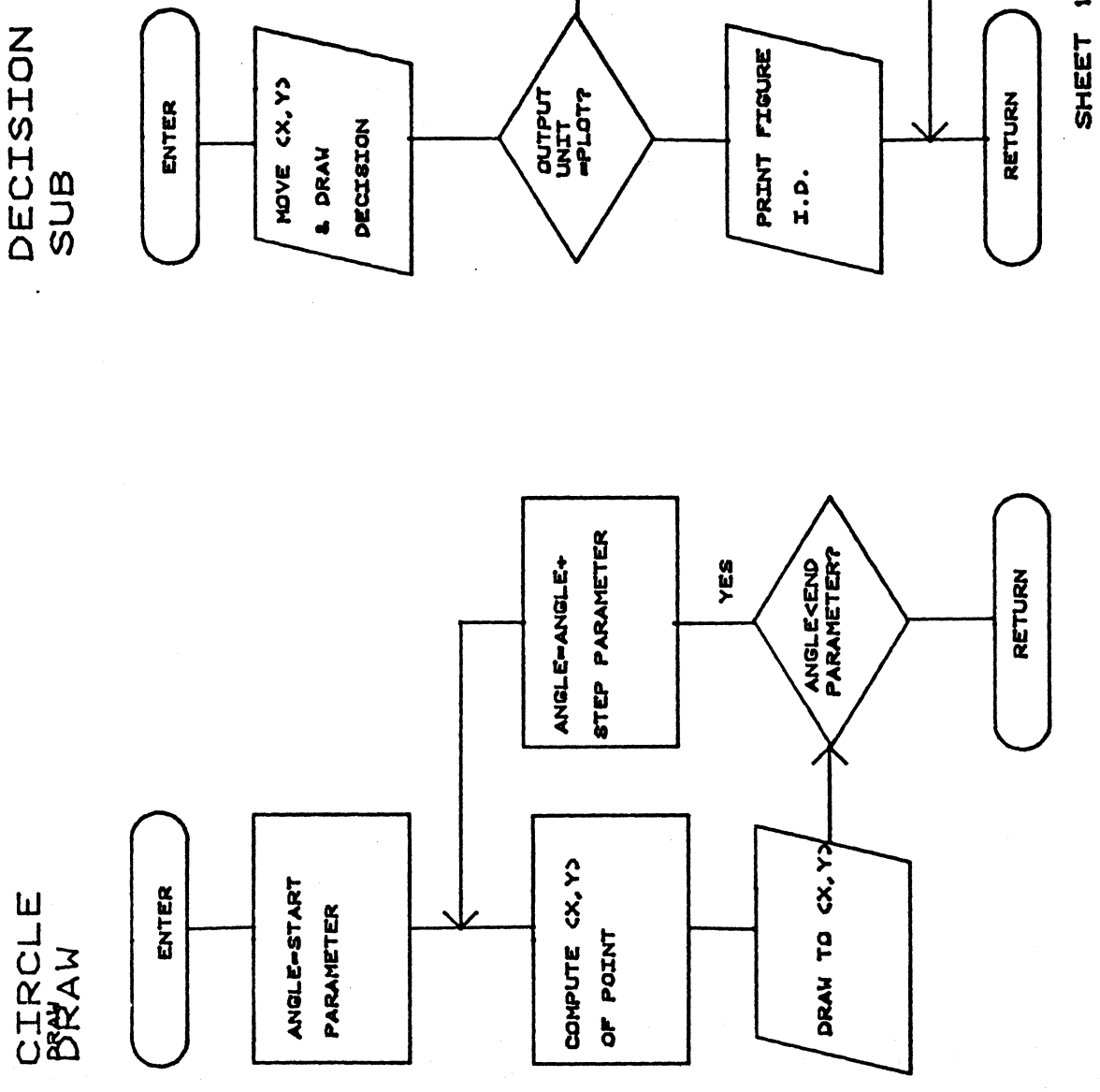
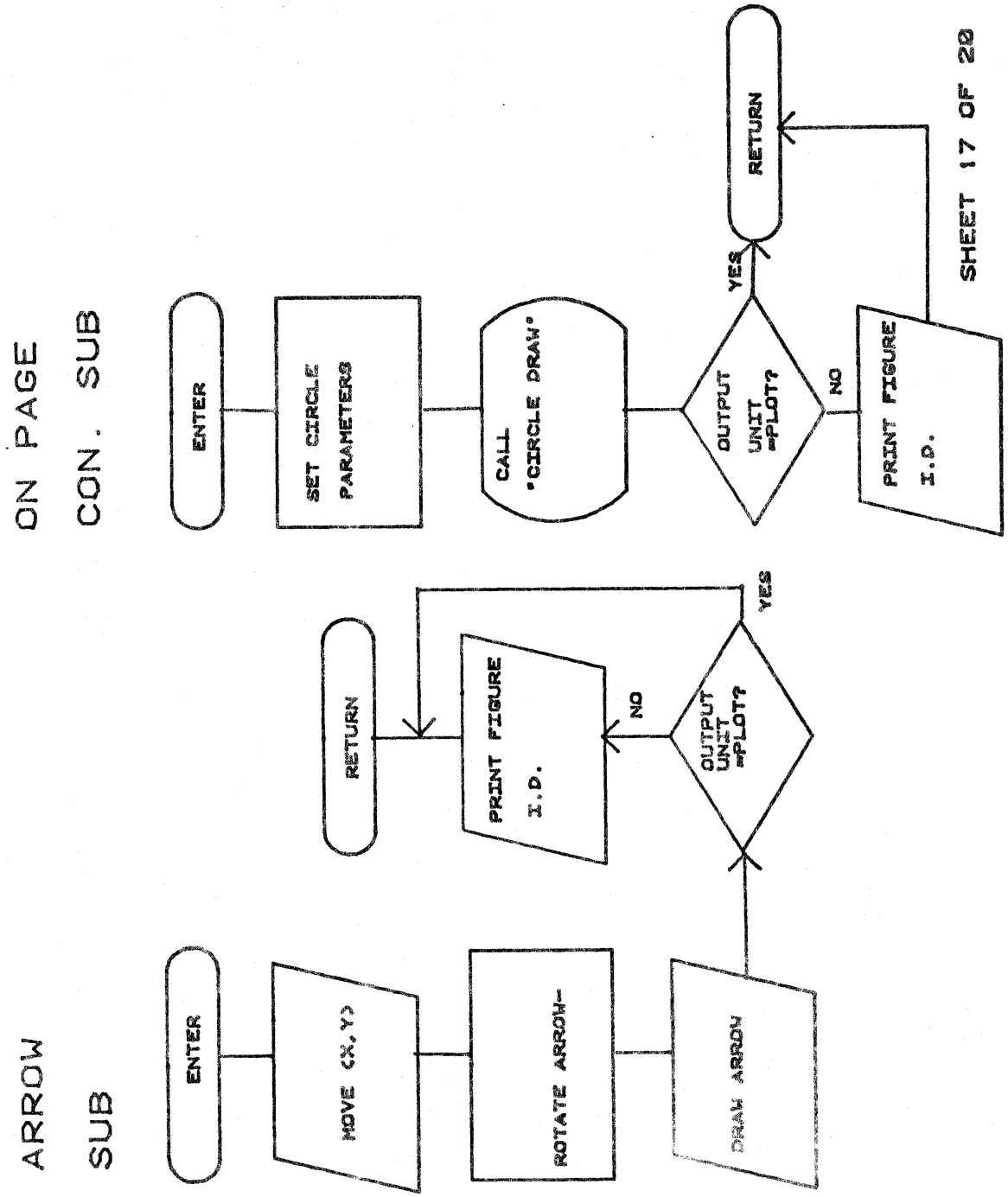


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0



TITLE	ABSTRACT NO:
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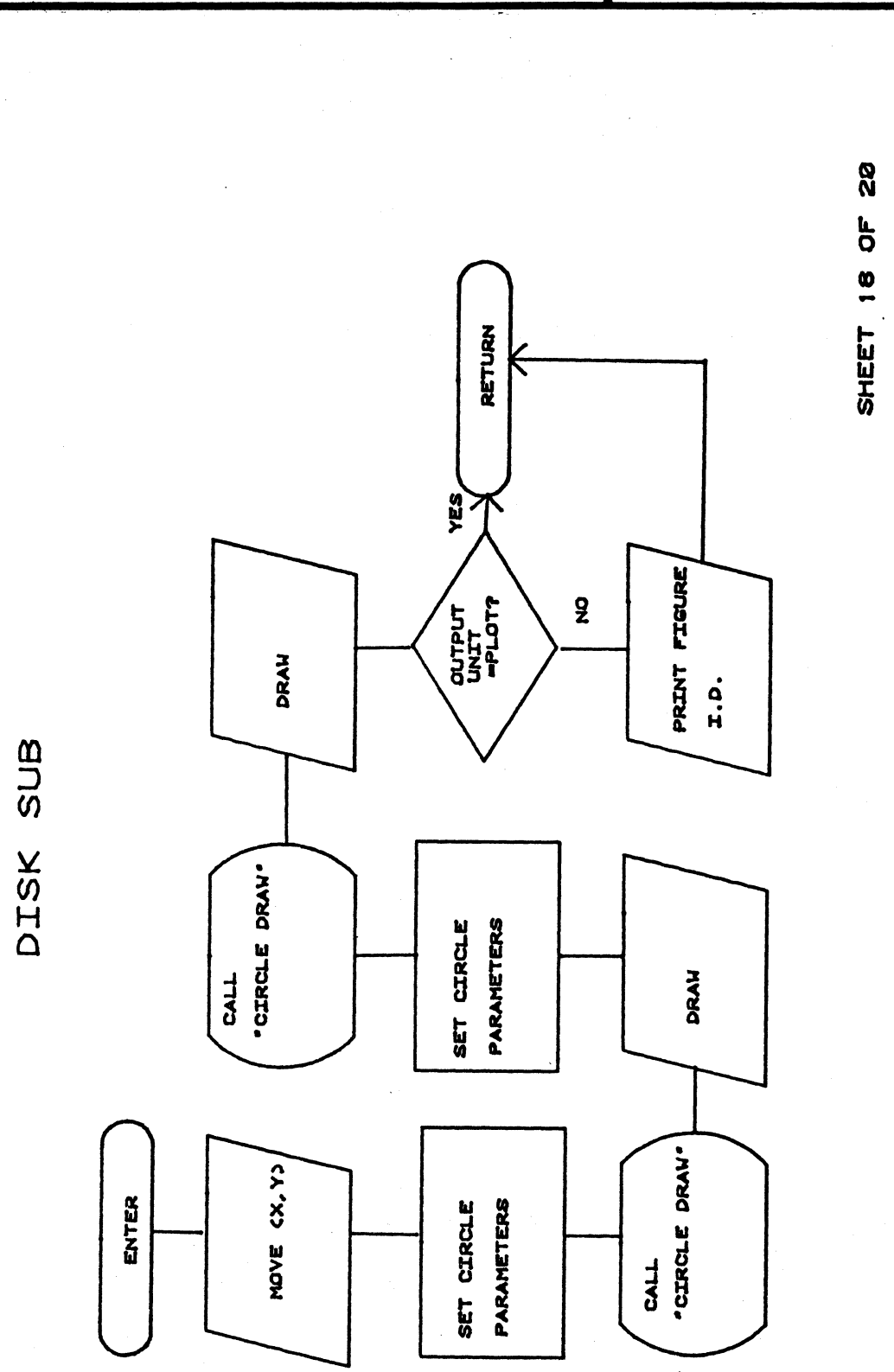
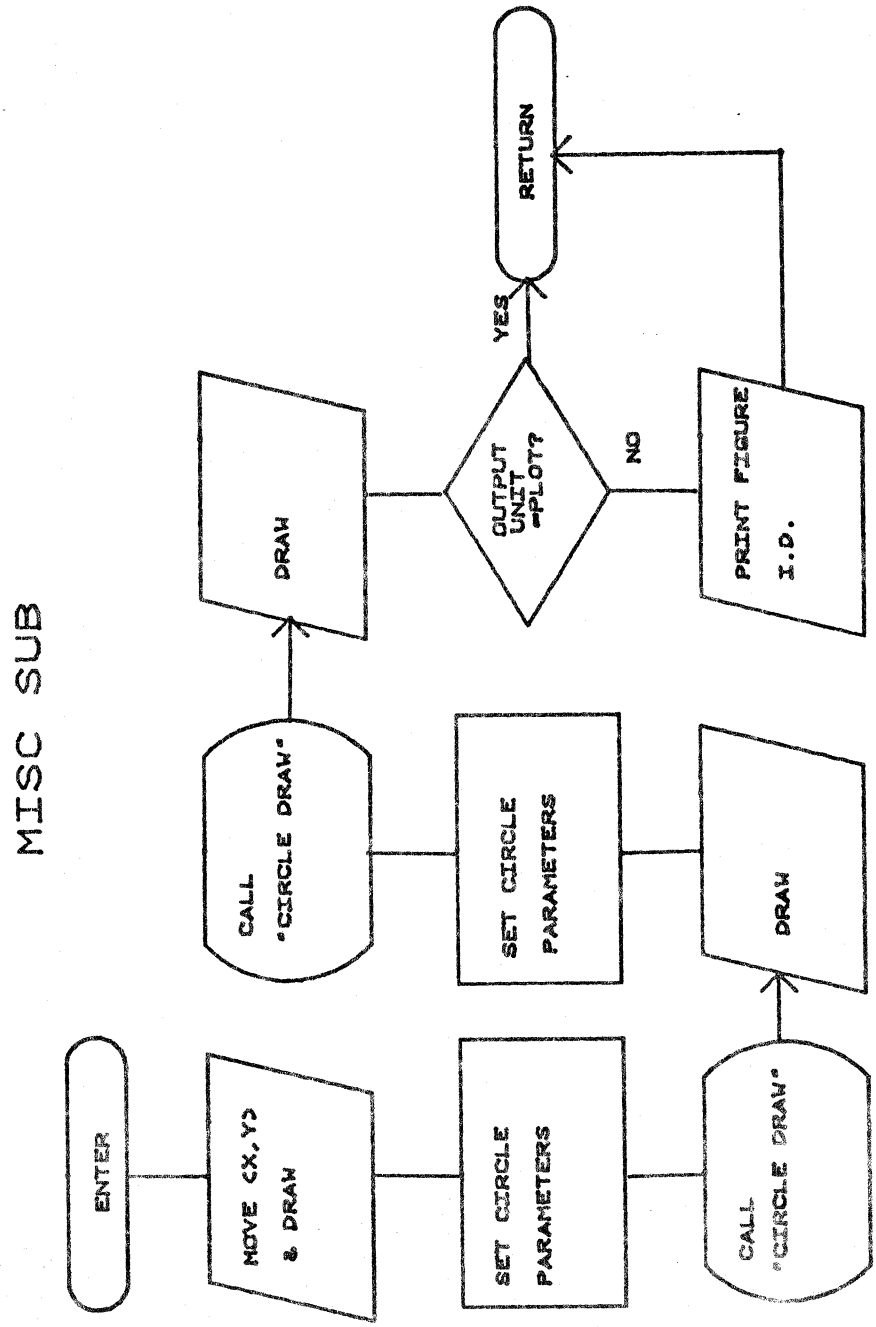


TITLE

ADVANCED MEDIA GRAPHICS Version 1.Ø

ABSTRACT NO:

51/00-9516/0



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TITLE	ABSTRACT NO:
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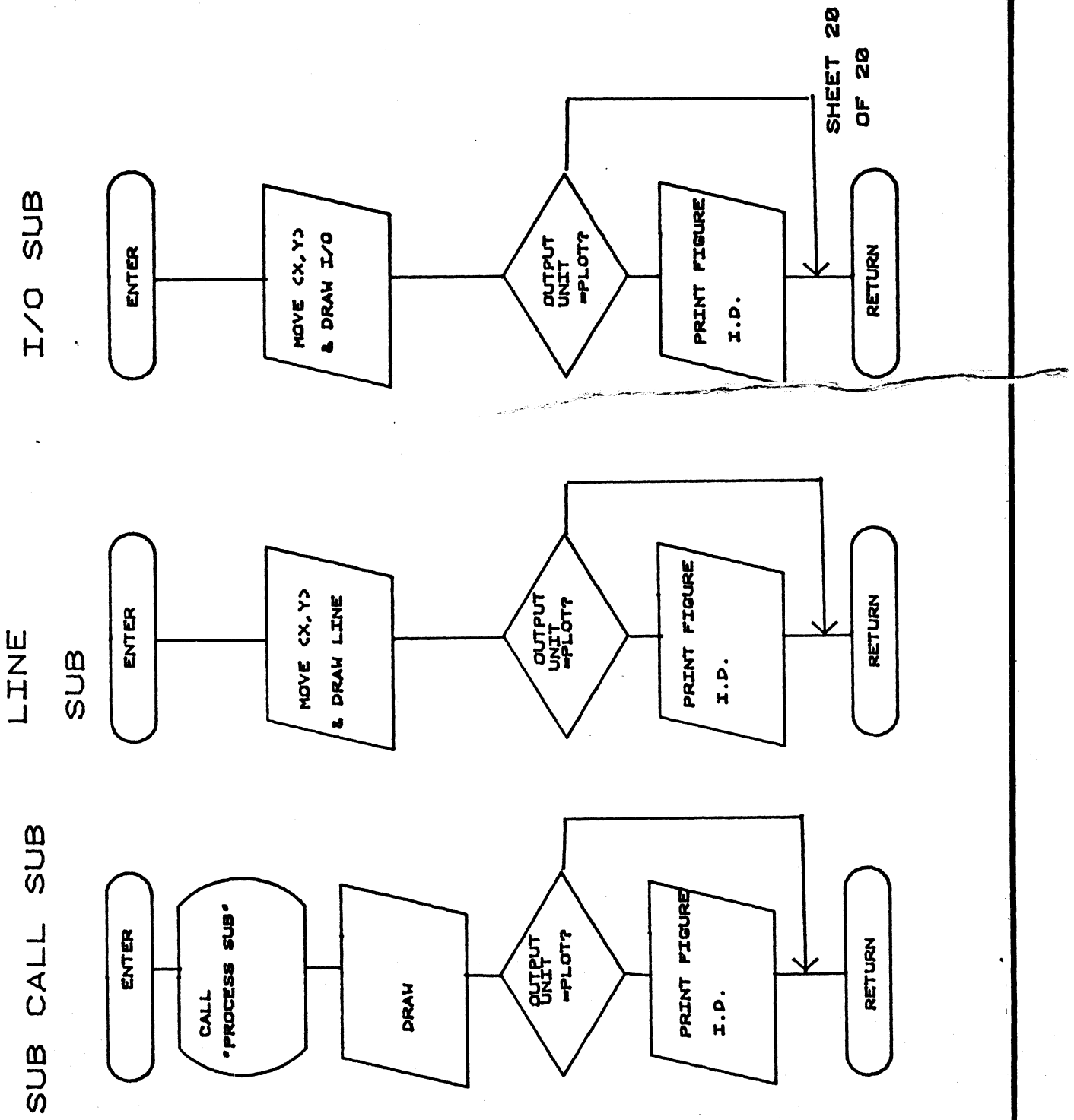

TITLE	ABSTRACT NO:
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```
100 REM*************51/00-9516/0**************************
110 REM
120 REM
130 REM           ADVANCED MEDIA GRAHICS
140 REM
150 REM           UNIVERSITY OF MISSOURI-COLUMBIA
160 REM           BIOENGINEERING/ADVANCED AUTOMATION
170 REM           AUTHORS-PAT RAFFERTY,LYLE WALLIS
180 REM
190 REM           8/30/77        VERSION 1.0
200 REM
210 REM*****************************************************

220 PAGE
230 PRINT "GGGGGGGG"
240 PRINT USING 250:"Advanced","Media","Graphics"
250 IMAGE 2L,10X,8A,10L,10X,5A,10L,10X,8A
260 FOR B1=1 TO 400
270 NEXT B1
280 INIT
290 DELETE A
300 ON SRQ THEN 320
310 DIM T$(11),I$(1),A(75)
320 WINDOW Ø,150,Ø,100
330 VIEWPORT Ø,150,Ø,100
340 T$="tiabcdloefr"
350 PRINT "LSELECT OPTION"
360 PRINT "TITLE,TEXT,ARC-CHAR,BOX,CIRCLE,DIAMOND,LINE,OUTLINE"
370 PRINT "FLOWCHART,ARROWHEAD,END"
380 PRINT "ENTER COMMAND i.e.,(T,I,A,B,C,D,L,O,F,R,E)"
390 INPUT I$
400 J=POS(T$,I$,1)
410 IF J=Ø THEN 350
420 N=Ø
430 GO TO J OF 510,500,1230,770,890,2060,1140,1630,2250,2260,7490
```

TITLE	ABSTRACT NO:
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```
440 GO TO 350

450 REM*****************************************************************
460 REM*
470 REM*  TITLE AND TEXT PROGRAM
480 REM*
490 REM*****************************************************************

500 N=1
510 X3=Ø.1
520 Y3=X3
530 PRINT "INPUT X AND Y CHAR SCALE"
540 INPUT X,Y
550 PRINT @1,17:X,Y
560 IF N=1 THEN 6ØØ
570 N=Y
580 IF N<5 THEN 6ØØ
590 N=5
600 PRINT "INPUT TEXT OR TITLE"
610 INPUT A$
620 PRINT "POSITION PLOTTER PEN AND DEPRESS CALL"
630 INPUT @1,27:X1,Y1,Z1
640 PRINT @1:"G";
650 FOR I=1 TO N
660     MOVE @1:X1,Y1
670     PRINT @1:A$
680     X1=X1+X3
690     Y1=Y1+Y3
700 NEXT I
710 GO TO 32Ø

720 REM*****************************************************************
730 REM*
740 REM*  BOX PROGRAM
750 REM*
760 REM*****************************************************************
```

TITLE	ABSTRACT NO:
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```
770 PRINT "MOVE PLOTTER PEN TO LOWER LEFT AND UPPER RIGHT"
780 PRINT "CORNERS OF BOX DEPRESSING CALL BOTTON"
790 INPUT @1,27:X1,Y1,Z1
800 PRINT @1:"G";
810 INPUT @1,27:X2,Y2,Z2
820 PRINT @1:"G";
830 MOVE @1:X1,Y1
840 DRAW @1:X2,Y1
850 DRAW @1:X2,Y2
860 DRAW @1:X1,Y2
870 DRAW @1:X1,Y1
880 GO TO 320

890 REM*****************************************
900 REM*
910 REM*   CIRCLE GENERATOR PGM
920 REM*
930 REM*****************************************

940 SET RADIANS
950 WINDOW -1,1,-1,1
960 PRINT "PLACE PEN AT THE CENTER OF CIRCLE AND INPUT RADIUS"
970 GIN @1:XØ,YØ
980 INPUT R
990 GIN @1:XØ,YØ
1000 DRAW @1:XØ,YØ
1010 DRAW @1:XØ,YØ
1020 MOVE @1:XØ+R,YØ
1030 FOR T=Ø TO 2*PI STEP PI/3Ø
1040      X=R*COS(T)
1050      Y=R*SIN(T)
1060      DRAW @1:XØ+X,YØ+Y
1070 NEXT T
1080 GO TO 320
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
1090 REM****************************************
1100 REM*
1110 REM*  LINE PROGRAM
1120 REM*
1130 REM************************************************************

1140 PRINT "MOVE PEN TO START AND END POINTS OF LINE "
1150 PRINT "DEPRESSING CALL BOTTON"
1160 INPUT @1,27:X1,Y1,Z1
1170 PRINT @1:"G";
1180 INPUT @1,27:X2,Y2,Z2
1190 PRINT @1:"G";
1200 MOVE @1:X2,Y2
1210 DRAW @1:X1,Y1
1220 GO TO 320

1230 REM*********************************************
1240 REM*
1250 REM*  ARC-CHARACTER PROGRAM
1260 REM*************************************************************

1270 WINDOW -1,1,-1,1
1280 VIEWPORT Ø,150,Ø,1ØØ
1290 DIM A$(8Ø),P$(1)
1300 SET DEGREES
1310 PRINT "input rotated character scale x and y "
1320 INPUT S1,S2
1330 PRINT @1,17:S1,S2
1340 PRINT "input line of text"
1350 INPUT A$
1360 L=LEN(A$)
1370 PRINT "position pen at center of arc and push call"
1380 INPUT @1,27:C1,C2
1390 PRINT @1:"G";
1400 GIN @1:C3,C4
1410 PRINT "position pen at beginning of characters and push call"
```

TITLE	ABSTRACT NO:
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```
1420 INPUT @1,27:O1,O2
1430 PRINT @1:"G";
1440 GIN @1:O1,O2
1450 R1=SQR((O1-C3)↑2+(O2-C4)↑2)
1460 B1=ATN((O2-C4)/(O1-C3))
1470 A1=S1/R1*Ø.85
1480 IF O1>C3 THEN 15ØØ
1490 B1=B1+18Ø
1500 I1=A1*L
1510 I1=B1-I1
1520 I=Ø
1530 FOR C1=B1 TO I1 STEP -A1
1540      I=I+1
1550      X=R1*COS(C1)+C3
1560      Y=R1*SIN(C1)+C4
1570      MOVE @1:X,Y
1580      PRINT @1,25:C1-9Ø
1590      P$=SEG(A$,I,1)
1600      PRINT @1:P$;
1610 NEXT C1
1615 PRINT @1,25:Ø
1620 GO TO 32Ø

1630 REM ****************************************
1640 REM *
1650 REM *      OUTLINE PROGRAM
1660 REM *
1670 REM ****************************************

1680 VIEWPORT Ø,15,Ø,1Ø
1690 WINDOW Ø,15,Ø,1Ø
1700 PRINT "Position pen to lower left and upper right of paper and "
1710 PRINT "depress call botton"
1720 INPUT @1,27:X1,Y1
1730 PRINT @1:"G";
1740 INPUT @1,27:X2,Y2
```

TITLE	ABSTRACT NO:
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```
1750 PRINT @1:"G";
1760 VIEWPORT X1,X2,Y1,Y2
1770 PRINT "Enter number of outline levels";
1780 INPUT L
1790 DELETE T$,S,T
1800 DIM T(L),S(L),T$(72)
1810 PAGE
1820 FOR I=1 TO L
1830     PAGE
1840     PRINT "Enter tab from left margin in inches for level",I
1850     PRINT "and Scale for characters at this level  ";
1860     INPUT T(I),S(I)
1870 NEXT I
1880 PAGE
1890 PRINT "Position plotter pen to desired vertical position and enter"
1900 PRINT "outline level number ";
1910 INPUT L
1920 PRINT @1,17:S(L),S(L)
1930 I=Ø
1940 PAGE
1950 I=I+1
1960 PRINT "Enter text for level",L,"item number",I
1970 PRINT "Carrage Return for new level or E to quit"
1980 INPUT T$
1990 IF LEN(T$)=Ø THEN 188Ø
2000 IF T$="E" THEN 2050
2010 GIN @1:X,Y
2020 MOVE @1:T(L),Y
2030 PRINT @1:T$
2040 GO TO 194Ø
2050 GO TO 28Ø

2060 REM*****************************************************************
2070 REM*
2080 REM*  DIAMOND GENERATOR PROGRAM
2090 REM*
```

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```
2100 REM*****************************************************************

2110 PRINT "POSITION PLOTTER PEN AT TOP AND LEFT CORNER OF DIAMOND AND"
2120 PRINT "DEPRESS CALL"
2130 INPUT @1,27:X1,Y1,Z1
2140 PRINT @1:"G";
2150 INPUT @1,27:X2,Y2,Z2
2160 PRINT @1:"G";
2170 Y3=Y1-(Y1-Y2)*2
2180 X4=X1+(X1-X2)
2190 MOVE @1:X1,Y1
2200 DRAW @1:X2,Y2
2210 DRAW @1:X1,Y3
2220 DRAW @1:X4,Y2
2230 DRAW @1:X1,Y1
2240 GO TO 320
2250 END

2260 REM************    flowchart program  *****************

2270 DELETE N,I,T,L,B
2280 WINDOW Ø,150,Ø,110
2290 DIM T(30),P(40),N(40),D(26),I(26),M(10),C(10),O(20),S$(1)
2300 DIM L(160),Z$(18),S(15),U(40),B(40)
2310 PAGE
2320 DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,32,Ø,Ø
2330 READ N1,S3,T1,M1,C2,P1,D1,L1,I1,C1,A1,H,U1,B1
2340 PRINT "Do you wish to see instructions?(y or n)"
2350 INPUT S$
2360 IF S$<>"Y" THEN 2380
2370 GOSUB 7150
2380 PRINT "Enter scale factor"
2390 SET DEGREES
2400 INPUT S1
2410 PAGE
2420 Z$="TPNDLIMOCAEHRS?QUB"
```

TITLE	ABSTRACT NO:
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```
2430 POINTER X,Y,S$
2440 J=POS(Z$,S$,1)
2450 IF J=Ø THEN 2430
2460 IF J>1Ø THEN 2480
2470 GO TO J OF 2500,2640,5610,2710,2780,2940,6870,3010,5800,3760,5990
2480 J=J-1Ø
2490 GO TO J OF 5990,4280,4300,6530,7110,280,7600,7850
2500 T1=T1+1
2510 T(T1)=X
2520 T1=T1+1
2530 T(T1)=Y
2540 GOSUB 3080
2550 IMAGE 1a,2d
2560 GO TO 2430

2570 REM***************** circle draw ***************

2580 FOR Z=Z2 TO Z3 STEP Z4
2590     X1=Ø.3*S1*COS(Z)
2600     Y1=Ø.3*S1*SIN(Z)
2610     RDRAW @H:X1,Y1
2620 NEXT Z
2630 RETURN

2640 REM**********  proc section **********************

2650 P1=P1+1
2660 P(P1)=X
2670 P1=P1+1
2680 P(P1)=Y
2690 GOSUB 3250
2700 GO TO 2430

2710 REM***********  decision section  **************

2720 D1=D1+1
```

TITLE	ABSTRACT NO:
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```
2730 D(D1)=X
2740 D1=D1+1
2750 D(D1)=Y
2760 GOSUB 3360
2770 GO TO 2430

2780 REM******  line section  *********

2790 X1=X
2800 Y1=Y
2810 POINTER X,Y,S$
2820 X2=X
2830 Y2=Y
2840 L1=L1+1
2850 L(L1)=X1
2860 L1=L1+1
2870 L(L1)=Y1
2880 L1=L1+1
2890 L(L1)=X2
2900 L1=L1+1
2910 L(L1)=Y2
2920 GOSUB 3460
2930 GO TO 2430

2940 REM******* i/o section  ****************************

2950 I1=I1+1
2960 I(I1)=X
2970 I1=I1+1
2980 I(I1)=Y
2990 GOSUB 3540
3000 GO TO 2430

3010 REM************  circle section   ********************************

3020 C1=C1+1
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
3030 O(C1)=X
3040 C1=C1+1
3050 O(C1)=Y
3060 GOSUB 3650
3070 GO TO 2430

3080 REM****** ter sub  ****************************************

3090 MOVE @H:X,Y
3100 RDRAW @H:S1*8,Ø
3110 Z2=Ø
3120 Z3=-180
3130 Z4=-8
3140 GOSUB 2570
3150 RDRAW @H:-S1*16,Ø
3160 Z2=180
3170 Z3=Ø
3180 GOSUB 2570
3190 DRAW @H:X,Y
3200 IF H=1 THEN 3240
3210 MOVE X,Y
3220 PRINT "J";
3230 PRINT USING 2550:"t",T1/2
3240 RETURN

3250 REM***********  process sub ****************************

3260 MOVE @H:X,Y
3270 RDRAW @H:S1*10,Ø
3280 RDRAW @H:Ø,-S1*12
3290 RDRAW @H:-S1*20,Ø
3300 RDRAW @H:Ø,S1*12
3310 DRAW @H:X,Y
3320 IF H=1 OR S1=1.000000001 THEN 3350
3330 PRINT "J";
3340 PRINT USING 2550:"p",P1/2
```

TITLE	ABSTRACT NO:
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```
3350 RETURN

3360 REM************  decision sub  ****************************

3370 MOVE @H:X,Y
3380 RDRAW @H:S1*10,-S1*6
3390 RDRAW @H:-S1*10,-S1*6
3400 RDRAW @H:-S1*10,S1*6
3410 DRAW @H:X,Y
3420 IF H=1 THEN 3450
3430 MOVE X-2,Y-5
3440 PRINT USING 2550:"d",D1/2
3450 RETURN

3460 REM************  line sub  ************************

3470 MOVE @H:X2,Y2
3480 DRAW @H:X1,Y1
3490 IF H=1 THEN 3520
3500 MOVE X2+2,Y2-2
3510 PRINT USING 2550:"l",L1/4
3520 RETURN

3530 REM******** i/o sub  ******************************

3540 MOVE @H:X+5,Y
3550 RDRAW @H:S1*5,Ø
3560 RDRAW @H:-S1*3,-S1*12
3570 RDRAW @H:-S1*17,Ø
3580 RDRAW @H:S1*3,S1*12
3590 DRAW @H:X+5,Y
3600 IF H=1 THEN 3630
3610 MOVE X-5,Y-3
3620 PRINT USING 2550:"i",I1/2
3630 RETURN
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
3640 REM*****  circle sub  *********************************

3650 MOVE @H:X,Y
3660 S1=S1*1.25
3670 Z2=Ø
3680 Z3=-360
3690 Z4=-7
3700 GOSUB 2570
3710 S1=S1/1.25
3720 IF H=1 THEN 3750
3730 PRINT "J";
3740 PRINT USING 2550:"o",C1/2
3750 RETURN

3760 REM****  arrow section  ********************

3770 IF SQR((X-X1)↑2+(Y-Y1)↑2)>SQR((X-X2)↑2+(Y-Y2)↑2) THEN 3830
3780 X=X1
3790 Y=Y1
3800 X9=X1-X2
3810 Y9=Y1-Y2
3820 GO TO 3870
3830 X=X2
3840 Y=Y2
3850 X9=X2-X1
3860 Y9=Y2-Y1
3870 IF X9=Ø THEN 4010
3880 M9=(Y2-Y1)/(X2-X1)
3890 T5=ATN(M9)
3900 IF T5=>Ø THEN 3920
3910 T5=T5+90
3920 IF X9=>Ø AND Y9=>Ø THEN 4000
3930 IF X9<=Ø AND Y9>Ø THEN 3990
3940 IF X9<Ø AND Y9<=Ø THEN 3970
3950 T5=T5+270
3960 GO TO 4050
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.0	51/00-9516/0

```
3970 T5=T5+180
3980 GO TO 4050
3990 T5=T5+90
4000 GO TO 4050
4010 IF Y9=>0 THEN 4040
4020 T5=270
4030 GO TO 4050
4040 T5=90
4050 T5=360-T5
4060 A1=A1+1
4070 A(A1)=X
4080 A1=A1+1
4090 A(A1)=Y
4100 A1=A1+1
4110 A(A1)=T5
4120 GOSUB 4150
4130 IF S1=1.00000001 THEN 350
4140 GO TO 2430

4150 REM*** arrow sub******

4160 MOVE @H:X,Y
4170 X3=(-1.3*COS(T5)+1.3*SIN(T5))*S1+X
4180 Y3=(1.3*SIN(T5)+1.3*COS(T5))*S1+Y
4190 DRAW @H:X3,Y3
4200 MOVE @H:X,Y
4210 X3=(-1.3*COS(T5)-1.3*SIN(T5))*S1+X
4220 Y3=(1.3*SIN(T5)-1.3*COS(T5))*S1+Y
4230 DRAW @H:X3,Y3
4240 IF H=1 THEN 4270
4250 PRINT "J";
4260 PRINT USING 2550:"a",A1/3
4270 RETURN

4280 REM***********PLOT SECTION*****************
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
4290 H=1
4300 K=T1
4310 PAGE
4320 IF K=Ø THEN 4410
4330 FOR T1=1 TO K STEP 2
4340     IF T(T1)=Ø THEN 4390
4350     MOVE @H:T(T1),T(T1+1)
4360     X=T(T1)
4370     Y=T(T1+1)
4380     GOSUB 3080
4390 NEXT T1
4400 T1=K
4410 K=D1
4420 IF K=Ø THEN 4500
4430 FOR D1=1 TO K STEP 2
4440     IF D(D1)=Ø THEN 4480
4450     X=D(D1)
4460     Y=D(D1+1)
4470     GOSUB 3360
4480 NEXT D1
4490 D1=K
4500 K=P1
4510 IF K=Ø THEN 4590
4520 FOR P1=1 TO K STEP 2
4530     IF P(P1)=Ø THEN 4570
4540     X=P(P1)
4550     Y=P(P1+1)
4560     GOSUB 3250
4570 NEXT P1
4580 P1=K
4590 K=L1
4600 IF K=Ø THEN 4720
4610 FOR L1=1 TO K STEP 4
4620     IF L(L1)=Ø THEN 4700
4630     X1=L(L1)
4640     Y1=L(L1+1)
```

TITLE	ABSTRACT NO:
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```
4650      X2=L(L1+2)
4660      Y2=L(L1+3)
4670      L1=L1+3
4680      GOSUB 3460
4690      L1=L1-3
4700 NEXT L1
4710 L1=K
4720 K=A1
4730 IF K=Ø THEN 4840
4740 FOR A1=1 TO K STEP 3
4750      IF A(A1)=Ø THEN 4820
4760      X=A(A1)
4770      Y=A(A1+1)
4780      T5=A(A1+2)
4790      A1=A1+2
4800      GOSUB 4150
4810      A1=A1-2
4820 NEXT A1
4830 A1=K
4840 K=I1
4850 IF K=Ø THEN 4930
4860 FOR I1=1 TO K STEP 2
4870      IF I(I1)=Ø THEN 4910
4880      X=I(I1)
4890      Y=I(I1+1)
4900      GOSUB 3530
4910 NEXT I1
4920 I1=K
4930 K=C1
4940 IF K=Ø THEN 5020
4950 FOR C1=1 TO K STEP 2
4960      IF O(C1)=Ø THEN 5000
4970      X=O(C1)
4980      Y=O(C1+1)
4990      GOSUB 3640
5000 NEXT C1
```

TITLE	ABSTRACT NO:
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```
5Ø1Ø C1=K
5Ø2Ø K=N1
5Ø3Ø IF K=Ø THEN 511Ø
5Ø4Ø FOR N1=1 TO K STEP 2
5Ø5Ø     IF N(N1)=Ø THEN 5Ø9Ø
5Ø6Ø     X=N(N1)
5Ø7Ø     Y=N(N1+1)
5Ø8Ø     GOSUB 568Ø
5Ø9Ø NEXT N1
51ØØ N1=K
511Ø K=C2
512Ø IF K=Ø THEN 52ØØ
513Ø FOR C2=1 TO K STEP 2
514Ø     IF C(C2)=Ø THEN 518Ø
515Ø     X=C(C2)
516Ø     Y=C(C2+1)
517Ø     GOSUB 587Ø
518Ø NEXT C2
519Ø C2=K
52ØØ K=M1
521Ø IF K=Ø THEN 528Ø
522Ø FOR M1=1 TO K STEP 2
523Ø     IF M(M1)=Ø THEN 527Ø
524Ø     X=M(M1)
525Ø     Y=M(M1+1)
526Ø     GOSUB 694Ø
527Ø NEXT M1
528Ø M1=K
529Ø K=S3
53ØØ IF K=Ø THEN 54ØØ
531Ø FOR S3=1 TO K STEP 3
532Ø     IF S(S3)=Ø THEN 539Ø
533Ø     X=S(S3)
534Ø     Y=S(S3+1)
535Ø     S2=S(S3+2)
536Ø     S3=S3+2
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.0	51/00-9516/0

```
5370      GOSUB 6640
5380      S3=S3-2
5390 NEXT S3
5400 S3=K
5410 K=B1
5420 IF K=0 THEN 5490
5430 FOR B1=1 TO K STEP 2
5440      IF B(B1)=0 THEN 5480
5450      X=B(B1)
5460      Y=B(B1+1)
5470      GOSUB 7920
5480 NEXT B1
5490 B1=K
5500 K=U1
5510 IF K=0 THEN 5590
5520 FOR U1=1 TO K STEP 2
5530      IF U(U1)=0 THEN 5570
5540      X=U(U1)
5550      Y=U(U1+1)
5560      GOSUB 7670
5570 NEXT U1
5580 U1=K
5590 H=32
5600 GO TO 2430

5610 REM**  off page connector sec  *******

5620 N1=N1+1
5630 N(N1)=X
5640 N1=N1+1
5650 N(N1)=Y
5660 GOSUB 5680
5670 GO TO 2430

5680 REM***  off page connector sub  *****
```

TITLE	ABSTRACT NO:
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```
5690 MOVE @H:X,Y
5700 RDRAW @H:S1*2,Ø
5710 RDRAW @H:Ø,-S1*3
5720 RDRAW @H:-S1*2,-3*S1
5730 RDRAW @H:-2*S1,3*S1
5740 RDRAW @H:Ø,3*S1
5750 DRAW @H:X,Y
5760 IF H=1 THEN 5790
5770 PRINT "J";
5780 PRINT USING 2550:"n",N1/2
5790 RETURN

5800 REM*** card sec  *****

5810 C2=C2+1
5820 C(C2)=X
5830 C2=C2+1
5840 C(C2)=Y
5850 GOSUB 5870
5860 GO TO 2430

5870 REM ******  card sub ******

5880 MOVE @H:X,Y
5890 RDRAW @H:S1*12,Ø
5900 RDRAW @H:Ø,S1*-1Ø
5910 RDRAW @H:S1*-24,Ø
5920 RDRAW @H:Ø,S1*7
5930 RDRAW @H:3*S1,3*S1
5940 DRAW @H:X,Y
5950 IF H=1 THEN 5980
5960 PRINT "J";
5970 PRINT USING 2550:"c",C2/2
5980 RETURN

5990 REM**  del section  ****
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
6ØØØ PRINT "J"
6Ø1Ø PRINT "block to be deleted"
6Ø2Ø INPUT S$,E1
6Ø3Ø J=POS(Z$,S$,1)
6Ø4Ø IF J>1Ø THEN 6Ø6Ø
6Ø5Ø GO TO J OF 6Ø8Ø,611Ø,632Ø,614Ø,617Ø,622Ø,638Ø,625Ø,635Ø,628Ø
6Ø6Ø J=J-1Ø
6Ø7Ø GO TO J OF 243Ø,243Ø,243Ø,641Ø,243Ø,243Ø,645Ø,649Ø
6Ø8Ø T(2*E1)=Ø
6Ø9Ø T(2*E1-1)=Ø
61ØØ GO TO 243Ø
611Ø P(E1*2-1)=Ø
612Ø P(E1*2)=Ø
613Ø GO TO 243Ø
614Ø D(E1*2)=Ø
615Ø D(E1*2-1)=Ø
616Ø GO TO 243Ø
617Ø L(E1*4)=Ø
618Ø L(E1*4-1)=Ø
619Ø L(E1*4-2)=Ø
62ØØ L(E1*4-3)=Ø
621Ø GO TO 243Ø
622Ø I(E1*2)=Ø
623Ø I(E1*2-1)=Ø
624Ø GO TO 243Ø
625Ø O(E1*2)=Ø
626Ø O(E1*2-1)=Ø
627Ø GO TO 243Ø
628Ø A(E1*3)=Ø
629Ø A(E1*3-1)=Ø
63ØØ A(E1*3-2)=Ø
631Ø GO TO 243Ø
632Ø N(E1*2)=Ø
633Ø N(E1*2-1)=Ø
634Ø GO TO 243Ø
```

TITLE	ABSTRACT NO:
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```
6350 C(E1*2-1)=Ø
6360 C(E1*2)=Ø
6370 GO TO 2430
6380 M(E1*2)=Ø
6390 M(E1*2-1)=Ø
6400 GO TO 2430
6410 S(E1*3)=Ø
6420 S(E1*3-1)=Ø
6430 S(E1*3-2)=Ø
6440 GO TO 2430
6450 U(E1*2)=Ø
6460 U(E1*2-1)=Ø
6470 GO TO 2430
6480 U(E1*2-1)=Ø
6490 B(E1*2)=Ø
6500 B(E1*2-1)=Ø
6510 GO TO 2430

6520 REM******  command proc sec  *******

6530 S3=S3+1
6540 S(S3)=X
6550 S3=S3+1
6560 S(S3)=Y
6570 PRINT "J"
6580 PRINT "J","input number of segments"
6590 INPUT S2
6600 S3=S3+1
6610 S(S3)=S2
6620 GOSUB 6640
6630 GO TO 2430

6640 REM****  command proc sub  ****

6650 MOVE @H:X,Y
6660 RDRAW @H:S2*1Ø*S1/2,Ø
```

TITLE	ABSTRACT NO:
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```
6670 Z2=Ø
6680 Z3=-180
6690 Z4=-8
6700 S1=2*S1
6710 GOSUB 2570
6720 RDRAW @H:-(S2*10)*(S1/2),Ø
6730 Z2=180
6740 Z3=Ø
6750 GOSUB 2570
6760 DRAW @H:X,Y
6770 RMOVE @H:S2*S1*10/4,Ø
6780 FOR S5=Ø TO S2
6790     RDRAW @H:Ø,-4.3*S1
6800     RMOVE @H:-5*S1,4.3*S1
6810 NEXT S5
6820 IF H=1 THEN 6850
6830 MOVE X,Y-2
6840 PRINT USING 2550:"s",S3/3
6850 S1=S1/2
6860 RETURN

6870 REM*** disk sec *****

6880 M1=M1+1
6890 M(M1)=X
6900 M1=M1+1
6910 M(M1)=Y
6920 GOSUB 6940
6930 GO TO 2430

6940 REM****** disk sub  *****************

6950 MOVE @H:X,Y
6960 Z2=90
6970 Z3=-270
6980 Z4=-8
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
6990 S1=S1*1.5
7000 GOSUB 2570
7010 RDRAW @H:0,-12*S1/1.5
7020 Z4=8
7030 Z2=-90
7040 Z3=90
7050 GOSUB 2570
7060 RDRAW @H:0,12*S1/1.5
7070 S1=S1/1.5
7080 IF H=1 THEN 7100
7090 PRINT USING 2550:"m",M1/2
7100 RETURN
7110 GOSUB 7150
7120 INPUT S$
7130 PAGE
7140 GO TO 2430
7150 PAGE
7160 PRINT "You are using the Flowchart Program.  The following flow-"
7170 PRINT "chart symbols can be created;","J"
7180 PRINT "TERMINAL symbol (T)","J"
7190 PRINT "PROCESS symbol (P)","J"
7200 PRINT "DECISION symbol (D)","J"
7210 PRINT "CIRCLE (O)","J"
7220 PRINT "LINE (L)","J"
7230 PRINT "I/O symbol (I)","J"
7240 PRINT "CARD (C) ","J"
7250 PRINT "ARROWHEAD (A)","J"
7260 PRINT "OFF PAGE CONNECTOR (N)","J"
7270 PRINT "DISK DRIVE (M)","J"
7280 PRINT "MISC. symbol (U)J"
7290 PRINT "PRE-DETERMINED PROCESS  (B)J"
7300 PRINT "COMMAND PROCESSOR symbol (S)","J","J"
7310 PRINT "The letter in parenthesis denotes the key to press to get"
7320 PRINT "the indicated symbol.  The symbol will be drawn from the"
7330 PRINT "tip of the pointer.  In addition to the listed symbols"
7340 PRINT "three functions have been included: ","J"
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
7350 PRINT "DELETE (E), PLOT (H), REDRAW (R)","J"
7360 PRINT "The DELETE (E) function will ask for the identifying letter"
7370 PRINT "and number of the symbol you wish to delete.  Key the "
7380 PRINT "proper identifying letter, press return and key the proper"
7390 PRINT "Number. To REDRAW the flowchart(Minus the deletions) key R"J"
7400 PRINT "The PLOT function copies the flowchart onto the 4662 "
7410 PRINT "plotter.J"
7420 PRINT "The pointer is controlled by the joystick controlJ"
7430 PRINT "To return to the rest of the Graphics Program key ""Q""J"
7440 PRINT "To see these instructions at any time key ""?""J"
7450 PRINT "The scale factor uniformly changes the size of all the"
7460 PRINT "symbols.  It cannnot be changed once it has been set at"
7470 PRINT "the beginning of the program.  "
7480 RETURN

7490 REM********  ARROW APPEND  *************************

7500 A1=1
7510 H=1
7520 S1=1.00000001
7530 PRINT "PLACE PEN AT THE PROPER END OF THE LAST LINE MADE AND"
7540 PRINT "DEPRESS CALL"
7550 INPUT @1,27:X,Y
7560 PRINT @1:"G";
7570 SET DEGREES
7580 GO TO 3760
7590 GO TO 350

7600 REM*******  SUBROUTINE CALL SEC  *****************

7610 U1=U1+1
7620 U(U1)=X
7630 U1=U1+1
7640 U(U1)=Y
7650 GOSUB 7670
7660 GO TO 2430
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
7670 REM******** SUBROUTINE CALL SUB  ****************

7680 MOVE @H:X,Y
7690 RDRAW @H:S1*7,Ø
7700 Z2=-45
7710 Z3=-135
7720 Z4=-6
7730 S1=S1/Ø.35
7740 GOSUB 257Ø
7750 RDRAW @H:-14*S1*Ø.35,Ø
7760 Z2=135
7770 Z3=45
7780 GOSUB 257Ø
7790 DRAW @H:X,Y
7800 S1=S1*Ø.35
7810 IF H=1 THEN 784Ø
7820 MOVE X,Y-2
7830 PRINT USING 255Ø:"u",U1/2
7840 RETURN

7850 REM****  PREDETERMINED PROCESS  SEC   ************

7860 B1=B1+1
7870 B(B1)=X
7880 B1=B1+1
7890 B(B1)=Y
7900 GOSUB 792Ø
7910 GO TO 243Ø

7920 REM****  PREDETERMINED PROCESS SUB   **************

7930 S1=S1+1.ØE-9
7940 GOSUB 325Ø
7950 S1=S1-1.ØE-9
7960 RMOVE @H:S1*8,Ø
```

TITLE	ABSTRACT NO:
ADVANCED MEDIA GRAPHICS Version 1.Ø	51/00-9516/0

```
7970 RDRAW @H:Ø,-S1*12
7980 RMOVE @H:-16*S1,Ø
7990 RDRAW @H:Ø,12*S1
8000 IF H=1 THEN 8030
8010 MOVE X,Y-3
8020 PRINT USING 2550:"B",B1/2
8030 RETURN
```

TEKTRONIX®
excellence in information display

4051 DEMO PROGRAM

TITLE		PART NUMBER
DIGITIZE AND DRAW		51/00-9520/0
ORIGINAL DATE	REVISION DATE	MEMORY REQUIREMENT
12/77		8K
AUTHOR Dr. R. J. Reimann Boise State University		PERIPHERALS 4662 Plotter Optional

ABSTRACT

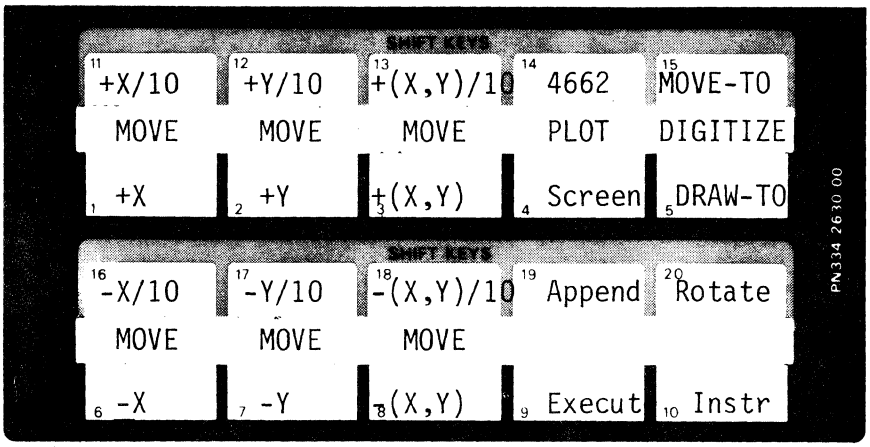
Using this program the user may easily draw figures or trace transparencies placed on the 4051 screen. The User Definable Keys are incorporated to move the cursor horizontally, vertically and diagonally, and digitize and store the selected points. The slope of diagonal movement may be altered. User Definable Keys also rotate the figure about a central axis, draw the figure and allow additions to the figure. Minimum resolution approximates that of the graphic display itself.

The points are stored in a binary data file for each stage of the drawing. Accumulated files are automatically linked together to reproduce the drawing. Output may be made to the screen or 4662 Plotter.

STATEMENTS: 175

TITLE	ABSTRACT NUMBER
DIGITIZE AND DRAW	51/00-9520/0

TITLE TAPE # FILE #



TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

TAPE STRUCTURE

The program file may reside on a separate tape from the binary data files; however, the data files for one figure must all reside on one tape. The binary data files must be pre-MARKed.*

Different stages of the drawing are stored in separate data files which are automatically linked to produce the composite figure.

OPERATION

Load the program file into the 4051. Insert your data tape. Type RUN.

Brief instructions are appended to the program including a summation of the User Definable Keys. These keys are used extensively and allow cursor movement horizontally, vertically and diagonally. The slope of diagonal movement may be altered by changing program steps 13 and 33.

Keys 1, 2, 3 and 6, 7, 8 are conveniently arranged for positive and negative deflection with step-size reduction by a factor of ten when the "SHIFT" key is used with these keys. The resulting resolution approximates that of the display itself.

User Definable Key 9 initializes parameters. UDK 5 and 15 store the DRAW-TO or MOVE-TO points. UDK 4/14 draw the figure. UDK 19 allows additions to the figure; 20 rotates the figure and 10 repeats the instruction set.

*Suggested length is 6144.

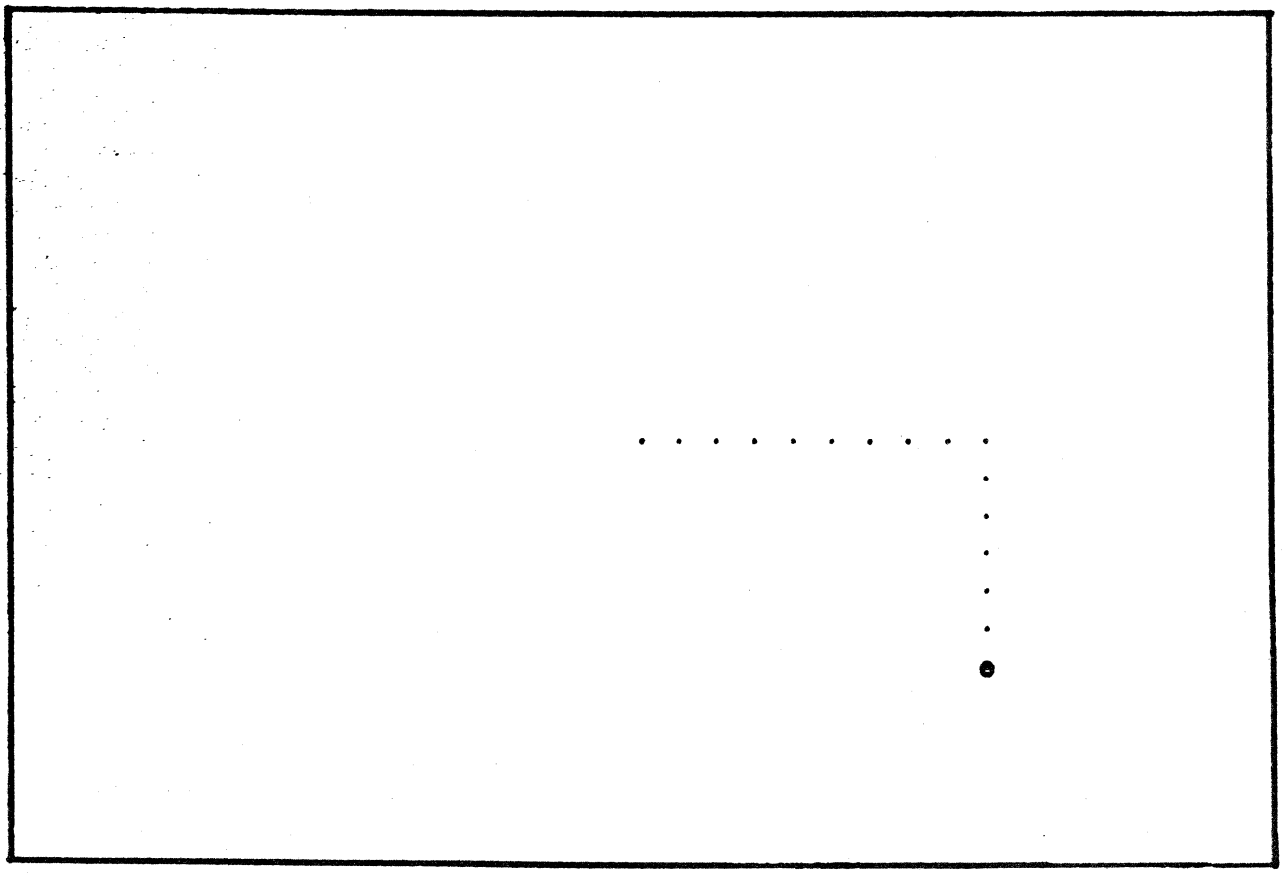
TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

EXAMPLE

In order to draw a figure such as a rectangle, the user would first press User Definable Key 9 to execute the program (initialize parameters), and when asked which file is desired for data storage, respond "2" and then "Y" or "YES" to verify.

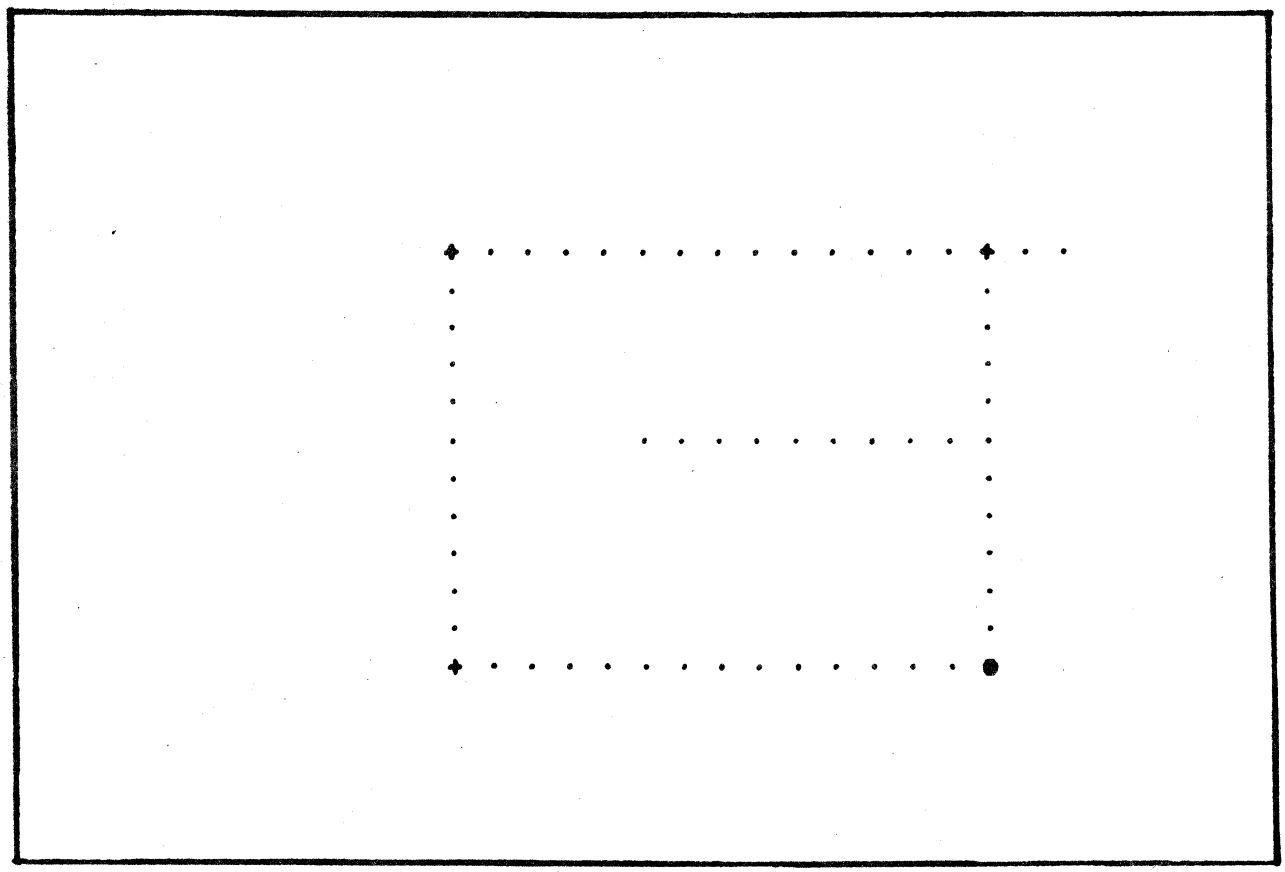
```
Enter desired file number for data set #1 = 2
Are you certain? Y
```

User Definable Keys 1, 2, 3, 6, 7 and 8 would then be used to position the cursor to the point where a corner of the desired rectangle is to originate and Key 15 pressed to digitize. The program responds with a "o" at that point to indicate a MOVE-TO point.



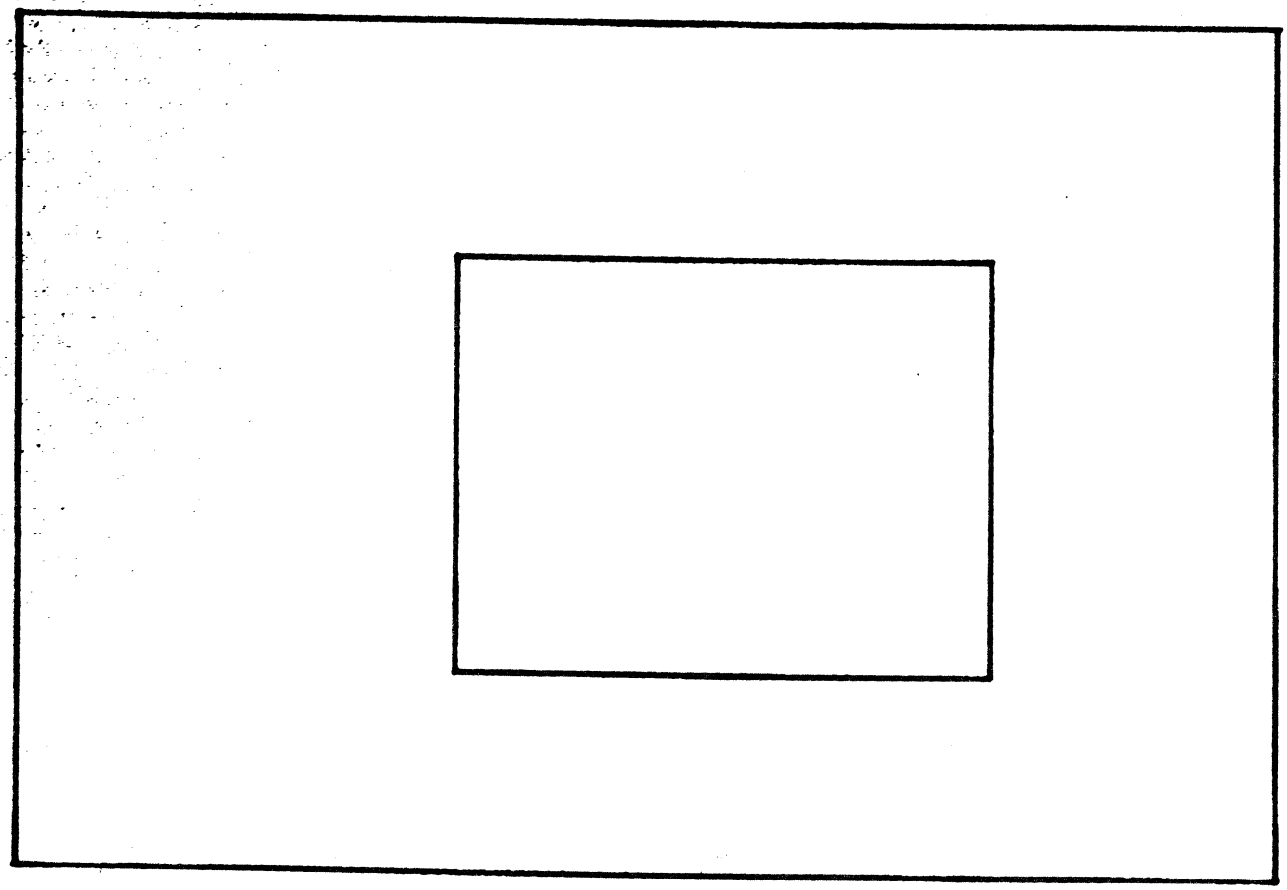
TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

The cursor is then moved to the desired location of each corner and Key 5 pressed to digitize each of the points to be connected. The program places a confirming "+" on these points. As all of the points are digitized, they are written to data file #2.



TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

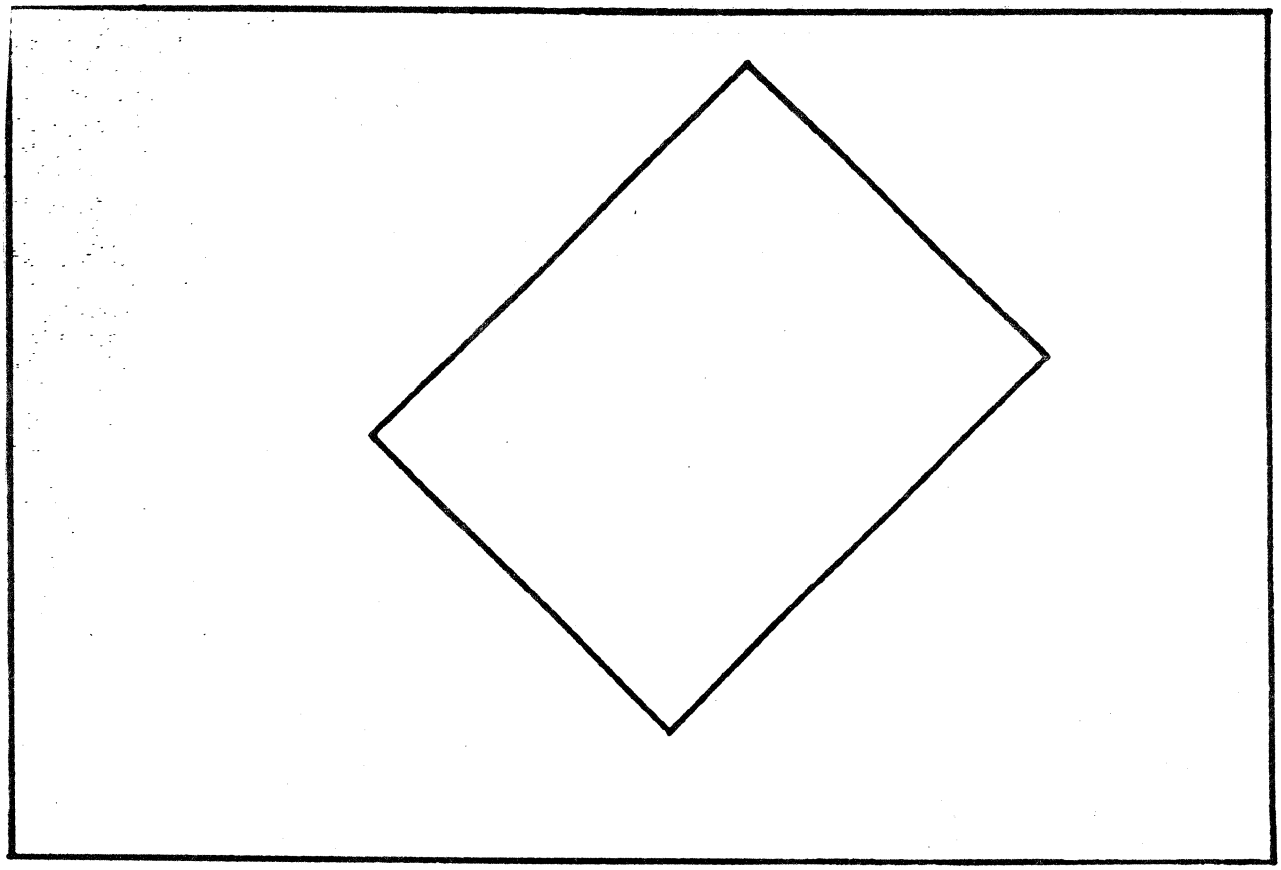
Upon completion of the drawing, Key 4 is pressed which pages the screen and reproduces the rectangle using the points from data file 2.



TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

The figure may be rotated if desired.

Enter desired rotation angle in degrees = 45



Use of Key 19 will add data points for the figure which are stored in a separate file and called automatically during the PLOT routine.

To retrieve data from the correct files, press UDK 9 and identify the main tape file. If no new points are to be added, press UDK 19 to identify each appendage to the drawing. The cumulative drawing can be reproduced at any stage by pressing UDK 4. Additions can also be made at any stage.

The user is encouraged to make drawings in stages with numerous small appendages since there is no provision for corrections other than redoing a complete appendage.

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
1 REM DIGITIZE & DRAW   (BSU 12/77)

2 RUN 1000
4 X=S
5 Y=0
6 RUN 340
8 X=0
9 Y=S
10 RUN 340
12 X=S
13 Y=S
14 RUN 340
16 D=32
17 RUN 600
18 RETURN
20 T4=0
21 RUN 480
24 X=-S
25 Y=0
26 RUN 340
28 X=0
29 Y=-S
30 RUN 340
32 X=-S
33 Y=-S
34 RUN 340
36 RUN 100
40 RUN 1000
44 X=S1
45 Y=0
46 RUN 340
48 X=0
49 Y=S1
50 RUN 340
52 X=S1
```

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
53 Y=S1
54 RUN 340
56 D=1
57 RUN 600
60 T4=1
61 RUN 480
64 X=-S1
65 Y=0
66 RUN 340
68 X=0
69 Y=-S1
70 RUN 340
72 X=-S1
73 Y=-S1
74 RUN 340
76 J=J+1
77 RUN 770
80 RUN 880
100 INIT
110 WINDOW -65,65,-50,50
120 DIM I(2),R(2),F(10)
130 I=0
140 R=0
150 F=0
160 A=0
170 J=1
180 S=4
190 S1=S/10
200 D=32
210 PAGE
220 GOSUB 790
230 PAGE
240 GOSUB 270
250 RDRAW 0,0
260 RETURN
270 MOVE -65,45
```

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
280 DRAW 65,45
290 DRAW 65,-45
300 DRAW -65,-45
310 DRAW -65,45
320 MOVE 0,0
330 RETURN

340 REM DISPLAY STEPPING SUBROUTINE

350 I(1)=I(1)+X
360 I(2)=I(2)+Y
370 IF ABS(I(1))<=64 AND ABS(I(2))<=44 THEN 420
380 PRINT "GG"
390 I(1)=I(1)-X
400 I(2)=I(2)-Y
410 GO TO 450
420 R(1)=R(1)+X
430 R(2)=R(2)+Y
440 RMOVE X,Y
450 RMOVE 0,0
460 RDRAW 0,0
470 RETURN

480 REM DIGITIZING SUBROUTINE

490 IF T4=0 THEN 540
500 RMOVE -0.56,-0.973
510 PRINT "o"
520 RMOVE 0.56,0.973
530 GO TO 570
540 RMOVE -0.56,-1.2
550 PRINT "+"
560 RMOVE 0.56,1.2
570 WRITE T4,R
580 R=0
590 RETURN
```

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
600 REM DRAW ROUTINE

610 PAGE
620 GOSUB 270
630 ROTATE A
640 FOR K=1 TO J
650     FIND F(K)
660     READ @33:T4,R
670     ON EOF (0) THEN 730
680     IF T4=1 THEN 710
690     RDRAW @D:R(1),R(2)
700     GO TO 660
710     RMOVE @D:R(1),R(2)
720     GO TO 660
730     R=0
740 NEXT K
750 A=0
755 ROTATE 0
760 RETURN

770 REM APPENDING DATA

780 HOME
790 PRINT "Enter desired file number for data set #";J;" = ";
800 INPUT F(J)
810 PRINT "Are you certain? ";
820 INPUT Y$
830 IF Y$="Y" OR Y$="YES" THEN 850
840 GO TO 790
850 FIND F(J)
860 MOVE I(1),I(2)
870 RETURN

880 REM ROTATION ROUTINE
```

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
890 SET DEGREES
900 HOME
910 PRINT "Enter desired rotation angle in degrees = ";
920 INPUT A
930 GOSUB 600
940 RETURN
1000 PAGE
1010 WINDOW -65,65,-50,50
1020 PRINT "PROGRAM INSTRUCTIONS:"
1030 PRINT
1040 PRINT "PROGRAM USES TEK 4051 SCREEN TO DRAW FIGURES AND"
1050 PRINT "DIGITIZE CHOSEN POINTS."
1060 PRINT
1070 PRINT "USER DEFINABLE KEYS ARE OUTLINED BELOW:"
1080 PRINT
1090 PRINT
1100 PRINT "  +X/10       +Y/10     (+X,+Y)/10  TEK 4662   MOVE-TO"
1110 PRINT "¦  MOVE  ¦ ¦  MOVE  ¦ ¦  MOVE  ¦ ¦  PLOT  ¦ ¦DIGITIZE¦"
1120 PRINT "    +X          +Y       (+X,+Y)     SCREEN    DRAW-TO"
1130 PRINT
1140 PRINT "---------------------USER DEFINABLE--------------------"
1150 PRINT
1160 PRINT "  -X/10       -Y/10     (-X,-Y)/10   APPEND   ROTATE FIG."
1170 PRINT "¦  MOVE  ¦ ¦  MOVE  ¦ ¦  MOVE  ¦ ¦         ¦ ¦         ¦"
1180 PRINT "    -X          -Y       (-X,-Y)     EXECUTE  INSTRUCTIONS"
1190 MOVE -65,25.7
1200 GOSUB 1310
1210 RMOVE -99,-3
1220 GOSUB 1310
1230 RMOVE -99,-14
1240 GOSUB 1310
1250 RMOVE -99,-3
1260 GOSUB 1310
1270 MOVE -65,-10
1280 PRINT "PRESS USER #9 TO EXECUTE"
1290 PRINT "          #10 TO REPEAT INSTRUCTIONS"
```

TITLE	ABSTRACT NO:
DIGITIZE AND DRAW	51/00-9520/0

```
1300 END
1310 FOR N=1 TO 5
1320     RDRAW 16.5,0
1330     RMOVE 3.3,0
1340 NEXT N
1350 RETURN
1360 END
```

TEKTRONIX®

4051

APPLICATIONS LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1
ORIGINAL DATE: Spring 1977 / REVISION DATE: Spring 1978	MEMORY REQUIREMENT: 8K
AUTHOR: Dr. R.J. Reimann, Physics Department, Boise State University	PERIPHERALS: 4662 Plotter (Optional)

ABSTRACT

Files: 12

Statements: 807

A second edition with an additional program and numerous improvements in the other programs. This is a program series, under the control of a directory, for the presentation of introductory astronomy and physics concepts to students with no computer experience. The series includes:

5 Ellipse--ellipses are drawn according to the user's choice of eccentricity. Kepler's first and second laws are illustrated.

6 Planetary Motion--the inner planets are initially aligned and then "race" in circular orbits according to Kepler's third law.

7 Binary Stars--circular orbits for binary systems are plotted using Kepler's third law. The user may select the masses and separation.

8 Stellar Magnitudes--relative apparent magnitudes (0-6) are drawn for stars under the assumption that brightness is proportional to area.

9 Phaser--a demonstration of the reference circle as related to simple harmonic motion.

10 Sidereal Time--a view of the Northern sky with sidereal clock is drawn according to the user's choice.

11 Solar Time--a view of the Northern sky is drawn according to the user's choice of date and time of day.

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

12 Satellite Orbit--earth satellite orbits are plotted using a 2-step iterative approximation of Newton's law of universal gravitation. User selects radial and tangential velocities with an optional choice of initial separation.

13 Trajectory--a 2-D trajectory is drawn using a 2-step iteration assuming drag is proportional to v^2. The plot is automatically scaled and labelled. The user selects velocity components v_x and v_y with an optional choice of drag coefficient.

14 Vector Combinations--addition of numerous 2-D vectors drawn head-to-tail. The plot is automatically scaled and the resultant is expressed in both rectangular and polar coordinates.

15 Linear Least-Squares Fit--user inputs number of data points and each x,y coordinate. The best fit to a straight line is calculated including standard errors. The plot is automatically scaled and "proper" "tic" marks are made on the axes. Hard copies are produced by pressing user definable #3 if a Tektronix model 4662 recorder is connected.

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

OPERATING INSTRUCTIONS

Insert the tape cartridge into 4051 and press the AUTO LOAD key. A table of contents will appear on the graphic display.

Select a program from the Table of Contents through the numeric keys located on the "typewriter" keyboard or the numeric key pad on the right, followed by pressing the RETURN key.

Each program has several functions, which are accessed by pressing function keys at the upper left of the 4051 keyboard. Do not confuse these with the numeric keys. The individual program will instruct the user on which function keys to use.

RUNNING A PROGRAM

Once a program is selected from the Table of Contents, function key #1 must be the first used to initialize the parameters.

The user enters data requested by the program through the numeric keys.

If the screen becomes full, keyboard entries will not be displayed, and a blinking "F" will appear in the upper left had corner of the screen. Press HOME/PAGE key to clear it and the program will continue.

You may return to the Table of Contents at any time by pressing the BREAK key twice, the pressing the AUTO LOAD key.

FILE STRUCTURE

This program consists of 11 files which are accessed from the Table of Contents on File 1. Therefore, it is necessary that the program always be allocated to Files 1 through 12 on the tape, or recode line 390 of the first file.

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM GRAPHICS DEMONSTRATIONS FOR ASTRONOMY & PHYSICS  (BSU 1/78)
2 REM TABLE OF CONTENTS

4 D=32
5 RUN 100

90 REM ********************************************
91 REM *** GRAPHICS DEMO FOR ASTRONOMY & PHYSICS ***
92 REM *** 51/00-5401/1                          ***
93 REM *** AUTHOR: DR. R. J.REIMANN, BOISE STATE ***
94 REM ********************************************

100 PAGE @D:
110 DIM L(24)
120 PRINT @D:"TABLE OF CONTENTS FOR MAGNETIC TAPE"
130 PRINT @D:
140 PRINT @D:"FILE   TITLE                      LENGTH"
150 PRINT @D:
160 FOR N=1 TO 7
170     L(N)=2000
180     READ T$
190     DATA "TABLE OF CONTENTS","ELLIPSE","PLANETARY MOTION","BINARY STARS"
200     DATA "STELLAR MAGNITUDES","PHASER","SIDEREAL TIME"
210     GOSUB 400
220 NEXT N
230 PRINT @D:
240 FOR N=8 TO 12
250     L(N)=6000
260     READ T$
270     DATA "SOLAR TIME","SATELLITE ORBITS","TRAJECTORY"
280     DATA "VECTOR COMBINATIONS","LINEAR LEAST SQUARES FIT"
290     GOSUB 400
300 NEXT N
310 PRINT @D:
320 PRINT
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
330 PRINT @D:"Enter desired file number and then press RETURN key ";
340 INPUT N
350 PAGE
360 FIND N
370 OLD
380 RUN
390 END

400 REM PRINTING SUBROUTINE

410 PRINT @D: USING 420:N,T$,L(N)
420 IMAGE 2D,2X,30A,4D
430 RETURN
440 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM ELLIPSE    (BSU 1/78)
2 REM ACKNOWLEDGMENT KARP - DARTMOUTH

3 RUN 1000
4 PAGE
5 RUN 100
8 T=0
9 RUN 260
12 T=1
13 RUN 260
20 D=1
21 RUN 130
40 PAGE
41 RUN 1000
100 INIT
110 D=32
120 C=0
130 T=0
140 SET DEGREES
150 SET KEY
160 WINDOW -65,65,-50,50
170 R0=40
180 MOVE @D:-0.5,-1.3
190 PRINT @D:"+"
200 FOR A=0 TO 360 STEP 10
210     MOVE @D:R0*COS(A),R0*SIN(A)
220     RDRAW @D:0,0
230 NEXT A
240 HOME
250 PRINT "GGENTER DESIRED ECCENTRICITY (0 < e < 1)"
260 C=C+1
270 IF C>9 THEN 4
280 MOVE -65,50-10*C
290 PRINT "e = ";
300 INPUT E
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
310 IF E<1 THEN 340
320 PRINT "UNBOUNDED"
330 GO TO 260
340 MOVE @D:E*R0,0
350 RDRAW @D:0,0
360 RMOVE @D:-4,-4
370 PRINT @D:E
380 IF T=1 THEN 550
390 A=0
400 I=10
410 R1=R0*(1-E)
420 X=R0
430 Y=0
440 IF A=>360 THEN 540
450 MOVE @D:X,Y
460 RDRAW @D:0,0
470 A=A+I
480 X=R0*COS(A)
490 Y=SQR(1-E↑2)*R0*SIN(A)
500 R2=SQR((X-E*R0)↑2+Y↑2)
510 I=R1*I/R2
520 R1=R2
530 GO TO 440
540 GO TO 590
550 FOR A=0 TO 360 STEP 10
560     MOVE @D:R0*COS(A),SQR(1-E↑2)*R0*SIN(A)
570     RDRAW @D:0,0
580 NEXT A
590 PRINT "GGG"
600 HOME
610 END
1000 PRINT "PROGRAM INSTRUCTIONS:"
1010 PRINT
1020 PRINT "ELLIPSES ARE PLOTTED ACCORDING TO DESIRED ECCENTRICITY"
1030 PRINT
1040 PRINT "KEPLER'S FIRST & SECOND LAWS ARE DEMONSTRATED"
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1050 PRINT
1060 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1070 PRINT "           #2 TO OVERLAP TRIALS"
1080 PRINT "           #3 FOR FAST DRAW WITHOUT KEPLER'S SECOND LAW"
1090 PRINT "           #5 FOR OUTPUT ON TEK 4662"
1100 PRINT "          #10 TO REPEAT INSTRUCTIONS"
1110 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM MOTIONS OF INNER PLANETS    (BSU 1/78)

2 RUN 1000
4 PAGE
5 RUN 100
8 D=1
9 RUN 110
40 RUN 1000
100 INIT
105 D=32
110 SET KEY
120 DIM P(4),R0(4),R1(4)
130 READ R0
140 DATA 0.387,0.723,1,1.524
150 P=R0↑(3/2)
160 R1=R0*30
170 WINDOW -65,65,-50,50
180 MOVE @D:0,0
190 PRINT @D:"S      M     V    E        MARS"
200 FOR N=1 TO 800
210 NEXT N
220 FOR T=0 TO P(3) STEP P(3)/52
230     FOR N=1 TO 4
240         MOVE @D:R1(N)*COS(2*PI*T/P(N)),R1(N)*SIN(2*PI*T/P(N))
250         RDRAW @D:0,0
260     NEXT N
270 NEXT T
280 HOME @D:
290 PRINT @D:"GGPLANET    AVE DIST FROM SUN    LENGTH OF YEAR"
300 PRINT @D:"              (IN A.U.)        (IN EARTH YEARS)"
310 FOR N=1 TO 4
320     PRINT @D: USING 330:N,R0(N),P(N)
330     IMAGE 2X,1D,12X,1D.3D,15X,1D.3D
340 NEXT N
350 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1000 PAGE
1010 PRINT "PROGRAM INSTRUCTIONS:"
1020 PRINT
1030 PRINT "Circular orbits for the inner planets are plotted using"
1040 PRINT "Kepler's 3rd law and a table of data is presented."
1050 PRINT
1060 PRINT "Time between points corresponds to 1 Earth week."
1070 PRINT
1080 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1090 PRINT "           #2 TO PLOT ON TEK 4662 IF AVAILABLE"
1100 PRINT "          #10 TO REPEAT INSTRUCTIONS"
1110 END
```

TITLE

GRAPHICS DEMONSTRATIONS FOR
ASTRONOMY AND PHYSICS

ABSTRACT NO:

51/00-5401/1

```
1 REM BINARY STARS   (BSU 7/76)

2 RUN 1000
4 RUN 100
8 RUN 160
40 RUN 1000
100 PAGE
110 INIT
120 SET KEY
130 PRINT "ENTER STAR MASSES AS MULTIPLES OF THE SOLAR MASS"
140 PRINT
150 C=0
160 C=C+1
170 PRINT "M1 = ";
180 INPUT M1
190 PRINT "M2 = ";
200 INPUT M2
210 PRINT "SEPARATION (A.U.) = ";
220 INPUT R
230 P=SQR(R^3/(M1+M2))
234 PRINT USING 235:P
235 IMAGE "PERIOD ="2D.1D" YEARS"
240 X2=R/(M2/M1+1)
250 X1=R-X2
260 IF C>1 THEN 290
270 S=4*R
280 WINDOW -1.3*S,1.3*S,-S,S
290 MOVE 0,0
300 RDRAW 0,0
310 FOR T=0 TO P STEP 1/52
320     A=2*PI*T/P
330     ROTATE A
340     RMOVE -X1,0
350     RDRAW 0,0
360     RMOVE X1,0
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
370     RMOVE X2,0
380     RDRAW 0,0
390     RMOVE -X2,0
400     ROTATE -A
410 NEXT T
420 MOVE -1.3*S,(1-(C+1)/4)*S
430 PRINT "GG"
440 END
1000 PAGE
1010 PRINT "PROGRAM INSTRUCTIONS:"
1020 PRINT
1030 PRINT "THIS PROGRAM PLOTS CIRCULAR ORBITS FOR BINARY SYSTEMS"
1040 PRINT "ACCORDING TO KEPLER'S THIRD LAW."
1050 PRINT
1060 PRINT "MASSES ARE EXPRESSED IN TERMS OF THE SUN'S MASS, AND"
1070 PRINT "SEPARATIONS ARE IN ASTRONOMICAL UNITS."
1080 PRINT "(1 A.U. = MEAN DISTANCE FROM EARTH TO SUN)"
1090 PRINT
1094 PRINT "TIME BETWEEN CONSECUTIVE POINTS REPRESENTS 1 WEEK"
1095 PRINT
1100 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1110 PRINT "           #2 TO OVERLAP RESULTS"
1120 PRINT "          #10 TO REPEAT INSTRUCTIONS"
1130 PRINT
1140 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM STELLAR MAGNITUDE  (BSU 6/76)

2 RUN 1000
4 PAGE
5 RUN 100
40 PAGE
41 RUN 1000
42 END
100 INIT
110 SET DEGREES
120 SET KEY
130 C=1
135 PRINT "  APPARANT STELLAR MAGNITUDES  (VIEW FROM 20 FEET)"
140 M$="6th MAGNITUDE"
150 GOSUB 400
160 M$="5th MAGNITUDE"
170 GOSUB 400
180 M$="4th MAGNITUDE"
190 GOSUB 400
200 M$="3rd MAGNITUDE"
210 GOSUB 400
220 M$="2nd MAGNITUDE"
230 GOSUB 400
240 M$="1st MAGNITUDE"
250 GOSUB 400
260 M$="0th MAGNITUDE"
270 GOSUB 400
280 HOME
290 PRINT "GG"
300 END

400 REM STELLAR DRAWING SUBROUTINE

410 Y=(C+1)↑2+20
420 MOVE 40,Y
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
430 PRINT M$
440 MOVE 80,Y
445 R=SQR(2.512↑C)/8
450 FOR A=0 TO 360 STEP 600/Y
460     ROTATE A
470     RDRAW R,0
471     RMOVE -R,0
475     ROTATE -A
480 NEXT A
485 C=C+1
490 RETURN
500 END
1000 PRINT "PROGRAM INSTRUCTIONS:"
1010 PRINT
1020 PRINT "RELATIVE APPARANT MAGNITUDES OF STARS ARE DRAWN ASSUMING"
1030 PRINT "THAT BRIGHTNESS IS PROPORTIONAL TO AREA."
1035 PRINT
1040 PRINT "PRESS USER #1 TO EXECUTE THE PROGRAM"
1045 PRINT "PRESS USER #10 TO REPEAT INSTRUCTIONS"
1050 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM PHASER DEMONSTRATION (BSU 6/76)

2 RUN 1000
4 PAGE
5 D=0
6 RUN 100
8 PAGE
9 PRINT "ADDITIONAL DELAY DESIRED IN SECONDS = ";
10 INPUT D
11 RUN 100
40 PAGE
41 RUN 1000

100 REM OPTIONS SELECTED--PROGRAM STARTS

110 SET KEY
120 SET DEGREES
130 WINDOW -65,65,-50,50
140 R=20
150 PRINT "DEMONSTRATION OF REFERENCE CIRCLE PHASER AND SINE WAVE"
155 MOVE 10,0
156 PRINT "TIME --->"
160 FOR A=0 TO 360 STEP 15
170     ROTATE A
180     MOVE -30,0
190     RDRAW R,0
200     MOVE A/10,R*SIN(A)
210     RDRAW 0,0

215     REM DELAY SUBROUTINE

220     FOR I=1 TO D*220
230     NEXT I
250     ROTATE -A
260 NEXT A
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
270 PRINT "GG"
280 END
1000 PRINT "PROGRAM INSTRUCTIONS"
1010 PRINT
1015 PRINT "THIS IS A DEMONSTRATION OF THE REFERENCE CIRCLE"
1016 PRINT
1020 PRINT "PRESS USER #1 TO RUN QUICKLY"
1030 PRINT "           #2 TO SELECT A DELAYED EXECUTION"
1040 PRINT "           #10 TO REPEAT INSTRUCTIONS"
1050 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM SIDEREAL TIME   (BSU 6/76)

2 RUN 1000
4 RUN 100
8 RUN 360
40 PAGE
41 RUN 1000
100 PAGE
110 INIT
120 SET KEY
130 SET DEGREES
140 WINDOW -65,65,-50,50
150 C=0

160 REM MARTIX(CONSTELLATION,STAR)

170 DIM X(3,7),Y(3,7),L(3,7)
180 READ X,Y,L

190 REM X(1,DATA)/X(2,DATA)/X(3,DATA)

200 DATA 0.444,-3.83,-4.138,-2.519,-2.734,-1.042,3.211
210 DATA 17.772,1.631,-7.414,-3.229,-5.725,-4.607,-5.796
220 DATA 18.859,4.634,1.34,3.722,1.771,0,0

230 REM Y(1,DATA)/Y(2,DATA)/Y(3,DATA)

240 DATA 0.864,-1.037,-2.163,-4.324,0.63,-5.485,0.022
250 DATA -15.553,-5.123,-3.832,3.364,-0.272,0.295,-3.609
260 DATA 67.336,2.169,-4.535,-0.649,-4.567,0,0

270 REM L(1,DATA)/L(2,DATA)/L(3,DATA)

275 DATA 0.3,0,0,0,0,0.2,0.2
280 DATA 0.6,0.6,0.6,0.3,0.6,0.6,0.6
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
290 DATA 0.3,0.3,0.3,0.1,0.3,0,0

292 REM LABELS

294 MOVE -65,-48
295 DRAW 65,-48
296 MOVE -30,-47
297 PRINT "N O R T H E R N     H O R I Z O N"
298 HOME
300 FOR N=1 TO 24
310     Z=N*15+90
320     MOVE 45*COS(Z),45*SIN(Z)
330     PRINT N
340 NEXT N
350 HOME
360 PRINT "SIDEREAL"
361 PRINT "TIME = ";
370 INPUT H
450 A=15*H
460 ROTATE A
470 MOVE 0,0
480 GOSUB 700
485 ROTATE -A
490 C=C+1
500 MOVE -65,50-C*20
510 END

700 REM DRAWING SUBROUTINE

705 FOR I=1 TO 3
710     FOR J=1 TO 7
715         RMOVE X(I,J),Y(I,J)
720         RDRAW L(I,J),C
730         RDRAW 0,L(I,J)
740         RDRAW -L(I,J),0
750         RDRAW 0,-L(I,J)
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
760     NEXT J
770 NEXT I
780 RETURN
1000 PRINT "PROGRAM INSTRUCTIONS:"
1010 PRINT
1015 PRINT "THIS PROGRAM IS TO AID IN UNDERSTANDING SIDEREAL TIME."
1016 PRINT
1020 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1030 PRINT "       USER #2 TO OVERLAP TRIALS"
1050 PRINT "       USER #10 TO REPEAT INSTRUCTIONS"
1060 PRINT
1070 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM SOLAR TIME      (BSU 1/78)

2 RUN 1000
4 PAGE
5 RUN 100
8 RUN 440
12 FOR N=1 TO 24
13     Z=N*15+90
14     MOVE @Z5:45*COS(Z),45*SIN(Z)
15     PRINT @Z5:N
16 NEXT N
17 END
40 RUN 1000
100 INIT
110 Z5=32
120 SET KEY
130 SET DEGREES
140 WINDOW -65,65,-50,50
150 C=0

160 REM MARTIX(CONSTELLATION,STAR)

170 DIM X(3,7),Y(3,7),L(3,7)
180 READ X,Y,L

190 REM X(1,DATA)/X(2,DATA)/X(3,DATA)

200 DATA 0.444,-3.83,-4.138,-2.519,-2.734,-1.042,3.211
210 DATA 17.772,1.631,-7.414,-3.229,-5.725,-4.607,-5.796
220 DATA 18.859,4.634,1.34,3.722,1.771,0,0

230 REM Y(1,DATA)/Y(2,DATA)/Y(3,DATA)

240 DATA 0.864,-1.037,-2.163,-4.324,0.63,-5.485,0.022
250 DATA -15.553,-5.123,-3.832,3.364,-0.272,0.295,-3.609
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
260 DATA 67.336,2.169,-4.535,-0.649,-4.567,0,0

270 REM L(1,DATA)/L(2,DATA)/L(3,DATA)

280 DATA 0.3,0,0,0,0,0.2,0.2
290 DATA 0.6,0.6,0.6,0.3,0.6,0.6,0.6
300 DATA 0.3,0.3,0.3,0.1,0.3,0,0

310 REM LABELS

320 MOVE @Z5:-65,-48
330 DRAW @Z5:65,-48
340 MOVE @Z5:-30,-47
350 PRINT @Z5:"N O R T H E R N     H O R I Z O N"
360 HOME @Z5:
370 PRINT @Z5:"MONTH (1-12) = ";
380 INPUT M
390 PRINT @Z5:"DAY (1-31) = ";
400 INPUT D
410 PRINT @Z5:"HOUR (0-24) =";
420 INPUT H
430 GO TO 540

440 REM OVERLAP FEATURE ENTERS HERE

450 C=C+1
460 IF C>4 THEN 4
470 MOVE @Z5:-65,50-C*20
480 PRINT @Z5:"MONTH = ";
490 INPUT M
500 PRINT @Z5:"DAY = ";
510 INPUT D
520 PRINT @Z5:"HOUR = ";
530 INPUT H
540 M=M-1
550 D=D-1
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
560 A=360*(M+D/30)/12-79.34
570 S1=6-1.5*SIN(A)
580 S2=18+1.5*SIN(A)
590 IF H<S1 OR H>S2 THEN 630
600 PRINT @Z5:"GGWARNING!  Sun is up between about";
610 PRINT @Z5: USING 620:S1,S2
620 IMAGE 2D.1D," and ",2D.1D," LOCAL STANDARD Time."
630 A=A+15*(H-12)
640 ROTATE A
650 MOVE @Z5:0,0
660 GOSUB 700
670 ROTATE -A
680 HOME
690 END

700 REM DRAWING SUBROUTINE

710 FOR I=1 TO 3
720     FOR J=1 TO 7
730         RMOVE @Z5:X(I,J),Y(I,J)
740         RDRAW @Z5:L(I,J),0
750         RDRAW @Z5:0,L(I,J)
760         RDRAW @Z5:-L(I,J),0
770         RDRAW @Z5:0,-L(I,J)
780     NEXT J
790 NEXT I
800 RETURN
1000 PAGE
1010 PRINT "PROGRAM INSTRUCTIONS:"
1020 PRINT
1030 PRINT "This program presents a veiw of the Northern sky from a"
1040 PRINT "latitude of approximately 40 degrees North according to"
1050 PRINT "the user's choice of date and time of day."
1060 PRINT
1070 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1080 PRINT "       USER #2 TO OVERLAP TRIALS"
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1090 PRINT "      USER #3 TO DRAW SIDEREAL CLOCK"
1100 PRINT "      USER #10 TO REPEAT INSTRUCTIONS"
1110 PRINT
1120 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM SATELLITE ORBITS USING NEWTON'S LAWS   (BSU 1/78)

2 RUN 1000
4 RUN 100
8 PRINT
9 RUN 310
12 PAGE
13 PRINT "INITIAL DISTANCE FROM CENTER OF EARTH IN KM = ";
14 INPUT R9
15 RUN 200
40 RUN 1000
100 PAGE
110 INIT
120 P=2115
130 SET KEY
140 SET DEGREES

150 REM MATRIX(SPACE,TIME)

160 DIM S(2,2),V(2,2),A(2,2),R(2)
170 R0=6380
180 R9=5*R0
190 R0=R0*1000
200 WINDOW -1.3E+8,1.3E+8,-1.0E+8,1.0E+8
210 G=3.99E+14
220 T=1800
230 C=0
240 MOVE R0,0
250 FOR X=0 TO 360 STEP 20
260     DRAW R0*COS(X),R0*SIN(X)
270 NEXT X
280 HOME
290 PRINT
300 PRINT "ENTER VELOCITIES IN KM/SEC"
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
310 REM

320 C=C+1
330 MOVE R9*1000,0
340 RDRAW 0,0
350 MOVE -1.3E+8,1.0E+8*(1-C/3)
360 PRINT "RADIAL VEL = ";
370 INPUT V1
380 PRINT "TANGENTIAL = ";
390 INPUT V2
400 V(1,1)=V1*1000
410 V(2,1)=V2*1000
420 S(1,1)=R9*1000
430 S(2,1)=0
440 MOVE S(1,1),S(2,1)
450 RDRAW 0,0
460 FOR J=1 TO 2
470     R(J)=SQR(S(1,J)↑2+S(2,J)↑2)
480     IF R(J)<R0 OR R(J)>1.1E+8 THEN 600
490     FOR I=1 TO 2
500         A(I,J)=-G*S(I,J)/R(J)↑3
510         S(I,2)=S(I,1)+V(I,1)*T+A(I,1)*T↑2/2
520     NEXT I
530 NEXT J
540 FOR I=1 TO 2
550     A(I,1)=(A(I,1)+A(I,2))/2
560     S(I,1)=S(I,1)+V(I,1)*T+A(I,1)*T↑2/2
570     V(I,1)=V(I,1)+A(I,1)*T
580 NEXT I
590 GO TO 440
600 MOVE -1.3E+8,1.0E+8*(1-C/3)
610 PRINT
620 PRINT
630 IF R(J)>R0 THEN 660
640 PRINT "GGGYOU CRASHED!"
650 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
660 PRINT "GESCAPED THE"
670 PRINT "ESTABLISHED LIMITS"
680 END
1000 PAGE
1010 PRINT "PROGRAM INSTRUCTIONS:"
1020 PRINT
1030 PRINT "Earth satellite  orbits are plotted using an approximation"
1040 PRINT "of Newton's law of universal gravitation.  Spiral orbits"
1050 PRINT "indicate a break-down of the approximation."
1060 PRINT
1070 PRINT "Time between points represents 30 minutes"
1080 PRINT
1090 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1100 PRINT "           #2 TO OVERLAP TRIALS"
1110 PRINT "           #3 TO SELECT A DIFFERENT INITIAL SEPARATION"
1120 PRINT "              (7000 TO 100,000 KM IS REASONABLE)"
1130 PRINT
1140 PRINT "           #10 TO REPEAT INSTRUCTIONS"
1150 PRINT
1160 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM TRAJECTORY WITH DRAG    (BSU 5/77)

2 RUN 1000
4 RUN 100
8 GOSUB 90
9 GOSUB 190
10 GOSUB 95
11 RUN 393
12 PAGE
13 PRINT "DESIRED DRAG COEFFICIENT = ";
14 INPUT D
15 RUN 160
40 RUN 1000
90 VIEWPORT 0,120,0,100
91 WINDOW 0,120,0,100
92 MOVE 0,100-C*20
93 RETURN
95 Y0=Y9
96 VIEWPORT 20,120,0,100
97 WINDOW -S9*0.2,S9*1.8,-S9*0.2,S9*1.8
98 RETURN
100 INIT
110 PAGE
120 SET KEY
130 SET DEGREES
140 DIM S(2),V(2),A(2)
150 D=0
160 PRINT "ELEVATION (0-99 METERS) = ";
165 C=0
170 INPUT Y0
175 Y9=Y0
180 PRINT "INITIAL VELOCITIES (0-99 M/SEC):"
190 PRINT "Vx = ";
200 INPUT V1
210 PRINT "Vy = ";
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
220 INPUT V2
222 IF C=0 THEN 230
225 RETURN
230 G=9.8

235 REM AUTO-SCALE

240 T1=ABS(2*V2/G)
250 S2=1.2*(Y0+V2*T1-G*T1↑2/2)
260 T2=ABS((+V2+SQR(V2↑2+2*G*Y0))/G)
270 S1=V1*T2*1.2
275 S9=S1 MAX S2 MAX 5
278 VIEWPORT 20,120,0,100
280 WINDOW -S9*0.2,S9*1.8,-S9*0.2,S9*1.8
290 S3=INT(S9/5)
295 AXIS S3,S3
300 FOR N=0 TO 5*S3 STEP S3
310     MOVE N-S3/2,-S9/10
320     PRINT USING 330:N
330     IMAGE 4D.1D
340 NEXT N
350 FOR N=0 TO 5*S3 STEP S3
360     MOVE -S3*1.2,N
370     PRINT USING 330:N
380 NEXT N
390 T=T2/20
393 X0=0
395 MOVE X0,Y0
396 RDRAW 0,0
400 A1=-SGN(V1)*D*V1↑2
410 A2=-SGN(V2)*D*V2↑2-G
420 V(1)=V1+A1*T
430 V(2)=V2+A2*T
440 A(1)=-SGN(V(1))*D*V(1)↑2
450 A(2)=-SGN(V(2))*D*V(2)↑2-G
460 V(1)=V1+A(1)*T
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
470 V(2)=V2+A(2)*T
480 S(1)=X0+(V1+V(1))*T/2
490 S(2)=Y0+(V2+V(2))*T/2
500 X0=S(1)
510 Y0=S(2)
512 V1=V(1)
513 V2=V(2)
520 IF S(2)>0 THEN 395
530 PRINT "GGG"
540 C=C+1
550 END
1000 PAGE
1010 PRINT "PROGRAM INSTRUCTIONS:"
1020 PRINT
1030 PRINT "TRAJECTORIES ARE PLOTTED WITH OR WITHOUT AIR RESISTANCE."
1040 PRINT
1050 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
1060 PRINT "            #2 TO OVERLAP TRIALS"
1070 PRINT "            #3 TO SELECT A DRAG COEFFICIENT"
1080 PRINT "            #10 TO REPEAT INSTRUCTIONS"
1090 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM VECTOR ADDITION  (BSU 1-77)

2 RUN 990
4 PAGE
5 RUN 100
40 RUN 990
100 INIT
110 SET DEGREES
120 SET KEY
130 PRINT "NUMBER OF VECTORS TO BE COMBINED = ";
140 INPUT N
150 DIM X(N),Y(N)
160 PRINT
170 PRINT
180 PRINT "VECTOR  X-COMPONENT      Y-COMPONENT"
190 FOR I=1 TO N
200     U=90-5*I
210     MOVE 3,U
220     PRINT I
230     MOVE 20,U
240     INPUT X(I)
250     MOVE 50,U
260     INPUT Y(I)
270 NEXT I

280 REM PRINT DATA ENTERED

290 PAGE
300 FOR I=1 TO N
310     PRINT
320     PRINT "S(";I;") = (";X(I);",";Y(I);")"
330 NEXT I

340 REM AUTO-SCALE THE DRAWING
```

TITLE

GRAPHICS DEMONSTRATIONS FOR
ASTRONOMY AND PHYSICS

ABSTRACT NO:

51/00-5401/1

```
350 P1=0
360 P2=0
370 M1=0
380 M2=0
390 FOR I=1 TO N
400     IF X(I)>0 THEN 430
410     M1=M1-X(I)
420     GO TO 440
430     P1=P1+X(I)
440     IF Y(I)>0 THEN 470
450     M2=M2-Y(I)
460     GO TO 480
470     P2=P2+Y(I)
480 NEXT I

490 REM CHOOSE LARGEST EXCURSION

500 E=P1 MAX M1
510 E=E MAX M2
520 E=E MAX P2
530 E=1.2*E
540 VIEWPORT 20,120,0,100
550 WINDOW -E,E,-E,E
560 R1=0
570 R2=0
580 FOR I=1 TO N
590     MOVE R1,R2
600     R1=R1+X(I)
610     R2=R2+Y(I)
620     DRAW R1,R2
630     GOSUB 860
640     FOR J=1 TO 210
650     NEXT J
660 NEXT I
670 MOVE 0,0
680 FOR J=1 TO 5
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
690     RDRAW R1/10,R2/10
700     RMOVE R1/10,R2/10
710 NEXT J
720 WINDOW 0,130,0,100
730 VIEWPORT 0,130,0,100
740 MOVE 0,U-6
750 PRINT "RESULTANT = (";R1;",";R2;")"
760 PRINT
770 R=SQR(R1↑2+R2↑2)
780 PRINT USING 785:R
785 IMAGE "MAGNITUDE =",4D.D
790 T=ACS(R1/R)
800 IF R2=>0 THEN 840
810 IF R1<0 THEN 830
820 T=360-T
825 GO TO 840
830 T=T+90
840 PRINT USING 845:T
845 IMAGE "THETA = ",3D.D
850 END

860 REM ARROWHEAD SUBROUTINE

870 A=ATN(Y(I)/(X(I)+1.0E-6))
880 IF X(I)=>0 THEN 900
890 A=A+180
900 ROTATE A
910 H1=E/40
920 H2=H1/2
930 RDRAW -H1,H2
940 RMOVE H1,-H2
950 RDRAW -H1,-H2
960 ROTATE 0
970 RETURN
980 END
990 PAGE
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1000 PRINT "PROGRAM INSTRUCTIONS:"
1010 PRINT
1020 PRINT "THIS PROGRAM ALLOWS ADDITION OF ANY NUMBER OF VECTORS"
1030 PRINT "BY THE HEAD-TO-TAIL TECHNIQUE"
1040 PRINT
1050 PRINT "PRESS USER #1 TO EXECUTE"
1060 PRINT
1070 PRINT "           #10 TO REPEAT INSTRUCTIONS"
1080 END
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1 REM LINEAR LSF   (BSU 1/78)

2 RUN 2000
4 RUN 100
8 RUN 260
12 GOSUB 1080
13 RUN 270
40 RUN 2000
100 INIT
110 PAGE
120 SET KEY
130 PRINT "NUMBER OF DATA PTS = ";
140 INPUT N
150 DIM X(N),Y(N)
160 PRINT
170 FOR I=1 TO N
180     P=95-4*I
190     MOVE 0,P
200     PRINT "X(";I;") = ";
210     INPUT X(I)
220     MOVE 30,P
230     PRINT "Y(";I;") = ";
240     INPUT Y(I)
250 NEXT I
260 D=32

270 REM CALCULATE BEST FIT

280 X1=0
290 Y1=0
300 X2=0
310 Y2=0
320 Z=0
330 FOR I=1 TO N
340     X1=X1+X(I)
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
350     Y1=Y1+Y(I)
360     X2=X2+X(I)↑2
370     Y2=Y2+Y(I)↑2
380     Z=Z+X(I)*Y(I)
390 NEXT I
400 D1=N*X2-X1↑2
410 IF D1=0 THEN 530
420 A=(Y1*X2-X1*Z)/D1
430 B=(N*Z-X1*Y1)/D1
440 E8=1.0E+99
450 E9=1.0E+99
460 IF N<3 THEN 560
470 E1=(N*X2-X1↑2)/(N*(N-1))
480 E2=(N*Y2-Y1↑2)/(N*(N-1))
490 E3=(N-1)*(E2-B↑2*E1)/(N-2)
500 E8=SQR(E3/E1)*SQR(X2/(N*(N-1)))
510 E9=E8*SQR(N/X2)
520 GO TO 560
530 PRINT "NONAPPLICABLE DATA,"
540 PRINT "PROGRAM TERMINATED!"
550 END

560 REM AUTO-SCALE AND DRAW AXIS

570 PAGE @D:
580 PRINT @D:
590 PRINT @D:"DATA POINTS"
600 PRINT @D:"(X,Y)"
610 L1=0
620 L2=0
630 FOR I=1 TO N
640     PRINT @D:X(I);", ";Y(I)
650     L1=L1 MAX X(I)
660     L2=L2 MAX Y(I)
670 NEXT I
680 PRINT @D:
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
690 PRINT @D:"SLOPE ="
700 PRINT @D: USING 790:B
710 PRINT @D:"STD ERROR ="
720 PRINT @D: USING 780:E9
730 PRINT @D:
740 PRINT @D:"INTERCEPT ="
750 PRINT @D: USING 790:A
760 PRINT @D:"STD ERROR ="
770 PRINT @D: USING 780:E8
780 IMAGE 1E
790 IMAGE 2E
800 S1=1.1*L1
810 S2=1.1*L2
820 VIEWPORT 20,120,0,100
830 WINDOW -S1/10,S1,-S1/10,S2
840 A1=10↑INT(LGT(L1))
850 A2=10↑INT(LGT(L1))
860 IF ABS(LGT(L1)-INT(LGT(L1)))>0.5 THEN 880
870 A1=A1/5
880 IF ABS(LGT(L2)-INT(LGT(L2)))>0.5 THEN 900
890 A2=A2/5
900 AXIS @D:A1,A2
910 S3=S1/50
920 S4=S2/50
930 FOR I=1 TO N
940     MOVE @D:X(I),Y(I)
950     RDRAW @D:0,0
960     RMOVE @D:0,S4/2
970     RDRAW @D:S3/2,0
980     RDRAW @D:0,-S4
990     RDRAW @D:-S3,0
1000     RDRAW @D:0,S4
1010     RDRAW @D:S3/2,0
1020     RMOVE @D:0,-S4/2
1030 NEXT I
1040 MOVE @D:0,A
```

TITLE	ABSTRACT NO:
GRAPHICS DEMONSTRATIONS FOR ASTRONOMY AND PHYSICS	51/00-5401/1

```
1050 DRAW @D:S1,A+B*S1
1060 HOME @D:
1070 END

1080 REM HARD COPY SUBROUTINE

1090 D=1
1100 PAGE
1110 PRINT "ENTER DESIRED LABEL FOR X-AXIS"
1120 INPUT X$
1130 PRINT
1140 PRINT "ENTER DESIRED LABEL FOR Y-AXIS"
1150 INPUT Y$
1160 MOVE @D:S1/10,-S2/20
1170 PRINT @D:X$
1180 SET DEGREES
1190 PRINT @D,25:90,90
1200 MOVE @D:-S1/20,S2/10
1210 PRINT @D:Y$
1220 PRINT @D,25:0,0
1230 RETURN
2000 PAGE
2010 PRINT "PROGRAM INSTRUCTIONS"
2020 PRINT
2030 PRINT "The best fit to a straight line is determined."
2040 PRINT "Standard errors are quoted."
2050 PRINT
2060 PRINT "PRESS USER #1 TO EXECUTE PROGRAM"
2070 PRINT "           #2 AFTER CORRECTING ANY DATA"
2080 PRINT "           #3 FOR HARDCOPY PLOT IF TEK 4662 AVAILABLE"
2090 PRINT "          #10 TO REPEAT INSTRUCTIONS"
```

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TEKTRONIX®

APPLICATION LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0
	MEMORY REQUIREMENT
	32K
AUTHOR	PERIPHERALS
Michael Poe	None

ABSTRACT

This program graphically plots on the screen of the Tektronix 4051 the contents of any M X N matrix. This matrix is entered and can be corrected with the program. There are 6 different methods of data presentation, two of which are in three dimensional perspective. A default viewpoint is calculated for each 3D plot, but the user may rotate the plot or change the perspective.

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INPUT

This program is controlled by choosing an operation by number from a menu that appears on the screen. The first menu viewed by the operator is called the general menu in this documentation, see figure 1.

When an operation is to be chosen, a blinking question mark will appear on the screen. To choose an operation, type in the number corresponding to the operation desired, and then push the RETURN key.

Data may be entered, changed, and corrected with this program. To enter data into an array, choose operation #7: Data Entry from the general menu.

The program also allows selection of operations from auxiliary menus, see figures 13 and 18.

OUTPUT

This program can create six different types of data plots.

1. 3D HISTOGRAM

   The value of each cell of a matrix is represented by the height and diameter of a box located in a matrix grid.

2. 3D POINT PLOT

   The value of each cell of a matrix is represented by a point above that cell and by lines connected to it from neighboring cells.

3. RANGED CELL GRAPH (not 3D)

   The value of a cell is represented by the diameter of the square inside it. The range, not the sign, is represented. The cell with the smallest value does not have a square inside it. The cell with the largest value has the largest square inside it.

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4. SIGNED CELL GRAPH (not 3D)

   The value of a cell is represented by the diameter of the polygon inside it. A negative number is denoted by a triangle, a positive number by a square. A value of zero denotes an empty cell.

5. BAR HISTOGRAM (not 3D)

   The value of each cell is represented by the height of a vertical bar.

6. POINT PLOT (not 3D)

   The value of each cell is represented by the height of a point, and this point is connected with lines to neighboring points within the same row or column.

HARDWARE REQUIREMENTS

This program requires a Tektronix 4051 with at least 16K of memory, which will allow an array of up to 7 X 7 to be stored. A larger memory size will allow much larger arrays to be plotted.

PROGRAM LIMITATIONS

A. MEMORY LIMITATIONS (see III above)

B. PERSPECTIVE LIMITATIONS

   The perspective algorithm will fail if the viewpoint is too close to the array to be plotted, or if the viewpoint is exactly above the center of the array.

METHODOLOGY n/a

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OPERATING HINTS

If a viewpoint is to be chosen for a 3D plot of a large size array, first make a signed cell graph (mode 4) to help in the determination of the ideal viewpoint. This will save time because 3D plots take much longer to make then non 3D plots.

REFERENCES n/a

MAN/MACHINE INTERFACE n/a

OPERATING INSTRUCTIONS

A. LOADING THE PROGRAM

To load the program, key in FIND followed by the file number of the program and press the return key. Then key in OLD, depress the RETURN key, key in RUN, and press the RETURN key again. The starting menu of figure 1 should appear on the screen.

If desired, a driving program to create an array may be keyed in between steps 100 and 4999. When the general menu is on the screen press the BREAK key twice, type in 100, 10 and press AUTO NUMBER key # 1. Type in your code. A call to the plot program may be made from the driving program with a "GOSUB 5005" step, or by pressing USER DEFINABLE key #1. When finished, press the AUTO NUMBER key again, then key in "RUN 100" followed by pressing the RETURN key.

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B. EXAMPLE OF RUNNING THE PROGRAM

1. THE GENERAL MENU

The menu of figure 1 is presented when the program is ready to operate in a new mode. A flashing question mark is generated in the top left quarter of the screen. Type in the number of the desired mode followed by pressing the RETURN key to operate the program. In this example, 7, for data entry, was entered.

2. DATA ENTRY

When data entry is chosen, the screen is cleared, and the array dimension statements of figure 2 are printed on the screen. In this example, an array size of 2 rows by 5 columns was used. Each size number was keyed in, followed by pressing RETURN after each number. The screen will then look like figure 3. Each data point is keyed in and followed by pressing RETURN. When the array is filled, the screen will look like figure 4. At the end of data entry, the screen is automatically cleared, and the general menu of figure 1 is again printed.

3. RANGED CELL GRAPH

By choosing mode #3, ranged cell graph, figure 5 was plotted. The program may plot the Y direction (columns) either vertically or horizontally to make maximum use of screen space. In this case, the rows (X) are plotted vertically, and the columns (Y) are plotted horizontally. The largest subscript numbers of each dimension are labeled where the subscript number of the opposite dimension is at its smallest value. In this case, the columns (Y) range from 1 on the left to 5 on the right. Row 1 is on the top and row 2 is on the bottom.

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The largest number is in cell (1,2) and the smallest is in cell (1,5) in this example. To return to the general menu, the USER DEFINABLE key #1 is pressed.

4. SIGNED CELL GRAPH

When mode #4, signed cell graph was chosen from the general menu, figure 6 was obtained. This graph is labeled in the same manner as the ranged cell graph. Squares represent positive numbers, and triangles represent negative numbers. The magnitude of the number is proportional to the diameter of the polygon. In this example, the number in row (X) 1, column (Y) 5, or (1,5) is negative. To return to the general menu, the USER DEFINABLE key #1 is pressed.

5. BAR HISTOGRAM

Mode #5, bar histogram, was used to create figure 7. Either rows (X) or columns (Y) will be plotted horizontally, depending on array dimensions, to make maximum use of screen space. In this example of figure 7, the columns (Y) were plotted horizontally. The thickness of the bars at each horizontal position represent the other dimension of the array. In this case, the thickness represents the rows of X dimension. The slimmest bars represent the cells of the array with the low row (X) or column (Y) numbers. The height of the bar represents the value of the array element. The horizontal line has a value of zero. In this example, the only negative value in the array occurs in row 1, column 5 (1,5). The general menu can be placed on the screen by pressing USER DEFINABLE key #1.

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6. POINT PLOT

The point plot, mode #6, was used to create figure 8. Either rows or columns may be plotted horizontally to use the screen area most effectively. In this case, the columns were plotted horizontally, because in this example there were more columns then rows. The horizontal line has a value of zero. The value of the array cells is represented by the height of a point in relation to the zero line. The points of either each row or each column are connected with lines. The general menu can be called by pressing USER DEFINABLE key #1.

7. 3D POINT PLOT

A 3D point plot can be created by choosing mode #2, an example of which is illustrated in figure 9. The grid represents a value of zero. The value of each of the cells is represented by the height of a point above or below the grid. Each of these points is connected to its neighbors in a checkerboard fashion. The viewpoint for a three dimensional plot is usually determined automatically, as it was for this figure. The X and Y axes are labeled in the same way for every three dimensional plot. The X is placed where the X (row #) is maximum, and the Y (column#) is minimum. In this example it is placed at (2,1). The Y is placed where the Y (column #) is maximum and the X (row #) is minimum, in this example at (1,5). The position of the origin may be determined by the orientation of the X and Y labels. Two lines, drawn through the center of each of the letters, and oriented horizontally to each of these letters, will intersect at the origin. In this example, the origin is in the upper center of the plot.

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8. 3D HISTOGRAM

Selecting mode #1 from the general menu causes a 3D histogram to be created (see figure 10). The method of drawing the grid and labeling the axes is identical to that of the 3D point plot. The grid has a value of zero. The value of an element of the array is represented by both the height of the box above or below the grid and by the diameter of the box. Note that in this example, element (1,5) is negative.

9. ROTATION OF 3D VIEWPOINT

In this example, the 3D histogram is used to illustrate the rotation of viewpoint. Mode 11: change of perspective is chosen from the general menu for this purpose. When it is chosen, figure 11 appears on the screen. In this example, a counterclockwise rotation of the graph is used. The number 2 is keyed in followed by pressing RETURN for this type of rotation. The general menu will then be printed on the screen. If mode 2: 3D histogram is chosen, then figure 12 will be plotted on the screen. Notice that this is the same plot as figure 10, only rotated. Clockwise rotation is used in a similar manner.

10. To choose exactly a viewpoint for a three dimensional plot, select mode 11: change of perspective from the general menu. Mode 3: choose viewpoint is then chosen from the change of perspective menu. Figure 13 is then printed on the screen. The flashing question mark indicates that data is needed. The X,Y, and Z values of the desired viewpoint, in this case (0,3,3), is entered by typing in each number followed by pressing RETURN after each number, see figure 14. The general menu is then printed on the screen. If the 3D histogram is then selected from it, in this example the resulting data plot is figure 15. The general menu is replaced on the screen by pressing USER DEFINABLE key #1.

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If, for example, a different viewpoint is desired, then choose mode 11: change of perspective from the general menu. Data is entered in the same way as above, in this example the viewpoint (0,0,3) was desired, see figure 16. The same 3D histogram from this new perspective is shown in figure 17.

11. COMPARISON OF TWO ROWS OR COLUMNS OF DATA

To compare two rows or columns of data, select mode 10: comparison of two rows or columns from the general menu. The menu of figure 18 is then printed on the screen. In this example, 2 was keyed in followed by pressing RETURN, so that two columns would be compared. The row and column numbers are each keyed in followed by pressing the RETURN key for each number. The numbers do not have to be in ascending order. Do not type the "and" that is illustrated in figure 18, as this is printed by the program. The program will then return to the general menu. In this example, if 3D histogram is then chosen, then figure 19 will be plotted.

12. SELECTION OF PART OF AN ARRAY

Mode #9: selection of part of array allows truncation of part of the array for plotting. Enter the range of the rows (X) and columns (Y) of the plot by keying in the numbers and pressing RETURN after each number, see figure 20. The word "to" of figure 20 should not be typed in, as it is printed by the program. In this example, rows 1 to 2 and columns 2 through 4 will be plotted. After the numbers are entered, the general menu will be printed. If a 3D histogram is plotted, as in this example, it would look like figure 21.

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VARIABLE MAP

DATA STRUCTURES

VARIABLE	TAPE FILE	USAGE
A		The data array. Its dimensions are X8 by Y8. The plotted region of the array ranges from X7 to X8, and from Y7 to Y8. The number of plotted cells per side is X6 by Y6.
C		Center of the three dimensional plot.
S		Distance of the projection plane from the center of a 3D plot in the direction of the viewpoint, or used as a scratch variable.
SØ		Diameter of the plotted polygon.
S1		Number of sides of the plotted polygon.
S2		Mode of the plotting program.
S3		Rotation of plotted polygon.
S4		Tag to draw legs on polygon. yes≠Ø no=Ø
S5		Tag to autoscale 3D plot. yes≠Ø no=Ø
S6		Scratch variable
S7		Scratch variable
S8		Scratch variable
S9		Scratch variable

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THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

VARIABLE MAP

DATA STRUCTURES

VARIABLE	TAPE FILE	USAGE
T		Target 3D point to be transformed to 2D.
T1		Origin of 3D plot.
T2		Normal vector of 3D transform.
T3		3D point to be transformed or scratch variable.
T4		X unit vector.
T5		Y unit vector.
T7		Scratch variable
T8		Scratch variable
T9		Scratch variable.
V		Viewpoint for 3D plot.
X		X value of 2D point to be plotted.
XØ		X value of center of 3D plot.
X1		Scratch variable.
X4		X value of 3D viewpoint
X5		Center of plotted 3D grid.

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VARIABLE MAP

DATA STRUCTURES

VARIABLE	TAPE FILE	USAGE
X6		Number of cells in the X dimension.
X7		Start of plotted array in the X dimension.
X8		End of plotted array in the X dimension.
X9		X value to be plotted.
Y		Y value of 2D point to be plotted.
YØ		Y value of center of 3D plot.
Y1		Scratch variable.
Y4		Y value of 3D viewpoint.
Y5		Center of plotted 3D grid.
Y6		Number of cells in the Y dimension.
X7		Start of plotted array in the Y dimension.
Y8		End of plotted array in the Y dimension.
Y9		Y value to be plotted.
Z		Scratch variable.
ZØ		Z value of center of 3D plot.

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VARIABLE MAP

DATA STRUCTURES

VARIABLE	TAPE FILE	USAGE
Z1		Scratch variable.
Z2		Minimum array value
Z3		Maximum array value.
Z4		Z value of 3D viewpoint.
Z6		Scratch variable.
Z7		Scratch variable.
Z8		Scratch variable.
Z9		Z value of point to be plotted.

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MEMORY ALLOCATION FOR THE PROGRAM

The program takes up approximately 15.8K.

TITLE	ABSTRACT NO:
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```
1 GO TO 82
4 GO TO 5005

81 REM * *** SET UP DEFAULT VALUES

82 INIT
83 DIM C(3),V(3),T(3)
84 X4=100
85 X6=2
86 X7=1
87 X8=2
88 Y4=100
89 Y6=2
90 Y7=1
91 Y8=2
92 Z4=50
93 Z6=0
94 Z7=0
95 Z8=0
96 S5=0
97 GOSUB 5005
98 END
99 GO TO 98

5000 REM * *** MODE SELECTION

5005 PRINT "LTYPE IN DESIRED MODE:___ 1:  3D HISTOGRAM"
5010 PRINT "_2:  3D POINT PLOT_"
5015 PRINT " 3:  RANGED CELL GRAPH_ 4:  SIGNED CELL GRAPH"
5020 PRINT " 5:  BAR HISTOGRAM_ 6:_ POINT PLOT_ G 7:  DATA ENTRY"
5025 PRINT " 8:  DATA CORRECTION_ 9:  SELECTION OF PART OF ARRAY"
5030 PRINT "10:  COMPARISON OF TWO ROWS OR COLUMNS_"
5035 PRINT "11:  CHANGE OF PERSPECTIVE^IG   ";
5036 PRINT "JJJ      (NOTE: DATA MUST BE ENTERED BEFORE ANY PLOTTING"
5037 PRINT  "       MAY BE DONE) ↑IG    ";
5040 INPUT S2
5045 S3=0
5050 X5=(X8+X7)*0.5
5055 X6=X8-X7+1
5060 Y5=(Y8+Y7)*0.5
5065 Y6=Y8-Y7+1
5070 S5=(S2<7 OR S2=8)*S5
5075 IF S2<7 THEN 5085
5080 GOSUB 6045
5085 IF S2>6 THEN 5095
5090 GOSUB 6535
5095 GO TO S2 OF 5235,5265,5345,5345,5400,5495,5640,5770,5845,5910,6125

5100 REM * *** PLOT ROUTINE MAINLINE
5105 REM *** INITIALIZE PARMETERS

5110 IF S5=PI THEN 5125
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
5115 GOSUB 6265
5120 GO TO 5130
5125 GOSUB 6290
5130 PAGE
5135 IF S2>4 THEN 5155

5140 REM *** LABEL

5145 GOSUB 6655

5150 REM *** PLOT GRID

5155 GOSUB 6815

5160 REM *** PLOT CELLS

5165 FOR X1=X7 TO X8
5170  FOR Y1=Y7 TO Y8
5175   X9=X1
5180   Y9=Y1
5185   Z1=A(X1,Y1)
5190   Z9=Z1
5195   GOSUB S2 OF 5250,5285,5360,5375,5420,5520
5200   GOSUB 6940
5205  NEXT Y1
5210 NEXT X1
5215 IF S2<3 THEN 5225
5220 S5=0
5225 RETURN

5230 REM * *** 3D HISTOGRAM  S2=1

5235 S1=4
5240 S4=1
5245 GO TO 5110
5250 S0=Z9/(-Z2 MAX Z3)
5255 RETURN

5260 REM * *** 3D POINT PLOT  S2=2

5265 S0=0
5270 S1=1
5275 S4=0
5280 GO TO 5110
5285 IF X1=X8 THEN 5335
5290 IF Y9>Y7 THEN 5305
5295 GOSUB 7050
5300 GO TO 5310
5305 GOSUB 7065
5310 X9=X9+1
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
5315 Z9=A(X9,Y9)
5320 GOSUB 7065
5325 X9=X9-1
5330 Z9=A(X9,Y9)
5335 RETURN

5340 REM * *** RANGED CELL PLOT  S2=3

5345 S1=4
5350 S4=0
5355 GO TO 5125
5360 S0=(Z9-Z2)/(Z3-Z2)
5365 RETURN

5370 REM * *** SIGNED CELL GRAPH  S2=4

5375 S0=((Z9>0)*0.3+0.7)*ABS(Z9)/(-Z2 MAX Z3)
5380 S1=3+(Z9>0)
5385 S3=(X6>Y6)*0.5*PI
5390 RETURN

5395 REM * *** BAR HISTOGRAM  S2=5

5400 S1=2
5405 S4=1
5410 S3=(X6>Y6)*0.5*PI
5415 GO TO 5125
5420 IF X9>X7 AND Y9>Y7 THEN 5480
5425 Z9=0
5430 GOSUB 7050
5435 IF ABS(Z2)<ABS(Z3) THEN 5445
5440 PRINT "J";
5445 IF X6<=Y6 THEN 5465
5450 IF Y9>Y7 THEN 5475
5455 PRINT "X=";X9;
5460 GO TO 5475
5465 IF X9>X7 THEN 5475
5470 PRINT "Y=";Y9;
5475 Z9=A(X9,Y9)
5480 S0=0.125+0.75*((Y9-Y7+1)/Y6+(X6<=Y6)*((X9-X7+1)/X6-(Y9-Y7+1)/Y6))
5485 RETURN

5490 REM * *** POINT PLOT  S2=6

5495 S0=0
5500 S1=1
5505 IF Y6=>X6 THEN 5125
5510 S3=1
5515 GO TO 5125
5520 IF Y6<X6 THEN 5560
```

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THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
5525 IF Y9>Y7 THEN 5555
5530 GOSUB 7050
5535 IF Z9<0 THEN 5545
5540 PRINT "J";
5545 PRINT "X=";X1;
5550 MOVE X,Y
5555 RETURN
5560 IF X9>X7 THEN 5585
5565 GOSUB 7050
5570 IF Z9<0 THEN 5580
5575 PRINT "J";
5580 PRINT "Y=";Y1;
5585 IF X1<X8 THEN 5605
5590 S1=2
5595 Y1=Y8
5600 RETURN
5605 X9=X1+1
5610 Z9=A(X9,Y9)
5615 GOSUB 7050
5620 Z9=A(X1,Y1)
5625 X9=X1
5630 RETURN

5635 REM * *** DATA ENTRY  S2=7

5640 PRINT "LGTYPE IN DIMENSIONS          ROWS (X)"
5645 PRINT "        COLUMNS (Y)^      ";
5650 INPUT X8
5655 PRINT "      ";
5660 INPUT Y8
5665 DIM A(X8,Y8)
5670 S3=3
5675 FOR S9=1 TO X8
5680  FOR S8=1 TO Y8
5685   S3=S3+1
5690   IF S8=1 AND S3<30 THEN 5715
5695   IF S8=1 AND S3>29 THEN 5705
5700   IF S3<34 THEN 5725
5705   PAGE
5710   S3=0
5715   PRINT "      ROW # (X=) ";S9;"_"
5720   S3=S3+4
5725   PRINT "          COLUMN # (Y=) ";S8;"   DATA = ";
5730   INPUT A(S9,S8)
5735  NEXT S8
5740 NEXT S9
5745 X7=1
5750 Y7=1
5755 S5=0
5760 GO TO 5005
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
5985 NEXT S9
5990 GO TO 5005
5995 Y7=Z6 MIN Z7
6000 Y8=Y7+1
6005 IF ABS(Z7-Z6)=1 THEN 5005
6010 FOR S9=X7 TO X8
6015  S8=A(S9,Y8)
6020  A(S9,Y8)=A(S9,Z6 MAX Z7)
6025  A(S9,Z6 MAX Z7)=S8
6030 NEXT S9
6035 GO TO 5005

6040 REM *** RESTORE ARRAY

6045 IF Z8=0 OR ABS(Z7-Z6)=1 THEN 6115
6050 IF Z8=2 THEN 6085
6055 FOR S9=Y7 TO Y8
6060  S8=A(Z6 MAX Z7,S9)
6065  A(Z6 MAX Z7,S9)=A((Z6 MIN Z7)+1,S9)
6070  A((Z6 MIN Z7)+1,S9)=S8
6075 NEXT S9
6080 GO TO 6110
6085 FOR S9=X7 TO X8
6090  S8=A(S9,Z6 MAX Z7)
6095  A(S9,Z6 MAX Z7)=A(S9,(Z6 MIN Z7)+1)
6100  A(S9,(Z6 MIN Z7)+1)=S8
6105 NEXT S9
6110 Z8=0
6115 RETURN

6120 REM * *** CHANGE OF PERSPECTIVE  S2=11

6125 PRINT "LGTYPE IN DESIRED MODE:___ 1:  ROTATE GRAPH CLOCKWISE"
6130 PRINT " 2:  ROTATE GRAPH COUNTERCLOCKWISE_ 3:  CHOOSE VIEWPOINT"
6135 PRINT " 4:  AUTOSCALE^I   ";
6140 S5=PI
6145 INPUT S9
6150 GO TO S9 OF 6155,6175,6190,6235
6155 S9=X4-X0+Y0
6160 X4=-Y4+Y0+X0
6165 Y4=S9
6170 GO TO 5005
6175 S9=-X4+X0+Y0
6180 X4=Y4-Y0+X0
6185 GO TO 6165
6190 PRINT "_______ GRAPH RANGES FROM:__ X:  ";X7;" TO  ";X8;"_ Y: ";
6195 PRINT Y7;" TO  ";Y8;"___ PREVIOUS VIEWPOINT:INEW VIEWPOINT:"
6200 PRINT "_ X:  ";X4;"_ Y:  ";Y4;"_ Z:  ";Z4;"_KKII";
6205 INPUT X4
6210 PRINT "II";
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
6215 INPUT Y4
6220 PRINT "II";
6225 INPUT Z4
6230 GO TO 5005
6235 S5=0
6240 GO TO 5005

6245 REM * *** INITIALIZATION OF 3D PLOT PERSPECTIVE

6250 IF S7<>X5 THEN 6265
6255 S7=S7+0.5

6260 REM *** DETERMINE VIEWPOINT

6265 X=10*(X6^2+Y6^2)^0.5
6270 X4=(2*(X5>S7)-1)*X*ABS(COS(ATN((Y5-S6)/(X5-S7))))+X5
6275 Y4=(2*(Y5>S6)-1)*X*ABS(SIN(ATN((Y5-S6)/(X5-S7))))+Y5
6280 Z4=(Z3+Z2)/2+10*(Z3-Z2)

6285 REM *** CENTER OF PLOT AND SCALE

6290 X0=X5
6295 Y0=Y5
6300 Z0=(Z3+Z2)/2
6305 S=((X4-X0)^2+(Y4-Y0)^2+(Z4-Z0)^2)^0.5

6310 REM *** INITIALIZE CONVERSION

6315 GOSUB 7125

6320 REM *** FIND MIN AND MAX X,Y COORDINATES OF MAPPING

6325 X9=X5
6330 Y9=Y5
6335 Z9=(Z3+Z2)/2
6340 GOSUB 7080
6345 X1=X
6350 X2=X
6355 Y1=Y
6360 Y2=Y
6365 IF S2>2 THEN 6455

6370 REM *** FOR 3D PLOTS

6375 FOR S9=X7 TO X8
6380  FOR S8=Y7 TO Y8
6385   S7=ABS((S8-Y0)/(S9-X0+1.0E-30))<Y5/X5
6390   S6=ABS((S8-Y0)/(S9-X0+1.0E-30))>Y5/X5
6395   FOR X9=S9-0.5+(S7 AND S9>X0) TO S9+0.5-(S7 AND S9<X0)
6400    FOR Y9=S8-0.5+(S6 AND S8>Y0) TO S8+0.5-(S6 AND S8<Y0)
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
6405    S=(S9>X7 AND S9<X8 OR (S8>Y7 AND S8<Y8))*A(S9,S8)
6410    FOR Z1=S TO A(S9,S8) STEP A(S9,S8)+(A(S9,S8)=0)
6415     GOSUB 6615
6420    NEXT Z1
6425   NEXT Y9
6430  NEXT X9
6435 NEXT S8
6440 NEXT S9
6445 GO TO 6505

6450 REM *** FOR FLAT PLOTS

6455 S9=(Z3>0)*Z3
6460 S8=(Z2<0)*Z2
6465 FOR Z1=S8 TO S9 STEP S9-S8
6470  FOR Y9=Y7-0.5 TO Y8+0.5 STEP Y6
6475   FOR X9=X7-0.5 TO X8+0.5 STEP X6
6480    GOSUB 6615
6485   NEXT X9
6490  NEXT Y9
6495 NEXT Z1

6500 REM *** SET UP WINDOW

6505 IF (X2-X1)/(Y2-Y1)>1.3 THEN 6520
6510 WINDOW (X2+X1)/2-0.65*(Y2-Y1),(X2+X1)/2+0.65*(Y2-Y1),Y1,Y2
6515 RETURN
6520 WINDOW X1,X2,(Y2+Y1)/2-(X2-X1)/2.6,(Y2+Y1)/2+(X2-X1)/2.6
6525 RETURN

6530 REM *** FIND MIN AND MAX Z VALUES

6535 Z2=1.0E+306
6540 Z3=-Z2
6545 FOR S9=X8 TO X7 STEP -1
6550  FOR S8=Y8 TO Y7 STEP -1
6555   Z2=Z2 MIN A(S9,S8)
6560   IF A(S9,S8)<Z3 THEN 6580
6565   Z3=A(S9,S8)
6570   S6=S8
6575   S7=S9
6580  NEXT S8
6585 NEXT S9
6590 IF Z2<Z3 THEN 6605
6595 Z2=Z2-1.0E-10
6600 Z3=Z3+1.0E-10
6605 RETURN

6610 REM *** FIND MIN AND MAX
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
6620 GOSUB 7080
6625 X1=X1 MIN X
6630 X2=X2 MAX X
6635 Y1=Y1 MIN Y
6640 Y2=Y2 MAX Y
6645 RETURN

6650 REM * *** LABEL

6655 Z9=0
6660 IF X6=1 THEN 6725

6665 REM *** DRAW THE X

6670 X9=X8+0.2
6675 Y9=Y7-0.4
6680 GOSUB 7050
6685 X9=X8-0.2
6690 Y9=Y7+0.4
6695 GOSUB 7065
6700 Y9=Y7-0.4
6705 GOSUB 7050
6710 X9=X8+0.2
6715 Y9=Y7+0.4
6720 GOSUB 7065
6725 IF Y6=1 THEN 6805

6730 REM *** DRAW THE Y

6735 X9=X7-0.4
6740 Y9=Y8-0.2
6745 GOSUB 7050
6750 X9=X7
6755 Y9=Y8
6760 GOSUB 7065
6765 X9=X7-0.4
6770 Y9=Y8+0.2
6775 GOSUB 7065
6780 X9=X7
6785 Y9=Y8
6790 GOSUB 7065
6795 X9=X7+0.4
6800 GOSUB 7065
6805 RETURN

6810 REM * *** GRID PLOT

6815 Z9=0
6820 IF S2>4 THEN 6900
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
6825 REM *** ALONG X COORDINATE

6830 FOR X9=X7-0.5 TO X8+0.5
6835  Y9=Y7-0.5
6840  GOSUB 7050
6845  Y9=Y8+0.5
6850  GOSUB 7065
6855 NEXT X9

6860 REM *** ALONG Y COORDINATE

6865 FOR Y9=Y7-0.5 TO Y8+0.5
6870  X9=X7-0.5
6875  GOSUB 7050
6880  X9=X8+0.5
6885  GOSUB 7065
6890 NEXT Y9
6895 RETURN
6900 X9=X7-0.5
6905 Y9=Y7-0.5
6910 GOSUB 7050
6915 X9=X8+0.5
6920 Y9=Y8+0.5
6925 GOSUB 7065
6930 RETURN

6935 REM * *** POLYGON TABLE

6940 IF S1=1 AND (Y1>Y7 OR S3=PI OR S2=6) THEN 6925
6945 IF S0=0 AND S1<>1 THEN 7040
6950 X9=COS(S3+PI/S1)*S0/2+X1
6955 Y9=SIN(S3+PI/S1)*S0/2+Y1
6960 GOSUB 7050
6965 IF S1=1 THEN 7040
6970 FOR S8=3*PI/S1+S3 TO 2*PI+2*PI/S1+S3 STEP 2*PI/S1
6975  IF S4=0 OR Z1=0 THEN 7000
6980  Z9=0
6985  GOSUB 7050
6990  Z9=Z1
6995  GOSUB 7065
7000  X9=COS(S8)*S0/2+X1
7005  Y9=SIN(S8)*S0/2+Y1
7010  GOSUB 7065
7015  IF S2<>5 THEN 7035
7020  Z9=0
7025  GOSUB 7065
7030  S8=S8+PI
7035 NEXT S8
7040 RETURN
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
7045 REM * *** LINK TO 3D PLOT

7050 GOSUB 7080
7055 MOVE X,Y
7060 RETURN
7065 GOSUB 7080
7070 DRAW X,Y
7075 RETURN
7080 IF S2<3 THEN 7100
7085 X=X9+(X6<=Y6)*(Y9-X9)
7090 Y=-Y9+(X6<=Y6 AND S2<5)*(Y9-X9)+(S2>4)*(Z9+Y9)
7095 RETURN
7100 T(1)=X9
7105 T(2)=Y9
7110 T(3)=Z9
7115 GOSUB 7315
7120 RETURN
7125 C(1)=X0
7130 C(2)=Y0
7135 C(3)=Z0
7140 V(1)=X4
7145 V(2)=Y4
7150 V(3)=Z4
7155 GOSUB 7175
7160 RETURN

7165 REM * *** 3D PLOT
7170 REM *** INITIALIZE INTERNAL VECTORS

7175 DIM T1(3),T2(3),T3(3),T4(3),T5(3)
7180 T7=0
7185 FOR T9=1 TO 3
7190  T3(T9)=V(T9)-C(T9)
7195  T7=T7+T3(T9)^2
7200 NEXT T9

7205 REM *** T1 IS THE ORIGIN, T2 IN NORMAL VECTOR

7210 FOR T9=1 TO 3
7215  T1(T9)=V(T9)-S/SQR(T7)*T3(T9)
7220  T2(T9)=T3(T9)/SQR(T7)
7225 NEXT T9
7230 T3=C
7235 T3(3)=T3(3)+1

7240 REM *** PROJECT ONTO VIEW PLANE

7245 GOSUB 7365
```

TITLE	ABSTRACT NUMBER
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
7255 T7=0
7260 FOR T9=1 TO 3
7265  T7=T7+(T3(T9)-T1(T9))^2
7270 NEXT T9
7275 FOR T9=1 TO 3
7280  T5(T9)=(T3(T9)-T1(T9))/SQR(T7)
7285 NEXT T9
7290 T4(1)=T5(2)*T2(3)-T5(3)*T2(2)
7295 T4(2)=T5(3)*T2(1)-T5(1)*T2(3)
7300 T4(3)=T5(1)*T2(2)-T5(2)*T2(1)
7305 RETURN

7310 REM *** ENTRY POINT TO CALC. 2D VALUES

7315 T3=T
7320 GOSUB 7365
7325 X=0
7330 Y=0
7335 FOR T9=1 TO 3
7340  X=X+(T3(T9)-T1(T9))*T4(T9)
7345  Y=Y+(T3(T9)-T1(T9))*T5(T9)
7350 NEXT T9
7355 RETURN

7360 REM *** INTERNAL ROUTINE TO PROJECT TO VIEW PLANE

7365 T7=0
7370 T8=0
7375 FOR T9=1 TO 3
7380  T7=T7+(T1(T9)-T3(T9))*T2(T9)
7385  T8=T8+(V(T9)-T3(T9))*T2(T9)
7390 NEXT T9
7395 FOR T9=1 TO 3
7400  T3(T9)=(V(T9)-T3(T9))*T7/T8+T3(T9)
7405 NEXT T9
7410 RETURN

7415 REM *** END OF 3D PLOT PROGRAM ***
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
TYPE IN DESIRED MODE:

 1:  3D HISTOGRAM
 2:  3D POINT PLOT

 3:  RANGED CELL GRAPH
 4:  SIGNED CELL GRAPH
 5:  BAR HISTOGRAM
 6:  POINT PLOT

 7:  DATA ENTRY
 8:  DATA CORRECTION

 9:  SELECTION OF PART OF ARRAY
10:  COMPARISON OF TWO ROWS OR COLUMNS

11:  CHANGE OF PERSPECTIVE


     (NOTE: DATA MUST BE ENTERED BEFORE ANY PLOTTING
      MAY BE DONE)
```

FIGURE 1

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
TYPE IN DIMENSIONS

     ?  ROWS (X)
        COLUMNS (Y)
```

FIGURE 2

```
TYPE IN DIMENSIONS

     2  ROWS (X)
     5  COLUMNS (Y)

     ROW # (X=) 1

          COLUMN # (Y=) 1    DATA = ?
```

FIGURE 3

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

```
TYPE IN DIMENSIONS

     2  ROWS (X)
     5  COLUMNS (Y)


     ROW # (X=) 1

          COLUMN # (Y=) 1    DATA = 1.25
          COLUMN # (Y=) 2    DATA = 2.5
          COLUMN # (Y=) 3    DATA = 1.25
          COLUMN # (Y=) 4    DATA = .25
          COLUMN # (Y=) 5    DATA = 1.25


     ROW # (X=) 2

          COLUMN # (Y=) 1    DATA = .25
          COLUMN # (Y=) 2    DATA = .5
          COLUMN # (Y=) 3    DATA = .75
          COLUMN # (Y=) 4    DATA = 1
          COLUMN # (Y=) 5    DATA = 1.25
```

FIGURE 4

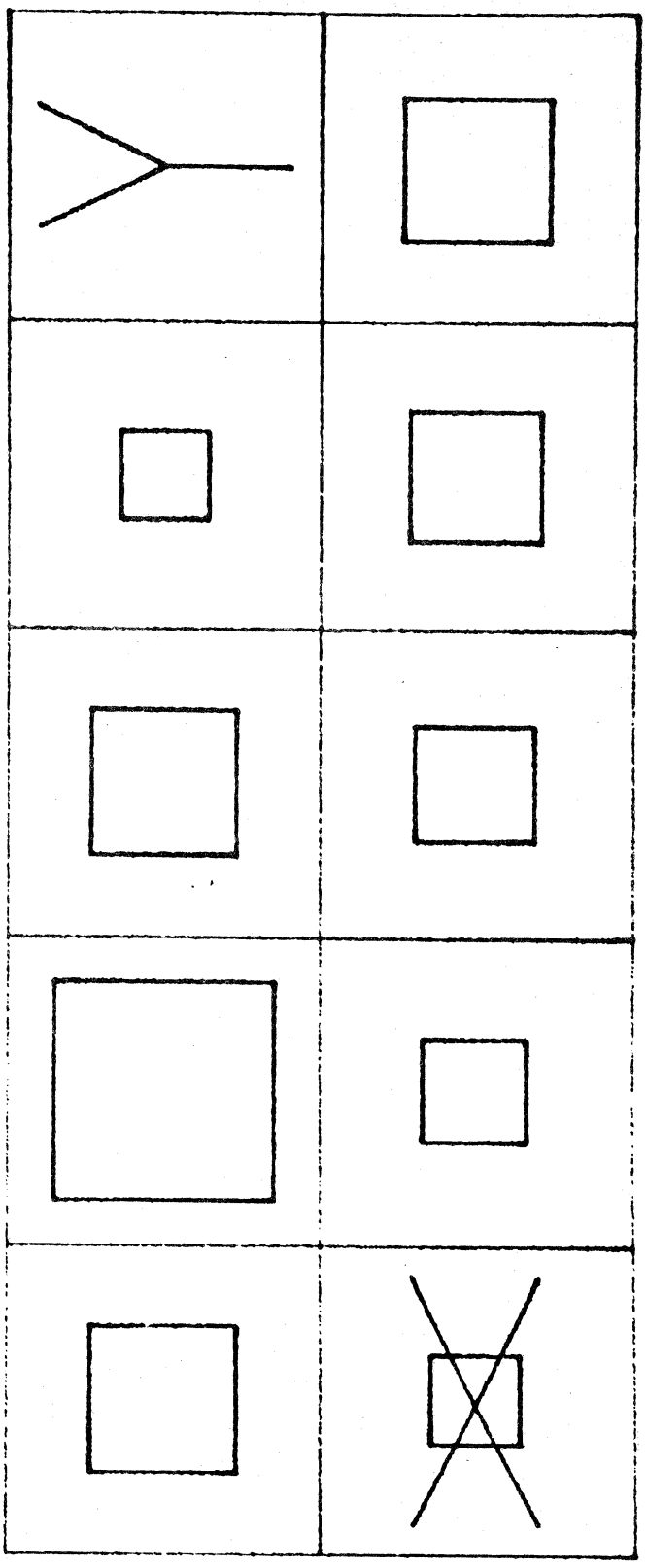
TITLE

THREE DIMENSIONAL DATA PLOT PROGRAM

ABSTRACT NO:

51/00-9506/0

FIGURE 5



RANGED CELL GRAPH (MODE = 3)

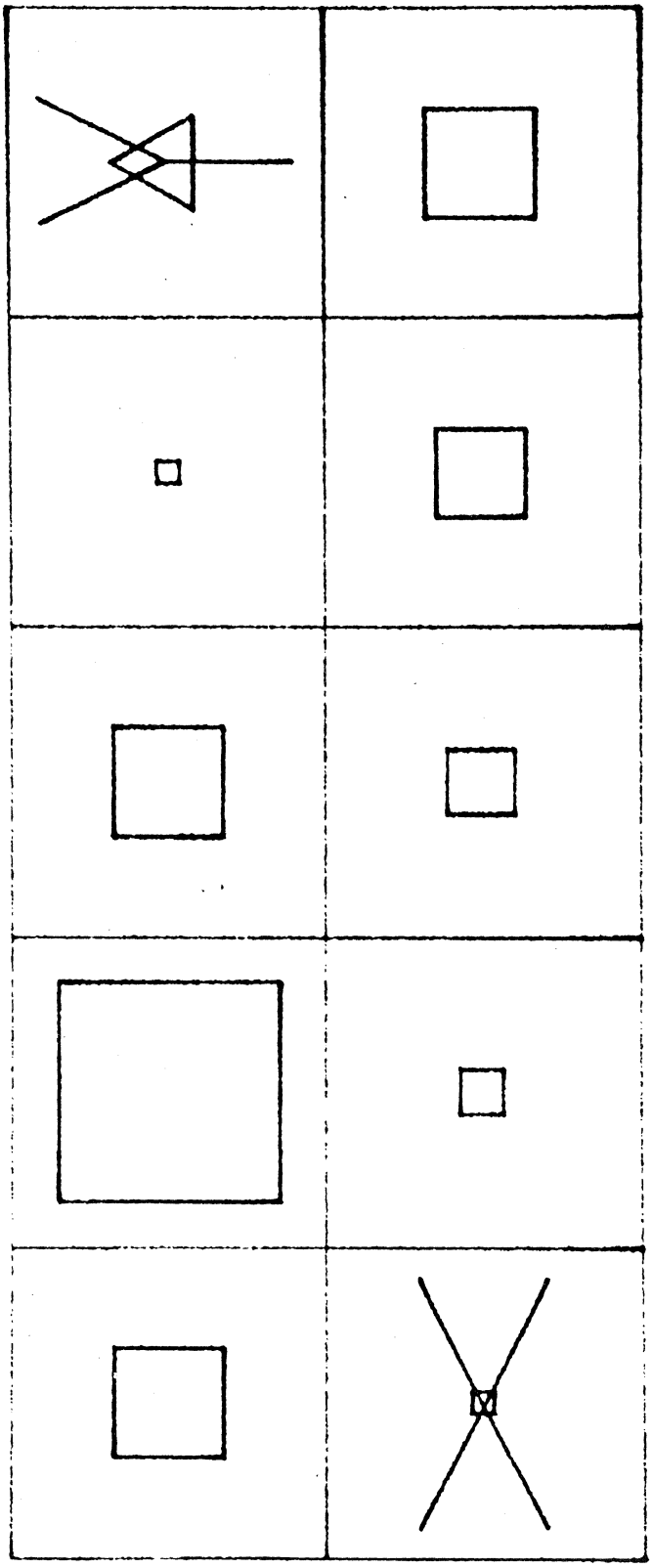
TITLE

THREE DIMENSIONAL DATA PLOT PROGRAM

ABSTRACT NO:

51/00-9506/0

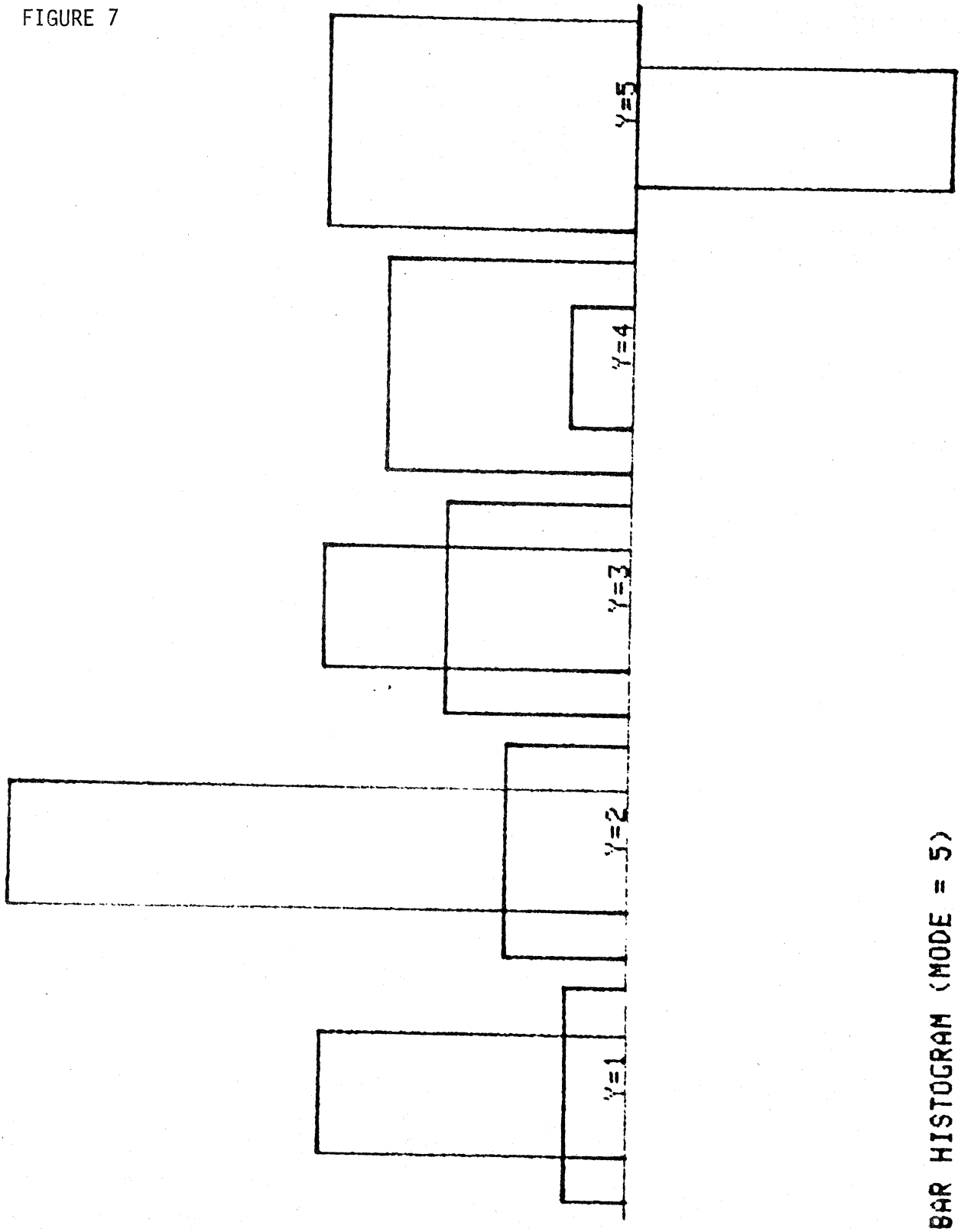
FIGURE 6



SIGNED CELL GRAPH (MODE = 4)

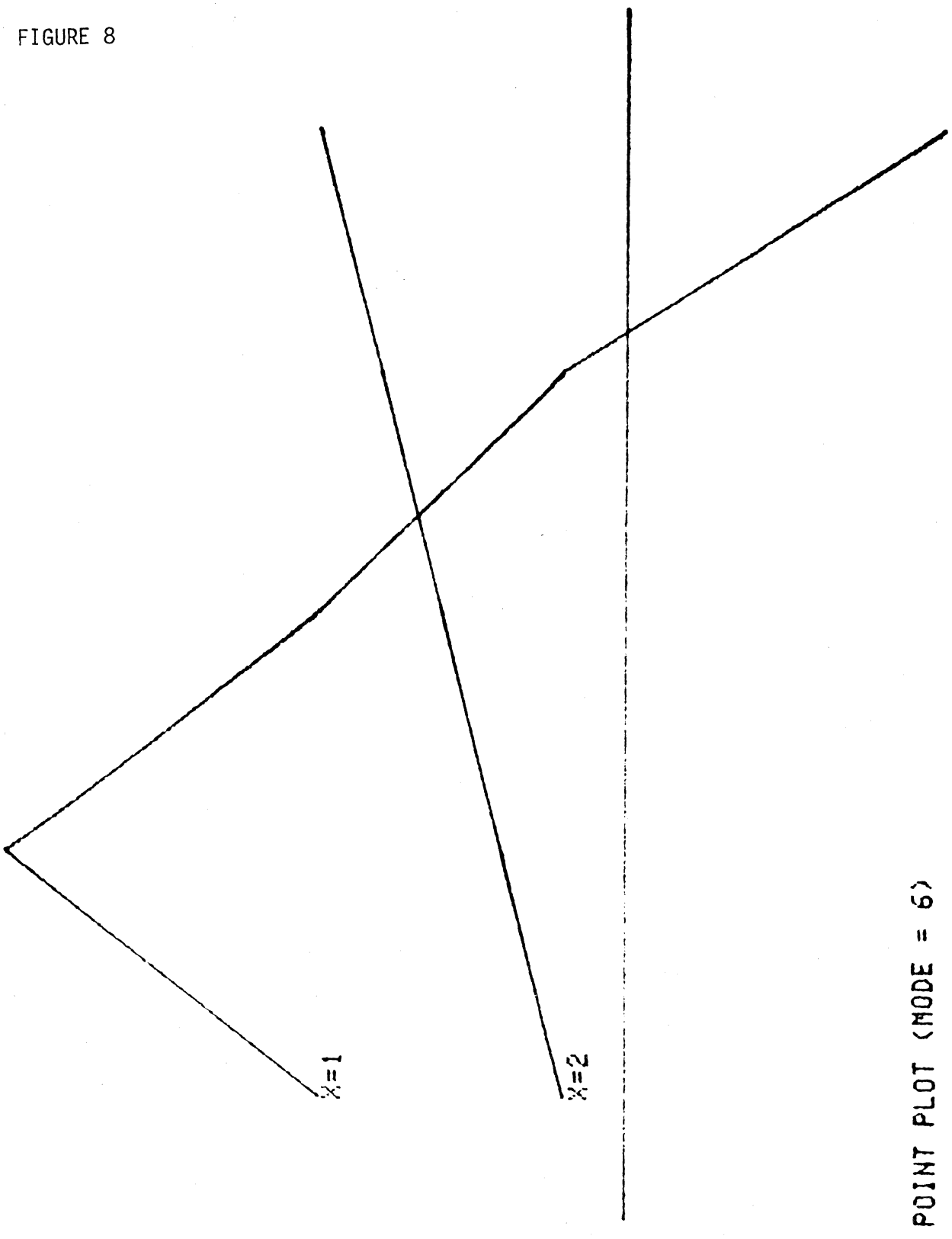
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 7



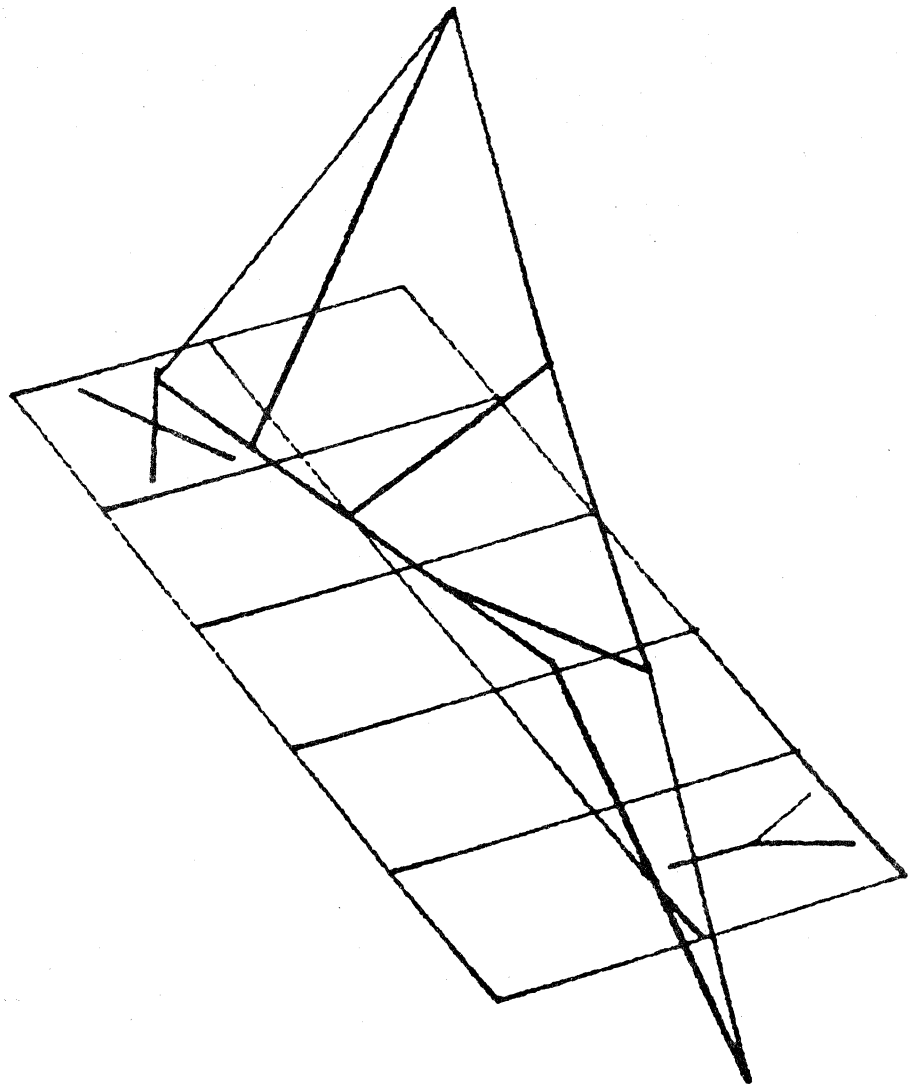
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 8



TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

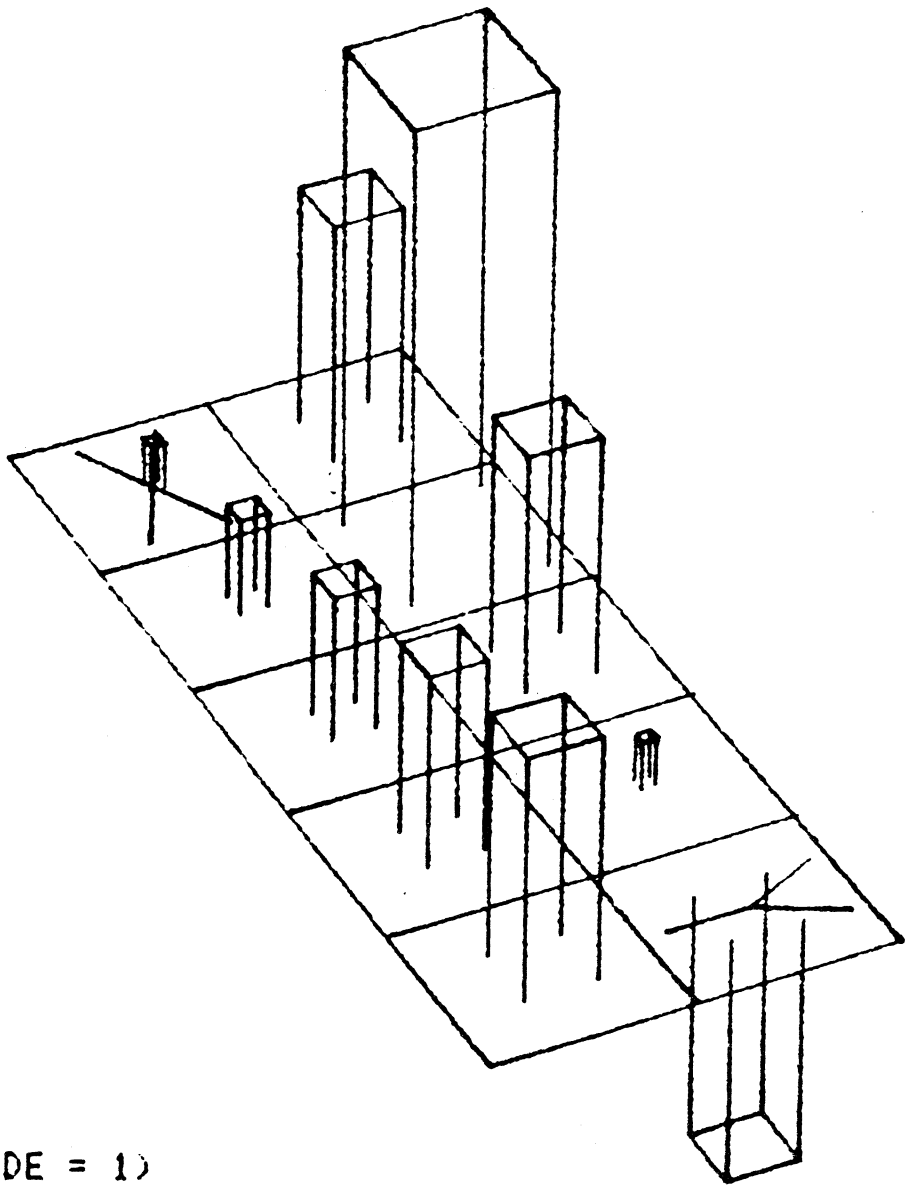
FIGURE 9



3D POINT PLOT (MODE = 2)

TITLE	ABSTRACT NO:
THREE DIMENSINOAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 10



3D HISTOGRAM (MODE = 1)

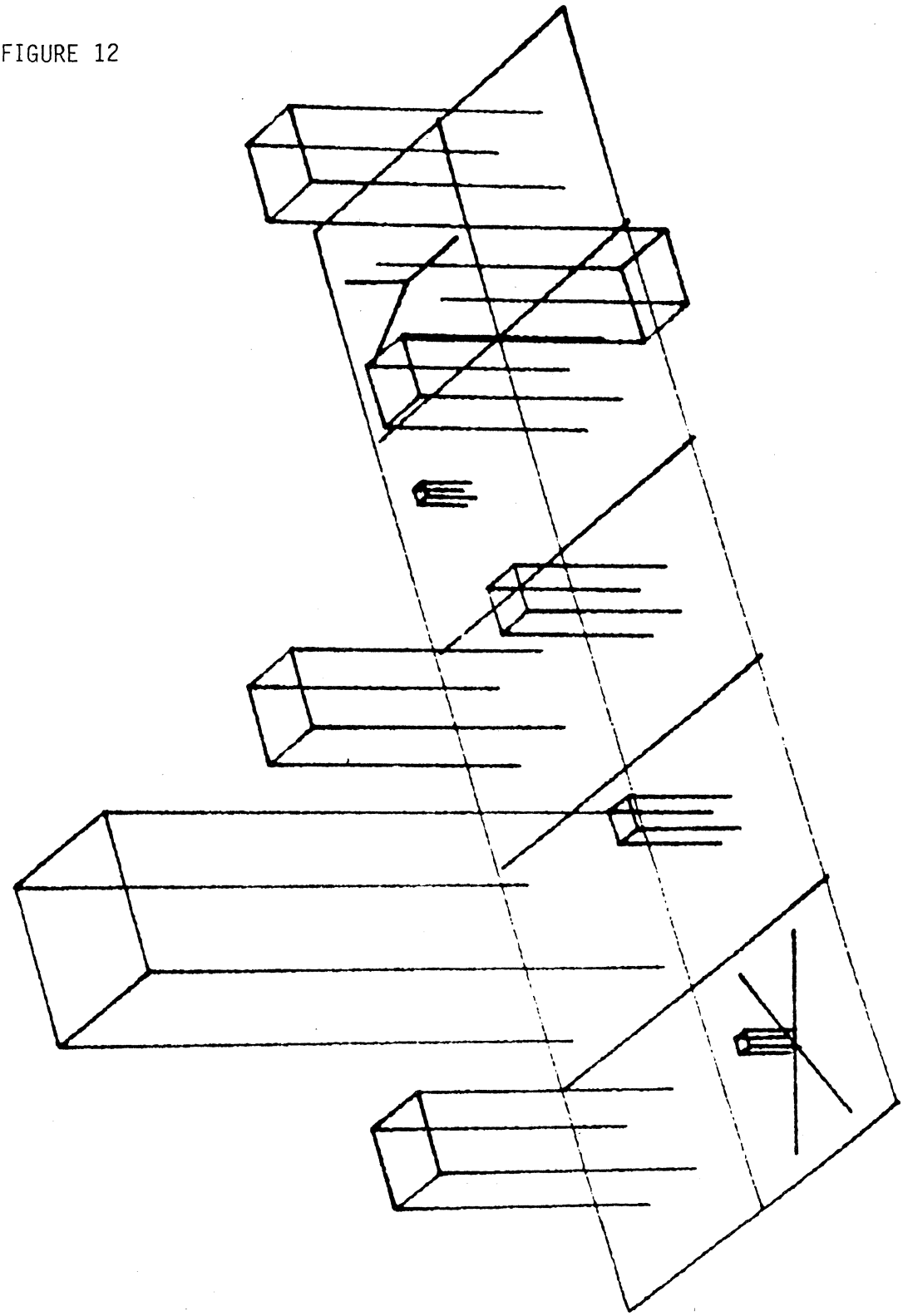
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 11

```
TYPE IN DESIRED MODE: 2

 1:  ROTATE GRAPH CLOCKWISE
 2:  ROTATE GRAPH COUNTERCLOCKWISE
 3:  CHOOSE VIEWPOINT
 4:  AUTOSCALE
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 12



3D HISTOGRAM ROTATED COUNTERCLOCKWISE (MODE = 2)

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 13

```
TYPE IN DESIRED MODE: 3

 1:  ROTATE GRAPH CLOCKWISE
 2:  ROTATE GRAPH COUNTERCLOCKWISE
 3:  CHOOSE VIEWPOINT
 4:  AUTOSCALE

GRAPH RANGES FROM:

X:  1 TO  2
Y:  1 TO  5

PREVIOUS VIEWPOINT:                    NEW VIEWPOINT:

X:  49.6663783152                      ?
Y:  -21.0831891576
Z:  38.125
```

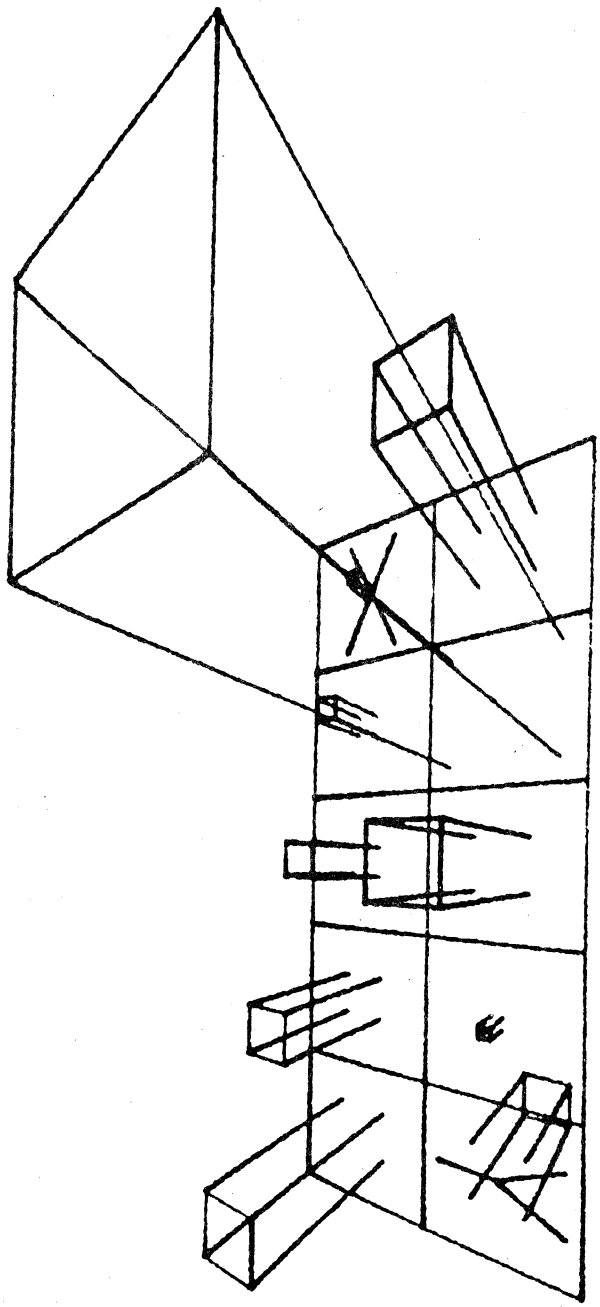
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 14

```
TYPE IN DESIRED MODE: 3

 1:  ROTATE GRAPH CLOCKWISE
 2:  ROTATE GRAPH COUNTERCLOCKWISE
 3:  CHOOSE VIEWPOINT
 4:  AUTOSCALE

 GRAPH RANGES FROM:

 X:  1 TO  2
 Y:  1 TO  5

 PREVIOUS VIEWPOINT:                NEW VIEWPOINT:

 X:  49.6663783152                  0
 Y:  -21.0831891576                 3
 Z:  38.125                         3
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 15



3D HISTOGRAM FROM VIEWPOINT 0,3,3

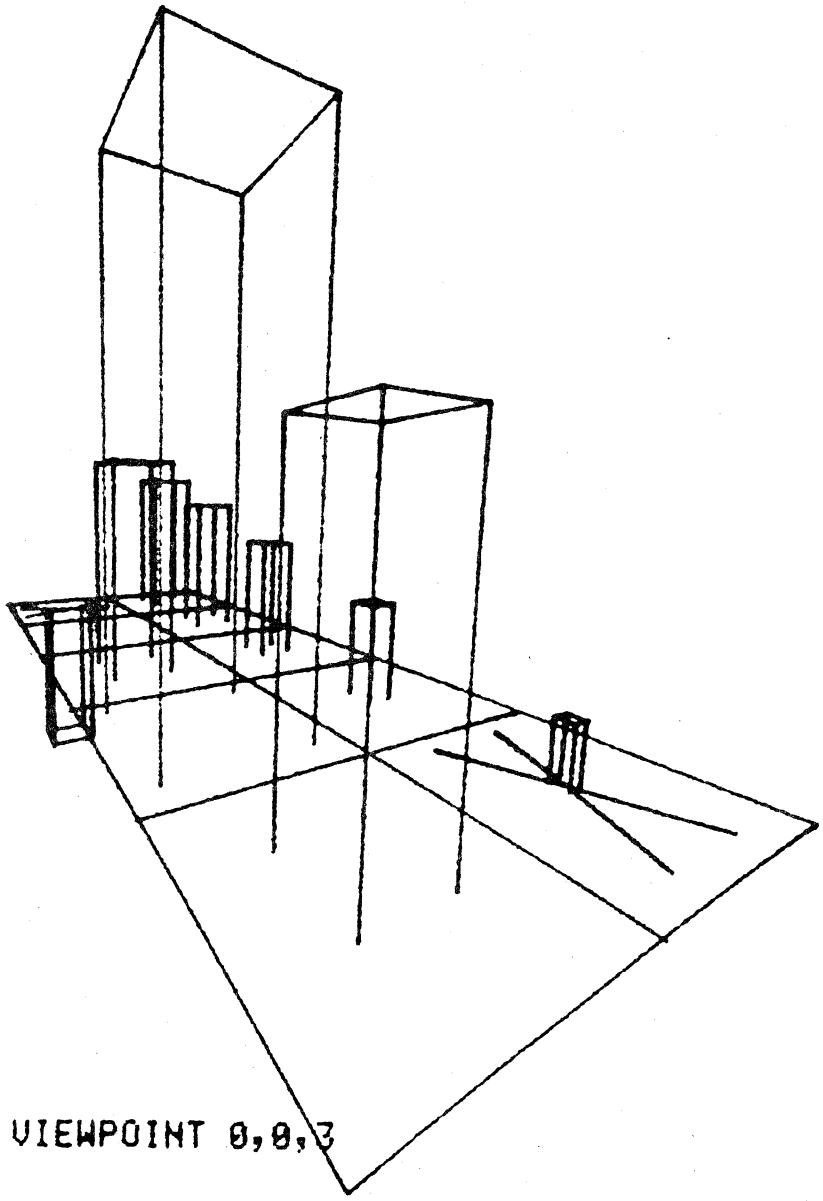
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 16

```
TYPE IN DESIRED MODE: 3

 1:  ROTATE GRAPH CLOCKWISE
 2:  ROTATE GRAPH COUNTERCLOCKWISE
 3:  CHOOSE VIEWPOINT
 4:  AUTOSCALE

 GRAPH RANGES FROM:

 X:  1 TO  2
 Y:  1 TO  5

 PREVIOUS VIEWPOINT:                NEW VIEWPOINT:

 X:  0                              0
 Y:  3                              0
 Z:  3                              3
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 17



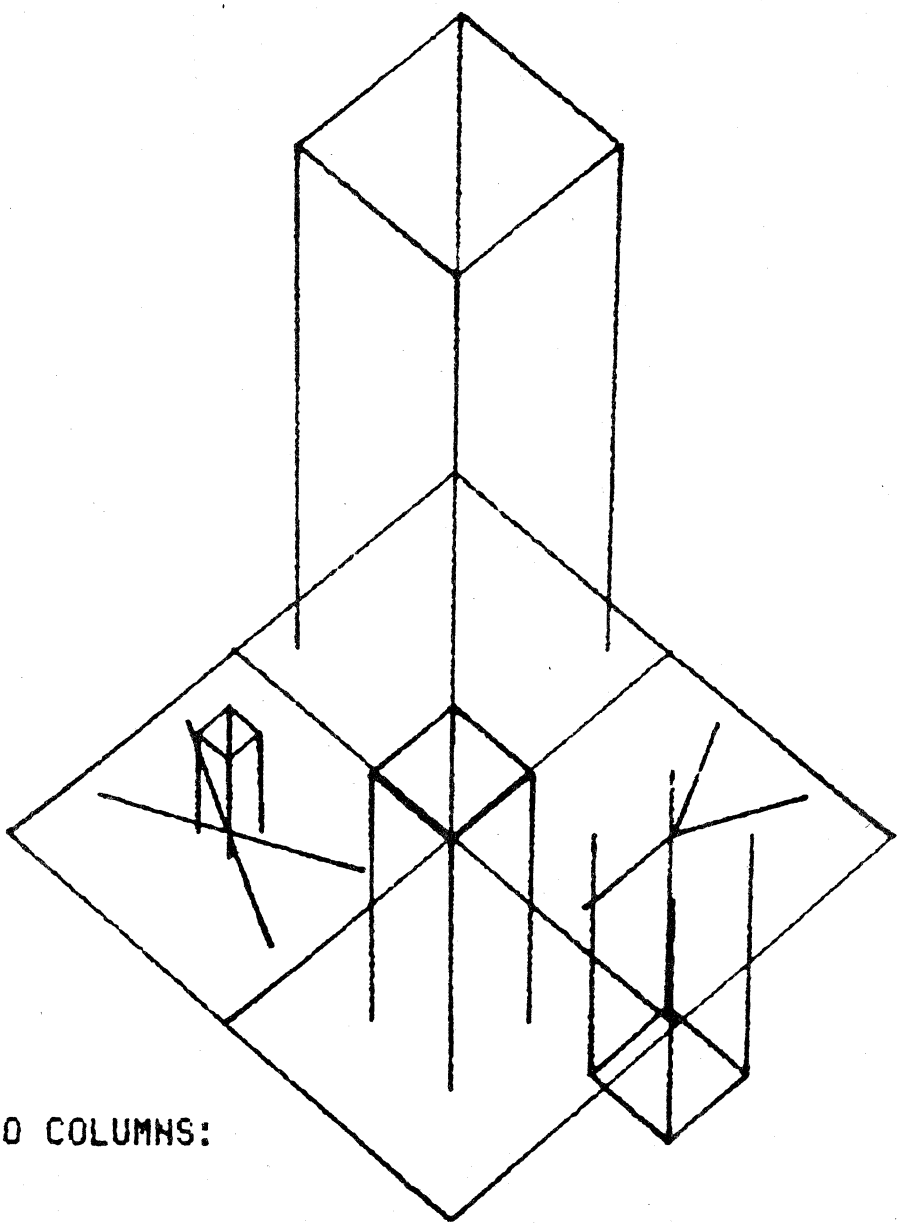
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 18

```
TYPE IN DESIRED MODE: 2

 1: COMPARISON OF TWO ROWS (X)
 2: COMPARISON OF TWO COLUMNS (Y)


     TYPE IN THE ROWS OR COLUMNS TO BE COMPARED: 2  AND 5
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 19



COMPARISON OF TWO COLUMNS:
COLUMNS 2 AND 5

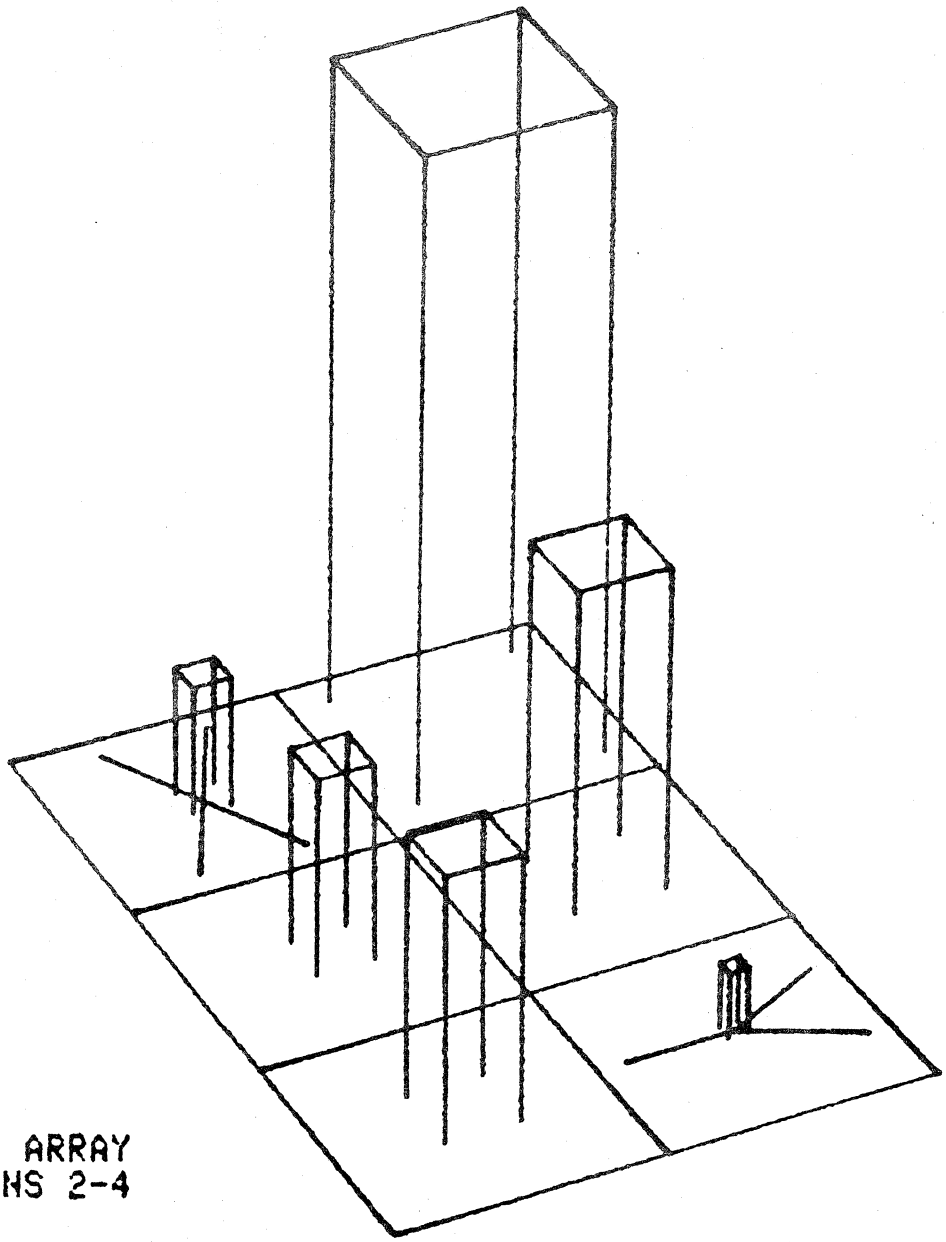
TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 20

```
SELECT THE LIMITS OF THE DISPLAYED ARRAY

     THE ROWS (X) RAN FROM 1 TO 2
     NOW THE ROWS (X) WILL RUN FROM  1 TO 2

     THE COLUMNS (Y) RAN FROM 1 TO 5
     NOW THE COLUMNS (Y) WILL RUN FROM 2  TO 4
```

TITLE	ABSTRACT NO:
THREE DIMENSIONAL DATA PLOT PROGRAM	51/00-9506/0

FIGURE 21



PLOT OF PART OF ARRAY
ROWS 1-2, COLUMNS 2-4

TEKTRONIX®

APPLICATION LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0
	MEMORY REQUIREMENT
	16K
AUTHOR	PERIPHERALS
Brian Diehm	

ABSTRACT

INTRODUCTION

A. This program allows the 4051 GCS to be used in a manner similar to several hand-held calculators currently on the market, specifically those operating in reverse "Polish" notation with a 4 place operational stack, for example, the Hewlett Packard series.

B. The input to the program is completely accomplished by use of the function keys. Input is interactive with the user; just like a hand-held calculator.

C. Output is placed on the screen. As each new display is presented, it is written on the screen below the previous one. Also, a record of the input keys is provided on the screen.

TITLE	ABSTRACT NUMBER
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HARDWARE REQUIREMENTS

The program requires a 4051 with 16K or more of memory. The proper overlay is required for the function keys.

PROGRAM LIMITATIONS

While the program is protected against invalid operations such as divide by zero, operations resulting in a result too large for the machine may result in an error message. The user may continue and disregard the message with no effect.

METHODOLOGY

The calculator program operates a stack, and problems are solved by utilizing reverse "Polish" logic. The stack has 4 positions.

OPERATING HINTS

N/A

REFERENCES

N/A

DESCRIPTION OF THE MAN/MACHINE INTERFACE

The user communicates with the program by using the function keys for input and the screen for readout. The manner of operation is similar to that of a hand-held calculator, except that previous results are saved on the screen as well as the directives used.

OPERATING INSTRUCTIONS

Loading - Place the program tape in the drive and press the "Auto-load" key. When the program clears the screen and prints "CLEAR" followed by a zero, the program is loaded and running.

Running the program with examples -

ACCESSING FUNCTIONS:

There are 10 function keys physically placed on the 4051 keyboard. The number of different entries is increased to 20 by the use of the shift keys.

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This program further increases the number of available functions to 39 by the use of a "shi t" function. On the overlay it will be noted that each of the 20 key labels except one have two labels, one in parentheses. By pressing that function key, the function printed without parentheses will be performed. By pressing the parenthesis key (the only one without two functions), and then pressing any function key, the function printed in parentheses will be performed.

KEYING IN NUMBERS

Each time a number key is pressed, the number appears on the screen, to the right of the last digit, if any. Note that a decimal point key is included; it must be pressed if it is part of the number. To enter the number 692.7, for example, one would press the keys 6, 9, 2, ., and 7 in that order. On the screen would appear 692.7 as the digits are pressed.

THE DISPLAY

This program, because it simulates a hand-held calculator, constantly displays the current calculator display on the screen. Each new value or result is displayed on successively lower lines. Since the screen is a storage CRT, a running record of intermediate results and subtotals is thus kept. To make these intermediate results meaningful, then, just before displaying the newest value, the name of the key used to achieve that result is also printed after the last number, if any. The program therefore is more like a printing calculator in that a running record of all transactions is kept. For example, the following sequence of keys:

CLEAR 4 5 STO 1 SIN RCL ÷ 1

will result in the following display:

CLEAR
0
45 STO 1
45 SIN
0.707106781187
RCL ÷ 1
0.0157134840264

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Note that all but one line is indented by one space. This one line is not indented because it is an actual number being entered into the calculator, not a directive or function key. Any number that is indented is either the result of an operation or the result of reprinting the previous value. (ENTER↑ is an example of reprinting a previous value.)

OPERATIONAL STACK

Stack Registers

The hand calculator program uses an operational stack and reverse "Polish" (Lukasiewicz) notation to evaluate mathematical expressions.

The four temporary memory locations (stack registers arranged vertically) are called X (bottom register), Y, Z, and T (top register), respectively. The contents of the X register are always displayed.

To avoid confusion between the name of a register and its contents, the register name is designated by a capital letter and the register contents by a lower case letter. Thus, register X contains the value x, which is always displayed.

When you key in a number, it goes into the X register and is displayed. When the ENTER↑ key is pressed, this number is duplicated into the Y register. At the same time, y is moved up to Z and z is moved up to T.

PRESS	CONTENTS	REGISTER
ENTER↑	t	(contents lost)
	z	T
	y	Z
	x	Y
		X

When + is pressed, x is added to y and is displayed in X, and the rest of the stack drops down one position. The same goes for −, ×, ÷, and Y^X.

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PRESS	CONTENTS	REGISTER
+, −, ×, ÷, Y^X	t → T z → Z y → y+x, y−x → Y x → y×x, y÷x, y^x → X	

Observing the stack operation during a chain calculation can help intuitively understand the concepts involved. For example, in calculating (4x2)+(3-(5x2)) the following analysis will explain the necessary keystrokes. Directly above the keys pressed, the information in each of the stack registers is shown, as they are after the key is pressed.

Note: ↑ = Enter↑

T								8	8	8	8	8
Z						8	8	3	3	8	8	8
Y		4	4		8	3	3	5	5	3	8	8
X (Display)	4	4	2	8	3	3	5	5	2	10	-7	1
Press →	4	↑	2	×	3	↑	5	↑	2	x	−	+

4 is in X (Display)
X is duplicated into Y
2 is in X (Display)
4 x 2 is in X (Display)
3 is in display, automatic enter performed first
Enter↑ pushes everything up, still shows 3
5 overwrites 3 in X since it immediately follows Enter↑
Enter↑ pushes everything up, still shows 5
2 overwrites 5 in X since it immediately follows Enter↑
Result of 5x2 displayed, everything else moves down
Result of 3-(5x2) displayed, everything else moves down
Result of (4x2)+(3-(5x2)) displayed

Note that numbers were keyed into the machine in the same order they were encountered in the expression, no pre-planning is required. Note also that all intermediate results were stored in the stack where they would be ready exactly when needed. No intermediate results needed to be written down and re-entered later.

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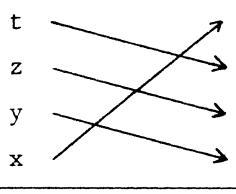
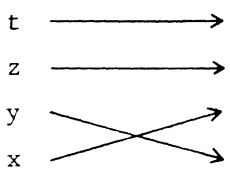
Manipulating the Stack

The R↓ key "rolls down" the stack and lets you review the contents (in last-in first-out order). It may be used to reposition data within the stack. The R↓ directive performs as follows:

PRESS	CONTENTS	REGISTER
R↓		

The X↕Y key exchanges x and y as follows:

PRESS	CONTENTS	REGISTER
X↕Y		

The X↕Y function is often useful before −, ÷, and Y^X operations. For example, if you are paying off a loan at 7% annual interest, you have $7000 principle left to pay, and your monthly payments are $105.65, how much of your payment goes to interest, how much towards principle, and what is the remaining principle? To do this:

PRESS	SEE	
7 →	7	(Interest Rate)
ENTER↑ →	7	
12 →	12	(Divide by 12 months)
÷ →	.583333333333	
100 →	100	For an easier way to do this,
÷ →	0.00583333333333	see the % key.
7000 →	7000	
× →	40.8333333333	(Amount to Interest)

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PRESS (cont)		SEE (cont)	
105.65	⟶	105.65	(Amount of Payment)
X↑↓Y	⟶	40.8333333333	
-	⟶	64.8166666667	(Amount to Principle)
7000	⟶	7000	(Old Principle)
X↑↓Y	⟶	64.8166666667	
-	⟶	6935.18333333	(Remaining Principle)

Performing Combined Arithmetic Processes

The foregoing explanation of the operational stack enables the user to perform the following calculations.

Serial Calculation

Any time a new number is entered after any calculation, the calculator performs an automatic ENTER↑ on the result of the calculation. This permits a serial calculation to be performed without being encumbered by extra ENTER↑ requirements, and allows the user to operate the calculator in an easy, natural manner. Also, the user never need copy down intermediate results. For example, to solve the following equation:

$$A = 1 + 3 - 5 \div 10$$

PRESS		SEE
1	⟶	1
ENTER↑	⟶	1
3	⟶	3
+	⟶	4
5	⟶	5
-	⟶	-1
10	⟶	10
÷	⟶	-0.1

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Chained Calculation

Chained calculations can be used to find the sums of products or the products of sums. For example, if a grocer sold 7 oranges at 18¢ each, 5 lb. of sugar at 67¢/lb., and 20 jars of jam at $1.17 per jar, the total sale price is:

$$(7\times.18) + (5\times.67) + (20 \times 1.17)$$

PRESS	SEE
7 ENTER↑ .18 × →	1.26
5 ENTER↑ .67 × →	3.35
+ →	4.61
20 ENTER↑ 1.17 × →	23.4
+ →	28.01 Total Sale Price

Note also how all the intermediate values are displayed.

Mixed Chain Calculations

Chained calculations may use any arithmetic operator. Additionally, a problem may be calculated using any combination of arithmetic operators in both nested and linked operations. For example, to calculate

$$(((8\times5)-12) + ((44\div2)\div2)) \times (13\times5\div.75) \div 2$$

PRESS	SEE
8 ENTER↑ 5 × →	40
12 - →	28
44 ENTER↑ 2 ÷ →	22
2 ÷ →	11
+ →	39
13 ENTER↑ 5 × →	65
.75 ÷ →	86.6666666667
× →	3380
2 ÷ →	1690

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CLEARING THE CALCULATOR

To clear the display (and zero the X register), press CLX. To clear the entire stack, including memory registers 5 through 8, press CLEAR. To restart the program (clear the stack, all the memory registers, and reset the angle mode to degrees), press the Break key and type RUN and press RETURN. More will be explained about memory registers and angle modes later. Note that CLX may be used to delete a number during keying if a keystroke is incorrect. The number may then be re-entered correctly.

Keying in Negative Numbers:

To enter a negative number, key in the number and then press CHS. The negative number will be displayed. For example, to enter -12:

PRESS		SEE
12	⟶	12
CHS	⟶	-12
ENTER↑	⟶	-12

or

PRESS		SEE
1	⟶	1
CHS	⟶	-1
2	⟶	-12
ENTER↑	⟶	-12

If CHS is pressed immediately after a calculation or ENTER↑, the number in the X register is negated and redisplayed.

Keying in Exponents

To key in a number with an exponent, use the EEX key. For example, to key in 1.56×10^{23}, press:

PRESS		SEE
1.56	⟶	1.56
EEX	⟶	1.56E
23	⟶	1.56E23
ENTER↑	⟶	1.56E+23

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To enter negative exponents, press CHS any time after EEX. For example, to key in 28.45×10^{-35}, press:

PRESS		SEE
28.45	→	28.45
EEX	→	28.45E
35	→	28.45E35
CHS	→	28.45E-35
ENTER↑	→	2.845E-34

or

PRESS		SEE
28.45	→	28.45
EEX	→	28.45E
CHS	→	28.45E-
35	→	28.45E-35
ENTER↑	→	2.845E-34

To enter a negative number with an exponent, be sure to press CHS before EEX. If you forget and if it won't disturb the stack (this is a first entry), you may press CHS after the ENTER↑. Entering -285×10^{-10} will illustrate both these points:

PRESS		SEE
285	→	285
CHS	→	-285
EEX	→	-285E
CHS	→	-285E-
10	→	-285E-10
ENTER↑	→	-2.85E-8
CHS	→	2.85E-8
CHS	→	-2.85E-8

If no mantissa is entered before EEX is pressed, a mantissa of 1 is assumed. If no exponent is entered after the EEX, an exponent of 0 is assumed.

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PRESS		SEE
CLEAR	⟶	0
EEX	⟶	1E
ENTER↑	⟶	1

Entering π

π is a fixed constant available to the user. To enter the value of π, press the π key. An automatic ENTER↑ is performed before the value of π is placed in the X register and displayed.

PRESS		SEE
2 ENTER↑	⟶	2
π	⟶	3.14159265359
3	⟶	3
×	⟶	9.42477796077
×	⟶	18.8495559215

PERFORMING MONADIC FUNCTIONS

Several monadic, or single operator, functions are included in the hand calculator program, including square root, reciprocals, natural and base 10 logs and natural and base antilogs. These functions replace the contents of the X register with the value of the function of x, leaving the rest of the stack alone.

PRESS	CONTENTS	REGISTER
$1/x$, $\sqrt{x}$	t ⟶	T
10^x, LOG	z ⟶	Z
e^x, LN	y ⟶	Y
	x ⟶ f(x) ⟶	X (displayed)

Reciprocals

To calculate the reciprocal of a displayed value, press 1/x:

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PRESS		SEE
5	→	5
1/x	→	0.2
1/x	→	5

Square Root

To calculate the square root of a displayed value, press x:

PRESS		SEE
81	→	81
$\sqrt{x}$	→	9
$\sqrt{x}$	→	3
$\sqrt{x}$	→	1.73205080757

Natural Logs and Antilogs:

To find the natural log of a displayed value, press LN. To find the natural antilog of a displayed value, press e^x.

PRESS		SEE
2.02	→	2.02
LN	→	0.703097511413
e^x	→	2.02

Base 10 Logs and Antilogs

To find the base 10 log of a displayed value, press LOG. To find the base 10 antilog of a displayed value, press 10^x.

PRESS		SEE
2.02	→	2.02
LOG	→	0.305351369447
10^x	→	2.02

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TRIGONOMETRIC FUNCTIONS

Three trigonometric functions are provided by the SIN, COS, and TAN keys. These are extended to six functions by first pressing the ARC key, to provide ARC SIN, ARC COS, and ARC TAN functions. The trig functions are monadic functions. For example, to find the sin, cos, and tan of 45 degrees:

PRESS		SEE
45	⟶	45
SIN	⟶	0.707106781187
ARC	⟶	ARC
SIN	⟶	45
COS	⟶	0.707106781187
ARC	⟶	ARC
COS	⟶	45
TAN	⟶	1
ARC	⟶	ARC
TAN	⟶	45

When first run, the program is set in degrees mode. The program may be set in radians, gradians, or back to degrees mode by briefly stepping outside the program. To do this, press the BREAK key. The error message PROGRAM INTERRUPTED PRIOR TO LINE 300 will be printed and the cursor will appear. Then, type in the appropriate command:

SET DEG	for Degrees mode
SET RAD	for Radians mode
SET GRAD	for Gradians mode

followed by a carriage return. Then type RUN 300 followed by a carriage return. DO NOT type just RUN, or the stack and memory registers will be cleared and the program will be set in degrees mode again. When this is done, the program is where it was before the mode change, with the stack and memory registers unaffected. As an example, let us see how many radians are equivalent to 45 degrees. Also, let us express the number of radians in relation to π, as $\pi/8$ or $\pi/2$ radians. Assuming the program is in degrees mode:

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PRESS SEE

45 ⟶ 45

SIN ⟶ 0.707106781187

BREAK ⟶ "PROGRAM INTERRUPTED PRIOR TO LINE 300"

SET RAD↵*

RUN 300↵

ARC ⟶ ARC

SIN ⟶ 0.785398163397 (number of radians equivalent to 45^{o})

π ⟶ 3.14159265359

÷ ⟶ 0.25

1/x ⟶ 4

The result is that 45 degrees is equivalent to $\pi/4$ radians.

DYADIC FUNCTIONS

Several dyadic, or two operator, functions are included in the hand calculator program. These are add, subtract, multiply, and divide, as well as exponentiation. For an explanation of the way these functions utilize the stack, see the section entitled "OPERATIONAL STACK".

Addition

Pressing the + key places the result y + x into the X register, and moves the stack up, propagating the T register.

PRESS	CONTENTS	REGISTER
+	t ⟶ T z ⟶ Z y ⟶ Y x, y+x ⟶ X	

Subtraction

Pressing the - key places the result of y-x into the X register, and moves the rest of the stack according to dyadic operator rules.

*↵ means carriage return

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Multiplication

Pressing the × key places the result of y×x into the X register, and moves the rest of the stack according to dyadic operator rules.

Division

Pressing the ÷ key places the result of y÷x into the X register, and moves the rest of the stack according to dyadic operator rules.

Exponentiation

Pressing the Y^x key places the result of y^x into the X register, moving the rest of the stack according to dyadic operator rules. For example, to find 2 raised to the 16th power:

PRESS		SEE
2	⟶	2
ENTER↑	⟶	2
16	⟶	16
Y^x	⟶	65536

When Y^x is used in conjunction with the reciprocal key, n-th roots may be extracted. To continue the above example, find the 16th root of 65536:

PRESS		SEE
		65536 (from above)
16	⟶	16
1/x	⟶	0.0625
Y^x	⟶	2

As can be seen, 2 is the 16th root of 65536.

The fact that the contents of the T register is unaffected by dyadic operators implies that this last number propagates throughout any number of dyadic operations. This is correct, and sometimes useful. For example, finding the powers of 2 using the Y^x key would involve each time entering 16 and then keying the next power and pressing Y^x. However, it can be done with the multiply key by completely filling the stack with 2's and allowing the stack to propagate them during the desired number of multiplies. To find the powers of 2, one would:

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PRESS		SEE
2	→	2
ENTER↑	→	2
ENTER↑	→	2
ENTER↑	→	2 (The stack now contains all 2's)
×	→	4 (or 2^2)
×	→	8 (or 2^3)
×	→	16 (or 2^4)
×	→	32 (or 2^5)
×	→	64 (or 2^6)
×	→	128 (or 2^7)
×	→	256 (or 2^8)

etc.

If desired, verification of the earlier result of 2 raised to the 16th power using the Y^X key can be accomplished with this method.

CALCULATING PERCENTAGE PROBLEMS

The hand calculator program simplified the calculation of percentage problems because conversion of percents to their decimal equivalents is performed automatically, just press the % key after keying in the percent value. Three types of problems are handled:

- o Finding percentage of number (base × rate)
- o Finding net amount (base + or - percentage)
- o Finding percent difference between a number and a base

$$\frac{\text{number - base}}{\text{base}}$$

Finding Percentage

To find the percentage of a number, key in the base number and press ENTER↑. Then key in the percent value and press %. For example, to find 25% of 256:

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PRESS		SEE
256 ENTER↑	⟶	256 base
25 –	⟶	25 percent value
%	⟶	64 percentage

Finding net amount

An additional feature is that the original base number is not destroyed during a percentage calculation. From this may be calculated the net amount simply by pressing + or –, as applicable:

PRESS		SEE
256 ENTER↑	⟶	256 base
25 %	⟶	64 percentage
+	⟶	320 net amount (base + percentage)

or

PRESS		SEE
256 ENTER↑	⟶	256 base
25 %	⟶	64 percentage
–	⟶	192 net amount (base – percentage)

Finding percent difference between two numbers

To find the percent difference between a number and a base, key in the base number and press ENTER↑. Key in the second number and press Δ%. For example, if you wish to find the rate of increase in your rent ($200 last month and $225 now),

PRESS		SEE
200 ENTER↑	⟶	200 base number
225	⟶	225 second number
Δ%	⟶	12.5 percent increase

to verify, continue:

X↕Y	⟶	200 base number
X↕Y	⟶	12.5 percentage
%	⟶	25 increase amount (second number – base)
+	⟶	225 second number

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DATA REGISTERS

In addition to the operational stack, the hand calculator program provides 9 registers for user storage.

Unrestricted Storage

Registers R_1 through R_4 and register R_9 can be used for temporary storage without restriction. Values stored in these registers are not affected by calculations or by clearing operations. New values are entered by writing over the old contents; that is, by storing a new number. The contents are lost, of course, whenever the program is started (RUN).

Restricted Storage

Registers R_5 through R_8 are zeroed by the CLEAR function. This is the only difference between restricted and unrestricted storage.

Storing and Recalling Data

To store a value appearing on the display (whether the result of a calculation or a key entry), press STO followed by the number key (1 through 9) specifying the indicated storage register. To retrieve the value at any time, press RCL followed by the applicable number key. A copy of the recalled value appears on the display (X register); the storage register is unaffected. The stack is pushed up (an automatic ENTER↑ is performed) before the recall unless the last operation was a CLX or ENTER↑. These keys do not cause the stack to be pushed up by the last data entry. For example, when calculating the amount of interest and the amount from principle in a loan payment above, the original principle amount was keyed in twice. Using a register can avoid this needless delay. Assuming a principle amount of $7000, monthly payments of $105.65, and a 7% annual interest rate, find the parts of the first <u>two</u> payments credited to interest and credited to principle, and the remaining principle after these two payments.

PRESS		SEE	
7 ENTER↑ 12 ÷	→	0.583333333333	(monthly percent)
STO 1	——→	0.583333333333	
105.65	——→	105.65	(monthly payment)
STO 2	——→	105.65	

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PRESS (cont)		SEE (cont)	
7000	→	7000	(principle)
STO 3	→	7000	
RCL 1	→	0.583333333333	
%	→	40.8333333333	(amount of interest in first payment)
RCL 2	→	105.65	
X↕Y	→	40.8333333333	
-	→	64.8166666667	(amount of first payment credited to principle)
RCL 3	→	7000	
X↕Y	→	64.8166666667	
-	→	6935.18333333	(amount of principle remaining after first payment)
STO 3	→	6935.18333333	(replace old principle)
RCL 1 %	→	40.4552361111	(amount of second payment credited to interest)
RCL 2 X↕Y -	→	65.1947638889	(amount of second payment credited to principle)
RCL 3 X↕Y -	→	6869.98856944	(remaining principle after second payment)

Note that one can loop back and perform this process repeatedly. Note also that only the values at the first were keyed in, all intermediate values are stored internally, thus reducing time required and also the chance for error.

Performing Register Arithmetic

Arithmetic operations (+, -, ×, ÷) can be performed between a data storage register and the X register (display). To modify the contents of a storage register, press STO followed by the applicable operator key (+, -, ×, ÷), then the number key specifying the storage register. For example, to store 6 in register R_1 and then increment it by 2:

PRESS		SEE
6 STO 1	→	6
2	→	2
STO + 1	→	2

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To see what is now in R_1,

RCL 1 ⟶ 8

Now, to subtract 3 from the contents of R_1,

3 ⟶ 3
STO - 1 ⟶ 3
RCL 1 ⟶ 5

Conversely, to alter the X register (display) without affecting the data storage register or any other stack registers, press RCL, then the applicable operator (+, −, ×, ÷), followed by the number of the desired register. For example:

PRESS	SEE
4 STO 9	9
CLX	0
7	7
RCL + 9	11
RCL - 9	7
RCL - 9	3
RCL ÷ 9	0.75
RCL 9	4

It is worth noting that a RCL ÷ 2 (for example) does exactly the same thing as a RCL 2 ÷, except that the stack is not moved up a position. This extends the number carrying capability of the stack.

APPENDIX

The flowchart which follows allows evaluation of any expression on a calculator using an operational stack and reverse "Polish" (Lukasiewicz) notation. Although the general case solution requires an operational stack of infinite length, the four register stack of the hand calculator program allows solutions of most expressions of normal complexity. Before using the algorithm, write the expression in serial form. For example $\frac{7}{32 - \frac{31}{(6)}}$ can be rewritten as

7/(32 - (31/(6))).

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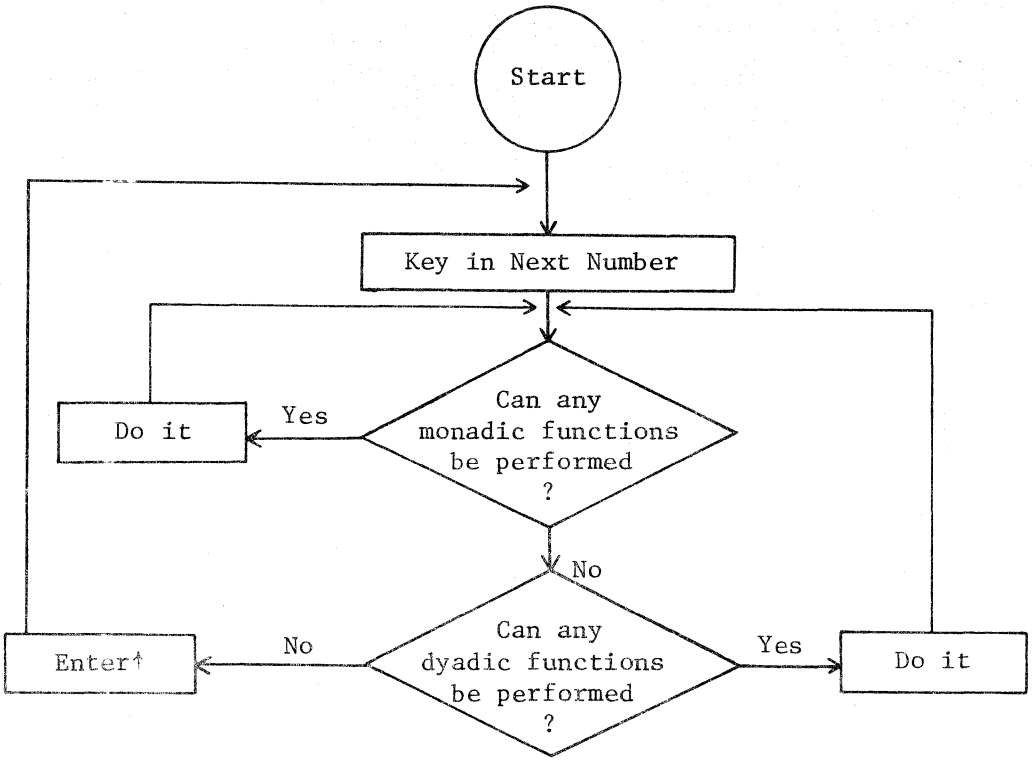

DATA STRUCTURES

Memory Allocation to Variables

736 Bytes

Memory Allocation for Program

8371 Bytes

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VARIABLE MAP

VARIABLE	TAPE FILE	USAGE
F		Used in RCL and STO operations to determine whether register arithmetic is desired and if so, what type: F = 0 No register arithmetic F = 1 + F = 2 − F = 3 × F = 4 ÷
G		Used to determine mode of operation. G = 1 Regular Function G = 2 Alternate (Colored) Function G = 3 STO Operation G = 4 RCL Operation G = 5 ARC Operation
I1		Work Variable
K		On some keys, used to store key number struck.
M(9)		The nine storage registers M(1) is register 1, etc.
S(4)		The four-place Stack. S(1) = X register, S(2) = Y register, S(3) = Z register, S(4) = T register.
B$		Work String (72)
C$		Work String (72)
D$		Work String (72)
V$		Contains Backspace Character (1)
X$		Contains Current Number Entry String (72)
Z$		Contains current function name (7)

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

USER PROGRAMMABLE KEYS

KEY	LABEL	TAPE FILE	FUNCTION
1	1(Y^x)		The digit 1 and the function Y^x.
2	2($\sqrt{x}$)		The digit 2 and the function $\sqrt{}$.
3	3(10^x)		The digit 3 and the base 10 antilog function.
4	4(Δ%)		The digit 4 and the function "change in percent".
5	5(%)		The digit 5 and the percent function.
6	6(1/x)		The digit 6 and the reciprocal function.
7	7(ARC)		The digit 7 and the ARC trig function shift.
8	8(SIN)		The digit 8 and the SIN function.
9	9(COS)		The digit 9 and the COS function.
10	0(TAN)		The digit 0 and the TAN function.
11	.(LOG)		The decimal point and the Base 10 Logarithm function.
12	CHS(LN)		The "change sign" directive and the natural logarithm function.
13	EEX(e^x)		The "enter exponent" directive and the natural antilog function.
14	CLX(CLEAR)		The clear x function and the clear calculator directive.
15	( )		The color shift (alternate function) key.
16	+(X↑↓Y)		The Add function and the X-Y swap directive.
17	-(R↓)		The Subtract function and the roll stack directive.
18	×(STO)		The Multiply function and the store register shift key.
19	÷(RCL)		The Divide function and the recall register shift key.
20	ENTER↑(π)		The Enter directive and the π constant.

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
1 GO TO 100
4 K=1
5 GO TO G OF 520,1890,2860,3000,520
8 K=2
9 GO TO G OF 520,1950,2860,3000,520
12 K=3
13 GO TO G OF 520,1850,2860,3000,520
16 K=4
17 GO TO G OF 520,2000,2860,3000,520
20 K=5
21 GO TO G OF 520,2210,2860,3000,520
24 K=6
25 GO TO G OF 520,2250,2860,3000,520
28 K=7
29 GO TO G OF 520,2390,2860,3000,2390
32 K=8
33 GO TO G OF 520,2300,2860,3000,2340
36 K=9
37 GO TO G OF 520,2430,2860,3000,2470
40 K=0
41 GO TO G OF 520,2520,520,520,2560
44 GO TO G OF 600,1580,600,600,600
48 GO TO G OF 890,1730,890,890,890
52 GO TO G OF 760,1810,760,760,760
56 GO TO G OF 1300,1210,1300,1300,1300
60 IF G=5 THEN 280
61 G=2
62 GO TO 280
64 K=16
65 GO TO G OF 1350,2050,2730,2730,1350
68 K=17
69 GO TO G OF 1400,2140,2730,2730,1400
72 K=18
73 GO TO G OF 1450,2600,2730,2730,1450
76 K=19
77 GO TO G OF 1500,2660,2730,2730,1500
80 GO TO G OF 420,470,420,420,420
100 INIT
110 SET KEY
120 SET DEGREE
130 PAGE
140 DIM S(4),M(9),V$(1),Z$(7)
150 V$=CHR(8)
160 Z$=""
170 S=0
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
180 M=0
190 X$=""
200 G=1
210 PRINT " CLEAR"
220 PRINT S(1)
230 GO TO 300
240 X$=""
250 G=1
260 PRINT " ";Z$
270 PRINT S(1)
280 Z$=""
290 RETURN
300 GO TO 300

310 REM PUSH SUBROUTINE ----------

320 S(4)=S(3)
330 S(3)=S(2)
340 S(2)=S(1)
350 RETURN

360 REM POP SUBROUTINE ----------

370 S(1)=S(2)
380 S(2)=S(3)
390 S(3)=S(4)
400 RETURN

410 REM ENTER↑ SECTION ----------

420 GOSUB 320
430 X$=" "
440 Z$="ENTER↑"
450 GO TO 250

460 REM PI SECTION ----------

470 GOSUB 320
480 S(1)=PI
490 Z$="PI"
500 GO TO 240

510 REM NUMBER SECTION ----------

520 IF LEN(X$)>0 THEN 540
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
530 GOSUB 320
540 B$=CHR(48+K)
550 X$=X$&B$
560 S(1)=VAL(X$)
570 PRINT B$;
580 GO TO 280

590 REM . SECTION --------------------

600 I1=POS(X$,".",1)
610 IF I1=0 THEN 630
620 GO TO 730
630 I1=POS(X$,"E",1)
640 IF I1<>0 THEN 730
650 IF LEN(X$)>0 THEN 700
660 GOSUB 320
670 X$="."
680 S(1)=0
690 GO TO 720
700 X$=X$&"."
710 S(1)=VAL(X$)
720 PRINT ".";
730 G=1
740 GO TO 280

750 REM EEX SECTION ------------------

760 I1=POS(X$,"E",1)
770 IF I1<>0 THEN 860
780 IF LEN(X$)>0 AND S(1)<>0 THEN 830
790 X$=X$&"1E0"
800 PRINT "1E";
810 S(1)=1
820 GO TO 860
830 IF X$=" " THEN 790
840 X$=X$&"E"
850 PRINT "E";
860 G=1
870 GO TO 280

880 REM CHS SECTION ------------------

890 Z$="CHS"
900 IF LEN(X$)=0 THEN 920
910 IF X$<>" " THEN 940
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
920 S(1)=S(1)*-1
930 GO TO 250
940 I1=POS(X$,"E",1)
950 IF I1=0 THEN 1050
960 C$=SEG(X$,1,I1)
970 D$=SEG(X$,I1+1,LEN(X$)-I1)
980 B$=SEG(D$,1,1)
990 IF B$="-" THEN 1020
1000 D$="-"&D$
1010 GO TO 1030
1020 D$=SEG(D$,2,LEN(D$)-1)
1030 X$=C$&D$
1040 GO TO 1100
1050 B$=SEG(X$,1,1)
1060 IF B$="-" THEN 1090
1070 X$="-"&X$
1080 GO TO 1100
1090 X$=SEG(X$,2,LEN(X$)-1)
1100 IF X$="." THEN 1180
1110 IF X$="-." THEN 1180
1120 IF X$="-" THEN 1180
1130 S(1)=VAL(X$)
1140 PRINT " ";Z$
1150 PRINT " ";X$;
1160 G=1
1170 GO TO 280
1180 S(1)=0
1190 GO TO 1140

1200 REM CLEAR SECTION ----------------

1210 S=0
1220 M(5)=0
1230 M(6)=0
1240 M(7)=0
1250 M(8)=0
1260 PAGE
1270 Z$="CLEAR"
1280 GO TO 240

1290 REM CLX SECTION ----------------

1300 S(1)=0
1310 X$=" "
1320 Z$="CLX"
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
1330 GO TO 250

1340 REM + SECTION --------------------

1350 S(1)=S(1)+S(2)
1360 GOSUB 380
1370 Z$="+"
1380 GO TO 240

1390 REM - SECTION --------------------

1400 S(1)=S(2)-S(1)
1410 GOSUB 380
1420 Z$="-"
1430 GO TO 240

1440 REM x SECTION --------------------

1450 S(1)=S(1)*S(2)
1460 GOSUB 380
1470 Z$="x"
1480 GO TO 240

1490 REM / SECTION --------------------

1500 Z$=V$
1510 Z$=Z$&":"
1520 Z$="-"&Z$
1530 IF S(1)=0 THEN 1650
1540 S(1)=S(2)/S(1)
1550 GOSUB 380
1560 GO TO 240

1570 REM LOG SECTION ------------------

1580 Z$="LOG"
1590 IF S(1)<=0 THEN 1660
1600 IF S(1)=1 THEN 1630
1610 S(1)=LGT(S(1))
1620 GO TO 240
1630 S(1)=0
1640 GO TO 240

1650 REM ERROR ROUTINE ----------------
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
1670 X$=""
1680 PRINT " ";Z$
1690 PRINT " ERROR! --- ";0
1700 S(1)=0
1710 GO TO 280

1720 REM LN ROUTINE ------------------

1730 Z$="LN"
1740 IF S(1)<=0 THEN 1660
1750 IF S(1)=1 THEN 1780
1760 S(1)=LOG(S(1))
1770 GO TO 240
1780 S(1)=0
1790 GO TO 240

1800 REM e↑X SECTION ------------------

1810 Z$="e↑X"
1820 S(1)=2.71828182846↑S(1)
1830 GO TO 240

1840 REM 10↑X SECTION ----------------

1850 Z$="10↑X"
1860 S(1)=10↑S(1)
1870 GO TO 240

1880 REM Y↑X SECTION ------------------

1890 Z$="Y↑X"
1900 IF S(2)<=0 THEN 1660
1910 S(1)=S(2)↑S(1)
1920 GOSUB 380
1930 GO TO 240

1940 REM SQRT SECTION ----------------

1950 Z$="SQRT"
1960 IF S(1)<0 THEN 1660
1970 S(1)=S(1)↑0.5
1980 GO TO 240

1990 REM DELTA % SECTION -------------
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
2000 Z$="DELTA %"
2010 IF S(2)=0 THEN 1660
2020 S(1)=(S(1)-S(2))/S(2)*100
2030 GO TO 240

2040 REM X<>Y SECTION ----------------

2050 Z$=CHR(127)
2060 Z$=Z$&V$
2070 Z$=Z$&"↑Y"
2080 Z$="X"&Z$
2090 I1=S(2)
2100 S(2)=S(1)
2110 S(1)=I1
2120 GO TO 240

2130 REM ROLL STACK SECTION -----------

2140 Z$=CHR(127)
2150 Z$="R"&Z$
2160 I1=S(1)
2170 GOSUB 370
2180 S(4)=I1
2190 GO TO 240

2200 REM % SECTION --------------------

2210 Z$="%"
2220 S(1)=S(1)*S(2)/100
2230 GO TO 240

2240 REM 1/X SECTION ------------------

2250 Z$="1/X"
2260 IF S(1)=0 THEN 1660
2270 S(1)=1/S(1)
2280 GO TO 240

2290 REM SIN SECTION ------------------

2300 Z$="SIN"
2310 S(1)=SIN(S(1))
2320 GO TO 240
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
2340 Z$="SIN"
2350 IF S(1)>1 THEN 1660
2360 S(1)=ASN(S(1))
2370 GO TO 240

2380 REM ARC SECTION ------------------

2390 G=5
2400 PRINT " ARC";
2410 GO TO 280

2420 REM COS SECTION ------------------

2430 Z$="COS"
2440 S(1)=COS(S(1))
2450 GO TO 240

2460 REM ARC COS SECTION --------------

2470 Z$="COS"
2480 IF S(1)>1 THEN 1660
2490 S(1)=ACS(S(1))
2500 GO TO 240

2510 REM TAN SECTION ------------------

2520 Z$="TAN"
2530 S(1)=TAN(S(1))
2540 GO TO 240

2550 REM ARC TAN SECTION --------------

2560 Z$="TAN"
2570 S(1)=ATN(S(1))
2580 GO TO 240

2590 REM STO SECTION ------------------

2600 G=3
2610 F=1
2620 X$=""
2630 PRINT " STO";
2640 GO TO 280
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
2650 REM RCL SECTION ------------------

2660 G=4
2670 F=1
2680 IF X$=" " THEN 2700
2690 X$=""
2700 PRINT " RCL";
2710 GO TO 280

2720 REM STO,RCL FUNCTION SECTION -----

2730 F=K-14
2740 IF X$=" " THEN 2760
2750 X$=""
2760 GO TO F OF 280,2770,2790,2810,2830
2770 PRINT " +";
2780 GO TO 280
2790 PRINT " -";
2800 GO TO 280
2810 PRINT " x";
2820 GO TO 280
2830 PRINT " -";V$;":";
2840 GO TO 280

2850 REM STO REG SECTION --------------

2860 Z$=CHR(K+48)
2870 GO TO F OF 2880,2900,2920,2940,2960
2880 M(K)=S(1)
2890 GO TO 240
2900 M(K)=M(K)+S(1)
2910 GO TO 240
2920 M(K)=M(K)-S(1)
2930 GO TO 240
2940 M(K)=M(K)*S(1)
2950 GO TO 240
2960 IF S(1)=0 THEN 1660
2970 M(K)=M(K)/S(1)
2980 GO TO 240

2990 REM RCL REG SECTION --------------

3000 Z$=CHR(K+48)
3010 GO TO F OF 3020,3060,3080,3100,3120
```

TITLE	ABSTRACT NUMBER
HAND CALCULATOR	51/00-6001/0

```
3020 IF X$=" " THEN 3040
3030 GOSUB 320
3040 S(1)=M(K)
3050 GO TO 240
3060 S(1)=S(1)+M(K)
3070 GO TO 240
3080 S(1)=S(1)-M(K)
3090 GO TO 240
3100 S(1)=S(1)*M(K)
3110 GO TO 240
3120 IF M(K)=0 THEN 1660
3130 S(1)=S(1)/M(K)
3140 GO TO 240
```

TEKTRONIX®

APPLICATION LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0
	MEMORY REQUIREMENT 16K
AUTHOR DAN TAYLOR, G S Software Engineering	PERIPHERALS

ABSTRACT

PLANE TRIANGLE SOLUTIONS is an interactive program which graphically demonstrates the relationship between sides and angles of a triangle.

The user enters any three of the three sides and three angles of a triangle. The program solves for the unknown sides and/or angles and prints their values. It then draws the triangle with the sides and angles labeled with their values.

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PLANE TRIANGLE SOLUTIONS	51/00-5501/0

LIMITATIONS

All angles are in decimal degrees. A user angle in degrees, minutes, seconds must be converted to decimal degrees by the user before it is entered.

For example:

X deg Y min Z sec = X + Y/60 + Z/3600 decimal degrees.

10 deg 30 min = 10.5 degrees.

However, the program is designed so that you need delete only two lines of code to change input and output of angles to deg, min, sec. form. Angles are then represented as deg. min sec. For example:

10 deg 30 min 15 sec = 10.3015

10 deg 30 min 15.28 sec = 10.301528

10.3015 would be the "number" the user enters and would receive printed back. Line No. 1800 and No. 3130 are the two lines which must be deleted. Both are preceeded with remark statements to that effect.

METHODOLOGY

Standard trig formulas such as the "law of sines" and "law of cosines" are used.

With angles A, B, C and opposite sides a, b, c

law of sines $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

law of cosines $a^2 = b^2 + c^2 - 2bc \cos A$

REFERENCES

Selby, Samuel M. Ph.D., editor, Standard Mathematical Tables, Fourteenth Edition, Cemical Rubber Co., Cleveland, Ohio.

Wilson, Jeff, Plane Triangles, Abstract No. 3558/001-00 (Tektronix 31 Demo Library) Systems Analyst, Palo Alto, Calif.

MAN/MACHINE INTERFACE

This program is a turn-key package and requires no user programming. You simply type RUN and follow the instructions.

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PLANE TRIANGLE SOLUTIONS	51/00-5501/0

OPERATING INSTRUCTIONS

LOADING THE PROGRAM

Type in the program from the listings or OLD it from tape.

RUNNING THE PROGRAM

Type RUN and press "RETURN". Follow the instructions printed on the screen. Note: a side or angle entered as 0 is treated as an unknown. Also, "side" always refers to the length of that side.

As soon as three (non-zero) values have been entered the program will attempt to find a solution.

If the values you have entered (or failed to enter) result in an error condition then:

1. One of the following messages is printed:

   NO SOLUTION

   NO SIDE ENTERED. TRY AGAIN.

   or LESS THAN 3 ENTRIES. TRY AGAIN.

2. The program pauses for a few seconds while the bell rings.
3. The program starts over from the beginning.

If a solution is found then:

1. The values for the unknown sides and/or angles are printed.

2. At the bottom of the screen it prints: Press "Return" for the graph. A blinking "?" appears. This causes execution to stop until you press "RETURN".
3. After you press "RETURN" it pages, draws the triangle, labels the vertices, and then labels the sides. The triangle is always oriented so that side A is horizontal and vertex A is above it. The window and viewport are adjusted so that all triangles are drawn distortion free (i.e., 90 degrees always looks like 90 degrees).

4. At the bottom of the screen it prints the message: Press "Return" to continue. When you're done looking at the picture press "RETURN".

5. If there was only one solution triangle the program starts over from the beginning. If there were two solutions the second solution is provided as in 1 through 4, above, and then it starts over.

MEMORY ALLOCATION FOR PROGRAM

The program itself requires 7.5K bytes. It was not designed to be broken into segments and overlayed on a 6K machine, and therefore requires at least an opt. 1 4051. (16K)

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0

VARIABLE MAP

VARIABLE	TAPE FILE	USAGE
J,J1		Scratch indexes
K0, K1, K2 K5,----K9		Scratch
K		A linear array, K(6), containing the values for the sides and angles. K(1), K(2), K(3) are sides A, B, C K(4), K(5), K(6) are angles A, B, C.
K3		A linear array, K3(3) containing the X-coordinate values when the triangle is situated on the X, Y plane.
K4		A linear array, K4(3), containing the Y-coordinate values. Vertexes B and C are always on the X axis. B is always at the origin and C is always to the right of B (positive X).
K$		Scratch string variable
R0,-----, R9		Scratch
R$		String variable used for the entry of user sides and angles and for scratch
S0,-----, S6		Scratch

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0

```
100 REM  PLANE TRIANGLE SOLUTIONS  --  4051/MATH-001
110 REM        SEPT. 1975,  DAN TAYLOR, GS SOFTWARE ENGINEERING
120 REM        TEKTRONIX INC., BEAVERTON, OREGON

1000 PRINT "L******PLANE TRIANGLE SOLUTIONS******"
1010 PRINT "JENTER SIDES AND/OR ANGLES AS THEY ARE REQUESTED."
1020 PRINT "IF UNKNOWN, PRESS ""RETURN"" WITHOUT MAKING AN ENTRY."
1030 PRINT "J      ALL ANGLES ARE ASSUMED TO BE IN DECIMAL DEGREES.J"
1040 INIT

1050 REM

1060 ON SIZE THEN 2220
1070 DIM K(6),K3(3),K4(3)
1080 SET DEGREES
1090 R0=0.5
1100 K0=0
1110 R1=0
1120 R2=0
1130 K=0
1140 K$="SIDE "
1150 J1=64
1160 GOSUB 1320
1170 IF K0<>0 THEN 1200
1180 PRINT "JJNO SIDE ENTERED.  TRY AGAIN.GGGGGGGGGGG"
1190 RUN
1200 K$="      ANGLE "
1210 J1=61
1220 GOSUB 1320
1230 PRINT "JJJ"
1240 R0=0
1250 K1=0
1260 IF K0=3 THEN 1290
1270 PRINT "JJLESS THAN 3 ENTRIES.  TRY AGAIN.GGGGGGGGGGG"
1280 RUN
1290 IF K(4)=0 AND K(5)=0 AND K(6)=0 THEN 2700
1300 GO TO 1540

1310 REM  ************************************

1320 FOR J=65 TO 67
1330    GOSUB 1380
1340    K(J-J1)=K8
1350 NEXT J
```

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```
1360 RETURN

1370 REM  DATA ENTRY OF SIDES/ANGLES

1380 R0=R0+R0
1390 K8=0
1400 IF K0<3 THEN 1420
1410 RETURN
1420 R$=CHR(J)
1430 PRINT "J";K$;R$;" = ";
1440 INPUT R$
1450 R$=R$&" 0"
1460 K8=ABS(VAL(R$))
1470 IF K8>0 THEN 1490
1480 RETURN
1490 K0=K0+1
1500 R2=R2+R0
1510 RETURN

1520 REM  ************************************
1530 REM            ANGLE CALCULATIONS

1540 K0=0
1550 FOR J=4 TO 6
1560    GOSUB 1740
1570 NEXT J
1580 IF K0=1 THEN 2550
1590 FOR J=4 TO 6
1600    IF K(J)<>0 THEN 1630
1610    IF K(J-3)<>0 THEN 1630
1620    GO TO 2100
1630 NEXT J
1640 FOR J=1 TO 2
1650    IF K(J)<>0 THEN 1670
1660    GOSUB J OF 1870,1960
1670 NEXT J
1680 K(3)=SQR(K(1)↑2-2*COS(K(6))*K(1)*K(2)+K(2)↑2)
1690 GOSUB 2040
1700 K(5)=180-K(4)-K(6)
1710 GOSUB 2770
1720 RUN

1730 REM  CHANGE DEG.MIN TO DECIMAL DEGREE(IF LINE BELOW IS REMOVED)

1740 IF K(J)<>0 THEN 1770
```

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0

```
1750 K0=K0+1
1760 RETURN
1770 K7=K(J)
1780 IF K7=>180 THEN 2220

1790 REM  REMOVE THE NEXT LINE FOR ANGLES = DEG.MINSEC

1800 GO TO 1850
1810 K8=INT(K7)
1820 K7=100*(K7-K8)
1830 K9=INT(K7+1.0E-10)
1840 K(J)=((K7-K9)/0.6+K9)/60+K8
1850 RETURN

1860 REM  CYCLE ANGLES AND SIDES

1870 R0=R0+1
1880 FOR J1=1 TO 4 STEP 3
1890    K0=K(J1)
1900    K(J1)=K(J1+1)
1910    K(J1+1)=K(J1+2)
1920    K(J1+2)=K0
1930 NEXT J1
1940 RETURN

1950 REM  SWITCH ELEMENTS OF K

1960 R1=-ABS(R1-1)
1970 FOR J1=2 TO 5 STEP 3
1980    K0=K(J1)
1990    K(J1)=K(J1+1)
2000    K(J1+1)=K0
2010 NEXT J1
2020 RETURN

2030 REM  CALCULATE ANGLE

2040 K(4)=0.5*(K(2)↑2-K(1)↑2+K(3)↑2)/(K(2)*K(3))
2050 IF ABS(K(4))>1 THEN 2220
2060 K(4)=ACS(K(4))
2070 RETURN

2080 REM  BOTH AN ANGLE AND ITS ASSOCIATED SIDE ARE MISSING
2090 REM  ************************************
```

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0

```
2110 GOSUB 1870
2120 GO TO 2100
2130 IF K(4)<>0 THEN 2160
2140 GOSUB 1870
2150 GO TO 2100
2160 IF K(2)<>0 THEN 2180
2170 GOSUB 1960
2180 K9=SIN(K(4))*K(2)/K(1)
2190 IF K9<=1 THEN 2240
2200 K9=K(1)
2210 IF K9<=1 THEN 2240
2220 PRINT "JJNO SOLUTIONGGGGGGGGGGG"
2230 RUN
2240 K(5)=ASN(K9)
2250 S1=K(5)-K(4)
2260 K(6)=180-K(5)-K(4)
2270 K(3)=SIN(K(6))*K(1)/SIN(K(4))
2280 IF S1=>0 THEN 2310
2290 GOSUB 2770
2300 RUN
2310 PRINT "JJTHERE ARE 2 SOLUTIONS.  THE FIRST IS:J"
2320 S0=180-K(5)
2330 R8=SIN(S1)*K(1)/SIN(K(4))
2340 R6=K(1)
2350 R7=K(2)
2360 R9=K(4)
2370 R3=R0
2380 R4=R1
2390 R5=R2
2400 GOSUB 2770
2410 PRINT "LTHE SECOND SOLUTION IS:J"
2420 R0=R3
2430 R1=R4
2440 R2=0
2450 K(1)=R6
2460 K(2)=R7
2470 K(3)=R8
2480 K(4)=R9
2490 K(5)=S0
2500 K(6)=S1
2510 GOSUB 2770
2520 RUN

2530 REM  ************************************
```

TITLE	ABSTRACT NUMBER
PLANE TRIANGLE SOLUTIONS	51/00-5501/0

```
2540 REM  ONE QUANTITY LEFT UNKNOWN

2550 IF K(1)<>0 THEN 2580
2560 GOSUB 1870
2570 GO TO 2550
2580 IF K(5)<>0 THEN 2600
2590 GOSUB 1960
2600 IF K(4)<>0 THEN 2620
2610 K(4)=180-K(5)-K(6)
2620 K9=K(1)/SIN(K(4))
2630 K(2)=K9*SIN(K(5))
2640 IF K(6)<>0 THEN 2660
2650 K(6)=180-K(4)-K(5)
2660 K(3)=K9*SIN(K(6))
2670 GOSUB 2770
2680 RUN

2690 REM  ALL THREE SIDES ARE GIVEN

2700 FOR J=1 TO 3
2710    GOSUB 2040
2720    GOSUB 1870
2730 NEXT J
2740 GOSUB 2770
2750 RUN
```

TEKTRONIX®

APPLICATION LIBRARY PROGRAM

TITLE	ABSTRACT NUMBER
CIRCLE SOLUTIONS	51/00-5502/0
	MEMORY REQUIREMENT 8K
AUTHOR DAN TAYLOR, G S Software Engineering	PERIPHERALS

ABSTRACT

CIRCLE SOLUTIONS is an interactive program which graphically demonstrates the relationship between a sector and its circle.

The user enters any two of the angle, radius, chord, or arc of a sector. The program solves for the unknowns and prints their values. It then draws the circle and the sector and labels the portions of the sector.

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LIMITATIONS

The angle of the sector is in decimal degrees. A user angle in degrees, minutes, seconds must be converted to decimal degrees by the user before it is entered. For example:

X deg Y min Z sec = X+Y/60 + Z/3600 decimal degrees.

10 deg 30 min = 10.5 degrees

METHODOLOGY

The standard formulas relating the portions of a sector are used:

arc = radius * angle * π/180

chord = 2 * radius * sin (angle/2)

radius = chord/ (2 * sin (angle/2))
= (arc/angle) * 180/π

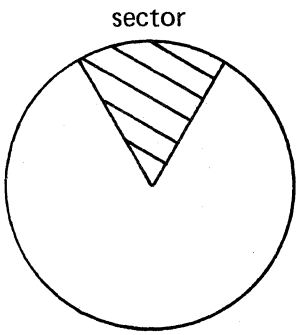
The only complication arises when the user enters the arc and the chord.

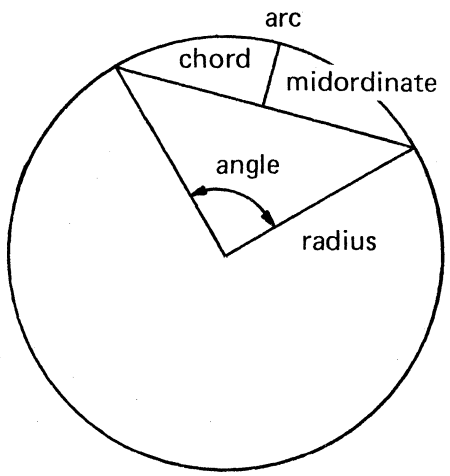
Then we use the formula:

sin(angle/2) / (angle/2) = (chord/arc) * π/180

This is a transcendental equation with the angle the unknown. An iterative method (bisection) is used to solve for the angle.

$$\text{midordinate} = \text{radius} - \sqrt{\text{radius}\uparrow 2 - \frac{\text{chord}\uparrow 2}{4}}$$





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REFERENCES

Lai, Leslie, Circle Solutions, Abstract No. 3558/004-000 (Tektronix 31 Demo Library) Irvine, Cal.

Selby, Samuel M. Ph.D., editor, Standard Mathematical Tables, Fourteenth Edition, Chemical Rubber Co., Cleveland, Ohio.

MAN/MACHINE INTERFACE

This program is a turn-key package and requires no user programming. You simply type RUN and follow the instructions.

OPERATING INSTRUCTIONS

LOADING THE PROGRAM

Type in the program from the listings or OLD it from tape.

RUNNING THE PROGRAM

Type RUN and press "RETURN". Follow the instructions printed on the screen. Note: a value entered as 0 is treated as an unknown.

After two valid (non-zero) values have been entered the program will attempt to solve for the unknowns.

If the values you have entered (or failed to enter) result in an error condition then:

1. One of the following messages is printed

   NO SOLUTION

   or TWO ENTRIES REQUIRED

2. The program pauses for a few seconds while the bell rings.

3. The program starts over from the beginning.

If a solution is found then:

1. The values for the unknown parameters are printed.

2. At the bottom of the screen it prints Press "Return" for the Graph and a blinking "?" appears. This causes execution to stop until you press "RETURN".

3. It pages, draws the circles, draws the sector, and labels the portions of the sector. The size of the circle on the screen depends upon the radius of the circle as long as the radius is between 1 and 100. The circle is never allowed to appear too big or too small.

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4. At the bottom of the screen it prints Press "Return" to continue. After you press "RETURN" the program starts over from the beginning.

MEMORY ALLOCATION FOR THE PROGRAM

The program requires about 4K bytes and will therefore fit easily in a 8K machine.

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VARIABLE MAP

VARIABLE	TAPE FILE	USAGE
K0		Used for the entry of the values.
K1		Angle
K2		Radius
K3		Arc
K4		Chord
K5		$180/\pi$
K6		Midordinate and (chord/arc)/K5 when chord and arc are entered.
K7, R1, R2		Scratch
K$		Used for entry of the values and as a scratch string variables.

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```
100 REM  CIRCLE SOLUTION  --  4051/MATH-002
110 REM          SEPT. 1975,  DAN TAYLOR, GS SOFTWARE ENGINEERING
120 REM          TEKTRONIX INC., BEAVERTON, OREGON

1000 PRINT "L******CIRCLE SOLUTIONS******J"
1010 PRINT "ENTER VALUES AS THEY ARE REQUESTED."
1020 PRINT "IF UNKNOWN, PRESS ""RETURN"" WITHOUT MAKING AN ENTRY."
1030 PRINT "J      ALL ANGLES ARE ASSUMED TO BE IN DECIMAL DEGREES.J"
1040 INIT
1050 K5=180/PI
1060 SET DEGREES
1070 ON SIZE THEN 2480
1080 DEF FNK(X)=SIN(X)-K6*X
1090 PRINT "J ANGLE = ";
1100 GOSUB 1470
1110 K1=K0
1120 IF K1=>360 THEN 2480
1130 IF K1=0 THEN 1520

1140 REM  ******THE ANGLE, K1, HAS BEEN ENTERED******

1150 GOSUB 1340
1160 IF K2=0 THEN 1220
1170 K3=K1/K5*K2
1180 PRINT "JJJI   ARC = ";K3
1190 K4=2*K2*SIN(0.5*K1)
1200 PRINT "JI CHORD = ";K4
1210 GO TO 1880
1220 GOSUB 1380
1230 IF K3=0 THEN 1270
1240 K2=K5/K1*K3
1250 PRINT "JJJIRADIUS = ";K2
1260 GO TO 1190
1270 GOSUB 1420
1280 K2=0.5*K4/SIN(0.5*K1)
1290 PRINT "JJJIRADIUS = ";K2
1300 K3=K1/K5*K2
1310 PRINT "JI   ARC = ";K3
1320 GO TO 1880

1330 REM ******FOUR UTILITY ROUTINES******

1340 PRINT "JRADIUS = ";
1350 GOSUB 1470
```

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```
1360 K2=K0
1370 RETURN
1380 PRINT "J   ARC = ";
1390 GOSUB 1470
1400 K3=K0
1410 RETURN
1420 PRINT "J CHORD = ";
1430 GOSUB 1470
1440 IF K0=0 THEN 2500
1450 K4=K0
1460 RETURN
1470 INPUT K$
1480 K$=K$&" 0"
1490 K0=ABS(VAL(K$))
1500 RETURN

1510 REM  ******THE ANGLE, K1, WAS NOT ENTERED.******

1520 GOSUB 1340
1530 IF K2=0 THEN 1670
1540 GOSUB 1380
1550 IF K3=0 THEN 1600
1560 K1=K5*K3/K2
1570 IF K1>360 THEN 2480
1580 PRINT "JJJI ANGLE = ";K1
1590 GO TO 1190
1600 GOSUB 1420
1610 K1=0.5*K4/K2
1620 IF K1>1 THEN 2480
1630 K1=2*ASN(K1)
1640 PRINT "JJJI ANGLE = ";K1
1650 GO TO 1300

1660 REM  ******NEITHER ANGLE NOR RADIUS (K1,K2) WERE ENTERED******

1670 GOSUB 1380
1680 IF K3=0 THEN 2500
1690 GOSUB 1420
1700 IF K4=>K3 THEN 2480
1710 K6=K4/(K3*K5)

1720 REM  ******SOLVE SIN(K1/2) = (K1/2)*K6 BY BISECTION******

1730 R1=1.0E-300
1740 R2=180
```

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```
1750 IF FNK(R1)<0 THEN 2480
1760 FOR K2=1 TO 50
1770    K1=0.5*(R1+R2)
1780    IF FNK(K1)<0 THEN 1810
1790    R1=K1
1800    GO TO 1820
1810    R2=K1
1820 NEXT K2
1830 K1=K1+K1
1840 PRINT "JJJI ANGLE = ";K1
1850 K2=K5/K1*K3
1860 PRINT "JIRADIUS = ";K2

1870 REM  ******CALCULATE MIDORDINATE AND FIX SCREEN FOR PLOT*****

1880 K6=K2-SQR(K2↑2-0.25*K4↑2)
1890 PRINT "J              MIDORDINATE = ";K6
1900 PRINT "↑KIIPRESS ""RETURN"" FOR THE GRAPH.GK    ";
1910 INPUT K$

1920 REM  **************DRAW LABELED CIRCLE ON SCREEN**********
1930 REM 1ST:  ADJUST WINDOW AND VIEWPORT

1940 VIEWPORT 25,105,10,90
1950 R1=2.2-0.011*K2 MAX 1.1
1960 WINDOW -R1,R1,-R1,R1

1970 REM 2ND:  DRAW CIRCLE

1980 PAGE
1990 MOVE 1,0
2000 FOR R2=0 TO 360 STEP 6
2010    DRAW COS(R2),SIN(R2)
2020 NEXT R2

2030 REM 3RD:  DRAW TRIANGLE TO SHOW ANGLE

2040 R2=90-0.5*K1
2050 K5=COS(R2)
2060 K6=SIN(R2)
2070 MOVE K5,K6
2080 DRAW -K5,K6
2090 DRAW 0,0
2100 DRAW K5,K6
2110 K7=1+2↑-6
```

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```
2120 FOR R2=R2 TO R2+K1 STEP 6
2130    DRAW K7*COS(R2),K7*SIN(R2)
2140 NEXT R2
2150 DRAW -K5,K6
2160 K$=CHR(8)

2170 REM 4TH:  LABEL TRIANGLE

2180 R2=2*(K1=>45)-1
2190 MOVE 0,0.5
2200 PRINT USING "4(A),3D,"" DEG""":K$;K$;K$;K$;K1
2210 MOVE 0.5*K5,0.5*R2*K6
2220 PRINT " R = ";
2230 K7=K2
2240 GOSUB 2390
2250 MOVE 0,1.04
2260 PRINT K$;K$;K$;K$;"ARC = ";
2270 K7=K3
2280 GOSUB 2390
2290 IF ABS(K6-0.5)>0.07 THEN 2310
2300 R2=-1
2310 MOVE 0,R2*K6
2320 PRINT K$;
2330 K7=K4
2340 GOSUB 2390
2350 PRINT "↑KI      PRESS ""RETURN"" TO CONTINUE.GK    ";
2360 INPUT K$
2370 RUN

2380 REM  ***************SUBR TO PRINT K7**********

2390 IF K7=>1000 OR K7<1 THEN 2450
2400 IF K7<10 THEN 2430
2410 PRINT USING "3D,S":K7
2420 RETURN
2430 PRINT USING "D.D,S":K7
2440 RETURN
2450 PRINT USING "2E,S":K7
2460 RETURN

2470 REM

2480 PRINT "JJJNO SOLUTIONGGGGGGGGGGG"
2490 RUN
2500 PRINT "JJJTWO ENTRIES REQUIREDGGGGGGGGGGG"
```

TITLE	ABSTRACT NUMBER
CIRCLE SOLUTIONS	51/00-5502/0

2510 RUN